**SUSITNA**
**HYDROELECTRIC PROJECT**

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114



# RESPONSE OF AQUATIC HABITAT SURFACE AREAS TO MAINSTEM DISCHARGE IN THE TALKEETNA-TO-DEVIL CANYON SEGMENT OF THE SUSITNA RIVER, ALASKA

PREPARED BY

Trihey & Associates
Aquatic Resource Specialists

FINAL REPORT

UNDER CONTRACT TO

HARZA-EBASCO
SUSITNA JOINT VENTURE

NOVEMBER 1985
DOCUMENT No. 2945



**Alaska Power Authority**

Document No. 2945
Susitna File No. 4.3.1.3



SUSITNA HYDROELECTRIC PROJECT

# Response of Aquatic Habitat Surface Areas to Mainstem Discharge in the Talkeetna-to-Devil Canyon Segment of the Susitna River, Alaska

By

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Under Contract To

Harza-Ebasco Susitna Joint Venture

Prepared For

Alaska Power Authority

Final Report

November 1985

NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

ACKNOWLEDGEMENTS

This work was undertaken in cooperation with the Alaska Department of Fish and Game Susitna Hydro Aquatic Study Team and R & M Consultants, Inc., Anchorage, Alaska. ADF&G SuHydro personnel participated in the derivation of definitions for the various habitat types and the development of the aquatic habitat classification key. The aerial photography missions were scheduled through Mr. Steve Bredthauer, R & M Consultants, Inc. He did an exceptional job given the highly variable nature of streamflow and weather conditions. Aerial photography was flown and photo mosaics and enlargements prepared by Air Photo Tech, Inc., and North Pacific Aerial Surveys, Inc., Anchorage, Alaska, under contract to the Harza-Ebasco Susitna Joint Venture.



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# PREFACE

The goal of the Alaska Power Authority in identifying environmentally acceptable flow regimes for the proposed Susitna Hydroelectric Project is the maintenance of existing fish resources and levels of production. This goal is consistent with mitigation goals of the U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game. Maintenance of naturally occurring fish populations and habitats is the preferred goal in agency mitigation policies.

In 1982, following two years of baseline studies, a multi-disciplinary approach to quantify effects of the proposed Susitna Hydroelectric Project on existing fish habitats and to identify mitigation opportunities was initiated. The Instream Flow Relationships Studies focuses on the response of fish habitats in the middle Susitna River to incremental changes in mainstem discharge, temperature and water quality. As part of this multi-disciplinary effort, a technical report series was planned that would (1) describe the existing fish resources of the Susitna River and identify the seasonal habitat requirements of selected species, and (2) evaluate the effects of alternative project designs and operating scenarios on physical processes which most influence the seasonal availability of fish habitat.

The summary report for the IFRS, the Instream Flow Relationships Report (IFRR), (1) identifies the biologic significance of the physical processes evaluated in the technical report series, (2) integrates the findings of the technical report series, and (3)provides quantitative relationships and discussions regarding the influences of incremental changes in streamflow, stream temperature, and water quality on fish habitats in the middle Susitna River on a seasonal basis.

The IFRR consists of two volumes. Volume I uses project reports, data and professional judgement available before March 1985 to identify evaluation species, important life stages, and habitats. The report ranks a variety of physical habitat components with regard to their degree of influence on fish habitat at different times of the year. This ranking considers the biologic requirements of the evaluation species and life stage, as well as the physical characteristics of different habitat types, under both natural and anticipated with-project conditions. Volume II of the IFRR will address the third objective of the IFRR and provide quantitative relationships regarding the influences of incremental changes in streamflow, stream temperature and water quality of fish habitats in the middle Susitna River on a seasonal basis.

The influence of incremental changes in streamflow on the availability and quality of fish habitat is the central theme of the IFRR Volume II analysis. Project induced changes in stream temperature and water quality are used to condition or qualify the forecasted responses of fish habitat to instream hydraulics. The influence of streamflow on fish habitat will be evaluated at the microhabitat level and presented at the macrohabitat level in terms of a composite weighted usable area curve. This composite curve will describe the combined response of fish habitat at all sites within the same representative group to incremental changes in mainstem discharge.

Four technical reports are being prepared by E. Woody Trihey and Associates in support of the IFRR Volume II analysis. The function of each report is depicted in a flow diagram and described below.

1. Quantify Wetted Surface Area Response

2. Assess the Representativeness of Modeled and Non-modeled Sites

3. Determine Site Specific Hydraulic Conditions

4. Quantify Streamflow Dependent Habitat Response Functions for Juvenile Chinook and Spawning Chum Salmon

1. RESPONSE OF AQUATIC HABITAT SURFACE AREAS TO MAINSTEM DISCHARGE IN THE TALKEETNA-TO-DEVIL CANYON SEGMENT OF THE SUSITNA RIVER, ALASKA

    This report identifies five aquatic habitat types within the middle Susitna River directly influenced by changes in mainstem discharge and presents the necessary photography and surface area measurements to quantify the change in wetted surface area associated with incremental decreases in mainstem discharge between 23,000 and 5,100 cfs. The report also describes the influence of mainstem discharge on habitat transformations and tabulates the wetted surface area responses for 172 specific areas using the ten representative groups presented in the Habitat Characterization Report. Surface area measurements presented in this report provide a basis for extrapolating results from intensively studied modeling sites to the remainder of the middle Susitna River.

2. CHARACTERIZATION OF AQUATIC HABITATS IN THE TALKEETNA-TO-DEVIL CANYON SEGMENT OF THE SUSITNA RIVER, ALASKA

    This report describes the characterization and classification of 172 specific areas into ten representative groups that are hydrologically, hydraulically and morphologically similar. Emphasis is placed on the transformation of specific areas from one habitat type to another in response to incremental decreases in mainstem discharge from 23,000 cfs to 5,100 cfs. Both modeled and non-modeled sites are classified and a structural habitat index is presented for each specific area based upon subjective evaluation of data obtained through field reconnaissance surveys. Representative groups and structural habitat indices presented in this report provide a basis for extrapolating habitat response functions developed at modeled sites to non-modeled areas within the remainder of the river.

3. HYDRAULIC RELATIONSHIPS AND MODEL CALIBRATION PROCEDURES AT 1984 STUDY SITES IN THE TALKEETNA-TO-DEVIL CANYON SEGMENT OF THE SUSITNA RIVER, ALASKA

    This report describes the influence of site-specific hydraulic conditions on the availability of habitat for juvenile chinook and spawning chum salmon. Two aquatic habitat models are applied to quantify site-specific habitat responses to incremental changes in depth and velocity for both steady and spatially varied streamflow conditions. Summaries of site-specific stage-discharge and flow-discharge relationships are presented as well as a description of data reduction methods and model calibration procedures. Weighted usable area forecasts are provided for juvenile chinook at eight side channel sites and for spawning chum salmon at 14 side channel and mainstem sites. These habitat response functions provide the basis for the instream flow assessment of the middle Susitna River.

4. RESPONSE OF JUVENILE CHINOOK AND SPAWNING CHUM SALMON HABITAT TO MAINSTEM DISCHARGE IN THE TALKEETNA-TO-DEVIL CANYON SEGMENT OF THE SUSITNA RIVER, ALASKA

    This report integrates results from the surface area mapping, habitat characterization, and hydraulic modeling reports to provide streamflow dependent habitat response functions for juvenile chinook and spawning chum salmon. Wetted surface area and weighted usable area are the principal determinants of habitat indices provided in Part A of the report for juvenile chinook at each specific area and the ten representative groups identified in the habitat characterization report. Part B of this report provides habitat response functions for existing chum salmon spawning sites. The habitat response functions contained in this report will be used for an incremental assessment of the rearing and spawning potential of the entire middle Susitna River under a wide range of natural and with-project streamflows.

## INTRODUCTION

The proposed Susitna hydroelectric project will alter the natural streamflow regime of the Susitna River downstream of River Mile 232, the upstream most extent of the Watana Impoundment. The river segment upstream from the Chulitna River confluence (Talkeetna) at River Mile 98 would experience notable alterations in naturally occurring streamflow patterns due to its proximity to the proposed dam sites and the limited amount of influence that tributary inflows have on total discharge in this river segment. With-project discharges are expected to be lower than naturally occurring flows during summer and higher than naturally occurring flows in the winter. These altered flows are expected to affect the amount and seasonal availability of aquatic habitats.

This report identifies the location and describes the areal extent of various aquatic habitat types within the Talkeetna-to-Devil Canyon segment of the Susitna River (hereafter referred to as the middle Susitna River) at different mainstem discharges. These data, in combination with the results of other studies focusing on biological aspects of aquatic habitats within this river segment, will facilitate forecasting the effects of project-induced changes to natural streamflows on the availability of aquatic habitat for anadromous and resident fish.

Aerial photography interpretation, along with field reconnaissance, is being used to identify and map various aquatic habitat types in the middle Susitna River. In 1984 initial work on aquatic habitat mapping and surface area measurements determined the location and amount of various aquatic habitat types. Four sets of aerial photographs were taken at mainstem discharges of 23,000; 16,000; 12,500; and 9,000 cfs, as measured at the U. S. Geological Survey (USGS) Gold Creek gaging station (Klinger and Trihey 1984). These photos are discussed in this report (with the exception of the 9,000 cfs photography) together with the surface area measurements at four additional streamflows: 18,000, 10,600, 7,400, and 5,100 cfs. The 18,000 cfs discharge falls within the 16,000 to 23,000 cfs range, where several side sloughs and side channels become inundated by mainstem water. The lower three discharges provide a good basis for evaluating low flow conditions in the river.

The surface area measurements obtained in 1984 from the 9,000 cfs photography were omitted from this report because the presence of snow and ice in the 9,000 cfs photography made it difficult to accurately determine the water's edge and measure the wetted surfaces (Klinger and Trihey 1984) (also see Discussion). The adverse influence of shoreline ice and snow cover on the accuracy of the 9,000 cfs data set was confirmed in a comparison between the 1984 surface area measurements obtained from the 9,000 cfs photography and the 1985 surface area data obtained at 7,400 and 10,600 cfs (Klinger 1985).

Surface area measurements for the seven discharges evaluated in this report provide an adequate basis for identifying the transformation of specific areas from one habitat type to another as a result of reductions in streamflow, as well as for quantifying the response of wetted surface area for habitat types and specific areas over the range of streamflows between 5,000 and 23,000 cfs. However, although wetted surface area may be used as an indicator of habitat availability, it does not represent habitat quality. This report, therefore, does not contain any statements concerning the suitability of the various habitat types for fish, nor does it contain conclusions regarding the response of habitat quality to changes in mainstem discharge.

## METHODS

### Habitat Type Designations

The total wetted surface area of the middle Susitna River was classified into six general aquatic habitat types: mainstem, side channel, side slough, upland slough, tributary mouth, and tributary. These habitat types were established during ice-free conditions from physical characteristics of the environment visually evident in aerial photography or helicopter overflights and do not necessarily depend upon any particular degree of utilization by fish (Figure 1). A description of the types follows.

The following brief descriptions were used to identify the six aquatic habitat types evaluated in this study. These definitions are limited to visually recognizable physical characteristics present during ice-free conditions that are easily identified during helicopter reconnaissance flights.

Mainstem habitat types are those channels of the river that normally convey streamflow throughout the entire year. They are visually recognizable by their turbid, glacial water and high velocities. In general, they convey more than 10 percent (approximate) of the total flow passing a given location.

Side Channel habitat types are also characterized by turbid, glacial water. Velocities often appear lower than in mainstem sites. In general, they convey less than 10 percent (approximate) of the total flow passing a given location. Side channel habitat may exist in well-defined channels or in areas possessing numerous islands and submerged gravel bars. When the upstream berms of side channels are dewatered and the channels contain clear water, they are classified as side sloughs.

Side slough habitat types contain clear water. Small tributaries, upwelling groundwater, and local surface runoff are the primary sources of clear water for these areas. Side sloughs have non-vegetated upper thalwegs that are overtopped during periods of moderate to high mainstem discharge. When these areas are overtopped they convey turbid water and are then classified as side channels.

Upland slough habitat types also contain clear water and depend on small streams, upwelling, and local surface runoff for their water supply. Upland sloughs possess vegetated upper thalwegs that are rarely overtopped by mainstem discharge.

_Tributary mouth_ habitat types are clear water areas that exist where tributaries flow into mainstem or side channel habitats. This habitat type is manifest as a clear water plume extending out into the turbid receiving water. Tributary mouth habitat also extends upstream into the tributary to the upper extent of any backwater influence that might exist. The surface area of tributary mouth habitat is affected both by tributary discharge and mainstem stage.

_Tributary_ habitat types are those reaches of tributary streams upstream of the tributary mouth habitats. Tributary habitat types have not been evaluated in this analysis because tributary habitat is not influenced by mainstem discharge.

Non-wetted areas were classified as either vegetated islands or gravel bars. Areas within the control corridor that were quantified but not relevant to the surface area analysis were classified as "background." For a more detailed description of each aquatic habitat type see the Alaska Department of Fish and Game Susitna Hydro Aquatic Studies (1983).

## Field Methods

For the seven mainstem discharges studied in the middle Susitna River, black-and-white aerial photographs were obtained at an approximate scale of 1 inch = 1000 feet, with a 60 percent overlap between adjacent photos. The dates of the photography and mainstem discharges as measured at the USGS Gold Creek gaging station (No. 15292000) at the time of photography are presented in Table 1.

Table 1. Dates and mainstem discharges at which aerial photography of the middle Susitna River was obtained.

| Date | Discharge (cfs) |
|---|---|
| 6-1-82 | 23,000 |
| 8-24-80 | 18,000 |
| 9-11-83 | 16,000 |
| 9-6-83 | 12,500 |
| 9-9-84 | 10,600 |
| 10-4-84 | 7,400 |
| 10-14-84 | 5,100 |

Helicopter reconnaissance flights were conducted over the middle Susitna River at mainstem discharges similar to those at which the aerial photography was obtained. During each of these reconnaissance flights, aquatic habitat types were identified using the key presented as Figure 1, and their locations were mapped on 1 inch = 1000 feet scale blueline prints of the Susitna River. Dewatered gravel bars and streambank areas were sketched on the blueline prints as were boundaries of the various habitat types.

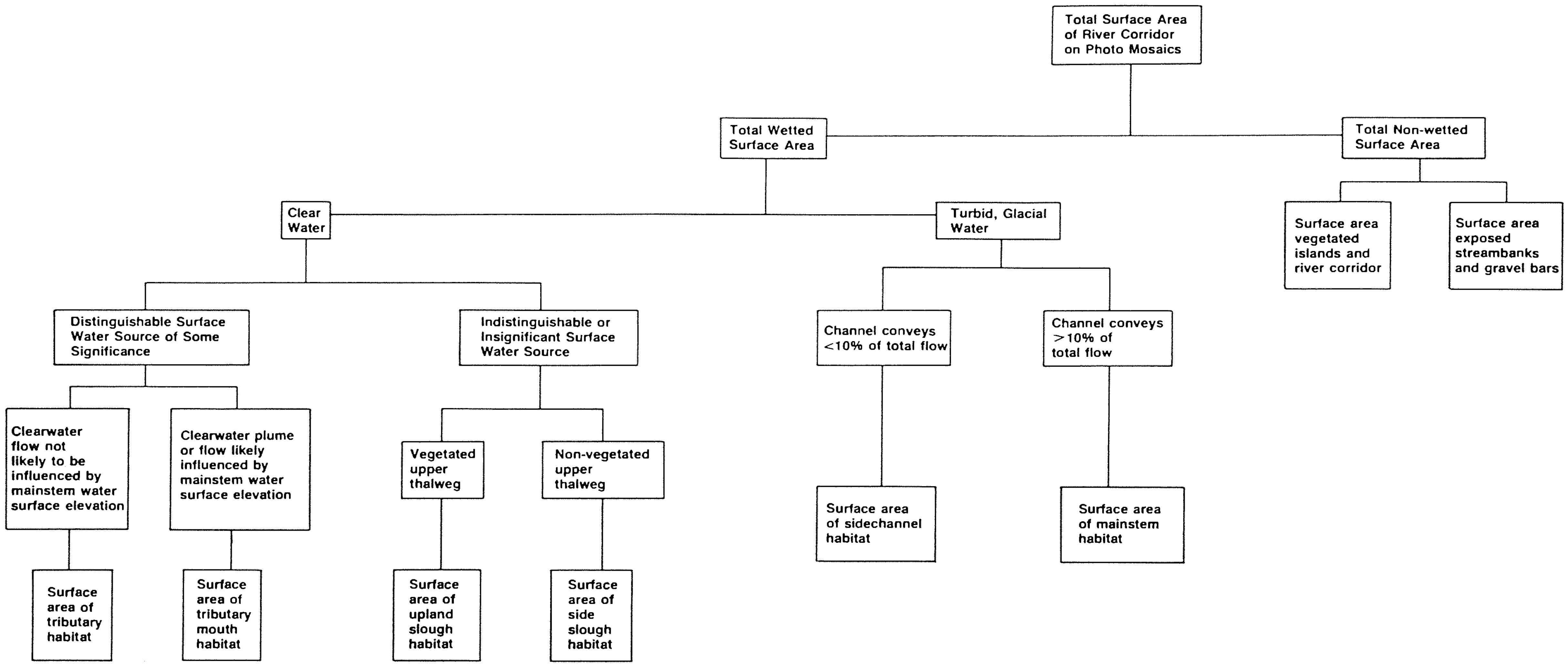


Figure 1. Key to aquatic habitat classification for the middle Susitna River (RM 101 to 149).

## Office Procedures

### Photo Plates and Enlargements

Photographic mosaics were prepared from the overlapping black-and-white photos to provide continuous 1 inch = 1000 feet coverage for each of the seven discharges. The photo mosaics were subdivided into eighteen sections of approximately the same length, with a small amount of overlap between adjoining river sections and a set of eighteen 4-1/2 inch by 15 inch photoplates was printed for each of the seven discharges (Appendix 1). For the sets of photography taken at 23,000; 18,000; 16,000; and 12,500 cfs, each photo plate was carefully examined and areas that were too small in size to provide detailed resolution were enlarged to a scale of 1 inch = 250 feet. Entire sets of photography taken at 10,600; 7,400; and 5,100 cfs, were enlarged to a scale of 1 inch = 250 feet.

### Habitat Type Boundaries

Aquatic habitat boundaries mapped on blueline prints during the helicopter reconnaissance flights were transferred to corresponding sets of photographs. Figure 2 provides an example of the technique used for the photography taken at 23,000; 18,000; 16,000; and 12,500 cfs. The technique used for the photography taken at 10,600; 7,400; and 5,100 cfs was essentially the same, with the exception that enlargement areas were not required because the entire set of photography was printed at the scale of 1 inch = 250 feet. Matchlines were drawn on adjoining photo plates to ensure that habitat areas within overlapping sections near the edges of the plates were not counted twice. The boundary of each enlargement area was established using prominent topographic features in the photography and drawn on both the plate and the individual enlargement. This ensured that areas within the enlargement could be summed and compared with the enlargement area on the plate.

The external boundaries of the total area to be included in the surface area analysis (control area) were defined on each plate, so that sub-areas within the control area could be totaled and compared with the total control area of that plate. In many cases, it was necessary to go beyond the river channel boundaries to establish an identifiable constant control area boundary. The area located between the control area boundary and the river channel was digitized (see below) as "background" (refer to Figure 2b).

In addition to delineating habitat type boundaries, individual channels, referred to as "specific areas," were also delineated and digitized. This enabled the habitat type at a given location to be tracked at different mainstem discharges. Close examination of the habitat type mapping revealed that habitat type at a given location may not remain the same over a range of discharges. In general, the geographical location and persistence of certain habitat types, such as tributaries and their mouths, are fixed, although their surface areas may respond significantly to changes in discharge. In other cases, transformations of one habitat type into another may occur as river stage increases or decreases. For more detailed description of the methodology and results of the habitat transformation analysis see Appendix 2.

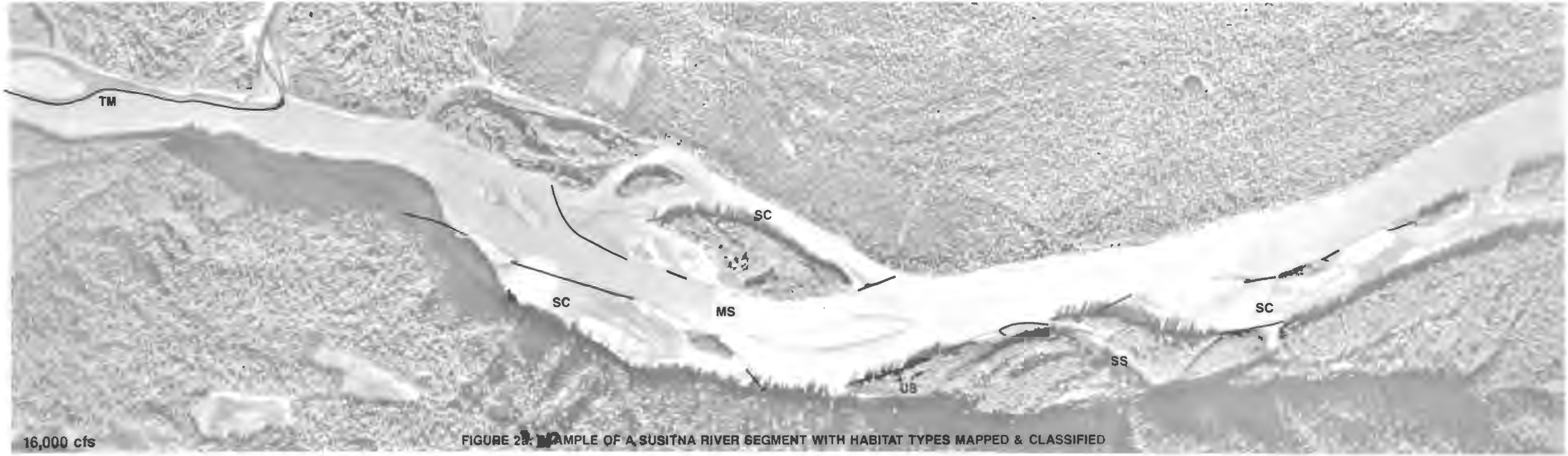


FIGURE 2a: EXAMPLE OF A SUSITNA RIVER SEGMENT WITH HABITAT TYPES MAPPED & CLASSIFIED

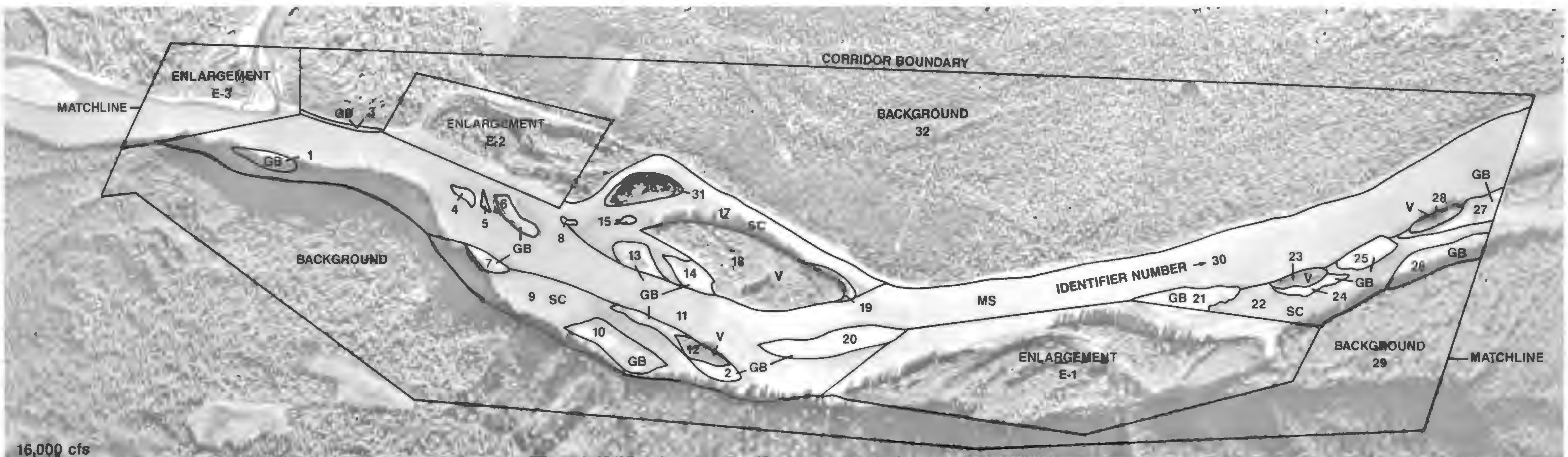


FIGURE 2b: EXAMPLE OF THE RIVER SEGMENT AS DELINEATED PRIOR TO DIGITIZING.

## Digitizing

In this report, digitizing refers to the process of calculating the area within a perimeter circumscribed on the aerial photographs. Area calculations were made using a Numonics Model 2400 DigiTablet and Electronic Graphics Calculator connected to an Epson HX-20 Notebook Computer. Prior to digitizing each photo plate and enlargement, boundaries were drawn around each wetted and non-wetted habitat element. By tracing the perimeter of a given area with the Numonics DigiTablet cursor, the area circumscribed is calculated by the Graphics Calculator to an accuracy of 0.01 square inch. This accuracy is greater than that of delineation and operator tracing error.

Digitizing strategy consisted of digitizing the control area, the enlargements (if any) and elements within the control area. If enlargements were present, the total area of the enlargement was digitized, followed by the elements within it. Each area calculation was performed twice. If the percent error between the two measurements was greater than five percent, the area was redigitized until the percent agreement was less than five. An interactive computer program was developed for the HX-20 which prompted the digitizing operator for the plate number, flow code, control area number, enlargement number (if any), enlargement factor, habitat code, element number, specific area river mile number, and the digitized area (transferred from the Graphics Calculator). The program checked percent agreement for each measurement and performed the summation of elements for comparison with the initial control area measurement.

## Data Base

Surface area measurements that had been stored on the Epson magnetic tape cassettes were transferred into a computerized data base for storage, sorting, and subsequent analysis. Each individual surface area measurement was entered as a separate record that enabled identification by discharge, photograph (corresponding to a river mile index), individual area number, and specific area river mile number, if appropriate.

Correction factors were entered to standardize to a common scale of 1 inch = 1000 feet. Due to prevailing weather factors at the time of the aerial photography flights, slight variations in scale occurred in the various photo sets. Surface areas within enlargement areas and for those sets of photos printed entirely at the enlarged scale were divided by a factor of 16 to account for the fourfold difference in scale between 1 inch = 250 feet and 1 inch = 1000 feet.

## Analysis Procedures

Surface areas were summed by habitat type for the entire river corridor between Talkeetna and Devil Canyon for each of the seven discharges. Percentages of the total river surface area represented by each aquatic habitat type were calculated. Surface areas of individual channels (specific areas) were also determined.

Localized changes in channel geometry which occurred as a result of high flow events in 1981 (Klinger-Kingsley and Trihey 1985) resulted in some inconsistent surface area measurements for the 18,000 cfs photography. These inconsistencies were considered an artifact of using photography obtained before and after a major flood event. The 18,000 cfs photography is the only pre-1981 condition analyzed, whereas post-1981 conditions are represented by six sets of photography with flows ranging from 5,100 to 23,000 cfs.

Because the change in surface area of aquatic habitat is a function of discharge and channel geometry, the middle Susitna River was subdivided into four subsegments, each possessing somewhat different geomorphological characteristics. RM 101 to 113 (Talkeetna-to-Lane Creek) is a relatively channelized subsegment of the middle river with few mid-channel vegetated islands or gravel bars and few side channels branching off from the mainstem. RM 113 to 122 (Lane Creek-to-Curry) is a more braided subsegment with mid-channel islands and side channels branching from the mainstem. RM 122 to 138 (Curry-to-Gold Creek) is a braided subsegment with large mid-channel islands and gravel bars and numerous side channels branching off from the mainstem. RM 138 to 149 (Gold Creek-to-Devil Canyon) is a more channelized subsegment with some large side channels branching off from the mainstem. Total surface areas of each habitat type within these subsegments were determined to focus attention on the diversity of habitat types and surface area responses among subsegments with different morphologic characteristics.

The percent change in habitat type surface area between that present at 23,000 cfs and at the other discharges of interest was calculated. Average monthly discharges for the Susitna River at Gold Creek range from 1,500 cfs in winter to 28,000 cfs during summer with an average annual discharge of 9,700 cfs (Figure 3a). Snowmelt runoff during June and early July accompanied by glacial melt and rainfall runoff during July and August provide stable and persistent high summer discharges (Figure 3b, c, d). From an analysis of the hydrologic data, it was determined that the aerial photography obtained at a mainstem discharge of 23,000 cfs represents a typical mid-summer discharge for the middle Susitna River. Therefore, this photography was used to depict baseline mid-summer conditions.

## RESULTS

Total surface areas for aquatic habitat types in the middle Susitna River are presented in Table 2. In some cases, such as for tributaries and their mouths, habitat type is associated with specific geographical location and the habitat type persists over a broad range of streamflows even though the surface areas may respond significantly to changes in discharge. In other instances, specific geographic locations transform from one habitat type into another as river stage increases or decreases.

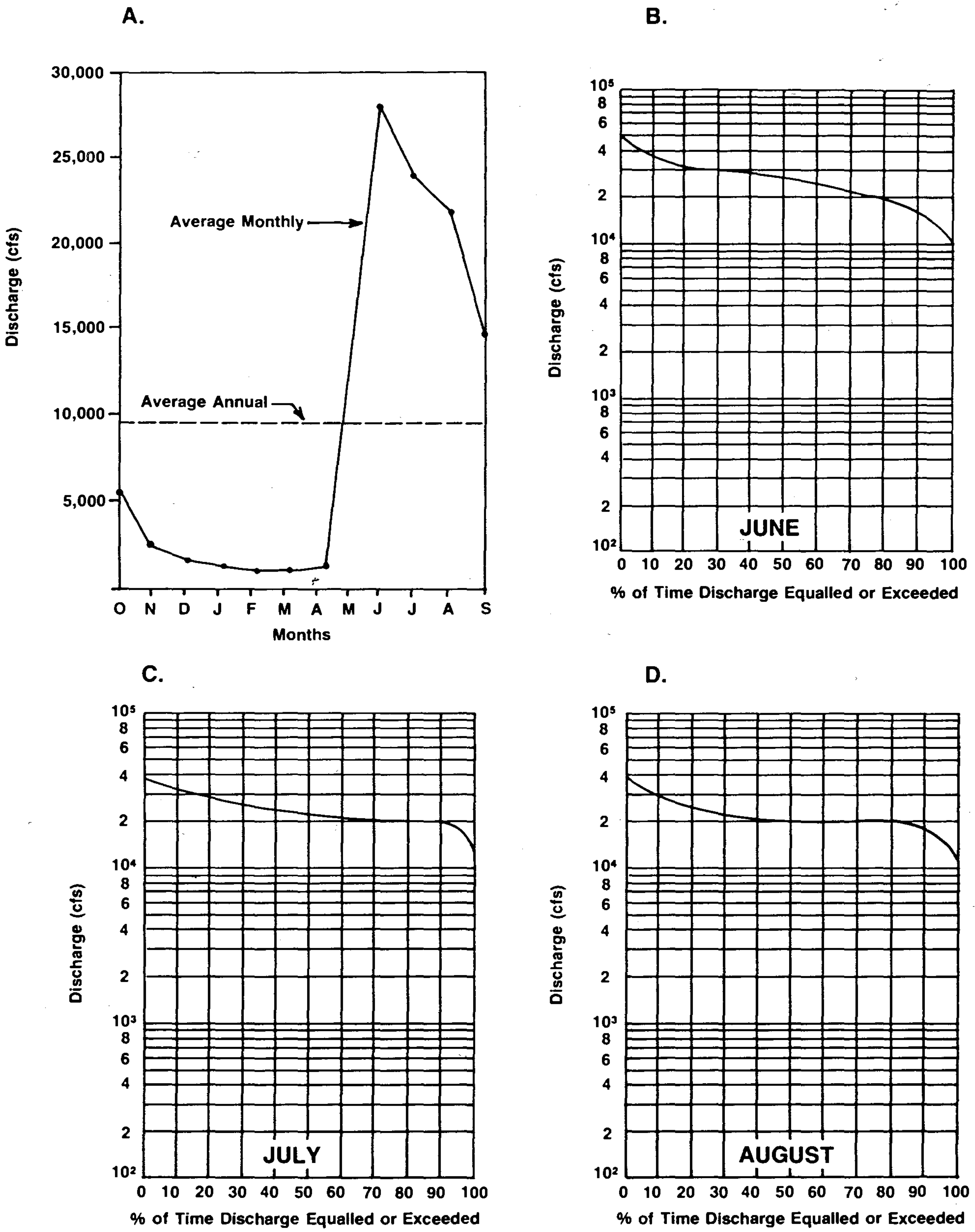


Figure 3. Average annual discharge and average monthly discharges for the Susitna River at Gold Creek (adapted from Scully, Leveen, and George 1978); b,c,d. Monthly flow duration curves for the Susitna River at Gold Creek (adapted from Acres American Inc. 1983).

Surface area values presented in Table 2 were plotted to illustrate the surface area responses of individual habitat types in response to changes in mainstem discharge (Figure 4). Surface areas of mainstem and side channel habitats were smaller at lower discharges. Concurrently, exposed gravel bar surface areas were larger at lower discharges.

Side slough surface area increased with decreasing discharge down to a mainstem discharge of 7,400 cfs, and then decreased at 5,100 cfs. Upland slough surface area remained relatively constant over the range of mainstem discharges, decreasing somewhat at 5,100 cfs. Surface area of tributary mouth habitat was largest at intermediate flows of 16,000 and 12,500 cfs. Vegetated bar surface area remained relatively constant over the range of mainstem discharges.

Examination of the data reveals inconsistent surface area measurements for side channel and side slough habitat types for the 18,000 cfs photography. Side channel surface area is lower and side slough surface area is higher than values expected from interpolation between data points at 16,000 and 23,000 cfs. Examination of flow records for the middle Susitna River reveal that July and August 1981 were periods of relatively continuous high flow events (Klinger-Kingsley and Trihey 1985). In addition, comparison of stage-discharge relationships prepared before and after July-August 1981 shows a 0.25 ft. reduction in stage for equivalent discharges (USGS 1972, 1982). This suggests that scouring occurred during the high flow events of 1981. This is consistent with the observation of less side slough and more side channel habitat surface area measured on post-1981 photography. As channels were scoured, lower mainstem discharges would be required to overtop the head berms, resulting in more side channel surface area and less side slough surface area at a given discharge after 1981 than prior to 1981.

Table 3 presents the percentage of the total river corridor represented by each habitat type for each of the seven mainstem discharges. Table 4 presents the percent change in the surface area of each habitat type at each discharge as calculated from a baseline discharge of 23,000 cfs.

The middle Susitna River was divided into four subsegments based upon differing geomorphological characteristics. These subsegments extend from approximately river miles (RM) 101 to 113, 113 to 122, 122 to 138, and 138 to 149. Because of differences in the amount of surface area within each river subsegment and the desire to accent the response of habitat surface areas within the river subsegments, surface areas for the various habitat types are reported as the percent of total area in the subsegment river corridor (Figure 5). Figure 6 presents a relative comparison of total surface areas calculated for various habitat types within the entire Talkeetna-to-Devil Canyon segment and within the four subsegments in response to changing mainstem discharge.

Table 2. Total surface areas by habitat type within the middle Susitna River.

| Habitat Type | Surface Area (acres) by Discharge | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5,100 cfs | 7,400 cfs | 10,600 cfs | 12,500 cfs | 16,000 cfs | 18,000 cfs | 23,000 cfs |
| Mainstem | 2453.0 | 2595.1 | 2789.8 | 2850.4 | 3158.5 | 3316.0 | 3737.2 |
| Side Channel | 768.2 | 854.0 | 982.9 | 1095.5 | 1222.2 | 952.0 | 1240.7 |
| Side Slough | 118.8 | 145.6 | 134.8 | 118.1 | 85.8 | 116.1 | 52.5 |
| Upland Slough | 16.4 | 20.8 | 21.5 | 22.0 | 22.6 | 24.6 | 24.4 |
| Tributary Mouth | 15.6 | 15.5 | 18.6 | 26.2 | 25.3 | 18.4 | 12.1 |
| Gravel Bar | 2522.9 | 2299.6 | 1852.4 | 1727.7 | 1419.2 | 1249.4 | 815.8 |
| Vegetated Bar | 1958.5 | 2140.3 | 2079.3 | 1919.1 | 2011.4 | 1985.2 | 1718.4 |

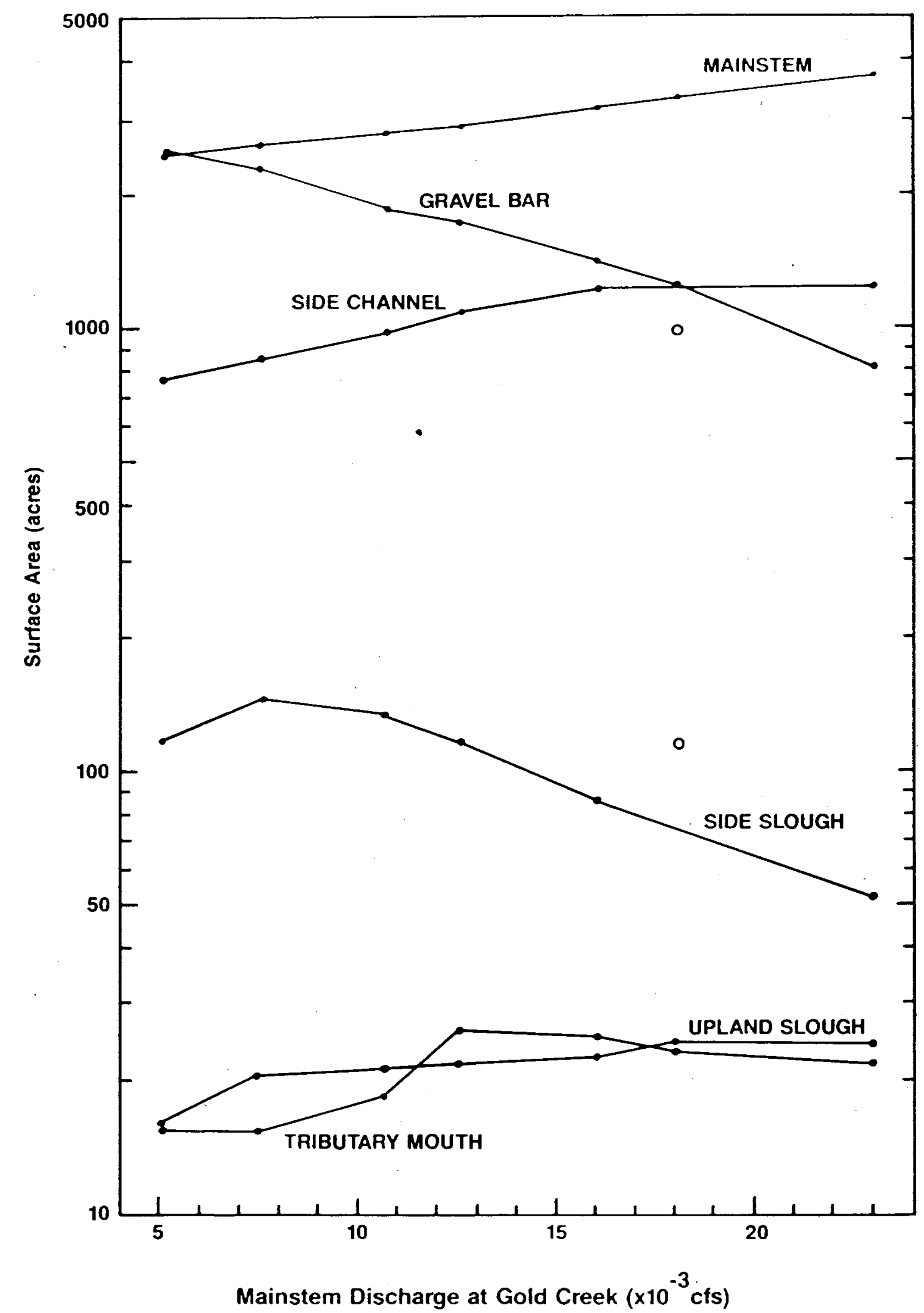


Figure 4. Surface area responses to mainstem discharge in the middle Susitna River (RM 101 to 149).

Table 3. Surface areas by habitat type within the middle Susitna River expressed as a percentage of the total river corridor area.

| | Percentage by Discharge | | | | | | |
|---|---|---|---|---|---|---|---|
| Habitat Type | 5,100 cfs | 7,400 cfs | 10,600 cfs | 12,500 cfs | 16,000 cfs | 18,000 cfs | 23,000 cfs |
| Mainstem | 31.2 | 32.2 | 35.1 | 36.7 | 39.7 | 43.3 | 49.1 |
| Side Channel | 9.8 | 10.6 | 12.5 | 14.1 | 15.4 | 12.4 | 16.3 |
| Side Slough | 1.5 | 1.8 | 1.7 | 1.5 | 1.1 | 1.5 | 0.7 |
| Upland Slough | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| Tributary Mouth | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 |
| Gravel Bar | 32.1 | 28.5 | 23.5 | 22.2 | 17.9 | 16.3 | 10.7 |
| Vegetated Bar | 24.9 | 26.5 | 26.4 | 24.7 | 25.3 | 25.9 | 22.6 |

Table 4. Percent change in digitized surface areas relative to corresponding areas present at 23,000 cfs.

| | Percentage Change by Discharge | | | | | |
|---|---|---|---|---|---|---|
| Habitat Type | 18,000 cfs | 16,000 cfs | 12,500 cfs | 10,600 cfs | 7,400 cfs | 5,100 cfs |
| Mainstem | -11.3 | -15.5 | -23.7 | -25.4 | -30.6 | -34.4 |
| Side Channel | -23.3 | -1.5 | -11.7 | -20.8 | -31.2 | -38.1 |
| Side Slough | 121.1 | 62.8 | 124.1 | 155.8 | 176.3 | 125.4 |
| Upland Slough | 0.8 | -7.4 | -9.8 | -11.9 | -14.8 | -32.8 |
| Tributary Mouth | 52.1 | 109.1 | 116.5 | 53.7 | 28.1 | 28.9 |
| Gravel Bar | 53.2 | 74.0 | 111.8 | 127.1 | 181.9 | 209.3 |

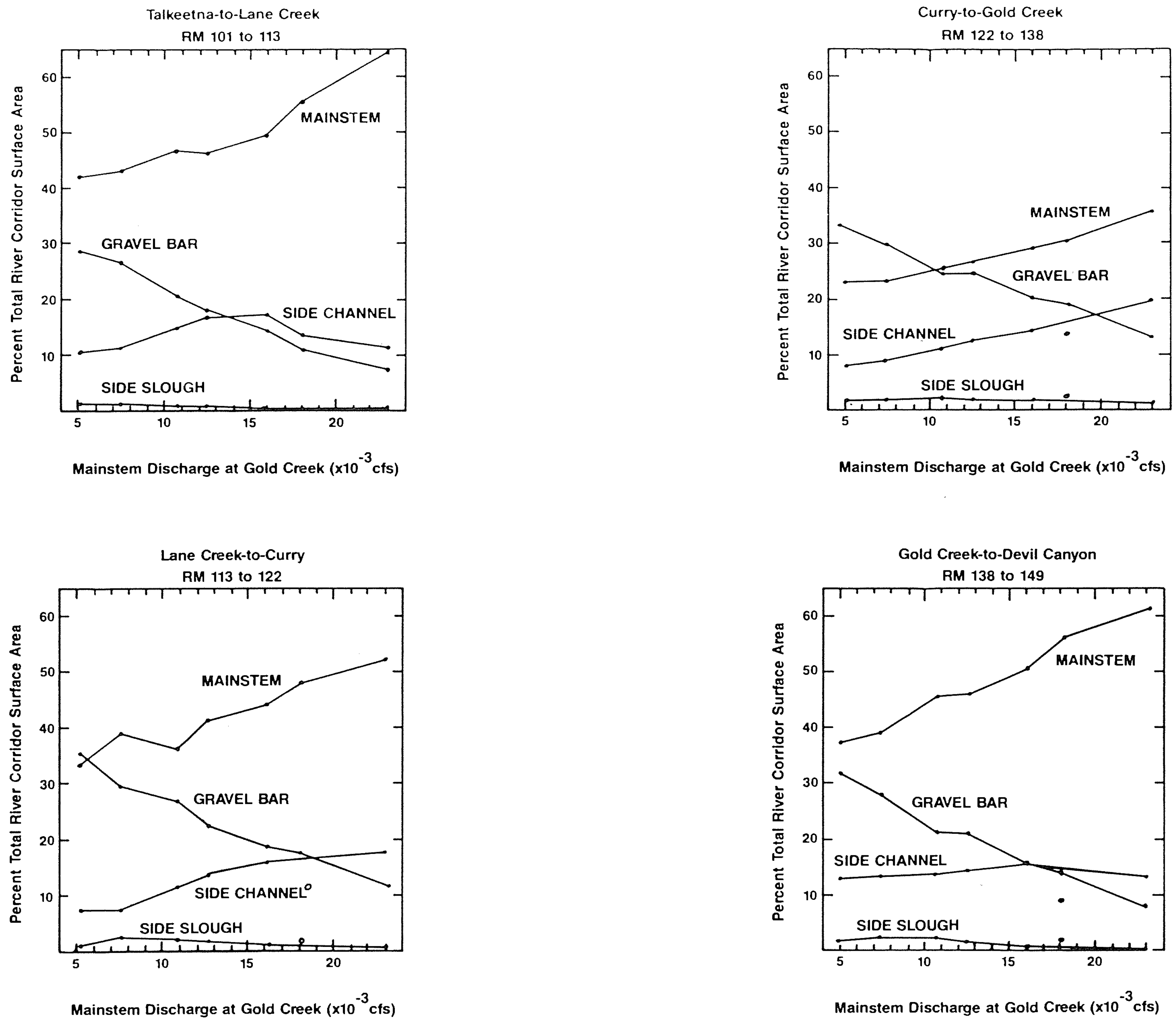


Figure 5. Surface area responses to mainstem discharge expressed as a percentage of the total river corridor surface area within each of four river subsegments.

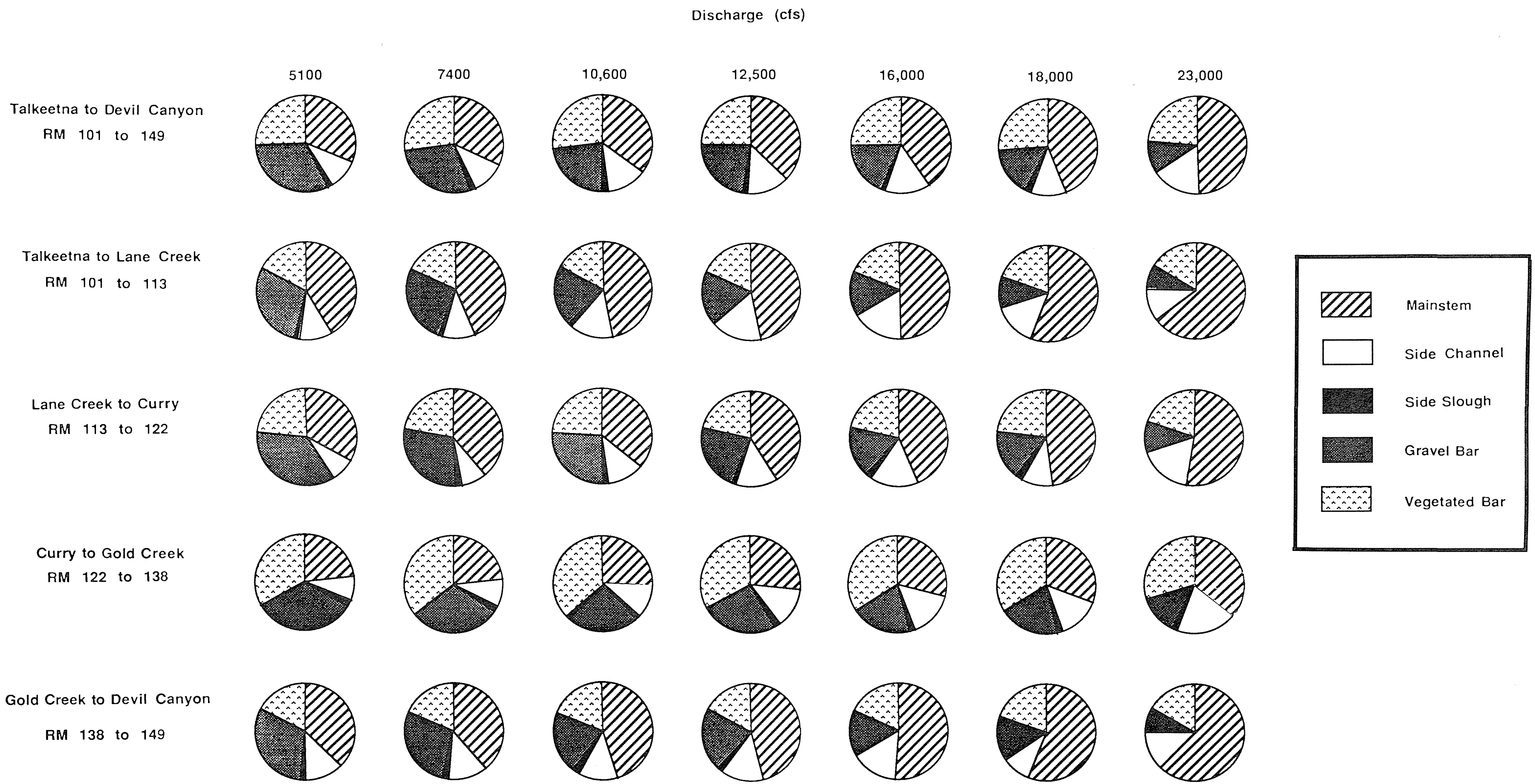


Figure 6. A comparison of relative amounts of the different habitat types comprising various subsegments of the Susitna River at seven mainstem discharges.

DISCUSSION

Air photo interpretation is highly dependent upon the quality of the photography. Although each set of photographs obtained for this study was generally clear and complete, the time of day, date, and prevailing weather conditions at the time the aerial photographic missions were flown affected the extent to which detailed riverine features were visible.

The 23,000 cfs photography, taken on June 1, 1982, was obtained at a time of the year when the sun was at a high angle and decidious vegetation had not fully leafed-out. This resulted in few shadows, enabling excellent delineation of water's edge and slough boundaries. The 7,400 cfs and 5,100 cfs photography, obtained on October 4 and 14, 1984, respectively, have extensive areas of shadows along the south and east shorelines. This was due primarily to the low sun angle during that time of year. These shadows sometimes obscured the water's edge and made some surface area delineations more difficult. The remaining sets of photography had isolated shadow problems. In spite of the minor problems with photographic detail, accurate and reliable surface area measurements were obtained using various techniques to aid in delineations.

Examination of the data suggests otherwise

The 9,000 cfs photography, taken on October 8, 1983, was suspected of providing somewhat erroneous surface area measurements because of prevailing snow and river ice conditions. Mainstem and side channel surface area measurements obtained from the 9,000 cfs photography underestimated total surface area because of the influence of shore ice which reduced wetted top width. Side slough habitat at 9,000 cfs was overestimated in 1983 because the sharp contrast between snow and wet sand made it extremely difficult to accurately define the water's edge. Tributary mouth habitat was underestimated in 1983 because of the difficulty in distinguishing between the clearwater plume of the tributary and the clearing mainstem. Because of these problems with the 9,000 cfs photography and the discrepancies in the surface area data when compared to the 10,600 and 7,400 cfs data, the 9,000 cfs photography and data were not included in this analysis.

Aquatic habitat surface area responses are a function of streamflow and channel geometry. Localized channel geometry changes were observed between the 18,000 cfs photography obtained in 1980 and the remaining six sets of photography taken in 1982-84 (Klinger-Kingsley and Trihey 1985). These appeared to have been the result of high flow events which occurred during July and August 1981. The apparently inconsistent surface area measurements for side channel and side slough habitat types at 18,000 cfs can be explained as a result of scouring which occurred during this period.

Closer examination of the 18,000 cfs data shows a difference of approximately +40 acres between the amount of side slough surface area present on the 18,000 cfs photos versus the amount expected by interpolation between 16,000 and 23,000 cfs. Conversely, a difference of approximately -280 acres is apparent between observed and expected surface area values for side channel habitat at 18,000 cfs. The scouring out of channels could be expected to have resulted in habitat transformations from side slough to side channels at locations where

## DISCUSSION

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Channel morphology changes and habitat transformations are considered a normal occurrence when viewed in the context of long term channel behavior. Studies conducted on braided glacial rivers in New Zealand (Mosley 1982, 1983) indicate that multi-channel river systems typically provide a relatively constant amount of habitat despite the frequent morphological changes the river experiences.

The channel changes and accompanying habitat transformations represent a relatively small percentage of the total wetted surface area of the middle Susitna River. At 23,000 cfs, approximately 5,000 acres of wetted area is present. The 40 acres of side slough habitat which was transformed into side channel habitat represents 0.8 percent of that total wetted area. The additional side channel habitat gained as a result of lateral channel bank cutting or other similar processes represents approximately 4.8 percent of the total wetted surface area. The magnitude of channel changes expected to occur during years exhibiting more typical flow regimes would be expected to be less than these.

Definitions for aquatic habitat types used in this study represent a set of visually recognizable, environmental characteristics that do not restrict the occurrence of a particular habitat type to fixed geographical locations. An example of the flow-dependent nature of these definitions and how habitat transformations may occur is reflected by side slough and side channel habitats. Side sloughs, by definition, are clear water habitats in which the flow is maintained by upwelling and local surface runoff. A non-vegetated alluvial berm at the upstream end of the dewatered overflow channel separates the clear water habitat from the active channel. When mainstem discharge increases and river stage rises, the alluvial berm at the head of the slough is overtopped. Turbid mainstem water flows into the channel and replaces the former clear water habitat with deeper, faster-flowing turbid water. The aquatic habitat at this location then fits the definition of side channel habitat. Conversely, as mainstem discharge decreases, areas classified as side channels may become cut off from mainstem flow at their upstream end and become clear water habitats. If the clear water inflow to these systems is sufficient to maintain a downstream connection with the mainstem, these areas fit the definition of side slough habitat.

General trends in surface area response to mainstem discharge became apparent in this study. As mainstem discharge decreased, the surface area of both mainstem and side channel habitat types decreased. Concurrently, side slough habitat surface area increased with decreasing discharge. The decrease in side slough surface area shown at 5,100 cfs was due to some of the sloughs dewatering at their downstream end leaving remnant, ponded water which was not considered available habitat.

The surface area response of mainstem, side channel, and side slough habitats is not necessarily directly correlated with habitat quality, nor does it directly reflect the amount of usable habitat available. For example, in mainstem and some side channel habitats, velocity and depth may be limiting factors for the distribution of fish. As mainstem and side channel surface areas decrease with decreasing mainstem stage, water depths and velocities in these areas are reduced, possibly making these habitats more suitable for use by fish. Conversely, as mainstem discharge decreases and side slough habitat surface area increases, these already shallow slough areas may become even shallower with very low velocities. Access into these areas may become a problem and/or the shallow depths of the sloughs themselves may result in less than suitable habitat.

Trends in surface area response for tributary mouth habitat were such that surface area was lowest at a mainstem discharge of 23,000 cfs, highest at moderate mainstem discharges and decreased at discharges of 10,600 cfs and below. At 23,000 cfs, the combination of high mainstem stage and water velocities resulted in a shearing off of the clear water plume as it entered the mainstem. Tributary mouth habitat surface area is a function of both mainstem discharge and tributary flow. The decrease in tributary mouth surface area at the lower mainstem discharges probably reflects lower tributary flows. The 5,100 and 7,400 cfs photos were taken in October when tributary flows are very low.

Upland slough surface area remained relatively constant over the range of mainstem discharges investigated. At 5,100 cfs, the low surface area was due to some upland sloughs becoming dewatered at their mouths leaving the sloughs as remnant, ponded areas inaccessible to fish.

At lower mainstem discharges, the combined surface area of clear water habitats was greater than at higher mainstem discharges. For example, a reduction in mainstem discharge from 23,000 to 10,600 cfs (essentially halving the mid-summer flow) results in a 200 percent increase in total clear water surface area with a 50 percent decrease in turbid water surface area, and a 125 percent increase in exposed gravel bars. Even a decrease in discharge from 23,000 to 16,000 cfs results in a 170 percent increase in clear water, primarily due to increased tributary mouth surface area. This increase in clear water may be important for primary and secondary production if these clear water areas remain relatively stable.

It must be re-emphasized here that an increase in clear water surface area is not directly correlated with an increase in suitable fish habitat. Upwelling and intragravel flow have been recognized as strongly influencing the spawning behavior of chum and sockeye salmon in Alaska (Estes and Vincent-Lang 1984). By definition, side sloughs are clear water areas maintained by upwelling. Without field verification, it is difficult to distinguish between true side sloughs and areas containing clear water due to settling out of suspended sediments and possibly dilution by surface water runoff once the upstream berm of a side channel is dewatered.

Different subsegments of the middle Susitna River have different morphology and vary in the relative amounts of wetted areas, gravel bars, and vegetated islands. In all subsegments, mainstem and vegetated island surface areas predominate. The greatest diversity occurs in the Lane Creek-to-Gold Creek subsegment (RM 113 to 138), in which a greater percentage of the total surface area is represented by gravel and vegetated bars. This river subsegment is characterized by a more braided channel pattern. In these areas, the relatively large edge effect due to the numerous islands and gravel bars may result in the greatest potential for creation of more usable habitat along channel margins and in channels with higher streambed elevations as mainstem stage drops and water velocities are reduced. In contrast, the relatively steep-banked, channelized areas of the river where edge effects are minimal, such as from RM 102 to 113, will probably not show as large an increase in potential habitat.

The results of this study can be used to indicate the potential for increase or decrease in the amount of usable habitat by evaluating surface area responses of various habitat types during the open water season and with existing channel geometry. The term usable habitat would include not only fish habitat, but also aquatic habitats suitable for primary and secondary production. However, the limitations of the surface area data generated by this study must be realized. These limitations reflect the strictly physical descriptions of the habitat types defined here.

The results of this study, however, can be applied to both ongoing and future studies which focus more directly on various biological features of aquatic habitats. Habitat reconnaissance work done by Aaserude, et al. (1985) focused on further defining and subdividing habitat types into categories which more specifically define habitat attributes and responses to flow. Fish utilization data (Hoffman 1985) will be applied to the results of the habitat reconnaissance work to provide a measure of the suitability of the various aquatic habitats for use by adult and juvenile salmon.

Measurements of primary production in the middle river are anticipated from AEIDC. This work, in combination with the development of a euphotic surface area response model (Reub, et al. 1985), will address the issue of with-project primary production potential. These studies will provide biological significance to the increase in total surface area of clear water habitats seen in this study as mainstem discharge decreased.

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Appendix 1. Aerial photographs of the middle Susitna River. Aquatic habitat types are delineated at seven mainstem discharges. Prominent topographic features and study sites are identified.



**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

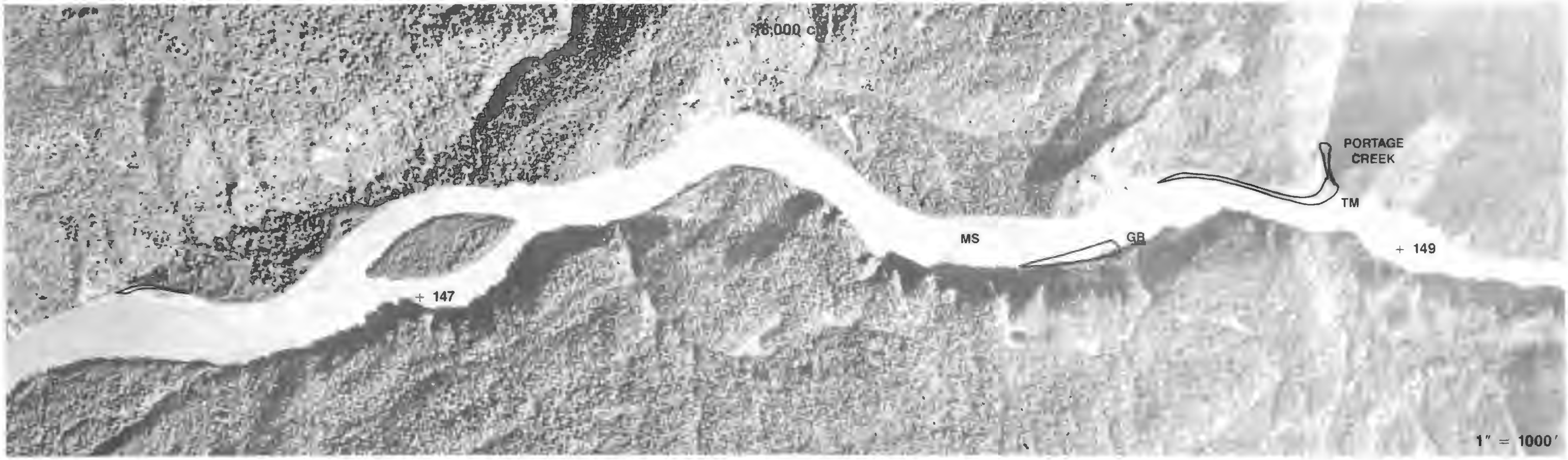
PLATE 1 OF 18 RIVERMILE 147 TO 149

23,000 cfs

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE





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| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 1 OF 18 RIVERMILE 147 TO 149

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

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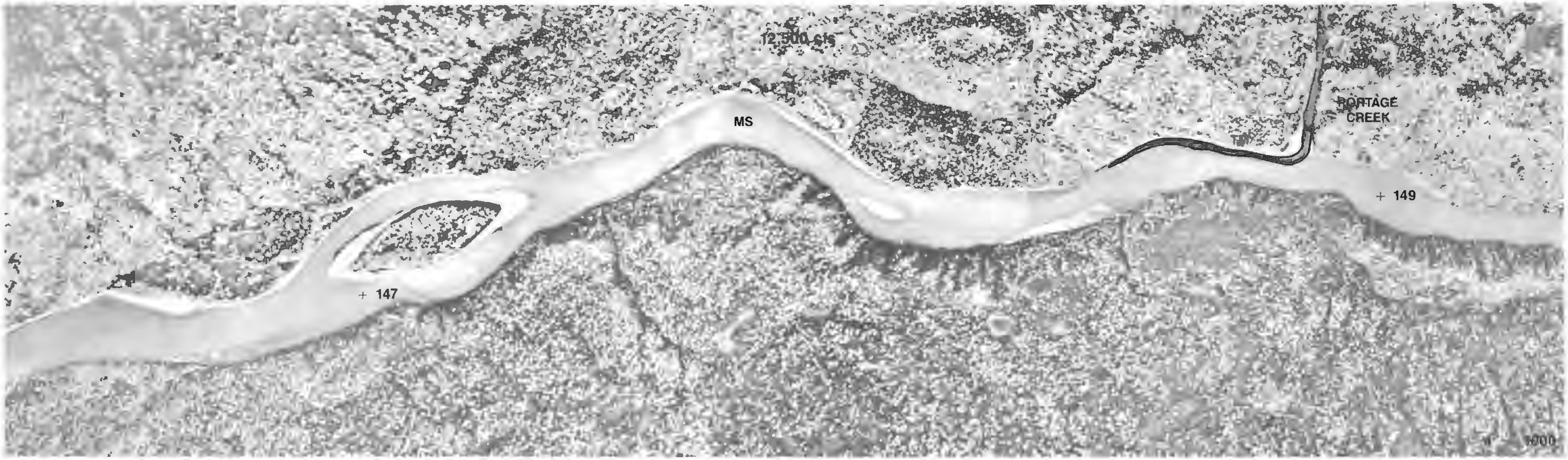
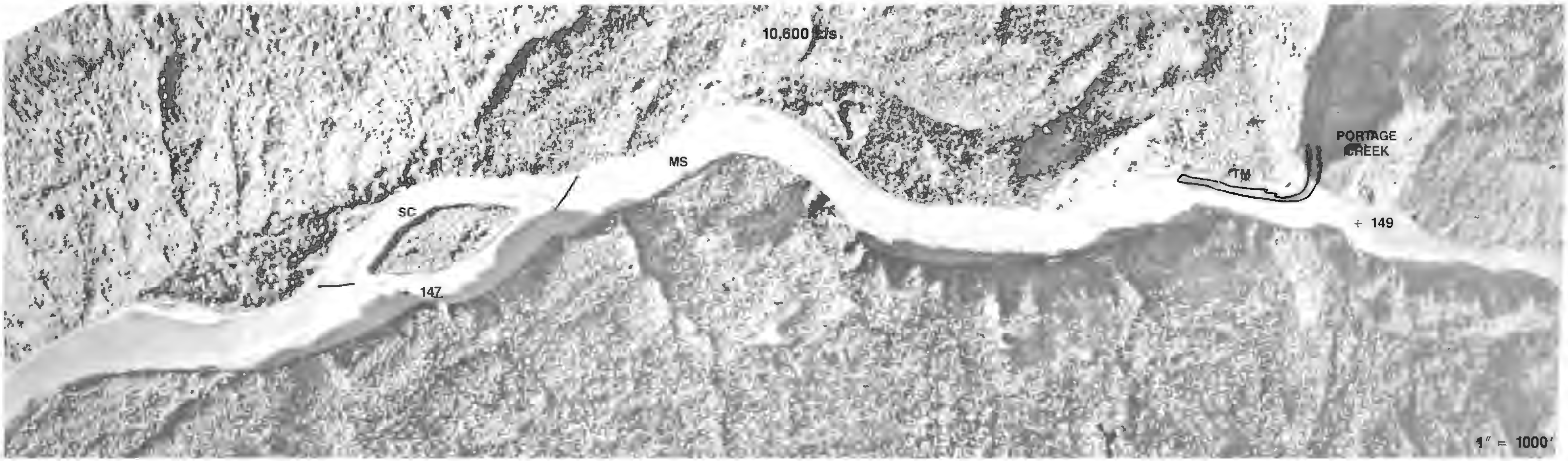
SUSITNA JOINT VENTURE

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| US | UPLAND SLOUGH | | |

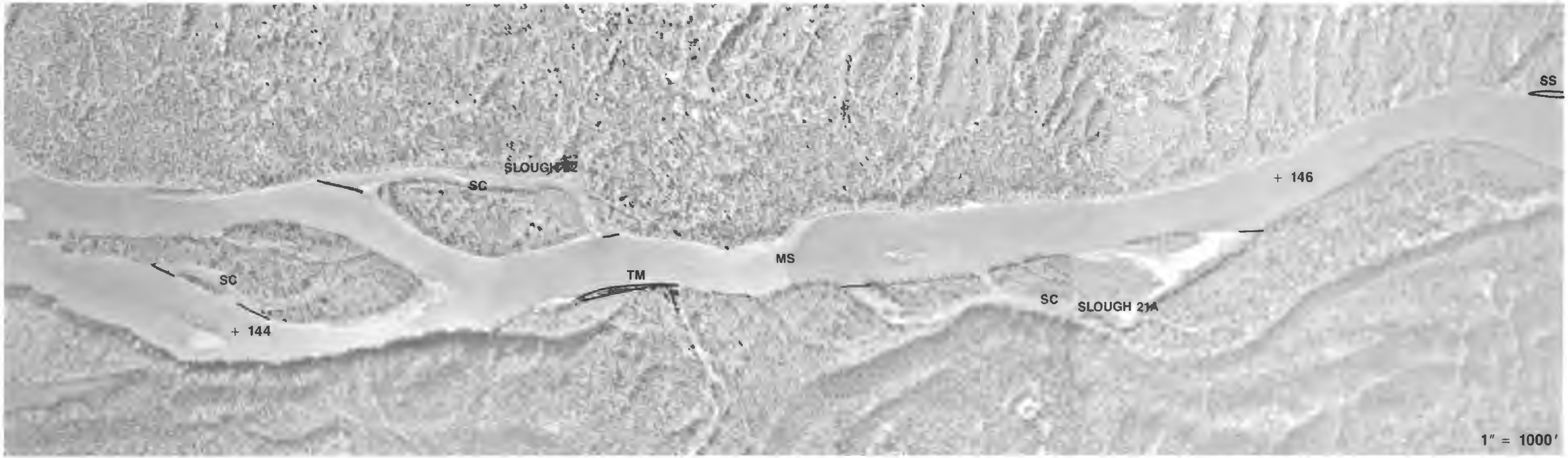
MIDDLE SUSITNA RIVER

PLATE 1 OF 18 RIVERMILE 147 TO 149

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE


## LEGEND

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
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**MIDDLE SUSITNA RIVER**

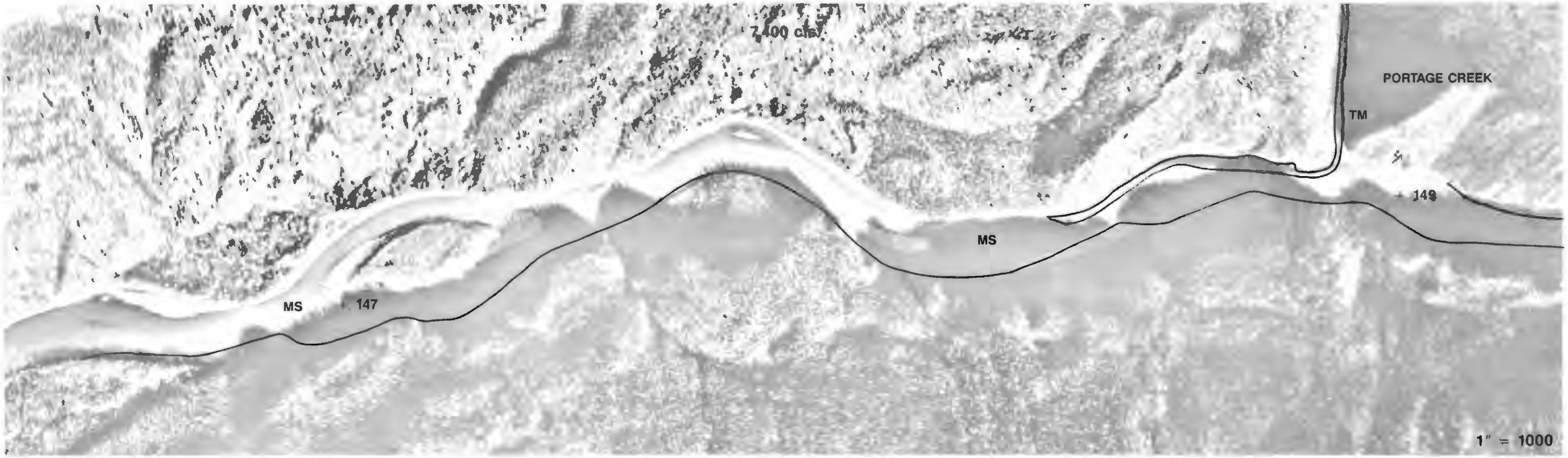
PLATE 2 OF 18 RIVERMILE 144 TO 146

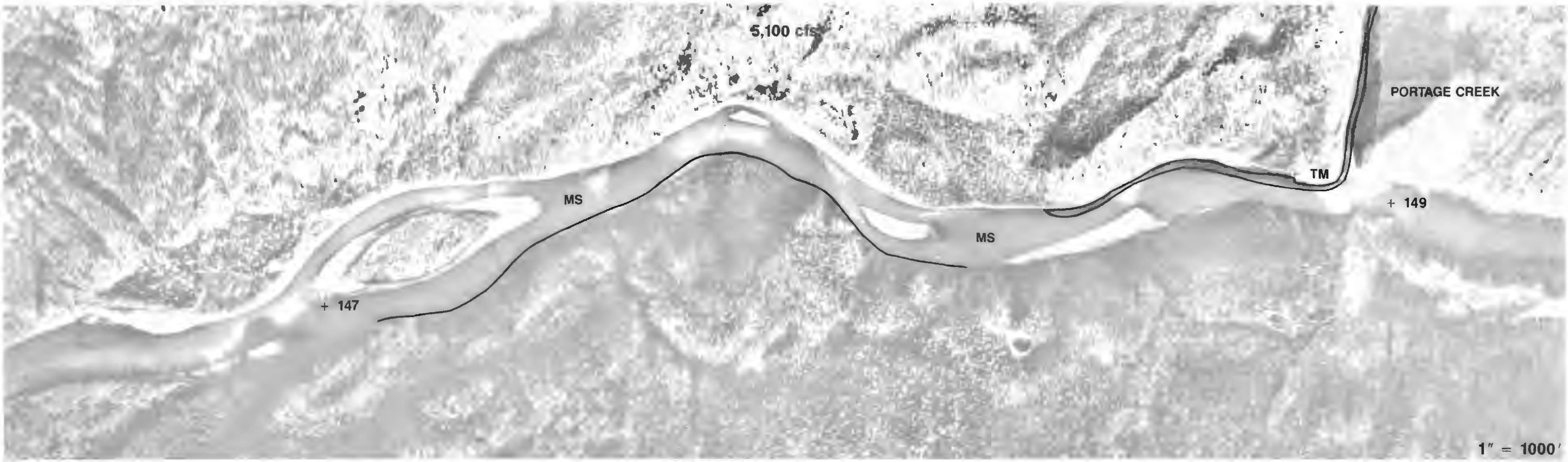
23,000 cfs

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE

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| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 1 OF 18 RIVERMILE 147 TO 149

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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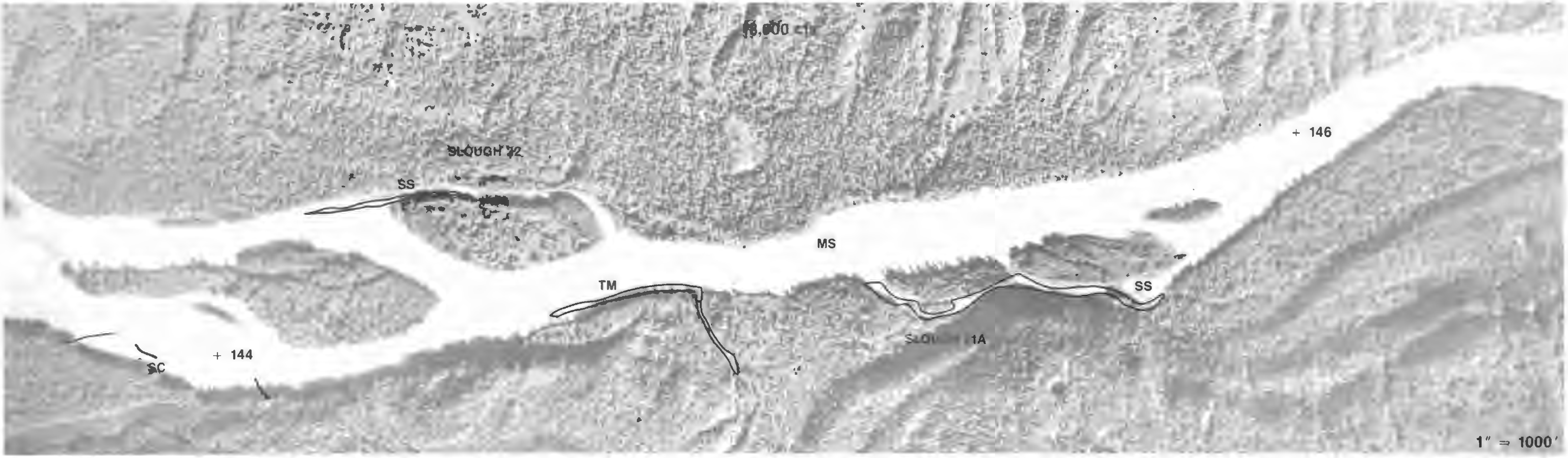
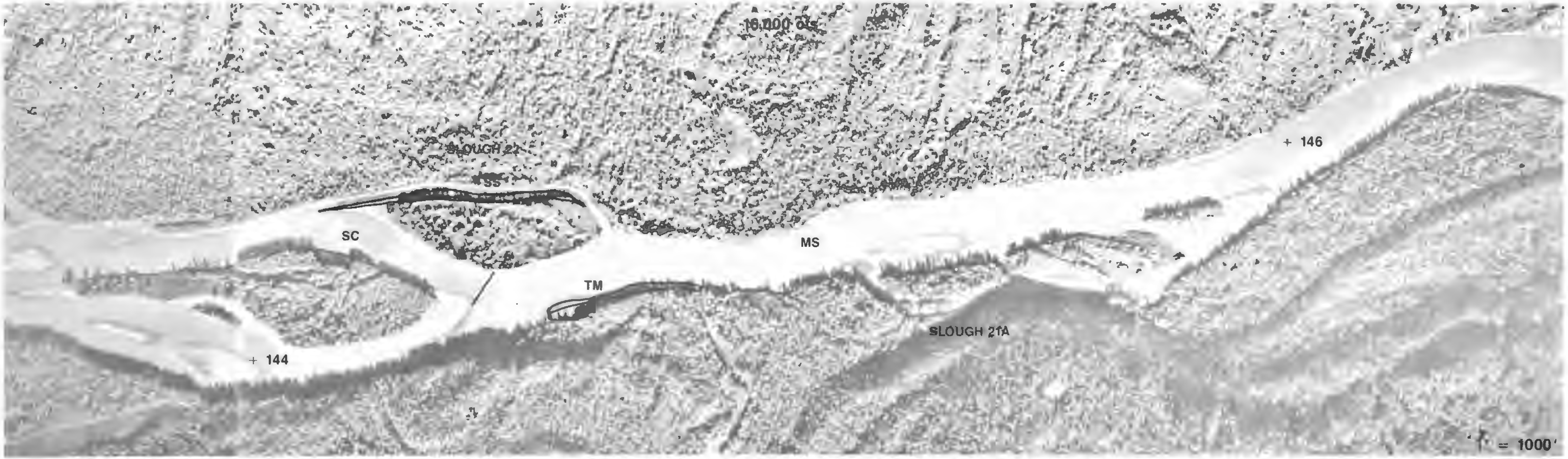
HARZA-EBASCO
SUSITNA JOINT VENTURE

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| US | UPLAND SLOUGH | | |

## MIDDLE SUSITNA RIVER

PLATE 2 OF 18 RIVERMILE 144 TO 146

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
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**MIDDLE SUSITNA RIVER**

PLATE 2 OF 18 RIVERMILE 144 TO 146

**ALASKA POWER AUTHORITY**
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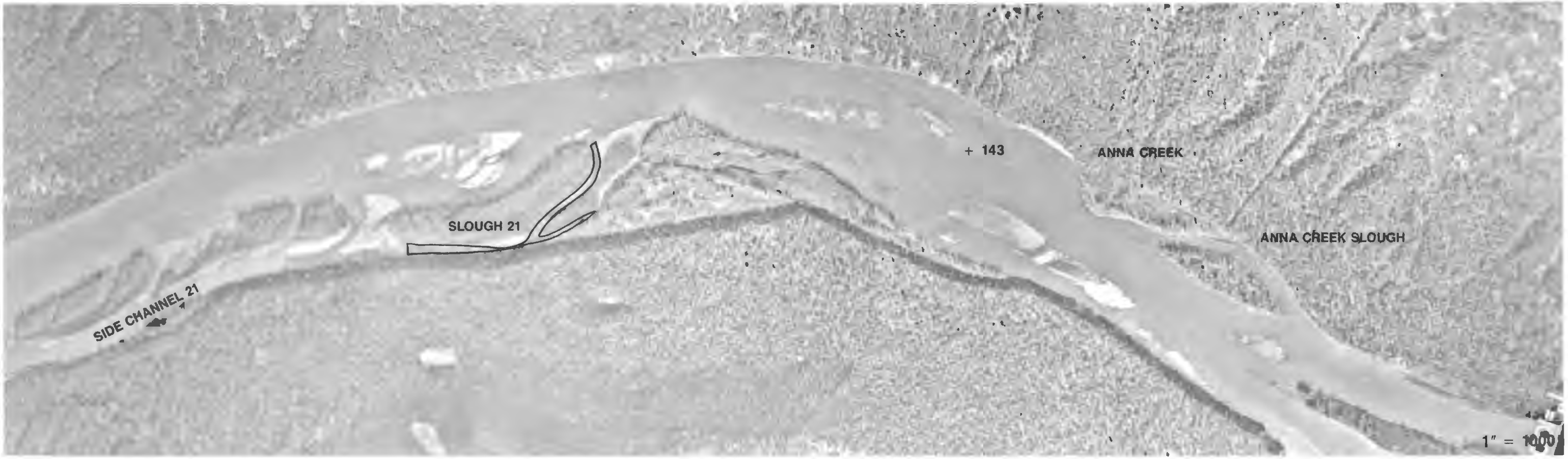


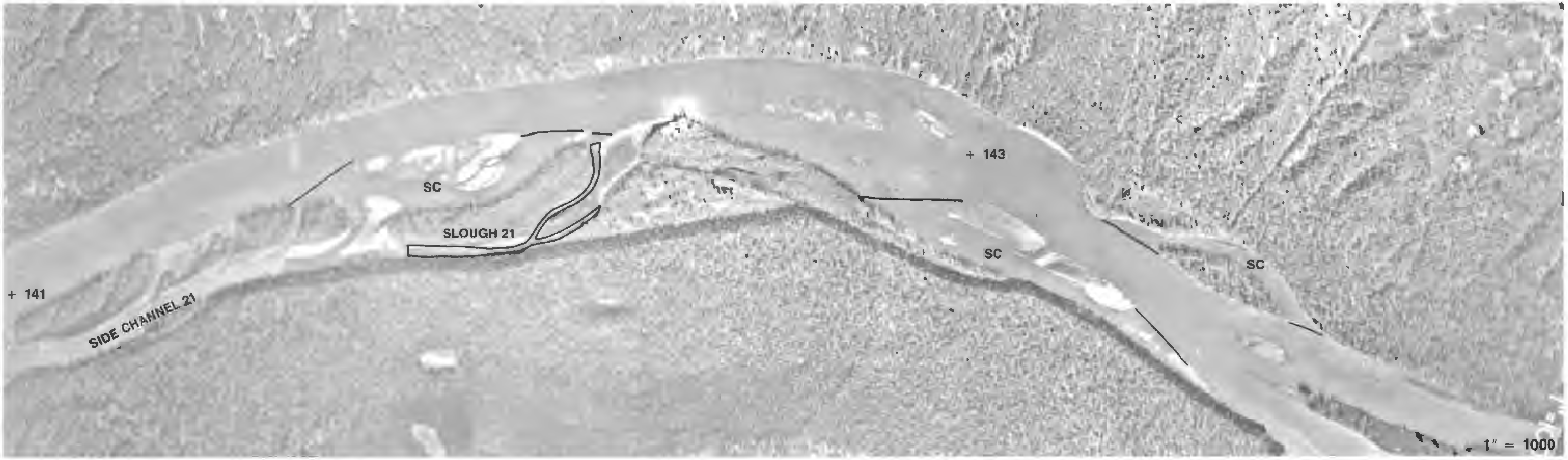


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| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 3 OF 18 RIVERMILE 141 TO 144

23,000 cfs

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
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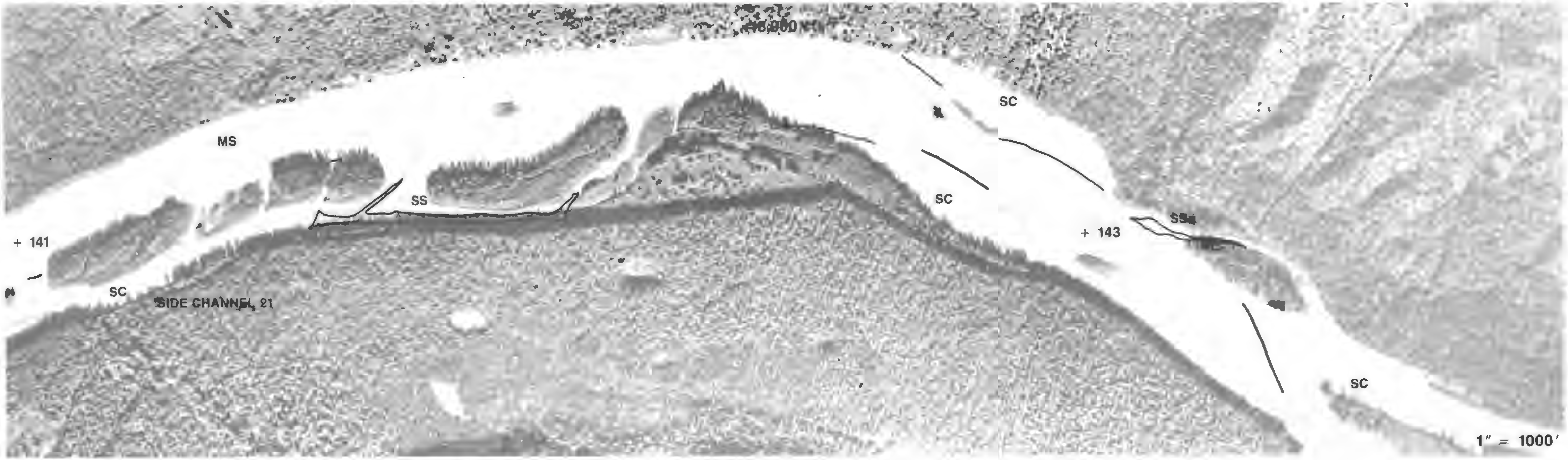
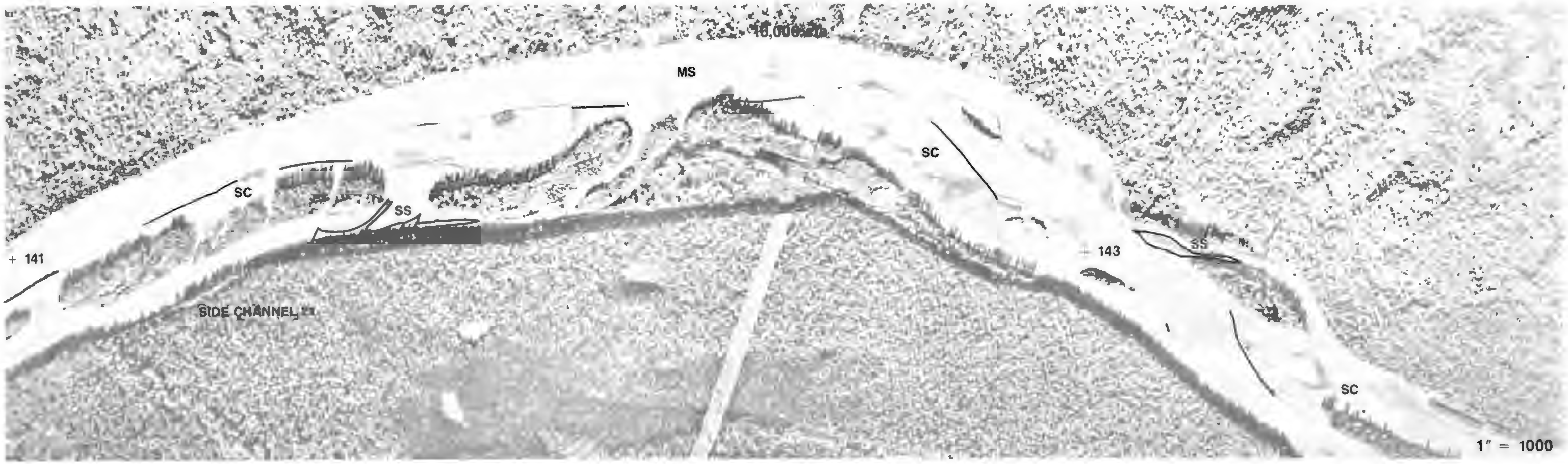
SUSITNA JOINT VENTURE

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| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 3 OF 18 RIVERMILE 141 TO 144

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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Aquatic Resource Specialists

SUSITNA JOINT VENTURE



**LEGEND**

MS MAINSTEM
SC SIDE CHANNEL
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MIDDLE SUSITNA RIVER

PLATE 3 OF 18 RIVERMILE 141 TO 144

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MIDDLE SUSITNA RIVER

PLATE 3 OF 18 RIVERMILE 141 TO 144

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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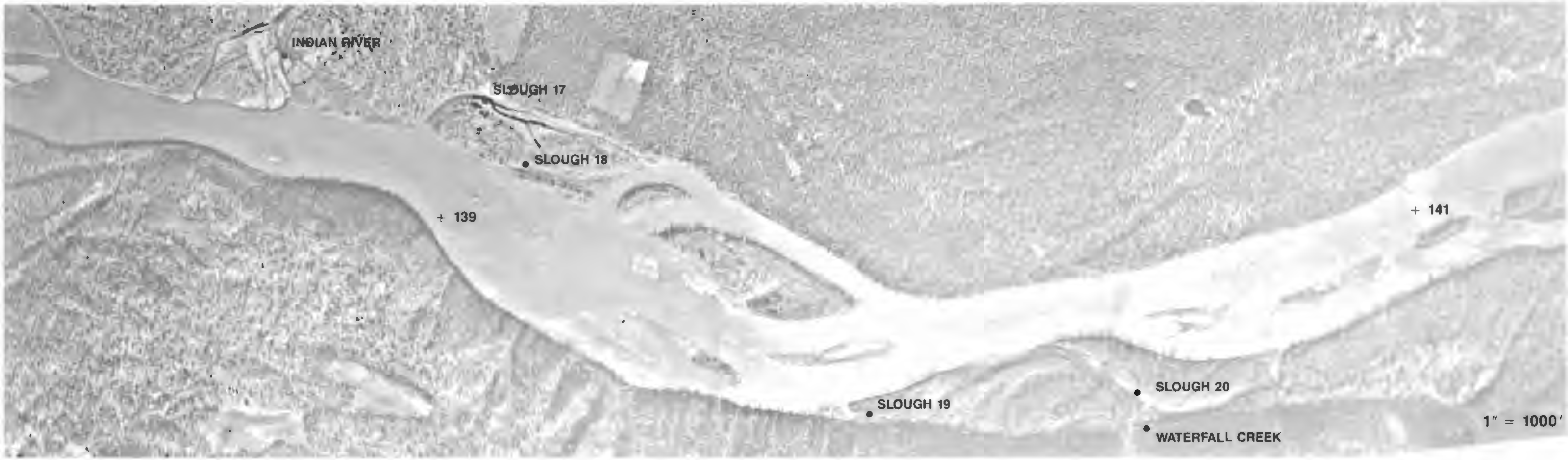


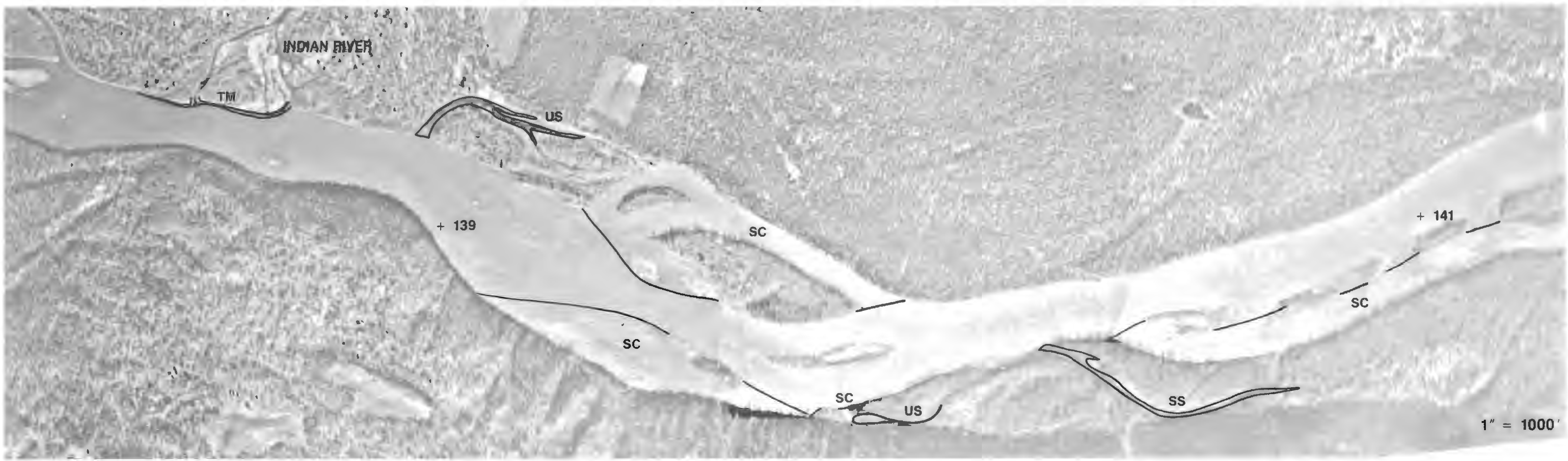


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| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 4 OF 18 RIVERMILE 139 TO 141

23,000 cfs

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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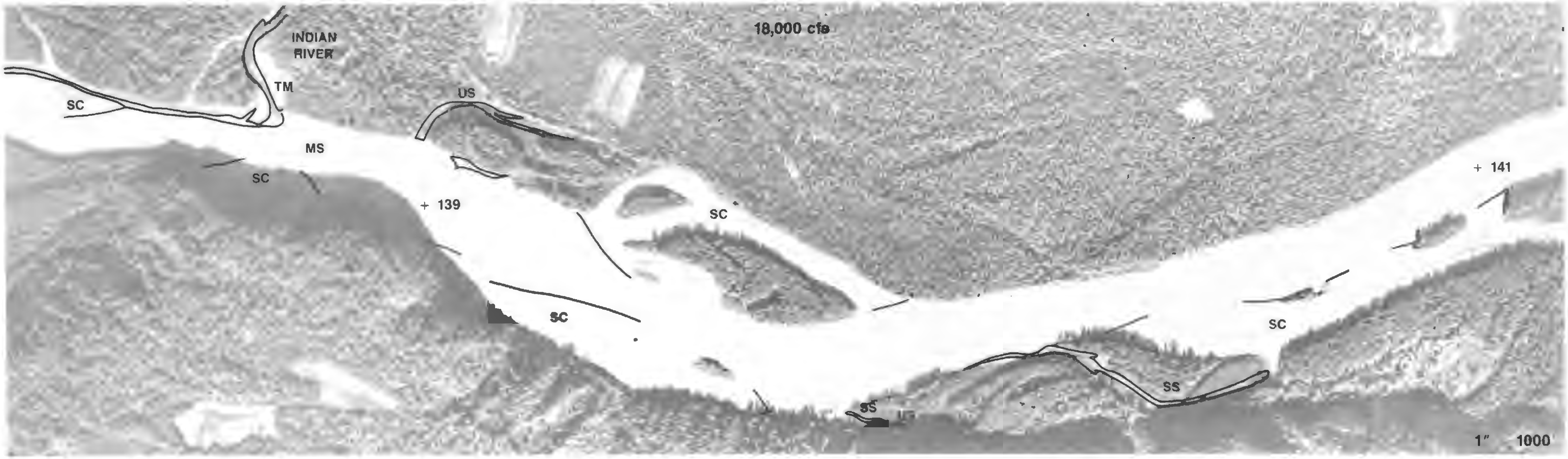



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**MIDDLE SUSITNA RIVER**

PLATE 4 OF 18 RIVERMILE 139 TO 141

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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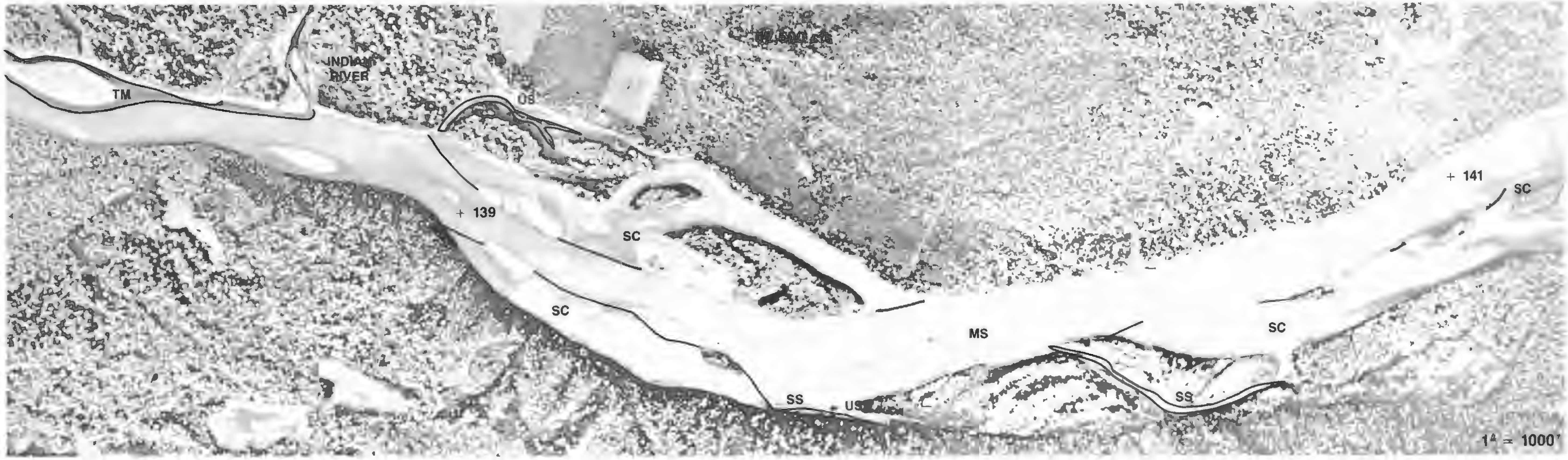
HARZA-EBASCO
SUSITNA JOINT VENTURE





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**MIDDLE SUSITNA RIVER**

PLATE 4 OF 18 RIVERMILE 139 TO 141

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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SUSITNA JOINT VENTURE



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

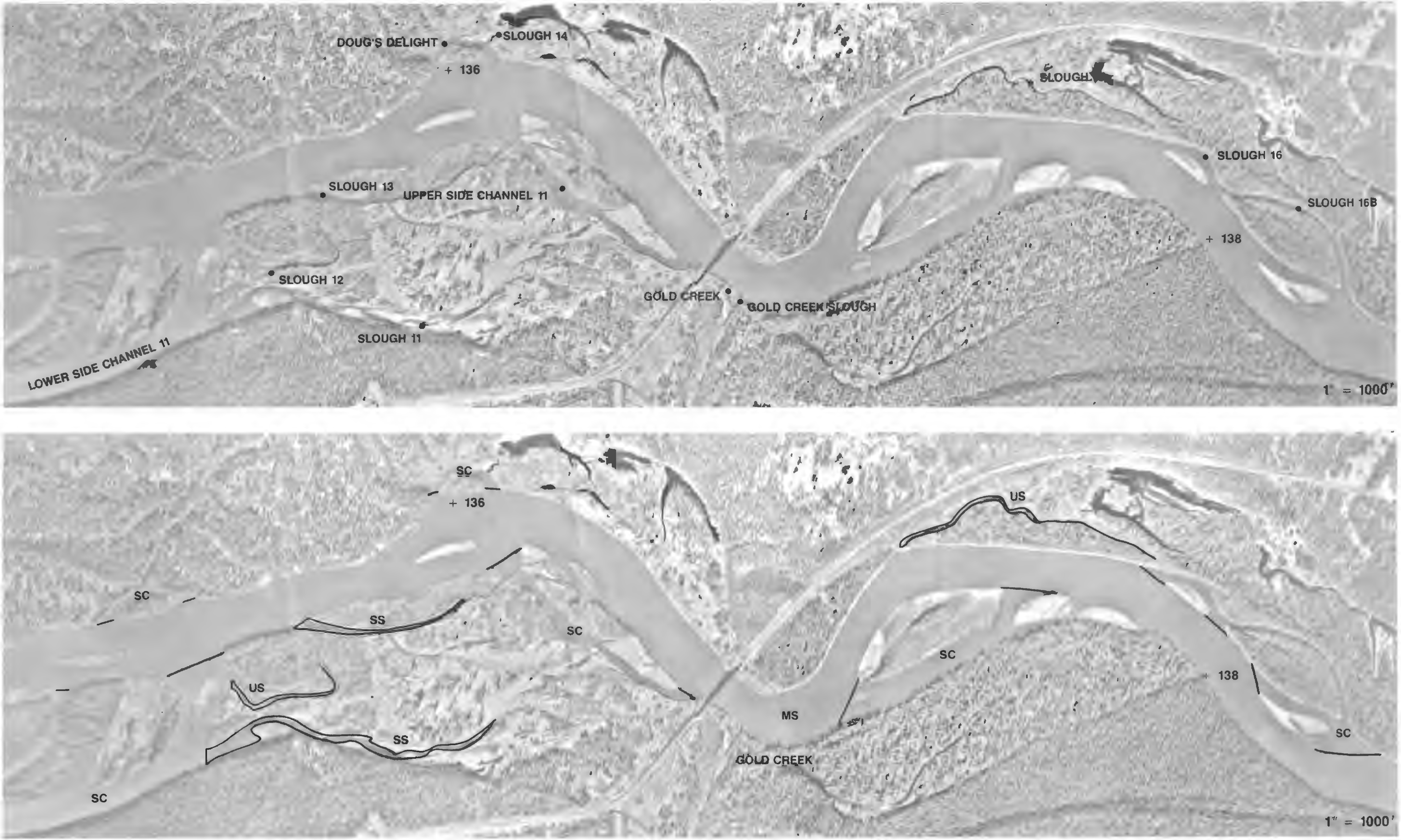
MIDDLE SUSITNA RIVER

PLATE 4 OF 18 RIVERMILE 139 TO 141

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE




## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 5 OF 18 RIVERMILE 136 TO 138

23,000 cfs

**ALASKA POWER AUTHORITY**

SUSITNA HYDROELECTRIC PROJECT

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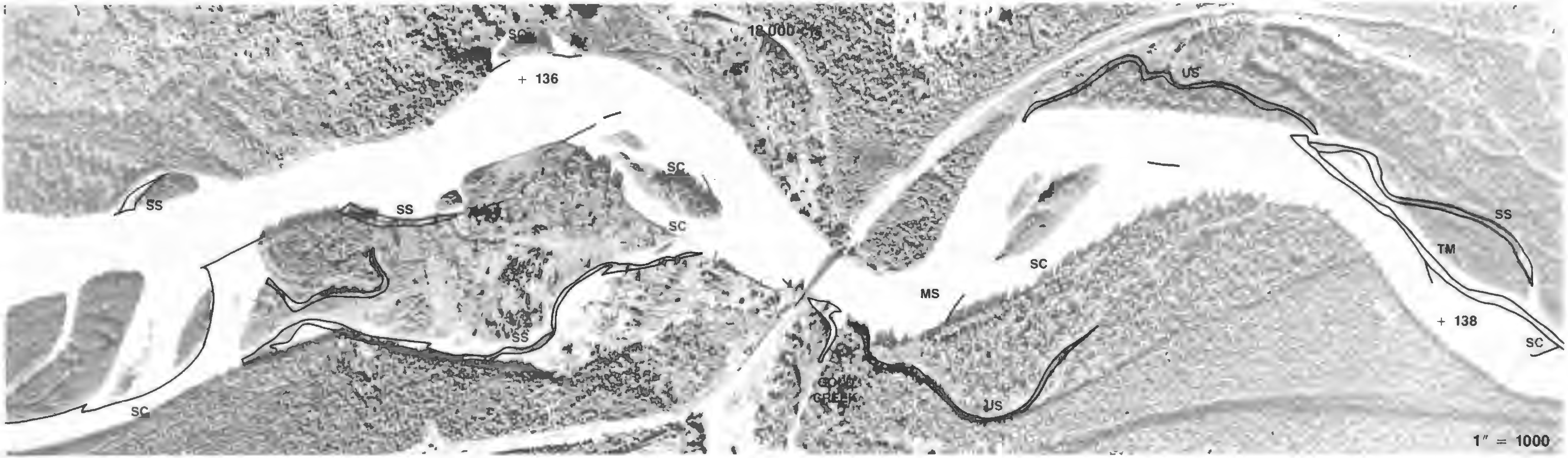
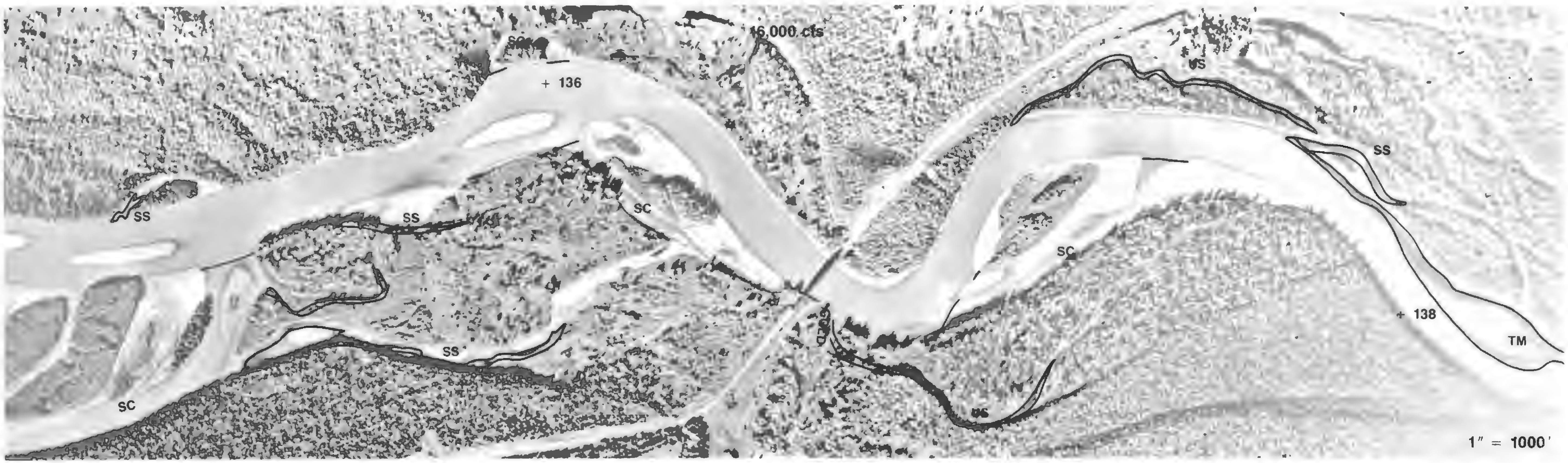
HARZA-EBASCO SUSITNA JOINT VENTURE




**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 5 OF 18 RIVERMILE 136 TO 138

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates Aquatic Resource Specialists

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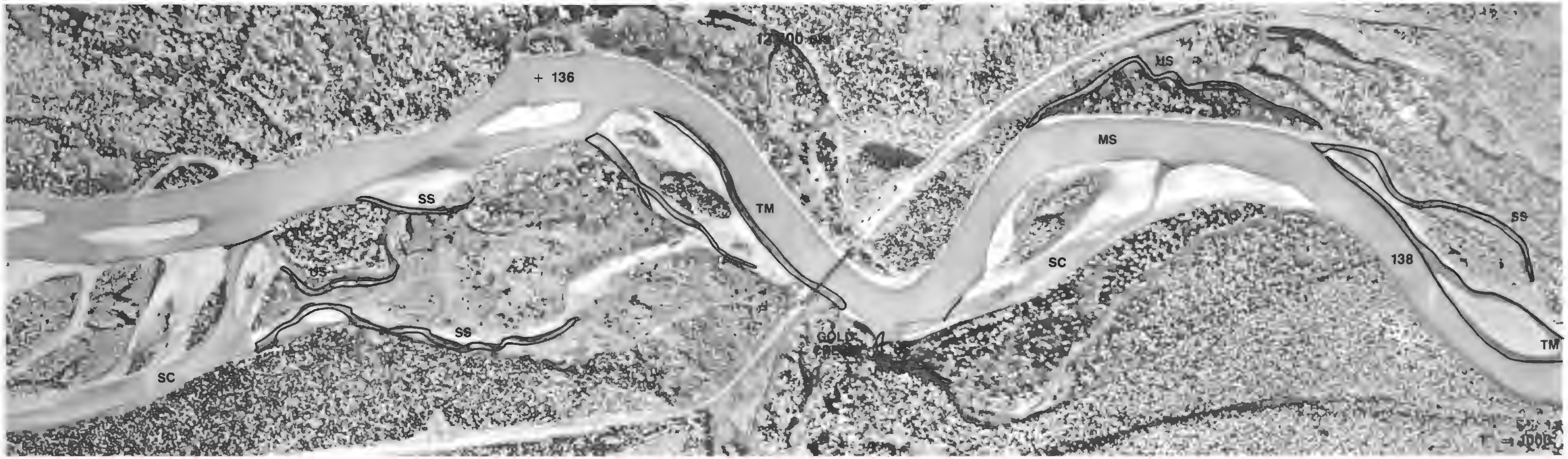
SUSITNA JOINT VENTURE





## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 5 OF 18 RIVERMILE 136 TO 138

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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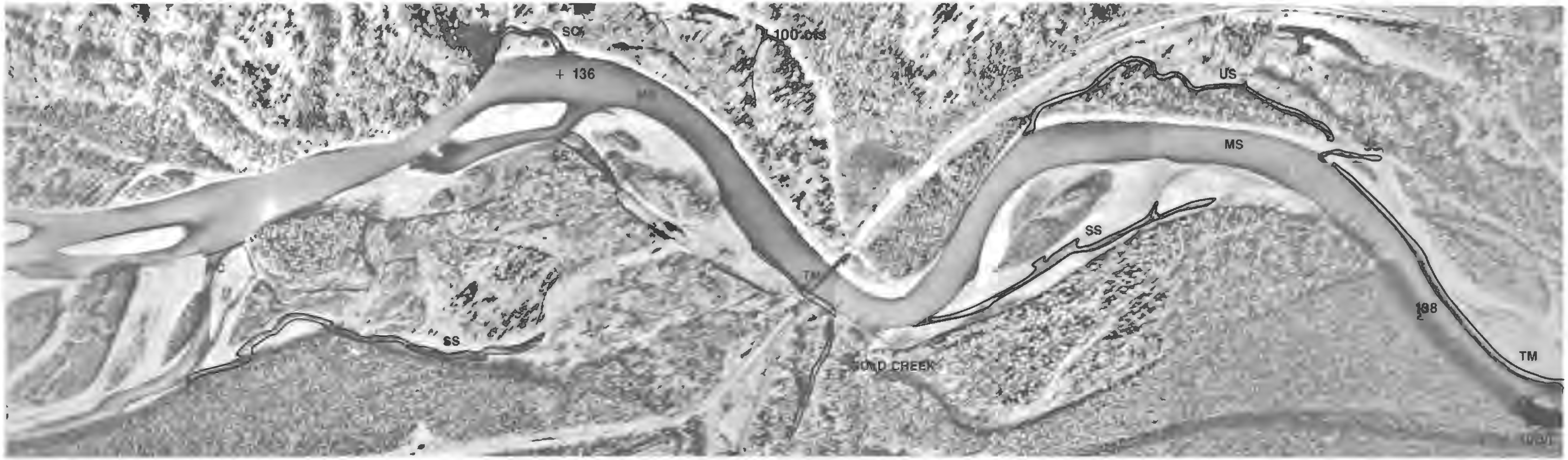
SUSITNA JOINT VENTURE


## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 5 OF 18 RIVERMILE 136 TO 138

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

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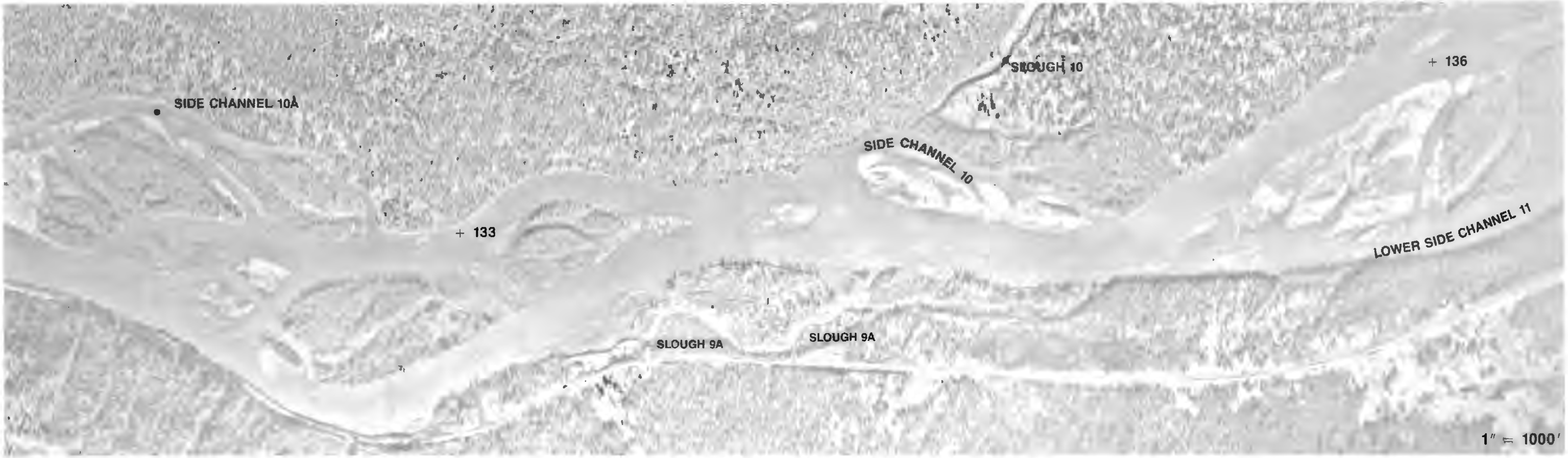
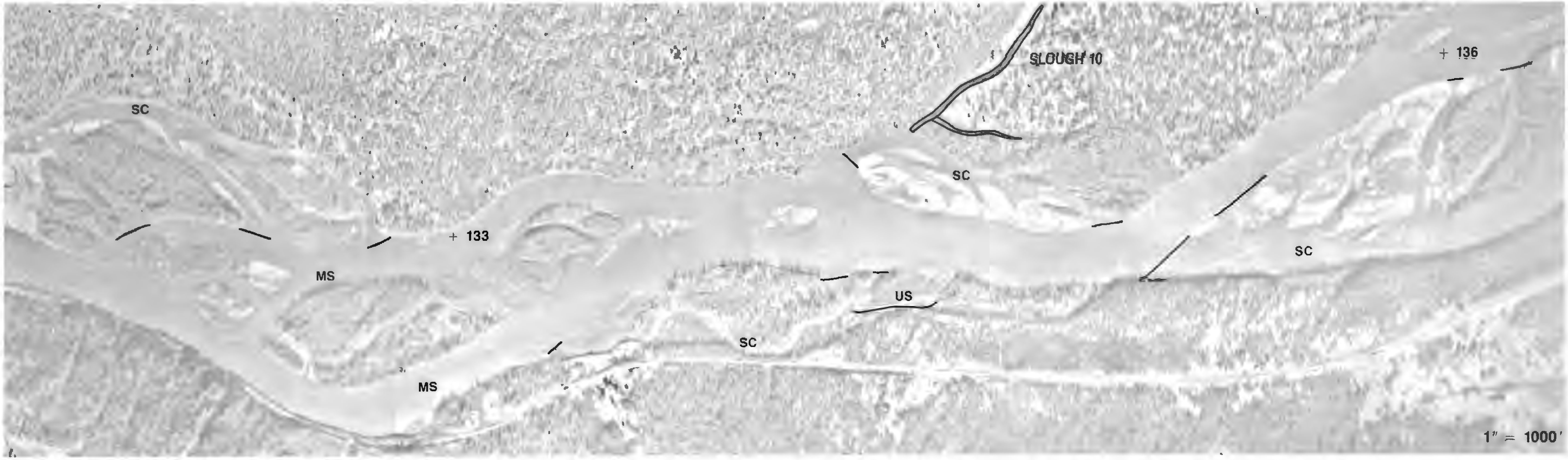
SUSITNA JOINT VENTURE




## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 6 OF 18 RIVERMILE 133 TO 136

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SUSITNA HYDROELECTRIC PROJECT

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HARZA-EBASCO
SUSITNA JOINT VENTURE



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 6 OF 18 RIVERMILE 133 TO 136

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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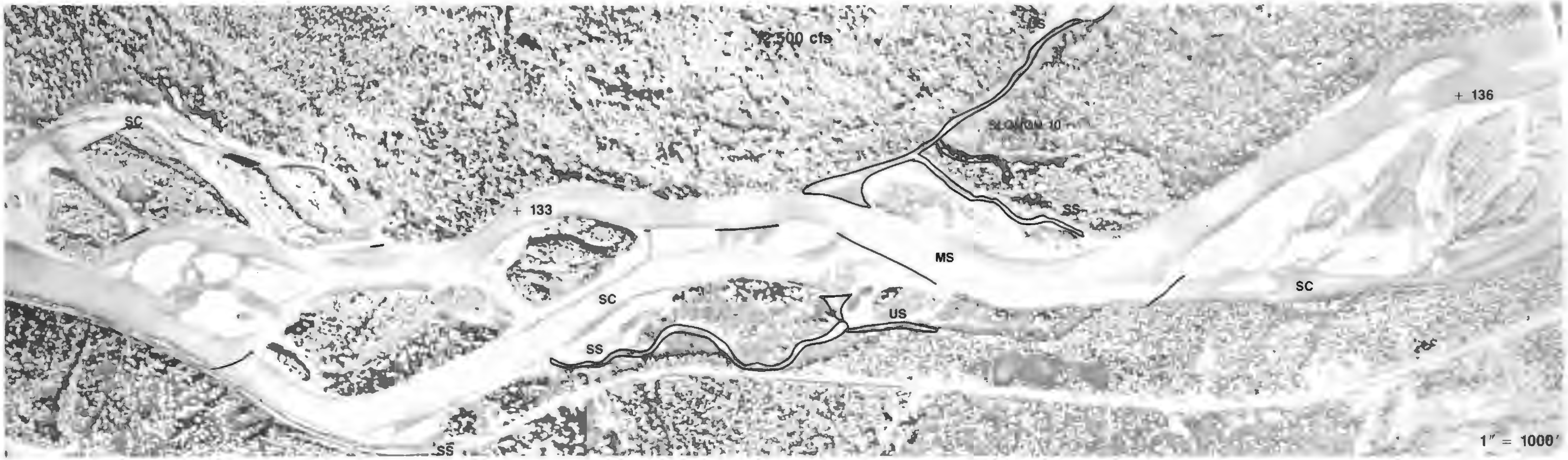
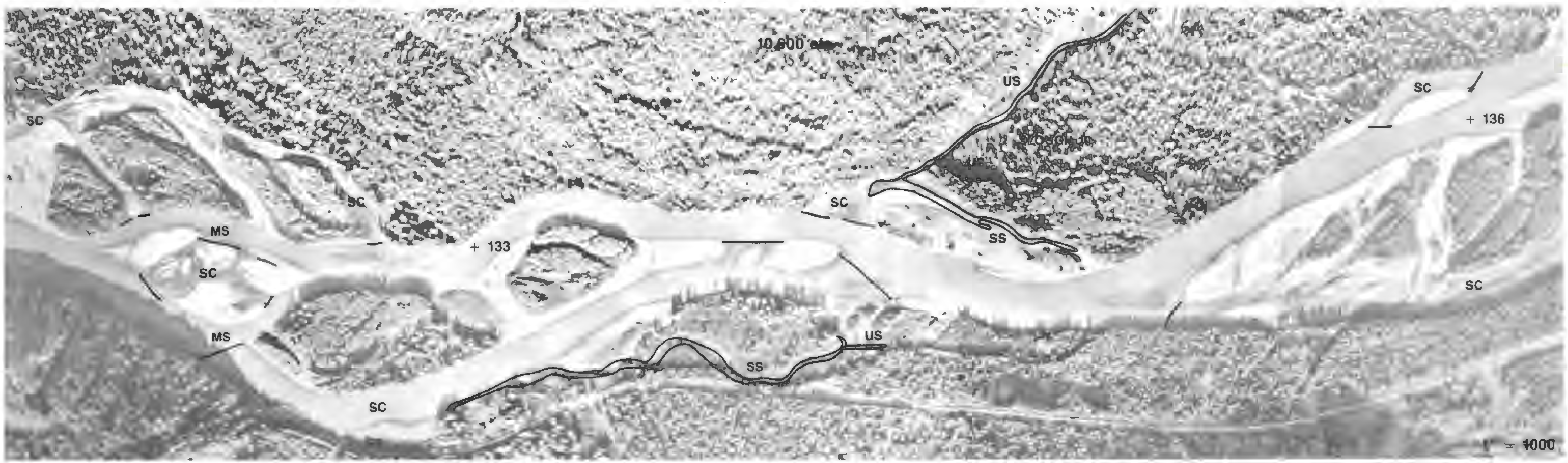
SUSITNA JOINT VENTURE




## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 6 OF 18 RIVERMILE 133 TO 136

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
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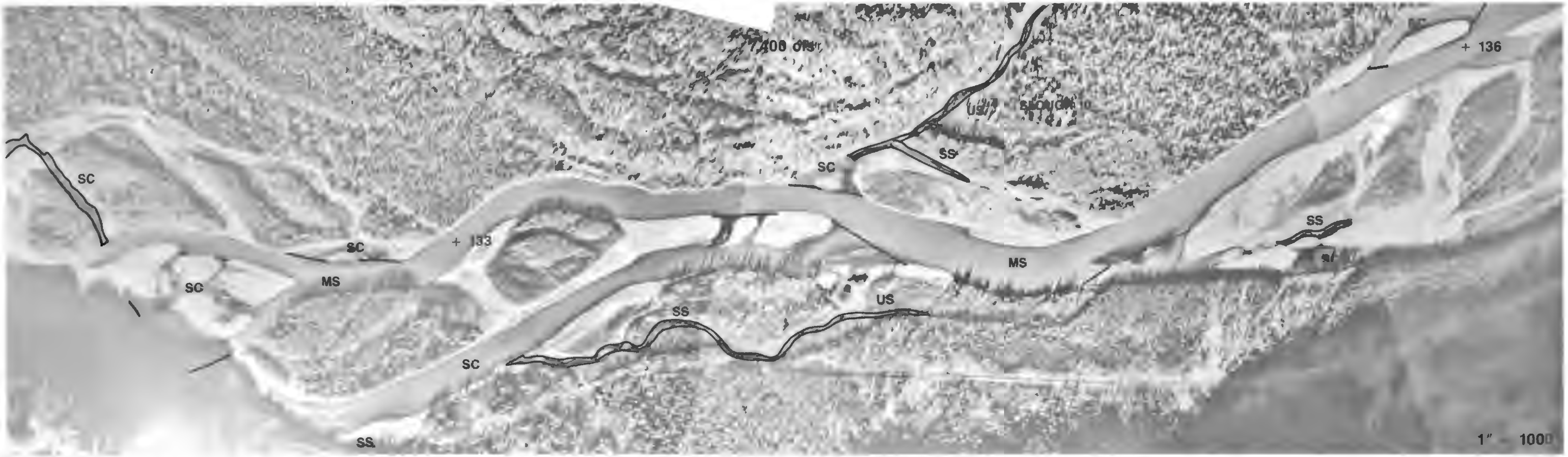
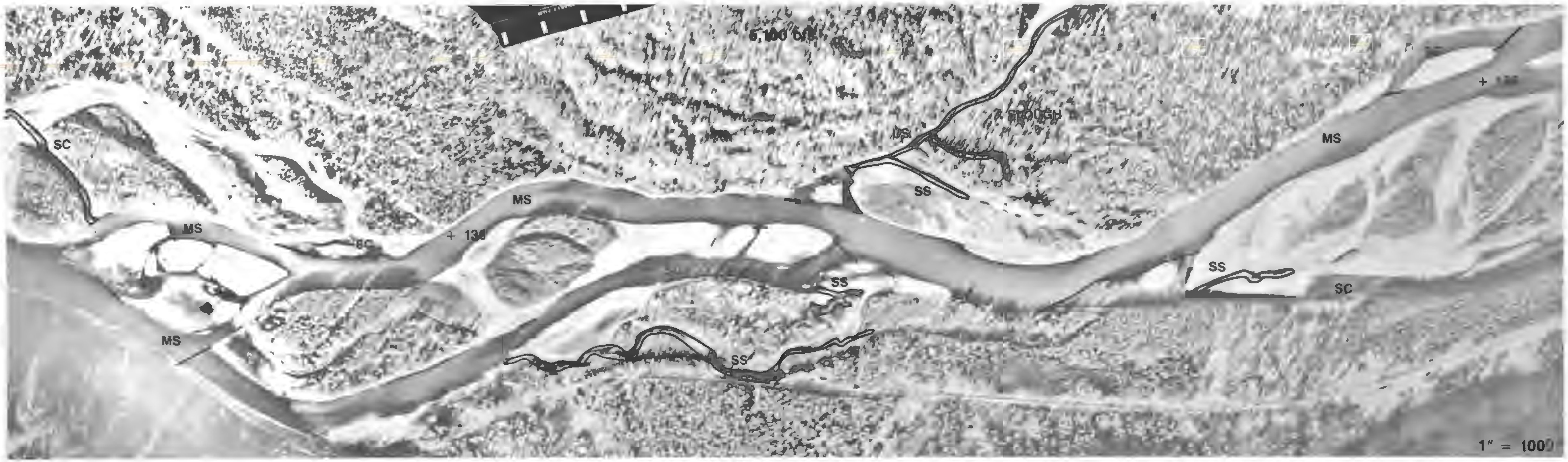
SUSITNA JOINT VENTURE




**LEGEND**

MS MAINSTEM
SC SIDE CHANNEL
SS SIDE SLOUGH
US UPLAND SLOUGH
TM TRIBUTARY MOUTH
T TRIBUTARY
\+ RIVER MILE

**MIDDLE SUSITNA RIVER**

PLATE 6 OF 18 RIVERMILE 133 TO 136

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 7 OF 18 RIVERMILE 130 TO 132

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 7 OF 18 RIVERMILE 130 TO 132

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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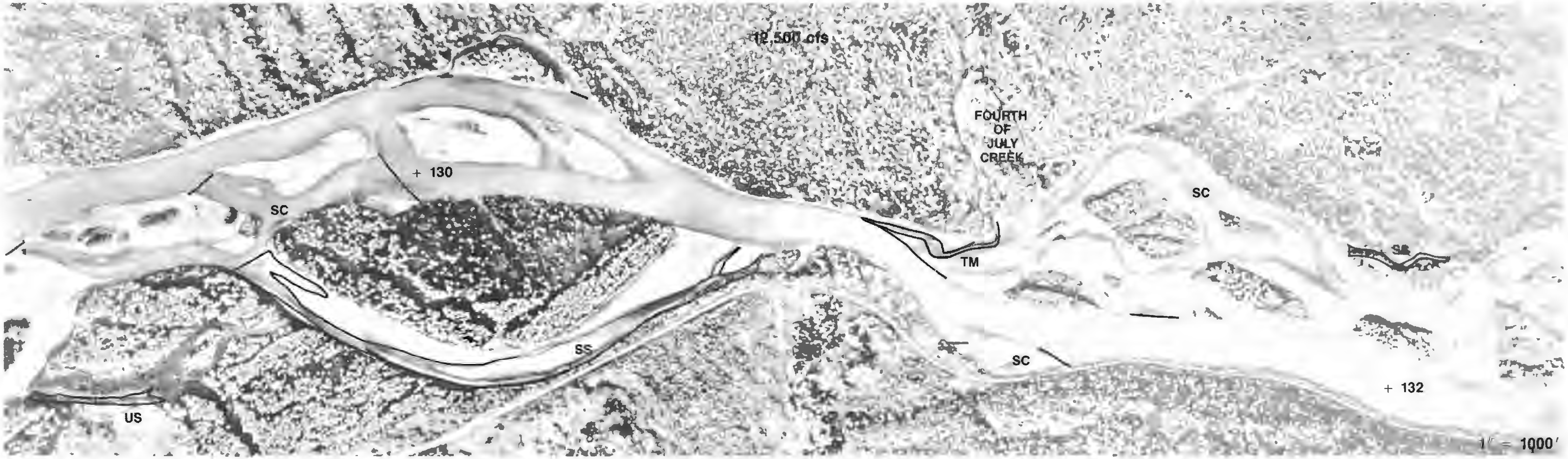


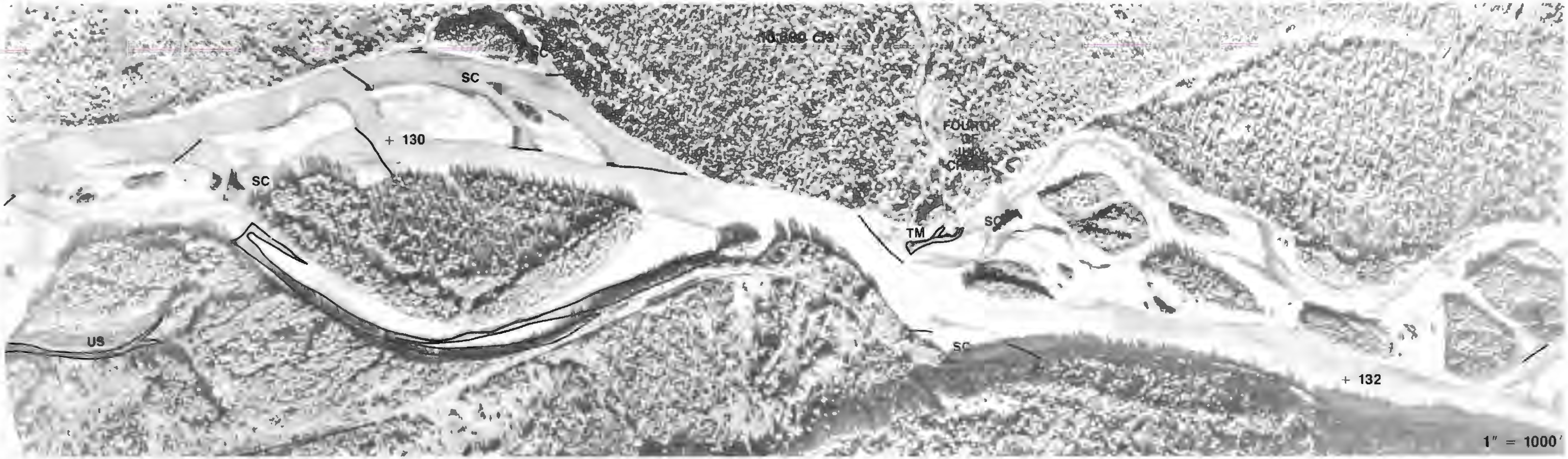


**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 7 OF 18 RIVERMILE 130 TO 132

ALASKA POWER AUTHORITY
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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 7 OF 18 RIVERMILE 130 TO 132

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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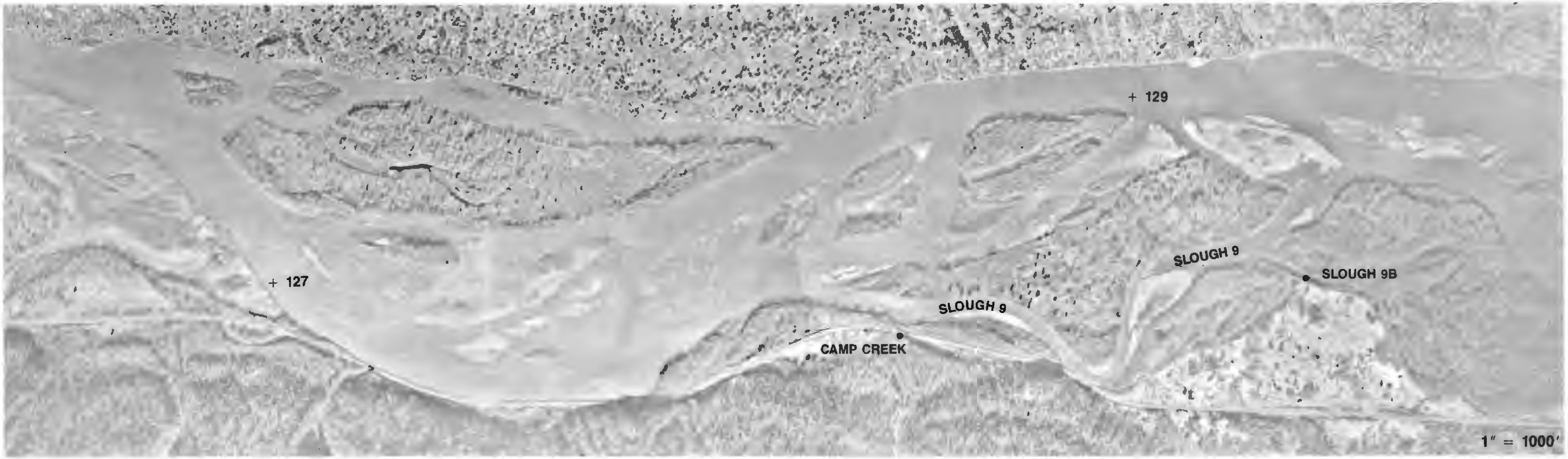


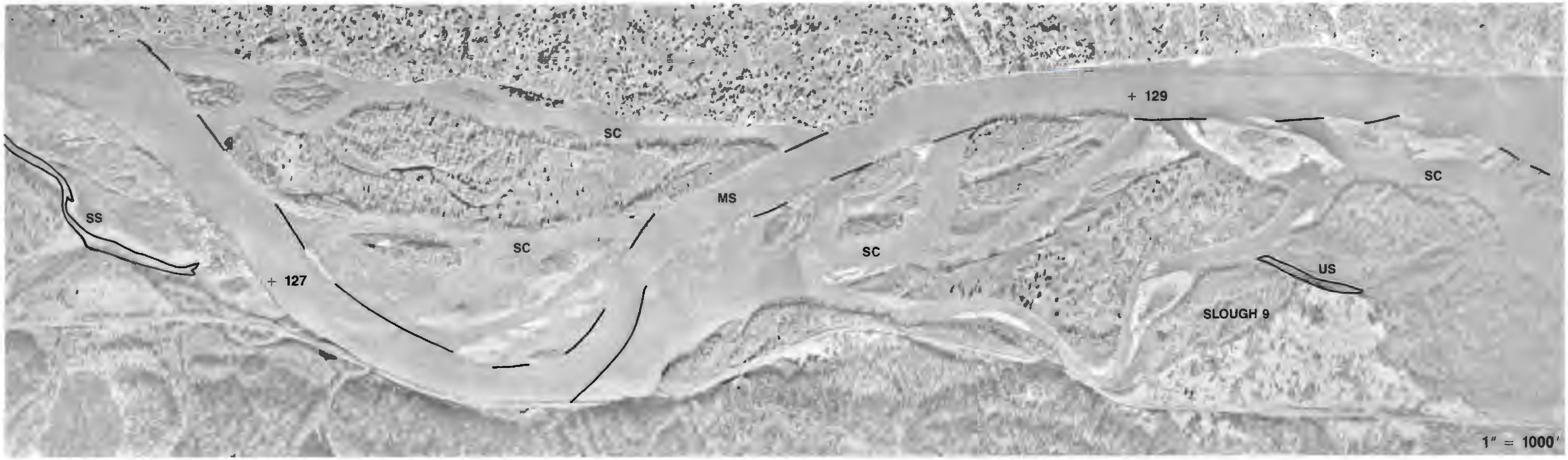


## LEGEND

| | |
|---|---|
| MS MAINSTEM | TM TRIBUTARY MOUTH |
| SC SIDE CHANNEL | T TRIBUTARY |
| SS SIDE SLOUGH | + RIVER MILE |
| US UPLAND SLOUGH | |

# MIDDLE SUSITNA RIVER

PLATE 8 OF 18 RIVERMILE 127 TO 129

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SUSITNA HYDROELECTRIC PROJECT

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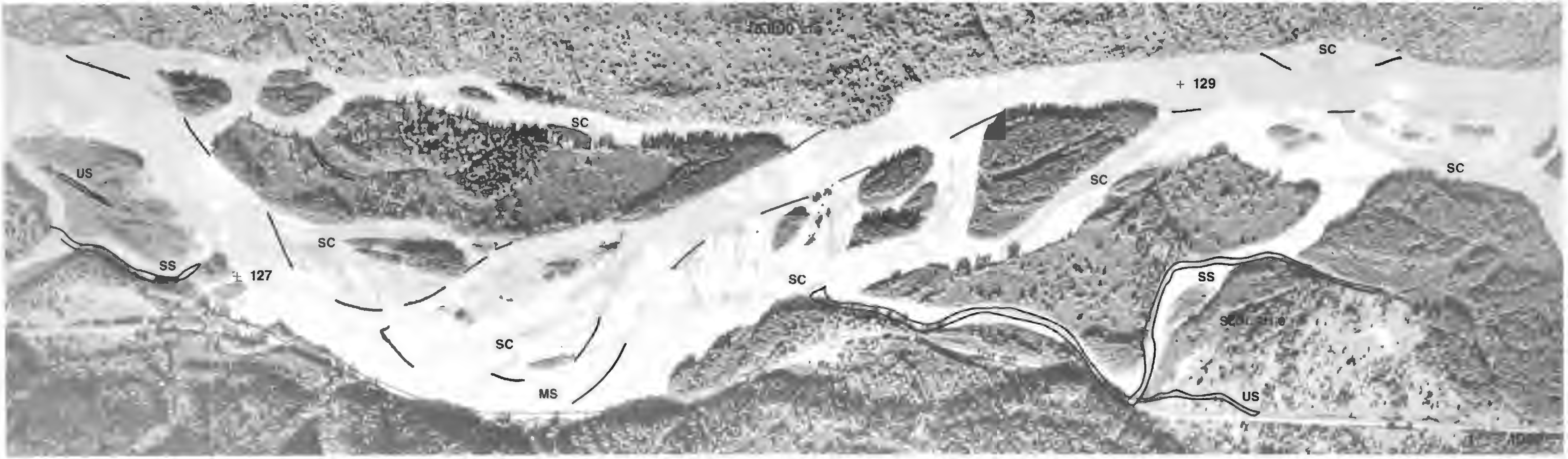


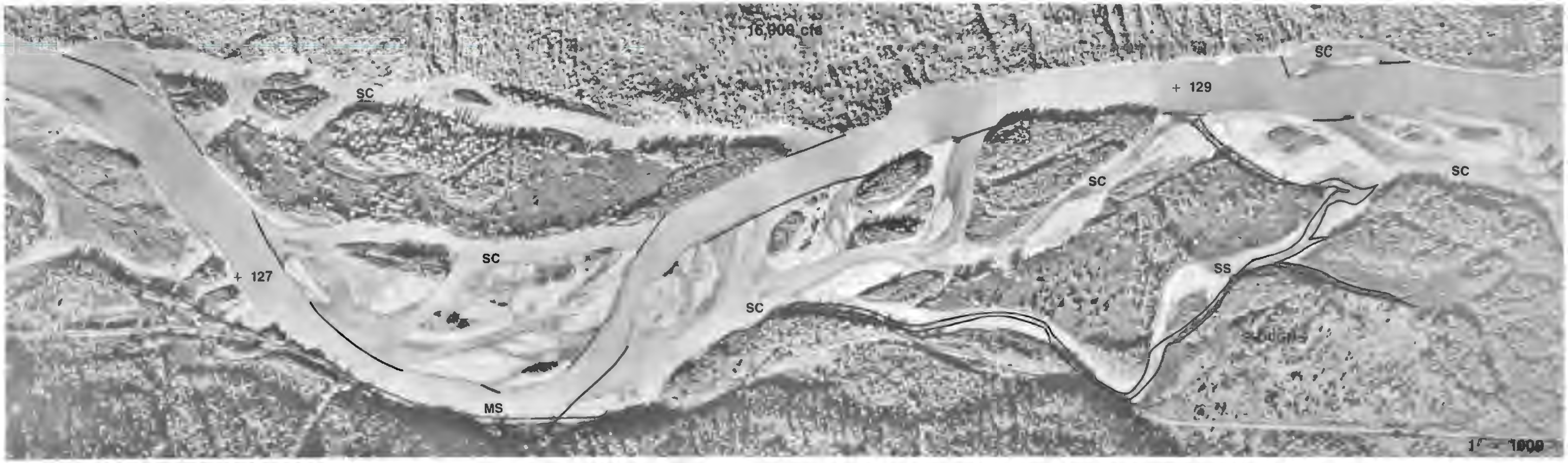


**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 8 OF 18 RIVERMILE 127 TO 129

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 8 OF 18 RIVERMILE 127 TO 129

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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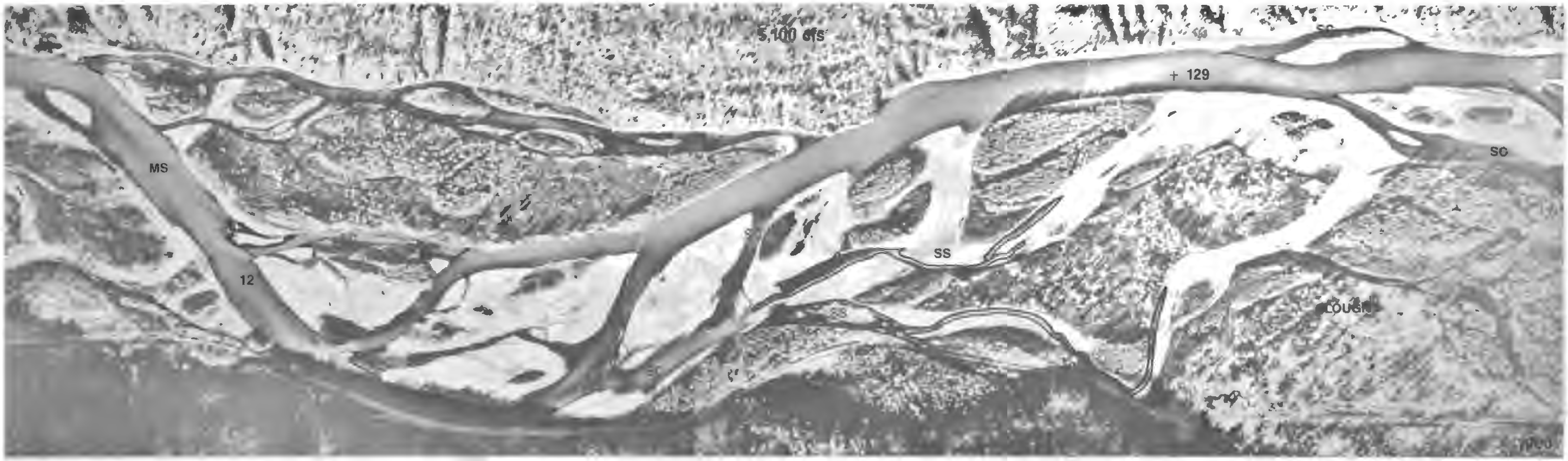


**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 8 OF 18 RIVERMILE 127 TO 129

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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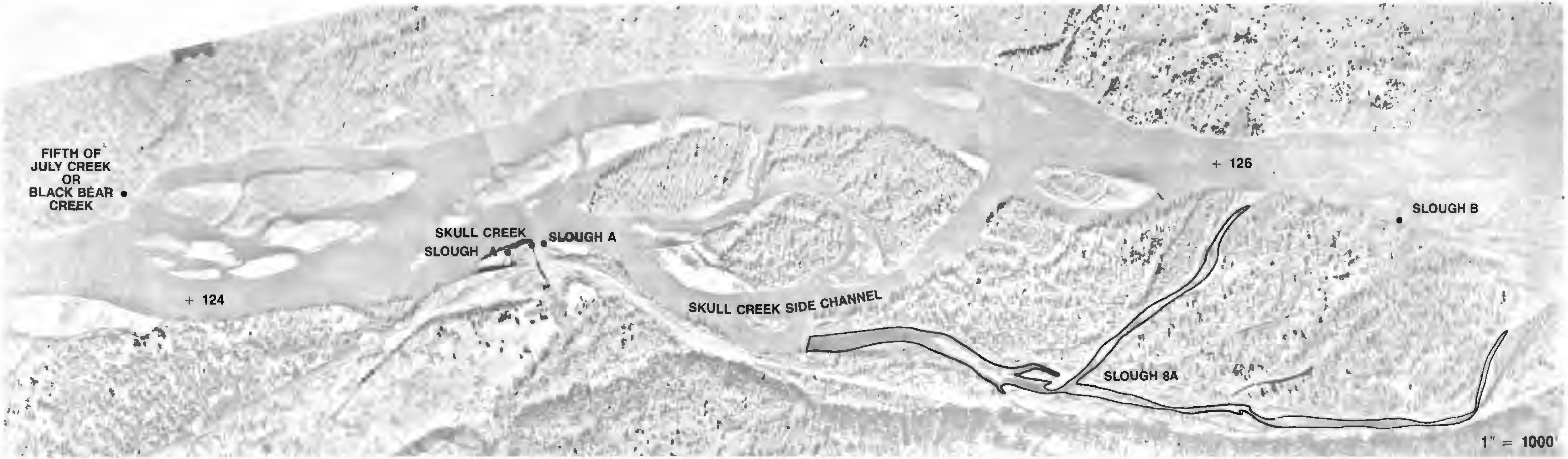



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 9 OF 18 RIVERMILE 124 TO 126

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SUSITNA HYDROELECTRIC PROJECT

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 9 OF 18 RIVERMILE 124 TO 126

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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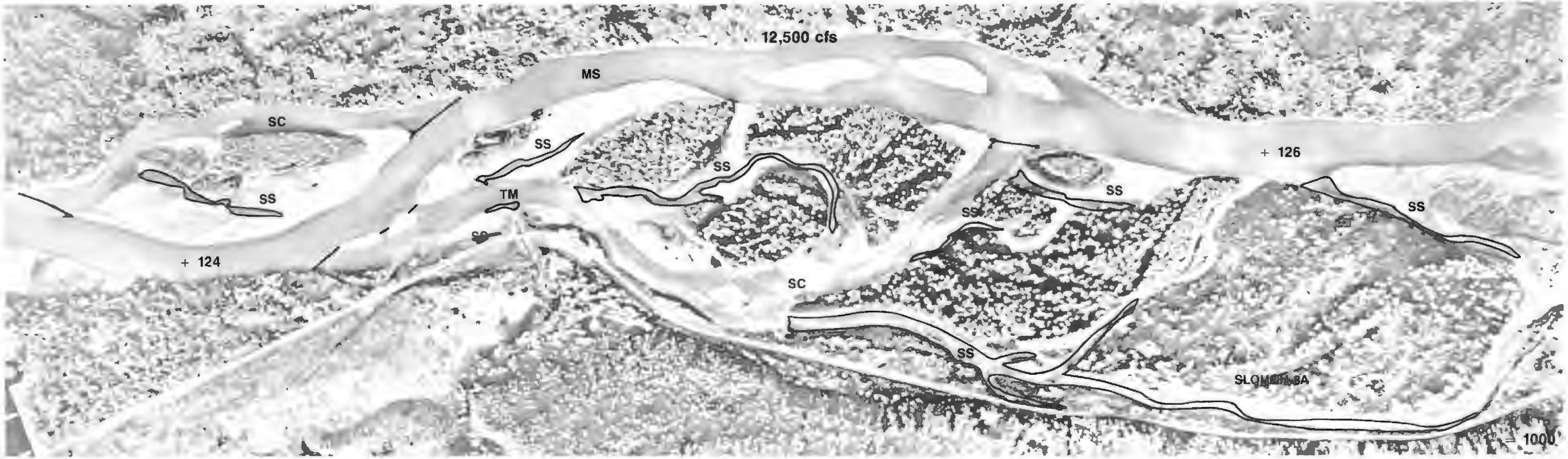



## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 9 OF 18 RIVERMILE 124 TO 126

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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SUSITNA JOINT VENTURE



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 9 OF 18 RIVERMILE 124 TO 126

**ALASKA POWER AUTHORITY**
SUSITNA HYDROELECTRIC PROJECT

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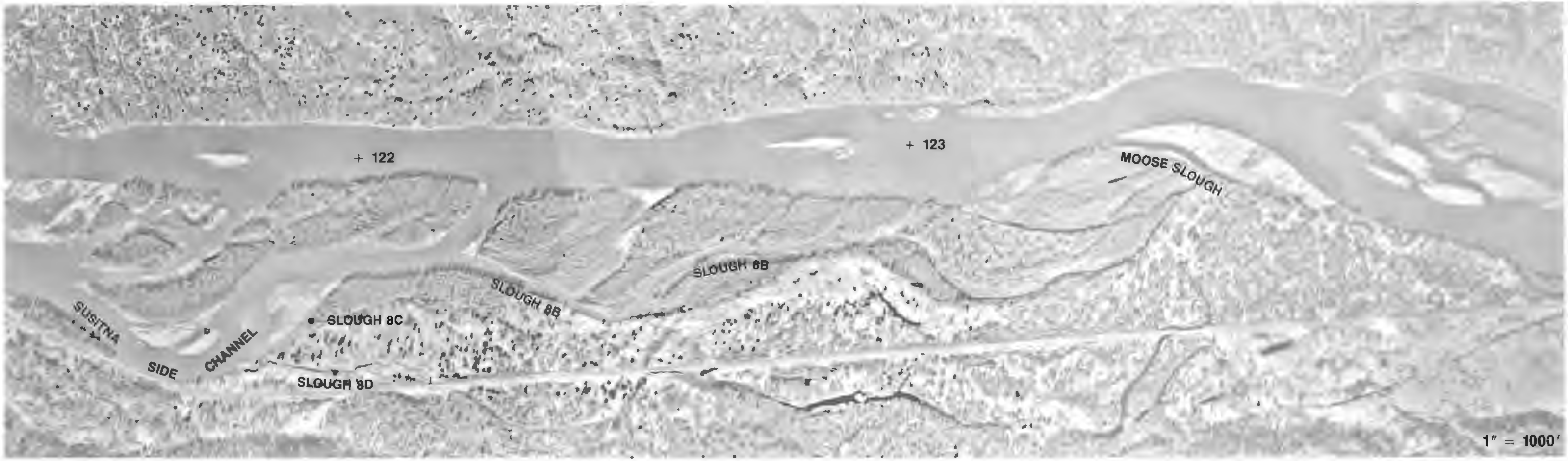


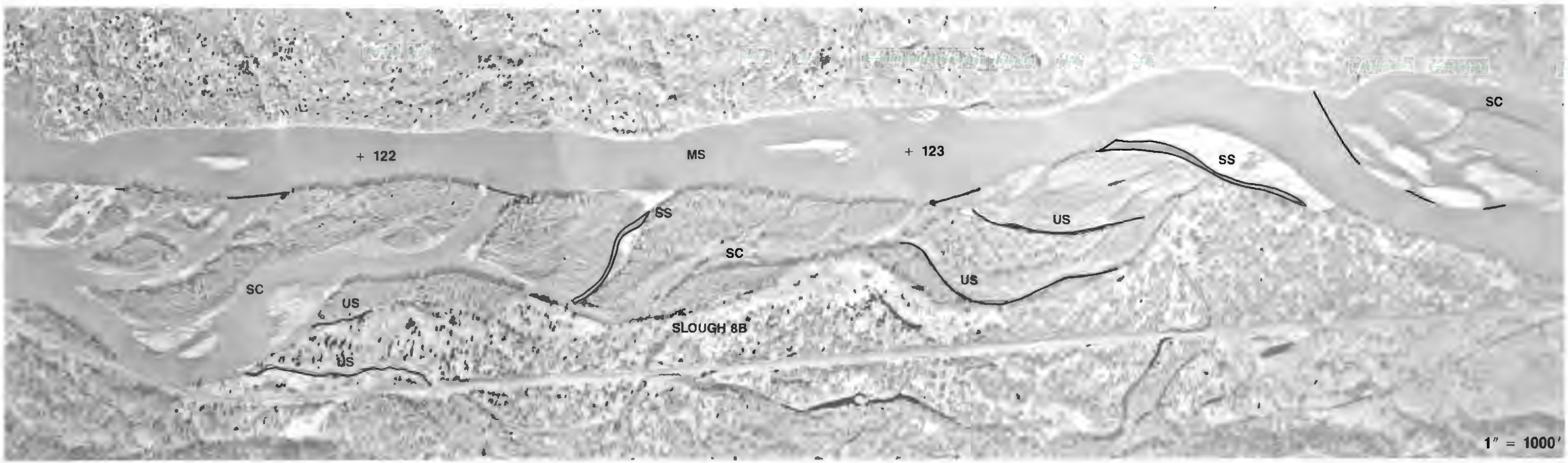


## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 10 OF 18 RIVERMILE 122 TO 124

23,000 cfs

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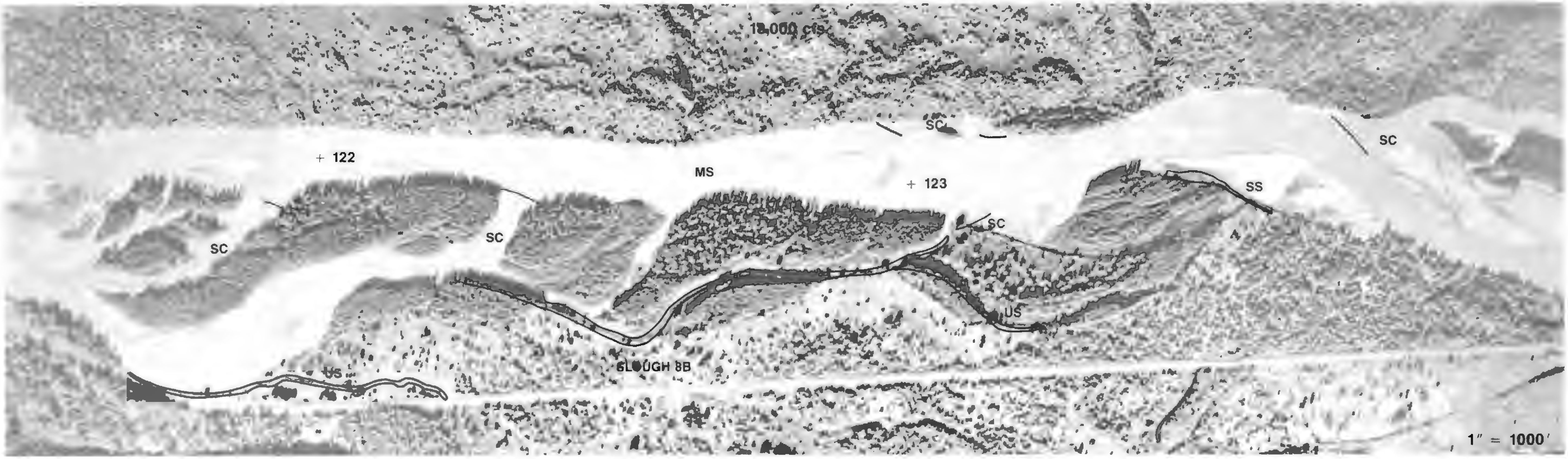


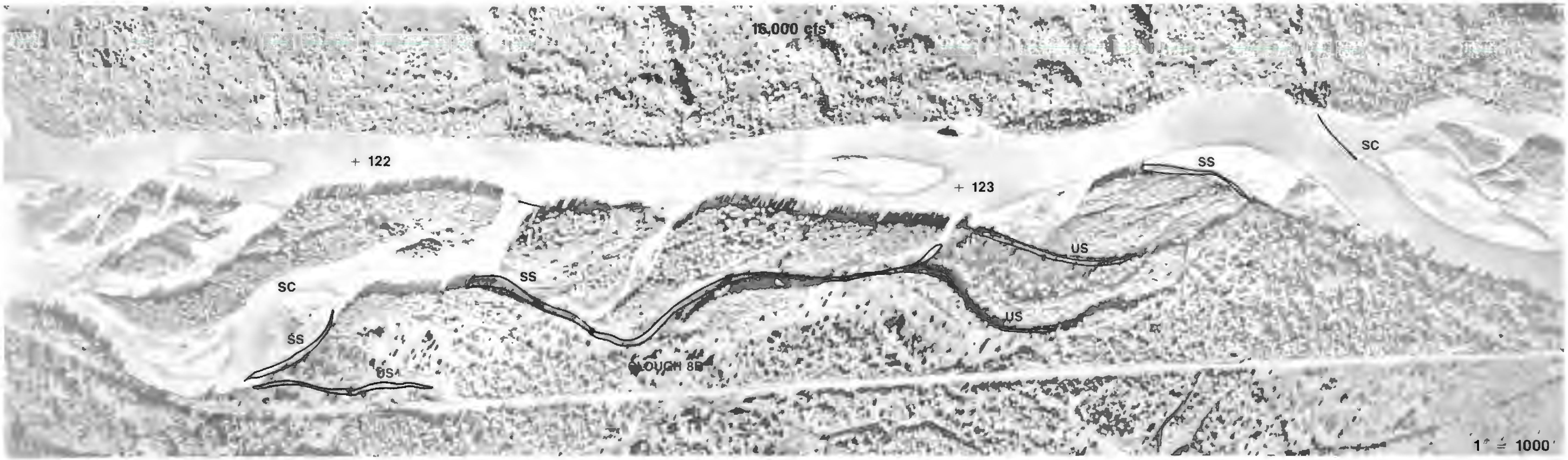


## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 10 OF 18 RIVERMILE 122 TO 124

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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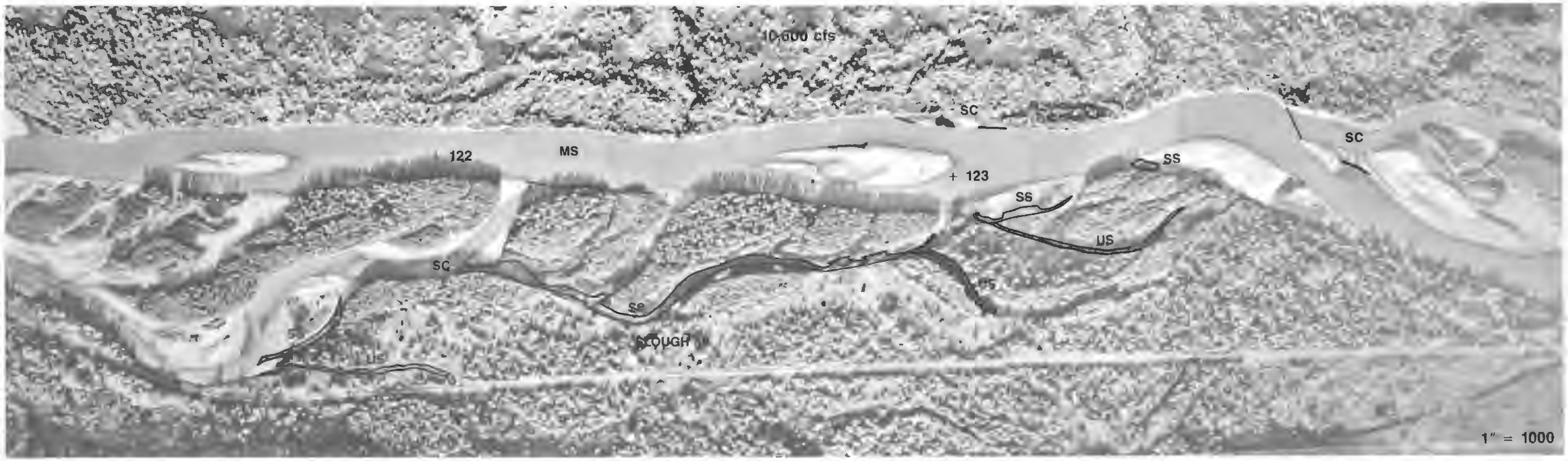
SUSITNA JOINT VENTURE


**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 10 OF 18 RIVERMILE 122 TO 124

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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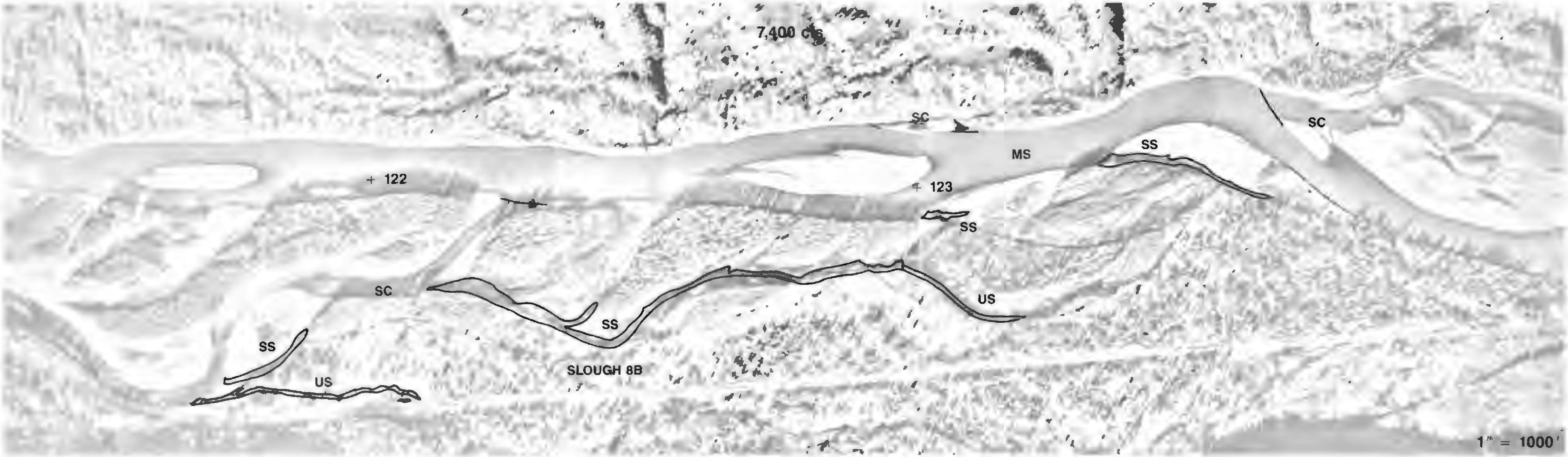


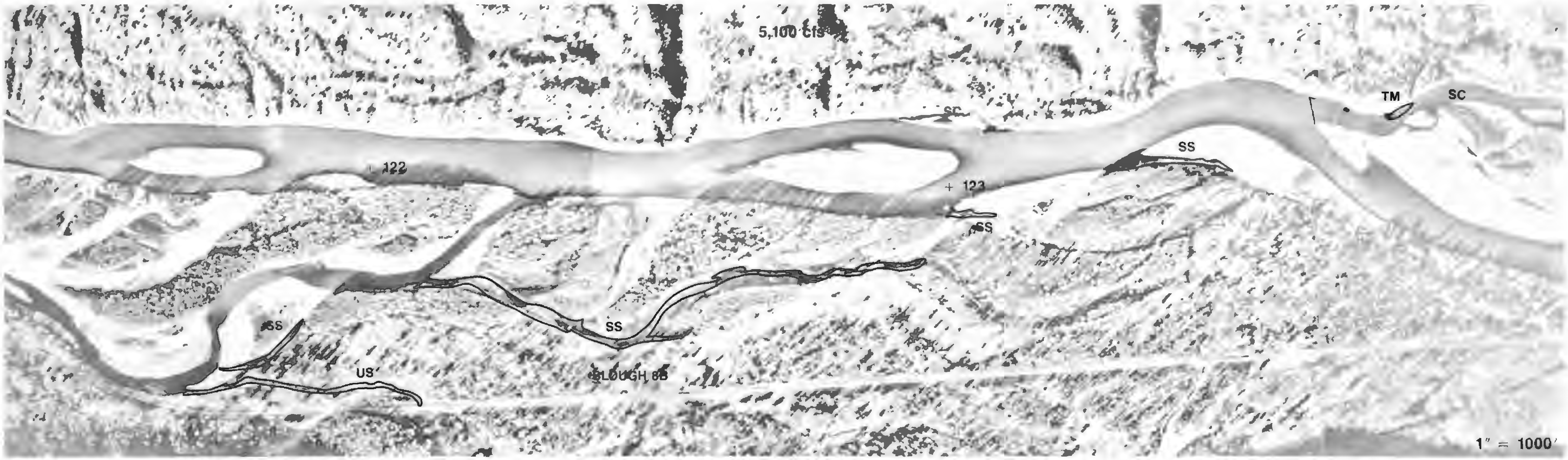


**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 10 OF 18 RIVERMILE 122 TO 124

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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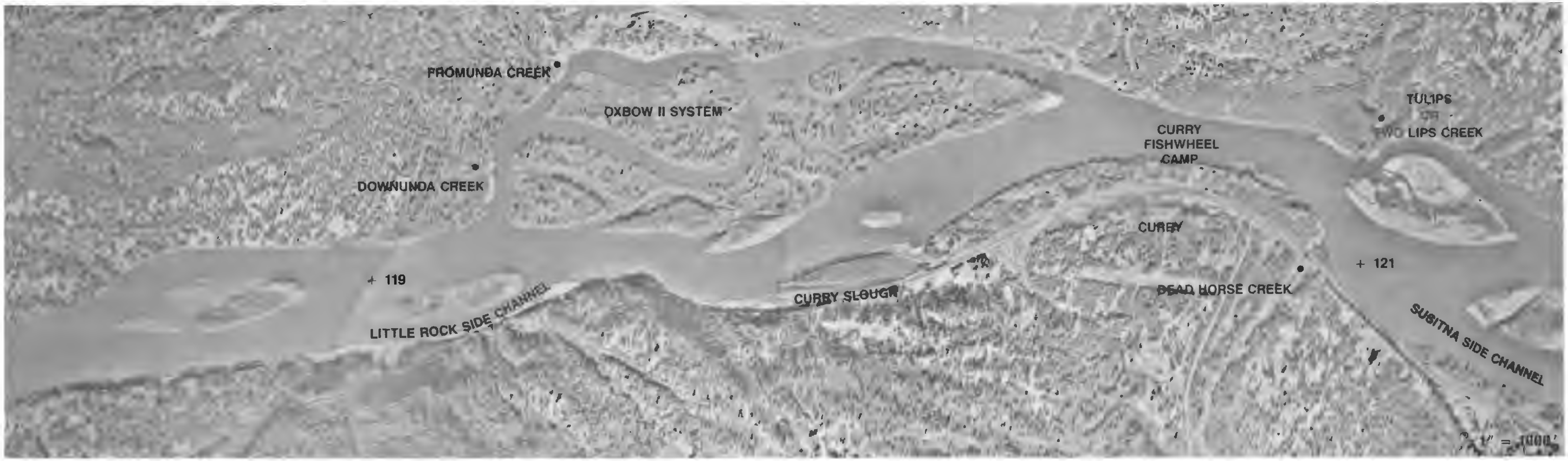
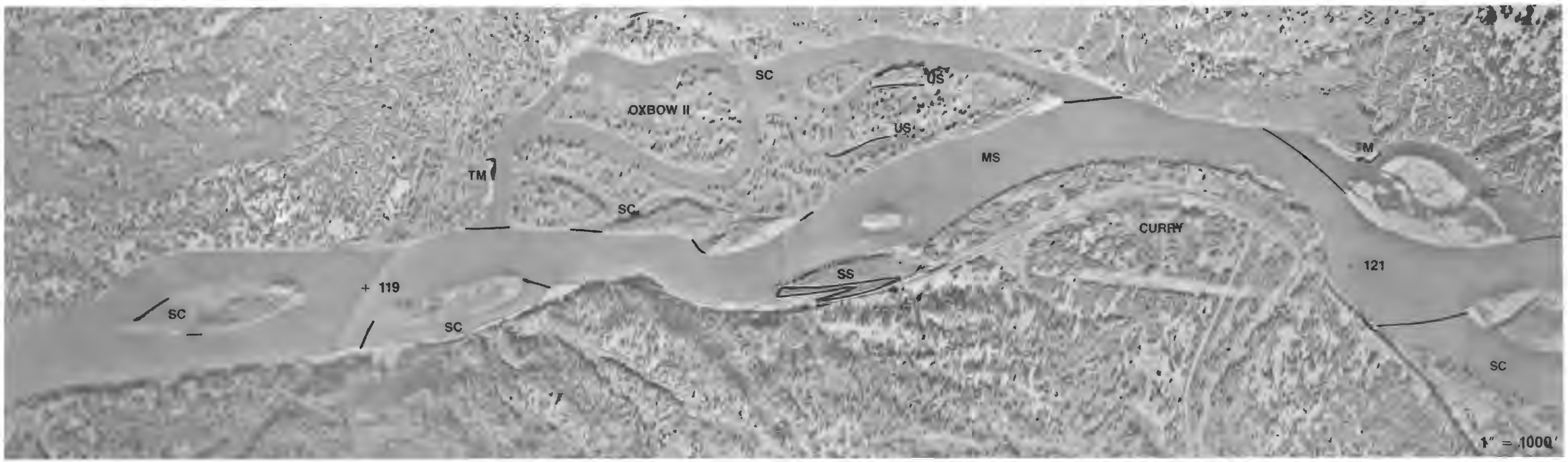
SUSITNA JOINT VENTURE




**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 11 OF 18 RIVERMILE 119 TO 121

23,000 cfs

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Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 11 OF 18 RIVERMILE 119 TO 121

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE



**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 11 OF 18 — RIVERMILE 119 TO 121

**ALASKA POWER AUTHORITY**
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SUSITNA JOINT VENTURE



## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 11 OF 18 RIVERMILE 119 TO 121

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 12 OF 18 RIVERMILE 116 TO 118

23,000 cfs

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**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 12 OF 18 RIVERMILE 116 TO 118

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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HARZA-EBASCO
SUSITNA JOINT VENTURE



**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 12 OF 18 RIVERMILE 116 TO 118

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**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 12 OF 18 RIVERMILE 116 TO 118

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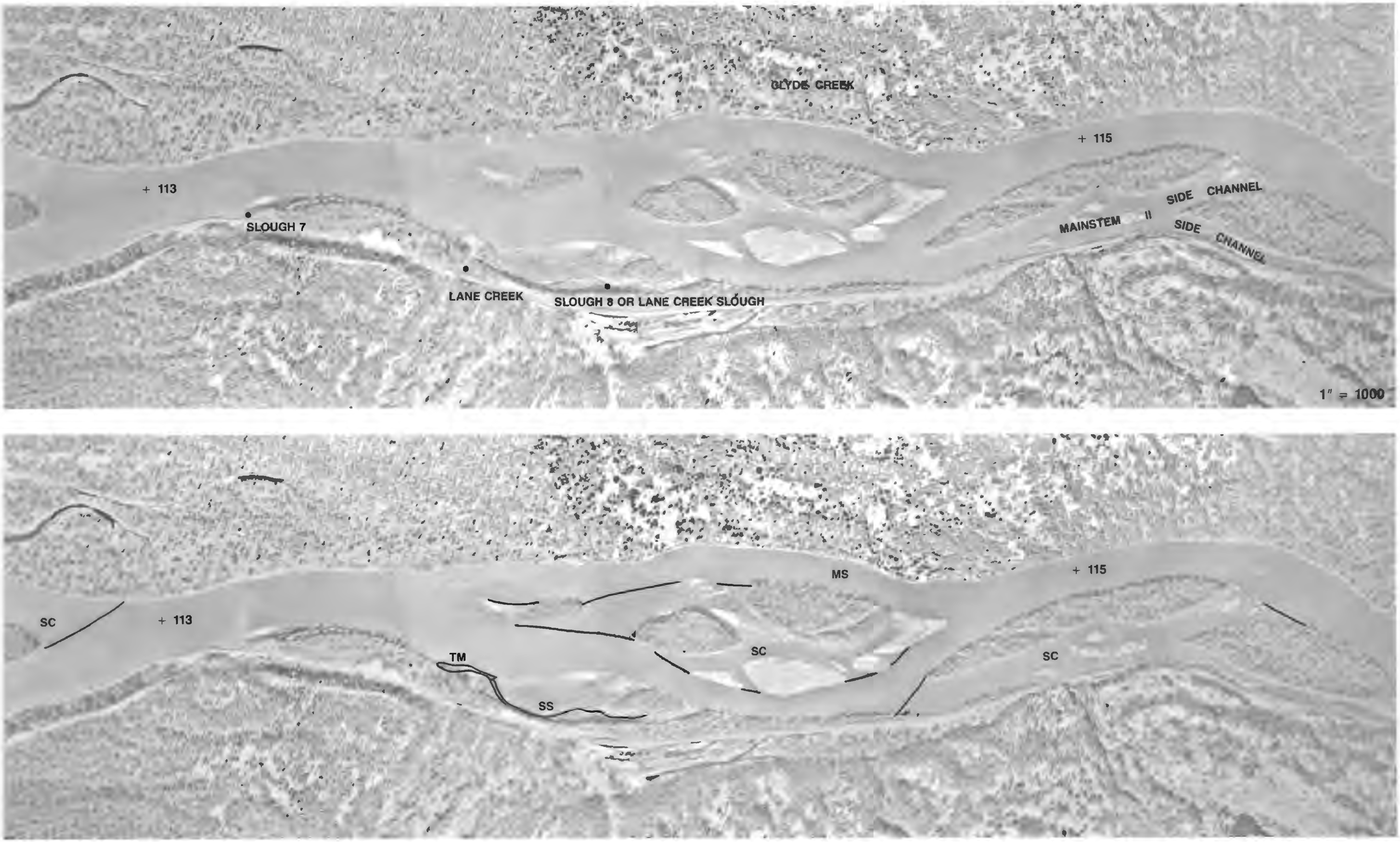


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| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 13 OF 18 RIVERMILE 113 TO 115

23,000 cfs

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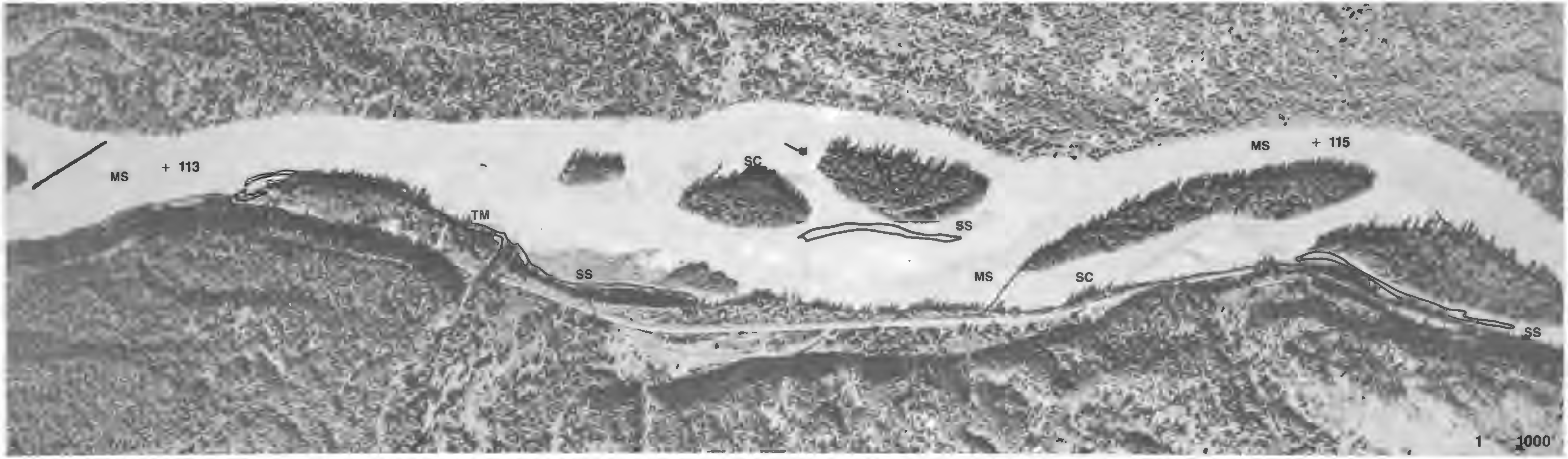



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| SC | SIDE CHANNEL | T | TRIBUTARY |
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| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 13 OF 18 RIVERMILE 113 TO 115

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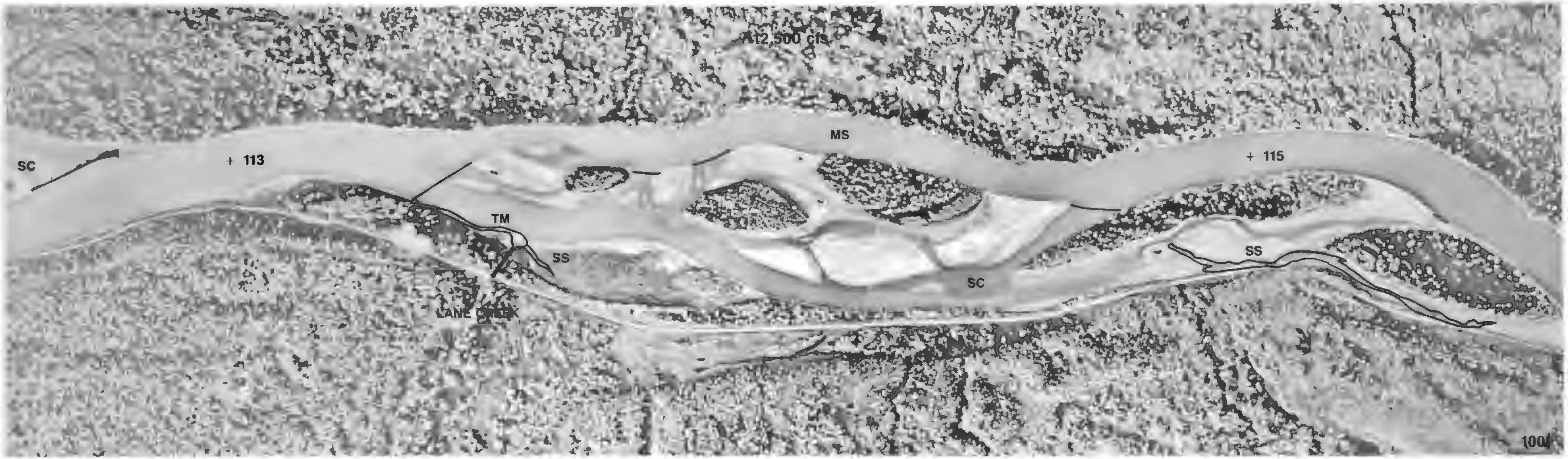


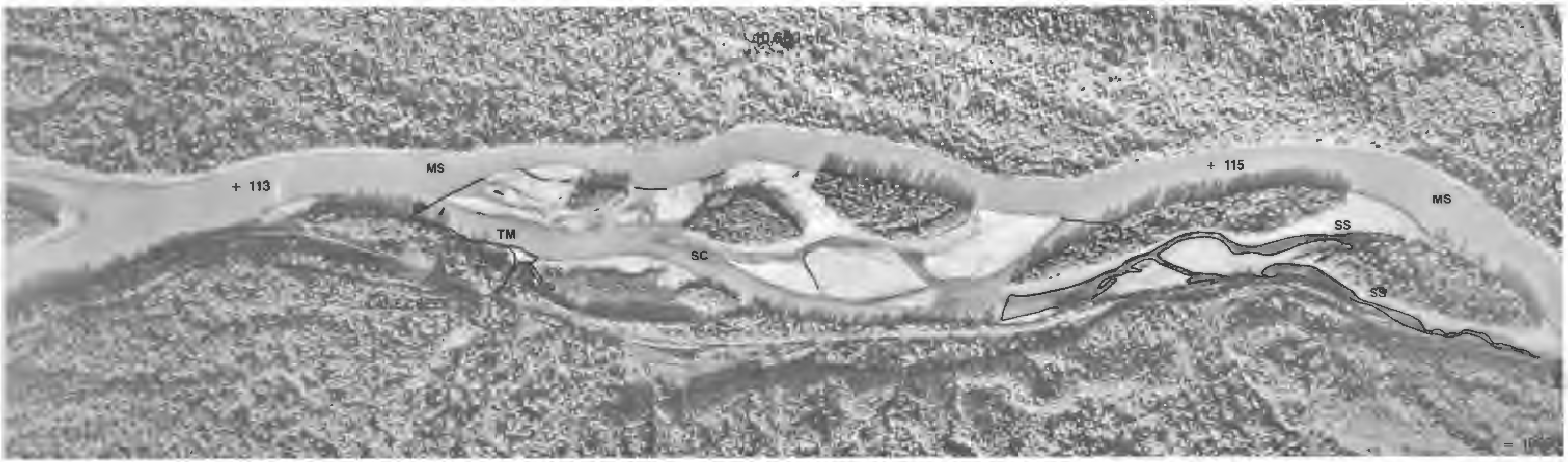


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| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 13 OF 18 RIVERMILE 113 TO 115

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**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
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**MIDDLE SUSITNA RIVER**

PLATE 13 OF 18 RIVERMILE 113 TO 115

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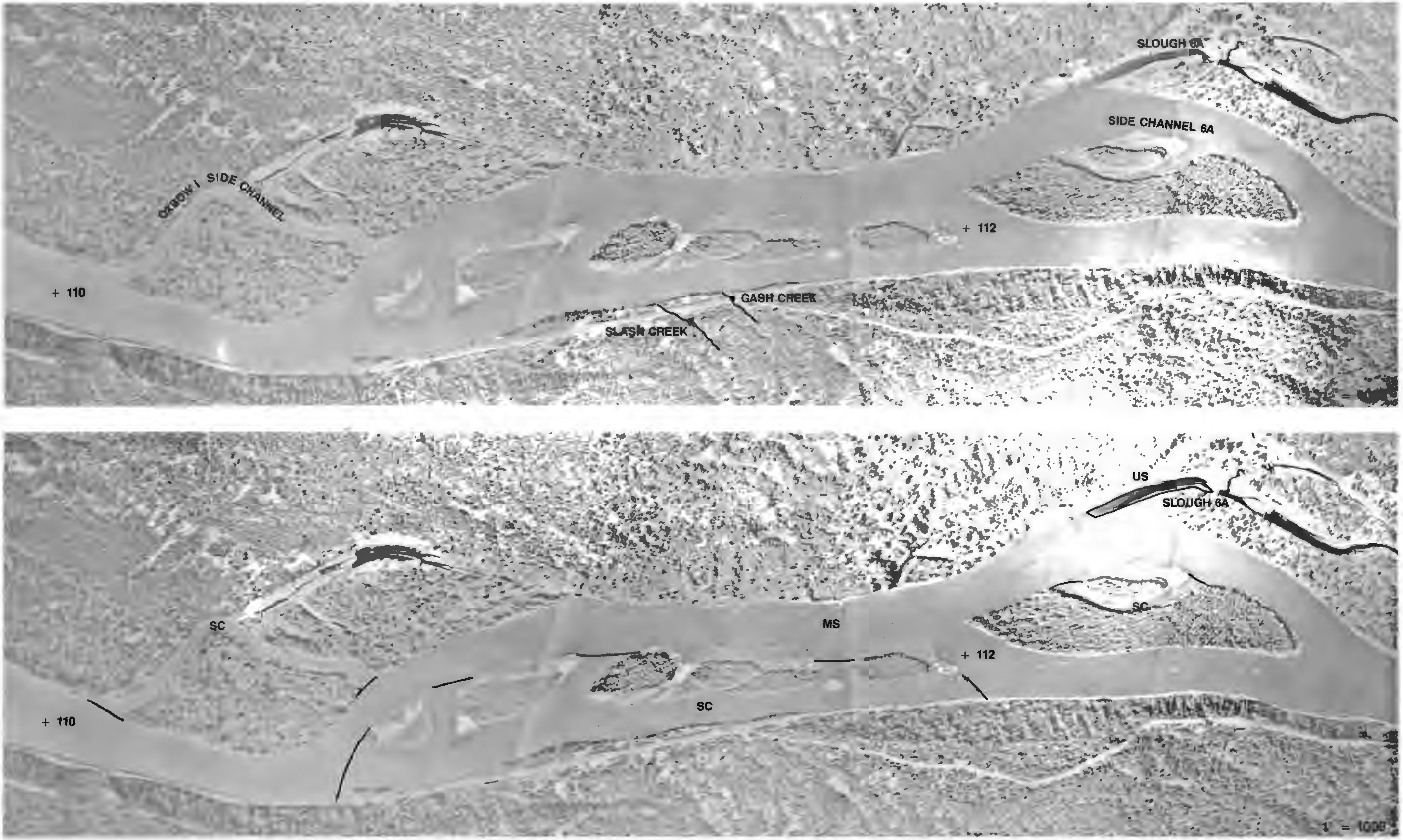


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| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 14 OF 18 RIVERMILE 110 TO 112

23,000 cfs

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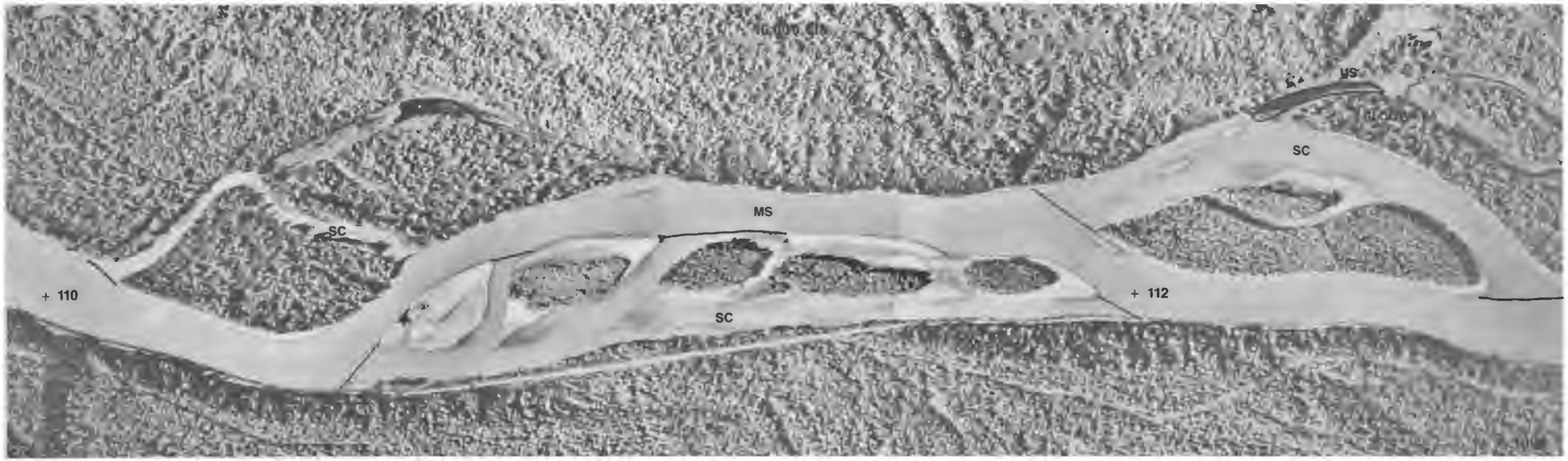


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| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 14 OF 18 RIVERMILE 110 TO 112

ALASKA POWER AUTHORITY
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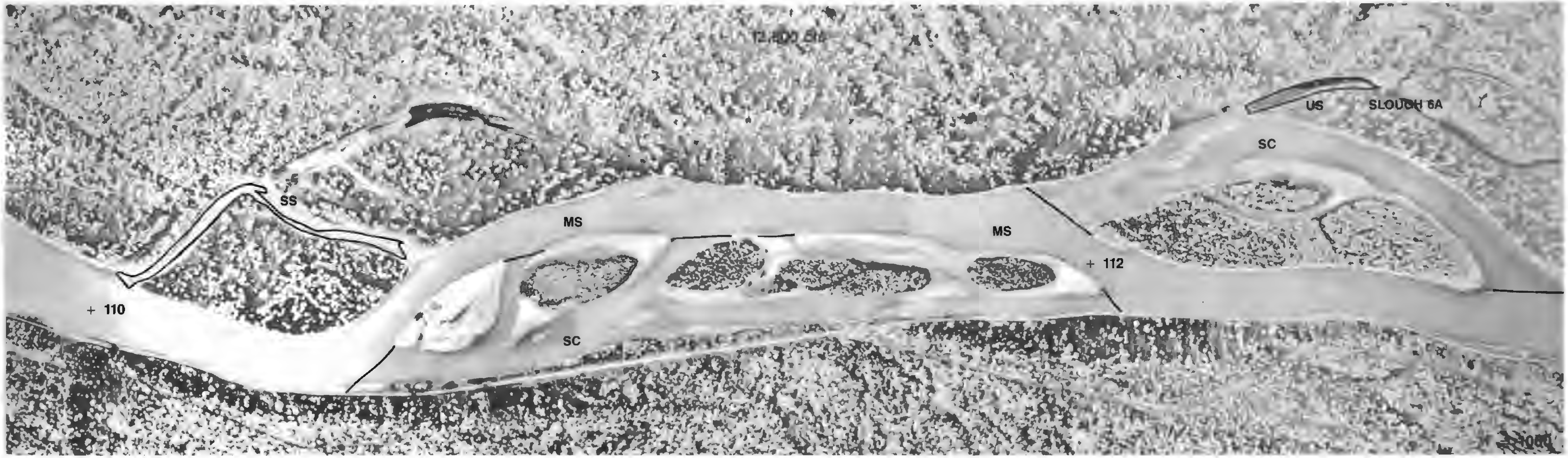



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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 14 OF 18    RIVERMILE 110 TO 112

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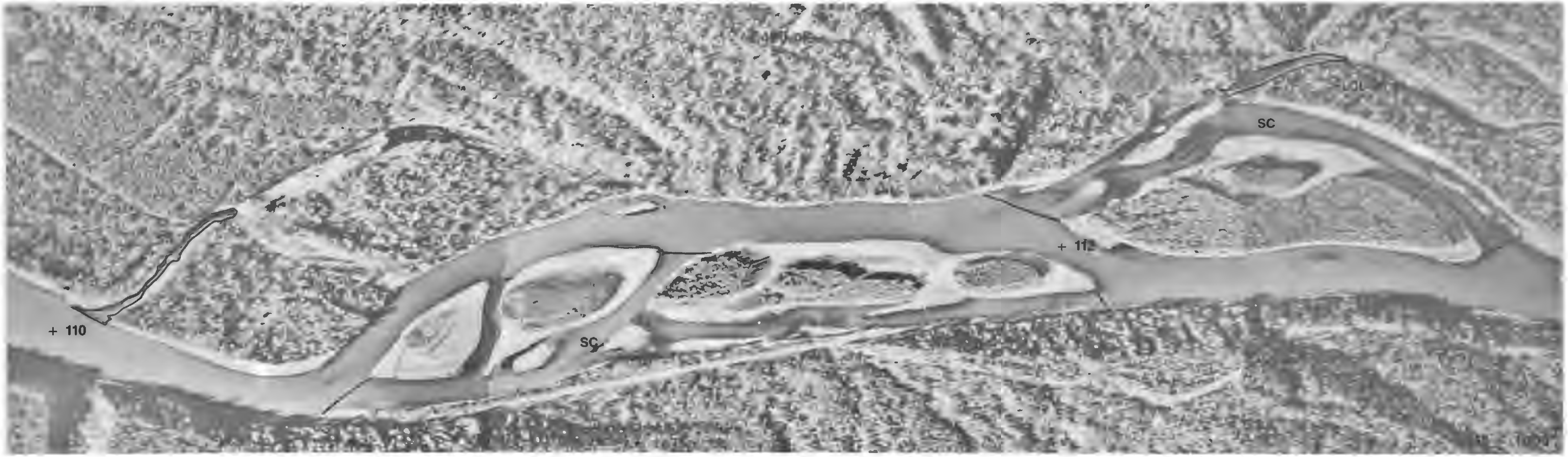



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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 14 OF 18 RIVERMILE 110 TO 112

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SUSITNA HYDROELECTRIC PROJECT

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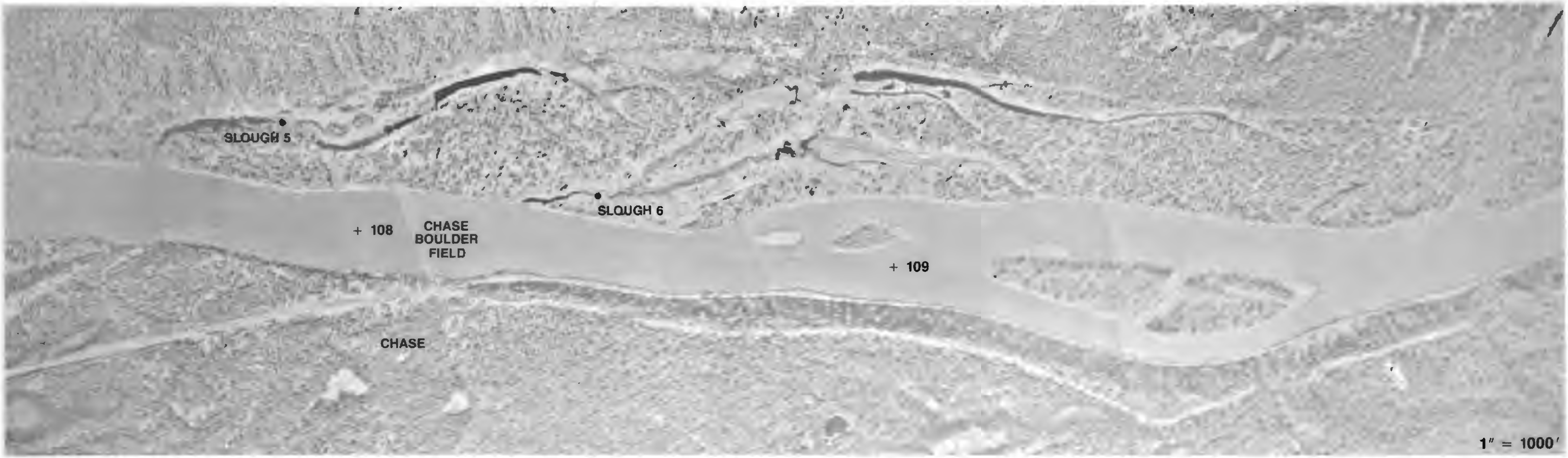


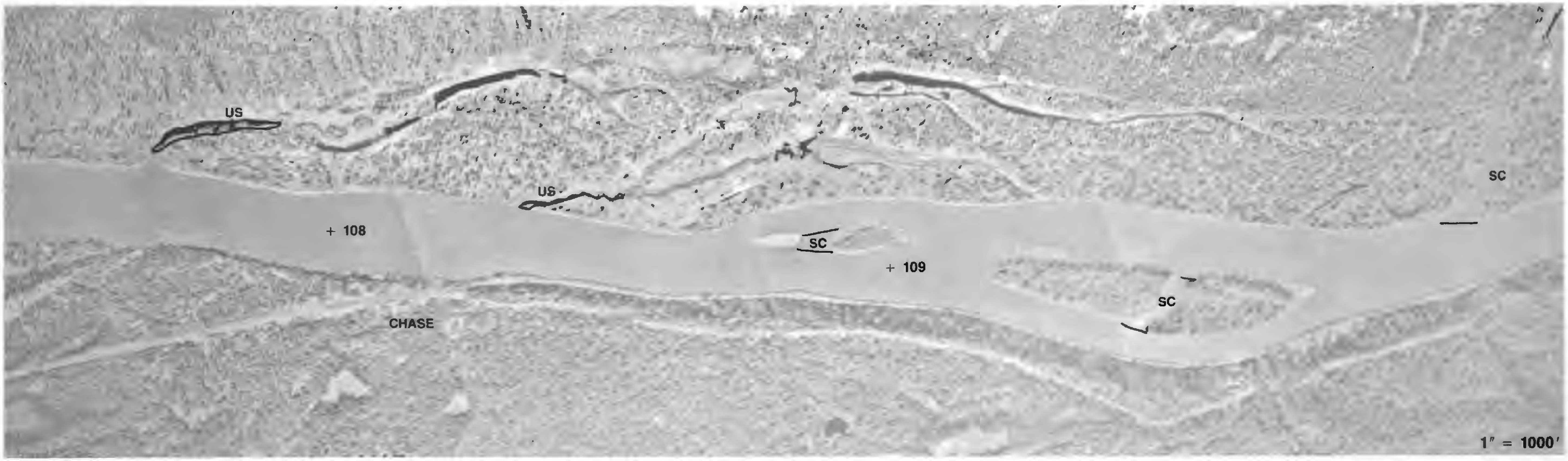


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 15 OF 18    RIVERMILE 108 TO 110

23,000 cfs

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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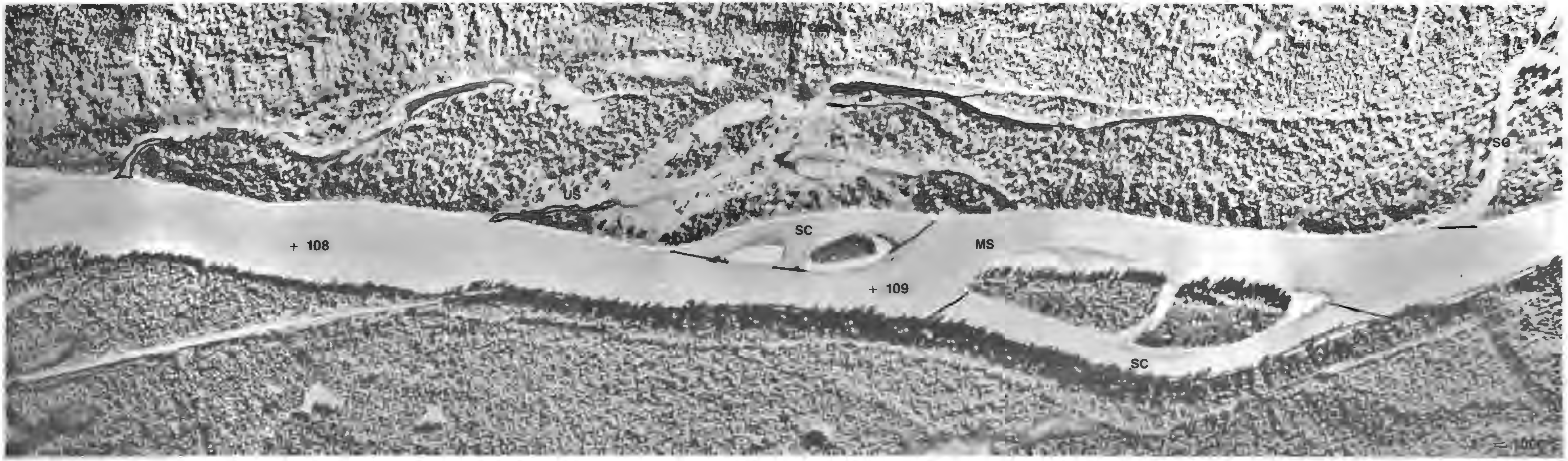


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 15 OF 18 RIVERMILE 108 TO 110

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 15 OF 18 RIVERMILE 108 TO 110

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**LEGEND**

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|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 15 OF 18 RIVERMILE 108 TO 110

ALASKA POWER AUTHORITY
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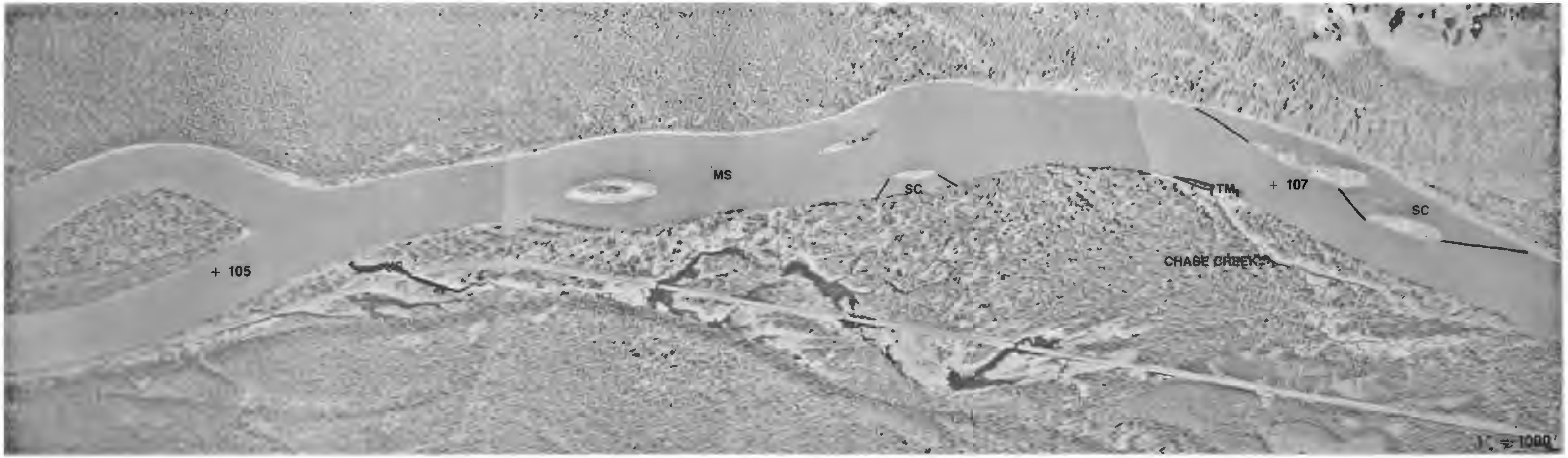


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 16 OF 18 RIVERMILE 105 TO 107

23,000 cfs

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 16 OF 18 RIVERMILE 105 TO 107

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 16 OF 18 RIVERMILE 105 TO 107

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## LEGEND

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 16 OF 18 RIVERMILE 105 TO 107

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SUSITNA HYDROELECTRIC PROJECT

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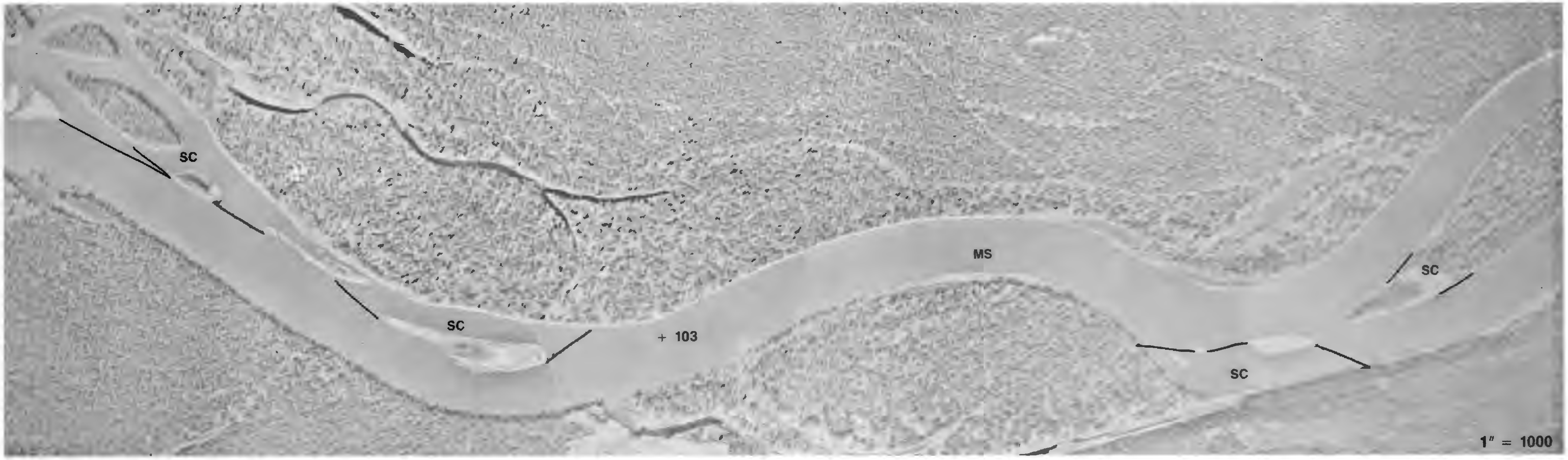


**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 17 OF 18 RIVERMILE 102 TO 104

23,000 cfs

ALASKA POWER AUTHORITY
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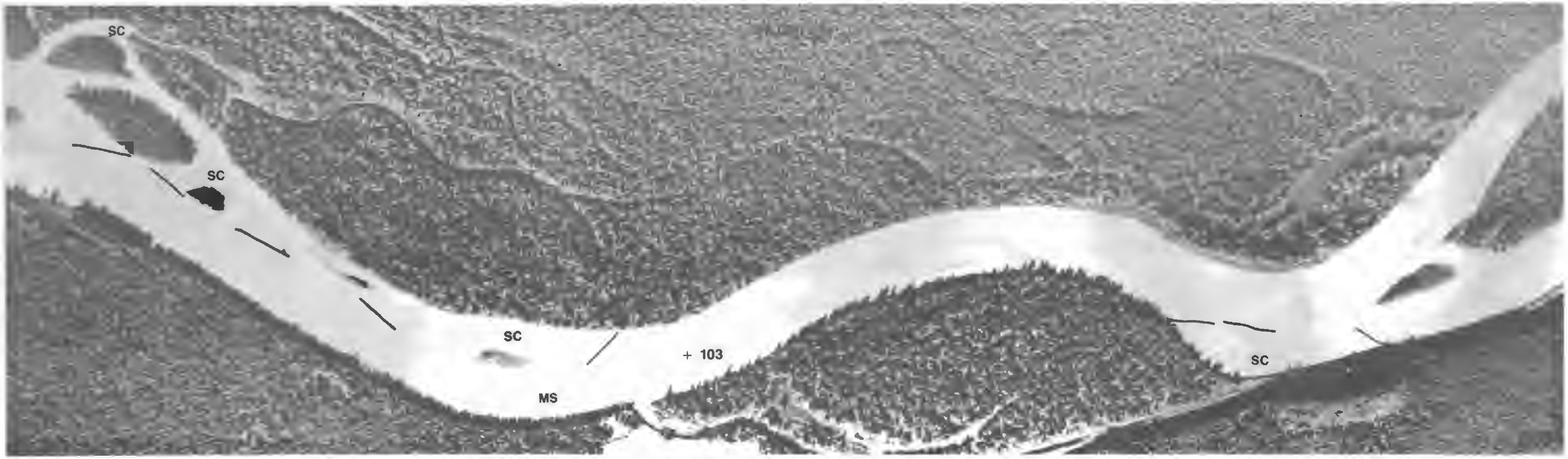


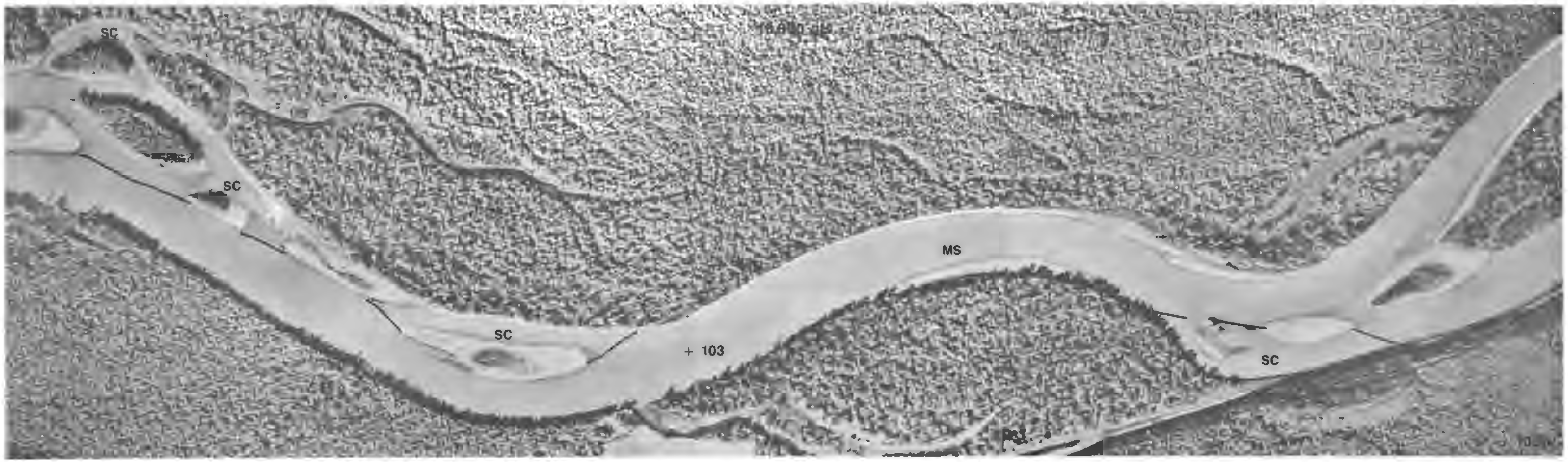


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 17 OF 18 RIVERMILE 102 TO 104

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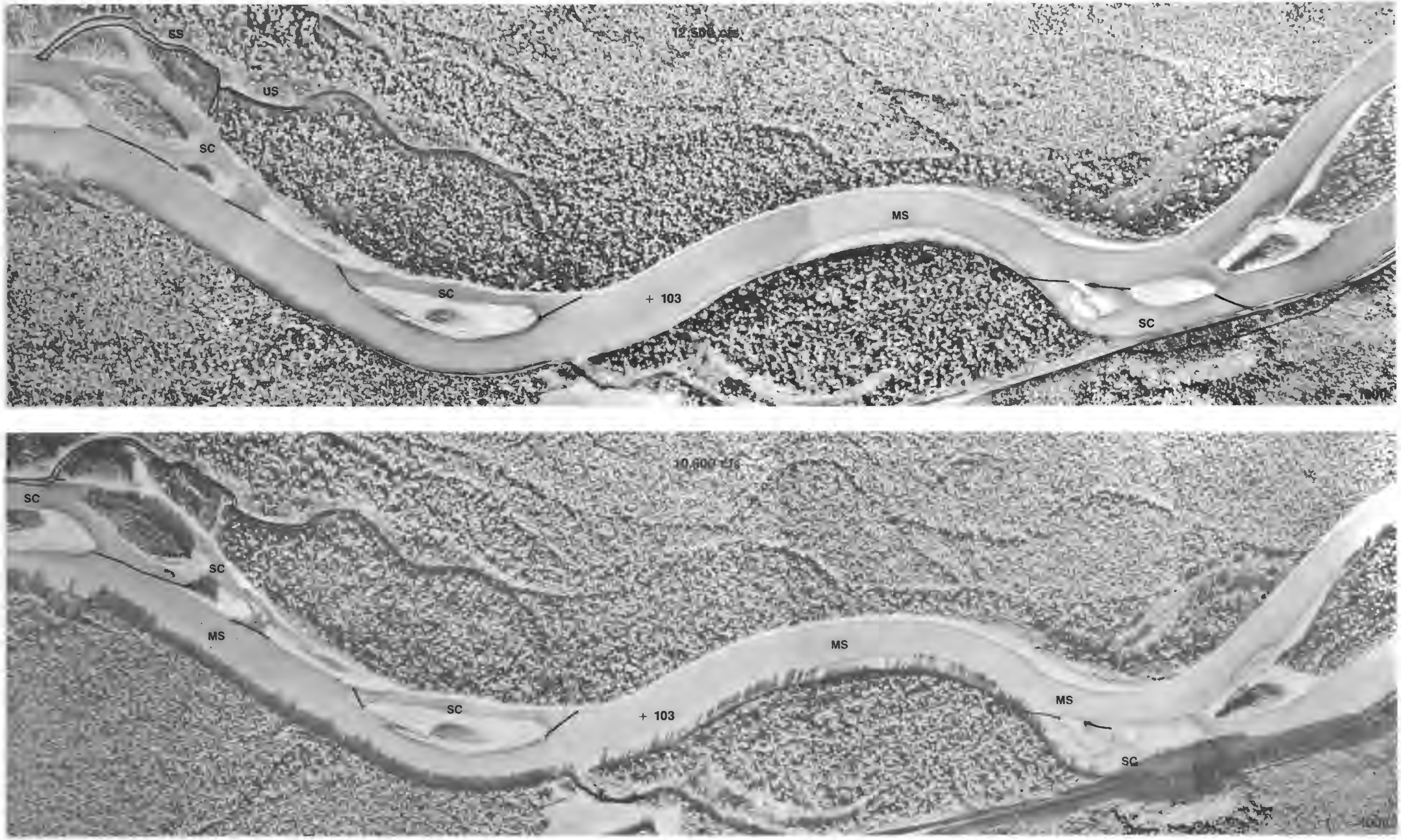


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 17 OF 18 RIVERMILE 102 TO 104

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**LEGEND**

| | | | |
|---|---|---|---|
| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 17 OF 18 RIVERMILE 102 TO 104

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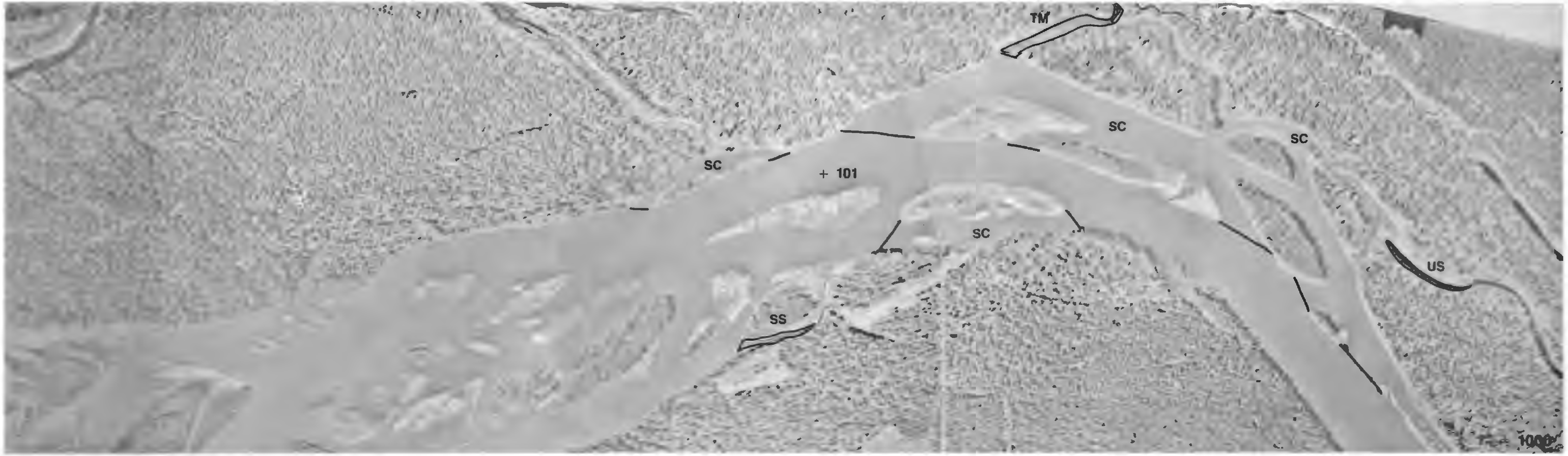


**LEGEND**

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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 18 OF 18 RIVERMILE 101 TO 102

23,000 cfs

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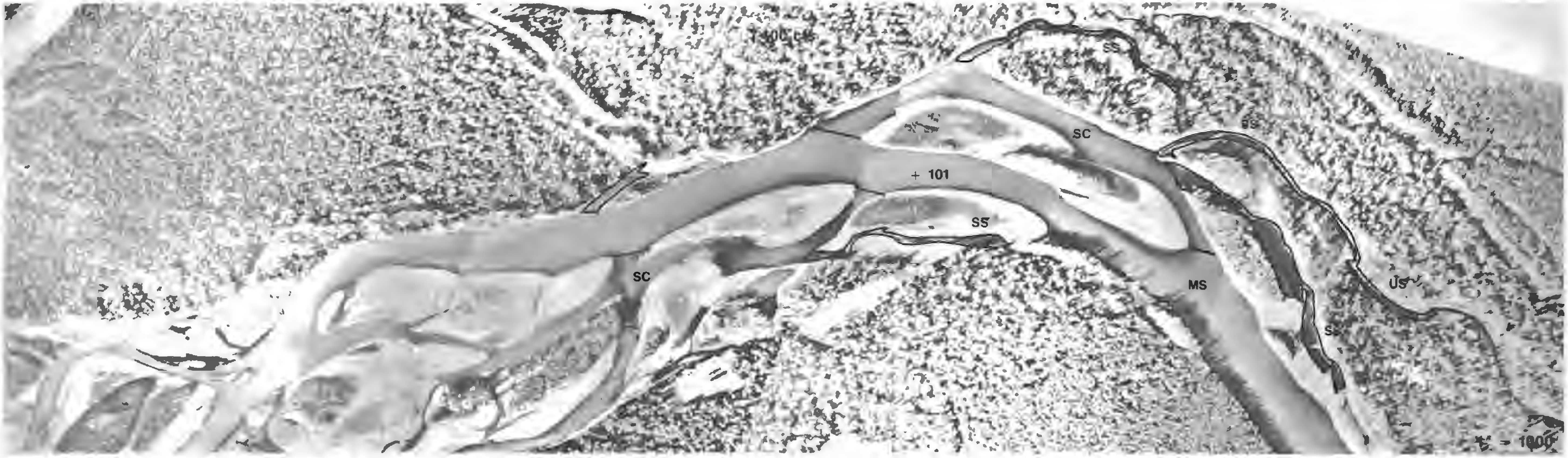


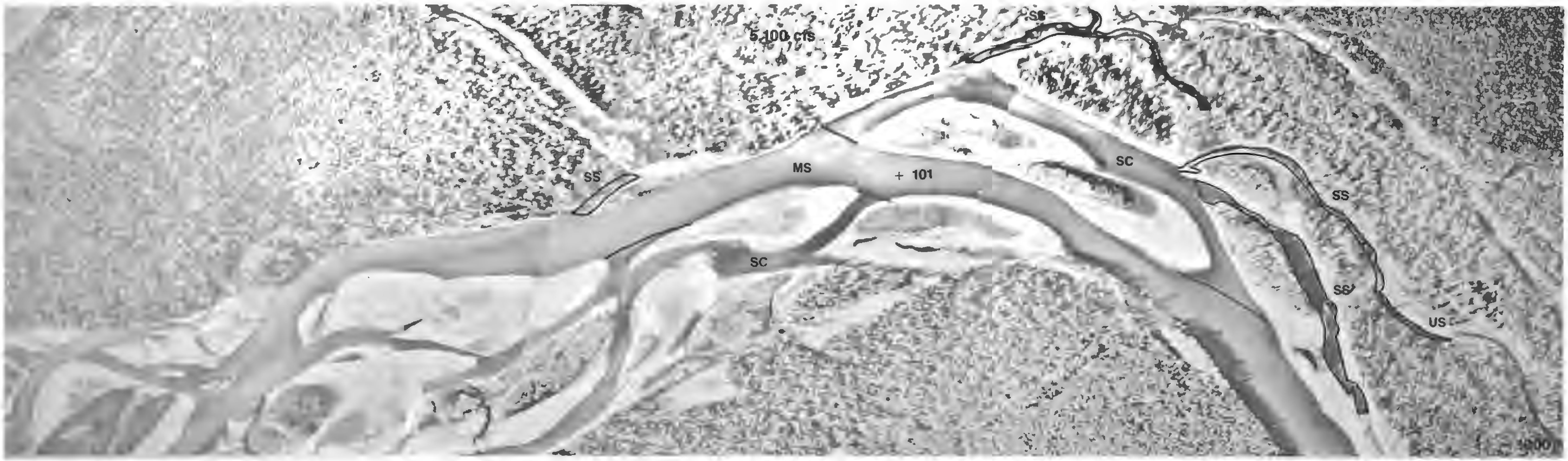


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

MIDDLE SUSITNA RIVER

PLATE 18 OF 18 RIVERMILE 101 TO 102

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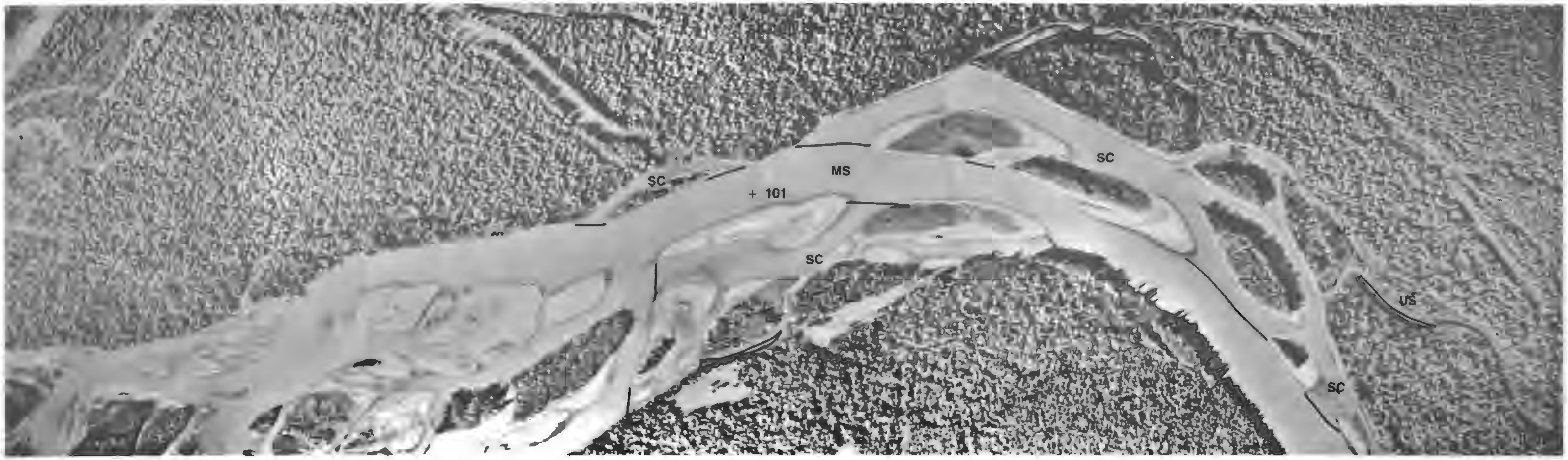


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| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 18 OF 18 RIVERMILE 101 TO 102

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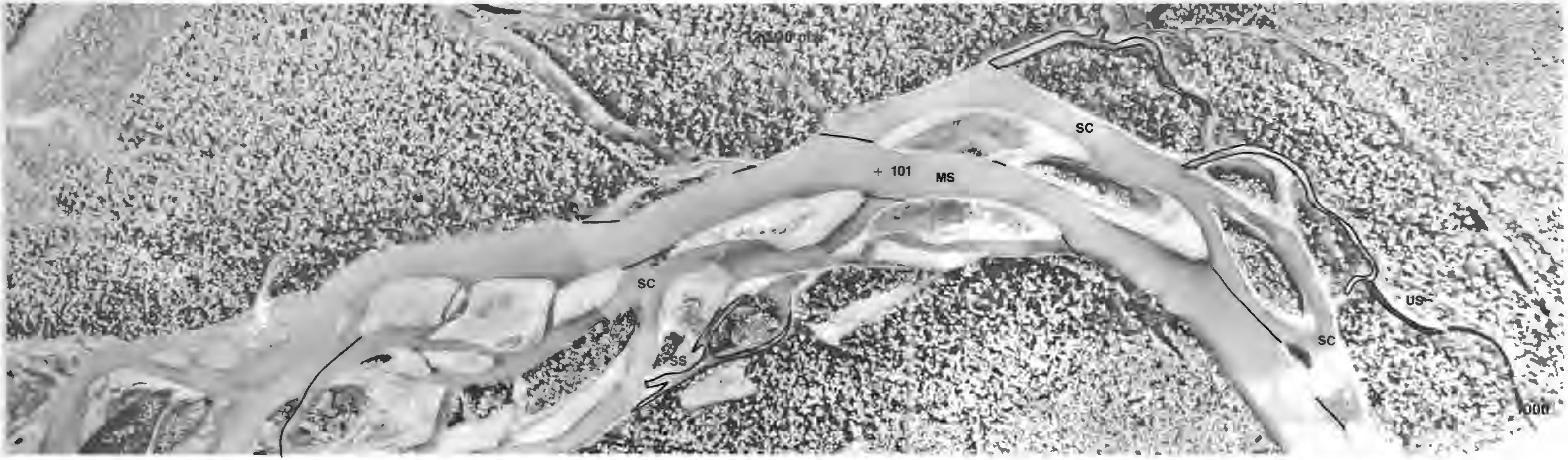


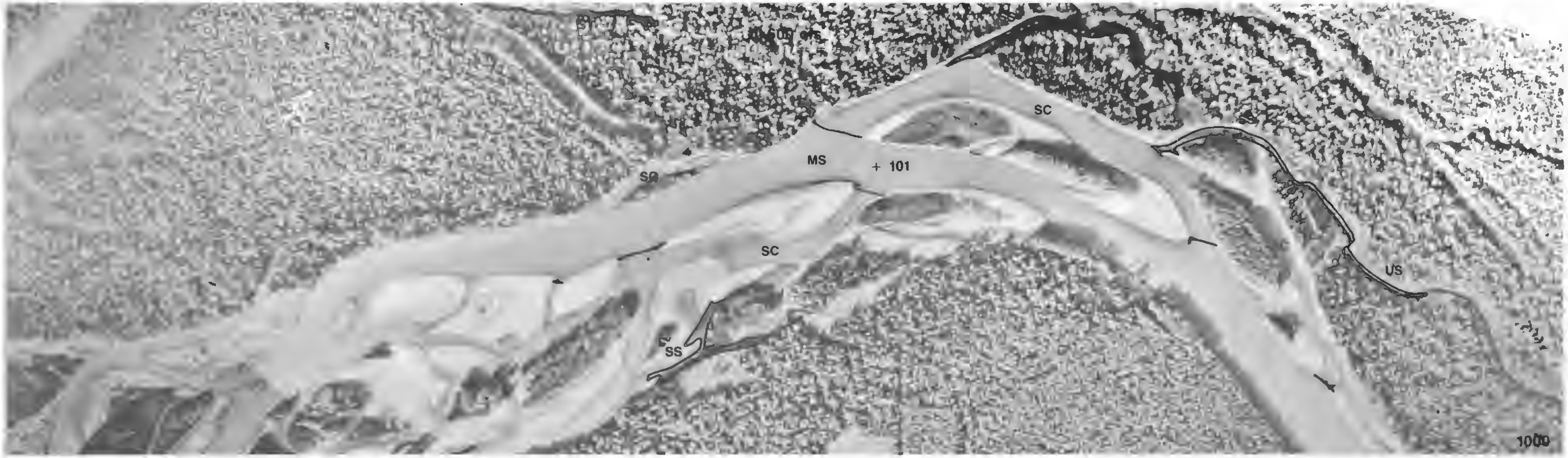


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| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 18 OF 18 RIVERMILE 101 TO 102

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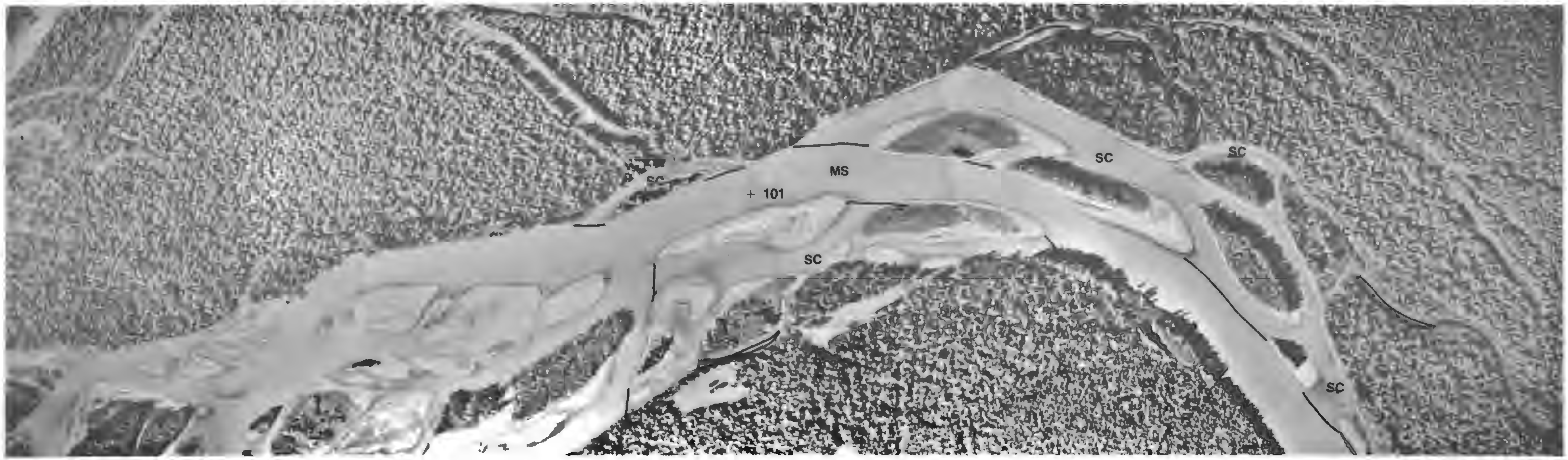


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| MS | MAINSTEM | TM | TRIBUTARY MOUTH |
| SC | SIDE CHANNEL | T | TRIBUTARY |
| SS | SIDE SLOUGH | + | RIVER MILE |
| US | UPLAND SLOUGH | | |

**MIDDLE SUSITNA RIVER**

PLATE 18 OF 18 RIVERMILE 101 TO 102

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Appendix 2. Habitat transformation in response to changing mainstem discharge. Surface areas and breaching flows for middle Susitna River specific areas are presented. The specific areas are delineated on aerial photography taken at 23,000 cfs.

In addition to surface area responding to changes in mainstem discharge, the type of habitat available in a specific area may also change in response to mainstem discharge. This flow dependent change from one habitat type to another is referred to as "habitat transformation." One example of a habitat transformation occurs when a side channel conveying turbid water becomes a clear water side slough as the mainstem discharge (stage) recedes to a level that prevents the flow of turbid mainstem water into the upstream entrance to the side channel and clearwater flow is maintained in the channel by subsurface inflow and infiltration. Another common transformation occurs when mainstem habitat becomes side channel habitat as a result of decreasing mainstem discharge.

Habitat transformations occur almost exclusively along the lateral margins of the river. Thus all wetted surface area present at 23,000 cfs which was not part of the main channel of the middle Susitna River was partitioned into "specific areas". These were defined as discrete geographical locations whose physical boundaries enclose relatively homogeneous morphologic subareas of the middle Susitna River. Nearly all the wetted surface area of the specific areas at 23,000 cfs is comprised of side channel, side slough, and upland slough habitats. Large side channels or side sloughs were occasionally subdivided into two or more specific areas based upon their channel morphology. Some portions of the mainstem (primarily shoals and upwelling areas) were also delineated as specific areas. Each specific area was referenced to a river mile (RM) and the side of the river (looking upstream) on which it was located: left (L), right (R), or middle (M) if between two mainstem forks. Locations of the 172 specific areas are delineated on photo plates of the 23,000 cfs aerial photography (Plates 1-18).

The methodology by which habitat transformations were tracked made use of aerial photography of the middle Susitna River taken at mainstem discharges of 23,000; 18,000; 16,000; 12,500; 10,600; 9000; 7400; and 5100 cfs. At each discharge, the surface area of each specific area was measured and the habitat type the specific area respresented was determined. Eleven "habitat transformation categories" were developed to define the types of habitat transformations that a specific area might undergo as mainstem discharge declines (Aaserude et al. 1985). Habitat transformations at each specific area were identified through photo comparison. Individual specific areas were then grouped according to the sequence of habitat transformations they underwent as mainstem discharge decreased from 23,000 cfs to 5100 cfs (Aaserude et al. 1985). The behavior (sequence of habitat transformation) of these specific areas in response to changing mainstem discharge served as one index by which specific areas could be described.

Another useful index by which specific areas were described and classified was breaching flow. Breaching flow is defined as that mainstem discharge at which the head of a side channel or side slough is overtopped by the mainstem river. Identification of habitat transformation sequence and breaching flows for individual specific areas enabled grouping channels displaying similar characteristics into "representative groups". These groups served as the focal point in the analysis of habitat response to changes in mainstem discharge. Table A-1 lists the mainstem discharges at which each of the specific areas becomes breached and into which representative group each specific area was grouped. Table A-2 presents surface areas for each specific area at each of the seven mainstem discharges for which aerial photography was analyzed. A detailed discussion of habitat transformations, breaching flows and their application to characterization of aquatic habitats can be found in Aaserude et al. (1985) and Steward et al. (1985).

**Plates 1-18.** Specific areas of the middle Susitna River delineated on photography taken at a mainstem discharge of 23,000 cfs.


**MIDDLE SUSITNA RIVER**

**SPECIFIC AREAS**
**at**
**23,000 cfs**

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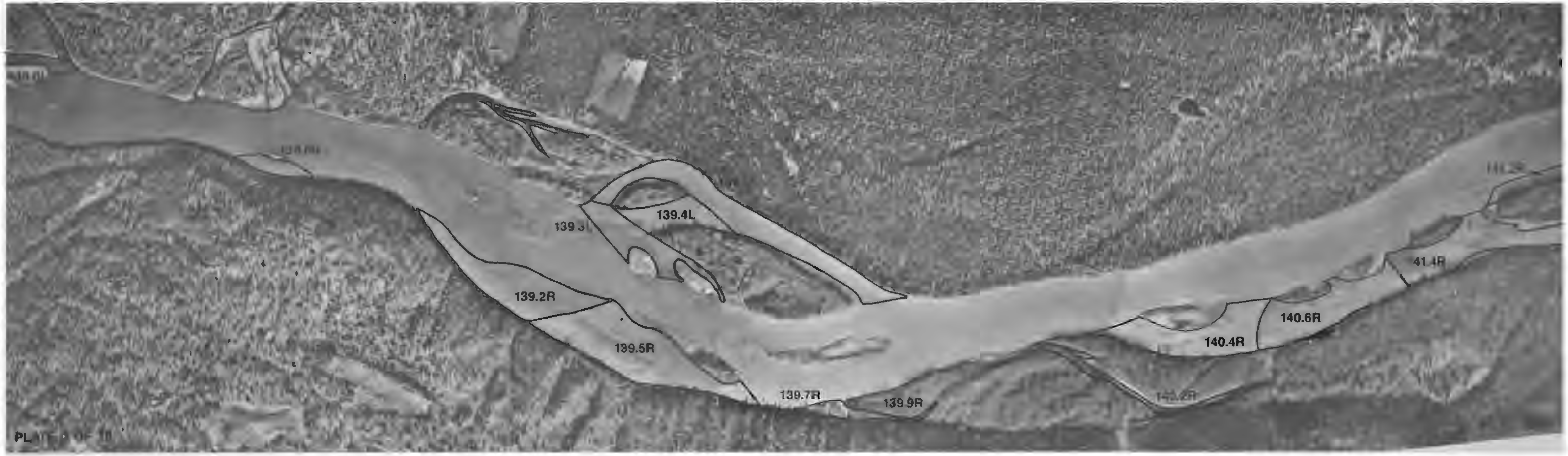


**MIDDLE SUSITNA RIVER**

**SPECIFIC AREAS**
**at**
**23,000 cfs**

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

Trihey & Associates
Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE

MIDDLE SUSITNA RIVER

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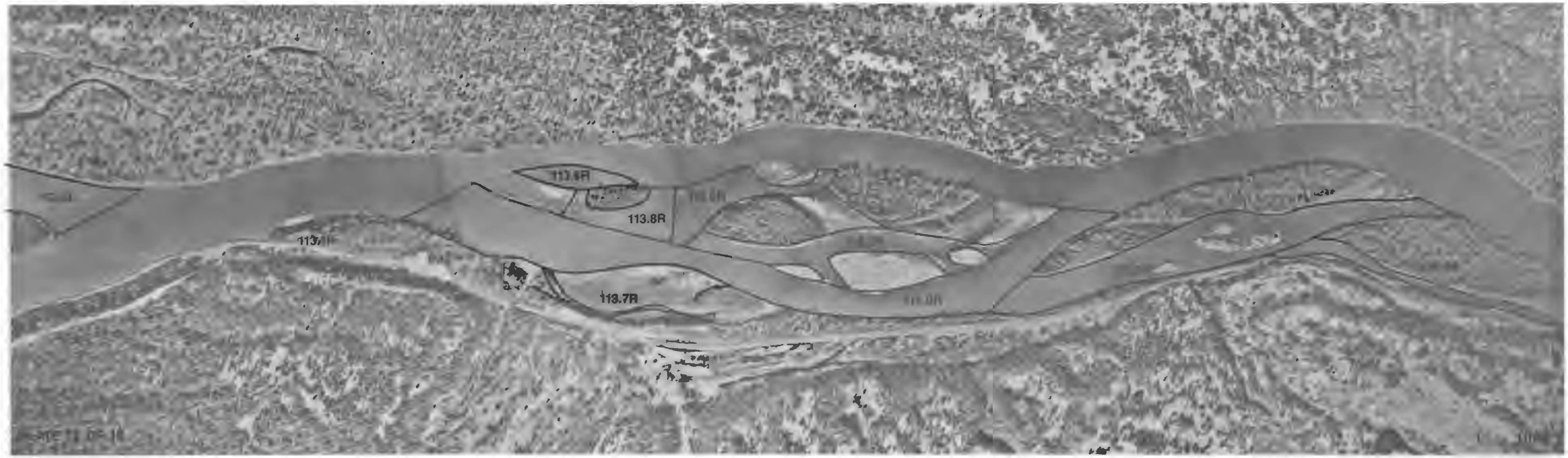


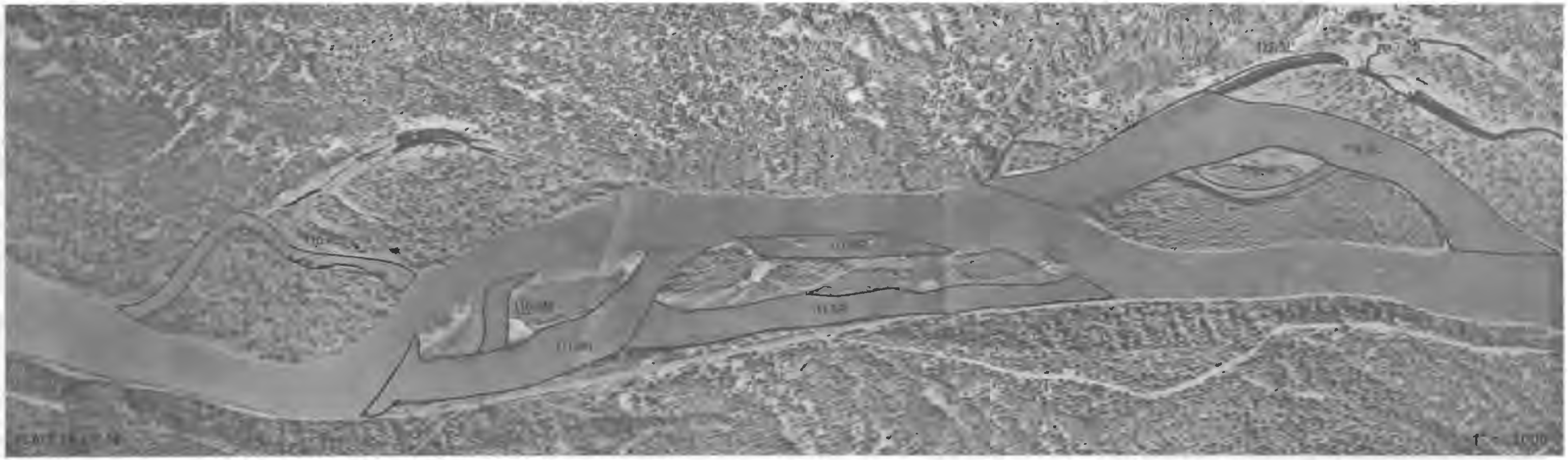

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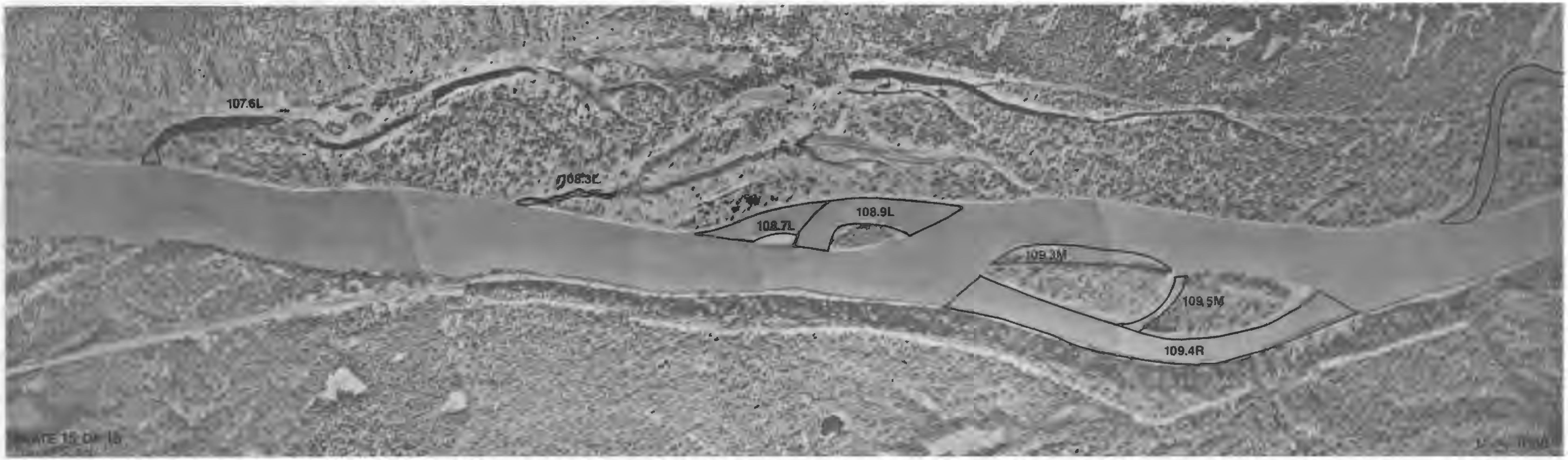


**MIDDLE SUSITNA RIVER**

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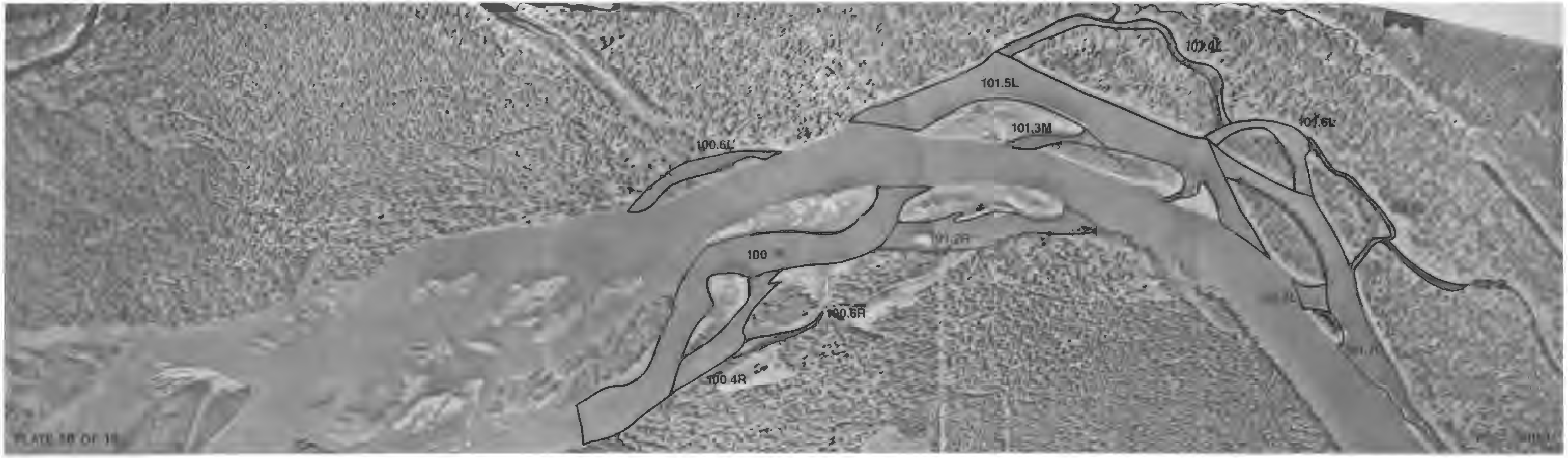


**MIDDLE SUSITNA RIVER**

**SPECIFIC AREAS**
**at**
**23,000 cfs**

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

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Aquatic Resource Specialists

HARZA-EBASCO
SUSITNA JOINT VENTURE

Table A-1. Approximate breaching flows of specific areas of the middle Susitna River.

| Specific Area | Breaching Flow (cfs) | Representative Group | Specific Area | Breaching Flow (cfs) | Representative Group |
|---|---|---|---|---|---|
| 100.40 R | 12500 | III | 115.60 R | 23000 | II |
| 100.60 R | 33000 | II | 116.80 R | <5100 | IV |
| 100.60 L | 9200 | III | 117.00 M | 15500 | V |
| 100.70 R | <5100 | IV | 117.10 M | 15500 | VIII |
| 101.20 R | 9200 | III | 117.20 M | 20000 | VIII |
| 101.30 M | 9200 | VIII | 117.70 L | <5100 | IX |
| 101.40 L | 22000 | II | 117.80 L | 8000 | III |
| 101.50 L | <5100 | IX | 117.90 R | 7300 | VI |
| 101.60 L | 14000 | III | 117.90 L | 22000 | II |
| 101.70 L | 9600 | III | 118.00 L | 22000 | II |
| 101.71 L | MSS | V | 118.60 M | 14000 | VIII |
| 101.80 L | 22000 | II | 118.91 L | MSS | V |
| 102.00 L | 10000 | VIII | 119.11 L | MSS | X |
| 102.20 L | US | I | 119.20 R | 10000 | VII |
| 102.60 L | 6500 | VI | 119.30 L | 16000 | III |
| 104.00 R | <5100 | IX | 119.40 L | US | I |
| 104.30 M | 21000 | VIII | 119.50 L | 5000 | IV |
| 105.20 R | US | I | 119.60 L | <5100 | IV |
| 105.70 R | <5100 | IX | 119.70 L | 23000 | VI |
| 105.81 L | MSS | X | 119.80 L | 15500 | VIII |
| 106.30 R | 4800 | VI | 120.00 R | US | I |
| 107.10 L | 9600 | VI | 120.00 L | 12500 | VIII |
| 107.60 L | US | I | 121.10 R | <5100 | X |
| 108.30 L | US | I | 121.10 L | 7400 | VII |
| 108.70 L | <5100 | IV | 121.50 R | 19500 | VIII |
| 108.90 L | <5100 | IX | 121.60 R | 15500 | VIII |
| 109.30 M | MSS | X | 121.70 R | <5100 | IV |
| 109.40 R | <5100 | IX | 121.80 R | 22000 | II |
| 109.50 M | 16000 | VIII | 121.90 R | US | I |
| 110.40 L | 12000 | III | 122.40 R | 26000 | II |
| 110.80 M | <5100 | IV | 122.50 R | 20000 | II |
| 111.00 R | <5100 | IX | 123.00 L | <5100 | VII |
| 111.50 R | <5100 | IV | 123.10 R | US | I |
| 111.60 R | 11500 | X | 123.20 R | 23000 | VIII |
| 112.40 L | 22000 | VIII | 123.30 R | US | I |
| 112.50 L | US | I | 123.60 R | 25500 | II |
| 112.60 L | <5100 | IV | 124.00 M | 23000 | V |
| 113.10 R | 26000 | II | 124.10 L | <5100 | IV |
| 113.60 R | 10500 | X | 124.80 R | 19500 | VIII |
| 113.70 R | 24000 | II | 125.10 R | 20000 | II |
| 113.80 R | <5100 | IX | 125.20 R | <5100 | IV |
| 113.90 R | 7000 | X | 125.60 L | <5100 | VII |
| 114.00 R | <5100 | IV | 125.60 R | 26000 | VIII |
| 114.10 R | <5100 | VII | 125.90 R | 26000 | II |
| 115.00 R | 12000 | III | 126.00 R | 33000 | II |

MSS = Mainstem Shoal
US = Upland Slough

| Specific Area | Breaching Flow (cfs) | Representative Group | Specific Area | Breaching Flow (cfs) | Representative Group |
|---|---|---|---|---|---|
| 126.30 R | 27000 | II | 137.20 R | 10400 | III |
| 127.00 M | <5100 | IV | 137.50 R | 22000 | II |
| 127.10 M | <5100 | IX | 137.80 L | 20000 | II |
| 127.20 M | US | I | 137.90 L | 21000 | II |
| 127.40 L | <5100 | IV | 138.00 L | 8000 | VI |
| 127.50 M | <5100 | VII | 138.71 L | MSS | X |
| 128.30 R | <5100 | IX | 138.80 R | 6000 | VI |
| 128.40 R | 9000 | VIII | 139.00 L | US | I |
| 128.50 R | 10400 | III | 139.01 L | MSS | V |
| 128.70 R | 15000 | III | 139.20 R | <5100 | IX |
| 128.80 R | 16000 | III | 139.30 L | MSS | X |
| 129.30 L | <5100 | IX | 139.40 L | <5100 | IV |
| 129.40 R | US | I | 139.41 L | MSS | X |
| 129.50 R | <5100 | IV | 139.50 R | 8900 | VI |
| 129.80 R | <5100 | IX | 139.60 L | <5100 | IV |
| 130.20 R | 12000 | III | 139.70 R | 22000 | V |
| 130.20 L | 8200 | III | 139.90 R | US | I |
| 131.20 R | <5100 | IX | 140.20 R | 26500 | II |
| 131.30 L | 9000 | VII | 140.40 R | <5100 | IV |
| 131.70 L | 5000 | IV | 140.60 R | 12000 | VI |
| 131.80 L | 26900 | II | 141.20 R | <5100 | IX |
| 132.50 L | 14500 | VIII | 141.30 R | <5100 | IX |
| 132.60 L | 10500 | III | 141.40 R | 11500 | III |
| 132.80 R | 19500 | V | 141.60 R | 21000 | V |
| 133.70 R | 11500 | III | 142.00 R | 10500 | VI |
| 133.80 L | 17500 | VI | 142.10 R | 23000 | II |
| 133.81 R | MSS | X | 142.20 R | 26000 | II |
| 133.90 R | 30000 | II | 142.80 R | <5100 | IX |
| 133.90 L | US | I | 142.80 L | MSS | X |
| 134.00 L | US | I | 143.00 L | 7000 | V |
| 134.90 R | <5100 | IV | 143.40 L | 23000 | II |
| 135.00 R | 21500 | VIII | 144.00 R | <5100 | IX |
| 135.00 L | <5100 | IX | 144.00 M | 22000 | VIII |
| 135.10 R | 20000 | VIII | 144.20 L | <5100 | IX |
| 135.30 L | 23000 | II | 144.40 L | 21000 | II |
| 135.50 R | US | I | 145.30 R | <5100 | IV |
| 135.60 R | 42000 | I | 145.60 R | 22000 | VIII |
| 135.70 R | 27500 | VI | 146.60 L | 26500 | VIII |
| 136.00 L | <5100 | IV | 147.10 L | <5100 | IX |
| 136.30 R | 13000 | VI | 148.20 R | MSS | X |
| 136.90 R | US | I | | | |

Table A-2. Surface areas by discharge for individual specific areas of the middle Susitna River. Areas are in square inches measured at a scale of 1 inch = 1000 feet (1 square inch = 22.95 acres). The line indicates between which two analyzed discharges breaching of the individual channel occurred.

Did this turn into trib. mouth?

REPRESENTATIVE GROUP I

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 3A — 102.2 L | .054 | .041 | .054 | .048 | .046 | .054 | .040 |
| 4 — 105.2 R | .000 | .010 | .008 | .054 | .039 | .030 | .036 |
| 5 — 107.6 L | .034 | .035 | .016 | .018 | .024 | .024 | .094 |
| 6 — 108.3 L | .032 | .023 | .023 | .018 | .024 | .014 | .024 |
| 6A 112.5 L | .113 | .099 | .111 | .127 | .115 | .119 | .125 |
| 119.4 L | .000 | .000 | .000 | .018 | .019 | .043 | .032 |
| 120.0 R | .039 | .049 | .051 | .052 | .050 | .050 | .092 |
| 8D 121.9 R | .049 ? | .008 | .033 | .006 | .012 | .013 | .009 |
| 123.1 R | .000 | .010 | .022 | .021 | .014 | .047 | .037 |
| 123.3 R | .000 | .058 | .050 | .025 | .024 | .051 | .038 |
| 127.2 M | .005 | .006 | .008 | .027 | .028 | .042 | .031 |
| 9B — 129.4 R | .000 | .098 | .097 | .062 | .060 | .048 | .049 |
| 10 — 133.9 L | .045 | .056 | .074 | .037 | .048 | .049 | .055 |
| 4A — 134.0 L | .016 | .025 | .014 | .008 | .014 | .013 | .019 |
| 12 — 135.5 R | .000 | .045 | .036 | .000 | .042 | .039 | .042 |
| 11 — 135.6 R | .168 | .152 | .159 | .139 | .170 | .275 | .000 |
| 15 — 136.9 R | .007 | .006 | .017 | .018 | .053 | .134 | .094 |
| Slough 17 — 139.0 L | .011 | .084 | .036 | .051 | .047 | .044 | .081 |
| Slough 19 139.9 R | .012 | .020 | .000 | .000 | .013 | .012 | .035 |

— Slough 11 dis

OK sure

Has lower McKenzie been deleted?

There is no suggestion in this report that there are any errors in delineating these areas. Examination of the upland slough data suggests otherwise. Comparisons of individual site areas at different flows shows that 1) large variations in area exist unrelated to flow fluctuations – either errors in delineation, differences in site flow due to local runoff, or some unknown factors

[REPR]ESENTATIVE GROUP II

| Specific Area | 5,100 | 7,400 | Discharge (cfs) 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| | | | .042 | .038 | .044 | .035 | .041 |
| | | | .086* | .170 | .180 | .207 | .220 |
| | | | .030 | .038 | .040 | .039 | .047 |
| | | | .000 | .007 | .013 | .020* | .018 |
| | | | .040 | .024* | .037 | .054 | .132 |
| | | | .174 | .175 | .132 | .254* | .240 |
| | | | .044 | .054 | .042* | .104 | .155 |
| | | | .007 | .000 | .022 | .030 | .078 |
| | | | .037 | .053 | .044 | .053 | .050 |
| | | | .000 | .000 | .000 | .000 | .061 |
| | | | .270 | .293 | .246* | .189* | .376 |
| | | | .044 | .049 | .065 | .052 | .118 |
| | | | .089 | .137 | .000 | .123 | .477 |
| | | | .035 | .055 | .062 | .161* | .095 |
| | | | .418 | .619 | .684 | .680 | .783 |
| | | | .116 | .102 | .284 | .086 | .470 |
| | | | .025* | .014 | .018 | .114* | .019 |
| | | | .056 | .068 | .071 | .015* | .088 |
| | | | .000 | .000 | .015 | .039 | .077 |
| | | | .039 | .043 | .032* | .054 | .066 |
| 137.[illegible] L | | | .113 | .031 | .024 | .080 | .093 |
| 137.8 L | .013 | [illegible] | .039 | .035 | .059 | .061 | .078 |
| 137.9 L | .000 | .000 | .000 | .041 | .059 | .033* | .083 |
| 20 — 140.2 R | .058 | .072 | .084 | .072 | .134 | .119* | .148 |
| 142.1 R | .000 | .000 | .000 | .062 | .017* | .075 | .117 |
| 143.4 L | .000 | .000 | .027 | .048 | .052 | .070 | .199 |
| Slough 22 144.4 L | .101 | .098 | .119 | .117 | .125 | .124 | .176 |
| 142.2 R | * | * | * | .018 | * | * | .023 |

*deleted from further analysis

What are all these (*) deleted from further analysis? Are they the ones ~~so~~ far off base they can't possibly be right?

Did this turn into trib. mouth

Table A-2. Surface areas by discharge for individual specific areas of the middle Susitna River. Areas are in square inches measured at a scale of 1 inch = 1000 feet (1 square inch = 22.95 acres). The line indicates between which two analyzed discharges breaching of the individual channel occurred.

REPRESENTATIVE GROUP I

| | Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|---|
| 3A | 102.2 L | .054 | .041 | .054 | .048 | .046 | .054 | .040 |
| 4 | 105.2 R | .000 | .010 | .008 | .054 | .039 | .030 | .036 |
| 5 | 107.6 L | .034 | .035 | .016 | .018 | .024 | .024 | .094 |
| 6 | 108.3 L | .032 | .023 | .023 | .018 | .024 | .014 | .024 |
| 6A | 112.5 L | .113 | .099 | .111 | .127 | .115 | .119 | .125 |
| | 119.4 L | .000 | .000 | .000 | .018 | .019 | .043 | .032 |
| | 120.0 R | .039 | .049 | .051 | .052 | .050 | .050 | .092 |
| 8D | 121.9 R | .049 ? | .008 | .033 | .006 | .012 | .013 | .009 |
| | 123.1 R | .000 | .010 | .022 | .021 | .014 | .047 | .037 |
| | 123.3 R | .000 | .058 | .050 | .025 | .024 | .051 | .038 |
| | 127.2 M | .005 | .006 | .008 | .027 | .028 | .042 | .031 |
| 9B | 129.4 R | .000 | .098 | .097 | .062 | .060 | .048 | .049 |
| 10 | 133.9 L | .045 | .056 | .074 | .037 | .048 | .049 | .055 |
| 4A | 134.0 L | .016 | .025 | .014 | .008 | .014 | .013 | .019 |
| 12 | 135.5 R | .000 | .045 | .036 | .000 | .042 | .039 | .042 |
| 11 | 135.6 R | .168 | .152 | .159 | .139 | .170 | .275 | .000 |
| 15 | 136.9 R | .007 | .006 | .017 | .018 | .053 | .134 | .094 |
| Slough 17 | 139.0 L | .011 | .084 | .036 | .051 | .047 | .044 | .081 |
| Slough 19 | 139.9 R | .012 | .020 | .000 | .000 | .013 | .012 | .035 |

Slough 11 disappears?

OK sure

Has lower McKenzie been deleted?

REPRESENTATIVE GROUP II

| | Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|---|
| 2 | 100.6 R | .039 | .043 | .042 | .038 | .044 | .035 | .041 |
| Whiskers | 101.4 L | .160 | .153 | .086* | .170 | .180 | .207 | .220 |
| | 101.8 L | .038 | .034 | .030 | .038 | .040 | .039 | .047 |
| | 113.1 R | .000 | .000 | .000 | .007 | .013 | .020* | .018 |
| 8 | 113.7 R | .041 | .038 | .040 | .024* | .037 | .054 | .132 |
| | 115.6 R | .000 | .367* | .174 | .175 | .132 | .254* | .240 |
| Bushrod | 117.9 L | .019 | .016 | .044 | .054 | .042* | .104 | .155 |
| | 118.0 L | .011 | .008 | .007 | .000 | .022 | .030 | .078 |
| | 121.8 R | .035 | .036 | .037 | .053 | .044 | .053 | .050 |
| | 122.4 R | .005 | .024 | .000 | .000 | .000 | .000 | .061 |
| | 122.5 R | .240 | .242 | .270 | .293 | .246* | .189* | .376 |
| Moose | 123.6 R | .031 | .067 | .044 | .049 | .065 | .052 | .118 |
| | 125.1 R | .000 | .011 | .089 | .137 | .000 | .123 | .477 |
| | 125.9 R | .054 | .048 | .035 | .055 | .062 | .161* | .095 |
| 8A | 126.0 R | .498 | .537 | .418 | .619 | .684 | .680 | .783 |
| | 126.3 R | .000 | .084 | .116 | .102 | .284 | .086 | .470 |
| | 131.8 L | .000 | .000 | .025* | .014 | .018 | .114* | .019 |
| | 133.9 R | .021 | .043 | .056 | .068 | .071 | .015* | .088 |
| | 135.3 L | .000 | .000 | .000 | .000 | .015 | .039 | .077 |
| | 137.5 R | .014 | .014 | .039 | .043 | .032* | .054 | .066 |
| | 137.5 L | .106 | .113 | .113 | .031 | .024 | .080 | .093 |
| | 137.8 L | .013 | .016 | .039 | .035 | .059 | .061 | .078 |
| | 137.9 L | .000 | .000 | .000 | .041 | .059 | .033* | .083 |
| 20 | 140.2 R | .058 | .072 | .084 | .072 | .134 | .119* | .148 |
| | 142.1 R | .000 | .000 | .000 | .062 | .017* | .075 | .117 |
| | 143.4 L | .000 | .000 | .027 | .048 | .052 | .070 | .199 |
| Slough 22 | 144.4 L | .101 | .098 | .119 | .117 | .125 | .124 | .176 |
| | 142.2 R | * | * | * | .018 | * | * | .023 |

*deleted from further analysis

What are all these (*) deleted from further analysis? Are they the ones so far off base they can't possibly be right?

Table A-2. Surface areas by discharge for individual specific areas of the middle Susitna River. Areas are in square inches measured at a scale of 1 inch = 1000 feet (1 square inch = 22.95 acres). The line indicates between which two analyzed discharges breaching of the individual channel occurred.

REPRESENTATIVE GROUP III

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 100.4 R | .110 | .115 | .115 | .120 | .174 | .161 | .325 |
| 100.6 L | .050 | .056 | .086 | .100 | .139 | .137 | .162 |
| 101.2 R | .045 | .124 | .232 | .272 | .317 | .455 | .492 |
| 101.6 L | .059 | .070 | .084 | .059 | .112 | .153 | .166 |
| 101.7 L | .313 | .297 | .450 | .670 | .697 | .720 | .800 |
| 110.4 L | .153 | .097 | .204 | .272 | .342 | .399 | .420 |
| 115.0 R | .109 | .225 | .373 | .735 | .780 | 1.135 | 1.231 |
| 119.3 L | .000 | .017 | .052 | .076 | .086 | .096 | .111 |
| 128.5 R | .144 | .143 | .276 | .379 | .894 | .724 | .919 |
| 128.7 R | .080 | .077 | .153 | .184 | .315 | .343 | .389 |
| 128.8 R | .253 | .250 | .265 | .286 | .591 | .435 | 1.281 |
| 130.2 R | .525 | .430 | .459 | .563 | .902 | 1.127 | 1.462 |
| 130.2 L | .022 | .017 | .070 | .079 | .129 | .121 | .145 |
| 132.6 L | .000 | .043 | .183 | .193 | .295 | .325 | .441 |
| 133.7 R | .181 | .170 | .156 | .149 | .237 | .222 | .352 |
| 137.2 R | .116 | .122 | .227 | .401 | .435 | .484 | .579 |
| 141.4 R | .262 | .268 | .278 | .459 | .649 | .696 | .927 |

*deleted from further analysis

REPRESENTATIVE GROUP IV

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 100.7 R | .775 | .828 | .889 | .910 | .972 | 1.162 | 1.243 |
| 108.7 L | .178 | .190 | .198 | .204 | .221 | .227 | .246 |
| 110.8 M | .174 | * | .182 | .188 | .184 | .178* | .208 |
| 111.5 R | .764 | .919 | .999 | 1.113 | 1.180 | 1.197 | 1.423 |
| 112.6 L | 1.730 | 1.660 | 1.934 | 2.116 | 2.290 | 2.338 | 2.309 |
| 114.0 R | 1.450 | 1.703 | 1.706 | 2.116 | 2.326 | 2.517 | 2.152 |
| 116.8 R | .366 | .410* | .399* | .383 | .415 | .325* | .433 |
| 119.5 L | .351 | .376 | .400 | .505 | .518 | .524 | .601 |
| 119.6 L | .000* | 1.274 | 1.216 | * | 1.304 | 1.363 | 1.378 |
| 121.7 R | 1.311 | 1.380 | 1.611 | 1.762 | 1.990 | 2.061 | 2.363 |
| 124.1 L | * | .792 | .900 | .890 | .933 | 1.116 | .768 |
| 125.2 R | 1.582 | 1.528 | 1.872 | 2.198 | 2.405 | 2.335 | 2.453 |
| 127.0 M | .216 | .215 | .310 | .292 | .326 | .377 | .339 |
| 127.4 L | 1.217 | 1.217 | 1.256 | 1.295 | 1.434 | 1.554 | 1.502 |
| 129.5 R | .497 | .486 | .526 | .547 | .270* | .406* | .716 |
| 131.7 L | .231 | .774 | 1.158 | .088* | 1.584 | 1.738 | 2.072 |
| 134.9 R | 1.278 | 1.372 | 1.468 | 1.451 | 1.882 | 1.915 | 2.182 |
| 136.0 L | .038 | .041 | .048 | .054 | .061 | .066 | .071 |
| 139.4 L | .123 | .168* | .137 | .188* | .156 | .147* | .161 |
| 139.6 L | .548 | .528* | .472* | .595 | .637 | .612* | .688 |
| 140.4 R | .338 | .331 | .567* | .445 | .471 | .407* | .517 |
| 144.0 R | .617 | .548 | .193 | .339 | .368 | .284 | .190 |
| 145.3 R | .251* | .229 | .160* | .239 | .234 | .255* | .241 |

*deleted from further analysis

Table A-2. Surface areas by discharge for individual specific areas of the middle Susitna River. Areas are in square inches measured at a scale of 1 inch = 1000 feet (1 square inch = 22.95 acres). The line indicates between which two analyzed discharges breaching of the individual channel occurred.

REPRESENTATIVE GROUP V

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 101.7 L | .313 | .297 | .450 | .670 | .671 | .261* | .729 |
| 117.0 M | .000 | .000 | .000 | .032 | .093 | .310 | .342 |
| 124.0 M | .000 | .019 | .044 | .052 | .103 | .157 | .526 |
| 132.8 R | .021 | .807* | .015* | .023 | .042 | .045 | .078 |
| 139.0 L | .011 | .084* | .036 | .051 | .047 | .044* | .081 |
| 139.7 R | .000 | .000 | .000 | .000 | .000 | .005 | .076 |
| 141.6 R | .094 | .100 | .072* | .111 | .112 | .148 | .217 |
| 143.0 L | .019 | .026 | .084 | .090 | .089 | .084 | .161 |

*deleted from further analysis

REPRESENTATIVE GROUP VI

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 102.6 L | .143 | .229 | .330 | .414 | .479 | .488 | .520 |
| 106.3 R | .086 | .084 | .117 | .156 | .161 | .159 | .180 |
| 107.1 L | .000 | .024 | .207 | .212 | .363 | .436 | .698 |
| 117.8 L | .081 | .056* | .123 | .170 | .194 | .154* | .262 |
| 117.9 R | .041 | .035 | .036 | .038 | .041 | .206* | .071 |
| 119.7 L | .040 | .027 | .000 | .025 | .058 | .000* | .045 |
| 10 SC. 133.8 L | .130 | .127 | .166 | .201 | .216 | .344 | .378 |
| 135.7 R | .000 | .029 | .000 | .071* | .036 | .091* | .064 |
| 136.3 R | .062 | .112 | .116 | .134 | .175 | .257 | .336 |
| 138.0 L | .000 | .000 | .070 | .163 | .194 | .109* | .224 |
| 138.8 R | .008 | .099 | .080* | .119 | .154 | .142 | .193 |
| 139.5 R | .163* | .128 | .097 | .296 | .423 | .549 | .692 |
| 140.6 R | .041 | .069 | .009* | .325 | .363 | .315 | .574 |
| 142.0 R | .066 | .138 | .175 | .266 | .360 | .623 | .747 |

*deleted from further analysis

REPRESENTATIVE GROUP VII

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 114.1 R | .256 | .338 | .386 | .393 | .442 | .000* | .489 |
| 119.2 R | .122 | .120 | .196 | .206 | .283 | .334 | .330 |
| 121.1 L | .060 | .094 | .173 | .242 | .322 | .503 | .581 |
| 123.0 L | .040 | .046 | .000* | .054 | .047 | .116* | .079 |
| 125.6 L | .141 | .000* | .151 | .182 | .146* | .228* | .198 |
| 127.5 M | .281 | .335 | .334 | .430 | .363 | .708* | .495 |
| 131.3 L | .110 | .072 | .163 | .292 | .405 | .532 | .649 |

*deleted from further analysis

Table A-2. Surface areas by discharge for individual specific areas of the middle Susitna River. Areas are in square inches measured at a scale of 1 inch = 1000 feet (1 square inch = 22.95 acres). The line indicates between which two analyzed discharges breaching of the individual channel occurred.

REPRESENTATIVE GROUP VIII

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 101.3 M | .000 | .000 | .038 | .045 | .097 | .061* | .108 |
| 102.0 L | .000 | .000 | .058 | .090 | .098 | .091 | .123 |
| 104.3 M | .000 | .000 | .000 | .000 | .000 | .065* | .036 |
| 109.5 M | .000 | .000 | .000 | .000 | .000 | .014 | .056 |
| 112.4 L | .000 | .000 | .000 | .000 | .000 | .035 | .143 |
| 117.1 M | .000 | .000 | .000 | .071 | .271 | .447* | .422 |
| 117.2 M | .000 | .000 | .000 | .000 | .000 | .024 | .045 |
| 118.6 M | .007 | .025 | .013 | .021 | .034 | .054 | .076 |
| 119.8 L | .000 | .000 | .000 | .000 | .031 | .091* | .037 |
| 120.0 L | .000 | .011 | .036 | .086 | .160 | .064* | .244 |
| 121.5 R | .000 | .000 | .000 | .000 | .034 | .105 | .294 |
| 121.6 R | .000 | .000 | .000 | .000 | .135 | .339 | .385 |
| 123.2 R | .012 | .018 | .023 | .025 | .016 | .055 | .123 |
| 124.8 R | .000 | .000 | .010 | .023 | .067 | .074 | .262 |
| 125.6 R | .000 | .000 | .016 | .012 | .011 | .029 | .162 |
| 128.4 R | .000 | .000 | .052 | .091 | .132 | .144 | .269 |
| 132.5 R | .000 | .000 | .000 | .000 | .097 | .054* | .146 |
| 135.0 R | .000 | .000 | .000 | .000 | .041 | .000* | .243 |
| 135.1 R | .000 | .000 | .000 | .058 | .058 | .000* | .135 |
| 144.0 M | .000 | .000 | .000 | .000 | .000 | .000 | .102 |
| 145.6 R | .000 | .000 | .000 | .000 | .000 | .180 | .242 |
| 146.6 L | .000 | .000 | .000 | .000 | .000 | .010 | .014 |

*deleted from further analysis

REPRESENTATIVE GROUP IX

| Specific Area | Discharge (cfs) 5,100 | 7,400 | 10,600 | 12,500 | 16,000 | 18,000 | 23,000 |
|---|---|---|---|---|---|---|---|
| 101.5 L | 1.343 | 1.278 | 1.208 | 1.239 | 1.651 | 1.698 | 2.661 |
| 104.0 R | .641 | .631 | .631 | .716 | .698 | .679 | .887 |
| 105.7 R | .363 | .419 | .358 | .407 | .417 | .389 | .447 |
| 108.9 L | .307 | .272 | .290 | .283 | .333 | .366 | .401 |
| 109.4 R | .917 | .951 | .990 | 1.081 | 1.062 | 1.072 | 1.218 |
| 111.0 R | .896 | .939 | 1.033 | 1.062 | 1.258 | 1.149* | 1.368 |
| 113.8 R | .135 | .123 | .145 | .154 | .171 | .186 | .181 |
| 117.7 L | .173 | .203 | .162* | .218 | .292 | .087* | .345 |
| 127.1 M | .403 | .404 | .442 | .537 | .628 | .738 | .887 |
| 128.3 R | .684 | .815 | .884 | 1.094 | 1.009 | 1.096 | 1.566 |
| 129.3 L | .179 | .181 | .142* | .178 | .163 | .132* | .266 |
| 129.8 R | .572 | .626 | .619 | .618 | .656 | .463* | .686 |
| 131.2 R | .142 | .185* | .133 | .139 | .161 | .169 | .226 |
| 135.0 L | .212 | .201 | .190 | .192 | .202 | .188* | .212 |
| 139.2 R | .434 | .458 | .516 | .530 | .583 | .510* | .662 |
| 141.2 R | .130 | .189* | .194 | .142 | .152 | .056* | .244 |
| 141.3 R | .294 | .000* | .297 | .290 | .288 | .332 | .331 |
| 142.8 R | .839 | .925 | 1.100* | .978 | 1.264 | .582* | 1.305 |
| 144.2 L | 1.846 | 1.787 | 1.133* | 1.127* | 1.838 | .709* | 1.943 |
| 147.1 L | .516 | .503 | .552 | .497 | .534 | .611 | .675 |

*deleted from further analysis