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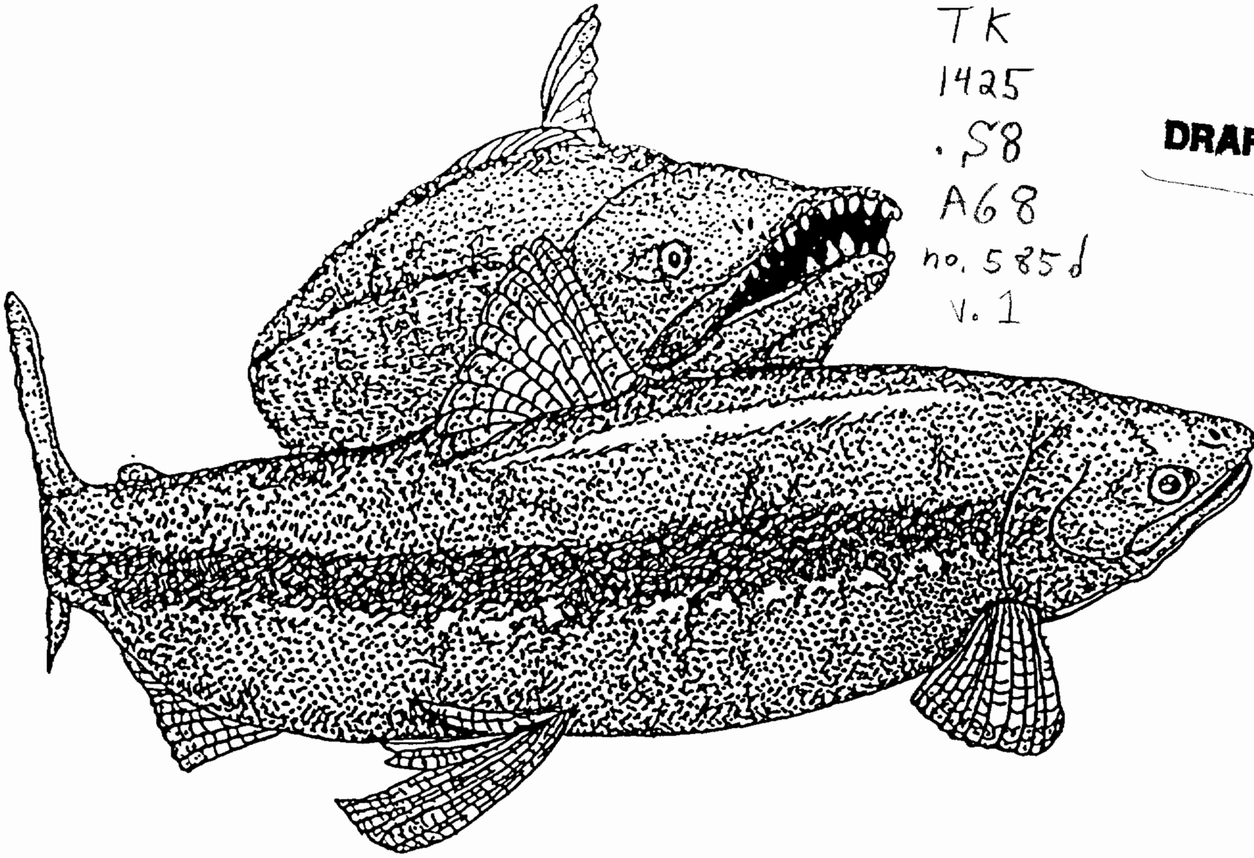

SUSITNA HYDRO AQUATIC STUDIES
PHASE II BASIC DATA REPORT

Volume 4. Aquatic Habitat and Instream Flow Studies, 1982.

Preface & Part I

ALASKA DEPARTMENT OF FISH AND GAME

-by-

ALASKA DEPARTMENT OF FISH AND GAME
Susitna Hydro Aquatic Studies
2207 Spenard Road
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1983

PREFACE

This report is part of a five volume presentation of the fisheries, aquatic habitat, and instream flow data collected by the Alaska Department of Fish and Game (ADF&G) Susitna Hydroelectric (Su Hydro) Feasibility Aquatic Studies Program during the 1981-82 (October-May) ice-covered and 1982 open water (May-October) seasons. It is one of a series of reports prepared for the Alaska Power Authority (APA) and its principal contractor, Acres American (Acres) by the ADF&G and other contractors to evaluate the feasibility of the proposed Susitna Hydroelectric Project. This preliminary draft is an internal working document and intended for data transmittal to other Susitna Hydroelectric Feasibility Study participants. A final report will be distributed April 15, 1983.

The topics discussed in Volumes Two through Five are illustrated in Figure A. Volume One (to be distributed with the final report) will present a synopsis of the information contained in the other four volumes. Volume Two also includes a comparison of 1981 and 1982 adult anadromous fisheries data.

A second ADF&G report will include an analysis of the pre-project fishery and habitat relationships derived from this and related reports prepared by other study participants. A review draft will be circulated to study participants on May 1, 1983. The final report will be submitted to the APA on June 30, 1983 for formal distribution to study participants, state and federal agencies, and the public. Scheduled for completion on the same date is the first draft of the ADF&G 1982-83 ice covered season basic data report. It will include a presentation of 1982-83 incubation and other fishery and habitat data.

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[1]Refer to Volume One for References.

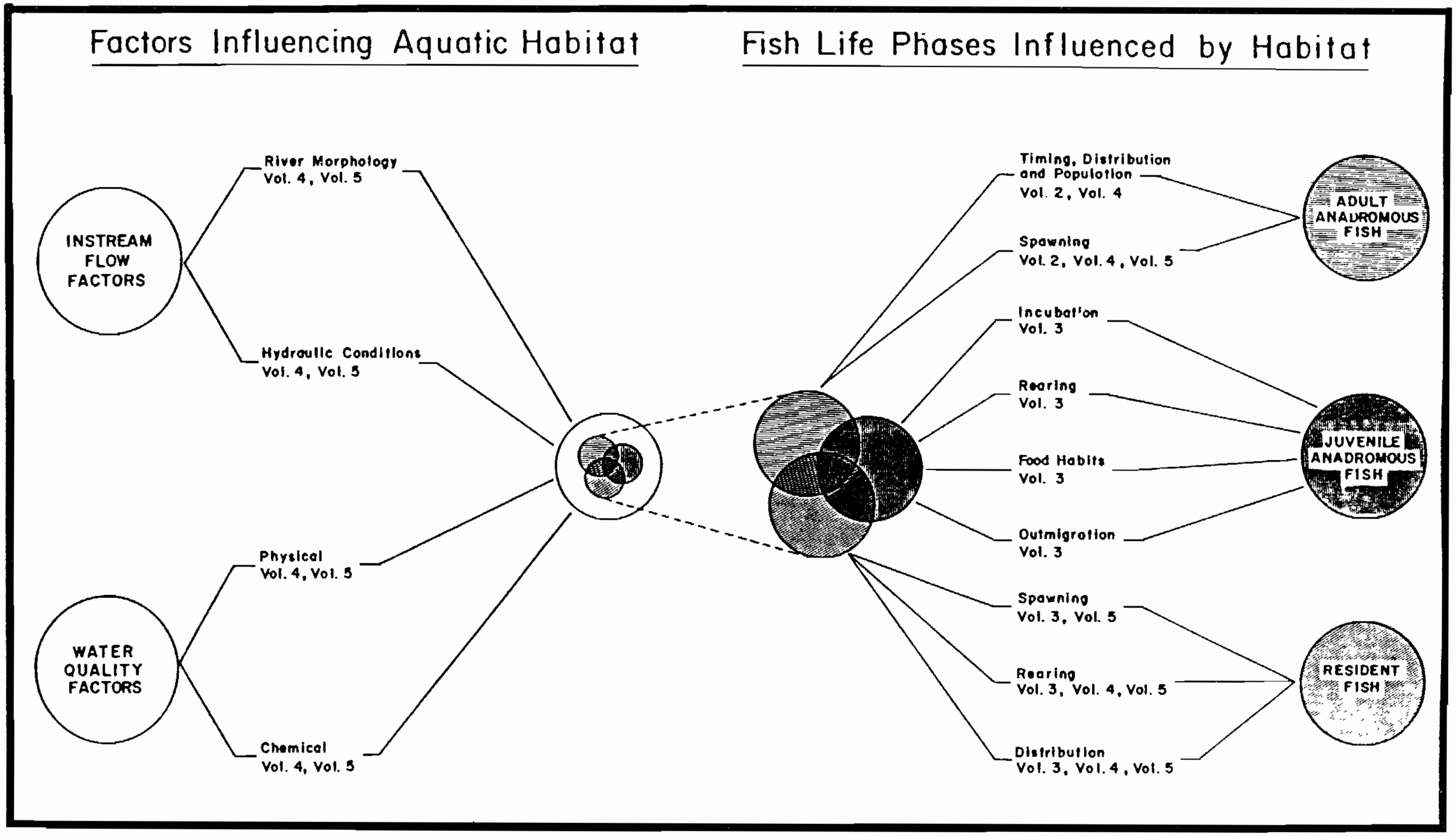

Figure A   Program elements presented in Volumes Two through Five.

These and other ADF&G reports (1974-1976, 1977, 1978, 1979, 1981a, b, c, d, e, f, 1982[1]) and information reported by others will be summarized and analyzed by the Arctic Environmental Information and Data Center (AEIDC) to evaluate post-project conditions. Woodward Clyde Consultants will, in turn, use this information to support their preparation of the Federal Energy Regulatory Commission License Application for Acres.

The five year (Acres 1980[1]) ADF&G Su Hydro Aquatic Studies program was initiated in November, 1980. It is subdivided into three study sections: Adult Anadromous Fish Studies (AA), Resident and Juvenile Anadromous Fish Studies (RJ), and Aquatic Habitat and Instream Flow Studies (AH).

Specific objectives of the three sections are:

1. AA - determine the seasonal distribution and relative abundance of adult anadromous fish populations produced within the study area (Figure B);

2. RJ - determine the seasonal distribution and relative abundance of selected resident and juvenile anadromous fish populations within the study area; and

3. AH - characterize the seasonal habitat requirements of selected anadromous and resident fish species within the study area and the relationship between the availability of these habitat conditions and the mainstem discharge of the Susitna River.

The 1982 ADF&G portion (Figures C and D) of the overall feasibility project study area (Figure B) was limited to the mainstem Susitna River and the mouths of major tributaries. Portions of tributaries which will

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[1] Refer to Volume One for References.

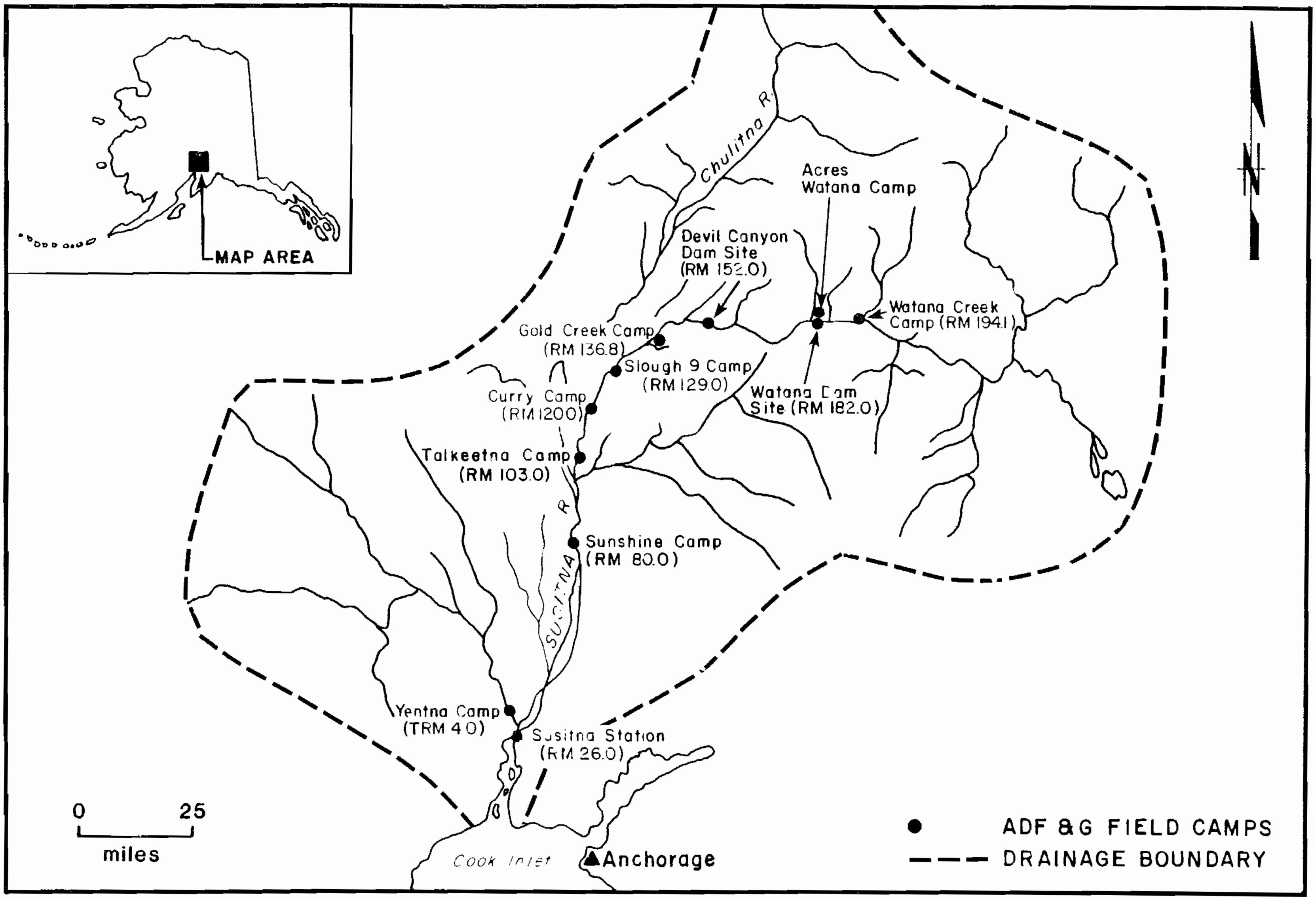

Figure 8. Susitna River drainage basin.

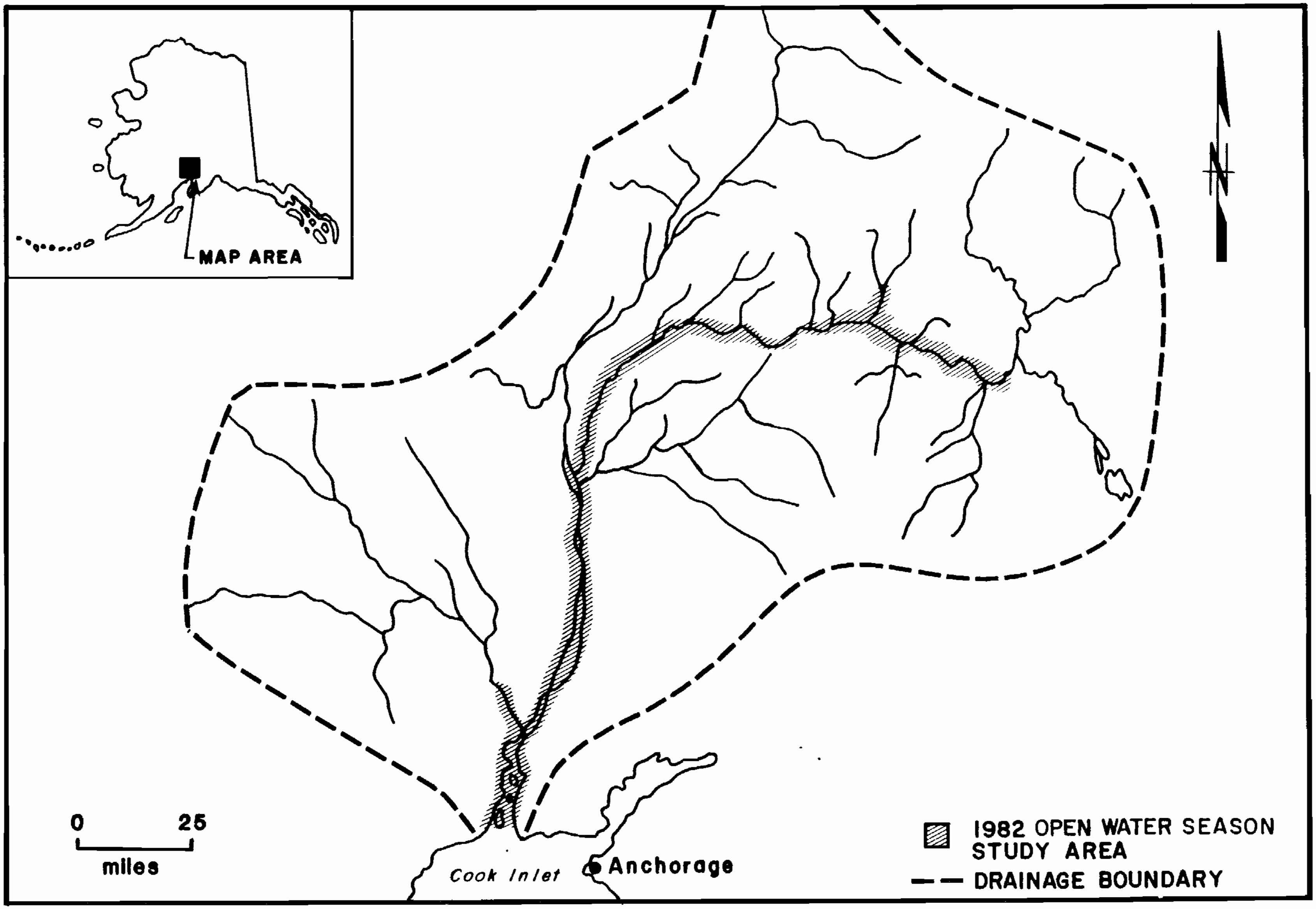

Figure C. 1982 ADF&G open water season (May through October) study area.

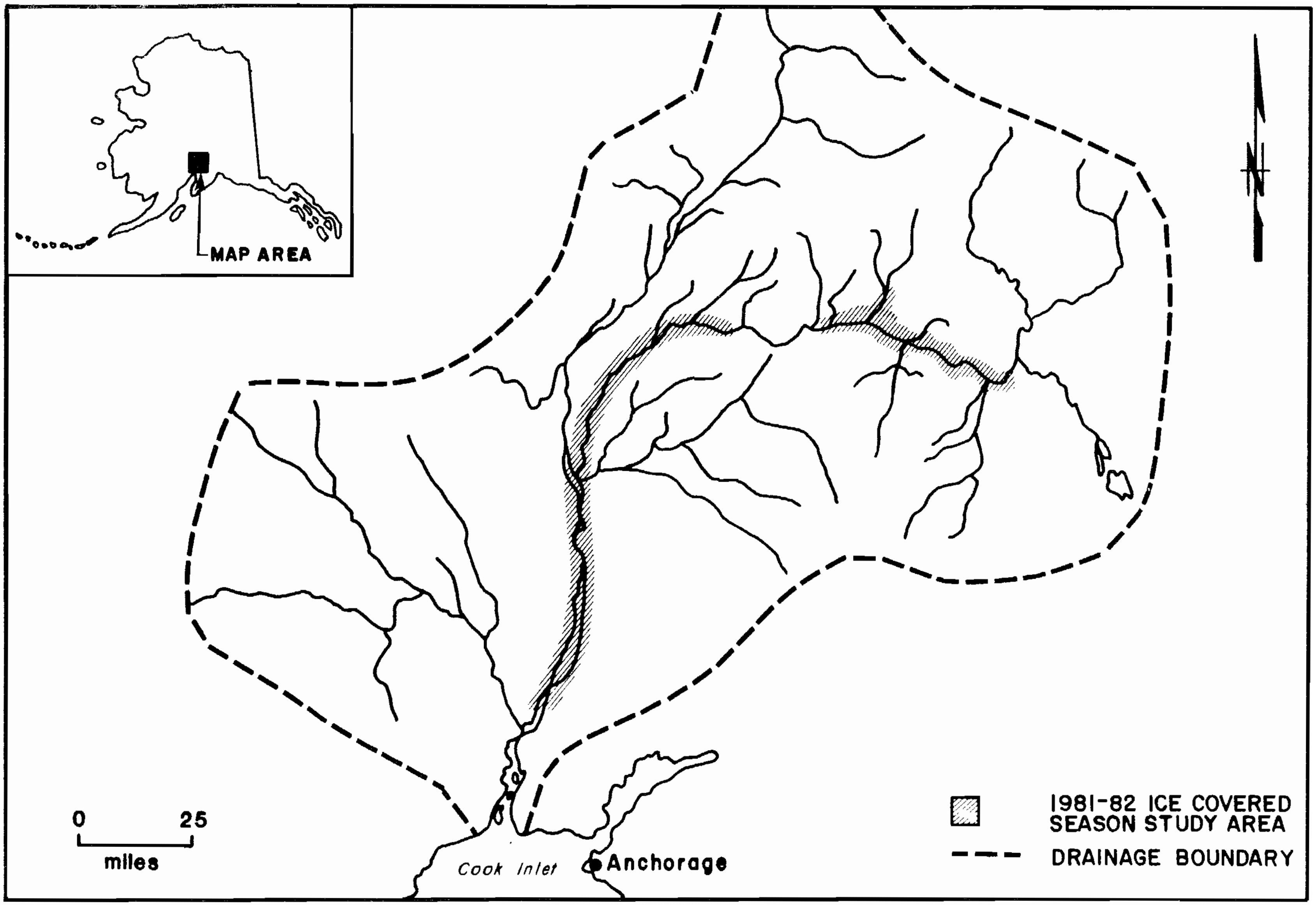

Figure D. 1981-82 ADF&G ice covered season (October through May) study area.

be inundated by the proposed impoundments were also evaluated. Descriptions of study sites are presented in each of these volumes including the ADF&G reports (ADF&G 1981a, b, c, d, e, f[1]).

The Susitna River is approximately 275 miles long from its sources in the Alaska Mountain Range to its point of discharge into Cook Inlet. Its drainage encompasses an area of 19,400 square miles. The mainstem and major tributaries of the Susitna River, including the Chulitna, Talkeetna and Yentna rivers, originate in glaciers and carry a heavy load of glacial flour during the ice-free months (approximately May through October). There are many smaller tributaries which are perenially clear.

Questions concerning these reports should be directed to:

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FOREWARD

This volume of the Aquatic Studies Draft Basic Data Report is divided into two parts (Figure 4-1). Part I, the "Hydrologic and Water Quality Investigations," is a compilation of the physical and chemical data collected by the ADF&G Su Hydro Aquatic Studies team. These data are arranged by individual variables for ease of access to user agencies. The combined data set represents the available physical habitat of the Susitna River.

Part II, the "Lower River Fisheries Habitat Investigations," describes the subset of available habitat compiled in Part I that is utilized by the various species and life phases of fish studied in the lower Susitna River (downstream of Devil Canyon). It represents the first stage of development for a fisheries and habitat relationships analysis report which will be completed in the spring 1983 (refer to Preface).

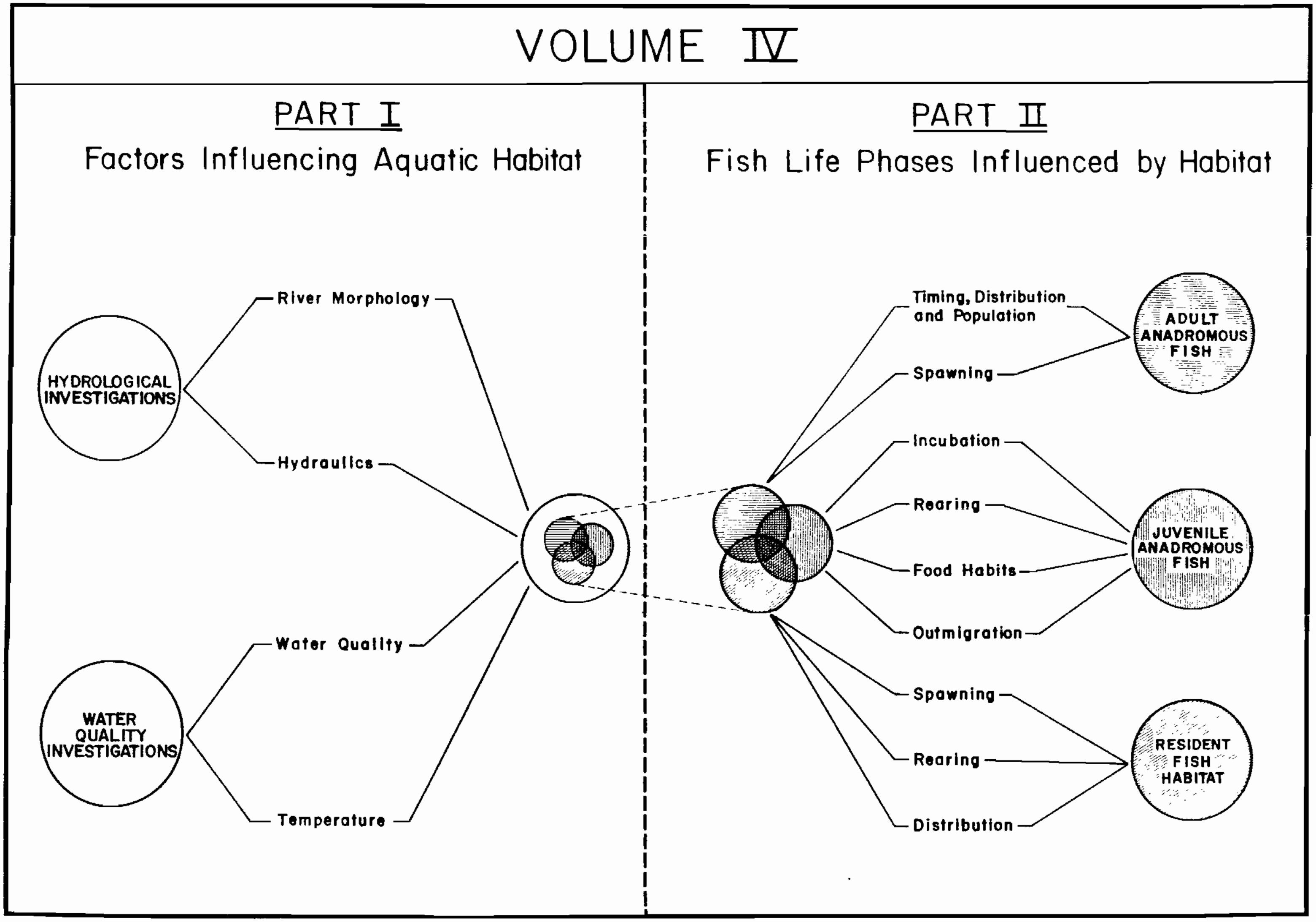

Figure 4-1. Organization of Volume 4.

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ACKNOWLEDGEMENTS

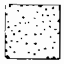
Special appreciation is extended to Nikki Newcome (ADF&G) for providing technical support to the computer modeling portion of the hydraulic studies; Beverly Valdez (Arctic Environmental Information and Data Center) for computer plotting stage/discharge curves; Dave Wangaard (U.S. Fish and Wildlife Service), James Dryden (Dryden and LaRue, Inc.) and Terrestrial Environmental Specialists, Inc. for their assistance with the dissolved gas study. We would like to also thank Marilyn Barker (Anchorage Community College) and Bjartmar Sveinbjornsson (University of Alaska) for their help with identification of aquatic plants; and the local residents and property owners who have assisted us and expressed interest in our work: Harold and Nancy Larson, Bill Blakeley, Roy Bloomfield, Dr. Clifford H. Driskell, and Doug and Marie Dunn.

The authors wish to thank Acres American, Inc.; Air Logistics; Akland Helicopter; the Alaska Railroad; R&M Consultants, Inc.; Gene and Rose Jenne (Three Rivers Union); and the U.S. Geological Survey for their support services.

Appreciation is also extended to the Alaska Power Authority for funding this project and to T. Trent, L. Bartlett, R. Dieryck, K. Watson, R. Logan, L. Heckart, M. Mills and other staff of the ADF&G for their administrative services support.

VOLUME FOUR

MAP SYMBOLS LEGEND

	Silt (SI)		River Mile (RM)
	Sand (SA)		Hydrolab Site
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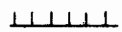
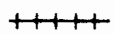
	Rubble (RU)		Thermograph Site
	Cobble (CO)		Eddy
	Boulder (BO)		Log
			Cut Bank
			Railroad
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		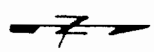	True North

P A R T   I

HYDRAULIC AND WATER QUALITY INVESTIGATIONS

1. OBJECTIVES

Investigations were initiated in 1981 by the Aquatic Habitat and Instream Flow Project (AH) to describe the physical and chemical characteristics of seasonal habitats utilized by juvenile and adult anadromous and resident fish within the Susitna River Basin (Preface Figures B, C and D). Studies conducted during 1981 provided baseline hydrological and water quality data for the various habitats (i.e., mainstem, side channel, slough and tributary, Figure 4I-1-1) present in the Susitna River and their relationships to changes in discharge of the mainstem Susitna River (ADF&G 1982b). These data were used to describe the seasonal habitat requirements of adult and juvenile anadromous and resident fish of the Susitna River and to evaluate the accuracy of hydrological and temperature models which will be used to predict discharge influenced impacts on fisheries habitat (ADF&G 1982a). The data collected during 1981 demonstrated the importance of these studies and the need to expand the data base during 1982 if the goals of defining discharge-influenced impacts to fishery habitats by the proposed project (as well as designing discharge-related mitigation options) are to be achieved.

The objectives of the hydrological and water quality investigations during 1982 were to further characterize:

1) the influence of mainstem Susitna River discharge on the hydrological and water quality characteristics of selected

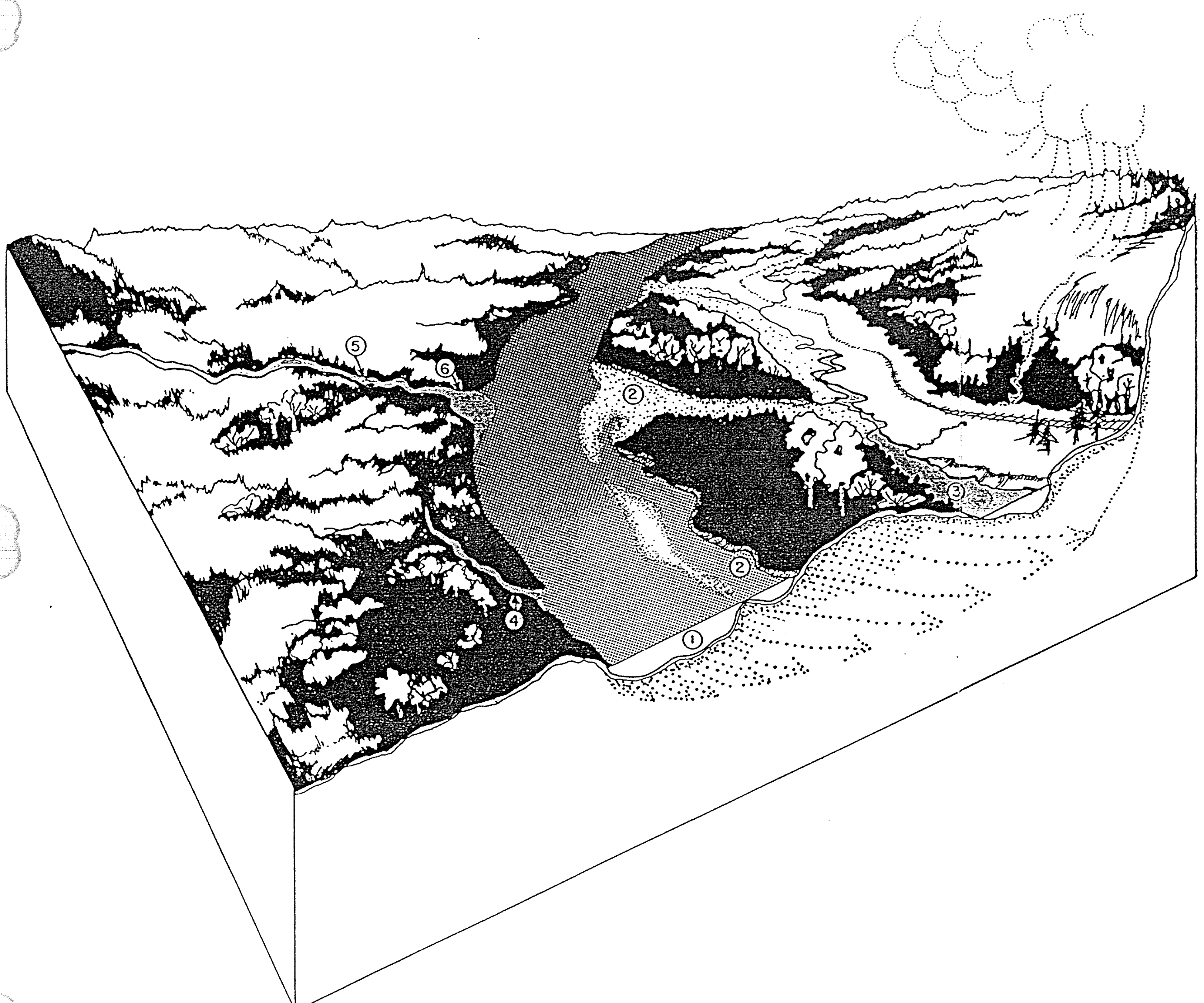

Figure 4I-1-1. General habitat categoties of the Susitna River - a conceptual diagram (adapted from AEDIC 1982; Trihey 1982).

GENERAL HABITAT CATEGORIES OF THE SUSITNA RIVER

1) Mainstem Habitat consists of those portions of the Susitna River that normally convey streamflow throughout the year. Both single and multiple channel reaches are included in this habitat category. Groundwater and tributary inflow appear to be inconsequential contributors to the overall characteristics of mainstem habitat. Mainstem habitat is typically characterized by high water velocities and well armored streambeds. Substrates generally consist of boulder and cobble size materials with interstitial spaces filled with a grout-like mixture of small gravels and glacial sands. Suspended sediment concentrations and turbidity are high during summer due to the influence of glacial melt-water. Streamflows recede in early fall and the mainstem clears appreciably in October. An ice cover forms on the river in late November or December.

2) Side Channel Habitat consists of those portions of the Susitna River that normally convey streamflow during the open water season but become appreciably dewatered during periods of low flow. Side channel habitat may exist either in well defined overflow channels, or in poorly defined water courses flowing through partially submerged gravel bars and islands along the margins of the mainstem river. Side channel streambed elevations are typically lower than the mean monthly water surface elevations of the mainstem Susitna River observed during June, July and August. Side channel habitats are characterized by shallower depths, lower velocities and smaller streambed materials than the adjacent habitat of the mainstem river.

3) Side Slough Habitat is located in spring fed overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna River and is usually separated from the mainstem and side channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem or side channel flows. The controlling streambed/streambank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly flows of the mainstem Susitna River observed for June, July, and August. At intermediate and low-flow periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater (ADF&G 1981c, 1982b). These clear water inflows are essential contributors to the existence of this habitat type. The water surface elevation of the Susitna River generally causes a backwater to extend well up into the slough from its lower end (ADF&G 1981c, 1982b). Even though this substantial backwater exists, the sloughs function hydraulically very much like small stream systems and several hundred feet of the slough channel often conveys water independent of mainstem backwater effects. At high flows the water surface elevation of the mainstem river is sufficient to overtop the upper end of the slough (ADF&G 1981c, 1982). Surface water temperatures in the side sloughs during summer months are principally a function of air temperature, solar radiation, and the temperature of the local runoff.

4) Upland Slough Habitat differs from side slough habitat in that the upstream end of the slough is not interconnected with the surface waters of the mainstem Susitna River or its side channels at higher flows.

5) Tributary Habitat consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal streamflow, sediment, and thermal regimes reflect the integration of the hydrology, geology, and climate of the tributary drainage. The physical attributes of tributary habitat are not dependent on mainstem conditions.

6) Tributary Mouth Habitat is characterized by the downstream portion of the tributary where a) the discharge of the mainstem Susitna River influences fish access into the tributary and b) the clear water of the tributary extends as a plume into the turbid waters of the mainstem Susitna River (ADF&G 1981c, 1982b).

slough, tributary and mainstem habitats downstream of Devil Canyon; and

2) the baseline hydrological and water quality characteristics of fishery habitats within the boundaries of the proposed impoundment areas (see Volume 5).

Tasks designed to meet objective one were:

1) to determine water surface elevations associated with various discharges of the Susitna River at selected mainstem, slough, and tributary locations from river mile 73.1 (Lower Goose 2) to RM 148.8 (Portage Creek);

   These data were collected to support analyses of the effects of mainstem Susitna River discharge on the availability of habitat for fish passage, rearing and spawning in slough, mainstem, and tributary habitats (eg., stage-discharge and stage-surface area relationships of hydraulic zones in sloughs, etc.).

2) obtain baseline discharge data of tributaries in the Talkeetna to Devil Canyon reach to quantify their contributions to the Susitna River;

3) monitor variations in seasonal surface water temperature of the mainstem Susitna River downstream of Devil Canyon to

support analysis of discharge and temperature relationships and relationships of temperature to fish passage and spawning;

4) monitor variations in seasonal surface and intragravel water temperatures at selected sloughs within the Devil Canyon to Talkeetna reach of the Susitna river to evaluate their relationship to mainstem discharge and support analyses of their relationships to fish passage and spawning;

5) obtain baseline water quality data to characterize the water chemistry of surface waters within selected sites of the Susitna River basin and support the analysis of the influence of discharge on water quality conditions and their relationships to fish passage, spawning and rearing; and

6) establish the baseline condition of supersaturation of dissolved gas in the vicinity of the Devil Canyon rapids of the Susitna River and the influence that changes in flow of the Susitna River have upon those conditions.

Objective two above is discussed in Volume 5.

2. METHODS

2.1 Hydrological Investigations

2.1.1 Stage and Discharge

2.1.1.1 Stage

Detailed methods pertaining to the collection of stage and discharge data are presented in the ADF&G procedure manuals (ADF&G 1981a, 1982a). The following discussion is a summary of those methods used in these investigations. Measurements of stage were obtained at least twice monthly at various mainstem and non-mainstem (i.e., sloughs and tributaries) sites in the Susitna River basin during the 1982 open water field season. Stage was determined to the nearest one-hundredth of a foot through observations of staff gages at all sites with the exception of Indian River and Portage Creek where an automatic recorder and associated pressure transducer was used to continuously monitor stage (ADF&G 1981a, 1982a).

At each staff gage placement site, staff gages were tiered to the high water marks to provide for the range of flows expected during 1982 as indicated from field observations during 1981 and the 31 year flow record (USGS 1977, 1978a, 1978b, 1979, 1980, 1981) obtained from the U.S. Geological Survey (USGS) gaging station at Gold Creek (15292000). Depending on the gradient of the streambank, each staff gage placement site was composed of a series of at least two to five individual staff gages (ADF&G 1982b). An assumed elevation, which was referenced to a temporary bench mark (TBM), was determined for each gage using basic survey techniques of differential leveling (ADF&G 1981, 1982). All TBM's were surveyed to a known elevation (project datum) so that resultant stage readings could be converted to true water surface elevations (with the exception of the staff gage on the Yentna River.

A continuous stage record was obtained at Indian River and Portage Creek with a pressure transducer installed on the streambed and connected to a recorder. This instrumentation system recorded an average water column depth every hour. These hourly stage recordings were used to calculate a mean daily stage. Periodically, the depth of flow over the pressure transducer was directly measured as a check on the accuracy of recorded values. The corresponding depth readings were recorded to determine the offset required to convert the depth of flow over the pressure transducer into equivalent stage readings.

Placement of staff gages varied, depending on the specific tasks of the various studies involved. Generally, staff gage placements consisted of mainstem Susitna River and non-mainstem staff gage locations (Figure 4I-2-1).

2.1.1.1.1 Mainstem staff gage locations

Staff gages were installed in the mainstem Susitna River (Figures 4I-2-2 and 4I-2-3) for the purpose of monitoring the relationships between

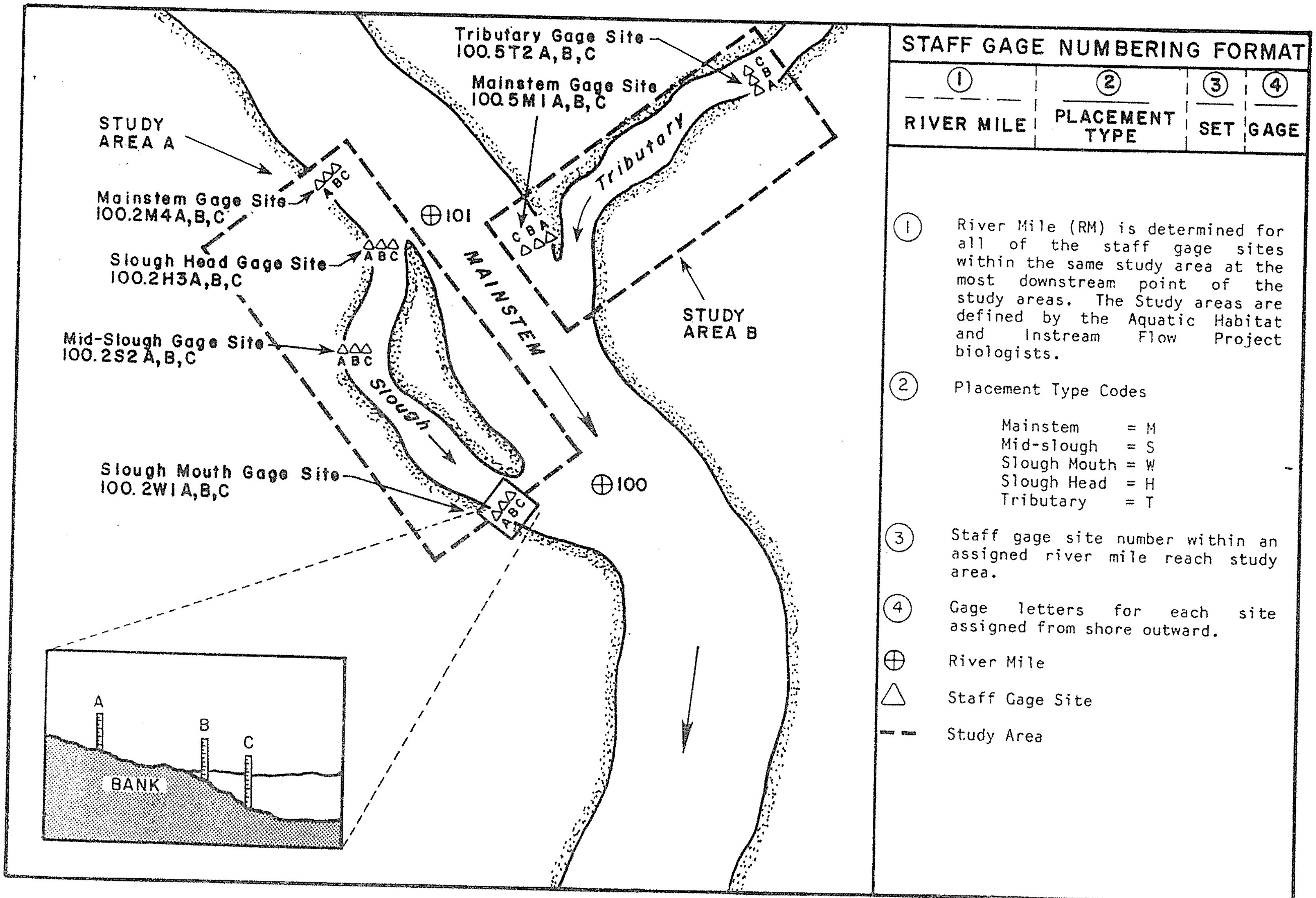

Figure 4I-2-1. ADF&G Staff Gage identification systems.

To be included in Final Draft.

Figure 4I-2-2. Mainstem staff gage locations in the Goose 2 Slough (RM 73.1) to Talkeetna reach.

To be included in final draft.

Figure 4I-2-3. Mainstem staff gage locations in the Talkeetna (RM 103.0) to Devil Canyon (RM 148.8) reach of the Susitna River.

relationships between mainstem water surface elevations and stage of the Susitna River to discharge values recorded by USGS gaging stations. Mainstem staff gages were located in the Talkeetna to Devil Canyon reach of the Susitna River are referenced to the USGS gaging station at Gold Creek (15292000). Mainstem staff gages located in the Susitna River downstream of Talkeetna are referenced to the USGS gaging station at the Parks Highway bridge (15292780).

Mainstem staff gages installed at each ADF&G Su Hydro fishwheel and sonar site were monitored daily. Mainstem staff gages installed at specific lower river cross section (LRX) sites established by R&M Consultants were monitored on an irregular basis.

Other mainstem staff gages were installed adjacent to study sloughs and tributaries and monitored periodically to determine the influence of stage and discharge of the mainstem Susitna River associated with these study areas (see 2.1.1.1.2).

2.1.1.1.2 Non-Mainstem Staff Gage Locations

Non-mainstem staff gages were located to monitor specific habitat characteristics in sloughs, side channels and tributaries. These staff gages were installed in various hydraulic zones of sloughs and tributaries and monitored a minimum of two times per month.

Staff gages located at the mouths (downstream end) of selected sloughs and side channels were monitored to evaluate fish accessibility between the mainstem and these habitats. Staff gages were located in the free-flowing portions of these study areas and were monitored to evaluate local stage-slough flow relationships. Other staff gages were located at the heads (upstream) portion of sloughs or side channels to evaluate the discharge of the Susitna River necessary to breach the heads of these areas. The ADF&G should be consulted for the interpretation of these data.

The following discussion describes the methods used for determining the mainstem discharges of the Susitna River at which breaching of selected side sloughs and channels situated in the reach of the Susitna River between Talkeetna and Devil Canyon occurred.

Cross section surveys, staff gage readings and on-site observations were used in conjunction with one another to determine the mainstem Susitna River discharges at which breaching of a slough began to occur.

The lowest representative elevation on a cross-section surveyed across the head of a slough is called the "point of zero flow" (PZF). Assuming the cross section at the head of a slough was surveyed at the point where streambed elevations control flow into the slough, the water surface elevation of the mainstem river at the head of the slough must be greater than the PZF before mainstem water can enter the head of the slough. PZF's were determined at selected sloughs in the Susitna River basin from the cross section surveys conducted by R&M Consultants, Inc.

Staff gages were installed at the head of study sloughs and side channels as near as possible to the upstream point that controlled mainstem flow into these areas so that the elevation of the bottom of the staff gage provided a good check on the accuracy of the point of zero flow (PZF) determined from the cross-section surveys. Mainstem water surface elevations necessary for breaching were obtained from staff gages tied into project datum which were installed in the mainstem near the head of the slough.

Periodic field observations were made to document at which mainstem discharge selected study sloughs and side channel areas were breached. However, even if field crews were fortunate enough to observe a site just as it was breached, this did not mean that the exact mainstem discharge required for breaching of that slough had been identified. Observations of slough breaching and staff gage readings obtained to determine breaching flows were referenced to the average daily streamflow at Gold Creek (USGS 1982). This gaging station is located up to 20 miles from various sloughs where breaching data were collected. Since the accuracy of the relationship between breaching and Gold Creek discharge was dependent on the rate that the river was rising or falling, the range of flows required for breaching were determined from a combination of the above methods.

2.1.1.2 Discharge

Measurements of discharge were obtained at selected sloughs and tributaries below Devil Canyon to determine the range of discharges which occur under an annual flow regime and thereby develop simple stage-discharge relationships in the form of rating curves. Discharge measurements were also obtained at six tributary locations upstream of Devil Canyon to monitor flow conditions and provide baseline flow data for future reservoir modeling. In addition, discharge measurements were also obtained as a byproduct of a series of depth and velocity measurements primarily intended to quantify potentially available fish habitat at several slough sites (refer to Part II - 2.1.3.2.1).

Downstream of Devil Canyon

Discharge sites (gaging stations) were placed within study locations in areas where conditions for obtaining stage and discharge measurements were maximized. Stream morphology was thus the major criteria used to establish gaging stations. Gaging stations were located in a free-flowing portion of the stream, removed from any backwater influences created by the mainstem river and within a uniform channel with a stable substrate; where water column velocities paralleled each other and were at right angles to the cross section. Discharge measurements were made by the current-meter method as outlined in the Procedures Manual (ADF&G 1981a), using standard USGS techniques (USGS 1977) employing either a Price AA or Pygmy meter. Cross sections at gaging stations were divided into a minimum of 20 cells to ensure that each velocity obtained measured no more than five percent of the total flows. The observed depth at each cell was then determined using a four foot top setting wading rod graduated into one-tenth foot increments. Mean water column velocities measured as feet/second (fps), were then determined at each cell using a two point or a six-tenth depth method. At depths less than six-tenths of a foot and velocities less than 2.5 ft/sec the Pygmy meter was utilized, while at greater depths and velocities a Price AA meter was used. At depths less than or equal to 2.5 feet, mean cell water column velocity was measured at six-tenth of the depth from the surface, while at depths exceeding 2.5 feet water column velocities were measured at two-tenths and eight-tenths of the depth from the surface and then averaged to yield a mean cell water column velocity. When velocities were observed not to be at right angles to the discharge transect, the velocity vector component normal to the measuring section was determined as described in the Procedures Manual (ADF&G 1981a). Total discharge was then determined as the summation of the products of cell area and mean cell column velocity. If sufficient discharge and corresponding stage data were collected at a gaging station, simple rating curves were developed by R&M Consultants.

Depth and velocity measurements were also obtained at specific intervals along each transect in the FHU study sites using a Marsh-McBirney model 201 electronic flow meter and methods outlined in the Procedures Manual (ADF&G 1981a). From these data, discharge was computed to estimate the range and quantity of habitat available to fish and to calibrate the IFG computer model for each study site (Milhous, et al. 1981).

Upstream of Devil Canyon

Discharge measurements were obtained in six tributaries located above Devil Canyon employing techniques outlined above and in the Procedures

Manual (ADF&G 1981a). Refer to Volume 5, section 2.2.3 for specific discharge methods employed upstream of Devil Canyon.

2.1.2 Thalweg Profiles

The thalweg, is defined in Nomenclature for Instream Assessments (Arnette 1975), as being

> "the line following the deepest part or middle of the bed or channel of a river or stream."

Thalweg data were collected using a surveying level, and standard surveying rod and rod level employing the standard surveying techniques of differential leveling. At the beginning of each survey a temporary bench mark (TBM) was established, that was later tied into project datum. To define the thalweg of each slough, the survey progressed downstream (or upstream) beginning at the head (or mouth) of each slough, selecting (based on visual assessments) the lowest points of significant change in gradient (i.e., tops and bottoms of riffles, bottoms of pools, etc.) as thalweg points. Distances between the surveyed points were measured (to the nearest foot) using a surveying tape and by reading the stadia on the level and computing distances. The data was then plotted with elevation as the ordinate and distance as the absissa.

In several sloughs, partial thalwegs were developed as a byproduct of other survey work in the slough. When applicable survey data (i.e., transects within study sites, cross sections at staff gages or mouth and head of a slough) was available and met the requirements of the thalweg profile, it was used in conjunction with the thalweg survey in order to conserve time and to avoid duplication of effort.

2.1.3 Other Hydrological Components

2.1.3.1 Backwater Areas

The purpose of this section is to present data describing the relationship between mainstem Susitna River discharge and the area of low velocity, backwater, which results from hydraulic barriers created by mainstem stage. These data were collected twice monthly at 17 slough and tributary habitat locations from June through September. The data base consists of a series of maps, one for each sampling period at each site, depicting the prevailing hydraulic features of the surface waters.

To map hydraulic conditions, nine different hydrological "zones" were defined to represent various conditions of water surface velocity, water source (tributary or mainstem) and hydraulic influence from mainstem water surface elevations present at the mouth of a study site. When the hydraulic conditions at a study area were categorized using the zone codes (numbers 1-9), maps of the wetted surface and zone boundaries were drawn.

Susitna River discharge data presented in results was provided by the USGS, as provisional data (USGS 1982). The June discharges for the upper river were estimated by the USGS from supporting data because the Gold Creek Gaging station was inoperative in June.

Descriptions of the field program and zone codes are presented in Volume 3, Section 2.1.3 and are discussed in detail in Part II, Section 2.2 of this volume. A narrative description of each habitat site is also available (Volume 4, Appendix 4-F). Included in the appendix descriptions are traced reductions of blueline zone-boundary maps (see Slough 21, Slough 6A, Whitefish Slough and Whiskers Creek and Sidechannel) which illustrate the mapping procedures.

Mapping

Aerial photographs of each habitat location were taken on May 31 and August 20, 1982 under contracts with R&M Consultants and North Pacific Aerial Surveys, Inc. These were printed as blueline copies at a scale of 1"=50' for use as reference maps. At the time of each sampling, the observed boundaries of wetted surfaces and the location of zones were drawn on the blueline maps. During the June samplings, blueline maps were not available; thus the June data compilations were constructed in Anchorage from sketches, measurements and photographs taken in the field. In general, wetted edge locations and zone boundaries were located on the blueline maps using natural points of reference (e.g., deadfall, trees, geographic features) and measurements made using surveyor's tapes. Wetted edge boundaries were typically mapped without a great amount of precision. Ground truth measurements were made at most sites to check and/or adjust the scales on the blueline photographs.

Surface Area Measurements

Surface areas were measured from the blueline maps (or direct tracings of the maps) with a Numonics^{R} model 2400 Digitizer.

Several random and systematic errors are associated with the measured surface areas.

Random errors were introduced during various steps of map construction. Specific sources of random errors include inaccurately locating the wetted edge boundary and inaccurately locating the boundary between hydraulic zones (for more on this see Part II, section 2.2).

Systematically, deviations as large as 7 percent were found between indicated linear distances (map scale) and measured ground features at some sites. Unfortunately, some sites had no natural features to check map scales against. Deviations also appeared across the surface of maps as a result of photographic image distortion (parallax). Scales on blueline maps made from the May and August flights for some sites were also found to differ by several percent. A combined estimate of systematic error might reasonably approach 15 percent in some of the surface areas measured.

Precise surface area measurements were not the objective of this study, rather the goal was to document trends in the distribution of hydraulic conditions to relate to the fish distribution. Finer resolution in the maps was not practical within the constraints of the 1982 program.

2.1.3.2 Open Channel

Segments of sloughs 8A, 9 and 21, Rabideux Slough and Chum Channel were selected for computer modeling using hydraulic simulation programs developed by the Instream Flow Group (Milhous, et. al., 1981). Given channel depths, velocities and widths and water surface elevations from transects at known discharges, these models extrapolate and predict hydraulic parameters including depth, velocity, width, wetted perimeter and water surface elevation at unobserved stream flows. Data from actual field observations are used to calibrate the model. When predicted hydraulic parameters at known discharges fit measured parameters and when predicted hydraulic parameters at hypothetical discharges fit a realistic pattern based on past hydrological experience, the models are calibrated. Data collected during one field season will not necessarily include a sufficient range of conditions to calibrate the model at all potential discharges. Thus, the model is reliable only at stream flows within specified limits.

2.2 Water Quality Investigations

Water quality data were collected throughout the study area as discussed below.

2.2.1 Temperatures

Surface and intragravel water temperature were measured on an instantaneous and continuous basis at various locations in the Susitna River basin. Several types of temperature monitoring instruments were employed.

2.2.1.1 Surface Water Temperature

Instantaneous surface water temperature measurements were obtained at various locations in the water column from the streambed to the water surface. Continuous monitoring of the surface water temperature was confined to the portion of the water column adjacent to the streambed upon which the temperature sensor rested, usually 0.5 feet or less above the stream bed, or upon the streambed itself.

2.2.1.1.1 Instantaneous Water Temperature

Instantaneous water temperatures were obtained at each study site in the process of collecting the basic water quality field parameters. The measurements were collected with either a calibrated Brooklyn mercury thermometer or Hydrolab model 4041 electronic multiparameter unit using procedures outlined in the Phase I Procedures Manual (ADF&G 1981a).

2.2.1.1.2 Continuous Surface Water Temperature

Surface water temperature was measured during the 1982 open-water field season on a continuous basis at 23 stations (Figure 4I-2-4) within the Susitna River basin, including 10 mainstem sites (located from RM 5.0 to RM 140.0), ten major tributaries from the Yentna River (RM 28.4) to the

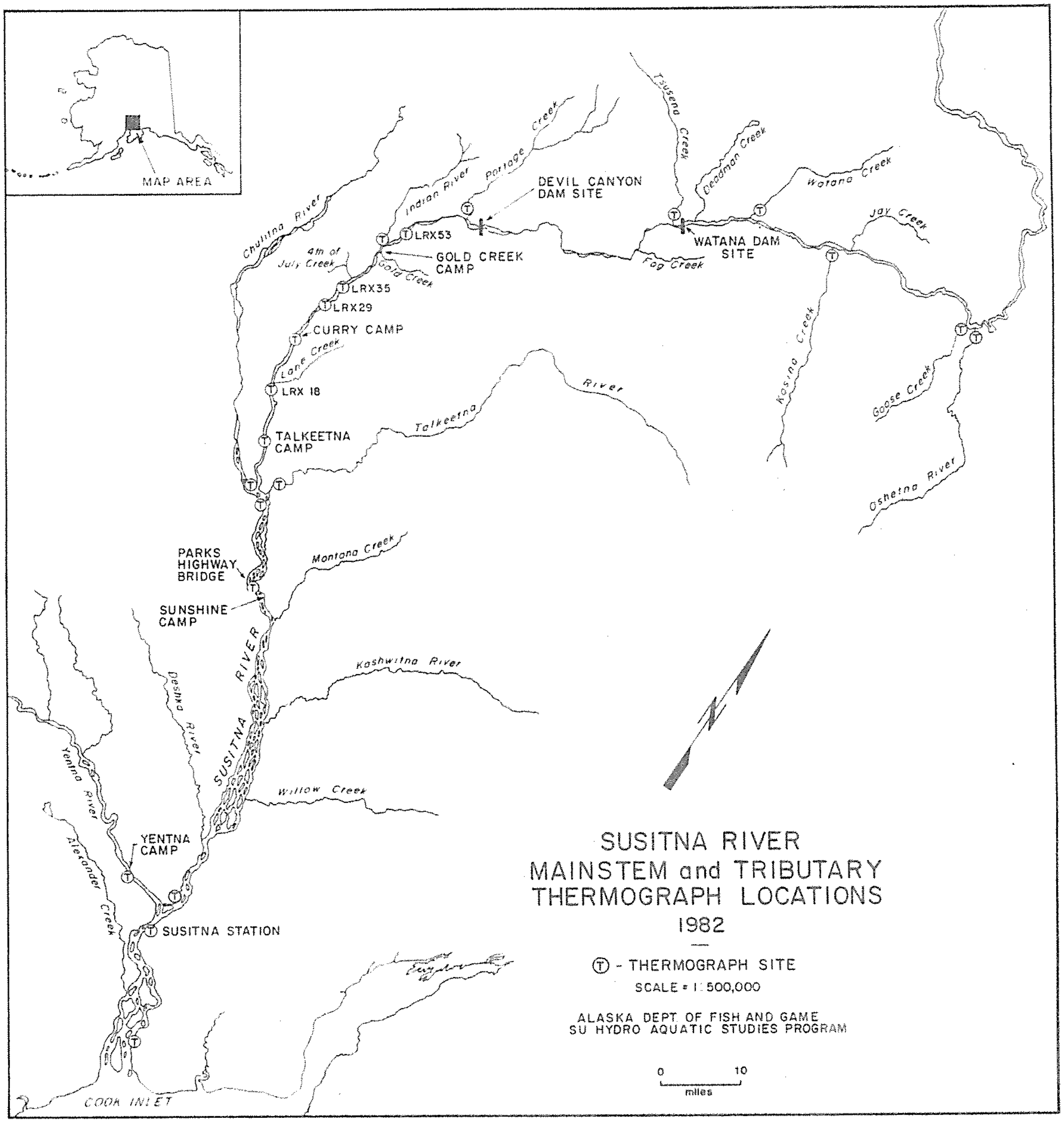

Figure 4Ⅱ-2-4 Thermograph site map.

Oshetna River (RM 233.4) and three sloughs above Talkeetna (sloughs 8A, 9 and 21). Two types of instruments were employed in the continuous measurement of temperature: the Peabody-Ryan model J-90 submersible thermograph and the Omnidata recorder with associated thermistors. For both the Peabody-Ryan thermograph and the Omnidata recorder, the temperature sensor was placed on the bottom of the stream to record the water temperature of the lower portion of the water column adjacent to the streambed.

Peabody-Ryan model J-90 thermographs continuously monitor and record temperature with an error of 0.6°C on 90-day charts. Thermographs, after installation, were monitored and serviced (if necessary) twice monthly, except those located above Devil Canyon which were monitored on a monthly basis. To ensure accuracy of temperature data collected, each thermograph was screened at two temperatures (0°C and between 11-16°C) prior to installation using a calibrated Brooklyn or American Society for Testing and Manufacturing (ASTM) thermometer as a standard. Thermographs found to be in error by more than 3°C at either screening temperature were not used and were returned to the manufacturer for calibration. To ensure proper calibration of temperature readings, surface water temperatures were obtained, using a calibrated thermometer, at the time of installation and removal of the thermograph from each site. A unique calibration factor was then determined for each thermograph, calculated as the difference in the readings between the surface water temperature obtained with the thermograph and the calibrated thermometer at the time of thermograph removal. The calibration factor was determined from data at the time of thermograph removal rather than the time of installation, because response time after installation varied for each thermograph. The calibration factor was then used to correct 2-hour point temperature readings from each recording chart. From these corrected 2-hour point temperatures mean, maximum and minimum temperatures were calculated by computer for each 6-hour period. The installation and service methods are outlined in the Phase I Procedures Manual (ADF&G 1981a).

The Omnidata recorders and associated thermistors used to continuously monitor surface water temperatures, were capable of simultaneously recording both intragravel and surface water temperature with an error of 0.1°C. The Omnidata instrument incorporates a non-volatile, u-v erasable, solid state data storage module (DSM) to record data. The DSM is capable of approximately three months data storage recorded in 6 hour intervals as minimum, maximum and mean water temperatures. The units were virtually maintenance-free but were periodically checked for low battery charge and disturbance by wildlife (bears).

To obtain surface water temperatures with an Omnidata instrument, the associated thermistor was attached to a weight and placed upon the substrate of the stream channel. Each thermistor probe was calibrated prior to field installation by Dryden and LaRue (distributors of the instruments) and assigned a calibration factor. The surface water temperature probe was placed immediately adjacent to an intragravel temperature probe (see Section 2.2.1.2.2) associated with the same recorder. Immediately after installation of the recorder and prior to removal of the DSM, a surface water temperature was obtained with a calibrated mercury thermometer. In addition, a short data dump the recorder is programmed to yield (including errors accumulated, numbers of data points stored, minutes to next recording, surface water temperature and intragravel water temperature) was obtained. This information along with the probe calibration factors were compared to ensure the instrument was accurate. The data was retrieved from the DSM via an Omnidata model 217 Datapod/Cassette Reader, and printed as 6-hour maximum, minimum and mean temperatures.

2.2.1.2 Intragravel Water Temperature

Intragravel water temperature measurements were obtained on an instantaneous and continuous basis in the Susitna River basin during the 1982 open-water field season using Ryan thermographs and Omnidata recorders for the continuous measurements and Digi-Sense recorders for the instantaneous measurements.

2.2.1.2.1 Instantaneous Intragravel Water Temperature

Instantaneous intragravel water temperatures were obtained at salmon and Bering cisco mainstem spawning sites and in Sloughs 8A, 9, 11, and 21 using a Digi-Sense temperature recorder and associated YSI series 400 insertion probe. Variations in measurements associated with drift (±0.2°C) and damp field conditions (usually erroneous values) made it necessary to check instruments in the field (before and after a series of readings) with a calibrated mercury thermometer (verified accuracy

±0.2°C of an ASTM thermometer). A calibration factor was then determined for each set of readings as the difference between the mercury thermometer reading and Digi-Sense readings. The calibration factor was then used to correct the Digi-Sense readings.

The following procedure was utilized to obtain an instantaneous intragravel temperature using a Digi-Sense temperature meter and associated YSI insertion probe.

1) The wire lead was attached from the insertion probe to the Digi-Sense unit.
2) The insertion probe was pushed into substrate to a depth of at least six inches.
3) The unit was turned on for a period long enough to allow the digital readout to stabilize (usually within 30-60 seconds).
4) The water temperature was recorded.

2.2.1.2.2 Continuous Intragravel Water Temperature

Intragravel water temperature was continuously monitored and recorded at various sites in the Susitna River basin during 1982 using both the Peabody-Ryan model J-90 submersible thermograph and the Omnidata recorder and associated thermistor. Peabody-Ryan model J-90 thermographs were used only for determining intragravel water temperatures during the 1982 winter-spring ice covered period.

Peabody-Ryan model J-90 thermographs were buried 1-3 feet in the substrate. The installation procedure for these thermographs is the same as for the surface water temperature thermographs, with the exception that the intragravel water temperature monitoring thermographs were checked within 90 days and full 90 day recording charts were used (ADF&G 1981a). Methods of data reduction are the same as those presented in Section 2.1.1.2.2 for the continuous measurements of surface water temperature data by Peabody-Ryan model J-90 thermographs, except that the thermographs were not screened and calibrated according to procedures described in Section 2.2.1.1.2. Calibration factors were determined (for each thermograph) by allowing each thermograph to reach equilibrium in a water bath at 8°C (as determined by a calibrated Brooklyn thermometer) and then following procedures outlined in Section 2.2.1.1.2 for computing calibration factors.

The Omnidata recorder was also used to record intragravel water temperatures during the 1982 field season. The Omnidata recorders were found to be advantageous over the Peabody-Ryan thermographs because of several unique features the Omnidata recorders incorporate to record intragravel water temperatures including: (1) an ability to measure temperature to an accuracy of 0.1°C, (2) a minimal amount of effort is expended in calibrating the probes, (3) only the Data Storage Module (DSM) must be removed for data retrieval and not the entire instrument thus allowing for a continuous flow of intragravel water temperature data, (4) the recorder can be secured out of the water on a safe location with the risk of only losing the temperature probe during periods of flooding and bank erosion, (5) two probes can be used simultaneously to record both intragravel and surface water temperatures on the same DSM, and (6) there is considerably less data reduction time in comparison to the Peabody-Ryan thermograph.

Each Omnidata recorder was equipped to monitor simultaneously both the intragravel and surface water temperature. The associated thermistor was secured within a steel, slotted tube and inserted approximately 18 inches into the substrate. The thermistor probe wire was connected to the Omnidata recorder which was stored in a waterproof container secured on the stream bank out of the range of flood flows and eroding banks. A surface water temperature probe was weighted and placed adjacent to the intragravel probe (see section 2.2.1.1.2 for details). Field installation procedures and data reduction techniques are the same as described in Section 2.2.1.1.2.

2.2.2 Other Basic Field Parameters

The dissolved oxygen (DO), pH, temperature, and specific conductance of surface water were collected throughout the Susitna River basin during 1982 by Instream Flow Evaluation Study, Fishery Habitat Utilization Study, Fishery Distribution Study, Electrofishing Study and Impoundment Study personnel. The basic field parameters of DO, pH, water temperature, and specific conductance were measured in the field using a Hydrolab model 4041 portable multiparameter meter. The four parameters were measured simultaneously at the Sonde unit (underwater unit) and the readings were displayed in an indicator unit. Each hydrolab was calibrated prior to entering the field (see Procedures Manual for methods of calibration) except for temperature which was calibrated by the manufacturer. Measurement of the basic field parameters varied, depending on the specific tasks of the various studies involved.

The basic field parameters were obtained at each discharge transect within each Resident Fish Designated Habitat site at intervals necessary to characterize the water quality present.

The basic field parameters were collected to determine the overall differences in water quality within each Adult Anadromous Fish Habitat Investigation Slough site. Sites for measurement of water quality were located at the head and mouth of the FHU study slough and in, above and below any tributary (sufficiently far downstream to allow mixing) or other water sources (spring or upwelling) within the site.

Twice monthly, hydraulic zones were determined within each Resident Fish Designated Habitat site. To characterize the water quality present within each zone, the basic field parameters were collected in an area of the zone considered representative for the entire zone.

Measurements of the basic field parameters gathered in conjunction with the mainstem Adult Anadromous Fish Habitat investigations were collected at spawning sites of resident and anadromous fish species (refer to Vol. 4, Part II for specific information concerning site selection and data collection techniques).

The basic field parameters were obtained at least once per month at designated tributary, mainstem and lake sampling sites in the impoundment zone (see Vol. 5 for details). Additional sites, including minor tributaries and tributary study sections, were sampled on irregular intervals.

Water samples for turbidity analysis were collected by both the Fish Distribution Study (FDS) and the Impoundment Study personnel. Turbidity samples were collected in 250 ml bottles and stored for a maximum of 18 days in a cool, dark location prior to analysis. Samples were obtained within each FDS zone twice monthly and analyzed in the field on a HF Instruments DRT-15 turbidity meter according to procedures described in the Procedures Manual (ADF&G 1981a). Turbidity samples were also collected by Impoundment Study personnel on a monthly basis at designated tributary and mainstem sampling sites (see Impoundment WQ site selection Vol. 5). Analysis was performed on a Hach 2100A immediately upon returning from the field using procedures described in the Procedures Manual (ADF&G 1982b).

Turbidity values, reported as Nephelometric turbidity units (NTUs) were measured to the sensitivity of the turbidimeter calibrated with the appropriate standard. Measured turbidity values less than 1 NTU are reported as less than 1 NTU. Values equal to or less than 100 NTUs are reported to the nearest whole number. Values greater than 100 NTUs are reported to two significant figures.

2.2.3 Total Dissolved Gases

A study of dissolved gases was conducted in the Susitna River between the Chulitna River confluence and the upper extent of the Devil Canyon rapids. The uppermost sampling site was located approximately one quarter mile above the mouth of Devil Creek (RM 161.4). Dissolved gas concentrations were measured at several points through the 10 mile reach of the proposed Devil Canyon rapids, downstream to approximately 50 miles below the Devil Canyon dam site. During the summer of 1982, a continuous recording monitor was installed approximately two miles below the Devil Canyon dam site. Most of the decay data was collected between this monitor and the Alaska Railroad bridge at Gold Creek. Precise locations are indicated in the Appendix Tables by river mile (Appendix 4-D-1).

Dissolved gas measurements were taken approximately one meter below the surface, although this varied somewhat depending on conditions. Very minor variations in dissolved gas pressures were recorded with depth. Sampling was usually done from a river boat drifting with the current in the river below Devil Canyon. Above the Devil Canyon dam site, gas measurements were often made by suspending the probe from a hovering helicopter. Because of the high velocities, this was generally done in eddies below the rapids. Where possible in the canyon, measurements were made from shore by landing on islands or rock outcroppings. Approximately 15 to 30 minutes was allowed for the dissolved gas readings to stabilize before the probe readings were recorded. Temperature and tensionometer pressure readings were recorded at each site.

Because of the difficulties in sampling in the canyon, these values are somewhat less precise than those in the lower river. Two types of instruments were used to measure dissolved gas pressure during this study. A saturometer described by Bouck (1982) was used for the initial measurements during the 1981 field season. However, because of the lack of portability of this instrument, a tensionometer developed by Common Sensing was used for all subsequent measurements. This instrument was modified for continuous recording of dissolved gas pressure and was deployed during August through October 10, 1982. A Datapod solid state recorder was connected to the tensionometer and used to record temperature and dissolved gas pressure hourly throughout this period.

Dissolved oxygen was also recorded during the initial sampling periods of 1981 to determine the relative contribution of dissolved oxygen to the overall gas supersaturation. Measurements were made in the field with a YSI dissolved oxygen probe with duplicate measurements at some sites by use of the Winkler method. Because the dissolved oxygen levels closely paralleled total gas supersaturation, further measurements of dissolved oxygen during the remainder of the study were not conducted. Barometric pressure readings were recorded by use of the tensionometer atmospheric readings, when point measurements were made. The Talkeetna weather station barometric pressure data from the U.S. Weather Bureau was used for calibration of the continuous recording dissolved gas concentrations, using standard correction factors for altitude differences.

Discharge data used are the provisional records of the U.S. Geological Survey from the Gold Creek gaging station (15292000). Hourly data was obtained by digitizing copies of the original gage tracings and converting to discharge by use of the most current rating table for this gage.

Dissolved gas supersaturation and all other values were calculated using the formula of Bouck (1982). These formula are duplicated in Appendix Table 4-D-2 of this report. All statistics were calculated using microcomputer statistical programs or by use of programmable calculators. Further references in addition to details of statistical analysis are included in Appendix Table 4-D-3.

3. RESULTS

3.1 Hydrological Investigations

3.1.1 Stage and Discharge

Stage and discharge measurements were obtained during the 1982 open-water season from various mainstem, slough and tributary sites within the Susitna River basin (Appendix Table 4-A-1).

3.1.1.1 Mainstem Between Talkeetna and Devil Canyon

Periodic stage readings (converted to water surface elevations) were obtained at 31 mainstem locations between Talkeetna and Devil Canyon during the 1982 open-water season. These data, along with corresponding average daily discharges recorded at Gold Creek (USGS provisional data, 1982), are presented in Appendix Table 4-A-2. Plots of these data (Appendix Figures 4-A-1 - 4-A-16) indicate that the relationship between water surface elevation and mainstem discharge is relatively well defined at most of the 31 locations for the range of flows from 8,000 to 30,000 cubic feet/second (cfs). The water surface elevation of the river rises approximately 1.5 to 2.0 feet as stream flows increase from 10,000 to 20,000 cfs. A mainstem gradient map (Figure 4I-3-1) shows a drop of 10.6 ft/mi from Portage Creek to Curry and 7.8 ft/mi from Curry to Whiskers Creek Slough.

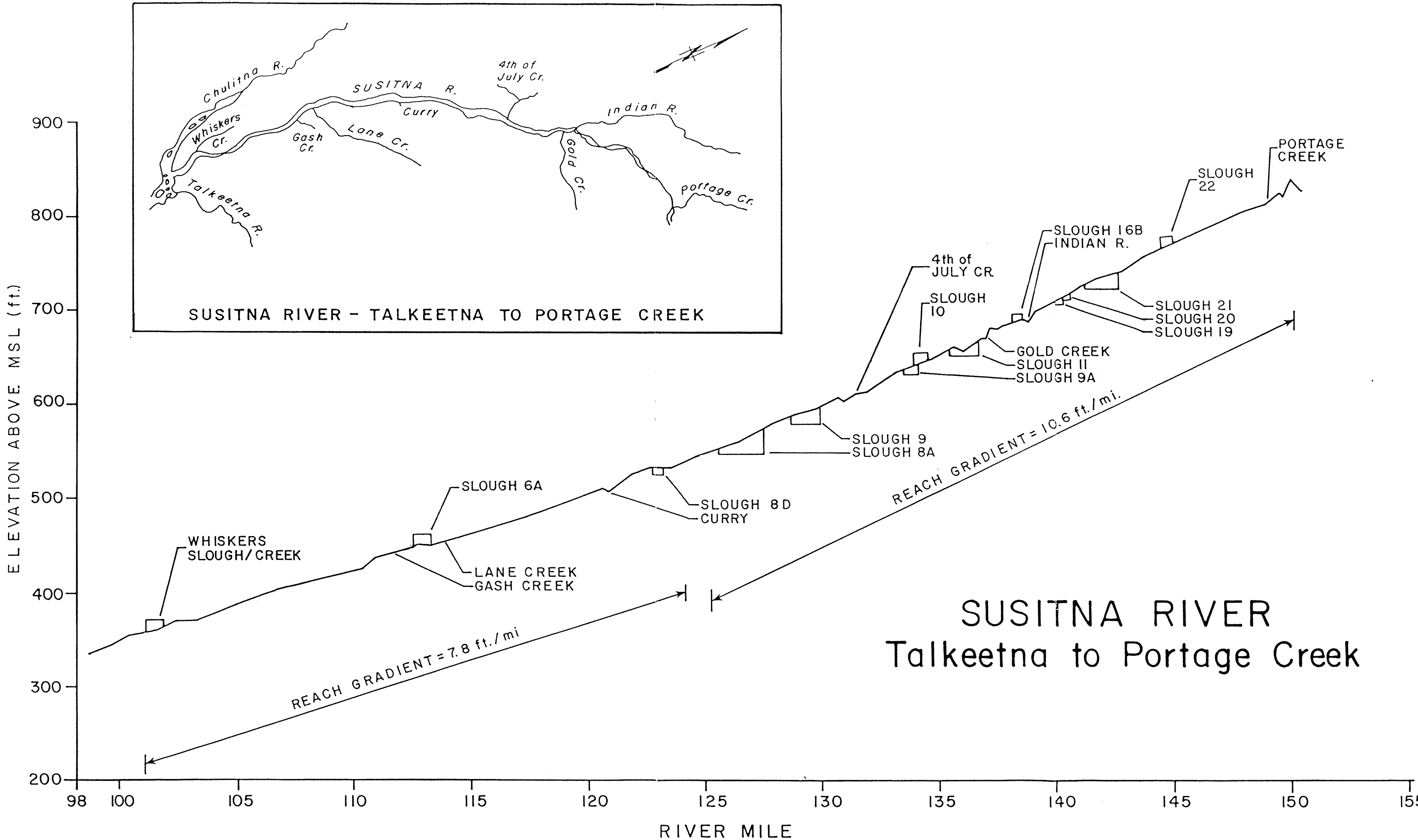

Figure 4I-3-1. Gradient of the Susitna River from Portage Creek to Whiskers Creek/Slough.

At the onset of the 1982 field season, it was intended to define the relationship of stage and discharge for the mainstem upstream of Talkeetna for the full range of discharges that normally occur during the open water season. However, abnormally low discharges this past summer, followed by high fall flows and an early freeze-up, precluded our ability to obtain the necessary field data to define water surface profiles for mainstem discharges in the 5,000 to 8,000 cfs or 30,000 to 45,000 cfs ranges.

3.1.1.2 Sloughs in the Talkeetna to Devil Canyon Reach of the Susitna River

Periodic staff gage readings and discharge measurements were obtained at nine sloughs located between Talkeetna and Devil Canyon during the 1982 open water field season. For five of these sloughs these baseline data were used to construct preliminary rating curves. Insufficient data at the other four sloughs did not permit the development of rating curves. For these nine sloughs plots were made comparing the observed water surface elevation within the slough to the mainstem discharge (Appendix Figures 4-A-17 - 4-A-30). Cross sections were made for six sloughs utilizing survey data at R&M Consultants (Appendix Figures 4-A-31 - 4-A-36). Additional cross sections were developed utilizing ADF&G survey data obtained in 1982 for Sloughs 8A, 9 and 21 (Appendix Figures 4-A-37 - 4-A-39).

The sloughs were characterized as either upland or side sloughs. Upland sloughs were defined as those having no connection to the mainstem other than at their mouth, with their water sources consisting primarily of ground water and/or surface water runoff. Side sloughs were defined as those connected to the mainstem at their mouth and, during periods of high mainstem flow, at their upstream juncture (head) with the mainstem.

3.1.1.2.1 Upland Slough

Slough 6A

Slough 6A (Figure 4I-3-2) is an area of clear backwater characterized by extremely low velocities with water sources primarily composed of ground water and surface runoff from a beaver dam in its upstream portion. Twelve staff gage readings were obtained at the mouth of Slough 6A showing a range of 3.2 feet of water surface elevation change over a corresponding range of mainstem flows from 8,440 to 32,000 cfs (Appendix Table 4-A-3). Water surface elevations obtained at the mouth of the slough were within 0.25 feet of the corresponding water surface elevations obtained in the mainstem (Appendix Table 4-A-1) for mainstem flows in the range of 14,000 to 32,000 cfs, indicating that a significant backwater effect occurs at the slough mouth for this range of mainstem flows. A single slough discharge, measured at 0.6 cfs, was obtained at the mouth of the slough when the corresponding mainstem discharge was 24,200 cfs (Table 4I-3-1).

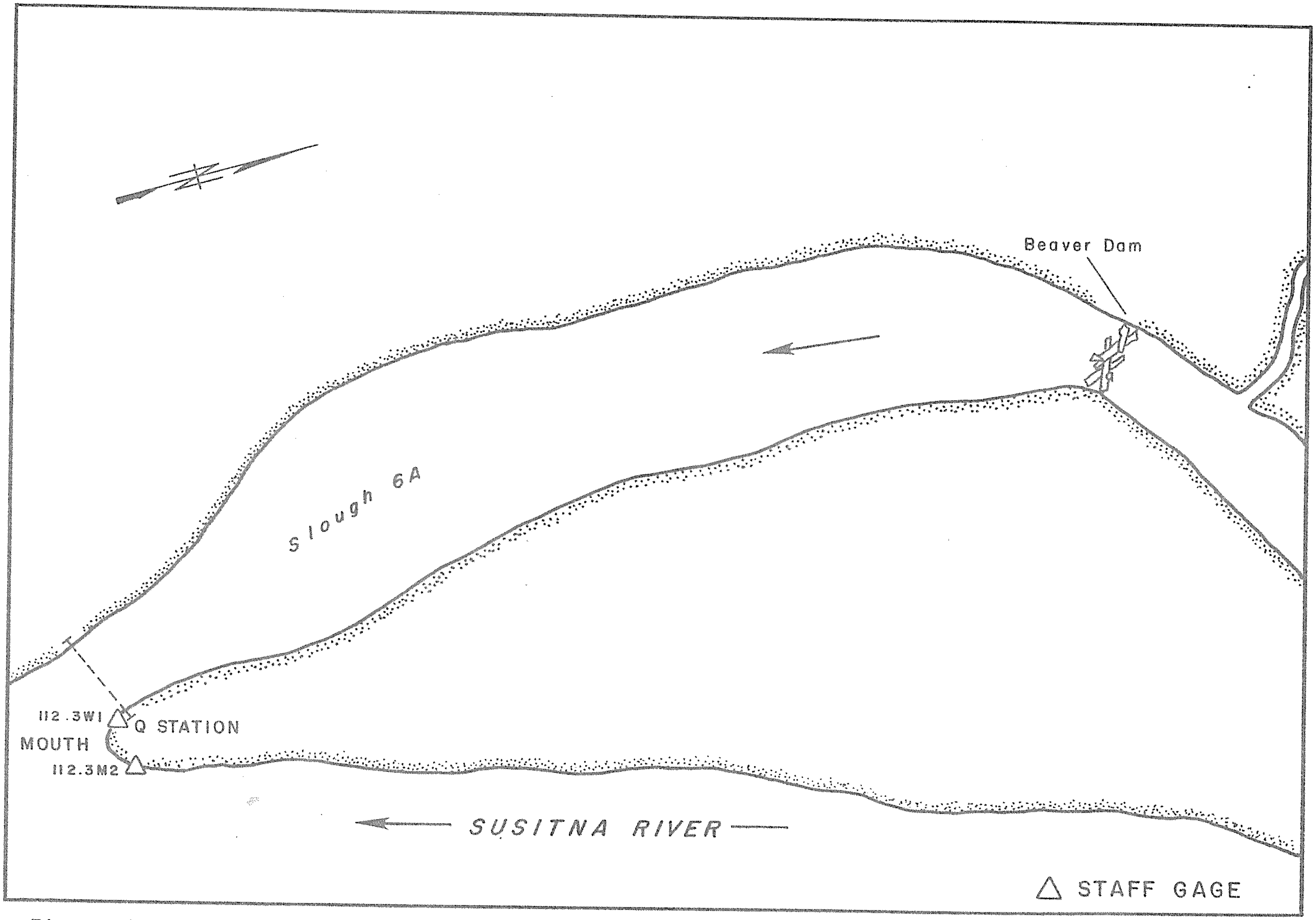

Figure 4I-3-2 Planimetric site map of Slough 6A, RM 112.3, GC S28N05W13CAC.

Table 4I-3-1. Comparison of periodic measurements of slough flow at selected locations upstream of Talkeetna to the corresponding mean daily mainstem discharge at Gold Creek.[a]

Location	Date	Time	Slough Discharge (cfs)	WSEL	Mainstem Discharge (cfs)
Whiskers Creek Slough	821009	1145	2.0	362.92	8,470
(RM 101.4)	820903	1625	0.7	363.97	14,600
	820816	1445	0.2	364.03	15,600
	820920	1530	35.1	365.38	24,000
Slough 6A	820817	1040	0.6	--	24,200
(RM 112.3)					
Lane Creek Slough	820903	1456	2.0	468.28	14,600
(RM 113.6)	820920	1333	9.9	469.41	24,000
	820917	1517	20.7	470.75	32,000
Slough 11	820830	1244	3.1		13,100
(RM 135.7)	820918	1010	5.5		27,500
Slough 16B	820919	1617	700.58	23.50	24,100
(RM 138.0)	820801	1551	700.85	54.80	26,400
	820915	1412	701.69	257.64	28,200
Slough 19	820819	1700	0.4	--	13,300
(RM 139.8)					
Slough 20	820820	1120	2.6	726.72	12,500
(RM 140.2)	820901	1643	11.6	726.89	17,900
	820802	1220	16.4	726.99	22,500
	820918	1825	44.8		27,500
	820916	1415	158.8	728.00	32,500
Slough 21	820831	1518	3.2	744.91	16,000
(RM 141.9)	820802	1400	5.0	744.99	22,500
	820916	1024	59.2	746.52	32,500
Slough 22	820919	1124	5.1	783.82	24,100
(RM 144.6)	820918	1425	31.2	784.30	27,500
	820915	1642	118.5	785.08	28,200

[a] USGS Provisional Data, 1982.

Slough 19

Slough 19 (Figure 4I-3-3) is a relatively short slough that, during periods of relatively high mainstem flow, exhibits a substantial area of backwater in its lower reaches. The primary sources of clear water in this slough, based on visual observations, appears to be groundwater and surface water runoff. Nineteen water surface elevations obtained at the downstream point of access (below the mouth) to Slough 19 had a range of 3.27 feet over a corresponding range of mainstem flows from 11,700 to 31,800 cfs (Appendix Table 4-A-3). Water surface elevations, obtained in the mainstem adjacent to the Slough 19, had a range of 3.54 feet during mainstem flows of 6,900 to 31,900 cfs (Appendix Table 4-A-2). A single slough discharge, measured at 0.4 cfs, was obtained at the mouth of Slough 19 when the mainstem discharge was 13,300 cfs (Table 4I-3-1).

3.1.1.2.2 Side Slough

Whiskers Creek Slough

Whiskers Creek Slough is a relatively open water channel that has as its primary water source, when it is not breached, Whiskers Creek, which empties into the slough approximately midway between its head and mouth (Figure 4I-3-4). Four discharge measurements, obtained in Whiskers Creek Slough above its confluence with Whiskers Creek, ranged from 0.2 to 35.1 cfs (Table 4I-3-1). The highest discharge measured (35.1 cfs) was recorded during a period when the head was breached and the mainstem

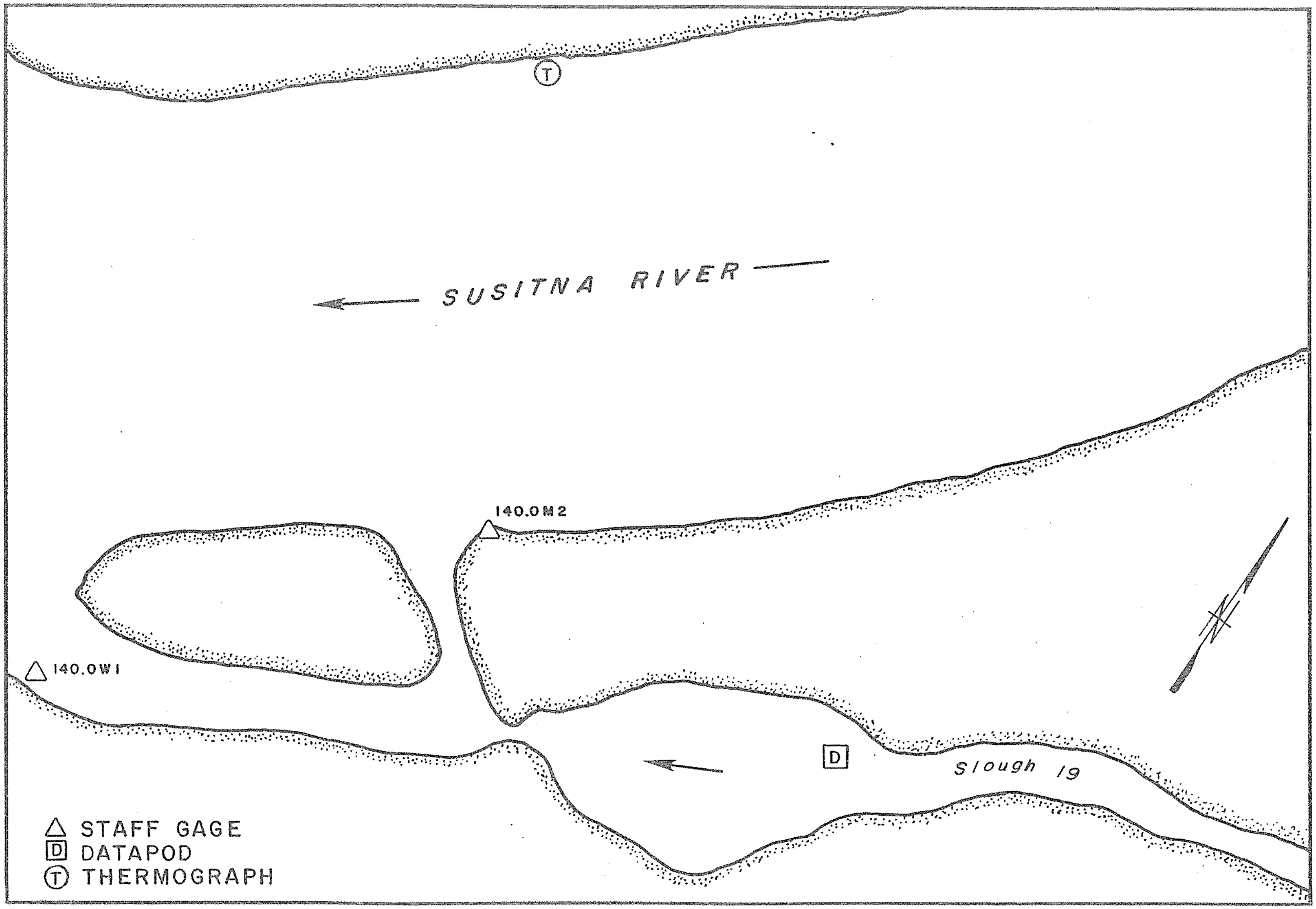

Figure 4I-3-3 Planimetric site map of Slough 19, RM 140.0, GC S31N02W10DBB.

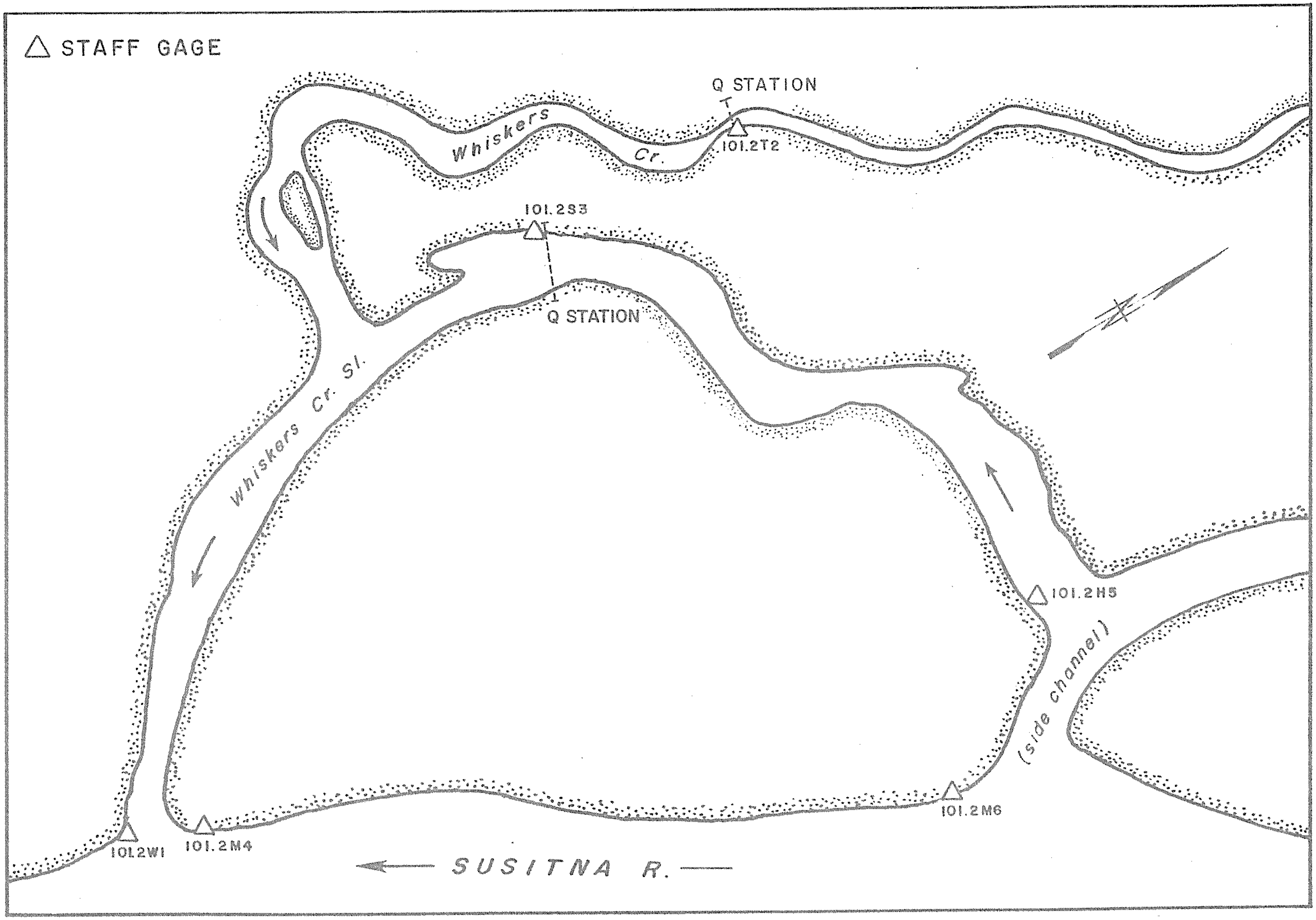

Figure 4I-3-4 Planimetric site map of Whiskers Creek and Whiskers Creek Slough, RM 101.2, GC S26N05W03AAC.

discharge was 24,000 cfs (Table 4I-3-2). The lower three flow measurements ranged from 0.2 to 2.0 cfs. The main water sources contributing to the flow during this period appeared to be groundwater and surface water runoff. Corresponding water surface elevations obtained during the low flows showed a range of 0.62 feet, with the overall range of water surface elevations being 2.03 feet (Appendix Table 4-A-3). These data were used to construct a preliminary rating curve (Figure 4I-3-5). Corresponding ranges of mainstem flows during this period were from 8,440 to 28,000 cfs.

Six water surface elevations obtained at the head of Whiskers Creek Slough (which joins a side channel of the Susitna River) had a range of 1.59 feet for corresponding mainstem flows of 13,600 to 31,900 cfs (Appendix Table 4-A-3). At mainstem discharges of 13,600 and 15,600 cfs, the head was not breached (staff gage readings were dry), while at mainstem discharges of 24,000 to 31,900 cfs, the head was breached, Table 4I-3-2.

Fourteen water surface elevations from the mouth of the slough were found to have a range of 4.0 feet corresponding to mainstem flows ranging from 8,440 to 31,900 cfs (Appendix Table 4-A-3). The water surface elevation of the mainstem, adjacent to the mouth of Whiskers Creek Slough, ranged 2.50 feet over mainstem flows from 8,440 to 24,000 cfs (Appendix Table 4-A-2). Water surface elevations obtained at the mouth of the slough were within 0.03 feet of the corresponding mainstem water surface elevations over the range of mainstem flows from 8,400 to

Table 41-3-2 Determination of the mainstem discharge at Gold Creek (cfs) required to breach the upstream end (head) of selected side sloughs in the Talkeetna to Devil Canyon Reach.

	Analytical Determination from Staff Gage at Slough Head		Field Observations		
Location	PZF at Slough Head	Mainstem Flow at Gold Creek	Date	Mainstem Flow at Gold Creek	Status of Slough
Whiskers Creek Slough	367.3	18,000	820816	15,600	Not breached
RM 101.2			820920	24,000	Breached
Lane Creek Slough	472.9	24,000	820920	24,000	Almost breached
RM 113.6			820607	25,000	Breached
Slough 11	684.0	--	Never breached in 1982	Estimated breaching flow @ 42,000	
RM 135.3					
Slough 16B	703.0	19,000	820708	18,100	Not breached
RM 138.0			820914	20,200	Breached
Slough 20	730.75	20,000	820914	20,200	Not breached
RM 140.1			820709	21,500	Breached
Slough 21, NW Channel	754.6	24,000	820720	22,900	Not breached
RM 142.0			820711	24,000	Breached for a few feet
			820728	25,600	Breached
Slough 21, NE Channel	755.5	26,000	820728	25,600	Not breached
RM 142.0			820622	26,000[a]	Breached
Slough 22	787.8	21,000	820914	20,200	Breached for a few feet
RM 144.3			820919	24,100	Breached

[a] USGS gaging station was inoperable in June, mainstem discharges are estimates

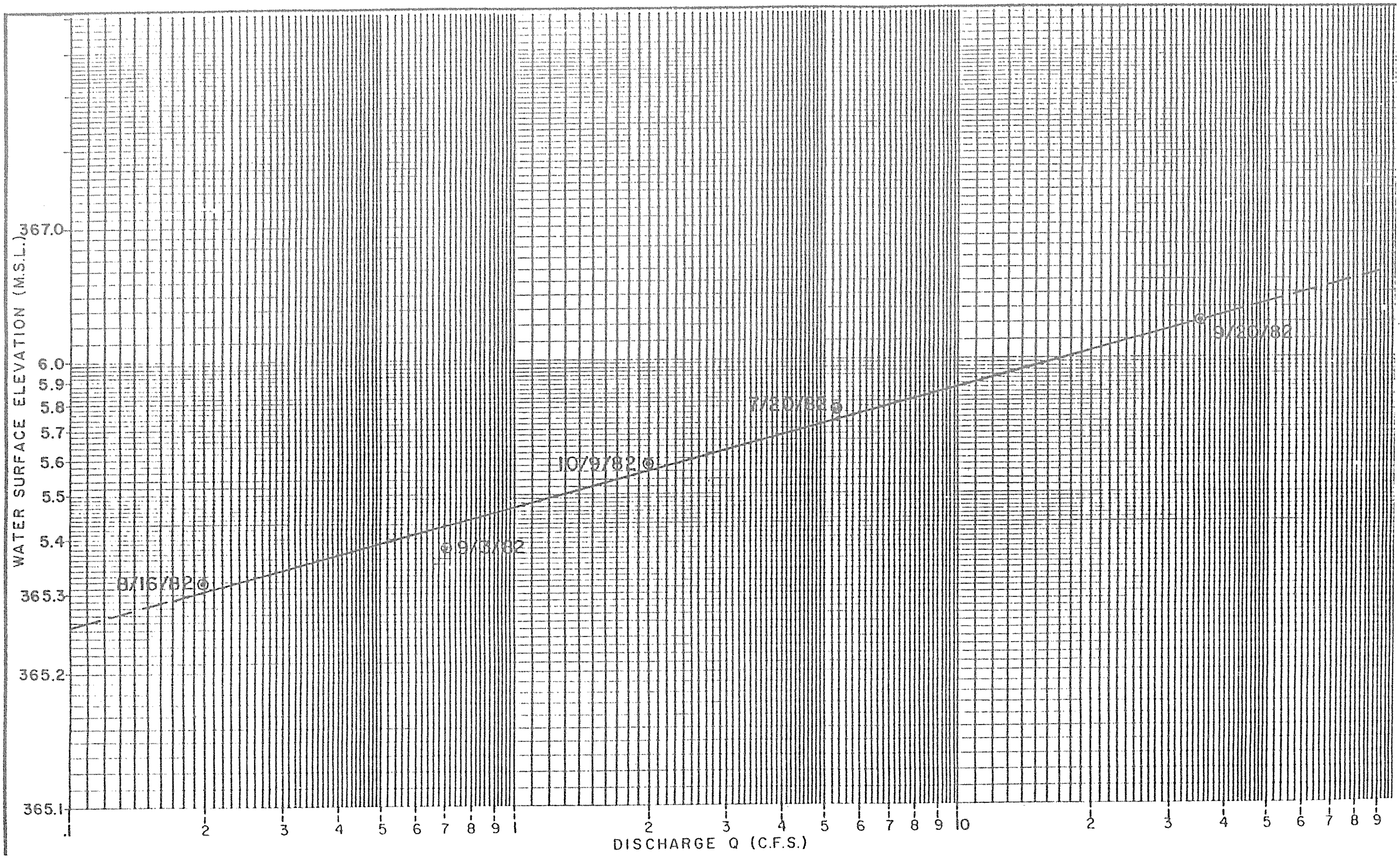

Figure 4I-3-5 Whiskers Creek Slough stage discharge rating curve (prepared by R&M Consultants 1982.)

24,000 cfs, indicating that a substantial backwater effect occurs at the mouth of the slough for this range of mainstem flows.

Lane Creek Slough

Lane Creek Slough (Figure 4I-3-6) is a free-flowing, meandering slough which empties into the mouth of Lane Creek. Seven water surface elevations obtained at mid-slough gaging station showed a range of 2.5 feet over a corresponding range of mainstem flows from 10,500 to 32,100 cfs (Appendix Table 4-A-3). Three discharge measurements were also obtained at the mid-slough gaging station (Table 4I-3-1). Flow during the two lowest discharges (2.0 and 9.9 cfs) appeared to result primarily from ground water seepage and surface water runoff. Flow during the highest measured discharge (20.7 cfs), taken when the mainstem flow was 32,000 cfs, appeared to be primarily from the mainstem. The mainstem was observed to breach the head of Lane Creek Slough at mainstem flows of approximately 25,000 cfs (Table 4I-3-2). Of the three staff gage readings obtained at the head of the slough, two were dry at mainstem flows of 14,000 and 24,000 cfs and one showed a water surface elevation of 474.30 feet at a mainstem discharge of 32,000 cfs. Water surface elevations were not determined at the mouth of Lane Creek Slough. However, a small backwater area was noted at the mouth of the slough over all ranges of mainstem flows in 1982.

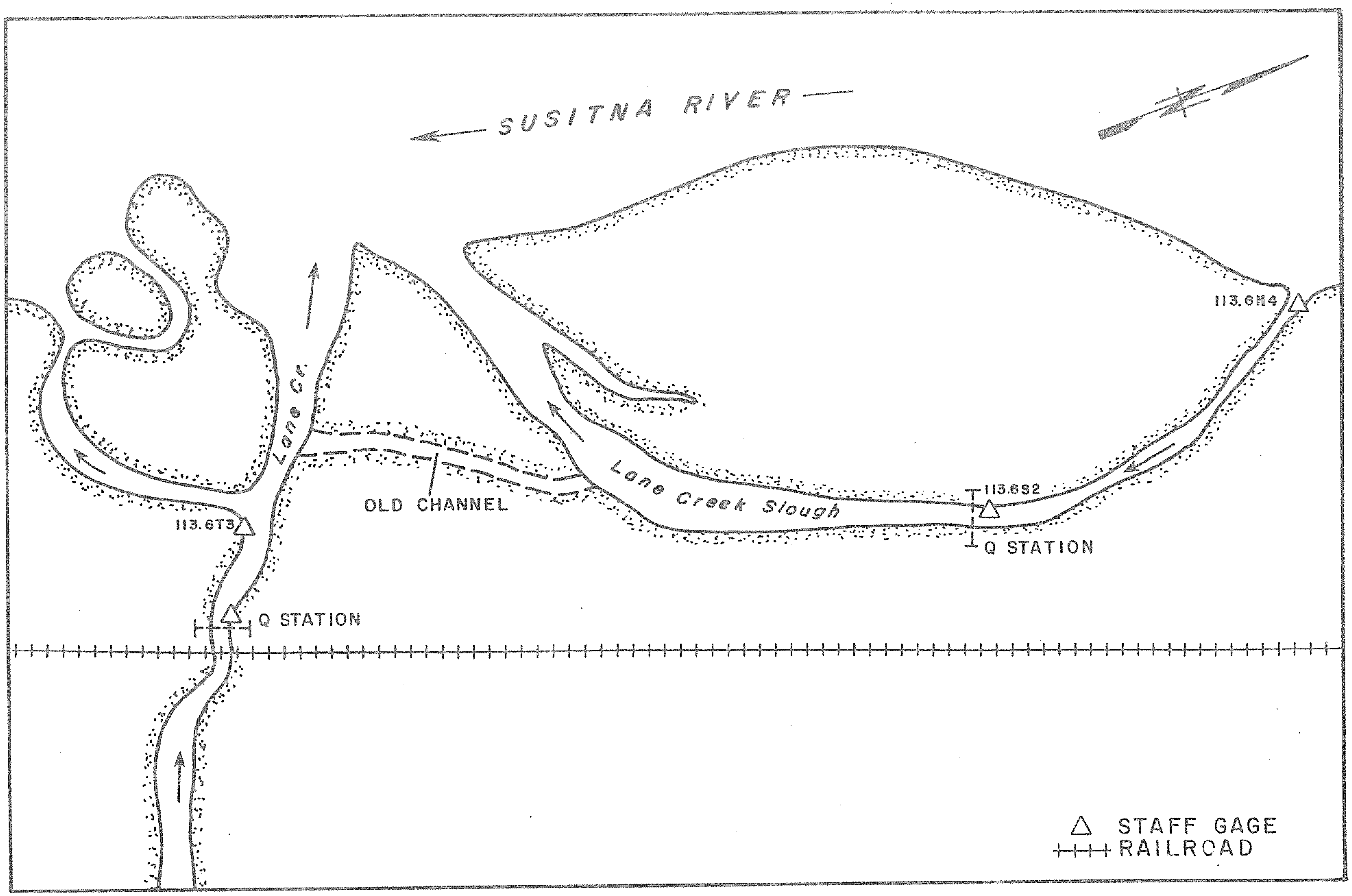

Figure 4I-3-6 Planimetric site map of Lane Creek and Lane Creek Slough, RM 113.6, GC S28N05W12ADD.

Slough 11

Slough 11 (Figure 4I-3-7) is a relatively long, unforked side slough with a head and mouth which join side channels of the mainstem. Six water surface elevations obtained from gages at the mid-slough gaging station were found to vary 0.05 feet (Appendix Table 4-A-3). Two discharge measurements obtained at the mid-slough gaging stations varied from 3.1 to 5.5 cfs (Table 4I-3-1). Due to the limited range of flows measured in Slough 11, a rating curve was not developed for this slough. The main sources of water contributing to the flow in Slough 11 during the open water season of 1982 appeared to be from groundwater and surface water runoff. The slough was never breached by the mainstem during the 1982 period of observation.

At the mouth, fifteen water surface elevations showed a range of 3.65 feet over a corresponding range of mainstem flows from 11,700 to 28,000 cfs. Water surface elevations of the mainstem, adjacent to the mouth, during this period had a range of 3.14 feet (Appendix Table 4-A-2). Backwater effects were limited to the immediate area of the mouth, increasing with mainstem discharge.

Slough 16B

Slough 16B (Figure 4I-3-8) consists of a relatively open, free-flowing channel which head and mouth confluence the mainstem. Eight water surface elevations obtained at the mid-slough gaging station showed a range of 1.61 feet (Appendix Table 4-A-3). Three discharge measurements

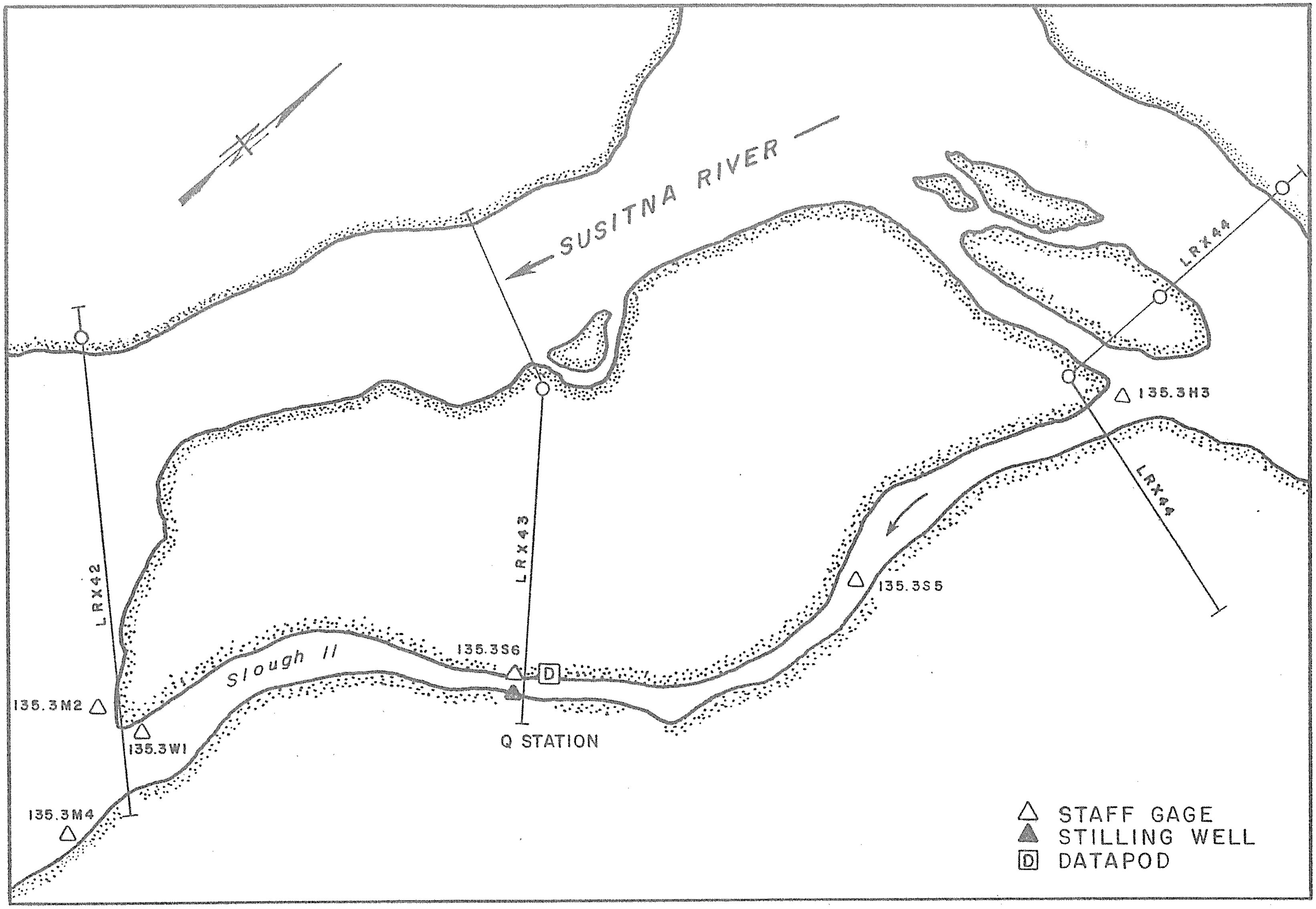

Figure 4E-3-7 Planimetric site map of Slough 11, RM 135.3, GC S31N02S19DDD.

were also obtained at the mid-slough gaging station ranging from 23.5 to 257.6 cfs (Table 4I-3-1). These data were used to construct a preliminary rating curve for this slough (Figure 4I-3-9). All discharge measurements measured at the mid-slough gaging station were obtained while the slough was breached by the mainstem. Corresponding mainstem flows ranged from 11,700 to 28,200 cfs. A single discharge measurement was made during a low flow, unbreached period near the mouth of the slough when the mainstem flow was 16,000 cfs. The flow was measured at 0.9 cfs and appeared to consist primarily of groundwater and surface water runoff.

Slough 16B was observed to be breached by the mainstem at the head of the slough when mainstem flows were 20,200 cfs (Table 4I-3-2). From five water surface elevations determined from staff gages placed at the head of Slough 16B, it was found that during a range of flows in the mainstem from 20,200 to 31,900 cfs, the water surface at the head ranged 1.4 feet.

The overall range of water surface elevations measured at the mouth of the slough was 2.88 feet over a corresponding range of mainstem discharges from 11,700 to 31,900 cfs. Thirteen water surface elevations of the mainstem, adjacent to the mouth of Slough 16B, ranged 5.83 feet over a range of mainstem discharges from 7,950 to 31,900 cfs. No pooling or backwater effect caused by the mainstem apparent at the mouth of this slough during 1982.

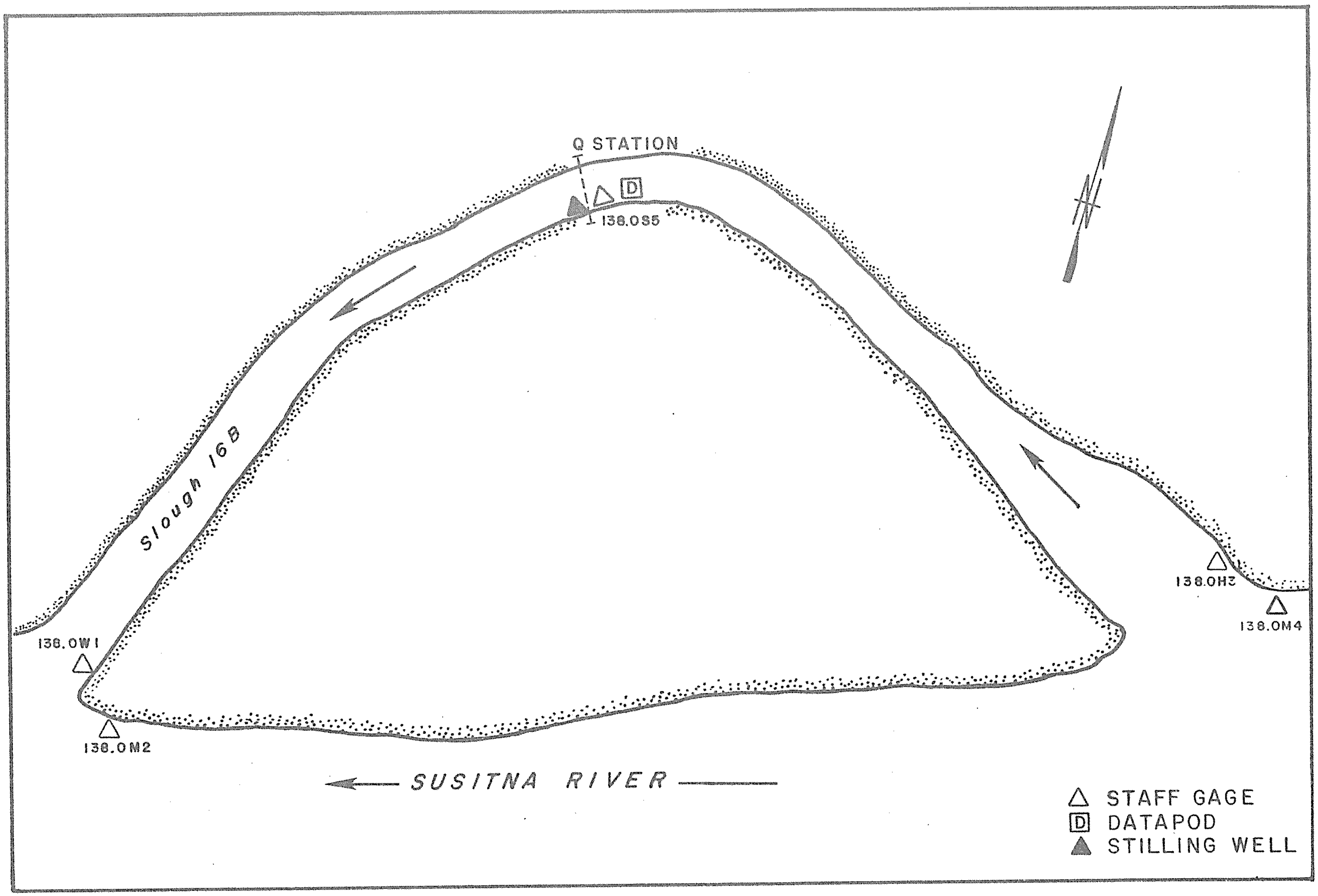

Figure 4I-3-8 Planimetric site map of Slough 16B, RM 138.0, GC S31N02W17ABC.

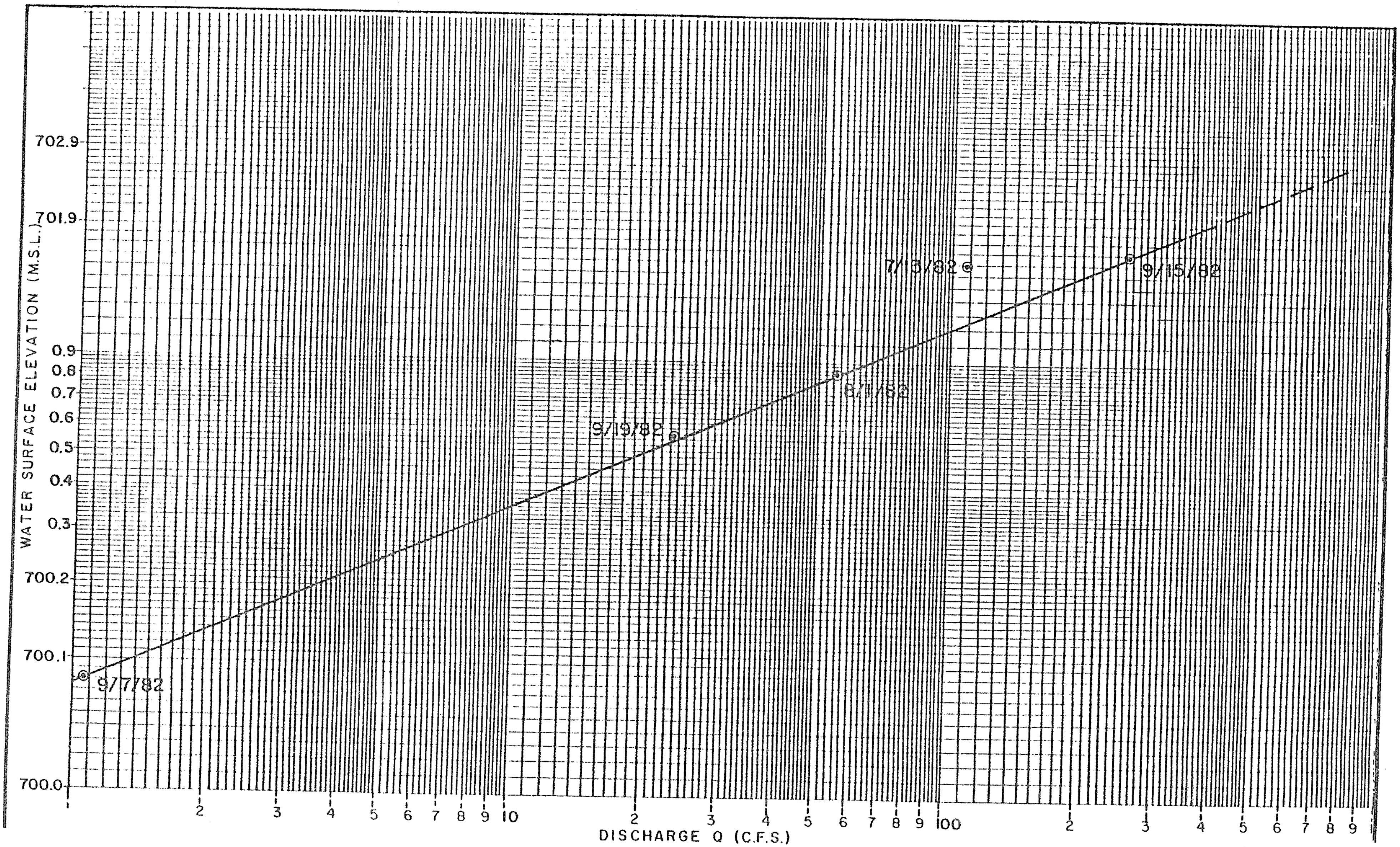

Figure VI-3-9 Slough 16B stage-discharge rating curve (prepared by R&M Consultants).

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Slough 20

Slough 20 (Figure 4I-3-10) as a relatively open, free-flowing channel which is fed by two clear water tributaries. Both its head and mouth confluence the mainstem Susitna River. Thirteen water surface elevations, obtained at the mid-slough gaging station varied 1.28 feet (Appendix Table 4-A-3). Five discharge measurements, taken at the mid-slough gaging station, ranged from 2.6 to 158.8 cfs (Table 4I-3-1). These data were used to construct a preliminary rating curve for this slough (Figure 4I-3-11). Corresponding mainstem flows during the period of measurements ranged from 8,480 to 32,500 cfs. Water surface elevations obtained at the mid-slough gaging station during breached and non-breached conditions varied 1.10 and 0.17 feet respectively while corresponding discharges measurements ranged from 16.4 to 158.8 cfs and 2.6 to 11.6 cfs, respectively. Mainstem flows during these periods ranged from 22,500 to 32,500 cfs and 12,500 and 17,900 cfs, respectively, with breaching occurring, as determined from the slough discharge measurements between the range of mainstem flows from 17,900 to 22,500 cfs.

Of the fourteen staff gage readings obtained at the head of the slough, three were dry at mainstem flows ranging from 12,500 to 20,200. The other eleven ranged from 0.40 to 1.39 feet over mainstem flows ranging from 21,500 to 32,500 cfs (Appendix Table 4-A-2). These data indicate the slough breaches between a mainstem discharge of 20,200 and 21,500 cfs (Table 4I-3-2.

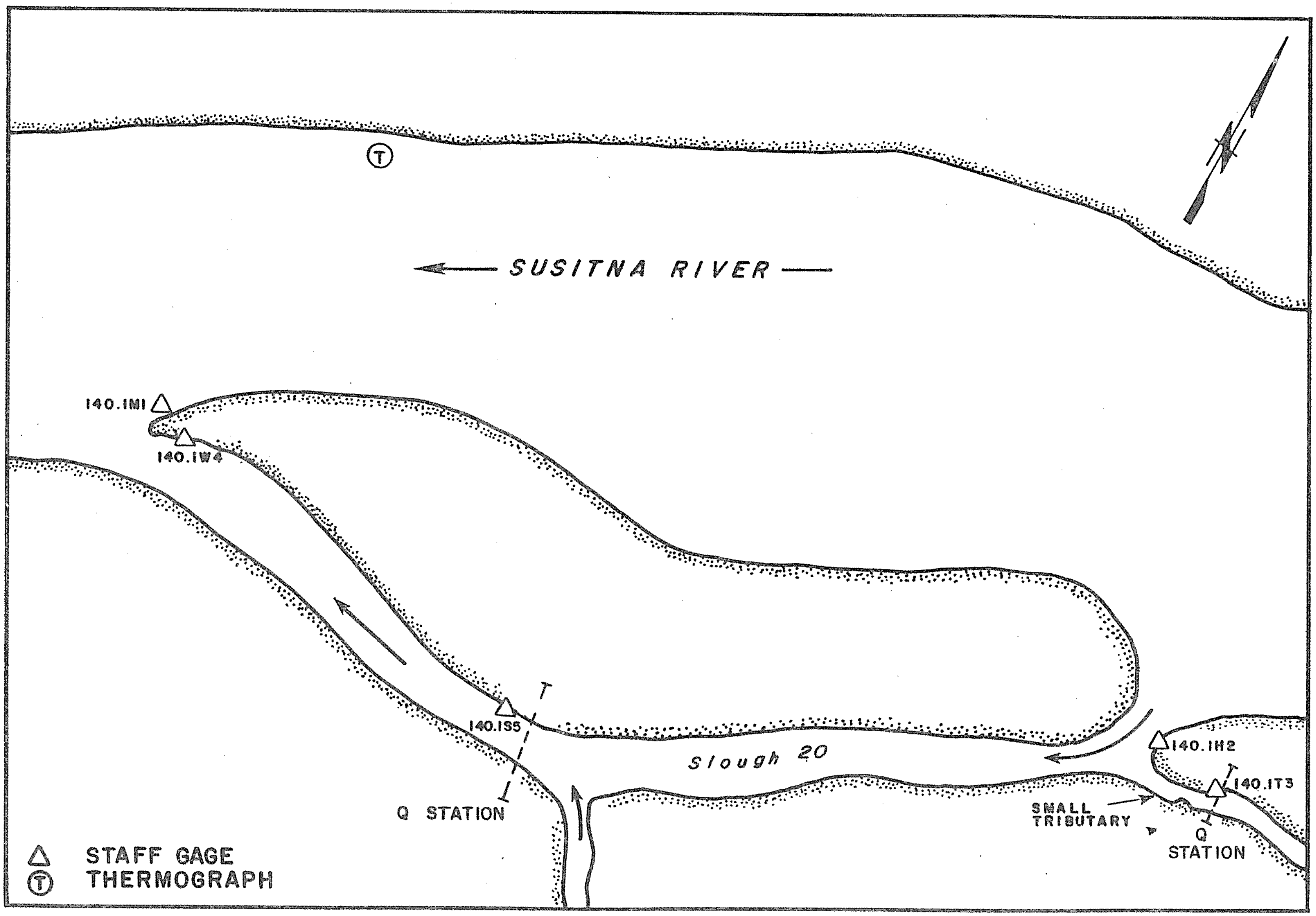

Figure 4E-3-10 Planimetric site map of Slough 20, RM 140.1, GC S31N02W11BBC.

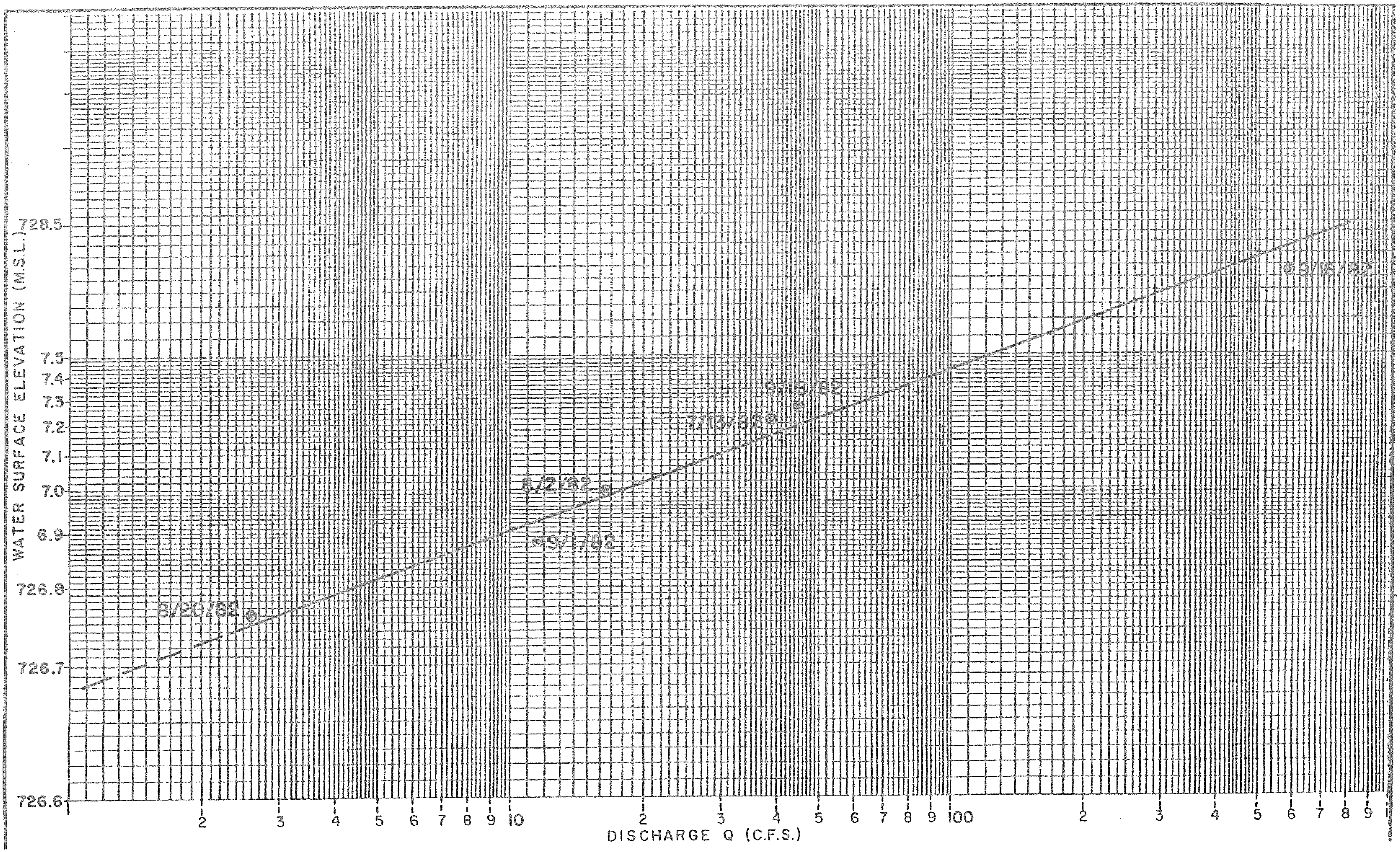

Figure 4E-3-11 Slough 20 stage-discharge curve (prepared by R&M Consultants 1982).

Twenty water surface elevations recorded at the mouth of Slough 20 ranged 2.44 feet during corresponding mainstem flows from 8,480 to 32,500 cfs (Appendix Table 4-A-3). Mainstem water surface elevations recorded adjacent to the mouth of Slough 20 for this same period ranged 2.48 feet (Appendix Table 4-A-2). These data indicate a backwater effect takes place in the vicinity of the mouth of the slough for these ranges of mainstem flows. Observations in 1982 substantiate this conclusion.

Slough 21

Slough 21 (Figure 4I-3-12) portion of the Slough 21 complex is a relatively long slough which parallels the mainstem Susitna River. The upper portion of Slough 21 forks into two channels and both heads join the mainstem. The mouth of the slough joins with a side channel of the mainstem. Seventeen water surface elevations were obtained at the gaging station located downstream of the forks varied 2.10 feet (Appendix Table 4-A-3). Three discharge measurements were also obtained at this gaging station ranging from 3.2 to 59.2 cfs (Table 4I-3-1). These data were used to construct a preliminary rating curve for this slough (Figure 4I-3-13). Corresponding mainstem discharges over the period of measurement ranged from 11,000 to 32,500 cfs. The two lowest discharge measurements, 3.2 and 5.0 cfs, were recorded during non-breaching mainstem flows of 16,000 and 22,500. The highest recorded slough discharge measured 59.2 cfs and was recorded during a breaching mainstem flow of 32,500 cfs. The primary sources of water to the slough

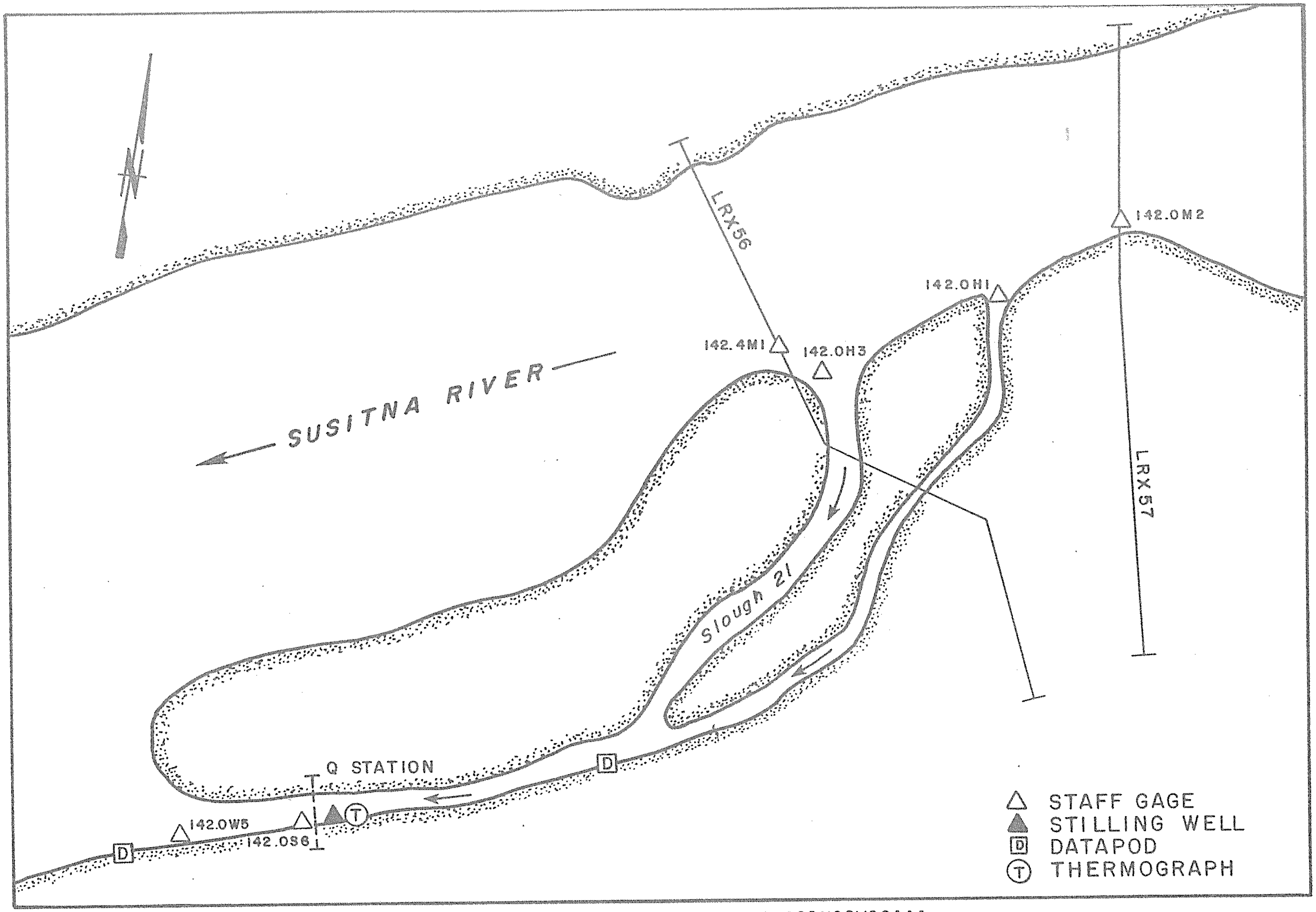

Figure 4E-3-12 Planimetric site map of Slough 21, RM 142.0, GC S31N02W02AAA.

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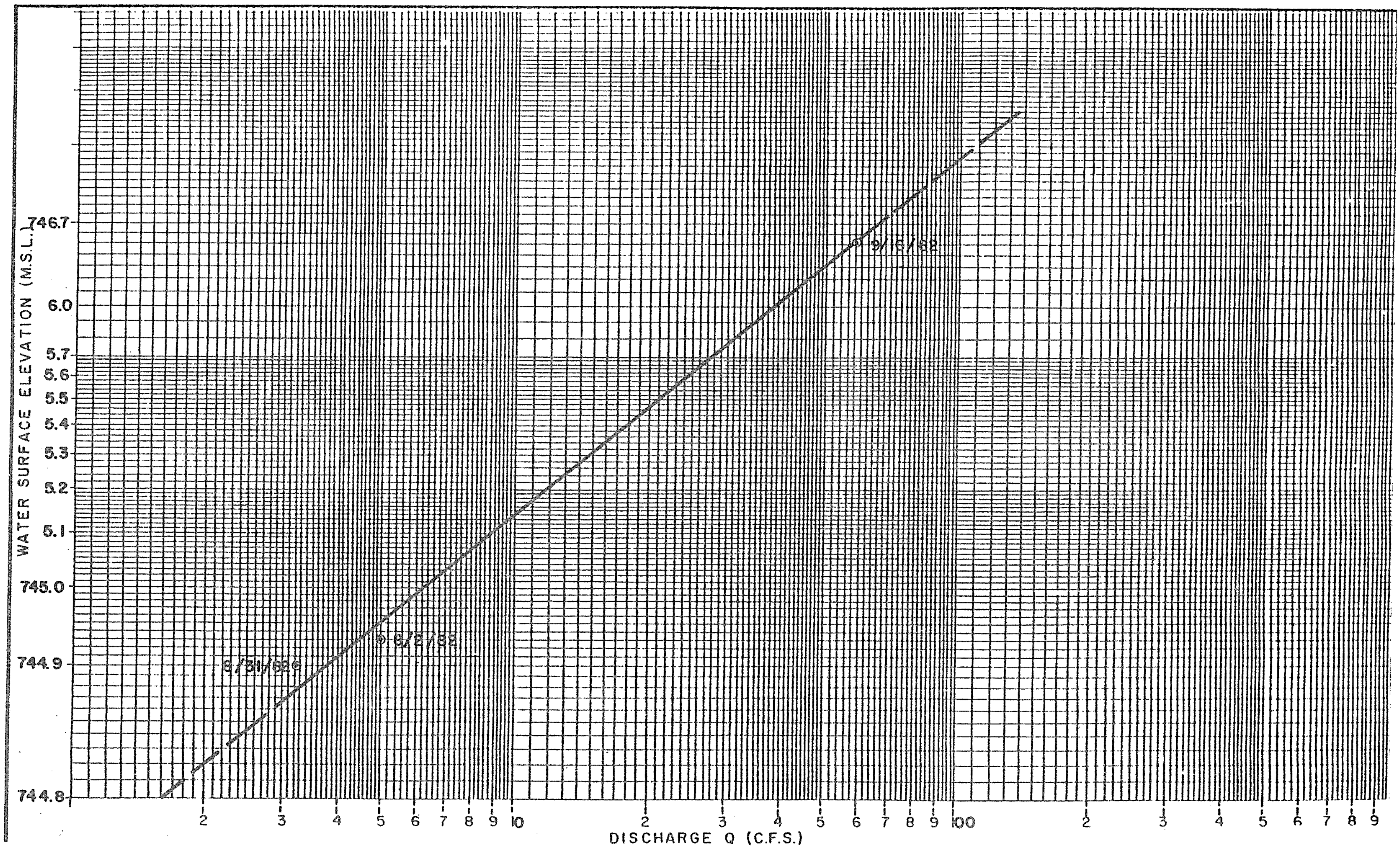

Figure 4E-3-13 Slough 21 stage- discharge curve (prepared by R&M Consultants 1982.)

flow during times of non-breaching mainstem flows appeared to be ground water and surface water runoff.

The NW (left channel looking upstream) head was observed to be breached by the mainstem at a mainstem flows greater than 24,000 cfs (Table 4I-3-2). Of the 12 staff gage readings obtained at the NW head of Slough 21, four were dry at mainstem flows between 16,000 and 22,900 cfs and eight had a range of 0.66 feet over mainstem flows from 24,000 to 32,500 cfs. Mainstem flows of at least 26,000 cfs, however, are required to breach the NE head. Of the nine staff gage readings obtained at the NE head of Slough 21, five were dry at mainstem flows ranging from 16,000 and 26,000 cfs and four had a range of 0.46 feet over mainstem flows from 26,000 to 31,900 cfs (Appendix Table 4-A-3). With a mainstem flow of 32,500 on September 16, both heads were breached by the mainstem.

Seventeen water surface elevations obtained at the mouth of Slough 21 (Appendix Table 4-A-3) had a range of 0.25 feet for mainstem flows from 12,200 to 24,100 cfs and a range of 1.42 feet for mainstem flows from 25,600 to 32,500 cfs. Very little backwater effects caused by the mainstem were observed in the vicinity of the mouth of Slough 21 in 1982.

Slough 22

Slough 22 is a relatively long, open-water channel with its head and mouth both confluenceing the mainstem Susitna River (Figure 4I-3-14).

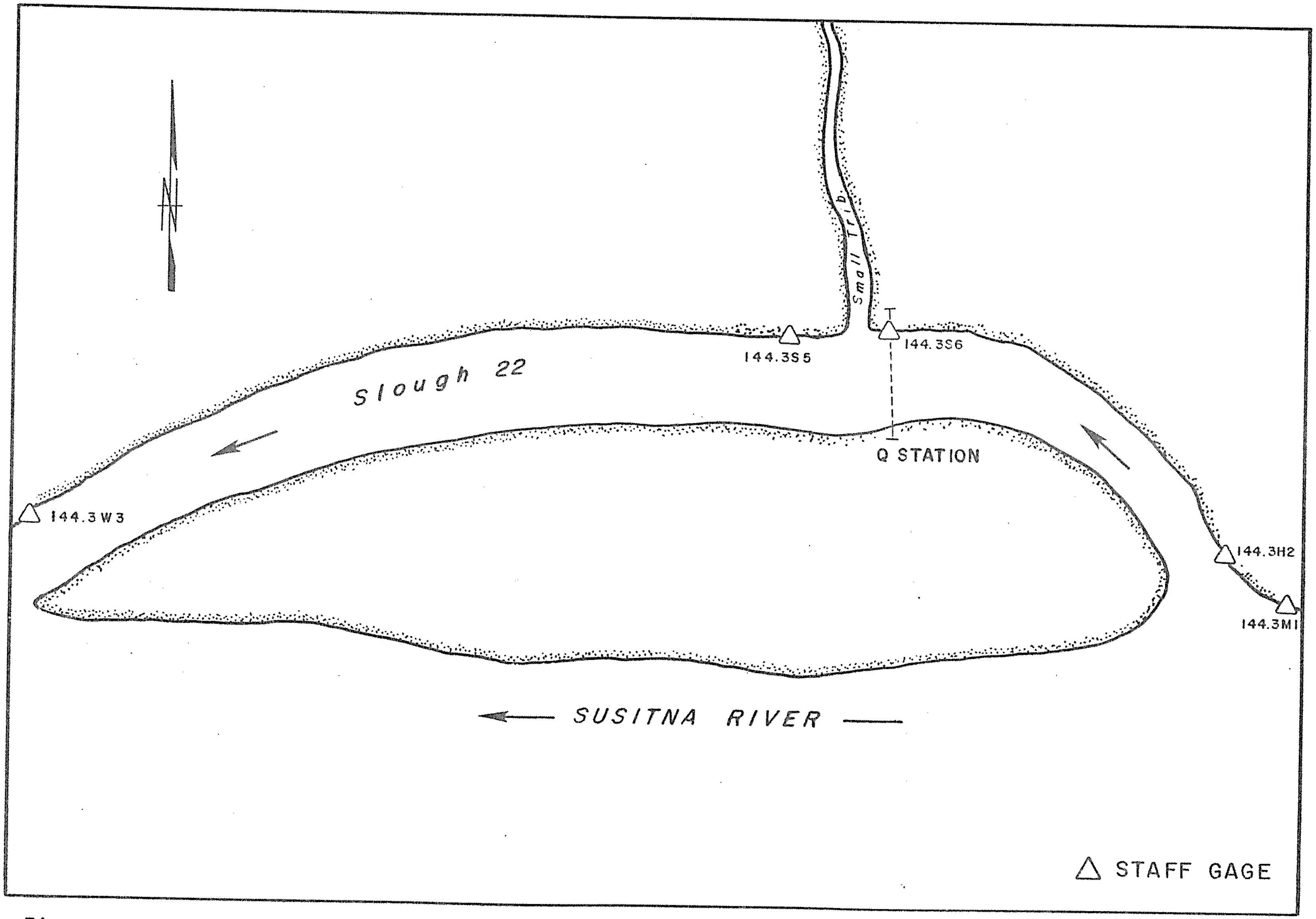

Figure 4I-3-14 Planimetric site map of Slough 22, RM 144.3, GC S32N02W32BBD.

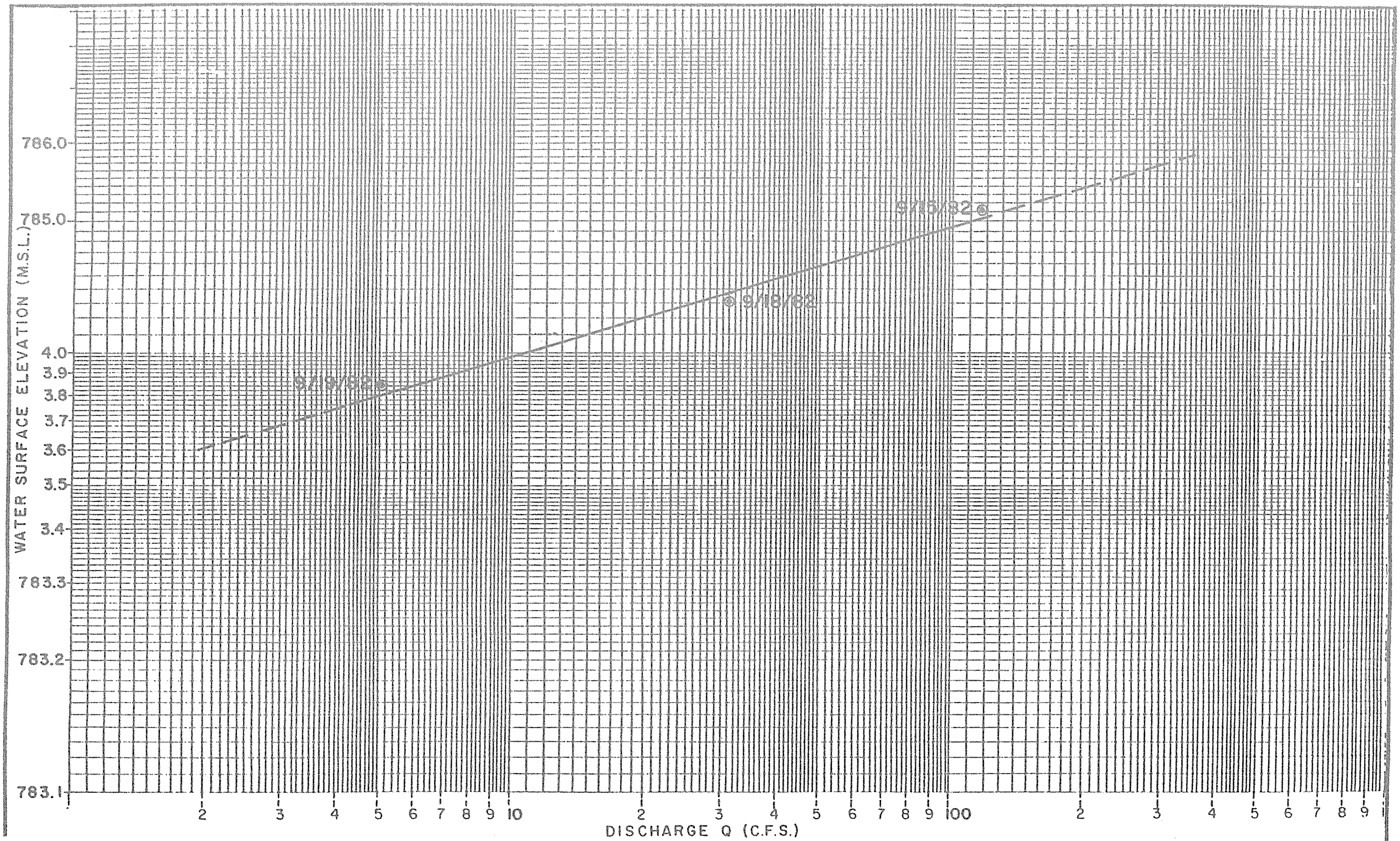

Figure 4I-3-15 Slough 22 stage-discharge curve (prepared by R&M Consultants 1982).

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Nine water surface elevations obtained at the mid-slough gaging station had a range of 1.72 (Appendix Table 4-A-3). Three discharge measurements obtained at this gaging station ranged from 5.1 to 118.5 cfs (Table 4I-3-1). These data were used to construct a preliminary rating curve for Slough 22 (Figure 4I-3-15). Corresponding mainstem discharges over the periods of measurement ranged from 13,600 to 28,200 cfs. All slough discharges were measured under mainstem breaching conditions.

Mainstem water was observed to begin to breach the head of Slough 22 with flows of 22,500 cfs (Table 4I-3-2). For mainstem flows in range of 22,500 to 28,200 cfs, the water surface elevation of the slough at the head varied 1.40 feet. Three dry staff gage readings were obtained under non-breaching mainstem flows of 18,100, 16,000 and 13,600 cfs.

Water surface elevations obtained at the mouth of Slough 22 varied 0.44 feet for mainstem flows ranging from 11,000 to 24,000 cfs and 0.99 feet for mainstem flows ranging from 24,100 to 28,200 cfs. For mainstem flows of 24,100 to 28,200 cfs, water depths over the head of Slough 22 ranged from 0.51 to 1.63 feet. No backwater effects caused by mainstem water influence were observed in 1982 in the vicinity of the mouth of Slough 22.

3.1.1.3 <u>Tributaries Between Talkeetna and Devil Canyon</u>

Staff gage readings and discharge measurements were obtained at seven tributaries located between Talkeetna and Devil Canyon during the 1982 open water field season. For two of these tributaries, Indian River and

Portage Creek, preliminary rating curves were developed. Due to insufficient data at the other sites, no rating curves were developed for Whiskers, Gash, Lane or Fourth of July Creeks, and an unnamed tributary at the head of Slough 20.

Whiskers Creek

Three discharge measurements were obtained on Whiskers Creek (Figure 4I-3-4) ranging from 18.3 to 142.5 cfs over a corresponding change in water surface elevation of 1.51 feet (Table 4I-3-3). Fifteen additional water surface elevations not collected in conjunction with discharge data showed a change in water surface elevation during the period of June to early October of 2.35 feet.

Gash Creek

Three discharge measurements were obtained on Gash Creek (Figure 4I-3-16) ranging from 1.3 to 16.6 cfs over a corresponding change in water surface elevation of 0.5 feet (Table 4I-3-3). Six additional water surface elevations not collected in associatation with discharge measurements had a range of 0.6 feet during the period August to October, 1982. Flows in Gash Creek are influenced by a culvert located upstream of the gaging station.

Table 4I-3-3. A comparison of water surface elevation and discharge (cfs) measurement at selected tributary streams upstream of Talkeetna to mainstem discharge (cfs) at Gold Creek.[a]

Location	Date	Time	WSEL (ft)	Measured Streamflow	Mainstem Discharge (cfs)
Whiskers Creek	821009	1145	366.51	31.8	7,080
(R.M. 101.4)	821006	1300	366.59	--	7,500
gage 101.2T2	820822	1400	366.21	--	12,200
	820928	1715	366.84	--	12,900
	820909	1315	366.39	--	13,400
	820813	1405	366.48	--	13,600
	820903	1550	366.85	54.7	14,600
	820816	1700	366.37	18.3	15,600
	820808	1930	366.12	--	16,600
	820611	--	366.06	--	24,000
	820930	1615	367.88	142.5	24,000
	820715	1320	365.49	--	25,600
	820622	0930	367.07	--	26,000
	820621	1300	367.40	--	28,000
	820725	1525	368.47	--	31,900
Gash Creek	821009	1545	453.32	5.9	8,440
(R.M. 111.5)	821004	1430	453.34	--	10,500
gage 111.5T1	820813	1320	453.10	--	13,600
	820818	1150	453.18	1.3	14,200
	820920	1707	453.69	16.6	24,000
	820921	1240	453.34	--	24,200
Lane Creek	821004	1228	472.03	--	10,500
(R.M. 113.6)	820909	1100	471.94	--	13,400
gage 113.6T3	820926	1335	472.11	--	14,400
	820910	1630	471.91	--	14,400
	820903	1450	472.23	--	14,600
	820925	1640	472.14	--	15,000
	820817	1425	471.89	27.5	15,100
	820816	--	475.44	35.3	15,600
	820902	--	475.79	51.7	16,000
	820831	--	475.94	56.7	16,000
	820808	1430	471.95	--	16,600
	820917	1645	472.58	--	32,000
4th of July Creek	820907	1745	625.29	--	11,700
(R.M. 131.1)	820908	1345	625.24	--	11,900
gage 131.1T1	820822	1315	624.99	--	12,200
	821001	1524	625.53	--	12,400
	820813	1220	625.18	--	13,600
	820818	1805	625.18	--	14,200
	820903	1130	625.81	--	14,600

[a] USGS provisional data, 1982.

Table 4I-3-3 (continued).

Location	Date	Time	WSEL (ft)	Measured Streamflow	Mainstem Discharge (cfs)
4th of July Creek (R.M. 131.1) gage 131.1T1	820811	1015	625.33	--	15,400
	820902	1640	625.67	--	16,000
	820810	1835	625.38	--	16,700
	820924	1750	625.53	--	17,100
	820803	1625	625.35	38.3	19,800
	820920	1030	626.28	--	24,000
	820919	1026	626.28	--	24,100
	820728	1625	625.52	--	25,600
	820917	1050	626.17	--	32,000
Tributary at head of Slough 20 (R.M. 140.6) gage 140.1T3	821003	1715	731.23	--	11,000
	820820	1145	730.16	--	12,500
	820813	1005	730.19	--	13,600
	820901	1540	730.21	0.2	17,900
	820804	1220	730.04	--	18,500
	820914	1447	730.52	--	20,200
	820802	1230	730.37	--	22,500
	820619	--	730.77	--	25,000
	820623	1015	730.61	--	26,000
	820622	1145	730.98	--	26,000
	820918	1217	730.74	9.3	27,500
	820727	1205	730.84	--	29,100
	820916	1230	731.39	23.4	32,500

[a] USGS provisional data, 1982.

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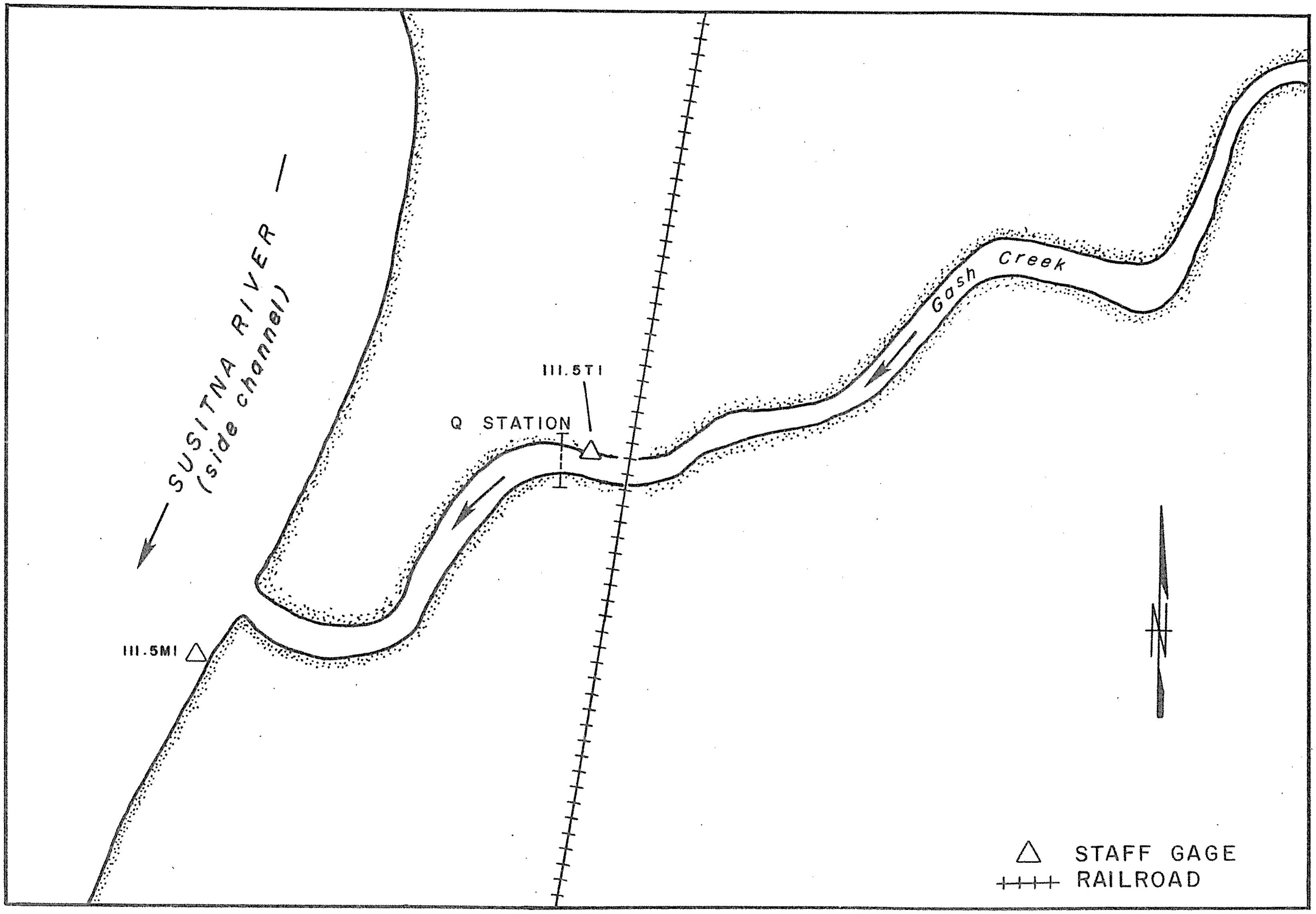

Figure 4E-3-16 Planimetric site map of Gash Creek, RM 111.5, GC S28N05W24ADA.

Lane Creek

Four discharge measurements were obtained on Lane Creek (Figure 4I-3-6) ranging from 27.5 to 56.7 cfs over a corresponding change in water surface elevation of 4.0 feet (Table 4I-3-3). Twelve additional water surface elevations not collected in conjunction with discharge data showed a range of 4.0 feet during the period August to October, 1982.

Fourth of July Creek

Due to high velocities, which made wading hazardous during most 1982 flows, only a single discharge measurement of 38.3 cfs corresponding to a water surface elevation of 625.35 feet was obtained on Fourth of July Creek (Figure 4I-3-17). Fifteen additional water surface elevations not collected in conjunction with discharge data showed a change in water surface elevation of 1.29 feet during the period July to October, 1982 (Table 4I-3-3).

Unnamed Tributary at the Head of Slough 20

Three discharge measurements were obtained on an unnamed tributary located at the head of Slough 20 (Figure 4I-3-10), ranging from 0.2 to 23.4 cfs over a corresponding change in water surface elevation of 1.18 feet (Table 4I-3-3). Ten additional water surface elevations not collected in conjunction with discharge data showed a change in water surface of 1.35 during the period of June to October, 1982.

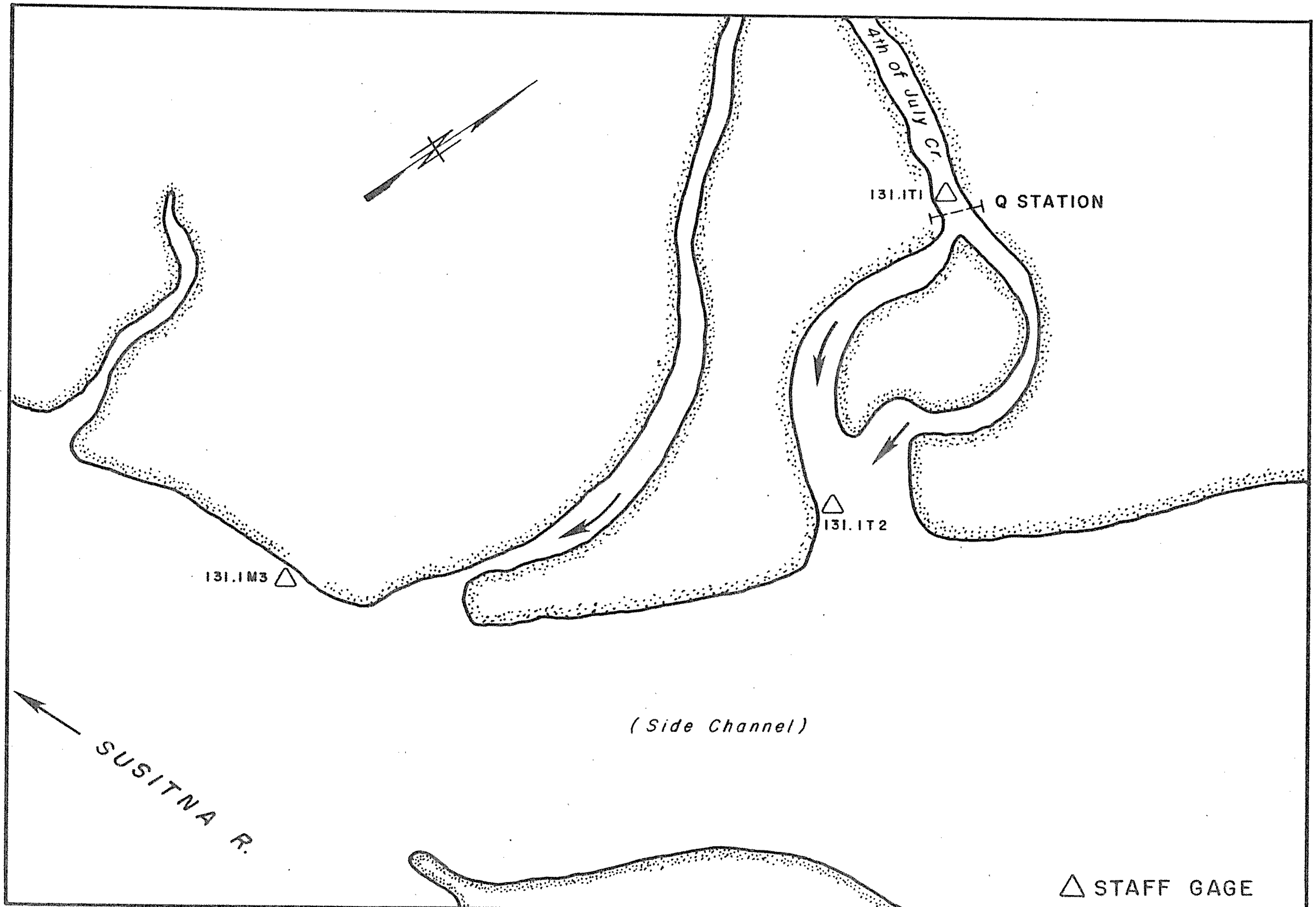

Figure 4E-3-17 Planimetric site map of Fourth of July Creek, RM 131.1, GC S30N03W03DAC.

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Indian River and Portage Creek

Continuous streamflow records for Indian River (Figure 4I-3-18) and Portage Creek (Figure 4I-3-19) were obtained from August 9 through October 22 (Appendix Tables 4-A-4 and 4-A-5). Streamflows generally ranged between 100 and 400 cfs over a corresponding change in water surface elevation of 1.82 ft at Indian River (Table 4I-3-4) and 200 to 600 cfs over a corresponding change in water surface elevation of 2.79 ft at Portage Creek (Table 4I-3-5). Due to prevailing weather conditions during the measurement period of 1982 these streamflows may be considerably less than normally expected for this period.

The peak runoff recorded from early August through October was 1,815 cfs on September 15 at Indian River and 1,673 cfs on September 16 in Portage Creek. These streamflows were the effect of a 3-day rainstorm during which 2.7 inches of precipitation was recorded at Devil Canyon (R&M, 1982 observations). A cursory review of monthly precipitation values at Talkeetna indicate that this was a fairly large, but not uncommon, amount of precipitation for September. Preliminary rating curves were developed utilizing stage-discharge data collected by R&M Consultants (Figure 4I-3-20).

3.1.1.4 Mainstem, Sloughs and Tributaries Downstream of Talkeetna

Measurements of water surface elevation and discharge were obtained at four tributaries (Goose, Rabideux, Sunshine and Birch Creeks) and four

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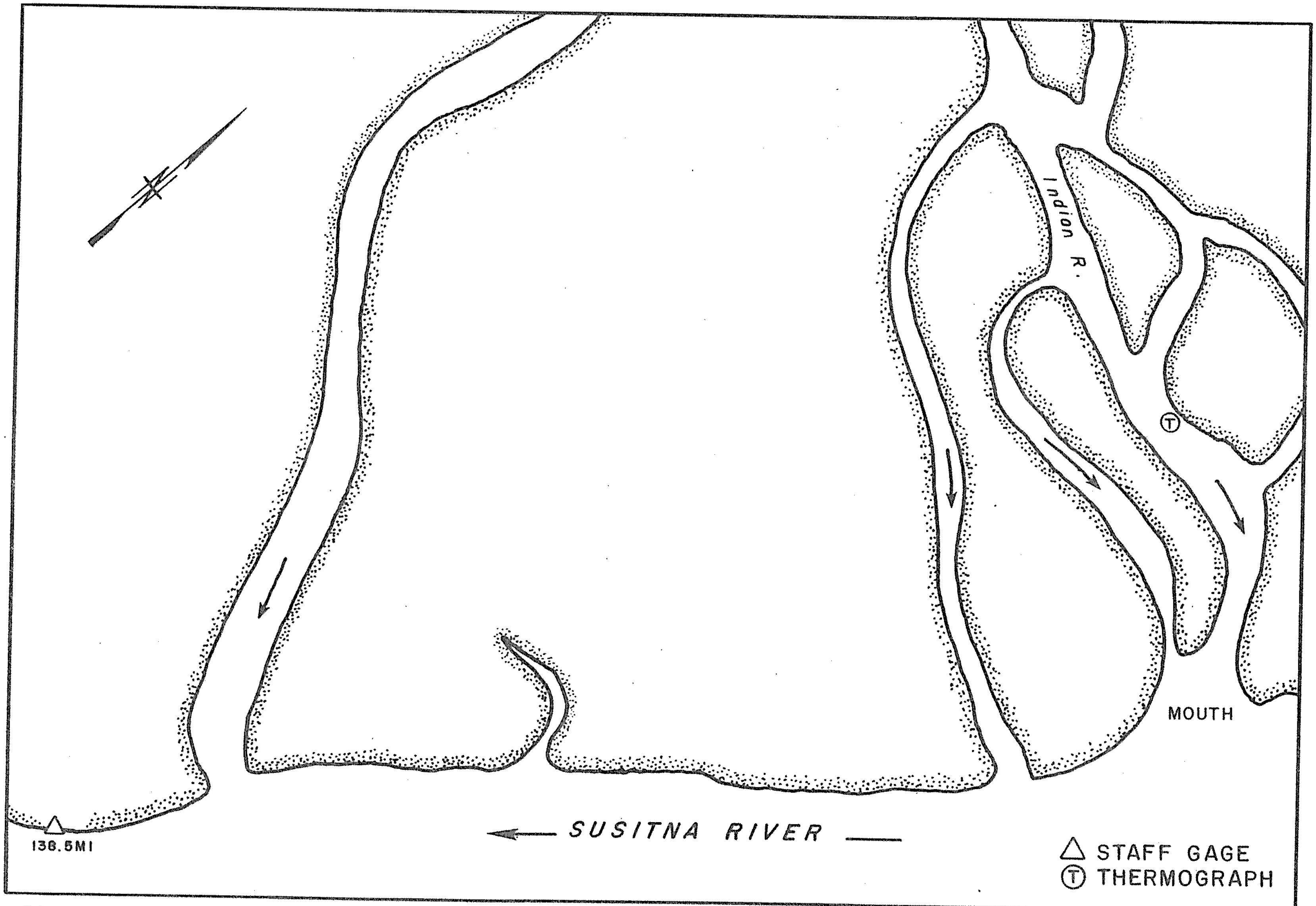


Figure 4I-3-18 Planimetric site map of Indian River, RM 138.6, GC S31N02W09CDA.

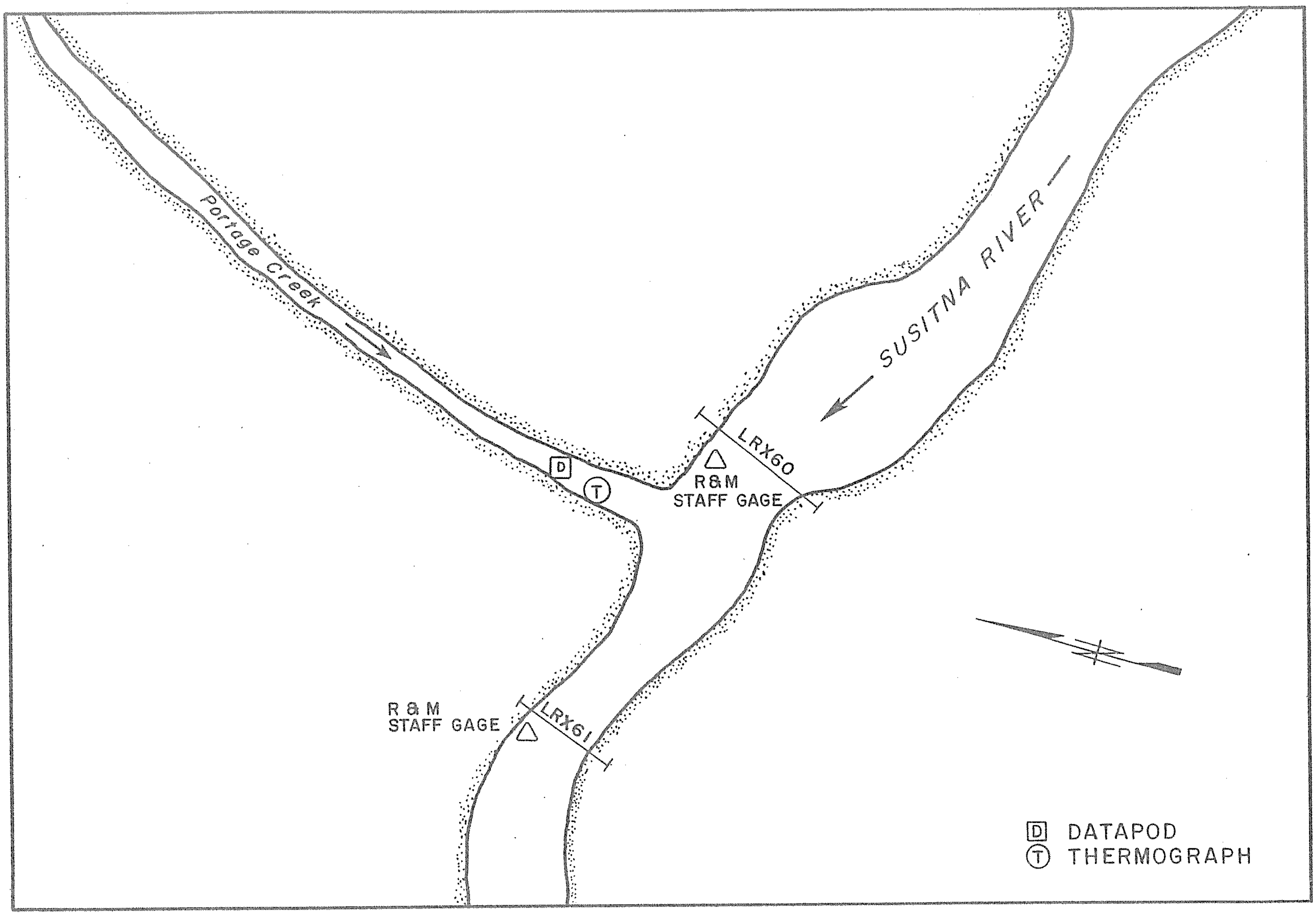


Figure 4E-3-19 Planimetric site map of Portage Creek, RM 148.8, GC S32N01W25CDB.

Table 4I-3-4 Daily mean streamflow and surface water temperature record for Indian River, Alaska.

DATE	GAGE HEIGHT (ft)	DISCHARGE (cfs)	SURFACE WATER TEMPERATURE (C)
820809	1.76	257	8.6
820810	1.73	244	8.4
820811	1.69	228	8.9
820812	1.59	195	8.9
820813	1.53	176	9.6
820814	1.51	169	9.0
820815	1.50	168	9.0
820816	1.46	156	9.4
820817	1.53	175	8.8
820818	1.53	177	8.4
820819	1.47	158	8.6
820820	1.42	145	9.4
820821	1.38	136	9.3
820822	1.36	131	9.3
820823	1.37	132	9.6
820824	1.35	130	9.7
820825	1.36	130	9.8
820826	1.36	131	9.7
820827	1.33	124	8.8
820828	1.33	123	8.6
820829	1.39	139	8.6
820830	1.80	275	8.0
820831	2.12	446	7.8
820901	1.99	367	7.9
820902	1.87	307	7.9
820903	1.90	322	7.6
820904	1.83	288	7.6
820905	1.77	259	7.5
820906	1.71	235	7.8
820907	1.72	240	8.1
820908	1.68	227	7.6
820909	1.67	220	7.4
820910	1.68	223	7.1
820911	1.71	238	6.6
820912	1.72	240	6.2
820913	2.15	473	6.2
820914	2.48	762	6.6
820915	3.13	1815	7.1
820916	3.01	1557	6.7
820917	2.71	1041	5.8
820918	2.44	716	6.0
820919	2.63	931	6.2

Table 4I-3-4 Cont.

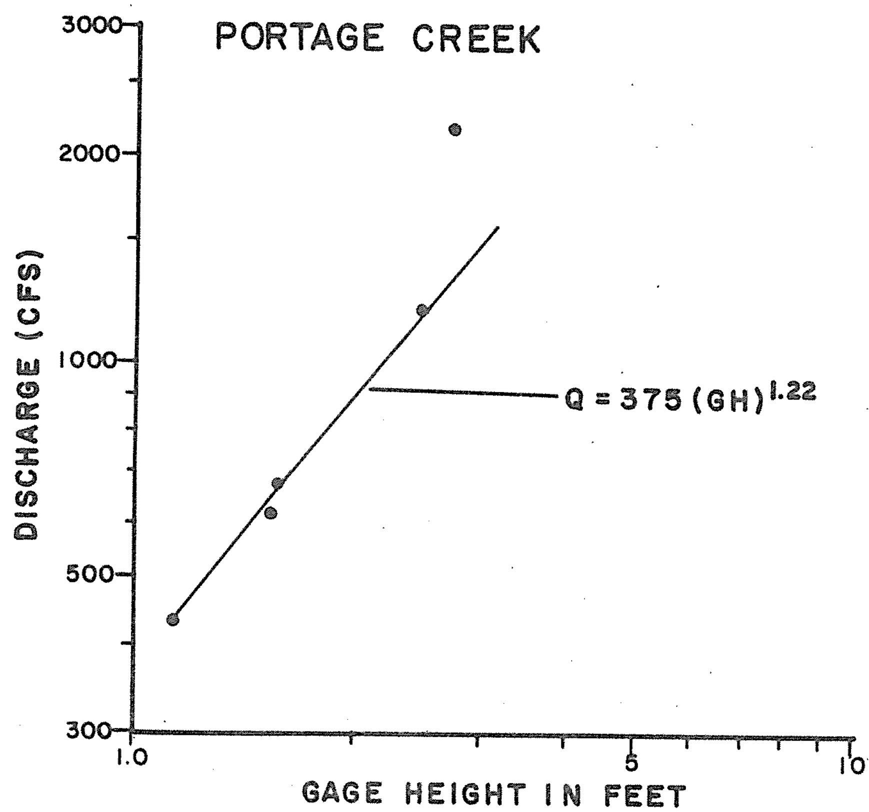
DATE	GAGE HEIGHT (ft)	DISCHARGE (cfs)	SURFACE WATER TEMPERATURE (C)
820920	2.87	1291	6.1
820921	2.59	879	5.9
820922	2.42	693	5.7
820923	2.24	539	4.7
820924	2.11	444	4.2
820925	2.01	378	4.6
820926	1.96	352	5.0
820927	2.10	434	5.0
820928	1.95	347	4.0
820929	1.95	345	4.9
820930	1.92	330	5.1
821001	1.86	277	4.6
821002	1.80	252	4.5
821003	1.75	233	4.3
821004	1.70	215	3.3
821005	1.67	202	2.7
821006	1.61	183	2.2
821007	1.60	182	2.4
821008	1.58	174	2.4
821009	1.56	170	2.6
821010	1.53	161	2.6
821011	1.50	154	2.1
821012	1.53	162	2.0
821013	1.53	160	1.7
821014	1.47	146	1.3
821015	1.42	132	.1
821016	1.42	134	.6
821017	1.43	136	1.6
821018	1.40	130	.6
821019	1.40	129	1.0
821020	1.37	123	.6
821021	1.31	110	0.0
821022	1.32	111	0.0

Table 4-I-3-5 Daily mean streamflow and surface water temperature record for Portage Creek, Alaska.

DATE	GAGE HEIGHT (ft)	DISCHARGE (cfs)	SURFACE WATER TEMPERATURE (C)
820809	2.17	602	8.0
820810	2.22	625	7.9
820811	2.16	594	8.7
820812	2.02	527	8.7
820813	1.94	489	9.7
820814	1.93	484	9.4
820815	1.96	495	9.3
820816	1.86	451	9.6
820817	1.89	464	8.6
820818	1.87	455	8.4
820819	1.79	418	8.6
820820	1.74	392	9.5
820821	1.70	376	9.4
820822	1.67	359	9.4
820823	1.69	369	9.8
820824	1.68	368	9.8
820825	1.69	371	10.0
820826	1.74	394	9.9
820827	1.67	362	8.7
820828	1.63	342	8.1
820829	1.72	385	8.4
820830	2.19	609	7.5
820831	2.50	766	7.3
820901	2.31	672	7.6
820902	2.19	612	7.5
820903	2.33	682	7.1
820904	2.28	658	7.1
820905	2.19	611	7.0
820906	2.13	579	7.5
820907	2.15	589	7.8
820908	2.09	563	7.0
820909	2.08	557	6.9
820910	2.15	592	6.8
820911	2.15	590	6.0
820912	2.16	595	5.7
820913	2.59	814	6.0
820914	3.19	1088	6.1
820915	4.06	1584	6.6
820916	4.21	1673	5.9
820917	3.73	1391	5.2
820918	3.41	1210	5.4
820919	3.58	1308	5.8

Table -I- - Cont.

DATE	GAGE HEIGHT (ft)	DISCHARGE (cfs)	SURFACE WATER TEMPERATURE (C)
820920	3.70	1375	5.5
820921	3.45	1229	5.5
820922	3.24	1114	5.3
820923	3.01	988	4.1
820924	2.83	891	3.6
820925	2.69	817	4.1
820926	2.59	765	4.6
820927	2.57	754	4.7
820928	2.45	691	3.5
820929	2.41	670	4.4
820930	2.39	660	4.6
821001	2.30	613	4.1
821002	2.22	578	4.0
821003	2.16	544	3.6
821004	2.09	512	2.6
821005	2.03	484	2.0
821006	1.96	449	1.5
821007	1.94	441	1.6
821008	1.91	428	1.5
821009	1.88	413	1.5
821010	1.84	394	1.7
821011	1.80	376	1.2
821012	1.79	371	1.7
821013	1.77	360	1.5
821014	1.72	340	1.0
821015	1.61	290	0.0
821016	1.69	325	0.0
821017	1.69	324	.2
821018	1.62	292	0.0
821019	1.61	290	.1
821020	1.55	265	0.0
821021	1.42	210	0.0
821022	1.42	208	0.0



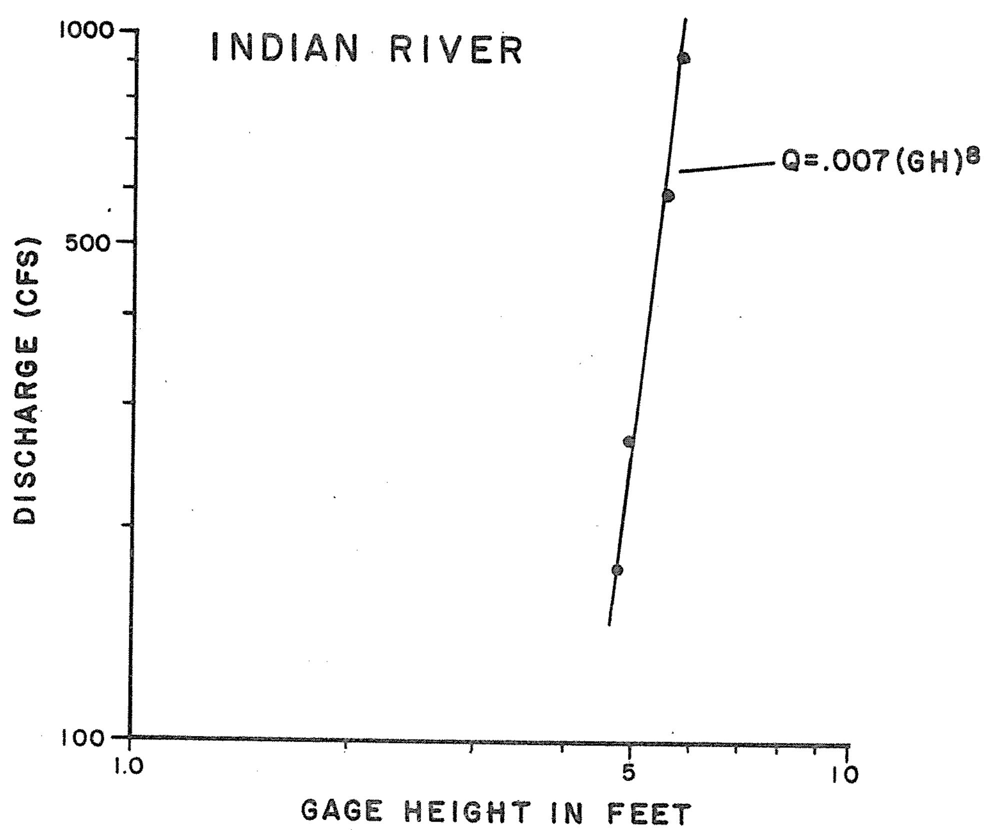


Figure 9I-3-20 Stage discharge rating curve for Indian River and Portage Creek.

sloughs (Goose II, Whitefish, Sunshine and Birch Creek Sloughs) located downstream of Talkeetna. These data are currently being developed into preliminary rating curves which will be presented in the final draft of this report. Goose II Slough and Sunshine Slough are also referred to in the backwater area section of this report as Goose II side channel and Sunshine minor side channel, respectively.

Stage readings were obtained in the mainstem Susitna River at Sunshine fishwheel station and mainstem Yentna River at the Yentna River fishwheel station. These data were compared to provisional USGS data collected at Sunshine (for the Susitna River) and the Yentna River respectively. In addition, mainstem Susitna River water surface elevation data was collected at the confluences of the tributary and slough sites noted above. This data is presented in conjunction with the slough and tributary data. Cross sections were made from survey data collected by ADF&G in 1982 for Rabideux Slough and Chum Channel (Appendix Figures 4-A-40 and 4-A-41).

3.1.1.4.1 Mainstem Sites

Sunshine Fishwheel Station

The Sunshine fishwheel station stage data is currently in the process of being reduced and will appear in the final draft of this report.

Yentna Fishwheel Station

A summary of the Yentna River fishwheel station stage data as compared to provisional USGS discharge data (1982) for the Yentna River is presented in Table 4I-3-6. The stage data at the Yentna River fishwheel station was relative to an arbitrary benchmark (elevation = 100.00 ft) and was not tied to project datum. Stage readings obtained periodically from June 30 to September 15, 1982, varied 3.51 feet. Corresponding discharges of the Yentna River varied from 30,000 to 61,000 cfs and within the Susitna River downstream of the Yentna River confluence from 71,000 to 142,000 cfs during the same period.

3.1.1.4.2 Tributaries

Lower Goose Creek 2

Three discharge measurements were obtained on Lower Goose Creek 2 (Figure 4I-3-21) ranging from 84.10 to 251.0 cfs over a corresponding change in water surface elevation of 0.92 feet. Nine additional water surface elevations not collected in conjunction with discharge data showed a change in water surface elevation during the period June through October, 1982, of 1.46 feet. Lower Goose Creek 2 was not directly influenced by mainstem flows as determined from comparisons of change in the observed water surface elevations in the creek to the mainstem discharge (Appendix Table 4-A-6).

Table 4I-3-6. Comparison of the relative water surface elevations of the Yentna River obtained from staff gages located at the Yentna River Fishwheel station to the mean daily Yentna River[a] and Susitna River[b] discharge (CFS).

Date	Time	WSEL (ft)[c]	Yentna River Discharge	Susitna River Discharge
820829	2000	86.55	30,000	71,000
820905	1730	86.68	31,000	75,000
820828	1740	86.72	31,500	74,000
820913	1920	87.36	32,000	90,000
820903	1740	87.26	32,000	82,000
820904	1850	87.35	32,000	72,000
820906	1800	87.49	33,000	74,000
820912	1950	88.00	33,000	77,000
820823	2200	87.19	33,100	78,000
820911	1920	88.03	34,000	77,000
820902	1930	87.67	34,000	87,000
820824	2130	87.43	34,200	80,000
820822	2350	87.28	34,200	78,000
820826	2300	87.11	34,400	80,000
820821	2350	87.51	34,800	79,600
820831	2100	90.16	35,000	92,000
820820	2100	87.50	35,200	81,600
820825	2200	87.48	35,500	82,000
820819	2200	87.60	36,800	86,700
820910	1815	87.66	37,000	80,000
820814	2030	87.83	37,400	88,100
820813	1000	88.01	39,200	91,800
820818	1930	88.07	40,300	93,300
820806	1450	88.28	41,500	104,000
820806	1945	88.33	41,500	104,000
820808	2150	88.42	41,900	109,000
820809	1830	88.33	42,100	107,000
820807	1945	88.33	42,300	103,000
820810	2000	88.48	42,600	107,000
820914	1930	88.96	43,000	140,000
820804	1645	88.48	43,900	112,000
820811	2100	88.71	44,500	104,000
820803	2045	88.88	47,100	120,000
820816	2030	88.95	48,300	103,000
820630	1630	90.15	61,600	142,000

[a]Gaging station on the Yentna River near Su Station (USGS provisional data, 1982).

[b]Gaging station at Su Station (USGS provisional data, 1982).

[c]Water surface elevations are relative to a temporary bench mark which was assigned an elevation of 100.00 feet.

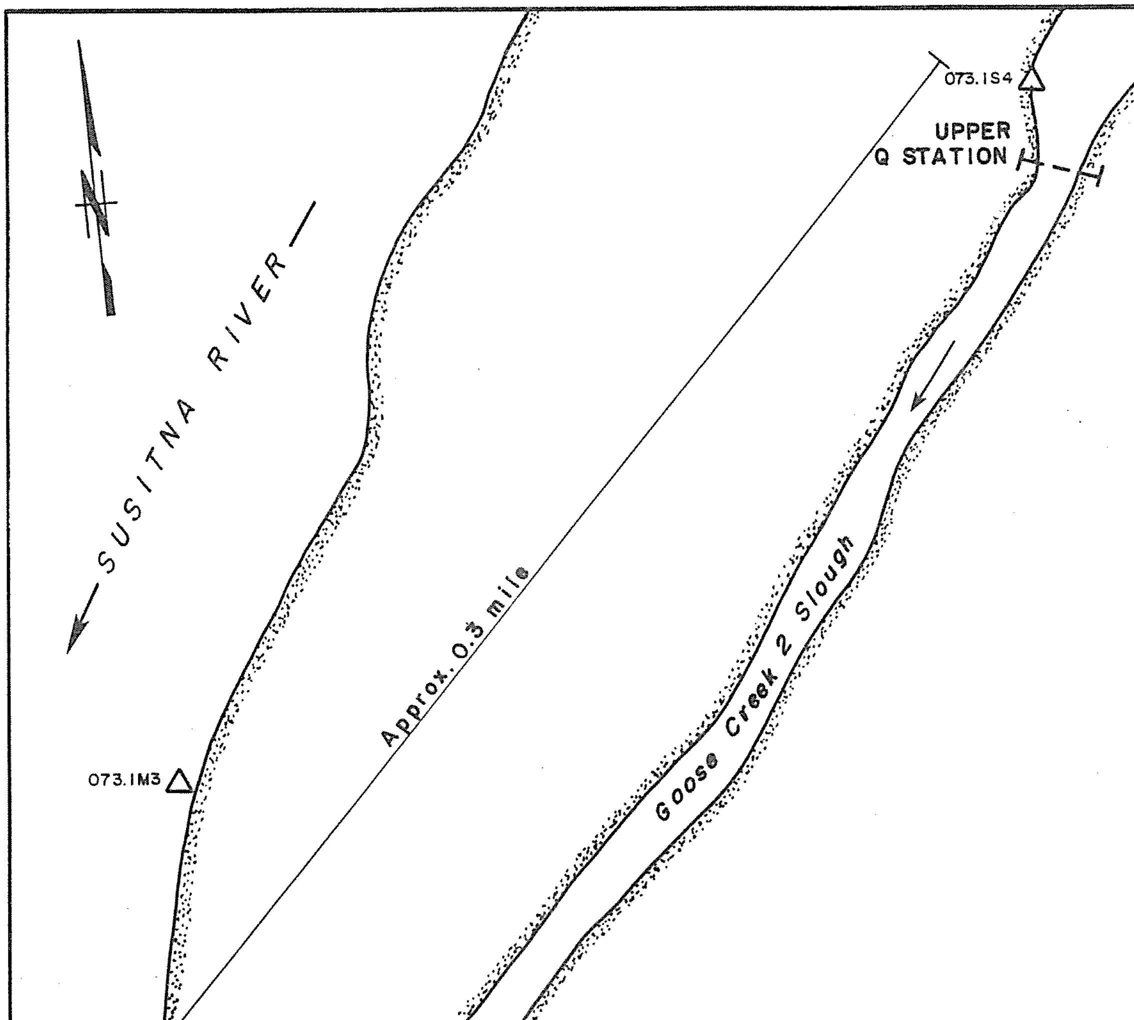


Figure 4E-3-2 Planimetric site map of Goose Creek 2 and Goose Creek 2 Slough, RM 73.1, S23N04W30BCB.

Rabideux Creek

Discharge measurements were obtained at two gaging stations in Rabideux Creek (Figure 4I-3-22), an upper site located 1.7 miles upstream from the mouth and a lower site approximately 0.25 miles upstream from the mouth. Three discharge measurements obtained at the upper gaging station ranged from 129.0 to 222.9 cfs over a corresponding change in water surface elevation of 0.51 feet. Two additional water surface elevations not collected in conjunction with discharge data showed the change in water surface elevation 1.65 feet overall (Appendix Table 4-A-6). Two discharge measurements obtained at the lower gaging site were 131.1 and 271.0 cfs over a corresponding change in water surface elevation of 0.80 ft. The mainstem flow during these two measurements was 29,700 and 36,400 cfs, respectively. Twelve additional water surface elevations not collected in conjunction with discharge data at this site showed a change in water surface elevation to be 6.37 feet overall, during which time the mainstem discharge varied from 24,000 to 88,400 cfs. From observations, the backwater area created during high mainstem discharges was substantial, extending upstream past the lower gaging station.

Sunshine Creek

Four discharge measurements were obtained 0.7 miles upstream of the mouth in Sunshine Creek (Figure 4I-3-23) ranging from 31.8 to 103.9 cfs over a corresponding range of water surface elevation of 1.98 feet (Appendix Table 4-A-6). Eleven additional water surface elevations, not collected in conjunction with discharge measurements, showed the

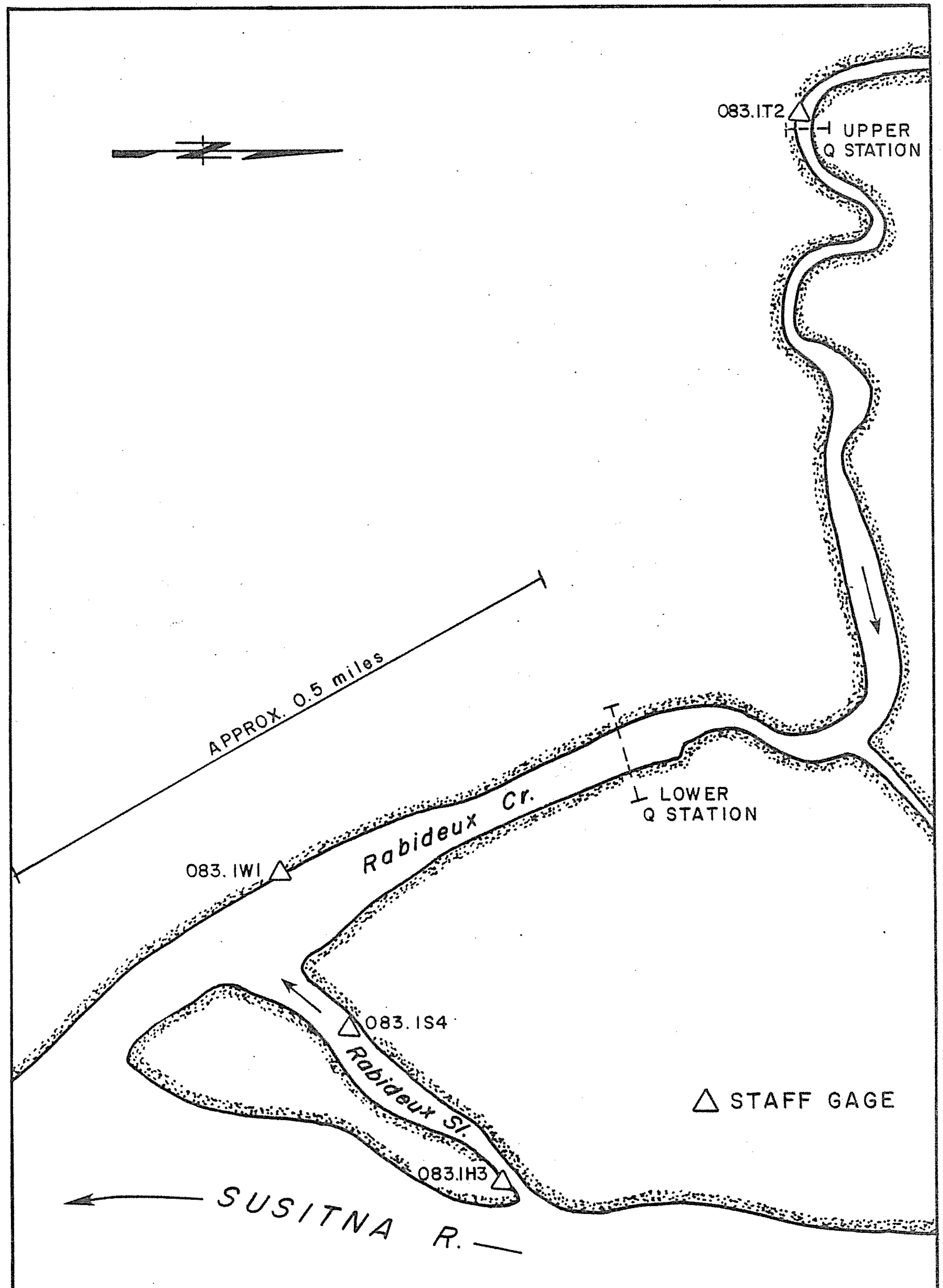


Figure 4E-3-22 Planimetric site map of Rabideux Creek and Rabideux Creek Slough, RM 83.1, GC S24N05W16ADC.

overall range in water surface elevation to be 4.14 feet at the gaging station. In addition, water surface elevation data was collected at the mouth of Sunshine Creek (which flows into Sunshine Creek Slough). This data had a range of 6.51 feet over a range of mainstem discharges of 21,400 to 91,300 cfs.

Sunshine Creek, during periods of high mainstem flow, was found to exhibit an area of low velocity backwater originating at the creek mouth and extending upstream at least as far as the upstream gaging station (0.7 miles upstream). A comparison of the creek discharge obtained on October 4 (68.6 cfs) to the discharge obtained on September 1 (31.7 cfs) showed that water surface elevations were higher for the lower flow (267.20 feet) than for the higher flow (266.93 feet). This stage-discharge relationship is evidence that the discharge site (Figure 4I-3-23) was within a backwater area created during mainstem flows of 45,200 cfs or greater.

Birch Creek

Four discharge measurements were obtained 0.1 miles upstream of the mouth in Birch Creek (Figure 4I-3-24) ranging from 62.4 to 114.1 cfs over a corresponding change in water surface elevation of 0.35 feet (Appendix Table 4-A-6). Six additional water surface elevations, not collected in conjunction with discharge data, showed an overall change in water surface elevation of 0.58 feet at the gaging station. In addition, 12 water surface elevations were collected at the mouth of Birch Creek varying 2.09 feet over a corresponding range of mainstem flows from

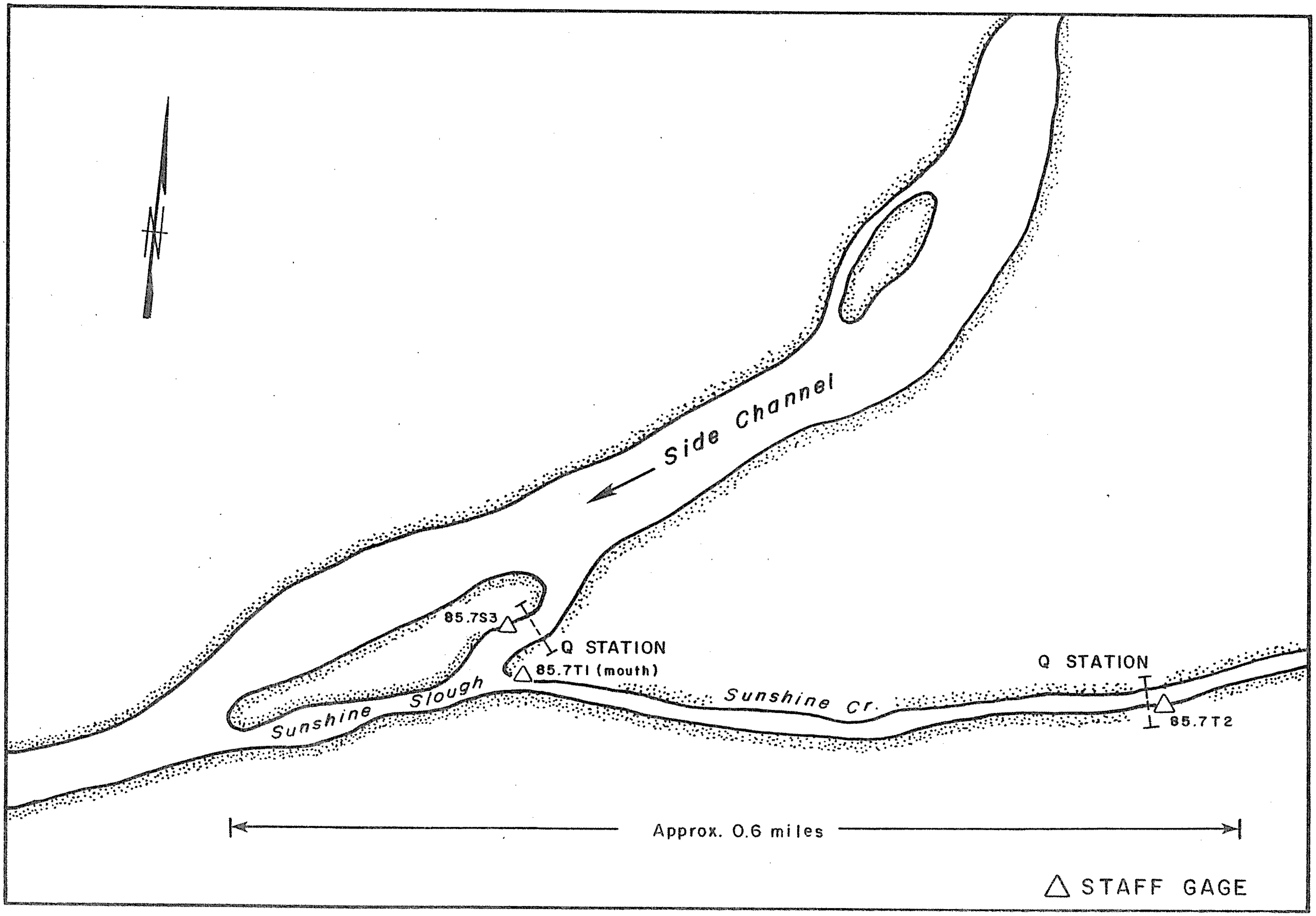


Figure 4I-3-23 Planimetric site map of Sunshine Creek and Sunshine Creek Slough, RM 85.7, GC S24N05W14AAB.

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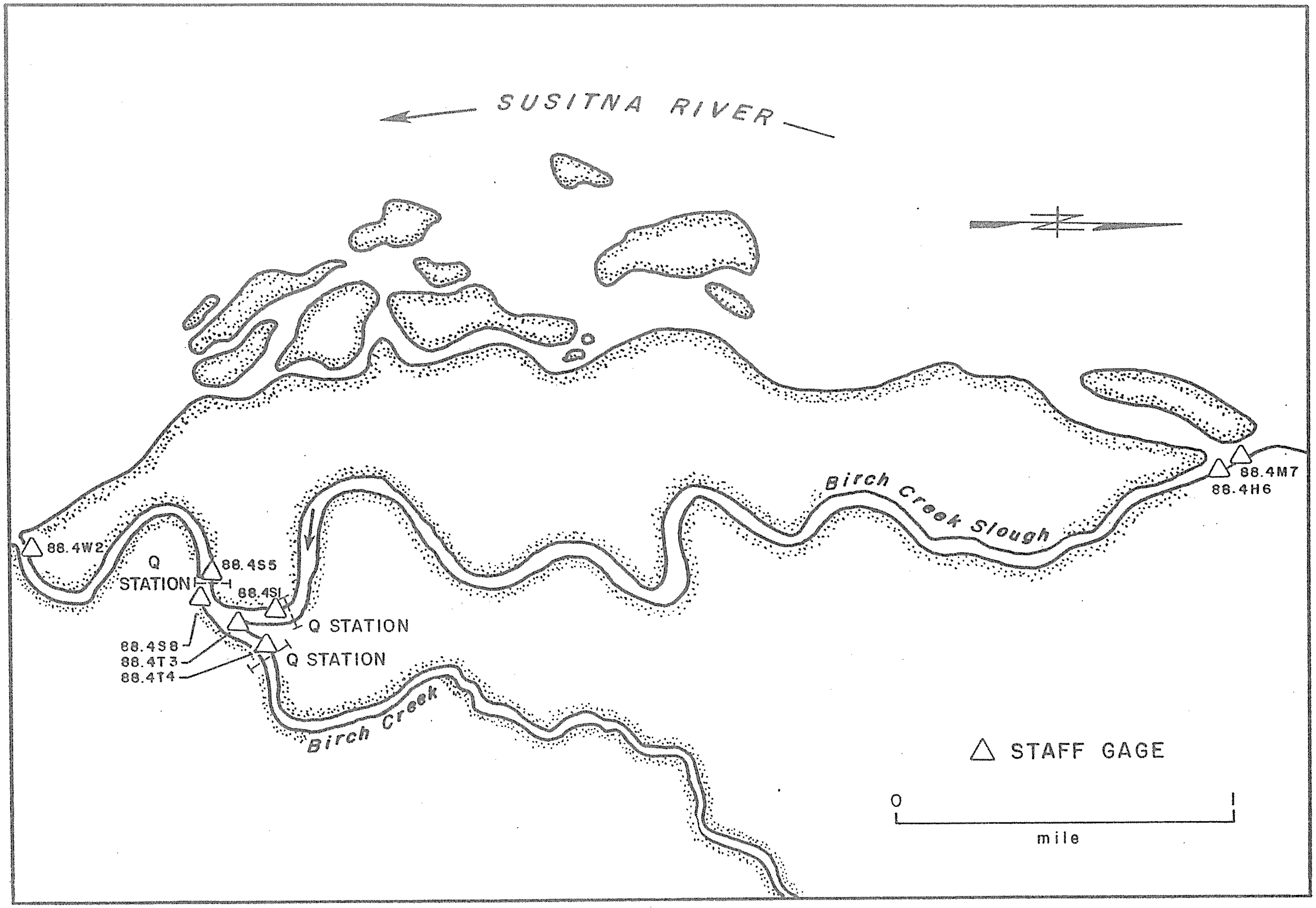

Figure 4I-3-24 Planimetric site map of Birch Creek and Birch Creek Slough, RM 88.4, GC S25N05W25DCC.

22,300 to 99,300 cfs. Backwater effects were observed to be only present in the immediate vicinity of the creek mouth, not extending up to the creek gaging station.

3.1.1.4.3 Sloughs

Lower Goose 2 Slough

Lower Goose 2 Slough (Figure 4I-3-21) is a relatively long slough with a head and mouth which confluence with the mainstem Susitna River. Two gaging stations were located in this slough, one above and one below the confluence with Lower Goose Creek 2. Three discharge measurements, obtained at the upstream gaging station (upstream of the confluence with Lower Goose Creek 2), ranged from 1.8 to 458.0 cfs over a corresponding change in water surface elevation of 1.55 feet (Appendix Table 4-A-6). The overall range of water surface elevation is the same as found for the range of discharge measurements because only two staff gage readings were obtained, one during each of the discharge measurements for the 1.8 cfs flow and one for the 458.0 flow. Only one discharge measurement (101.0 cfs) was obtained at the lower gaging station (below the confluence with Lower Goose Creek 2) corresponding to a water surface elevation of 209.33 feet (Appendix Table 4-A-6). Fourteen additional the water surface elevations, not collected in conjunction with discharge measurements at the lower gaging station, showed water surface elevation to range 1.82 feet over a corresponding mainstem discharge from 31,500 to 68,700 cfs. Mainstem water surface elevations, collected adjacent to the mouth of Goose 2 Slough, had a range of 2.85 feet for mainstem flows of 31,500 to 68,700 cfs. A substantial backwater effect was observed to occur at the mouth of this slough during the range of mainstem flows from 31,500 to 68,700 cfs.

Whitefish Slough

Three discharge measurements were obtained at the mouth of Whitefish Slough (Figure 4I-3-25) ranging from 6.6 to 24.2 cfs over a corresponding change in water surface elevation of 8.05 feet (Appendix Table 4-A-6). Corresponding mainstem flows during the periods of discharge measurement varied from 29,700 to 91,300 cfs. Seven additional water surface elevations, not collected in conjunction with discharge measurements, showed the overall change in water surface elevation at the gaging station to be 8.94 feet. At all mainstem discharges observed this year, a backwater effect was present at the gaging station which, during high mainstem discharges, extended approximately 3/4 of a mile up Whitefish Slough. No staff gages were placed in the mainstem adjacent to this site.

One discharge measurement (31.0 cfs) was obtained at a mainstem flow of 91,300 cfs in an unnamed tributary entering Whitefish Slough (Figure 4I-3-25). The slough discharge taken on the same day was found to be less than the flow from the tributary. This difference was attributed to the backwater, low velocity phenomenon created by mainstem flow occurring at the slough gaging station, lowering the slough discharge measurement.

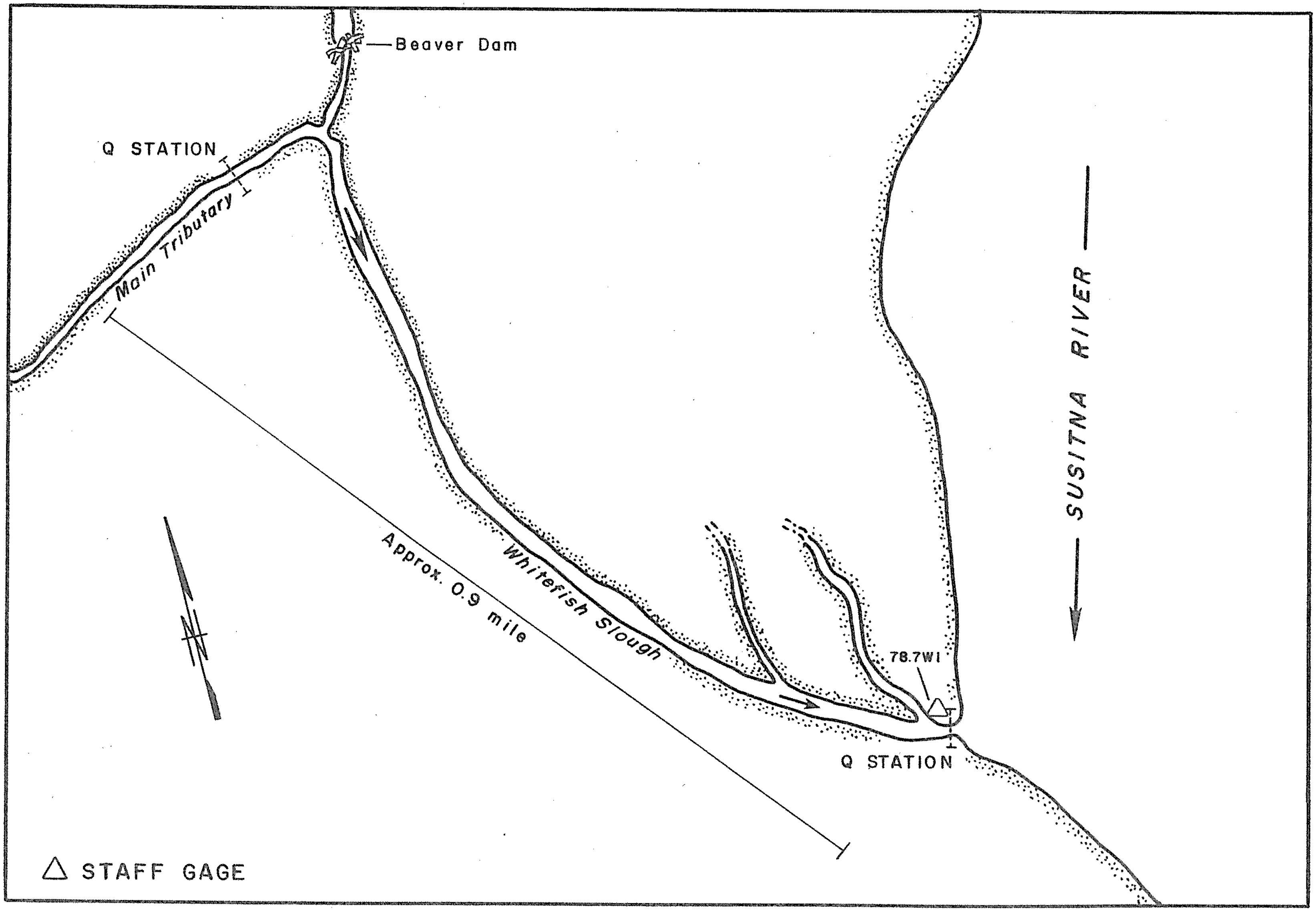

Figure 4E-3-25 Planimetric site map of Whitefish Slough, RM 78.7, GC S23N05W01BBC.

Sunshine Slough

Sunshine Slough is a relatively long, meandering slough with a head and mouth which confluence the mainstem Susitna River (Figure 4I-3-23). Three discharge measurements were obtained in Sunshine Slough which ranged from 0.2 to 607.0 cfs over a corresponding change in water surface elevation of 4.19 feet (Appendix Table 4-A-6). Thirteen additional water surface elevations, not collected in conjunction with discharge measurements, showed an overall change in water surface elevation at the gaging station of 6.25 feet. Corresponding mainstem flows during this period ranged from 25,800 to 91,300 cfs.

The slough was breached during the measured slough discharges of 85.7 and 607.0 cfs when corresponding mainstem flows were 47,200 and 76,500 cfs, respectively.

By comparing ranges of water surface elevations measured at the slough gaging station to those measured at the Sunshine Creek mouth gaging station (5.32 feet and 5.29 feet, respectively) while the slough was breached by the mainstem, it was apparent that backwater effects occurred at least as far upstream as these gaging stations. At a mainstem flow of 91,300 cfs the slough water surface elevation at the slough gaging station was 270.80 feet while at the gaging station at the mouth of Sunshine Creek it was 270.70 feet, and at the gaging station upstream on Sunshine Creek it was 270.81 feet.

Birch Creek Slough

Birch Creek Slough is a relatively long, meandering slough with a head and mouth which confluence with the mainstem Susitna River, (Figure 4I-3-24). Discharge measurements were obtained at two gaging stations in Birch Creek Slough; above the confluence with Birch Creek and below the confluence with Birch Creek. One discharge measurement (15.7 cfs) was obtained at the gaging station above the confluence with Birch Creek corresponding to a water surface elevation of 284.74 feet (Appendix Table 4-A-6). Eleven additional water surface elevations, not collected in conjunction with discharge measurements, showed an overall change in water surface elevation at the gaging station to be 2.05 feet. Four discharge measurements were obtained at the gaging station below the confluence with Birch Creek ranging from 75.4 to 131.8 cfs over a corresponding change in water surface elevation of 0.92 feet. Five additional water surface elevations, not collected in conjunction with discharge, showed an overall change in water surface elevation at the gaging site of 1.01 feet. Corresponding mainstem flows during this time ranged from 22,300 to 69,500 cfs.

Stage was also collected (not in conjunction with discharge) in Birch Creek Slough at the head at the confluence with Birch Creek and at the mouth. At mainstem discharges of 42,000 to 69,500 cfs, flow was observed through the head of the slough with the water surface elevation varying 2.03 feet. Water surface elevations measured in the mainstem adjacent to the head of Birch Creek Slough had a range of 3.51 feet during corresponding mainstem flows of 27,800 to 69,500 cfs. The range of water surface elevations in Birch Creek Slough at the confluence with Birch Creek were found to have a range of 0.75 feet. Water surface elevations at the mouth of Birch Creek Slough were found to have a range of 3.78 feet. during corresponding mainstem flows of 22,300 to 82,400 cfs. A significant area of backwater influence occur in this slough during high mainstem flows.

3.1.1.5 Upstream of Devil Canyon

Above Devil Canyon, periodic discharge measurements were obtained in seven tributaries. Appendix Table 4-A-1 compares the discharge of the tributaries to that of the mainstem Susitna River at Vee Canyon. Refer to Volume 5 for the specific results and discussion of these discharge measurements.

3.1.2 Thalweg Profile

Streambed profiles for Sloughs 8A, 9, 11, and 21 are presented in Figures 4I-3-26, 4I-3-27, 4I-3-28 and 4I-3-29, respectively. Each figure contains a schematic drawing (upper left of Figure) showing gross morphological features of the slough and mainstem Susitna River. In addition, each profile has been partitioned into discrete reaches defined by obvious changes in gradient. Corresponding gradients of the mainstem Susitna River are also provided below the key for surface substrate types. Also, study sites have been positioned on the profiles for sloughs 8A, 9, and 21 to provide a reasonably accurate representation of the gross morphological features in each slough and the relative

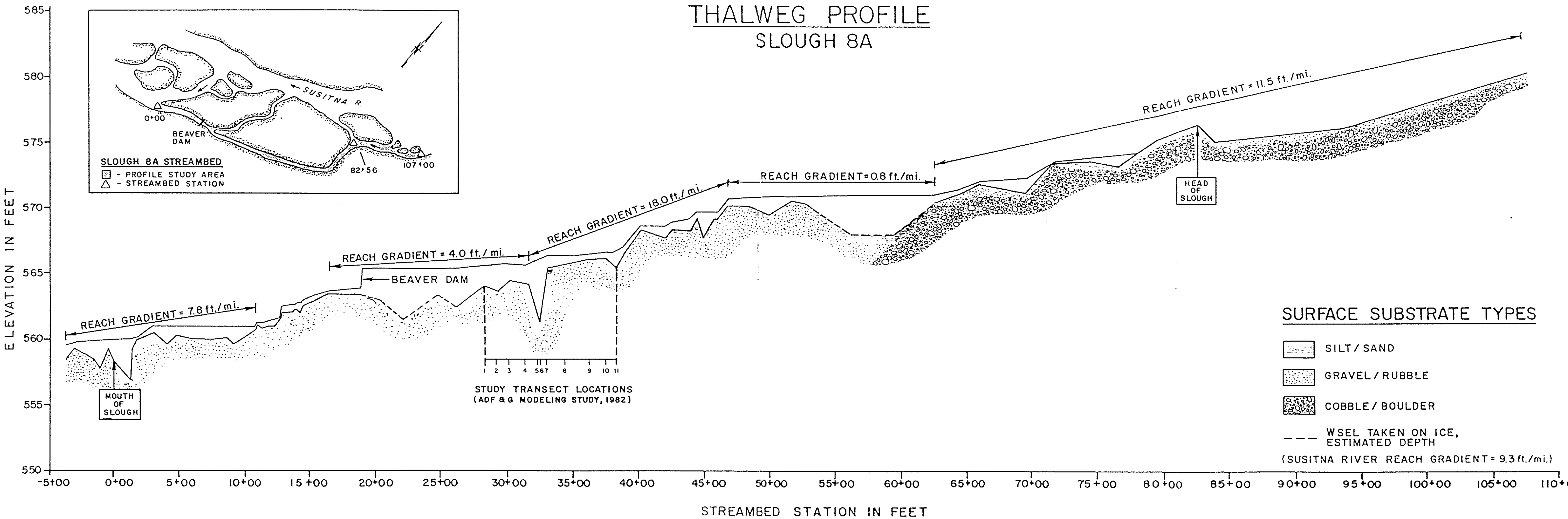

Figure 4I-3-26. Streambed profile for Slough 8A.

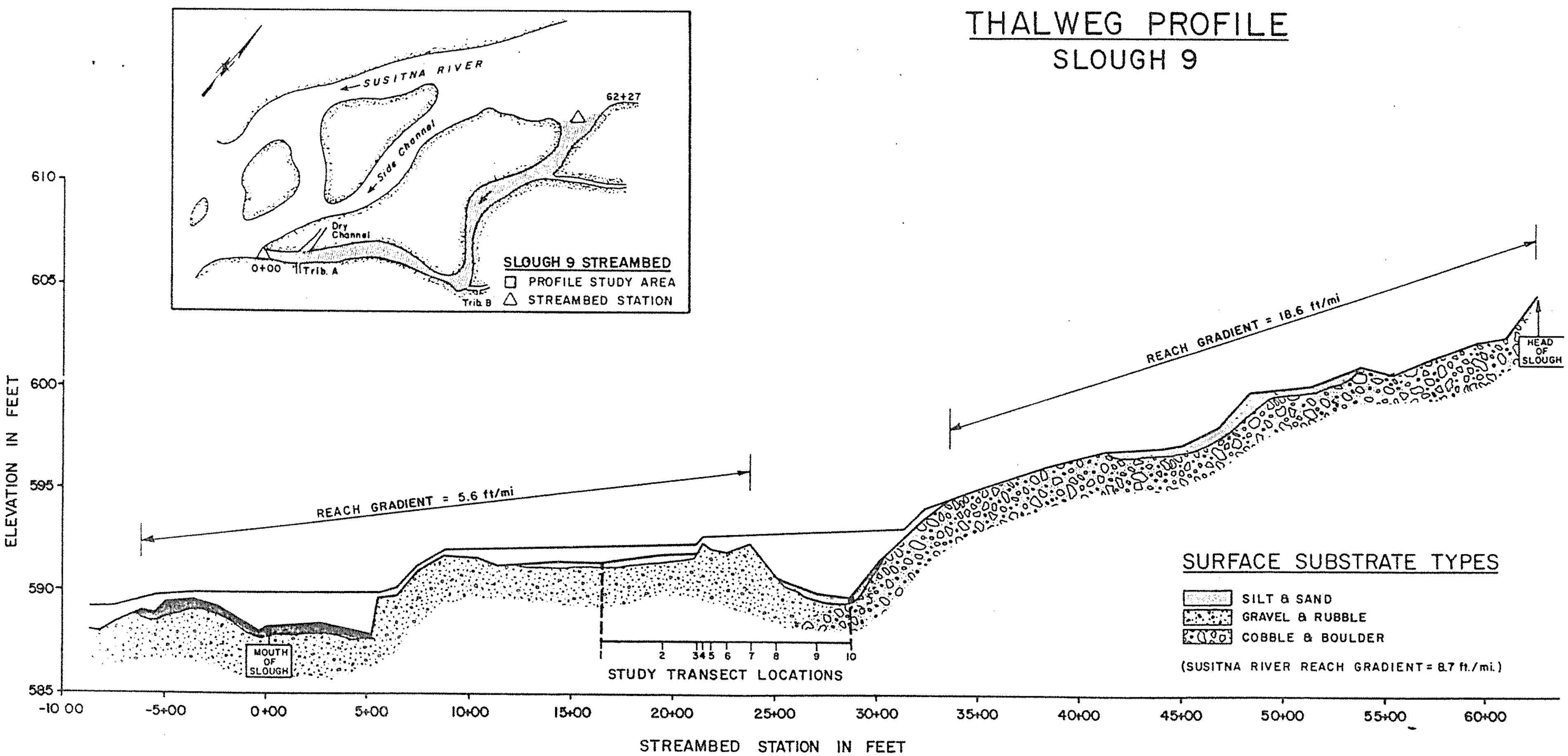

Figure 4I-3-27. Streambed profile for Slough 9.

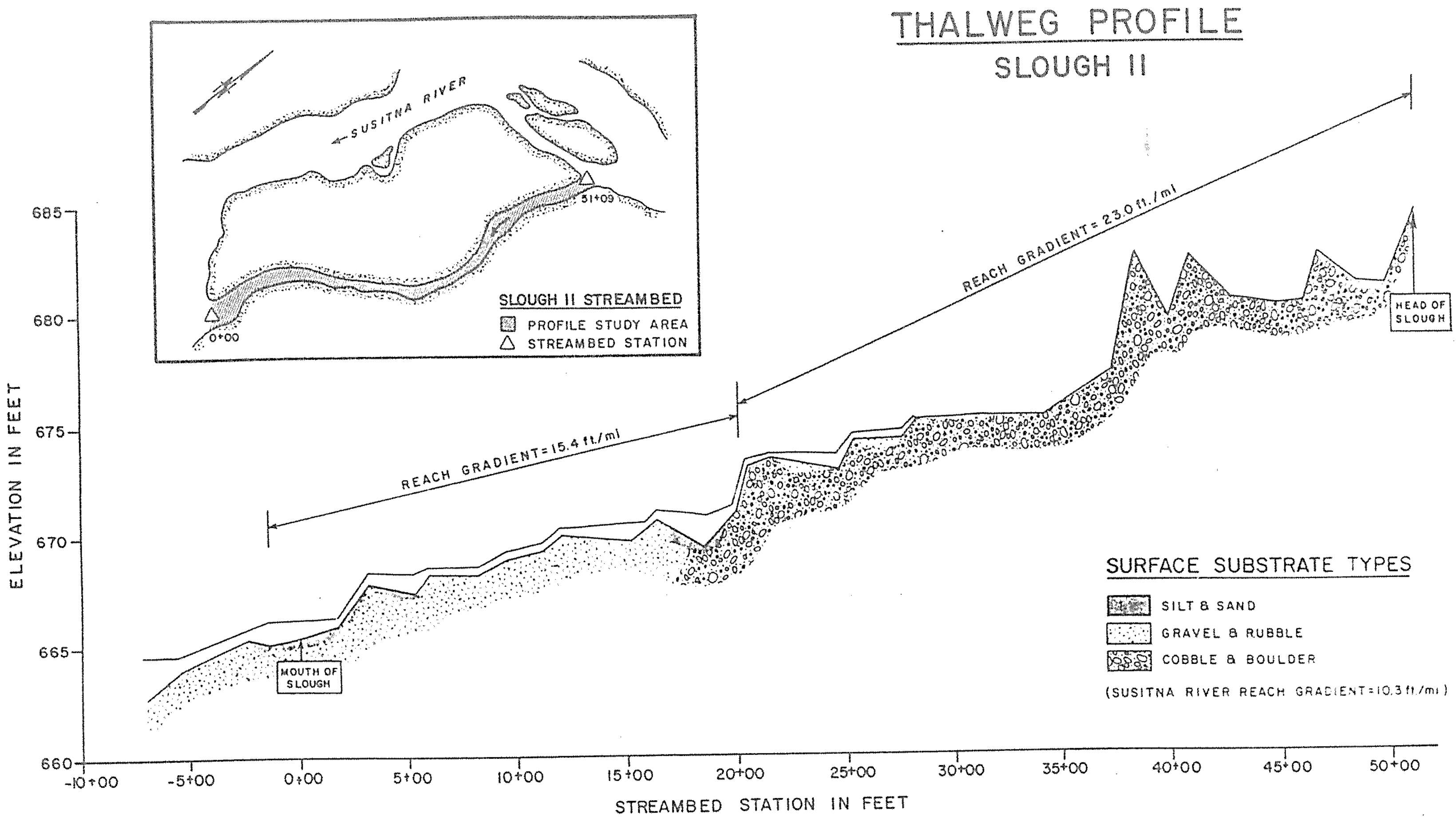

Figure 4I-3-28. Streambed profile for Slough 11.

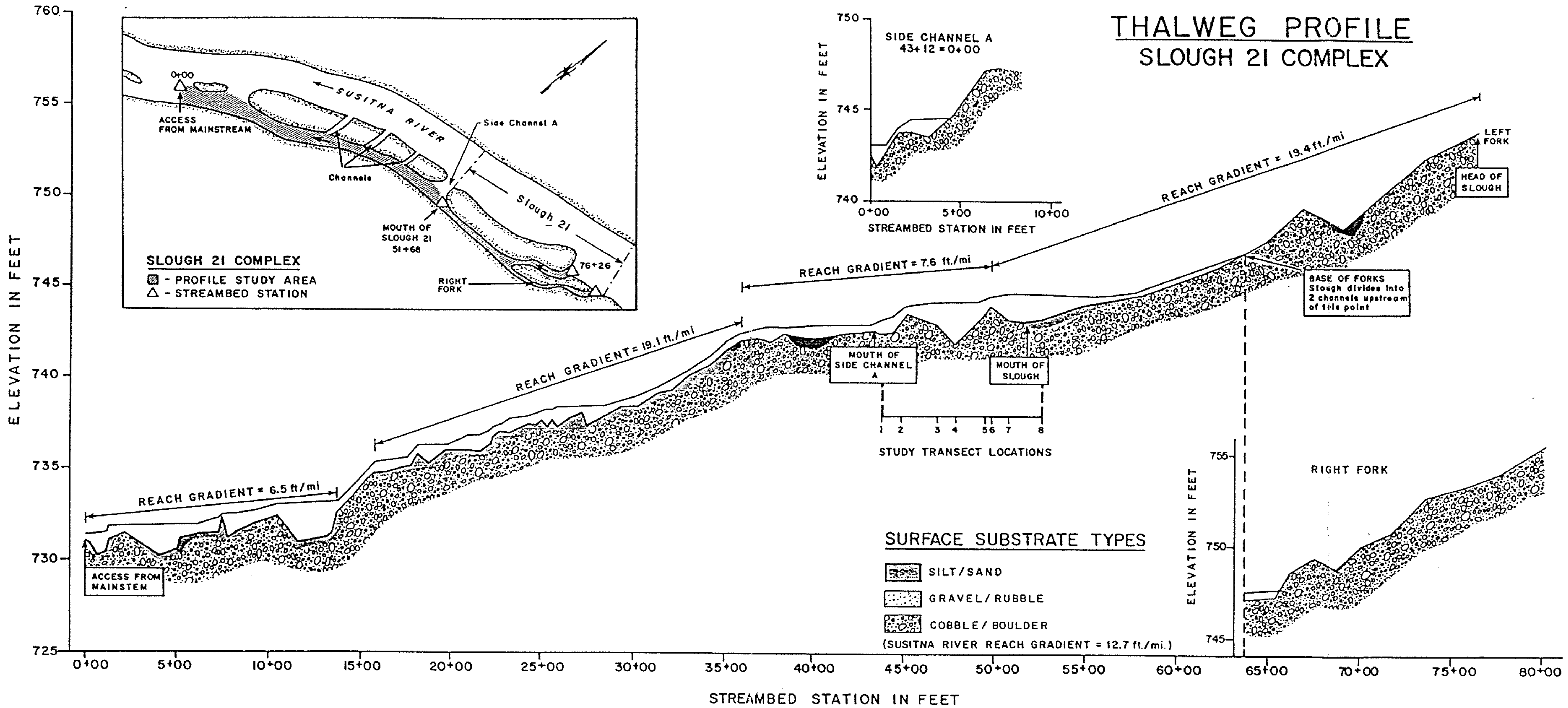

Figure 4I-3-29. Streambed profile for Slough 21.

position of important features (e.g., study transects, beaver dams, etc). At some points, streambed elevations and/or water surface elevations were estimated. The reader is advised to consult the methods section and data source (Appendix E) before extracting and applying information represented in the above figures. The following summary statements are primarily restricted to gross features of streambed gradient.

Slough 8A

Progressing upstream in Slough 8A, the streambed profile is comprised of a relatively gentle gradient near the mouth (7.8 ft/mi), followed by a riffle area (gradient undetermined) ending at a beaver beaver dam. The dam marks the downstream end of a short bench-like reach (4.0 ft/mi) followed by a steep incline (18.0 ft/mi) which terminates at another bench-like area (0.8 ft/mi). Above the second bench, water depths were much reduced and gradient increased to 11.5 ft/mi.

Slough 9

The most notable characteristics of Slough 9 are the obvious differences in gradient between the upper and lower reaches of the slough (18.6 and 5.6 ft/mi, respectively), and the "S" shaped configuration of the channel (see schematic drawing in upper left corner of Figure 4I-3-27). This sharp bend is near station 30+00, marking the area where the gradient changes and water levels decrease.

Slough 11

The upper reach of Slough 11 is more steeply inclined (23.0 ft/mi) than its lower reach (15.4 ft/mi), however both are relatively steep compared to other sloughs. This slough is relatively short and the streambed is structured in distinct pool/riffle sequences up to station 30+00, followed by a series of mounds near the head of the slough. These mounds may be the result of previous ice movement. It should be noted that since no water existed in this area and surveyors were selecting thalweg points on the basis of visual inspection, the mounds may misrepresent the true thalweg in this reach of the slough.

Slough 21 Complex

Morphology of the Slough 21 complex is more complicated than most sloughs since it is preceded by a long access channel which is longer than the slough itself. This access channel is connected to the mainstem Susitna River by several channels, two of which were observed dewatered for most of the open-water season. Note that the mouth of this slough is located near station 52+00 ft, and not at station 0+00 as for sloughs 8A, 9, and 11. The slough (from stations 52+00 to 76+00) has a relatively steep, uniform gradient (19.4 ft/mi) and had very little water present immediately above station 55+00. At its upper end, this slough is forked, with the left fork head functioning as the hydraulic control point.

3.1.3 Other Hydrological Components

3.1.3.1 Backwater Areas

Appendix Table 4-A-7 presents the measurements of the area of the low velocity surface water occurring behind the hydraulic barrier of mainstem Susitna River elevation at Designated Fish Habitat locations on 2 week intervals between June and September 1982. This water surface is called the aggregate zone type II (H-II) and is defined in Section 2.2, Part II of this volume. Each area is listed with the mean daily discharge either at gold Creek or Sunshine gaging station reported by the USGS (as provisional data), for the corresponding date. Figures 4I-3-30 to 4I-3-43 plot the surface areas measured at each site against mainstem discharge. The Portage, Indian, and Fourth of July River habitat locations, which had no significant aggregate type II areas above their geographic mouths, are not included. A descriptive summary of the hydraulic conditins associated with the data and curves presented for each site during these samplings are presented as follows.

The graphical presentation of the aggregate type II (H-II) zone surface area versus Susitna River discharge relationship at each site was carefully interpreted with respect to the smoothing of scattered area measurements (mostly mapping errors) for closely related mainstem water surface elevations. In the case(s) where it was not obvious that a specific distribution of area measurements was a result of data scatter (mapping errors) the data was not smoothed. Examples of both conditions occur in Figure 4I-3-32 (Slough 19). The measurements indicating a total loss of (H-II) water area at discharges near 15,000 cfs are accurate; but area measurements at higher discharges were highly scattered as a result of obvious mapping difficulties at this site. Sloughs 21 and 11 are two other sites where measured areas (at related discharges) are interpreted as obvious scatter (map errors) from our accumulated information on the site, and the measurements were smoothed as shown. Whiskers Creek and Sidechannel presented some unusual mapping difficulties at mainstem discharges of 25,000 cfs and above. These data were thus not connected at all (see Whiskers Creek section). Unless specifically noted, tributaty discharges are not considered in the data presentations.

Refer to photographs and additional site narratives of each habitat location in Appendix 4-F of Volume 4 for further information.

Summary By Habitat Location

Slough 21

At mainstem discharges at Gold Creek greater than approximately 24,000 cfs, the head of Slough 21 is breached, with mainstem water observed flowing through a series of islands (Slough 21 complex), which separate the slough's mouth from the mainstem at lower discharges. Mainstem flow also enters, when the slough is breached, directly across the mouth of the slough, forming a sort of "eddy," which creates the barrier for water exiting the slough from upstream. As the mainstem discharge

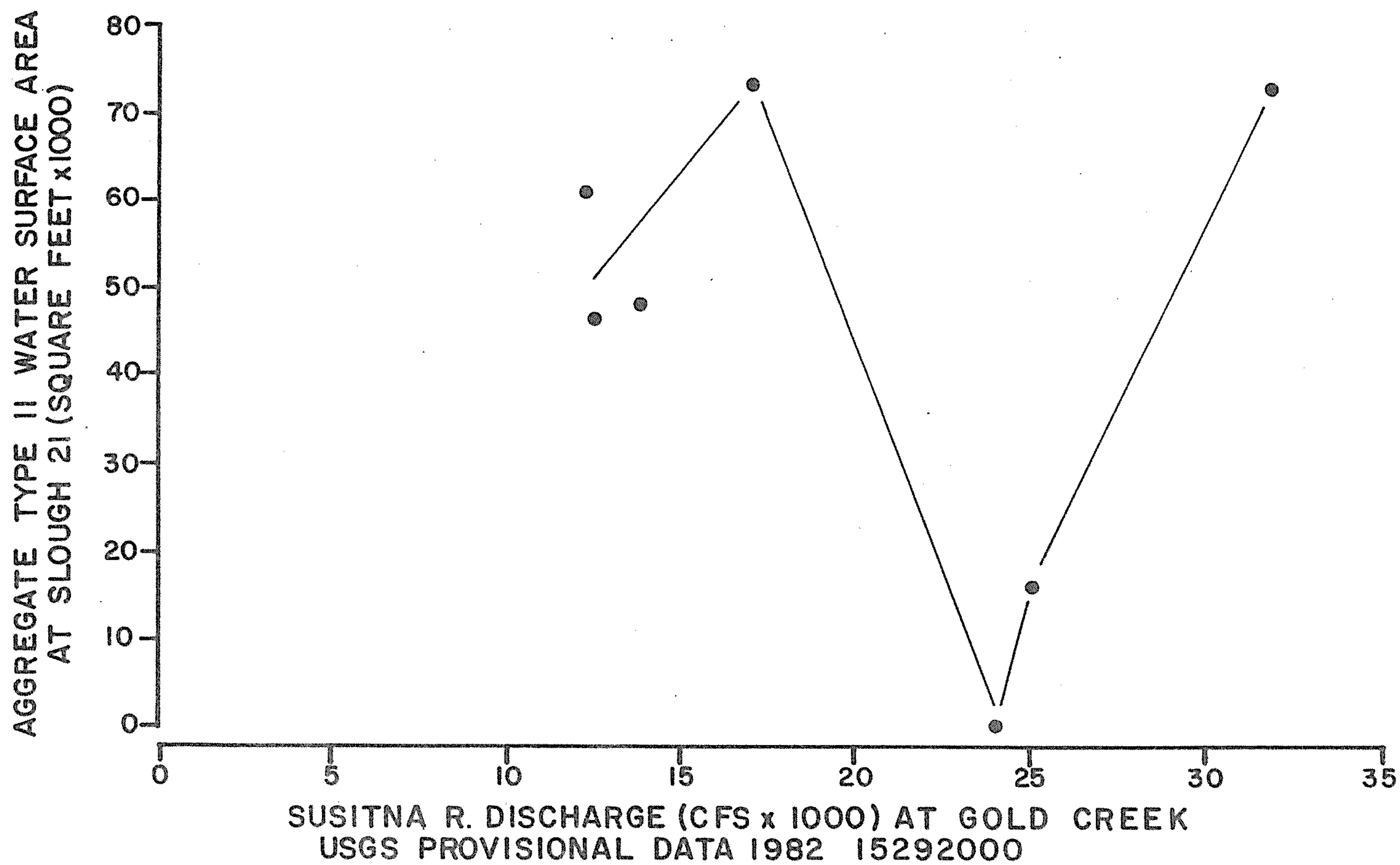

Figure 4E-3-30 Aggregate type II water surface area at Slough 21 versus mainstem discharge at Gold Creek (USGS, 1982).

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decreased, the elevation at the eddy decreased and the area of H-II water decreased on July 11th (at 24,000 cfs) the head of the slough had recently closed and the elevation at the eddy was not sufficient to create an area of H-II water in the slough.

During the August and September sampling trips discharges of 17,000 cfs and below water had stopped flowing through the islands at the locations referred to above (identified as reference mouths #1 and #2 on Appendix Plate 4-F-19). During these months, water existing the slough (e.g., ground water and surface runoff) joined the mainstem at reference mouth #3 (a lower island channel). The H-II water present during this time was found completely below the mouth (of the slough) as defined at the higher mainstem discharges.

During October, Slough 21 was visited only briefly and no maps were drawn. However, the new confluence of slough water with the mainstem was about 5,000 feet below the site of the mouth when the head of the slough was open. No appreciable H-II water was observed during this sampling trip (discharge was 8,220 cfs).

Slough 20

At 28,000 cfs, the head of Slough 20 was observed to be breached (refer to Table 4I-3-2). An H-II area extended from the slough mouth upwards for about 360 feet at this time.

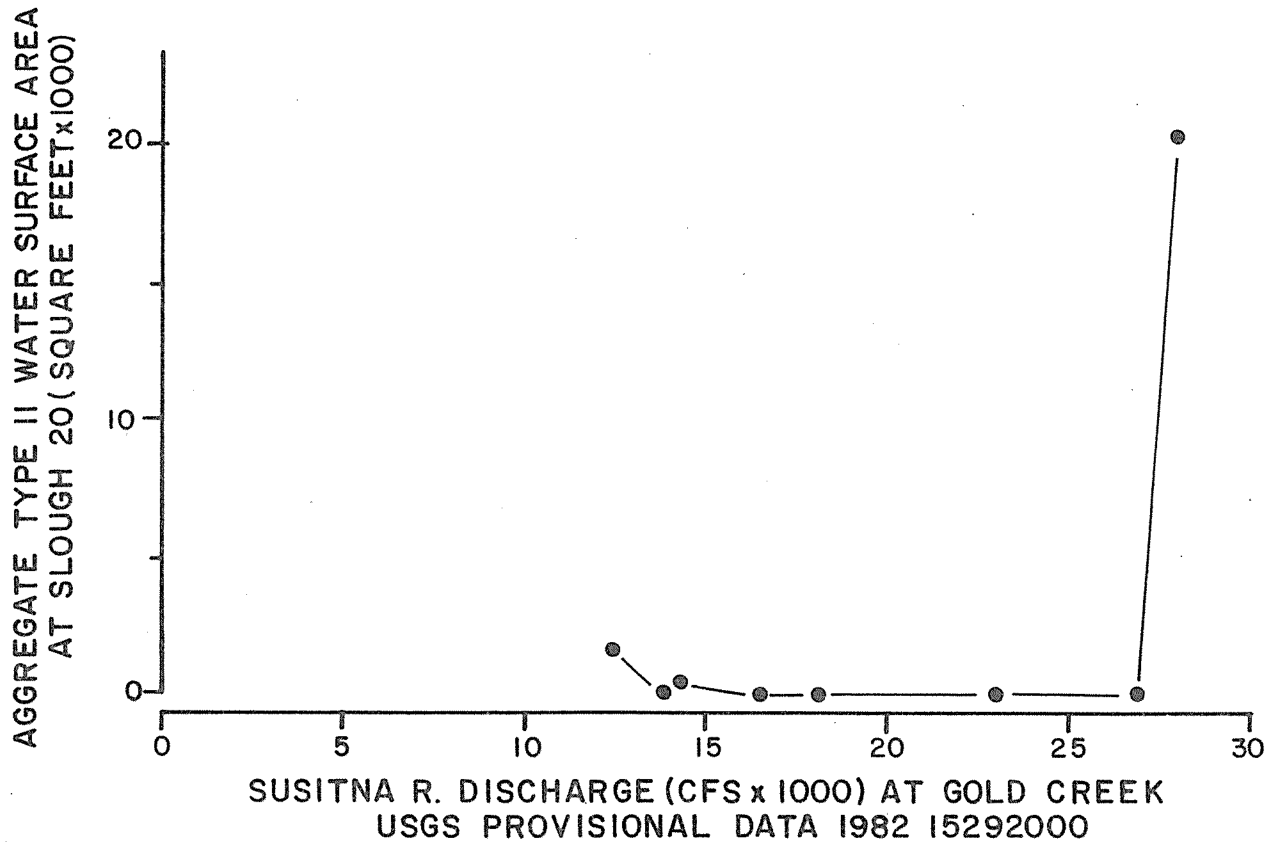

Figure 4E-3-31 Aggregate type II water surface area at Slough 20 versus mainstem discharge at Gold Creek (USGS, 1982).

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At observations during lower mainstem water surface elevation, flow from Slough 20 originating from Waterfall Creek (which enters the slough approximately 1,250 feet above the mouth) and a smaller tributary near the sloughs head freely entered the mainstem at the mouth of the slough.

At discharges between 12,500 and 14,400 cfs a small area of H-II water appeared directly above the barrier of confluence with the mainstem as a pool related to the streambed elevation.

Slough 19

Slough 19 is considered an upland slough which confluences the mainstem only at its mouth. The head of Slough 19 (most upstream portion) consists of a small pool fed by ground water and surface runoff which is the primary contributor of flow for the slough. Percolation in other respects, the hydraulic changes with decreasing discharges are analogous to those described for Slough 21 above. At mainstem discharges of 16,600 cfs and above the H-II area was regulated by mainstem stage and the cross-sectional shape of the pool bed.

At 15,000 cfs the mouth of the slough had moved downriver approximately 350 feet due to dewatring of the small sidechannel which accesses through a gravel island (reference mouth #1 on Appendix Plate 4-F-17). At this mainstem discharge the discharge from the head of the slough was free-flowing to the new confluence with mainstem water, indicated as reference mouth #2. At 13,300 cfs, continued dewatering of the gravel

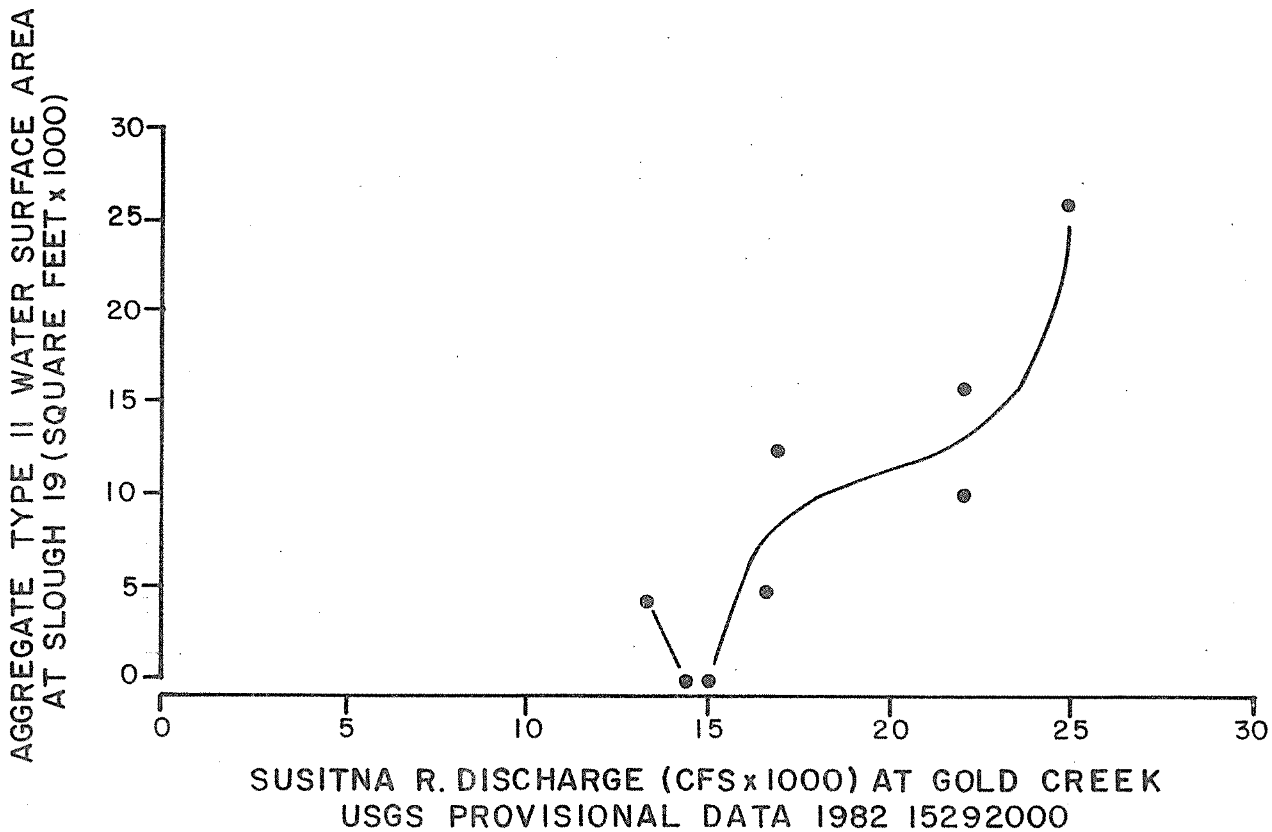

Figure 4I-3-32 Aggregate type II water surface area at Slough 19 versus mainstem discharge at Gold Creek (USGS, 1982).

island moved the confluence of slough and mainstem water an additional 300 feet to reference mouth #3. An area of H-II water existed between the free-flowing slough and the new mouth at this stage.

Slough 11

The head of Slough 11 was not breached by mainstem water during these sampling periods. The area of H-II type water measured this year in Slough 11 results completely from backwater in a pool at the slough's mouth. The area of this pool was controlled by the mainstem stage and the cross-section and elevation relationships that describe the slough (pool) bed.

Slough 9

The head of Slough 9 was open to mainstem flow during the June and July samplings trips. During the highest observed mainstem discharges, the surface water in the slough above the mouth possessed appreciable velocity, apparently conserving the momentum from water discharged from the head above.

During visits at mainstem discharges of 19,400 and 16,700 cfs the slough head was closed and a large area of H-II water (about 1000 feet long on August 10th) was found above the confluence of the slough and the mainstem. At the lower mainstem discharges sampled, the surface waters

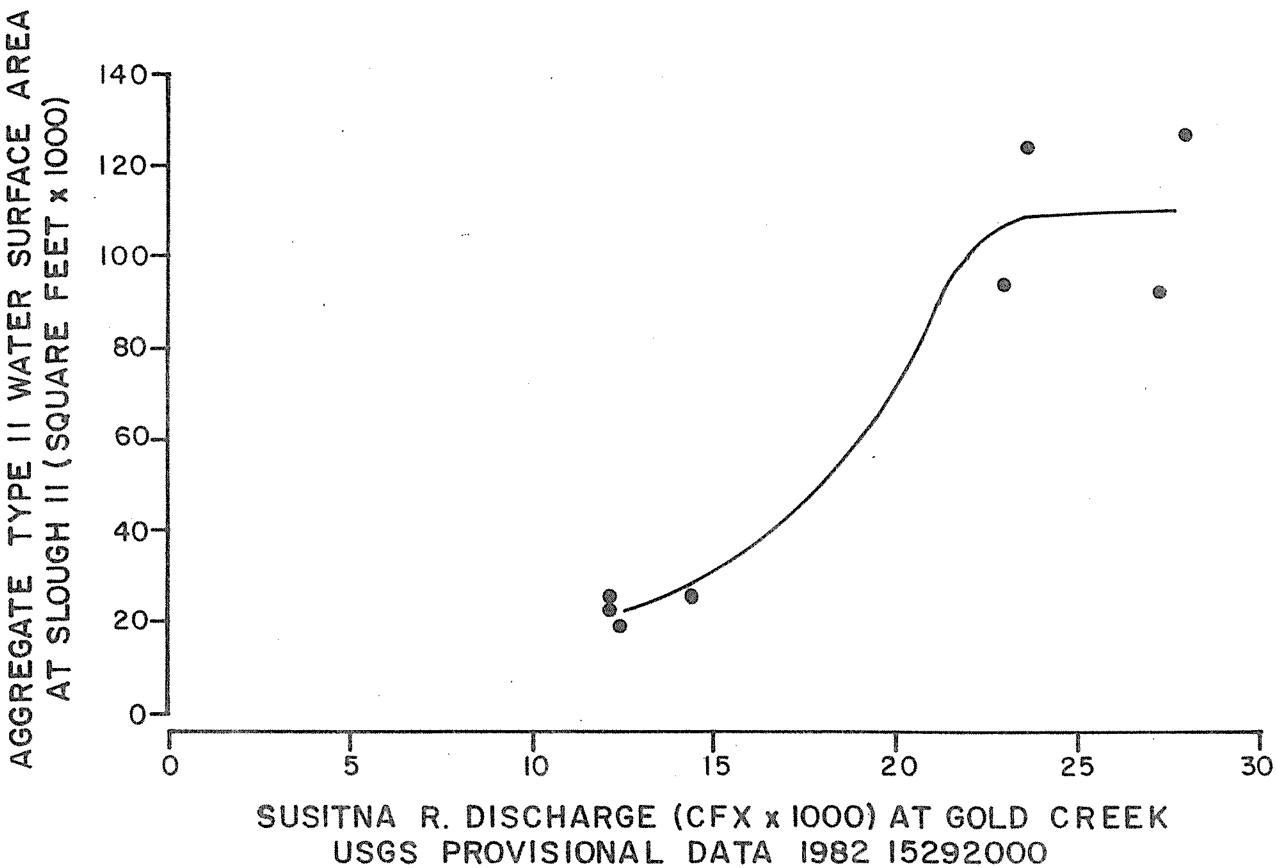

Figure 4E-3-33 Aggregate type II water surface area at Slough 11 versus mainstem discharge at Gold Creek (USGS, 1982).

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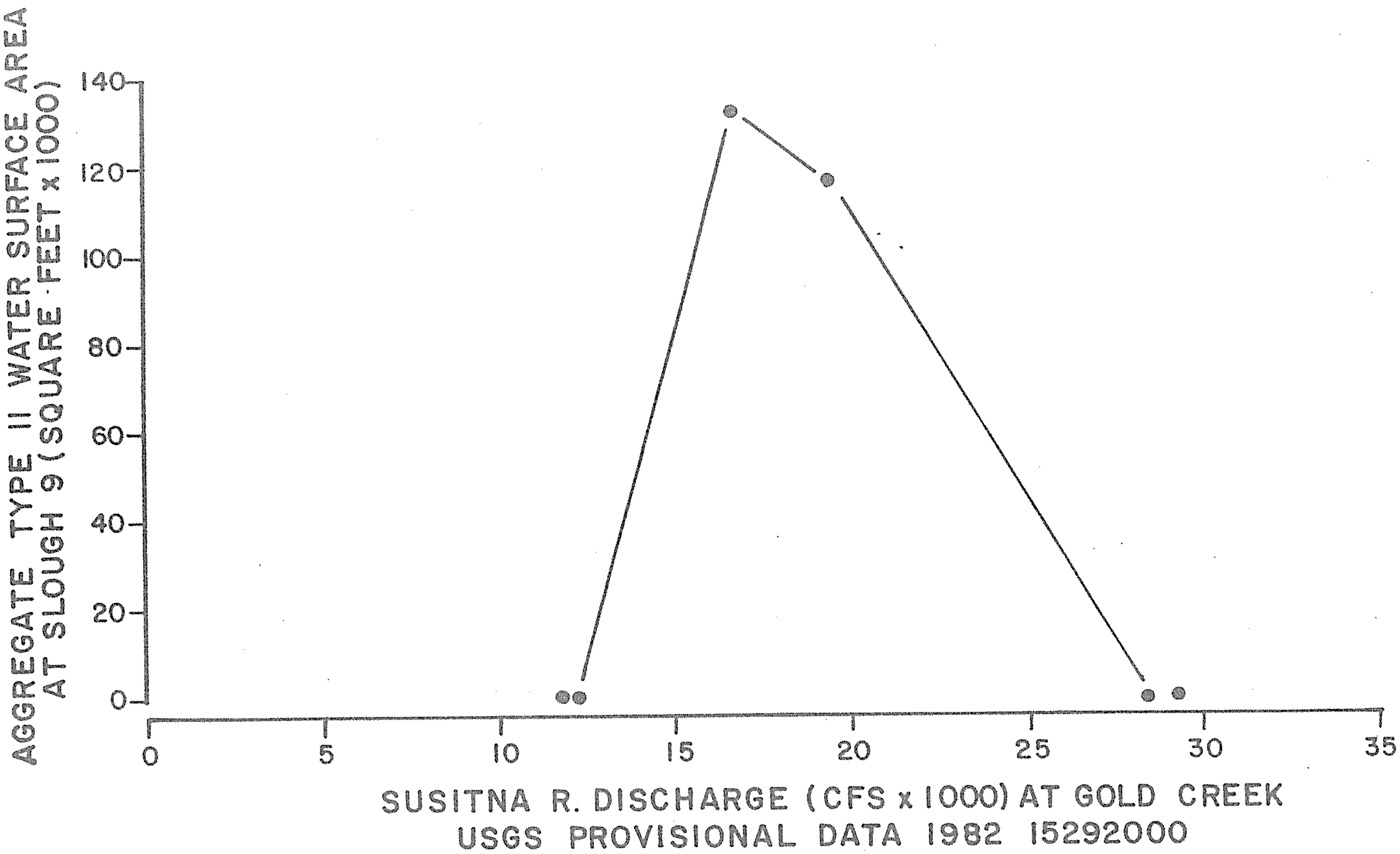

Figure 4E-3-34 Aggregate type II water surface area at Slough 9 versus mainstem discharge at Gold Creek (USGS, 1982).

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in the study area were not controlled by mainstem elevation and the clear water exiting the slough was free-flowing to a mainstem confluence at a lower elevation.

Slough 8A

The area mapped in this study extended to the first series of riffles and beaver dams which begin approximately 1350 feet above the mouth, and excludes the very large area of calm water above. Within these boundaries, the area of H-II type water closely approaches the total wetted surface area of the site. The head of the slough was open during the June 8 visit (28,000 cfs) but the many physical barriers in mid slough prevented the overflow water (discharged into the lower slough study area) from significantly affecting the velocity or size of the H-II area. The area of H-II type water in the slough study area was directly regulated by mainstem stage.

Lane Creek and Slough 8

The Lane Creek site consists of a long and narrow (30-foot wide), steep-sided trench (Slough B) which, during the June and July trips, joined the outfall of Lane Creek to become a 70-foot wide eroded channel entering the Susitna River approximately 300 feet downstream. Both June trips to Lane Creek occurred at an indicated Gold Creek stage of 25,000 cfs. Observed water levels at Lane Creek and Slough 8 were lower on June 18 than on June 7 and that the head of the long channel was open to

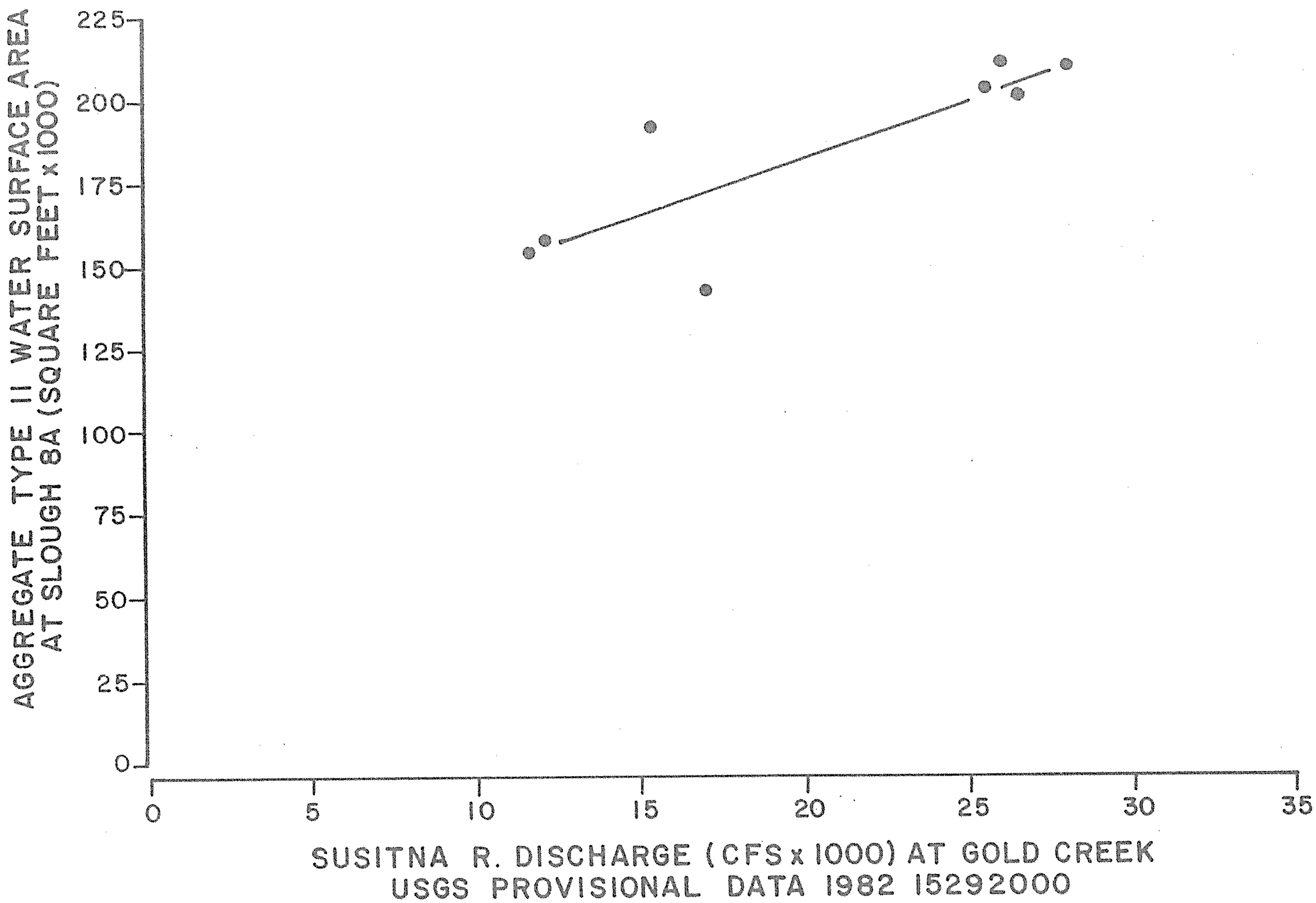

Figure 4.3.35 Aggregate type II water surface area at Slough 8A versus mainstem discharge at Gold Creek.

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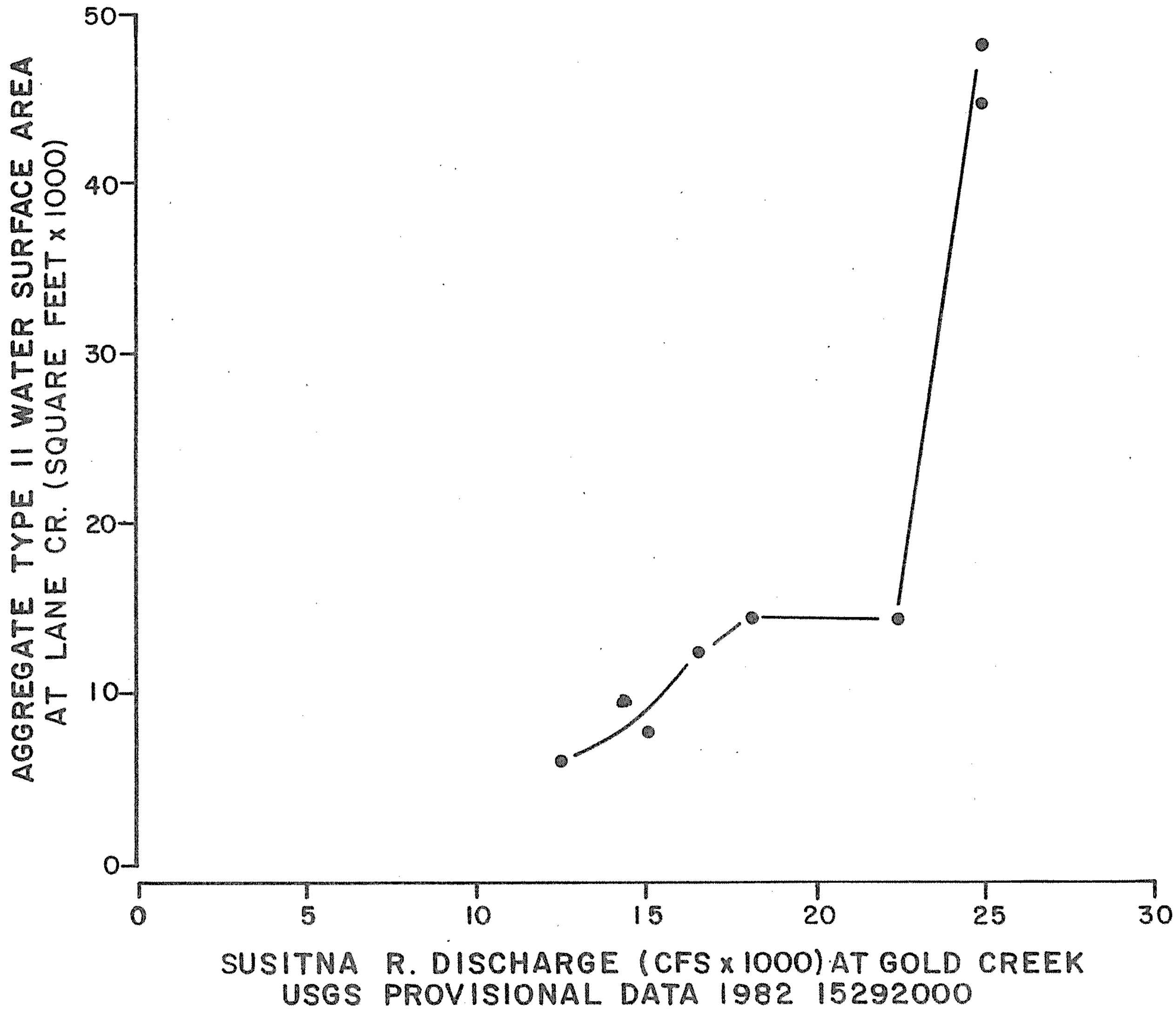

Figure 4E.3-36 Aggregate type II water surface area at Lane Creek versus mainstem discharge at Gold Creek (USGS, 1982).

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the mainstem on June 7 but not on June 18. During both of these samplings, H-II type water covered the channel from about 700 feet above Lane Creek to the mouth.

At 22,400 and 18,100 cfs the H-II area was limited by mainstem stage to the channel area between the outfall of Lane Creek and the mainstem.

Between July 22 and August 8 Lane Creek formed a new mouth of two forks entering the Susitna River directly below the erosion channel mentioned above (Appendix Plate 4-F-10). The H-II area in the August and September sampling trips (16,600 to 12,500 cfs) decreased as a function of Susitna River elevation and the shape of the channel between the Susitna and the old outfall of Lane Creek.

Slough 6A

Slough 6A is a steep walled erosion feature which is connected to pools above it through a series of thick sedge tussocks and a beaver dam. The area of H-II type water within the physical bounds of the slough represents the total wetted surface of the slough up to the beaver dam. The water surface area in the slough is controlled by the water surface elevation of the mainstem in the manner presented graphically.

Whiskers Creek and Slough

Whiskers Creek flows into Whiskers Creek Slough approximately 1100 feet above the slough's mouth. During three visits with mainstem discharges

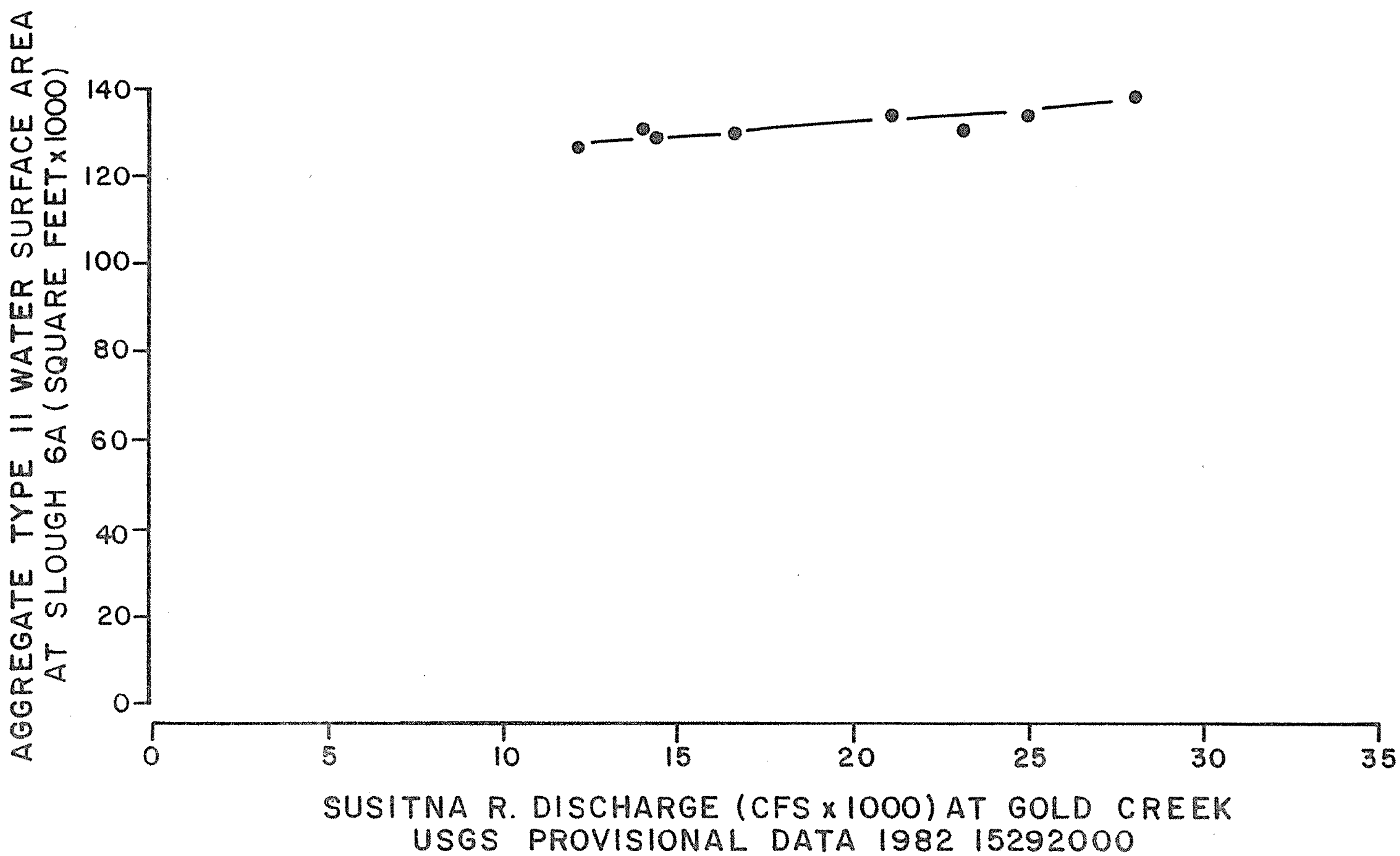

Figure 4-E-3-37 Aggregate type II water surface area at Slough 6A versus mainstem discharge at Gold Creek (USGS, 1982).

of 25,000 cfs and above the mainstem stage was sufficient to back water up the slough to an elevation similar to that of water in Whiskers Creek. On each of these three occasions the head of the slough was open. Slough water (mixed with creek water) with varying velocity's separated the backwater area in the lower slough from a calm water area in the creek above. This velocity zone appeared to become more pronounced at higher mainstem discharges and to separate the creek pool from mainstem control. Based on the observations, the velocity barrier was deemed insignificant at 25,000 cfs, and dominating at higher mainstem discharges (with respect to joining the two calm water areas). Thus, at 25,000 cfs we measured the H-II area from the slough mouth to 1200 feet up Whiskers Creek and at higher discharges only up to below Whiskers Creek. The 25,000 cfs (H-II) area is reported as a maximum value and the H-II areas at high discharges as minimum areas. More observations at this area are needed to better describe the relationship between these two areas.

At mainstem discharges of 23,000 and 16,600 cfs the slough head was closed and H-II type water was backed up 715 and 550 feet, respectively, above the slough mouth. Free from tributary influence, the area of H-II type water near the mouth of the slough will vary as a function of mainstem stage and slough bed shape. That the water in this area is impacted by the discharge of Whiskers Creek was dramatically observed on September 28 when a rain swollen discharge of Whiskers Creek increased velocities near the mouth eliminating the H-II area of water. The

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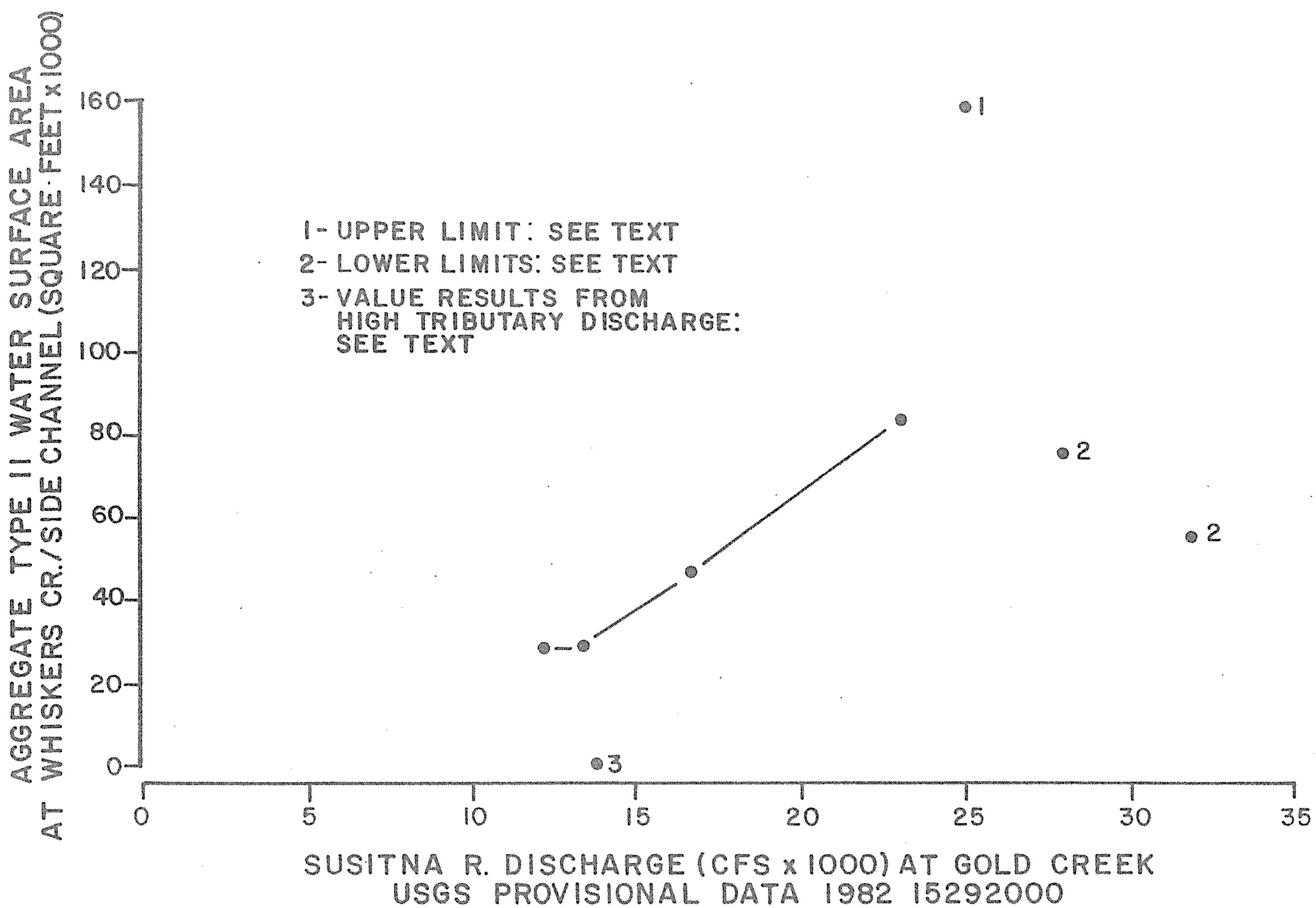

Figure 4I-3-38 Aggregate type II water surface area at Whiskers Creek/side channel versus mainstem discharge at Gold Creek (USGS, 1982).

(zero area) data point measured here was not used in drawing the H-II area versus mainstem discharge curve as it is a function of tributary discharge, not mainstem stage at 13,400 cfs.

Birch Creek and Slough

This site encompassed the nearly mile long lower section of Birch Creek slough between the Susitna River and its junction with Birch Creek, and one-tenth mile reaches of slough and tributary above this junction.

The length of the H-II type water area observed during four trips to this site (58,400 to a mainstem discharge of 99,300 cfs) was nearly constant, covering almost the entire site but Birch Creek itself, except at 99,300 cfs when a 160 foot section of the creek was also backed-up. The streambed elevations at the uppermost backwater boundaries just mentioned visually appeared steep enough to limit the backup observed.

At 52,500 cfs the slough head remained open but H-II water extended to only about 0.4 mile above the slough mouth. During trips where lower mainstem discharges prevailed (38,000 to 33,800 cfs) the head of the slough was closed and the backup zone extended only 0.14 mile above the slough mouth. The boundary between H-II and higher velocity waters at these intermediate discharges was partly regulated by the volume of slough and/or tributary water flowing into the backed up area. Judging the precise location of this boundary was often quite difficult.

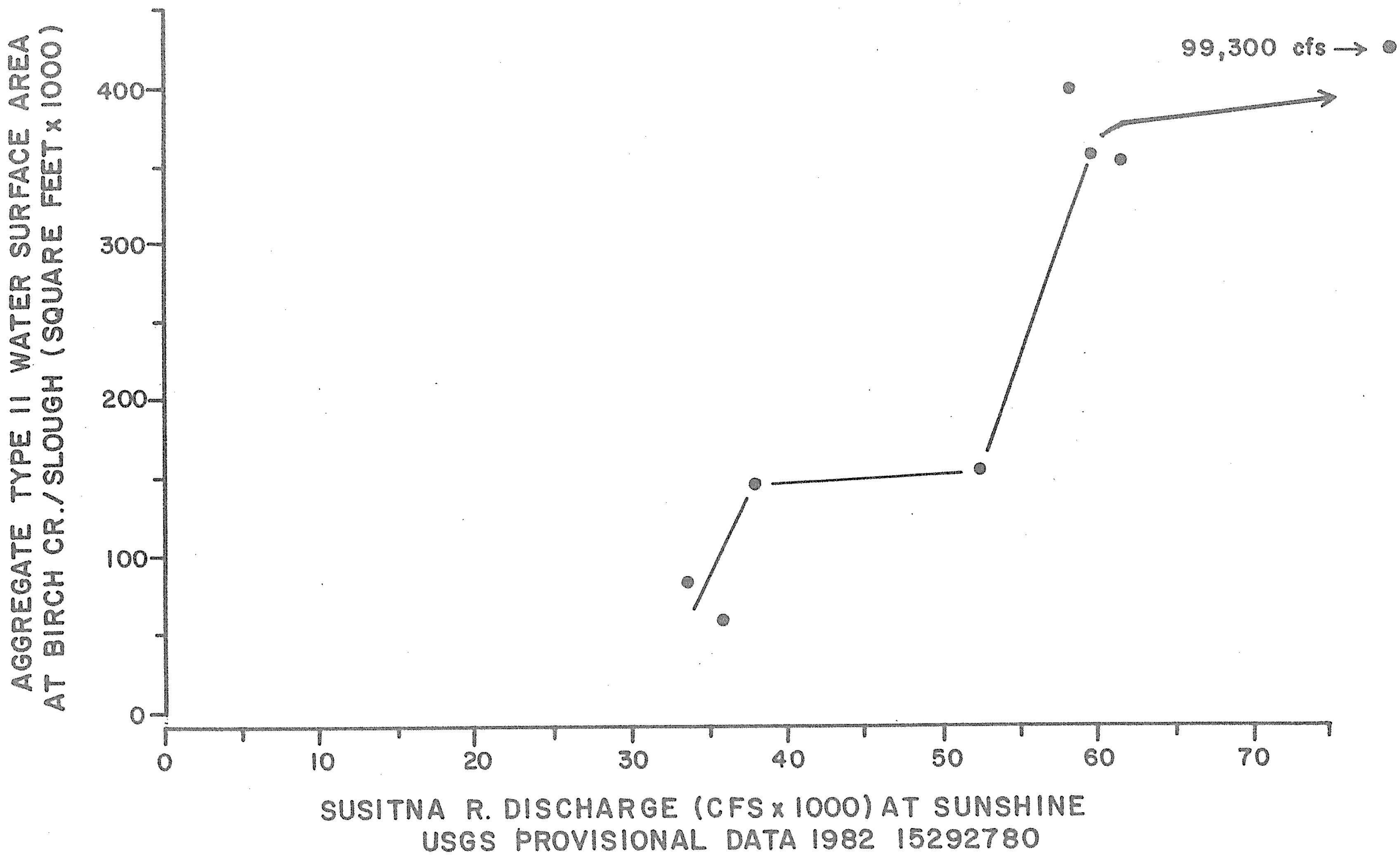

Figure 4E-3-39 Aggregate type II water surface area at Birch Creek/Slough versus mainstem discharge at Sunshine (USGS, 1982).

The mapping task at this site was also made somewhat imprecise by the extreme size of the wetted surface interface. During the limited time available for mapping, it was not possible to measure and record many slough width variations. The overall loss of H-II type area with decreasing mainstem stage is the significant result of the data collection at this site. More observations and more accurate mapping would be required to establish more accurate area data at this very large habitat location.

Sunshine Creek and Side Channel

This site was repeatedly sampled from the staff gage located about 0.75 miles up Sunshine Creek to its confluence with a minor sidechannel, then down another 1000 feet to the confluence with the a major side channel.

During our June and August sampling trips, mainstem discharges ranged from 82,400 to 60,100 cfs and the minor sidechannel's head was open. The H-II zone during these visits was determined to extend from the minor sidechannel-creek junction to about as far as 0.75 miles up the creek. The length of this backup zone was not easily determined nor relatable to mainstem discharges alone. This is visible in the decreases in H-II area seen at 70,200 and 62,700 cfs, relative to the areas mapped at higher and lower mainstem discharges. It is possible that the length of the H-II water zone in the creek was highly regulated by fluctuating creek discharges and not the result of errors in determining the exact location of the zone boundaries.

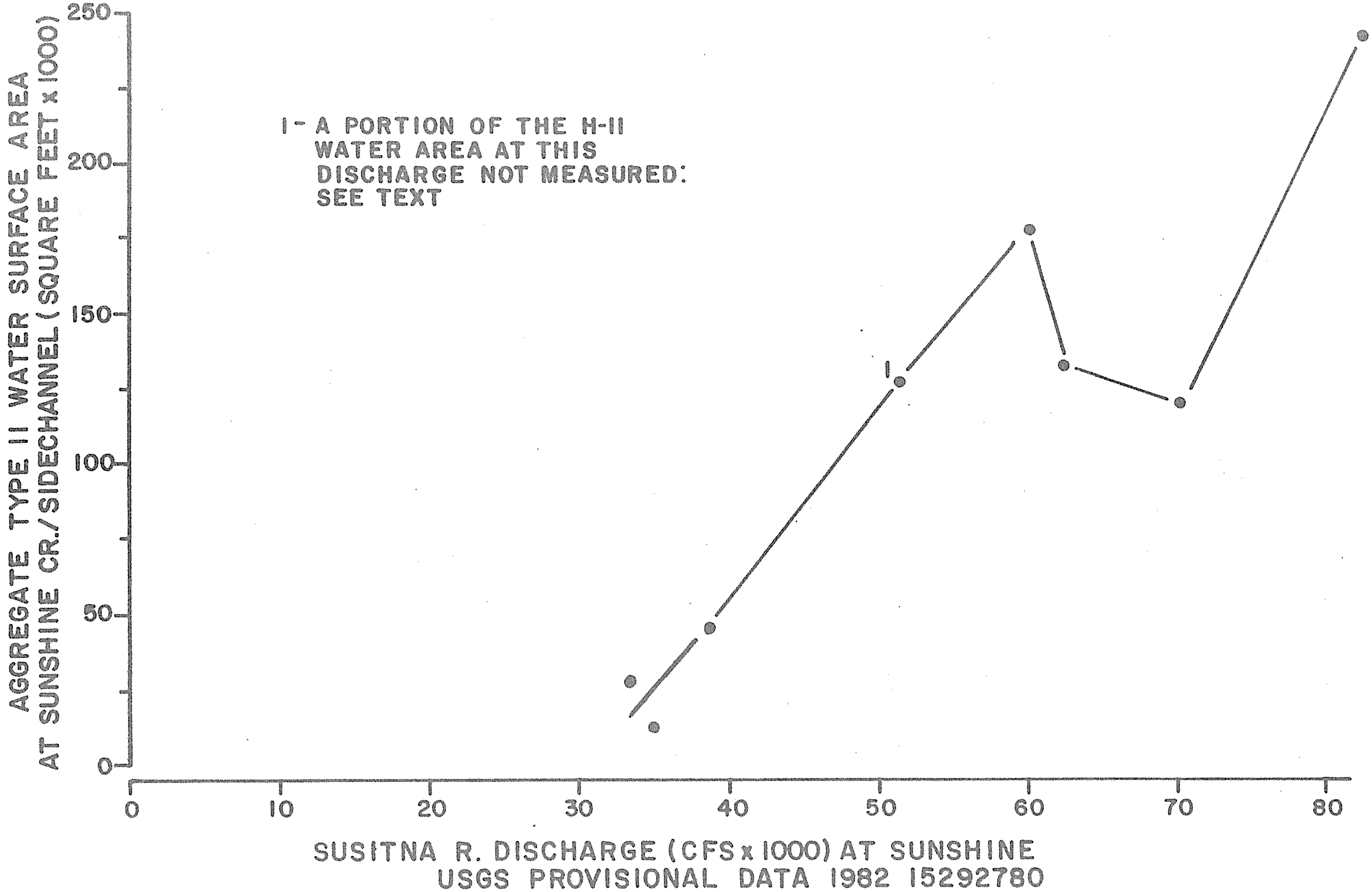

Figure 4I-3-40 Aggregate type II water surface area at Sunshine Creek/side channel versus mainstem discharge at Sunshine (USGS, 1982).

At 51,600 cfs the minor sidechannel's head was closing and the H-II boundaries extended from the minor sidechannel's confluence with the major side channel up into the creek and the closing minor channel's head. Part of the area of H-II water in the minor sidechannel at this discharge extended above the study boundary and was not mapped.

Between mainstem discharges of 38,700 and 33,400 cfs the backed up water area was located entirely between the major and minor sidechannel confluences and the minor sidechannel-creek junction.

The physical habitats in the reaches above and below the mouth of Sunshine Creek are notably dissimilar.

The field tasks at this site were subject to the same problems as at the Birch Creek site with the additional constraint that photographic bluelines showed sections of creek surface which were obscured by shadows. The significant result is the general relationship documented.

Rabideux Creek and Slough

Just below the old site of a bridge crossing (about 1 mile above its confluence with the Susitna River) Rabideux Creek widens into a pool like area. A sandy bottom channel about 700 feet in length connects the lower end of the pool to the upper end of a 0.5 mile long bay (or widening) of the creek which forms the creeks mouth area. At high mainstem discharges, the Susitna River breaches its banks and

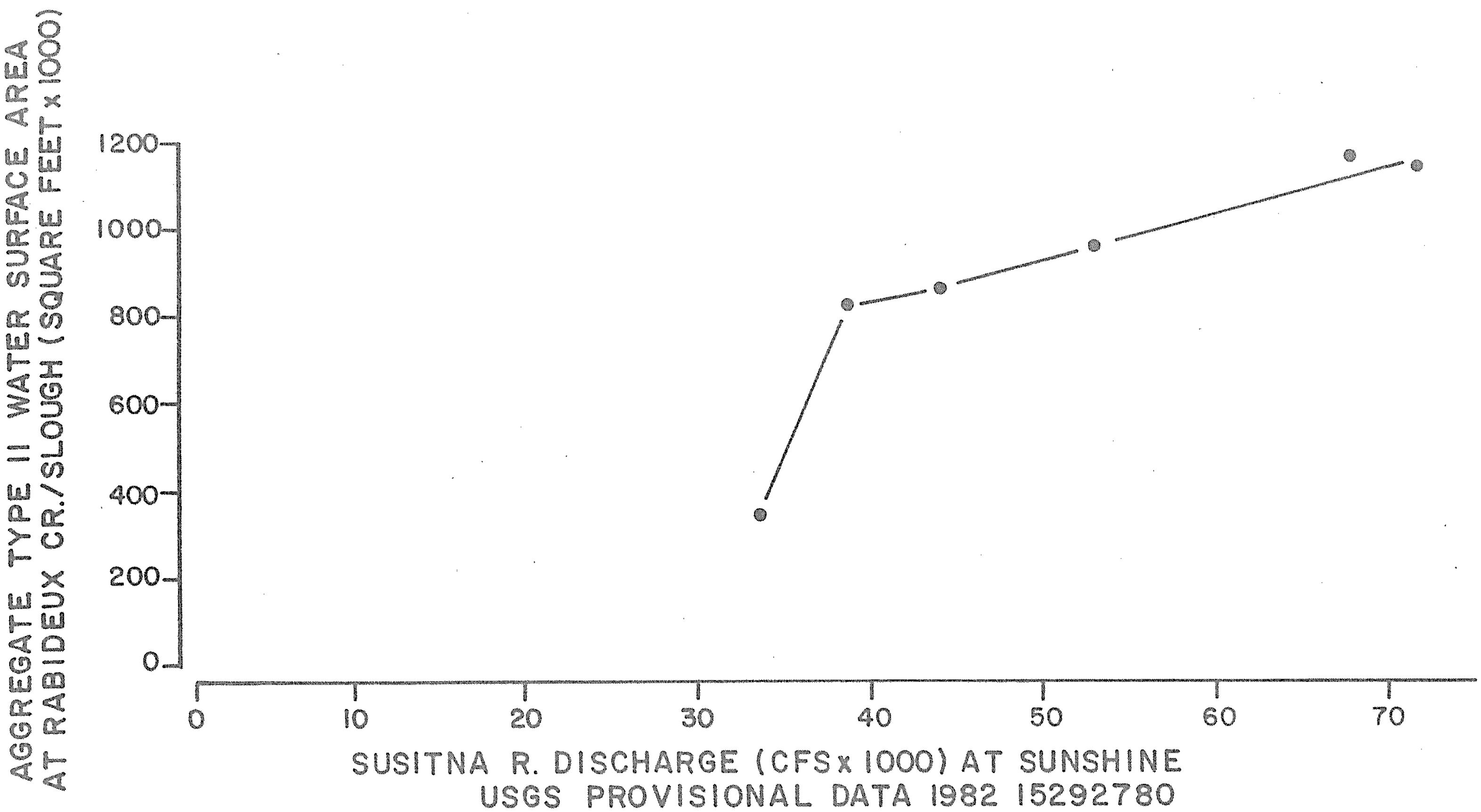

Figure 4E-3-41 Aggregate type II water surface area at Rabideux Creek/Slough versus mainstem discharge at Sunshine (USGS, 1982).

depressions and sections of this widening bay-like area become slough-like.

During every visit to this site a large backwater (H-II) area existed. At the highest mainstem discharges (71,700 cfs) the H-II area extended up to a point about 6,800 feet up from the Susitna River. Backwater thus extended approximately 1500 feet up the creek above the old bridge site and enlarged the wetted surface area in the pool area below the bridge site.

At mainstem discharges between 53,300 and 38,400 cfs, the boundary between the free flowing creek and the low velocity backwater occurred at locations in the pool area.

At the lowest mainstem discharge sampled (33,400 cfs) the elevation of mainstem water had dropped sufficiently to expose a controlling streambed elevation in the sandy bottom connecting channel, reducing the backwater area at this site to 41 percent of its previous observed area. The pool above the channel did not dewater; it simply became a geomorphological feature of the creek bed.

Whitefish Slough

The study boundaries of this site were limited to a 900 foot long section of the slough nearest the mouth. The surface area measurements are thus only partial totals of the entire H-II type area occurring in this long, channel-like area.

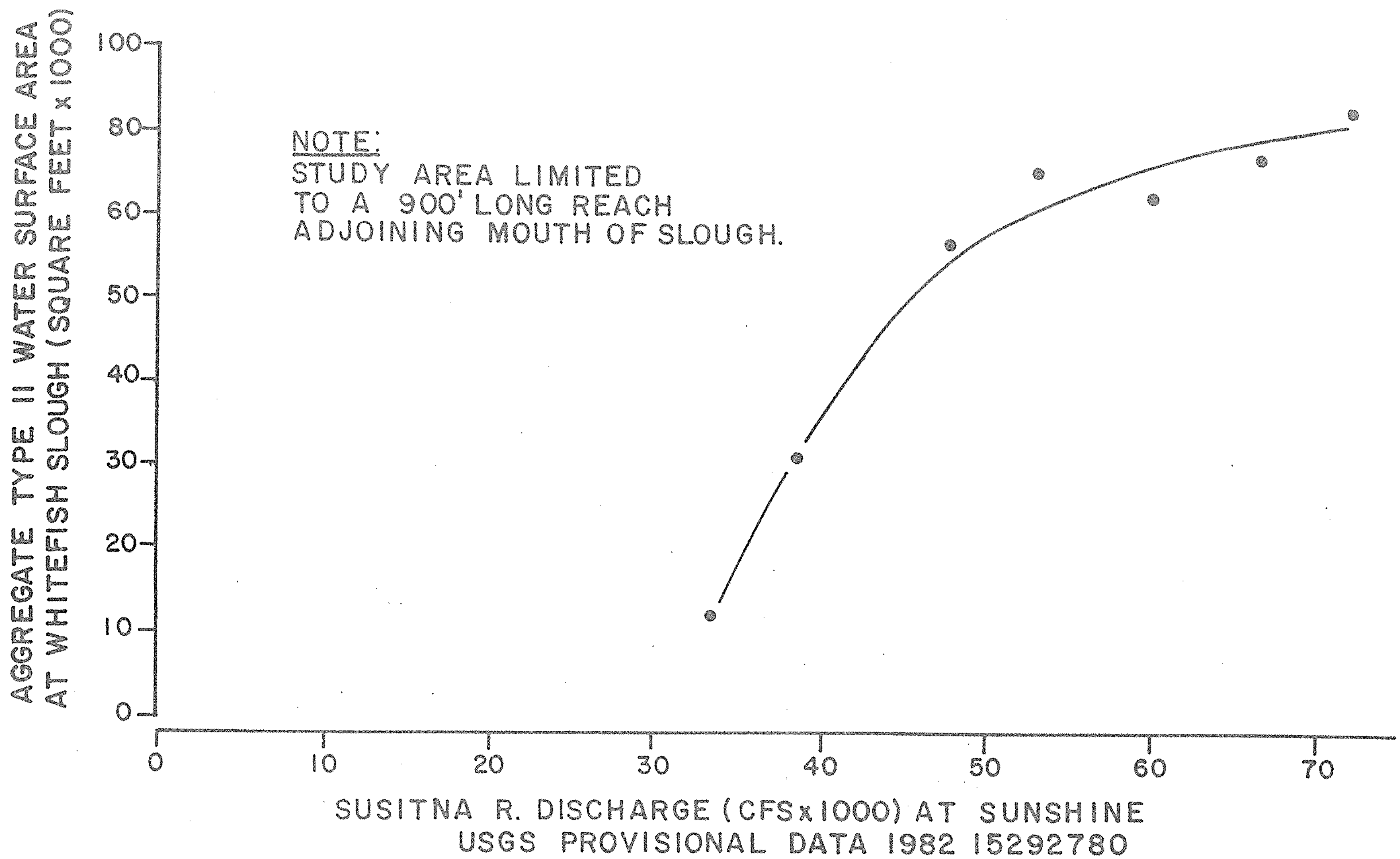

Figure 4E-3-42 Aggregate type II water surface area at Whitefish Slough versus mainstem discharge at Sunshine (USGS, 1982).

The entire wetted surface of this area was of the H-II type during each sampling. Its area was entirely controlled by mainstem water surface elevation at the mouth of the slough.

Lower Goose Creek 2 and Sidechannel

Lower Goose Creek 2 has two mouths. Its northernmost mouth empties into a sidechannel (460 feet above the sidechannel's mouth) over a log jam which maintained the elevation of the water in the creek over any sidechannel elevations observed in these samplings.

At all samplings between mainstem discharges of 38,700 and 64,200 cfs, the sidechannel's head was open. The volume of water which breached the head of the sidechannel significantly controlled the extent of H-II type backwater area in the lower (mouth) reach of the sidechannel by way of its effect on the velocity of these surfaces. At high flows over the sloughs head. The low velocity water was limited to a 600-foot reach nearest the sidechannel's mouth. As the breached water volume decreased the low velocity area extended further up the sidechannel until at 38,700 cfs the length of the H-II area was nearly 1,500 feet long.

During September visits (at mainstem discharges of 36,400 and 33,900 cfs), the sidechannel head was closed. Lower Goose Creek 2, at this point, was free-flowing to the confluence of the sidechannel and the Susitna River. The area of water in the sidechannel above the outfall of Lower Goose Creek 2 was not influenced by mainstem stage, it was

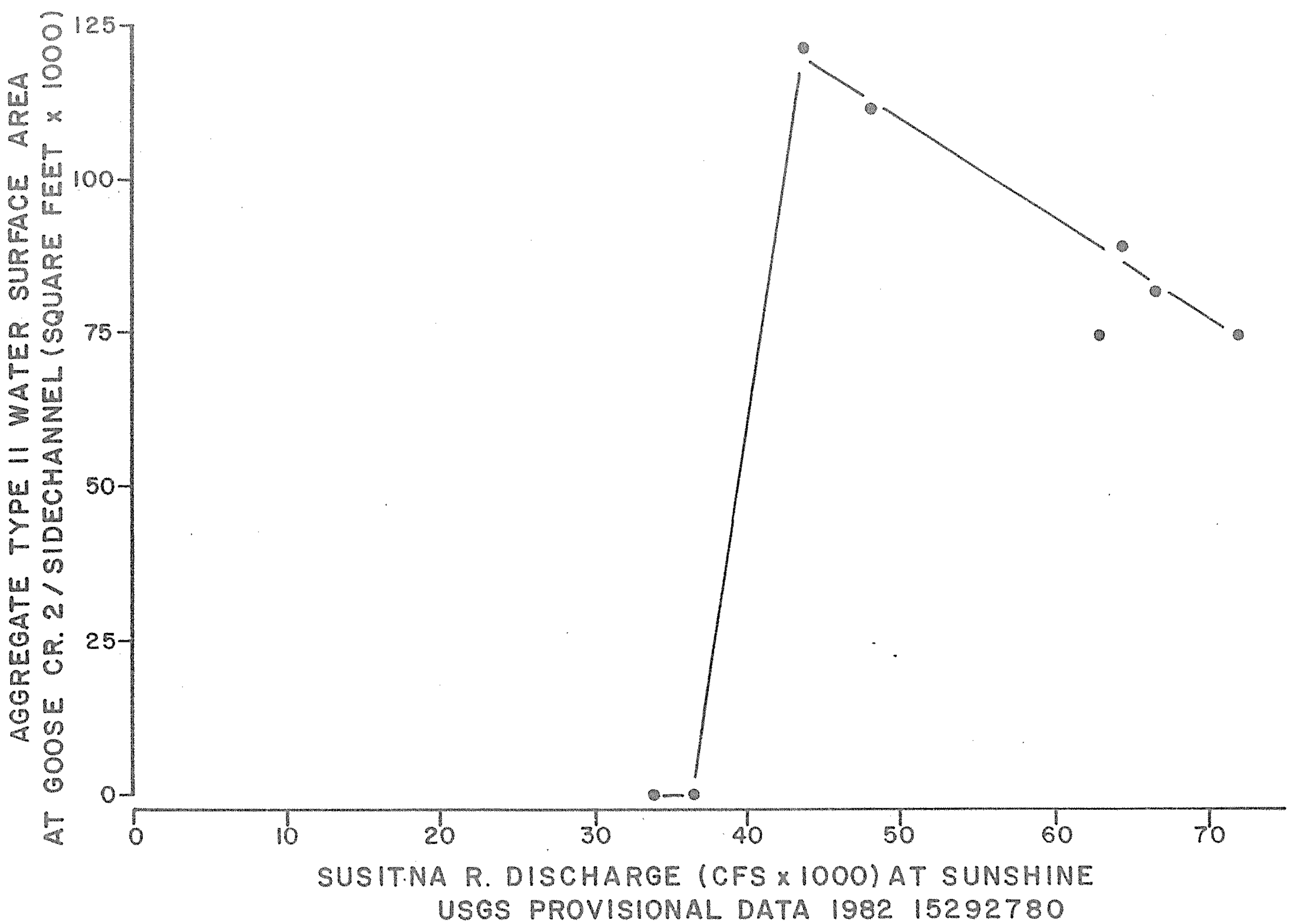

Figure 4/E-3-43 Aggregate type II water surface area at Lower Goose Creek 2/Slough versus mainstem discharge at Sunshine (USGS, 1982).

partly controlled by streambed elevation and partly by the barrier presented by Lower Goose Creek 2 water.

3.1.3.2 Open Channel

Depths, velocities, widths and water surface elevations used in the hydraulic simulations are tabulated and summarized in Appendices A, B and E. This data has been entered into the computer programs, however, the time of this report writing the calibration procedure has yet to be completed. Thus, hydraulic parameters at unknown discharges cannot be extrapolated at this time.

3.2 Water Quality Investigations

3.2.1 Water Temperature

Temperature measurements collected in 1982 included both instantaneous and continuous measurements.

Instantaneous temperature measurements were collected in conjunction with other water quality data and are compiled and presented in Appendix Table 4-D-4.

Continuous temperature data includes surface water and intragravel temperatures obtained with Peabody-Ryan thermographs, surface water and intragravel temperatures obtained with Omnidata recorders and associated thermistors (programmed as 2 channel temperature recorders) and surface water temperatures obtained with Omnidata recorders located at stream gage stations (Indian River and Portage Creek).

Temperatures obtained with Ryan-Peabody thermographs are presented in Appendix, Table 4-C-1 - 4-C-24 as six-hour minimum, mean and maximum temperatures calculated from corrected two-hour point temperature readings. Daily and monthly means, calculated from the 2 hour readings, are also shown in this table. Temperatures obtained with Omnidata 2 channel temperature recorders are presented in Appendix Tables 4-C-25 - 4-C-31 as mean, maximum and minimum temperatures for time periods of six hours and three minutes duration. Six-hour and daily means have been calculated from these temperatures using a two part linear equation interpolation method to "correct" readings from actual six hour and three minute time intervals to six hour intervals (Appendix Tables 4-C-32 - 4-C-38). Hourly and mean daily temperatures obtained with Omnidata recorders located at stream gage stations are presented in Appendix, Tables 4-A-4 and 4-A-5, with a summary of daily mean temperatures for these sites in Tables 4I-3-4 and 5.

3.2.1.1 Mainstem Between Talkeetna and Devil Canyon

3.2.1.1.1 Surface Water Temperature

Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperatures of the mainstem Susitna River were collected at various locations from May through

October, 1982 (Appendix Table 4-D-4). Instantaneous surface water temperatures ranged from 5.1°C to 13.4°C with the lowest occurring at RM 138.9 on September 6 and the highest occurring at RM 120.7 on July 7. In general, instantaneous surface water temperatures of the mainstem above Talkeetna increased from May to July and decreased from August to October, peaking in July and August.

Continuous Surface Water Temperature

Surface water temperature of the mainstem Susitna River between Talkeetna and Devil Canyon was continuously monitored with Peabody-Ryan thermographs at ten locations from May through October, 1982. This data is presented in Appendix C. Surface water temperature ranged from 0.0°C at LRX 18 (RM 113.0) in October to 15.2°C at LRX 29 (RM 126.1) in July. Generally, the mainstem surface water temperature increased during the period from May to July and decreased during the period from August to October usually peaking during July depending on location. 7 day average water temperatures based on a USGS water year will be included in the final draft of this volume.

3.2.1.1.2 Intragravel Water Temperature

Intragravel water temperature data was collected at various mainstem Susitna River locations between Talkeetna and Devil Canyon from May through October, 1982, in conjunction with the mainstem Adult Anadromous Fish Habitat Investigations (refer to Volume 4, Part II, section 3.1.1.1).

3.2.1.2 Sloughs Between Talkeetna and Devil Canyon

3.2.1.2.1 Surface Water Temperature

Instantaneous Surface Water Temperature

Instantaneous surface water temperatures of various sloughs situated between Talkeetna and Devil Canyon were collected from May through October, 1982 (Appendix Table 4-D-4). Due to the large variability among slough habitats and the periodic nature of the instantaneous surface water temperature data, no summary statements concerning the above data have been made.

Continuous Surface Water Temperature

During the open-water season, the surface water temperature of various sloughs located between Talkeetna and Devil Canyon was continuously monitored with Ryan-Peabody thermographs and/or Omnidata recorders at ten sites from August to October, 1982 (Appendix 4-C). During the winter the surface water temperature in seven of these sloughs was continously monitored using Peabody-Ryan thermographs from February - May, 1982 (Appendix Tables 4-C-39 - 4-C-45). Based on data from the open water season, the surface water temperatures in the sloughs ranged overall from 0.2°C at mid-slough in Slough 8A during October to 13.5°C in Slough 9 during August. Surface water temperatures in the sloughs were notably warmer than surface water temperatures in the mainstem during the months of September and October.

The greatest variance in maximum surface water temperatures among the sampled sloughs between Talkeetna and Devil Canyon for any one week occurred during the first week in September when the maximum surface water temperature in Slough 9 was 11.0°C and the maximum in Slough 11 was 3.5°C. The greatest variance in weekly minimum surface water temperatures between sloughs for a given week was 4.4°C occurring in the last week of August when the minimum temperatures in the mouth of Slough 8A and in Slough 11 were 7.7°C and 3.3°C, respectively. Comparing surface water temperatures in mid-slough 8A (RM 126.1) with surface water temperatures in the mainstem adjacent to the slough (at LRX 29, RM 126.1), for any given week, shows similar weekly maximum temperatures, but minimum weekly temperatures from 1° to 5.4°C colder in the slough than in the mainstem.

Based on data from the winter season, the overall range of surface water temperatures in the sloughs studied between Talkeetna and Devil Canyon was from 0.0°C in Whiskers Creek Slough in February to 10.3°C in Slough 9B in May. The greatest variance in maximum surface water temperatures among the sloughs occurred the first week of May when the surface water temperature reached 10.3°C in Slough 9B whereas the maximum in Whiskers Creek Slough was 2.0°C. Generally, winter surface temperatures in the sloughs increased gradually or remained stable through February and March and increased notably in April and the first week of May.

3.2.1.2.2 Intragravel Water Temperatures

Instantaneous Intragravel Water Temperature

Instantaneous measurements of intragravel water temperature were obtained at several sloughs between Talkeetna and Devil Canyon to identify groundwater sources and to obtain intragravel water temperature data on FHU study transects (see Volume 4, Part II section 3.1.1.2.3) and to characterize the intragravel water temperature regimes in locations of salmon redds (see Volume 4, Part II, section 3.1.2.2.4). Refer to the above sections for a summary of the results of this data.

Continuous Intragravel Water Temperature

During the 1982 open-water field season, the intragravel water temperature of various sloughs situated between Talkeetna and Devil Canyon was continuously monitored from late August to October, 1982 (Appendix Tables 4-C-25 - 4-C-38). During the winter, the intragravel water temperature in four of the sloughs was continuously monitored using Peabody-Ryan thermographs from February through the first week of May, 1982 (Appendix Tables 4-C-46 - 4-C-49).

Based on data from the open water season, the intragravel water temperature of the sloughs varied overall from 1.5°C at the mouth of Slough 21 during October to 7.5°C and 7.5°C in Slough 16B during August and during September. The overall range of intragravel water temperatures in the sloughs (1.5°C to 7.5°C) was considerably less than the range of surface water temperatures observed in the sloughs (0.2°C to 13.5°C).

In each slough studied, the minimum weekly intragravel water temperature was warmer than the corresponding surface water temperature from mid-September through October. Conversely, minimum intragravel water temperatures in the mouth of Slough 8A, upper Slough 8A, sloughs 11, 19 and upper Slough 21 were cooler than corresponding minimum surface water temperatures prior to September. The minimum intragravel temperatures in upper Slough 8A were consistently warmer than those in the other sloughs for this period. For August and September, the coolest intragravel temperatures in these sloughs were in Slough 19; the difference between minimum intragravel temperatures in the mouth of Slough 8A and in Slough 9 for September was 3.0°C.

Based on data from the winter season (February to April), overall of intragravel water temperatures ranged from 0.0°C in Slough 9 to 6.5°C also in Slough 9 in May. Conversely, the intragravel temperature in the mouth of Slough 21 remained a steady 3.0°C from February through April. In Slough 19, the average intragravel water temperature was warmer than the corresponding surface water temperature from February to April. The same was true in the mouth of Slough 21 for February and March, but by mid-April the average surface water temperature was warmer than the intragravel water temperature. In Slough 9 and 9B the surface water temperature was warmer than the intragravel water temperature from February through April.

3.2.1.3 Tributaries Between Talkeetna and Devil Canyon

3.2.1.3.1 Surface Water Temperature

Instantaneous Surface Water Temperatures

Instantaneous measurements of surface water temperatures in tributaries between Talkeetna and Devil Canyon were collected from June through October, 1982 (Appendix Table 4-D-4). In general, surface water temperature increased from June to August and decreased from September to October, peaking in August. Instantaneous measurements of surface water temperature ranged from 0.9°C in Portage Creek on October 11 to 12.1°C in Fourth of July Creek on August 22.

Continuous Surface Water Temperature

Surface water temperature was continuously monitored from June to October, 1982, in Indian River and Portage Creek. This data is presented in Appendix Tables 4-A-4 and 4-A-5 and Tables 4I-3-4 and 4I-3-5.

Based on the above data, the surface water temperature of Indian River varied from 0.0°C in late October to 12.5°C in mid-July. The surface water temperature of Portage Creek varied from 0.0°C beginning in mid-October to 13.0°C in mid-August. Temperatures in both Indian River and Portage Creek generally increased from June to August and decreased in September and October, peaking in August.

3.2.1.3.2 Intragravel Water Temperature

No intragravel water temperature data was collected from tributaries between Talkeetna and Devil Canyon during the 1982 open water field season.

3.2.1.4 Mainstem , Sloughs and Tributaries Downstream of Talkeetna

3.2.1.4.1 Surface Water Temperature

Mainstem Sites

Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature of the mainstem Susitna River below Talkeetna were collected from May through October, 1982 (Appendix Table 4-D-4). Instantaneous measurements of surface water temperature in the mainstem below Talkeetna ranged from 0.2°C at RM 77.0 on October 14 to 11.2°C at RM 18.2 on June 1. Because of the limited quantity of instantaneous surface water temperature data for the mainstem below Talkeetna, no further summary statements on the above data are made.

Continuous Surface Water Temperature

Surface water temperature of the mainstem Susitna River below Talkeetna was monitored at three sites from May through October, 1982. This data is presented in Appendix Tables 4-C-1, 4-C-3 and 4-C-4.

The surface water temperature of the mainstem Susitna River below Talkeetna ranged from 0.0°C in October to 13.5°C in June and July. Both temperatures were recorded above the Yentna River confluence at RM 29.3. Generally, the surface water temperature of all mainstem sites below Talkeetna increased during the period from May through August and decreased from September to October, peaking from mid- July to mid-August. The timing of the peak water temperature in the mainstem below Talkeetna (mid July to mid August) appeared to occur later than in the mainstem above Talkeetna (July; see section 3.2.1.1.1).

Slough Sites

Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature of various sloughs below Talkeetna were collected from June through October, 1982 (Appendix Table 4-D-4). Temperature measurements ranged from 3.7°C in Lower Goose 2 Slough on October 1 to 16.6°C in Rabideux Creek Slough on June 26. Surface water temperature in the sloughs below Talkeetna generally rose from June to July, peaking during July and August, and then decreased during September through October.

Continuous Surface Water Temperature

No sloughs below Talkeetna were continuously monitored for surface water temperature during 1982.

Tributary Sites

Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature in various tributaries below Talkeetna were collected from June through October, 1982 (Appendix Table 4-D-4). Instantaneous measurements of surface water temperature in various tributaries below Talkeetna ranged from 17.4°C in Birch Creek on August 5 to 3.6°C in Sunshine Creek on October 4. Because of the limited quantity of instantaneous surface water temperature data for the tributaries below Talkeetna, no further summary statements on the above data have been made.

Continuous Surface Water Temperature

Surface water temperature was continuously monitored in the three major tributaries below Talkeetna, the Chulitna, Talkeetna and Yentna Rivers, from May through October, 1982 (Appendix Tables 4-C-2, 4-C-7 and 4-C-8).

The surface water temperature of the Yentna River ranged from 3.5°C in late September (October temperatures not obtained) to 13.0°C in late June. The surface water temperature in the Chulitna River ranged from

0.0°C in October to 8.5°C in September (July and August temperatures not obtained). In the Talkeetna River, the temperature ranged from 0.1°C in October to 11.5°C in August. From July to September, monthly mean mainstem surface water temperatures obtained at the Talkeetna fishwheel camp approximately 5 miles upstream from the confluence with the Chulitna and Talkeetna Rivers, were 1-2°C warmer than the monthly mean temperatures obtained in the Chulitna and Talkeetna rivers from July to September. In October both the Chulitna and Talkeetna Rivers and the mainstem averaged temperatures between 0.5°C and 1.0°C. Monthly mean mainstem surface water temperatures obtained in the mainstem above the Yentna River compared to monthly mean surface water temperatures obtained in the mainstem above the Yentna River were from 1.0°C to 2.5°C warmer than monthly mean surface water temperatures in the Yentna River.

3.2.1.4.2 Intragravel Water Temperature

No intragravel water temperature data was collected below Talkeetna during 1982.

3.2.1.5 Locations Upstream of Devil Canyon

3.2.1.5.1 Surface Water Temperature

Instantaneous Surface Water Temperature

Instantaneous measurements of surface water temperature were collected at various locations above Devil Canyon from May through October, 1982 and are presented in Appendix Table 4-D-4. Refer to Volume 5 for further details on these results.

Continuous Surface Water Temperature

Surface water temperatures were continuously monitored within five tributaries above Devil Canyon from June to October, 1982. This data is presented in Appendix Tables 4-C-20 - 4-C-24. Refer to Volume 5 for further details on these results.

3.2.1.5.2 Intragravel Water Temperature

No intragravel water temperature data was collected above Devil Canyon during 1982.

3.2.2 Other Basic Field Parameters

The basic field parameters of dissolved oxygen, pH, specific conductance and temperature were collected at various locations in the Susitna River basin from RM 5.0 to RM 233.4 during the 1982 open water field season. In addition, turbidity was measured at various locations from RM 73.1 to RM 233.4. These data are compiled and presented in Appendix Table 4-D-4. The water quality data summarized in this section are provisional. The variety and large quantity of information presented in Appendix Table 4-D-4 limited sufficient review of this data for this first draft.

3.2.2.1 Mainstem and Sidechannels Between Talkeetna and Devil Canyon

The basic field parameters of dissolved oxygen, pH, specific conductance and temperature were collected at various mainstem and side channel sites between Talkeetna and Devil Canyon primarily in conjunction with the electrofishing program (see section 3.1.1.1, Vol. 4, Part II). These data are presented in Appendix Table 4-D-4.

From RM 114.2 to RM 148.2, the range of dissolved oxygen was 7.1 to 14.0 mg/l over a corresponding range of surface water temperatures from 5.8°C to 10.6°C. Measurements of pH were observed to a range from 6.9 to 8.7 and specific conductance ranged from 33 to 132 umhos/cm. Turbidity in the mainstem Susitna River between Talkeetna and Devil Canyon during the 1982 open water field season ranged from 2.4 to 154 NTU from RM 111.5 to RM 148.2.

3.2.2.2 Sloughs Between Talkeetna and Devil Canyon

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature and turbidity were measured at various upland and side sloughs situated between Talkeetna and Devil Canyon during the 1982 open water field season (refer to section 3.1.1.2 of Vol. 4, Part I for the definition of upland and side sloughs). This data is compiled and presented in Appendix Table 4-D-4.

3.2.2.2.1 Upland Sloughs

Two upland sloughs (Sloughs 6A and 19) were monitored for the basic field parameters discussed above, primarily in conjunction with the FDS program, from June to October, 1982. The results are presented in Appendix Table 4-D-4. In Slough 6A dissolved oxygen was found to range from 8.9 to 13.9 mg/l over a corresponding range of surface water temperatures from 4.9 to 15.0°C, while in Slough 19 the ranges for these parameters were 7.3 to 14.3 mg/l and 3.6° to 14.1°C, respectively. Measurements of pH and specific conductance in Slough 6A and 19 ranged from 6.3 to 7.8 and 28 to 135 umhos/cm and 6.0 to 7.7 and 52 to 159 umhos/cm, respectively. Turbidity in Slough 6A ranged from 3 to 146 NTUs while in Slough 19 it varied from less than 1 to 150 NTUs.

Overall, dissolved oxygen in the upland sloughs situated between Talkeetna and Devil Canyon was found to vary from 7.3 to 14.3 mg/l over a corresponding range of surface water temperatures from 3.6° to 15.8°C, while measurements of pH and specific conductance varied from 6.0 to 7.8 and 28 to 159 umhos/cm, respectively. Turbidity in upland sloughs was observed to vary from less than 1 NTU to 150 NTUs.

3.2.2.2.2 Side Sloughs

Twelve side sloughs situated between Talkeetna and Devil Canyon (Whiskers Creek and Lane Creek Slough and sloughs 8A, 9, 9A, 9B, 10, 11, 16, 20, 21 and 22) were monitored for dissolved oxygen, pH, specific conductance, temperature and turbidity during the 1982 open water field season in conjunction with the FDS, FHU, and IFE programs. These data are presented in Appendix Table 4-D-4 and discussed below on a site by site basis.

Overall, dissolved oxygen in the side sloughs situated between Talkeetna and Devil Canyon ranged from 4.8 to 15.7 mg/l over a corresponding range of surface water temperatures from 0.9° to 16.3°C, while measurements of pH and specific conductance varied from 5.3 to 7.9 and 14.0 to 277 umhos/cm, respectively. Turbidity was found to vary from less than 1 NTU to 200 NTUs.

Whiskers Creek Slough

In Whiskers Creek Slough from June to October, 1982, dissolved oxygen was observed to vary from 6.4 to 13.3 mg/l over a corresponding range of surface water temperatures from 3.3° to 12.7°C, while measurements of pH and specific conductance were found to range from 6.2 to 7.4 and 24 to 92 umhos/cm respectively. Turbidity measurements obtained from June to September, 1982, ranged from 3 NTUs to 41 NTUs.

Lane Creek Slough

In Lane Creek Slough from June to October, 1982, dissolved oxygen was found to vary from 6.8 to 14.5 mg/l over a corresponding range of surface water temperatures from 4.0° to 16.2°C, while measurements of pH and specific conductance ranged from 5.5 to 7.8 and 26 to 86 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 168 NTUs.

Slough 8A

In Slough 8A from June to October, 1982, dissolved oxygen was found to vary from 8.6 to 11.8 mg/l over a corresponding range of surface water temperatures from 2.4 to 14.0°C while measurements of pH and specific conductance ranged from 6.3 to 7.4 and 34 to 168 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 34 NTUs.

Slough 9

In Slough 9 from June to October, 1982, dissolved oxygen was observed to vary from 3.5 to 14.4 mg/l over a corresponding range of surface water temperatures from 4.9° to 13.4°C, while measurements of pH and specific conductance were found to range from 6.4 to 7.7 and 53 to 172 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged 2 to 48 NTUs.

Slough 9B

Measurements of the basic field parameters were measured once during the 1982 open water field season at Slough 9B. On October 4, the dissolved oxygen was observed to be 9.2 mg/l at a corresponding surface temperature of 3.3°C, while measurements of pH and specific conductance were 6.6 and 163 umhos/cm, respectively.

Slough 9A

Measurements of the basic field parameters were measured once during the 1982 open-water field season at three locations in Slough 9A. On September 3, dissolved oxygen was observed to range from 7.7 to 8.9 mg/l over a corresponding range of surface water temperatures from 3.6 to 5.0°C, while measurements of specific conductance varied from 121 to 161 umhos/cm. Measurements of pH was constant at 6.9 at all three locations.

Slough 10

Measurements of the basic field parameters were obtained twice in Slough 10 during the 1982 open-water field season. On June 8, measurements were made at two sites in Slough 10 while on October 4, measurements were obtained at four sites. At all measurement sites dissolved oxygen was observed to vary from 7.9 to 10.5 mg/l over a corresponding range of surface water temperatures from 4.2 to 6.5°C, while measurements of pH and specific conductance varied from 6.9 to 7.4 and 132 to 226 umhos/cm, respectively. Two turbidity samples, both obtained on June 8, were determined to be less than 1 NTU and 4 NTUs.

Slough 11

In Slough 11 from June to October, 1982, dissolved oxygen was observed to vary from 7.1 to 12.9 mg/l over a corresponding range of surface water temperatures from 3.0 to 11.6°C, while measurements of pH and specific conductances were found to range from 5.3 to 7.8 and 127 to 230 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 9 NTUs.

Slough 16

In Slough 16B, between June, and October, 1982, dissolved oxygen levels were measured on two occasions, 11.1 and 11.8 mg/l. Surface water temperature was found to vary from 4.3° to 7.5°C, while pH and specific conductance were found to range from 6.2 to 6.6 and 34 to 70 umhos/cm. A single turbidity measurement of 3 NTU was obtained on June 4.

Slough 20

In Slough 20 from July to October, 1982, dissolved oxygen was observed to vary from 10.3 to 15.7 mg/l over a corresponding range of surface water temperatures from 3.0 to 12.4°C while measurements of pH and specific conductance were found to range from 6.2 to 8.0 and 65 to 105 umhos/cm, respectively. Turbidity measurements obtained from July to October, 1982 ranged from less than one NTU to 50 NTUs.

Slough 21

In Slough 21 from June to September, 1982, dissolved oxygen was observed to vary from 5.3 to 12.7 mg/l over a corresponding range of surface water temperatures from 4.6 to 10.8°C, while measurements of pH and specific conductance were found to range from 6.0 to 7.8 and 115 to 277 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 62 NTUs.

Slough 22

In Slough 22 from June to September, 1982, dissolved oxygen was observed to vary from 9.3 to 13.2 mg/l over a corresponding range of surface water temperatures from 4.5 to 11.2°C, while measurements of pH and specific conductance were found to range from 6.3 to 7.4 and 34 to 141 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 8 NTU to 130 NTUs.

3.2.2.3 Tributaries Between Talkeetna and Devil Canyon

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature and turbidity were collected at various tributaries situated between Talkeetna and Devil Canyon during the 1982 open water field season. These data are presented in Appendix Table 4-D-4. Overall, dissolved oxygen in the tributaries sampled ranged from 7.2 to 15.3 mg/l over a corresponding range of surface water temperatures from

0.9° to 15.3°C, while pH and specific conductance varied from 5.7 to 7.5 and 14 to 103 umhos/cm, respectively. Turbidity was found to vary from less than one NTU to 100 NTUs. These results are summarized below for each site.

Whiskers Creek

In Whiskers Creek from June to September 1982, dissolved oxygen was observed to vary from 7.9 - 13.0 mg/l over a corresponding range of surface water temperature from 4.3 to 12.2°C while measurements of pH and specific conductance were found to range from 5.8 to 7.4 and 24 to 31 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982 ranged from less than 1 to 40 NTUs.

Gash Creek

Measurements of the basic field parameters were measured once during the 1982 open water field season at Gash Creek. On August 18, the dissolved oxygen was observed to be 10.5 mg/l at a corresponding surface water temperature of 10.5, while measurements of pH and specific conductance were 6.7 and 9.4 umhos/cm, respectively.

Lane Creek

Measurements of water quality were obtained from Lane Creek from June to September, 1982. The basic field parameters of dissolved oxygen and pH were found to range from 11.9 to 14.5 mg/l and 6.0 to 7.8, respectively. Surface water temperature was found to vary from 4.0 to 8.3°C while specific conductance was found to range from 26 to 52 umhos/cm. Turbidity values were observed to range from 1-6 NTUs.

Fourth of July Creek (mouth)

In Fourth of July Creek from June to September, 1982, dissolved oxygen was observed to vary from 9.9 to 12.5 mg/l over a corresponding range of surface water temperatures from 5.6° to 12.0°C, while measurements of pH and specific conductance were found to range from 6.2 to 7.3 and 16 to 26 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 2 NTUs.

Indian River

In Indian River from June to September, 1982, dissolved oxygen was observed to vary from 10.3 to 14.2 mg/l over a corresponding range of surface water temperatures from 2.6° to 11.7°C, while measurements of pH and specific conductance were found to range from 6.0 to 7.2 and 29 to 46 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 85 NTUs.

Portage Creek

In Portage Creek from June to October, 1982, dissolved oxygen was observed to vary from 10.7 to 15.0 mg/l over a corresponding range of surface water temperatures from 0.9° to 9.7°C, while measurements of pH and specific conductance were found to range from 6.2 to 7.5 and 36 to 100 umhos/cm, respectively. Turbidity measurements obtained from June to October, 1982 ranged from less than 1 NTU to 8 NTUs.

3.2.2.4 Mainstem and Sidechannel Downstream of Talkeetna

The basic field parameters of dissolved oxygen, pH, specific conductance and temperature were collected at various mainstem Susitna River and side channel sites below Talkeetna during the 1982 open water field season primarily in conjunction with the electrofishing program (refer to Section 3.1.1.1, Vol. 4, Part II). These data are presented in Appendix Table 4-D-4. From RM 5.0 to RM 85.7, the range of dissolved oxygen varied from 5.7 to 13.8 mg/l over a corresponding range of surface water temperatures from 0.2° to 16.4°C. Measurements of pH were observed to vary from 5.6 to 7.6 while specific conductance ranged from 41 to 138 umhos/cm. Turbidity sampled solely from Sunshine Creek Sidechannel and ranged from 1 NTU to 100 NTUs.

3.2.2.5 Sloughs Downstream of Talkeetna

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature and turbidity were collected at various sloughs below Talkeetna during the 1982 open-water field season primarily in conjunction with the FDS, FHU and IFE programs. These data are compiled and presented in Appendix Table 4-D-4.

Overall, dissolved oxygen ranged from 8.3 to 13.4 mg/l over a corresponding range of surface water temperatures from 4.5° to 16.4°C. Measurements of pH and specific conductance were observed to vary from 5.2 to 7.7 and 19 to 204 umhos/cm, respectively. Turbidity ranged from less than 1 NTU to 158 NTUs. These results are summarized below for each site.

Lower Goose 2 Slough

In Lower Goose 2 Slough from June to October, 1982, dissolved oxygen was observed to vary from 8.7 to 11.2 mg/l over a corresponding range of surface water temperature from 5.3° to 12.8°C, while measurements of pH and specific conductance were found to range from 6.7 to 7.7 and 33 to 179 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 5 NTUs to 115 NTUs.

Whitefish Slough

In Whitefish Slough from June to October, 1982, dissolved oxygen was observed to vary from 8.3 to 10.7 mg/l over a corresponding range of surface water temperature from 6.1° to 16.4°C, while measurements of pH and specific conductance were found to range from 6.7 to 7.3 and 14 to 121 umhos/cm, respectively. Turbidity measurements obtained from July to September, 1982, ranged from 18 NTUs to 46 NTUs.

Rabideux Creek Slough

In Rabideux Creek Slough from June to September, 1982, dissolved oxygen was observed to vary from 8.9 to 11.8 mg/l over a corresponding range of surface water temperatures from 5.1 to 15.6 while measurements of pH and specific conductance were found to range from 5.8 to 7.5 and 23 to 96 umho/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 2 NTU to 158 NTUs.

Sunshine Slough

In Sunshine Slough from May to October, 1982, dissolved oxygen was observed to vary from 5.7 to 11.4 mg/l over a corresponding range of surface water temperatures from 6.1° to 12.4°C while measurements of pH and specific conductance were found to range from 6.7 to 7.2 and 54 to 138 umhos/cm, respectively. Turbidity measurements obtained from June to September ranged from 1 NTU to 100 NTUs.

Birch Creek Slough

In Birch Creek Slough from June to October, 1982, dissolved oxygen was observed to vary from 9.9 to 12.8 mg/l over a corresponding range of surface water temperatures from 8.7° to 15.4°C, while measurement of pH and specific conductance were found to range from 6.4 to 7.7 and 60 to 165 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 2 NTU to 76 NTUs.

3.2.2.6 Tributaries Downstream of Talkeetna

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature and turbidity were collected at various tributaries below Talkeetna during the 1982 open water field season primarily in conjunction with the FDS, FHU and IFE programs. These data are compiled and presented in Appendix Table 4-D-4.

Overall, dissolved oxygen varied from 9.2 to 12.0 mg/l over a corresponding range of surface water temperatures from 3.6° to 17.2°C. Measurements of pH and specific conductance were observed to vary from 6.1 to 6.8 and 14 to 204 umhos/cm, respectively. No measurements of turbidity were obtained at any tributaries below Talkeetna during 1982. These data are summarized below for each site.

<u>Lower Goose 2 Creek</u>

In Lower Goose 2 Creek from June - September, 1982, dissolved oxygen was observed to vary from 8.7 to 11.0 mg/l over a corresponding range of surface water temperature of 3.7° to 11.6°C while measurements of pH and specific conductances were found to range from 6.8 to 7.4 and 27 to 40 unhos, respectively. Turbidity measurements obtained from June to September, 1982, ranged from less than 1 NTU to 18 NTUs.

Whitefish Slough Tributary

A single measurement of the basic field parameters was obtained on September 16 from a tributary entering Whitefish Slough. Due to a meter malfunction, only surface water temperature (9.3°C) and specific conductance (14 umhos/cm) were obtained.

Rabideux Creek

In Rabideux Creek from September to October, 1983, dissolved oxygen was observed to vary from 8.9 - 10.6 mg/l over a corresponding range of surface water temperature 6.0°-17.2°C, while measurements of pH and specific conductance were found to range from 5.8 to 7.2 and 23 to 96 umhos/cm, respectively. Turbidity measurements, obtained from June to September, 1982 ranged from 2 NTUs to 10 NTUs.

Sunshine Creek

In Sunshine Creek from August to October, 1982, dissolved oxygen was observed to vary from 9.4 to 13.4 mg/l over a corresponding range of surface water temperature from 6/0° to 16.4°C, while measurements of pH and specific conductance were found to range from 5.6 to 7.3 and 27 to 63 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 1 NTU to 9 NTUs.

Birch Creek

In Birch Creek from June to October, 1982, dissolved oxygen was observed to vary from 8.5 to 13.4 mg/l over a corresponding range of surface water temperature from 5.2° to 16.0°C while measurements of pH and specific conductance were found to range from 5.5 to 7.4 and 50 to 94 umhos/cm, respectively. Turbidity measurements obtained from June to September, 1982, ranged from 1 NTU to 38 NTUs.

3.2.2.7 Locations Upstream of Devil Canyon

The basic field parameters of dissolved oxygen, pH, specific conductance, temperature and turbidity were collected at various locations in the Susitna River basin above Devil Canyon during the 1982 open-water field season. These data are compiled and presented in Appendix Table 4-D-4.

Overall, dissolved oxygen the tributaries above Devil Canyon ranged from 9.6 to 12.2 mg/l over a corresponding range of surface water temperatures from 0.1° to 14.8°C, while measurements of pH and specific conductance ranged from 6.7 to 8.1 and 22 to 212 umhos/cm, respectively. Turbidity in the tributaries ranged from less than 1 NTU to 25 NTUs.

In the mainstem above Devil Canyon, dissolved oxygen ranged from 9.0 to 13.5 mg/l over a corresponding range of surface water temperatures from 0.1° to 13.9°C, while measurements of pH and specific conductance ranged from 6.8 to 8.1 and 73 to 144 umhos/cm, respectively. Turbidity in the mainstem above Devil Canyon was found to vary from 14 to 150 NTUs.

Refer to Volume 5 for a site by site presentation of these results.

3.2.3 Total Dissolved Gases

All basic field data is recorded in Appendix Table 4-D-1 for all of the dissolved gas data recorded during 1981 and 1982. The 1981 data has been previously reported in TES (1981,1982). Some minor corrections in calculations were made in these data and are presented in this report. In addition, Appendix Table 4-D-3 is included on the residual analysis of the multiple regression examination of decay data. Although temperature was examined initially, only discharge (at Gold Creek) and distance below the proposed Devil Canyon dam site are examined as predictor variables. Temperature did not have any significant contribution to the variability in the concentrations of dissolved gas recorded. The decay of the supersaturation that began in the canyon near the dam site is plotted in Figure 4I-3-44 for four different sampling periods. The decay of the supersaturated gas follows a reasonable log decay function and the regression coefficients are indicated, but the slopes of the decay curves vary from sampling period to sampling period.

The concentrations of dissolved gas immediately above and below the rapids of the canyon were measured on two separate trips during the summer of 1981. During the initial trip, the dissolved oxygen was also recorded (Figure 4I-3-45).

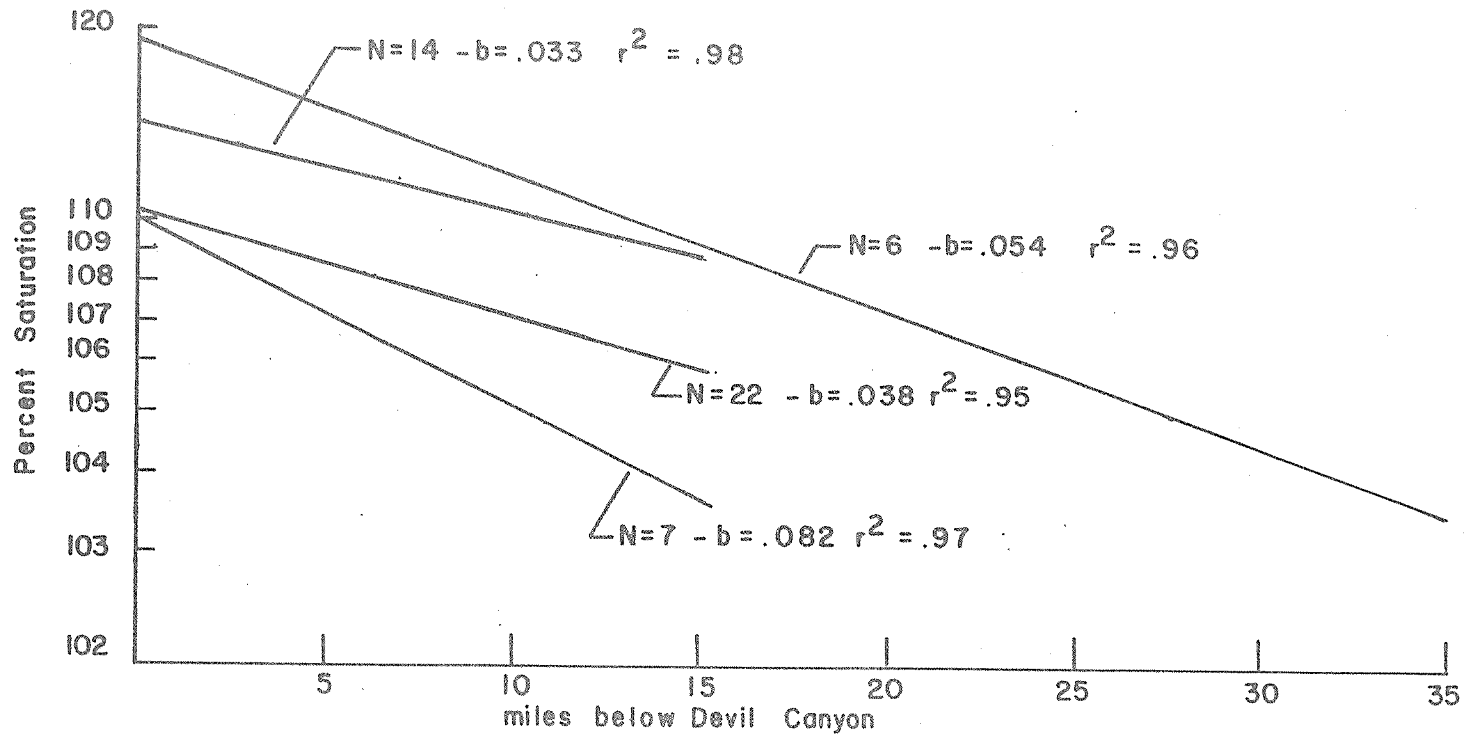

Figure 4.I-34 Percent concentration of total Dissolved gas versus distance below the Devil Canyon proposed dam site.

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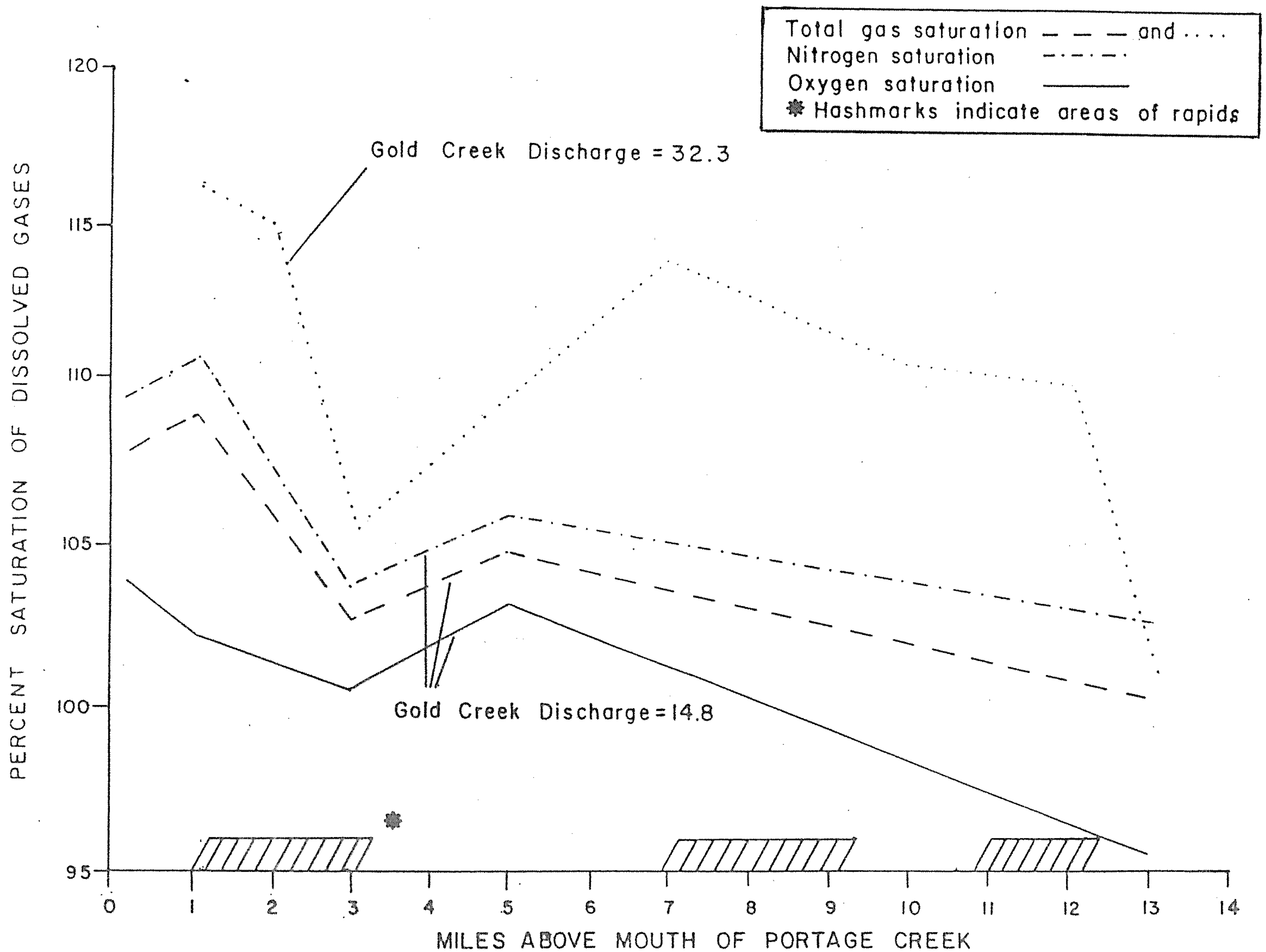

Figure 4I-3-45. Concentration of dissolved gases in the Devil Canyon rapids complex.

The continuous record of dissolved gas concentrations and temperature at the site immediately below Devil Canyon are listed in Appendix 4-D-5. The relationship of the dissolved gas concentrations to discharge is plotted in Figure 4I-3-46.

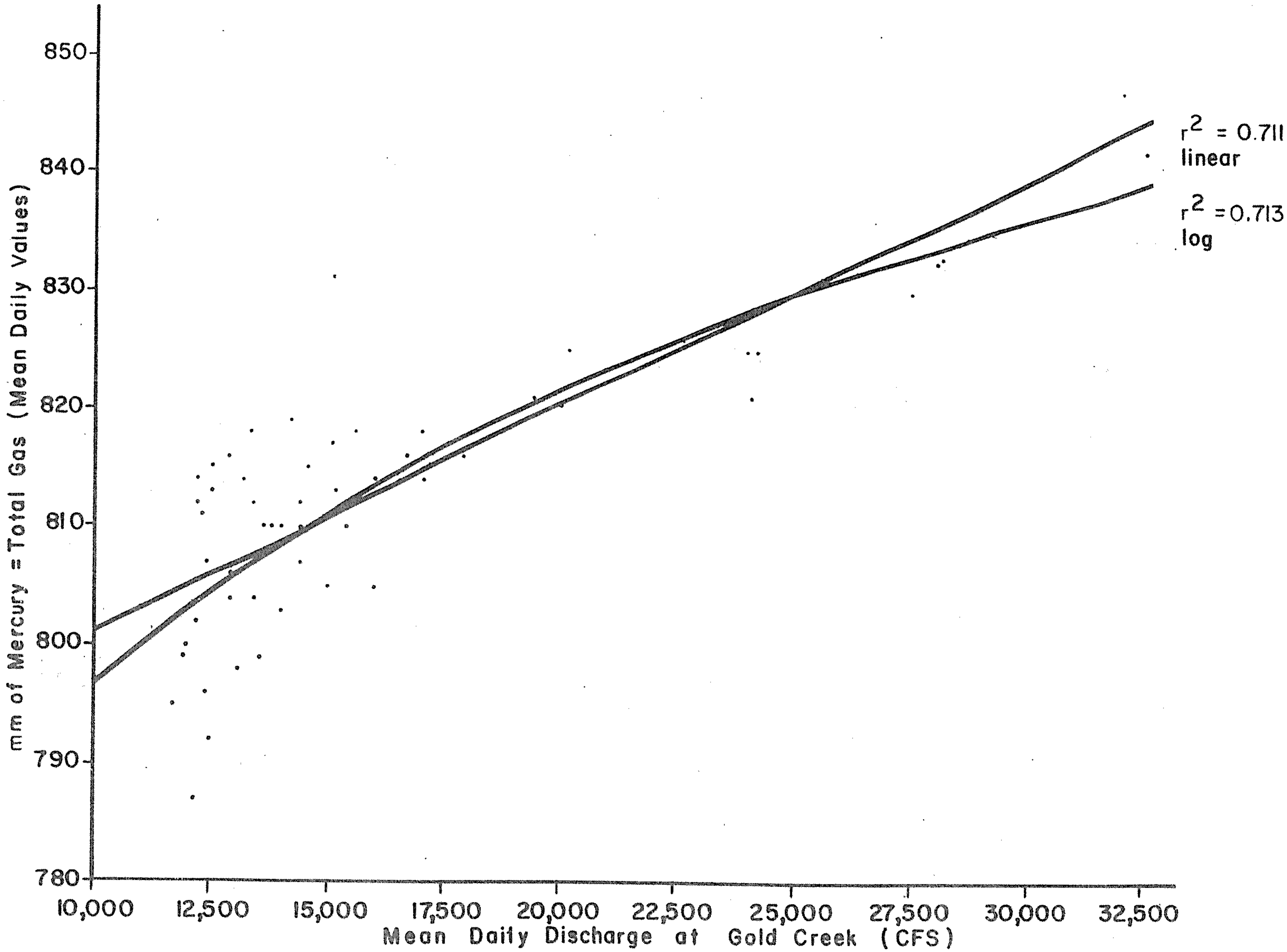

Figure 4I-3-46 Mean Daily Discharge versus saturometer readings below Devil Canyon.

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4.1 Hydrological Investigations

4.1.1 Stage and Discharge

Talkeetna to Devil Canyon

Mainstem water surface elevations were monitored at 31 staff gage sites located between Talkeetna and Devil Canyon. Mainstem water surface elevations were compared to the mean daily mainstem discharge at the USGS Gold Creek gaging station. Changes in the mainstem water surface elevation were found to generally range between 3 to 5 feet for a range of mainstem discharge of 8,000 to 32,000 cfs. Review of 1949-1975 streamflow records (USGS 1978), indicate the mean monthly Susitna River discharge determined at Gold Creek for the months of June - October can range from a low of 3,124 cfs (October 1970) to a high of 50,850 (June 1964).

The stage-discharge relationship for the mainstem Susitna River between Talkeetna to Devil Canyon reach as determined from 1982 observations, is well defined for flows ranging from 12,000 to 25,000 cfs at Gold Creek. Additional data need to be obtained to further define the range of flows not adequately defined during the 1982 open water season (below 12,000 cfs and above 25,000 cfs).

Mainstem discharge was found to influence the water surface elevation at the slough mouths studied to varying degrees (also see section 4.1.3.1).

Backwater areas were still present at the mouths of Whiskers Creek Slough and Slough 6A as mainstem discharges at Gold Creek dropped to 8,500 cfs. A backwater area was present at the mouth of Slough 11 at mainstem discharge of 11,700 cfs; whereas mainstem discharges of 18,000 to 22,000 cfs were necessary before backwater areas even began to form at the mouths of sloughs 16B, 20 and 22. The effects of mainstem discharge on backwater area and access to sloughs 8A, 9 and 21 has been discussed partially in this report and further will be discussed in the final June report.

Except when overtopped at their upstream end by mainstem water, discharge within side-sloughs (sloughflows) are generally quite small. Of the nine sloughs (omitting Slough 9, refer to the June report) studied between Talkeetna and Devil Canyon, only Whiskers Creek Slough and Slough 20 had substantial flow from tributaries contributing to the sloughflow. The other seven sloughs were dependent on groundwater and surface runoff for flow. During the 1982 open water field season, sloughflows during unbreached conditions ranged from 0.2 to 16.4 cfs. Discharge measurements for two side sloughs during 1981 in the unbreached condition ranged between 0.7 cfs and 6.3 cfs. (ADF&G, 1981c) Once the side sloughs became breached, sloughflow generally increases by an order of magnitude. Measurements of sloughflow during 1982 ranged from 21 cfs to 282 cfs when sloughs were breached (ADF&G 1981c). The 1982 flow measurements are considerably less than the 60 cfs to 500 cfs range measured inside sloughs during breached conditions in 1981 (ADF&G 1982). This is primarily attributable to the abnormally low mainstem discharges occurring during the late summer of 1982. Mainstem discharges were relatively high during 1981 however the average daily discharges based on past records on the dates that slough flow measurements were made (in 1981) were not excessively large.

Most side sloughs between Talkeetna and Devil Canyon were found to breach as mainstem discharge at Gold Creek passed from 20,000 cfs to 26,000 cfs. Some error is associated with these discharge values because breaching observations are referenced to the average daily discharge at Gold Creek rather than a site specific discharge measurement. The error is believed to be slight, however, mounting to approximately ±15%.

Periodic discharge measurements were obtained at seven tributaries entering the Susitna River between Talkeetna and Devil Canyon. These measurements were made to determine the general flow contributed by these tributaries to the mainstream during the 1982 open water season. The discharge measurements obtained from these tributaries were found to range from 0.2 to 142.5 cfs. Sufficient data was not collected, however, to establish the overall ranges of flows or seasonal patterns of flows for each tributary.

Whiskers Creek and a small unnamed tributary near the head of Slough 20 were the only tributaries studied in this reach of river that contributed flow to a slough. Whiskers Creek provided a substantial contribution of the total slough flow of Whiskers Creek Slough while the unnamed tributary provided only a minimal contribution to the total slough flow of Slough 20. All other tributaries studied emptied into the mainstem. Continuous streamflow records were obtained for Indian River and Portage Creek from August 9 through October 22, 1982. These flow data were obtained to determine the general magnitude and variability of seasonal streamflows from these tributaries and to provide a basis for estimating their effect on the mainstem discharge at Gold Creek. Discharges estimated from Indian River and Portage Creek were found to be relatively stable with flows in August averaging approximately 180 cfs for Indian River and 465 cfs for Portage Creek. During most of September flows increased to an average of 316 cfs for Indian River and 648 cfs for Portage Creek. Mid-September was a period of high discharge for both Indian River and Portage Creek with a peak flow of 1815 cfs for Indian River and 1673 cfs for Portage Creek. These high flows were the result of a storm which occurred around September 14 or 15. Flows in both tributaries were found to recede in the month of October to 111 cfs in Indian River and 208 cfs in Portage Creek. Overall, the 1982 flows in Indian River and Portage Creek were relatively stable with a peak occurring in mid-September and flow decreasing in October.

Below Talkeetna

Mainstem water surface elevations were only measured adjacently to slough study areas below Talkeetna in order to determine the influence that the mainstem has on these sloughs at various discharges. These data are discussed below in conjunction with the sloughs. Mainstem discharge was found to influence to varying degree the water surface elevation at the mouths of the sloughs and tributaries studied downstream of Talkeetna (also see section 4.1.3.1). Backwater areas were present at Whitefish Slough mouth at mainstem flows of at least 34,000 cfs as determined from the USGS Sunshine gaging station. Backwater areas were also present at the mouth of Lower Goose 2 Slough at mainstem flows of 32,000 cfs, at Sunshine Creek Slough mouth at mainstem flows of 58,000 cfs and at Birch Creek Slough mouth at 23,000 cfs.

Except when overtopped at their upstream end by mainstem water slough-flow within Lower Goose 2 Slough, Sunshine Slough and Birch Creek Slough was generally provided by tributaries flowing into the slough. Upstream of the slough/creek interface, discharge was quite small during unbreached conditions consisting of surface water runoff and pondage within the slough. Whitefish Slough was the only slough studied below Talkeetna which confluenced with the mainstem at its mouth. The 1982 discharge measurements for Lower Goose 2, Sunshine Creek Slough and Birch Creek Slough ranged between 0.2 to 109.9 cfs upstream of the slough/creek confluence and from 86.5 to 131.8 cfs for Lower Goose 2 Slough and Birch Creek Slough downstream of the slough/creek confluence. Sunshine Creek Slough did not have a discharge site below the slough/creek confluence.

Periodic discharge measurements were also obtained at five tributaries located downstream of Talkeetna. These flow measurements were made to determine the general magnitude of flow contributed by these tributaries during the open water season of 1982. The discharge measurements obtained from these tributaries were found to range from 31 to 271 cfs. Of the five sloughs studied, only Rabideux Creek did not contribute flow into an adjoining slough. Lower Goose Creek 2, the unnamed tributary on Whitefish Slough, Sunshine Creek and Birch Creek emptied into adjoining sloughs. These tributaries provided during unbreached conditions provided the majority of flow passing through the mouth of the slough. During both unbreached and breached conditions, Lower Goose 2 Creek and Sunshine Creek contributed at least 90% of the flow within the slough. From site observations, Birch Creek provided at least 50% of the flow of Birch Creek Slough at the mouth during unbreached conditions.

4.1.2 Thalweg Profile

Thalweg proviles are valuable for assessing the effects of discharge and channel morphology on fish migration and access; thus they are discussed in Part II.

4.1.3 Other Hydrological Components

4.1.3.1 Backwater Areas

Calm backwater areas which are largely regulated by the stage of the mainstem Susitna River, occupy many of the sloughs and the lower reaches of low gradient rivers and side channels. The surfaces of these backwater areashave been designated as type H-II zones and consist of aggregates of nine broadly defined hydraulic conditions, defined in Volume 4, Part II, Section 2.2 of this report. These low velocity areas respond in a complex manner to the changes in discharge of the mainstem and to the discharges of associated tributaries. The proportion of the total wetted surface areas available as fisheries habitat, that these areas compose, often vary in an unusual, but predictive manner in response to discharge in the mainstem Susitna River. These areas have been traditionally recognized as unique ecological areas in riverine systems.

The total area of H-II zones within the boundaries of upper and lower Susitna River study sites is shown in Tables 4I-4-1 and 4I-4-2 and Figures 4I-4-1 and 4I-4-2. These values were obtained by recording the areas indicated at 2,500 and 5,000 cfs discharge intervals from Figures 4I-3-30 to 4I-3-43. Some of the data is synthesized by connecting data points in areas of discharge that had no data base. These curves represent the best available data of the overall availability of this specific hydraulic zone as a function of mainstem discharge. Generally the number of observations used to generate these curves are much higher for the upper river summary than for the lower river (h=9 vs. n=5 respectively). The upper river data indicate a rather marked inflection in the relationship of areas to Gold Creek discharges above and below 17,500 cfs. The lower river curves indicate that a change in the relationship of areas to Sunshine discharge occurs at 40,000 cfs.

Interpretation of surface area curves presented here and in results requires caution. These may be misinterpreted as broader concepts of overall wetted surface or of available habitat. They represent only the

Table 41-4-1 Total surface areas of Type II hydraulic zones within the boundaries of nine study areas on the upper Susitna River vs. Gold Creek discharge[a], June through September, 1982.

	Surface Areas[b] (Square Feet x 1000) at Habitat Location						
	Discharge (cfs)[a]						
Habitat Location	12,500	15,000	17,500	20,000	22,500	25,000	27,500
Slough 21	52.	63.8	69.	42.3	16.5	16.3	37.2
Slough 20	1.8	0.4	0	0	0	0	11.3
Slough 19	4.2[c]	0	9.4	11.3	13.7	26.[d]	26.[d]
Slough 11	22.	32.	46.	73.	105.	109.	110.
Slough 9	10.	84.	128.	109.	77.	44.	11.
Slough 8A	155.8	164.4	173.1	181.7	109.4	199.	107.7
Lane Creek/Slough 8	6.1	9.	13.8	14.5	16.2	46.5	46.5[e]
Slough 6A	127.7	129.2	130.7	132.3	133.8	135.4	136.9
Whiskers Creek/Sidechannel	29.	37.5	52.	66.	80.5	83.9[f]	76.[g]
Total by Discharge	408.6	520.3	622.	630.1	633.1	660.1	662.6

[a]USGS Provisional data at Gold Creek, 1982, 15292000.
[b]Data compiled from figures 4.3._ through 4.3._.
[c]Area measured at 13,300 cfs.
[d]Area measured at 24,900 cfs.
[e]Area measured at 25,000 cfs.
[f]Area measured at 23,000 cfs.
[g]Area measured at 28,000 cfs.

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Table 41-4-2 Total surface areas of Type II hydraulic zones within the boundaries of five study areas on the Lower Susitna River vs. Sunshine station discharge[a], June through September, 1982.

	Surface Areas[b] (Square Feet x 1000) at Habitat Location							
Habitat Location	35,000	40,000	45,000	50,000	55,000	60,000	65,000	70,000
Birch Creek	84.	147.	150.	153.	225.	365.	392.	414.
Sunshine Creek/Sidechannel	25.	55.	86.	118.	148.	178.	128.	121.
Rabideux Creek/Slough	496.	826.	880.	933.	987.	1040.	1090.	1150.
Whitefish Slough	18.2	36.	50.	58.	63.	66.	69.	71.
Goose Creek/Sidechannel	0.	58.	117.	109.	103.	93.5	85.5	77.5
Total by Discharge	623.2	1122.	1283.	1371.	1526.	1743.	1765.	1833.

[a]USGS Provisional data at Gold Creek, 1982, 15292000.

[b]Data compiled from figures 4.3._ through 4.3._.

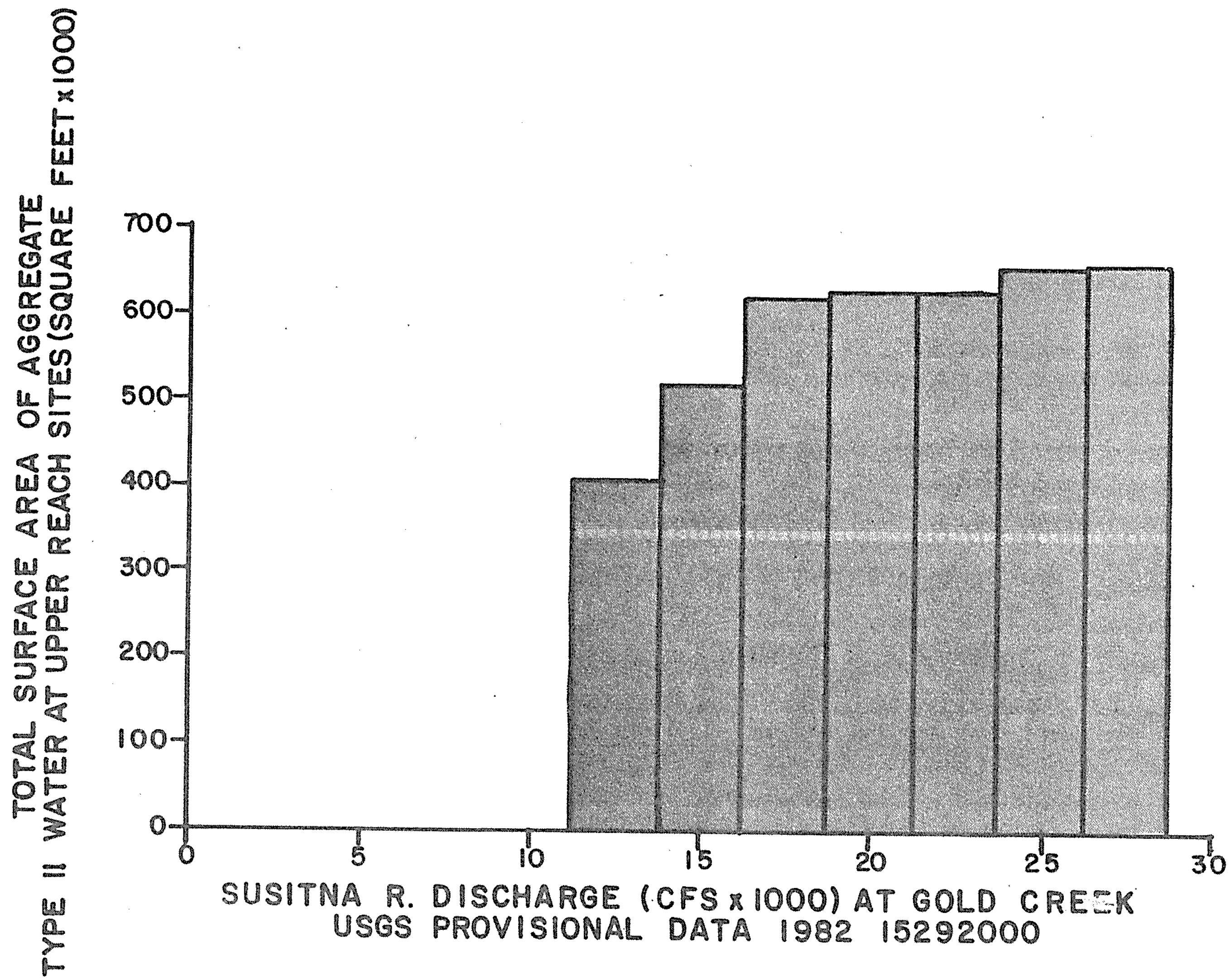

Figure 4E-4-1 Total surface area of aggregate type II water at upper reach sites versus Susitna River discharge at Gold Creek (USGS Provisional Data).

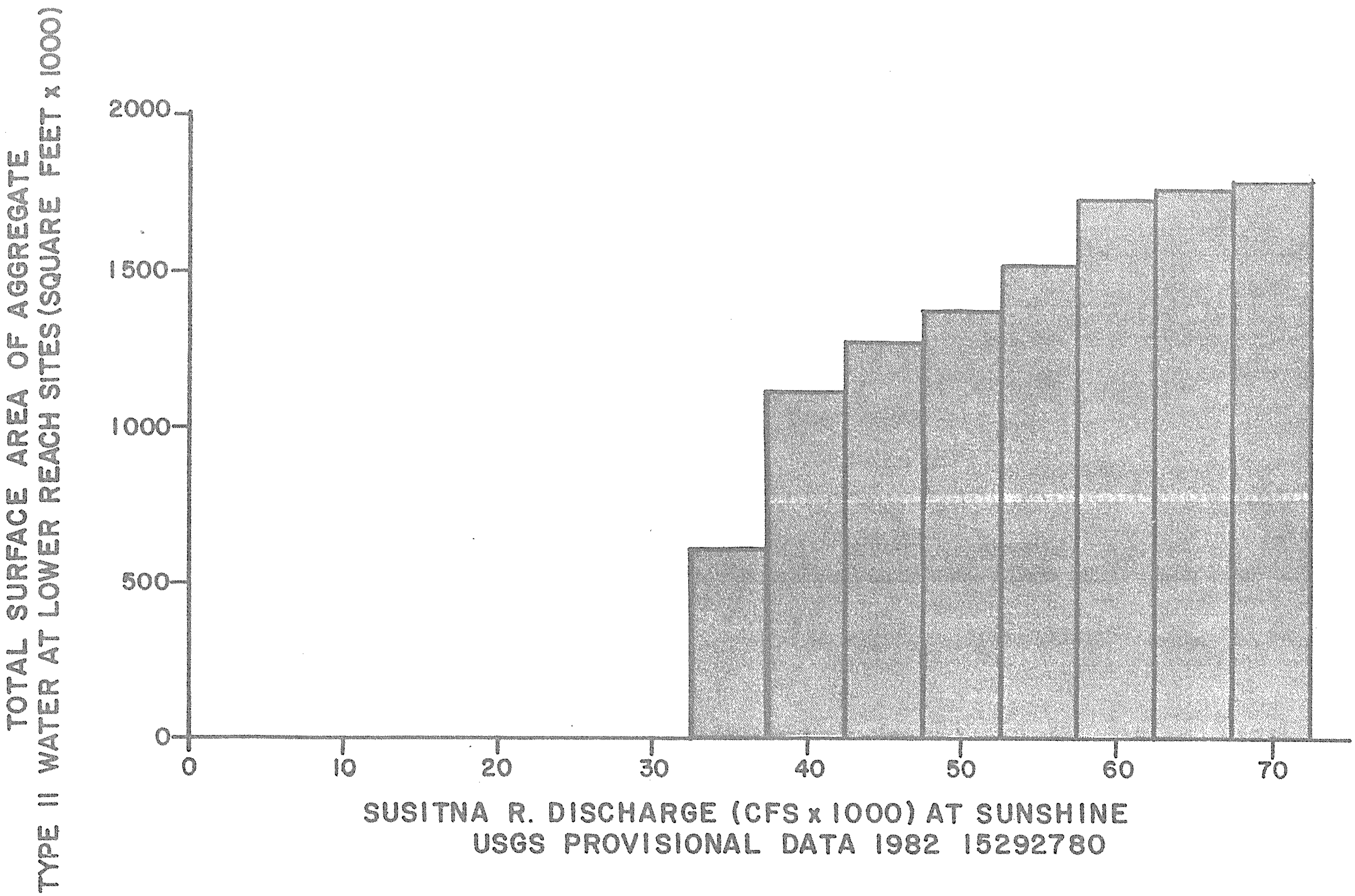

Figure 4C-4-2 Total surface area of aggregate type II water at lower reach sites versus Susitna River discharge at Sunshine (USGS Provisional Data).

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surface area of low velocity reaches that are caused by Susitna River stage. For instance, at several locations it was noted that the area of these type H-II conditions begins to increase with decreasing Susitna River stage. At Slough 19 for example, above 16,000 cfs, it was observed That a type H-II wetted surface approached the total wetted surface area while at lower discharges, new type H-II areas developed downstream as the mainstem receded. Appendix Figure 4-F-4 demonstrates that trend was also apparent at Slough 21. These new type H-II areas often had very different depths, substrate conditions and rearing potential for juvenile fish because of unstable geomorphological conditions. These conditions were not a factor in this analysis. Similarly, in Rabideux Creek, the sudden loss of type H-II area requires interpretation. The pool area created by the mainstem backup disappears as the water recedes, thus reflecting a sudden decrease in surface area; what remained was a morphological pool that provided similar habitat. This pool however, is apparently maintained by geomorphological processes that are influenced by mainstem stage.

4.1.3.2 Open Channel

The open channel studies are comprised of the hydraulic model, used for simulation of hydraulic conditin under various flow regimes. These models are in the preliminary stages of calibration and are discussed in Part II.

4.2 Water Quality Investigations

4.2.1 Temperature

The continued monitoring of surface water temperatures through the 1982 field season provided background data concerning the thermal regime of the Susitna River.

Continuous surface water temperatures of the mainstem Susitna River were obtained at 12 locations during the 1982 open water season. Since the most notable effects in the thermal regime of the river during dam construction and operation will probably occur between Talkeetna and Devil Canyon, efforts were concentrated in this reach. Generally, monthly mean surface water temperatures were relatively constant in the reach from Talkeetna to Devil Canyon, varying at most about 2°C. Maximum daily temperatures recorded in the mainstem during 1982 peaked to 13-15°C in July and August and dropped down to 0°C by late October.

To better understand the intragravel/surface water temperature relationship in side sloughs, temperature recorders which continuously monitor both intragravel and surface water temperatures were installed in six sloughs upstream of Talkeetna. Except when the mainstem breaches the head of a slough, surface water temperatures in side sloughs are independent of surface water temperatures in the mainstem. When a side slough is not breached, surface water temperatures are largely affected by local runoff and solar radiation, and to a lesser degree, by groundwater percolation and air temperature. In Sloughs 21 and 8A, recorders were installed at 2 sites (near the head and near the mouth) and a thermograph monitoring surface water temperature was installed mid-slough. Data to date (August - October, 1982) shows significantly more fluctuation in surface water temperatures than in intragravel temperatures on both a daily and seasonal basis. Surface water temperatures in the mouth of Slough 8A varied as much as 5.6°C in one day in late August during which temperatures ranged from a high of 13.4°C to a low of 7.8°C. Overall, surface water temperatures ranged between 14.8° to 0.9°C in the period August - October. In comparison, intragravel temperatures at this site varied at most 0.2°C in one day, always remaining within the range of 5-7°C.

Surface water temperatures obtained in the mouth of Slough 8A were markedly warmer than surface water temperatures obtained in the other sloughs monitored. Generally, intragravel temperatures were in the range from 3-5°C from August to October and surface water temperatures ranged from 8-9°C in August down to 1-3°C in October. Slough surface water temperatures remained warmer than intragravel temperatures until mid to late September, when the surface water temperatures had dropped down to the 3-5°C range. As surface water temperatures continued to decrease into October, the intragravel temperature dropped at a slower rate and remained warmer than the corresponding surface water.

Continuous surface water temperatures were also obtained during the 1982 open water season in ten tributaries to the Susitna River between RM 30.1 (Yentna River) and RM 206.8 (Kosina Creek). Generally, surface water in the tributaries was 1-2°C cooler than adjacent (i.e., to the nearest mainstem temperature monitoring station) mainstem surface water. In the first couple weeks of October, however, when the mainstem dropped rapidly from 3-4°C for a couple weeks, the surface water temperature of the tributaries dropped to 0°C

4.2.2 Other Basic Field Parameters

The basic field parameters of specific conductance, pH, dissolved oxygen, water temperature and turbidity were collected in conjunction with various sub-projects of the ADF&G Su Hydro Aquatic Studies Team. The parameters were collected at various locations in the Susitna River basin from RM 5.0 to RM 258.0 during the 1982 open water field season. Portions of these data, as they relate to the respective sub-project involved in its collection, are discussed in Part II of this volume and Volume 5. The discussion of water quality in this section includes an overview of the water quality data collected in the mainstem (entire river), the sloughs and tributaries between Talkeetna and Devil Canyon and the sloughs and tributaries downstream of Talkeetna.

Mainstem (entire river)

Adequate water quality measurements were not collected in the mainstem Susitna River during the 1982 open water field season to quantify the overall ranges of water quality present in the mainstem throughout the ice-free season. From the limited data collected, the water quality of the mainstem Susitna River appeared to be relatively homogenous throughout the areas sampled (RM 5.0 - RM 148.5) with no apparent relation to mainstem discharge, location or date of collection. A comparison of the water quality in the mainstem between Talkeetna and Devil Canyon to that downstream of Talkeetna showed no significant differences between these reaches of the river.

Primarily, the basic field parameters gathered in the mainstem Susitna River during the 1982 open water field season were collected in conjunction with the electrofishing sub-program to characterize the water quality present at habitats utilized for spawning by adult anadromous and resident fish. Refer to Part II of this Volume for a further discussion of these results.

Sloughs Between Talkeetna and Devil Canyon

Water quality data were collected on a regular basis in various upland and side slough located between Talkeetna and Devil Canyon during the 1982 open water field season. In several of these sloughs, water quality was collected during both breaching and non-breaching mainstem flows. It is expected that water quality in a slough will vary depending on whether or not it is breached by the mainstem. During breaching conditions, the water quality present in a slough is expected to be directly tied to the mainstem while under non-breaching condition it is expected to be more closely tied to the characteristics of the slough. Thus a comparison of the water quality in a slough under breaching and non-breaching conditions can be used to determine the effect the mainstem has on the overall water quality present in the slough.

Two upland sloughs (Sloughs 6A and 19) were monitored for their water quality during the 1982 open water field season. Upland sloughs are defined as sloughs having no collection to the mainstem other than at their mouths (see Section 3.1.1.2). Thus it is expected that these sloughs will not exhibit any significant changes in water quality over than within the zone of backwater influence, that can be related directly to mainstem discharge. A comparison of the upland slough water quality to mainstem discharge revealed that for mainstem flows ranging from 12,400 to 28,000 cfs for Slough 19 and 11,700 to 28,000 cfs for Slough 6A the parameters of dissolved oxygen and pH remained constant. This indicates that the water quality in the upland sloughs is not related to mainstem discharge.

Both these sloughs were observed to have large backwater areas during relatively mainstem discharges. At Slough 19, the conductivity values were determined to be slightly higher in the areas of the slough removed from mainstem influence while the inverse of this was found for turbidity levels.

In addition, nine side sloughs were monitored for their water quality during the 1982 open water field season. Side sloughs are defined as those sloughs connected to mainstem at their mouth and, during periods of high mainstem flow, at their heads to the mainstem (see section 3.1.1.2). Thus these sloughs should exhibit a significant change in their water quality during breaching and non-breaching conditions.

Whiskers Creek Slough

Surprisingly, the water quality in Whiskers Creek Sloughs was similar during periods of both breaching and non-breaching mainstem flows. Ranges of surface water temperature, dissolved oxygen, pH and specific conductance were very similar during periods of both breaching and non-breaching mainstem flows. Even ranges for turbidity, which would be expected to increase during periods of breaching mainstem flows, were similar. The high turbidity levels obtained in the slough during periods of non-breaching mainstem flows are most likely attributable to the turbid flow from Whiskers Creek during periods of high creek discharge. During periods of non -breaching mainstem flow, the major source of flow into Whiskers Creek Slough is from Whiskers Creek. A comparison of the slough water quality to that of the creek during unbreached conditions showed that overall the water quality in the creek was similar to that in the slough except that the ranges of surface water temperature, dissolved oxygen and specific conductance were slightly greater in the slough. These data indicates that the major influence on the water quality in Whiskers Creek Slough during periods of both non-breaching and breaching mainstem flows is from Whiskers Creek.

Lane Creek Slough (Slough 8)

During periods of breaching mainstem flows, the water quality in Lane Creek Slough appears to be primarily influenced by the mainstem. A comparison of the ranges of dissolved oxygen, pH and specific conductance during periods of breaching and non-breaching mainstem flows shows that the ranges of these parameters were slightly less during periods of breaching mainstem flows than during periods of non-breaching mainstem flows. Due to a lack of turbidity samples collected during the 1982 open water field season, ranges of turbidity during periods of breaching and non-breaching mainstem flows could not unfortunately be determined for Lane Creek Slough.

During periods of non-breaching mainflows, the water quality in Lane Creek Slough appeared to be primarily influenced by groundwater and surface water. This is indicated in that ranges specific conductance and surface water temperature were slightly higher in the slough than in the mainstem during periods of non-breaching mainstem flows.

Sloughs 8A and 9

The mainstem flows necessary to breach the heads of sloughs 8A and 9 has not been adequately defined at the time of this report writing. Consequently, the water quality data cannot be referenced at this time to breaching or non-breached mainstem flows. The parameters of dissolved oxygen, pH, and specific conductance appear to be similar in range to those observed in other studied side sloughs.

Slough 11

Slough 11 was never breached by the mainstem Susitna River during the 1982 open water field season. The relatively high levels of specific conductance observed in the slough during this summer (127-230 umhos/cm) indicate that the primary source of water in the slough is groundwater, except during periods of high precipitation when surface water influence becomes important. The parameters of dissolved oxygen, pH and turbidity did not appear to be a limiting factor to fish in Slough 11.

Slough 16B

Water quality data was collected twice in Slough 16B during the 1982 open water field season; once during breaching and once during non-breaching mainstem flows. Based on this limited data, the water quality in the slough during periods of breaching mainstem flows appeared to be dependent on the mainstem while during periods of non-breaching mainstem flows appeared to be dependent on groundwater and surface water runoff. This is indicated in that the surface water temperature and specific conductance were lower in the slough during breached conditions than during non-breached conditions. From the 1981 data, the water quality in the slough during non-breaching mainstem flows appears to be influenced by Indian River (ADF&G 1981c).

Slough 20

During periods of breaching mainstem flows, the water quality in Slough 20 appeared to be primarily influenced by the mainstem. This is shown in a comparison of the ranges of surface water temperature and turbidity in the slough during periods of breaching and non-breaching mainstem flows. Surface water temperatures were generally lower and turbidity levels generally higher in the slough during periods of breaching mainstem flows. Ranges of dissolved oxygen, pH and specific conductance were very similar within the slough during both the breached and unbreached condition.

During periods of non-breaching mainstem flows, the water quality in Slough 20 appeared to be primarily influenced by Waterfall Creek. Ranges of pH, specific conductance and turbidity were similar in the slough and Waterfall Creek during unbreached conditions.

Slough 21

During periods of breaching mainstem flows, the water quality in Slough 21 appeared to be primarily influenced by the mainstem. This is shown in a comparison of the ranges of surface water temperature and turbidity in the slough during periods of breaching and non-breaching mainstem flows. Surfaces water temperature were generally lower and turbidity levels generally higher in the slough during periods of breaching mainstem flows. During periods of non-breaching mainstem flows, the water quality in Slough 21 appeared to be primarily influenced by groundwater and surface water runoff from a small tributary located near the head of the slough.

Slough 22

During periods of breaching mainstem flows, the water quality in Slough 21 appeared to be primarily influenced by the mainstem. This is shown in a comparison of the ranges of surface water temperature and turbidity during breaching and non-breaching mainstem flows. Surface water temperatures were generally lower and turbidity levels generally higher in the slough during periods of breaching mainstem flows. In addition, ranges of dissolved oxygen, pH and specific conductance were higher in the slough during periods of breaching mainstem flows. The main influences on the water quality in Slough 21 during periods of non-breaching mainstem flows appeared to be from surface water runoff. Groundwater did not appear to have a major influence on the water quality of this slough during unbreached conditions.

Sloughs and Tributaries Downstream of Talkeetna

All sloughs studied downstream of Talkeetna during the 1982 open water field season had tributary influences. Water quality data was collected in these sloughs during both breached and unbreached conditions, in the associated tributaries and the adjacent mainstem. The mainstem flows necessary to breach the heads of the studied sloughs downstream of Talkeetna are not currently defined. Consequently, the water quality data cannot, at this time, be referenced to mainstem flow conditions.

Based on a preliminary overview of the water quality data obtained in the sloughs and their associated tributaries downstream of Talkeetna, several relationships are apparent. Comparisons of the water quality in the slough to that in the adjacent tributary reveals that ranges of specific conductance, turbidity, surface water temperature and pH were higher in the sloughs than in the adjacent tributaries. Only the range of dissolved oxygen was lower in the sloughs than the associated tributaries.

Of the four sloughs and their adjacent tributaries studied downstream of Talkeetna, all are well within the water quality standards for fish production. Each are relatively similar in their water quality characteristics.

4.2.3 Dissolved Gases

The formation of dissolved gas below the lower Devil Canyon rapids provides an unusual phenomenon. Higher dissolved gas concentrations were recorded at this location than at any other in the ten mile reach of Devil Canyon. The continuous monitor installed during the summer of 1982 provided an extensive collection of baseline conditions and provided an accurate portrayal of the response of gas supersaturation to the volume of water passing through the canyon. This increased supersaturation depicted in Figure 4I-3-46 as a function of discharge is probably associated with increased depths of the plunge pools and the amount of air trapped as water passes through this precipitous set of rapids. Fish collected in the area of highest concentrations have not exhibited any embolisms associated with gas bubble disease. The concentrations of dissolved gasses are sufficiently high to create gas bubble disease at high water periods for sensitive species if exposure is for a sufficient period of time. These type of conditions did not occur during the low flow year experienced in 1982.

The formation of dissolved gas supersaturation appears to be a purely physical process, probably caused by plunge pools below the rapids within Devil Canyon. Figure 4I-3-45 depicts the changes in gas concentrations through the canyon during two separate sampling trips. This relationship suggests that both rapid formation and dissipation occur in the river through the canyon. Dissolved oxygen levels paralleled total dissolved gas suggesting also that the supersaturated conditions were caused by a physical process. Saturation above the canyon was consistently near 100% as were conditions in Gold Creek, a clear water tributary that was sampled occasionally as a control. This suggests that the supersaturated conditions found in the vicinity of Devil Canyon are apparently unique to the mainstem river. Although the data presented does not provide any direct support as to the fate of man caused supersaturated gas entering the canyon above the Devil Creek rapids, the wide range in values recorded would suggest equilibration to be likely. The elevated conditions occurring below the rapids would be similar to the natural situation. However, examination of data collected in a similar situation near Kootenai Falls below Libby dam in Montana suggests that elevated gas concentrations entering an area of entrainment may dissipate only partially when the concentrations initially entering the falls are above the natural level of supersaturation (USACOE, 1981). Therefore, major reductions in dissolved gas entering the lower Devil Canyon rapids, may not occur if high concentrations enter the rapids.

Initial examination of the decay data below Devil Canyon during the 1981 field season suggested a predictable response of the decay of supersaturated gas. The initial concentrations of dissolved gas appear to be a linear function of discharge, with the initial concentrations predictably increasing with increases in mainstem discharge. The supersaturated condition of the dissolved gas decreased, downstream as would be predicted, following standard relationships of gas law physics. It also appeared, from this limited initial data base, that the rate of decay was also dependent on mainstem discharge (Figure 4I-4-3). Further supporting this relationship was the data collected below Libby dam by the USACOE (1981). However, data collected during the summer of 1982 did not support this relationship and suggested other factors may affect the decay of dissolved gas.

The effects of the variables discharge, temperature, and distance downstream on the concentrations of dissolved gas were examined in depth by use of multiple regression analysis techniques. The computer printouts from this analysis are included in Appendix Table 4-D-3.

The main conclusion from these analyses is that a high degree of predictability of dissolved gas concentrations can be established using discharge and distance downstream for two variables for the first 11.8 miles of the river below the Devil Canyon dam site. Regardless of the initial concentration, decay of supersaturated gas occurs at a predictable rate of approximately a 50% decrease in the initial concentration for approximately every 20 miles downstream. Below this distance, the predictability becomes less reliable and the gas decays at a faster rate.

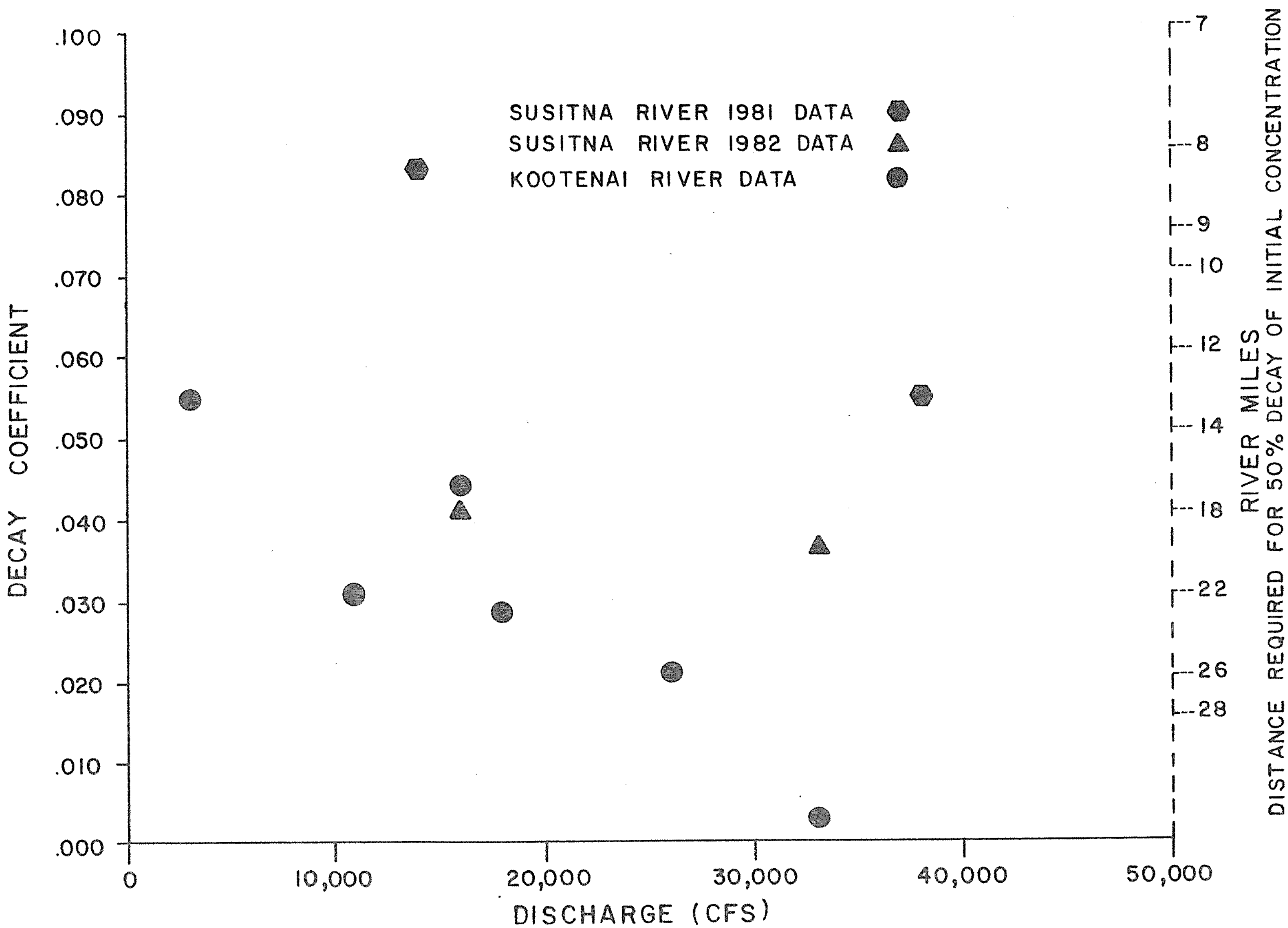

Figure 4E-4-3 Dissolved gas decay rates versus Gold Creek discharge with dissolved gas data below Libby Dam, Kootenai River, Montana provided as a comparison. (Source: U.S. Army Corp of Engineers, T. Bonde, Seattle, WA.).

Several factors may contribute to the above conclusions. These include changes in river morphology in this lower reach of the river. The channel is more braided with a mean depth less than that which is present in the river above mile 11.8. This would provide conditions for more rapid equilibration of the supersaturated water to stable conditions (100% of saturation). Dilution of the dissolved gas concentrations by the addition of water from Indian River and Gold Creek may also contribute to the increase in the decay rate.

However, one other major factor may contribute to the data observed. During the 1981 summer period, instrument problems occurred frequently. The high degree of autocorrelation observed when the data was ordered by time period suggest possible effects of the analytical procedure used in the field. When using only the data collected during the summer of 1982, this problem does not occur. The data points collected in the lower river were almost all collected during the 1981 field season. Further sampling of the lower river decay rates of dissolved gasses is planned for the 1983 open water season to determine if the dissipation of dissolved gas occurs at a different rate in this reach.

The results of this study can easily be applied to determining the relative hazard of supersaturated gas to downstream fisheries. The State of Alaska standard for dissolved gas supersaturation is 110%. This value is clearly exceeded under natural conditions below Devil Canyon. Concentrations of dissolved gasses produce increased mortalities in fish hatchery environments at levels between 105% and 110% (Weitkamp and Katz, 1980). Fish have no method of escaping the elevated gas conditions by sounding in hatchery holding areas. In natural systems, the threshold for increases in natural mortality caused by elevated gas supersaturation usually are documented to occur between 115 and 120%. These conditions are approached only under the highest discharge conditions that occur in the Susitna River, thus suggesting that the natural hazard to fish is very minimal.

The data presented suggests that the decay rate of dissolved gas is sufficiently low so that any elevation above the peak levels associated with the natural conditions could potentially create problems for the salmon stocks associated with Portage Creek and would probably affect the Indian River stocks as well. These systems are major producers of salmon in addition to resident species in the system.