







TK 1425 .S8 A68

> ALASKA DEPARTMENT OF FISH AND GAME SUSITNA HYDRO AQUATIC STUDIES REPORT SERIES

TK 1425 ,58 A68 No. 1933

ALASKA DEPARTMENT OF FISH AND GAME SUSITNA HYDRO AQUATIC STUDIES

REPORT NO. 3

100 m 100

್ರತ್ರ

4

AQUATIC HABITAT AND INSTREAM FLOW INVESTIGATIONS (MAY-OCTOBER 1983)

Chapter 4: Water Quality Investigations

Edited by:

Christopher C. Estes and Douglas S. Vincent-Lang

Prepared for:

ALASKA POWER AUTHORITY 334 W. FIFTH AVE. ANCHORAGE, ALASKA 99501

ARLIS

Alaska Resources Library & Information Services Anchorage, Alaska

ო

PREFACE

This report is one of a series of reports prepared for the Alaska Power Authority (APA) by the Alaska Department of Fish and Game (ADF&G) to provide information to be used in evaluating the feasibility of the proposed Susitna Hydroelectric Project. The ADF&G Susitna Hydro Aquatic Studies program was initiated in November 1980. The five year study program was divided into three study sections: Adult Anadromous Fish Studies (AA), Resident and Juvenile Anadromous Studies (RJ), and Aquatic Habitat and Instream Flow Studies (AH). Reports prepared by the ADF&G prior to 1983 on this subject are available from the APA.

The information in this report summarizes the findings of the 1983 open water field season investigations. Beginning with the 1983 reports, all reports were sequentially numbered as part of the <u>Alaska Department of</u> Fish and Game Susitna Hydro Aquatic Studies Report Series.

TITLES IN THE 1983 SERIES

Report <u>Number</u>	TitleDa	ublication ate
1	Adult Anadromous Fish Investigations: A May - October 1983	pril 1984
2	Resident and Juvenile Anadromous Fish Ju Investigations: May - October 1983	uly 1984
3	Aquatic Habitat and Instream Flow Investigations: May - October 1983	1984
4	Access and Transmission Corridor Aquatic	1984

Investigations: May - October 1983

This report, "Aquatic Habitat and Instream Flow Investigations" is divided into two parts. Part I, the "Hydrologic and Water Quality Investigations", is a compilation of the physical and chemical data collected by th ADF&G Su Hydro Aquatic Studies team during 1983. These data are arranged by individual variables and geographic location for ease of access to user agencies. The combined data set represents the available physical habitat of the study area within the Cook Inlet to Oshetna River reach of the Susitna River. Part II, the "Adult Anadromous Fish Habitat Investigations", describes the subset of available habitat compiled in Part 1 that is utilized by adult anadromous fish studied in the middle and lower Susitna River (Cook Inlet to Devil Canyon) study area. The studies primarily emphasize the utilization of side slough and side channel habitats of the middle reach of the Susitna River for spawning (Figure A). It represents the first stage of development for an instream flow relationships analysis report which will be prepared by E.W. Trihey and Associates.



Figure A. Susitna River drainage basin.

.....

CONTENTS OF REPORT NO. 3

Part One

Chapter

- 1 Stage and Discharge Investigations.
- 2 Channel Geometry Investigations.
- 3 Continuous Water Temperature Investigations.
- 4 Water Quality Investigations.

Part Two

Chapter

- 5 Eulachon Spawning in the Lower Susitna River.
- 6 An Evaluation of Passage Conditions for Adult Salmon in Sloughs and Side Channels of the Middle Susitna River.
- 7 An Evaluation of Chum and Sockeye Salmon Spawning Habitat in Sloughs and Side Channels of the Middle Susitna River.
- 8 An Evaluation of Salmon Spawning Habitat in Selected Tributary Mouth Habitats of the Middle Susitna River.
- 9 Habitat Suitability Criteria for Chinook, Coho, and Pink Salmon Spawning.
- 10 The Effectiveness of Infrared Thermal Imagery Techniques for Detecting Upwelling Groundwater.

Questions concerning this and prior reports should be directed to:

Alaska Power Authority 334 W. 5th Avenue Anchorage, Alaska 99501 Telephone (907) 276-0001

> ARLIS Alaska Resources

Library & Information Services Anchorage, Alaska

Water Quality Investigations

1984 Report No. 3, Chapter 4

by: Gene Sandone and Tim Quane

Alaska Department of Fish and Game Susitna Hydro Aquatic Studies 2207 Spenard Road Anchorage, Alaska 99503

ABSTRACT

1

Baseline water quality data have been collected within the Susitna River basin since 1981 in conjunction with the baseline fisheries studies being conducted by the Alaska Department of Fish and Game Susitna Hydroelectric Aquatic Studies Feasibility Team. The primary objective of the data collection program has been to collect baseline water quality data (dissolved oxygen, pH, conductivity, temperature, and turbidity) within the habitats selected for fishery studies that are present in the Susitna River basin and to determine the influences of mainstem discharge conditions on the water quality characteristics of these habitats. Although these investigations have been conducted throughout this large glacially-fed river system, effort has been concentrated in the reach of river extending from Talkeetna (RM 97) to Devil Canyon (RM 150) as impacts from the construction and operation of the proposed hydroelectric development are expected to be greatest in this river reach.

The 1983 investigations (summarized in this report), concentrated on mainstem, side channel, side slough and tributary habitats. Water quality measurements of dissolved oxygen, pH, conductivity and turbidity were obtained in the mainstem Susitna River and the Talkeetna and Chulitna rivers twice a month on an instantaneous basis except for the Talkeetna fishwheel and Gold Creek camp stations, which were monitored daily. Turbidity measurements were obtained from several side channel and side sloughs in the Talkeetna to Devil Canyon reach twice a month.

Results of these investigations indicate that water quality in the mainstem Susitna River is relatively similar among sampling locations but that specific water quality variables at sampling stations change in relation to mainstem discharge. Increased levels of turbidity in the mainstem were found to correlate to mainstem discharge, but are assumed to result from suspended sediment contributed by the Susitna and Maclaren glaciers. Turbidity levels remain low when glacial melt ceases. Turbidity levels in side channels and side sloughs were found to be independent of mainstem discharge prior to breaching of the heads by the mainstem, however subsequent to breaching those sites were found to resemble the turbidity of the mainstem with the controlling factor being the relative flow contribution of the mainstem to that of the site flow. Tributary water quality was found to be independent of mainstem Susitna River discharge and was determined to influence to varying degrees the water quality conditions of the mainstem depending on the relative size of the tributary.

1 1

Information from these studies will be used by other project biologists and engineers to evaluate the impact of hydroelectric development on the Susitna River.

TABLE OF CONTENTS

(rkas

1.11

(1340)

Ì

1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1

ABST	RACT.	•••••	•••••	i
TABL	e OF	CONTENT	S	iii
LIST	OF F	IGURES.	• • • • • • • • • • • • • • • • • • • •	iv
LIST	OF T	ABLES		v
LIST	OF A	PPENDIX	TABLES	vi
1.0	INTR	ODUCTIO	N	1
	1.1 1.2	Introd Object	uctionives	1 1
		1.2.1 1.2.2	Mainstem Habitats Side Channel and Upland and Side	1
		1.2.3	Tributary Habitats	2
2.0	METH	ODS	•••••••••••••••••••••••••••••••••••••••	3
	2.1	Site S	election	3
		2.1.1	Mainstem Habitats	3
		2.1.3	Slough Habitats	3 3
	2.2	Field	Data Collection	3
	2.3	Analyt	ical Approach	7
3.0	RESU	LTS	•••••••••••••••••••••••••••••••••••••••	8
	3.1 3.2	Mainst Side C	em Habitats hannels and Side and Upland	8
5	3.3	Slough Tribut	Habitats	8 18
4.0	DISC	USSION.	•••	19
5.0	GLOS	SARY	••••••••••••••••••	24
6.0	CONT	RIBUTOR	S	28
7.0	ACKN	OWLEDGE	MENTS	29
8.0	LITE	RATURE	CITED	30
9.0	APPE	NDICES.		4-A-1

LIST OF FIGURES

Figure	No.	Page
4-1	Mainstem, side channel, and upland and side slough water quality monitoring stations for the 1983 open water field season	4
4-2	Dissolved oxygen data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites	9
4-3	Dissolved oxygen percent saturation data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites	10
4-4	pH data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites	11
4-5	Conductivity data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites	12
4-6	Turbidity data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites	13
4-7	Turbidity, surface water temperature, and Susitna River discharge at Gold Creek (USGS 15292000) versus time at the Talkeetna fishwheel camp	14
4-8	Turbidity, surface water temperature, and Susitna River discharge at Gold Creek (USGS 15292000) versus time at the Gold Creek camp	15
4-9	Turbidity versus Susitna River discharge at the Talkeetna fishwheel camp	16
4-10	Turbidity versus Susitna River discharge at the Gold Creek camp	17
4-11	Range of turbidity during unbreached and breached hydraulic conditions for side slough habitats	22
4-12	Range of turbidity during unbreached and breached hydraulic conditions for side channel habitats	23

LIST OF TABLES

<u>Table No.</u>

4 - 1	Location of mainstem Susitna River and selected tributary water quality monitoring stations selected for the 1983 open water field season	5
4-2	Locations of side channel, and upland and side slough water quality monitoring stations selected for the 1983 open water field season	6

Page

6

LIST OF APPENDIX TABLES

<u>Table No.</u>

a taraat

, 1998

Alegan

/***

6**140**

4-A-1	Water quality data collected at mainstem Susitna River sites for the 1983 open water field season	4-A-2
4-A-2	Comparisons of periodic water quality (tempera- ture and turbidity), water surface elevations (WSEL) and streamflow collected at selected non- mainstem locations upstream of Talkeetna with mean daily mainstem discharge at Gold Creek (15292000)	4-A-13
4-A-3	Incidental water quality data (temperature and turbidity) compared to tributary stream flow water surface for Indian River and Whisker's Creek for the 1983 open water field season	4-A-19

Page

1.0 INTRODUCTION AND OBJECTIVES

1.1 Introduction

The Alaska Department of Fish and Game (ADF&G) Susitna Hydroelectric Aquatic Study has collected baseline water quality data throughout the Susitna River basin since 1981. Although measurements of baseline water quality have been obtained throughout the entire river basin, the emphasis of the data collection program has been largely oriented to the reach of the Susitna River extending from Talkeetna to Devil Canyon (middle river). The primary focus of the data collection program to date has been to characterize the baseline water quality conditions present within the mainstem and its peripheral habitats and to determine how these baseline water quality conditions are influenced by mainstem discharge. Results of these investigations are presented in ADF&G 1981, 1982.

1.2 Objectives

The overall objective of the FY84 open water field season (May 15 -October 31, 1983) water quality investigations was to continue the monitoring of water quality conditions present in the mainstem, selected side channel, upland and side sloughs, and tributaries of the Susitna River from the Parks Highway Bridge (RM 83.9) to the mouth of Devil Canyon (RM 150.1). The water quality parameters measured included dissolved oxygen (DO), pH, water temperature, conductivity, and turbidity.

The FY 84 open water field season water quality investigations were segregated by habitat into three distinct programs, each with its own specific objectives.

1.2.1 Mainstem Habitats

The water quality data collection program conducted in mainstem habitats during the 1983 open water field season was designed to:

- 1. Characterize the general baseline water quality of the Talkeetna to Devil Canyon reach of the mainstem Susitna River;
- 2. Determine the effect that mainstem discharge has on selected water quality parameters sampled; and,
- 3. Support the analyses of fish habitats being conducted in mainstem habitats.

1.2.2 Side Channel and Upland and Side Slough Habitats

The water quality data collection program conducted in side channel and side and upland slough habitats during the 1983 open water field season was designed to:

1. Monitor the turbidity levels of selected side channels and sloughs (upland and side) in the Talkeetna to Devil Canyon reach of the Susitna River;

- 2. Determine the effect that mainstem discharge has on turbidity levels in these peripheral habitats; and,
- 3. Support the analyses of fish habitats being conducted in these peripheral habitats.

1.2.3 Tributary Habitats

The water quality data collection program conducted in tributary habitats during the 1983 open water field season was designed to:

- 1. Characterize the general water quality influence of the Talkeetna and Chulitna Rivers on the Susitna River.
- 2. Support the analyses of fish habitats being conducted in tributary habitats.

2.0 METHODS

2.1 Site Selection

2.1.1 Mainstem Habitats

The mainstem Susitna River water quality monitoring stations were specifically chosen to monitor representative water quality conditions present throughout the 1983 open water field season in the reach of river from Talkeetna to Devil Canyon (Figure 4-1, Table 4-1). Each water quality station was located at a site where continuous water temperature was also collected (see Chapter 3 of this report). Sampling intensity was daily at the two camp locations (Talkeetna fishwheel and Gold Creek Camp), whereas the remaining sites were monitored twice a month (Table 4-1).

2.1.2 Side Channel and Side and Upland Slough Habitats

The side channel and side and upland sloughs selected for water quality monitoring (Table 4-2, Figure 4-1) were chosen based upon their importance as salmon spawning and rearing habitat and their ability to represent side channel and side and upland slough habitats in the Talkeetna to Devil Canyon reach.

Turbidity was monitored twice monthly at each side channel and slough discharge monitoring station.

2.1.3 Tributary Habitats

Tributaries selected for water quality investigations (Table 4-1, Figure 4-1) included the Talkeetna and Chulitna.

The Talkeetna and Chulitna Rivers are major glacial tributaries which join the Susitna River near the town of Talkeetna. Because of their major contribution of flow to the Susitna River general water quality parameters were measured from these two tributaries.

Turbidity data were also collected in Indian River primarily to extend the record of turbidity measurements from this tributary.

The Talkeetna and Chulitna River water quality sites were chosen to coincide with the continuous water temperature stations located in these rivers. The water quality monitoring station for Indian River was the discharge station selected for Indian River.

2.2 Field Data Collection

Water quality parameters measured during the 1983 open water field season included dissolved oxygen (DO), pH, water temperature, specific conductance and turbidity. All water quality parameters except turbidity were measured employing a Hydrolab model 4041 portable multiparameter meter using procedures outlined in the FY84 ADF&G Procedures Manual (ADF&G 1984). Turbidity samples were analyzed in the field with a HF



Figure 4-1. Mainstem, side channels, and upland and side slough water quality study sites for 1983.

Table 4-1 Mainstem Susitna River and tributary water quality monitoring stations selected for the 1983 open water field season.

Location	<u>Habitat</u>	<u>River Mile</u>	TRM ¹	Sample Schedule
Parks Highway Bridge Talkeetna River Chulitna River Talkeetna Fishwheel LRX 24 LRX 29 MS above Gold Creek Indian River LRX 57 Eddy below Devil Canyon	Mainstem Tributary Tributary Mainstem Mainstem Mainstem Tributary Mainstem Mainstem	83.9 97.2 98.6 103.0 120.7 126.1 136.8 158.6 142.3 150.1	0.5 2.0	Twice monthly Twice monthly Twice monthly Daily Twice monthly Twice monthly Daily Twice monthly Twice monthly Twice monthly

Nipeza

anala .

¹ TRM = tributary river mile, determined from the mouth of the tributary upstream to the study site.

Site	River Mile
<u>Side channel</u>	
Mainstem II Side Channel Slough 10 Side Channel Upper Side Channel 11 Side Channel 21	114.4 134.2 136.5 141.1
Slough	
Whiskers Creek Slough 6A Slough 8 8A 9 11 16B 20 21	101.4 112.3 113.7 125.5 128.9 135.7 138.0 140.2 141.0

Table 4-2. Locations of side channel and upland and side slough water quality monitoring stations selected for the 1983 open water field season.

Instrument DRT-15 turbidity meter using procedures outlined in the FY84 ADF&G Procedures Manual (ADF&G 1984).

2.3 Analytical Approach

Water quality data collected at mainstem and major tributary sites were tabulated with presentation of the statistical analysis limited to the range and the percentile ranking. Turbidities and temperature obtained at the daily monitored stations in the mainstem were plotted against mainstem discharge and time. Turbidity and discharge were also analyzed for straight line characteristics utilizing a least square regression for these two daily monitoring stations.

Turbidity data collected in side channels and upland and side sloughs, were tabulated with corresponding water surface elevation estimated flow for the study site and mainstem discharge at Gold Creek (USGS 15292000).

3.0 RESULTS

3.1 <u>Mainstem Habitats</u>

Instantaneous measurements of water quality (dissolved oxygen, pH, water temperature, conductivity, and turbidity) were obtained at seven mainstem Susitna River water quality monitoring stations and two tributaries during the 1983 open water field season. These data are tabulated in Appendix Table 4-A-1. Graphical representations of the range, mean, and median values for each water quality parameter at each station are presented in Figures 4-2 through 4-6. The nature of the sampling procedure (instantaneous measurement) among stations, precludes strict comparisons of the ranges, means, and medians between stations. Thus, these data only provide an overview of the water quality characteristics of the mainstem Susitna River at a specific station.

Percent dissolved oxygen saturation was calculated for each monitoring station using the instantaneous water temperature and dissolved oxygen data bases and utilizing a dissolved oxygen saturation nomograph (Wetzel 1975). These data are tabulated in Appendix Table 4-A-1 and graphically presented in Figure 4-3.

A 200

Turbidity measurements collected on a daily basis at the Talkeetna fishwheel station and the Gold Creek camp monitoring stations were plotted against time along with mean daily mainstem Susitna River discharge at Gold Creek (15292000) and mean daily surface water temperatures (Figures 4-7 and 4-8). Turbidity data collected at these mainstem Susitna River monitoring stations were also plotted against mainstem Susitna River discharge at Gold Creek (15292000) (Figures 4-9 and 4-10). A time dependent trend becomes evident when turbidity data is plotted against mainstem Susitna River discharge. The trends are given as four periods of measurements:

- 1. Early period and late period (5/18/83 to 6/20/83 and 8/15/83 through 10/6/83);
- 2. Early transitional period (6/21/83 through 6/25/83);
- 3. Middle period (6/26/83 through 8/6/83);
- 4. Late transitional period (8/7/83 through 8/14/83).

Large changes in turbidity levels (100 NTUs) for comparable discharges defined the transitional periods. Transitional periods defined the early, late, and middle periods. Transitional period turbidity data were not used in the calibration of the relationships between mainstem turbidity and mean daily mainstem discharge at Gold Creek.

3.2 Side Channels and Side and Upland Slough Habitats

Instantaneous water temperature and turbidity measurements were obtained at 5 sites within 5 side channel habitats and at 13 sites within 11 side and upland slough habitats in the Talkeetna to Devil Canyon reach of the Susitna River. These data along with corresponding site specific water



1

- Alexandra ang

1 1

1

Figure 4-2. Dissolved oxygen data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites.



Figure 4-3. Dissolve oxygen percent saturation data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites.

備合え

. . .

10

1



1

Figure 4-4. pH data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary water quality study sites.

Ë



_ _

Figure 4-5. Conductivity data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary study sites.

12

1



Figure 4-6. Turbidity data summary showing range, 25th, 50th (median), and 75th percentile for mainstem and tributary study sites.



Figure 4-7. Turbidity, water temperature, and Susitna River discharge versus time at the Talkeetna fishwheel camp.

-

. . .

Page 1

14



Figure 4-8. Turbidity, water temperature, and Susitna River discharge versus time at the Gold Creek camp.



Figure 4-9. Turbidity versus Susitna River discharge at the Talkeetna fishwheel camp.



Figure 4-10. Turbidity versus Susitna River discharge at the Gold Creek camp.

DRAFT/PAGE 25, 8/1/84 4/20/84, 5/4/84, 7/24/84 SER10B/WQI 7/31/84

surface elevation, estimated flow (see Chapter 1 of this report) and mainstem Susitna River discharge at Gold Creek (15292000) are presented in Appendix Table 4-A-2.

3.3 Tributary Habitats

Instantaneous measurements of water quality (dissolved oxygen, pH, water temperature, specific conductance, and turbidity) were obtained twice a month during the 1983 open water field season at the Talkeetna (RM 97.1, TRM 0.5) and Chulitna (RM 98.0, TRM 0.6) River monitoring stations. Percent DO saturation was calculated for each monitoring station using the instantaneous water temperature and dissolved oxygen data bases and a dissolved oxygen saturation nomograph (Wetzel 1975). These data are tabulated in Appendix Table 4-A-1 and graphically presented in Figures 4-2 through 4-6.

Limited water quality measurements, instantaneous water temperatures, and turbidities were obtained at two tributary habitats in the Talkeetna to Devil Canyon reach of the Susitna River (Whiskers Creek and Indian River). These data are presented in Appendix Table 4-A-3.

4.0 DISCUSSION

Mainstem dissolved oxygen

Dissolved oxygen values (mean and medians) determined from mainstem water quality monitoring stations generally tended to decrease from the Back Eddy station (RM 150.1) located immediately below Devil Canyon, downstream to the Parks Highway Bridge station (RM 83.9) which is located below the confluence of the Talkeetna and Chulitna Rivers (Figure 4-2). The exception to this general trend is the station located at LRX 24 (RM 120.0).

In a separate study (ADF&G 1982) the highest levels of total dissolved gas supersaturation of the Susitna River were found to form in the Devil Canyon rapids located a short distance above the Back Eddy water quality monitoring station. This gas supersaturation was also found to decay moving downstream. In addition, the dissolved gas study noted that oxygen levels were found to parallel total dissolved gas saturation moving downstream from the Devil Canyon rapids.

Susitna River dissolved oxygen saturation levels were found to range higher above the confluence of the Talkeetna and Chulitna Rivers than at the Parks Highway Bridge station (Figure 4-2). These two tributaries contribute a substantial flow to the Susitna River and both were found to have lower dissolved oxygen values than observed in the mainstem Susitna River upstream of their confluence. The inflow of these tributaries may result in reducing the dissolved oxygen levels in the mainstem Susitna River, at least as far downstream as the Parks Highway.

Dissolved oxygen and dissolved oxygen saturation values observed at all mainstem Susitna River water quality monitoring stations were well above the minimum requirement to sustain aquatic life.

Mainstem pH and Conductivity

With the exception of the water quality station located at the Gold Creek camp, both pH and conductivity were found to vary little among the mainstem monitoring stations located within the reach of the Susitna River from the Parks Highway Bridge to Devil Canyon (Figures 4-4 and 4-5). The Gold Creek camp was found to have a greater range of pH and was lower in conductivity compared to the remaining mainstem water quality stations. Indian River, a relatively large, clearwater tributary is located on the same shore as the Gold Creek camp water quality station. This tributary may influence the water quality in the mainstem as far downstream as the two mile distance to the Gold Creek camp station for 1983 (pH 6.3_1 - pH 8.2) is compared to the pH values measured in 1982 for Indian River (ADF&G 1983), (pH 5.8 - pH 6.9), pH in the mainstem at the

pH was not monitored in Indian River in 1983 by ADF&G.

DRAFT/PAGE 27, 8/1/84 4/20/84, 5/4/84, 7/24/84 SER10B/WQI 7/31/84

Gold Creek camp station does not appear to be affected by Indian River. The opposite appears to be true for conductivity. The lower conductivity levels found in the mainstem at the Gold Creek camp may result from the clear water inflow of Indian River diluting the mainstem Susitna River. In 1982 Indian River was found to have a range of conductivity of 32-104 umhos (ADF&G 1982) compared to 61-142 umhos found in 1983 for the Gold Creek camp. Whereas, at LRX 57, which is located 3.2 miles upstream of Indian River, conductivity was found to range from 102-188 umhos in the mainstem for 1983.

Mainstem Turbidity

The periodic positive correlations between Susitna River turbidity and corresponding discharge during 1983 were most likely dependent in part upon the amount of suspended sediment contributed to the mainstem Susitna River by the Susitna and Maclaren glaciers. During the spring and early fall which includes the early and late open water periods characterized by relatively low turbidity, the contribution of suspended material from the glaciers via glacial melt water is small because of the cool air temperatures. Most of the turbidity associated with the spring (post breakup) period probably originate from the resuspension of glacial sediments which settled out from the water column during prior periods of decreasing discharge and receding water levels. Turbidity associated with the fall period may be the result of residual sediments originating from glacial melt and resuspension of glacial sediments during occasional high flow events. Once glacial melt and high flow events cease and residual sediments of glacial origin are settled out of the water column, turbidity levels remain low and continue so through the ice covered months.

The middle turbidity period (Figures 4-8 and 4-9), characterized by relatively high turbidity, most likely correspond to the melting of the glaciers. During this period changes in the suspended sediment load of the mainstem may be related to increases in glacial melt water. The turbidity/discharge relationship of this period is more dynamic and variable than the relationship of the early and late period, because of periodic variations of the volume of glacial melt water and the continuing deposition and resuspension of riverine glacial sediments.

Overall, increases in mainstem turbidity during the middle period may not be strictly correlated to the amount of suspended sediment present, but also depend, in part, on the size distribution of the suspended sediment. Because of their greater surface area to volume ratio of the finer particles, these particles may contribute more per unit weight to mainstem turbidity levels than larger particles.

These smaller particles remain suspended in the water column longer than larger particles. Once the glacial melt stops and the input of additional sediment ceases, the remaining suspended finer particles tend to wash out of the system. The reduced mainstem turbidity/discharge relationship of the early and late period may be partially due to the absence or reduced levels of these very fine particles (Figure 4-6).

DRAFT/PAGE 28, 8/1/84 4/20/84, 5/4/84, 7/24/84 SER10B/WQI 7/31/84

Side Channel and Slough Turbidity

Turbidity in sloughs and side channels of the middle Susitna River reach remained very low until a breaching event occurred (Figures 4-11 and 12). Turbidity levels of breached sloughs and side channels elevated rapidly and, from field observations, were found to remain elevated for a period after the breaching event ceased. This residual turbidity decays as a function of the settling rate of the suspended sediment and the ground water and surface runoff flushing rate.

Turbidity of sloughs and side channels during breaching events which initially overtopped the head (see Chapter 1 of this report) were usually lower than mainstem turbidities because of a diluting effect with ground water or surface water runoff. As mainstem discharge increased, the dilution of the mainstem turbid water decreased as more mainstem water entered the head. Slough or side channel turbidity levels may occasionally exceed mainstem turbidities because of the resuspension of previously deposited glacial sediments by the increasing velocities of the mainstem water within the slough.



Figure 4-11. Range of turbidity during unbreached and breached hydraulic condition for side slough habitats.

22

.

観察



Figure 4-12. Range of turbidity during unbreached and breached hydraulic condition for side channel habitats.

5.0 GLOSSARY

- Breaching The overtopping of the head of a side channel or side slough by the mainstem river.
- Conductivity Conductivity is a numerical expression of the ability of an aqueous solution to carry on electric current and is expressed in the reciprocal of ohms as mhos.
- Discharge Discharge, or streamflow, is defined as the volume rate of flow of water passing a specific location for a specific period of time. Dimensions are usually expressed as cubic feet per second (cfs). For the purpose of this report discharge will refer specifically to mainstem habitat and streamflow for side channel, slough and tributary habitats.
- Dissolved Oxygen The concentration of oxygen present in water as measured in mg/l.
- Flow The movement of a stream of water from place to place. See Discharge and Streamflow.
- Gaging Station A location which has been established for monitoring stage, flow and/or discharge.
- Head The upstream or point of origin of a lotic water body.
- Initial Breaching Discharge The mainstem discharge at Gold Creek which represents the initial point when mainstem water begins to enter the upstream head (berm) of a side slough or side channel.
- Lower Reach (of the Susitna River) The segment of the Susitna River between Cook Inlet and the Chulitna River confluence. (See also middle reach and upper reach).
- Mainstem Habitat Consists of those portions of the Susitna River that normally convey water 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. Discharges recede in early fall and the mainstem clears appreciably in October. An ice cover forms on the river in late November or December.
- Mean Daily Discharge The computed mean mainstem discharge per 24 hour period for a USGS gaging station.
- Middle Reach (of the Susitna River) The segment of the Susitna River between the Chulitna River confluence and Devil Canyon. (See also lower reach and upper reach).

- Monitoring Station A station set up for the collection of a particular data base.
- Mouth The downstream confluence of a lotic water body with another water body.
- Observed Data Values derived through a visual estimate or evaluation.
- Overflow Channel Those channels which adjoin the mainstem river with side channel and side slough habitats and are located downstream of the head portions of these habitats. Overflow channels periodically breach providing mainstem water into side channel and side slough habitats.

Overtopping - See breaching.

- Percent Dissolved Oxygen Saturation The percent saturation is the measured concentration of dissolved oxygen divided by the saturation value multiplied by 100.
- Peripheral Habitats Aquatic habitats adjacent to the mainstem Susitna River habitat (e.g. side channel, side slough, upland slough, tributary mouth and/or tributary habitats).

Project Datum - The project elevations referenced to mean sea level.

- Rating Curve A curve representing a simple relation between two variables to be used to determine values of the dependent variable as a function of the independent variable. The rating curves developed using project measurements of stage and discharge consist of discharge rating curves and stage rating curves. The discharge rating curves are used to determine streamflow as a function of mainstem discharge and streamflow as a function of water surface elevation. The stage rating curves are used to determine stage referred to as water surface elevation as a function of mainstem discharge.
- Side Channel Habitat Consists of those portions of the Susitna River that normally convey water during the open water season but become appreciably dewatered during periods of low mainstem discharge. 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.

- Side Slough Habitat is located in overflow channels between the edge of the floodplain and the mainstem and side channels of the Susitna It is usually separated from the mainstem and/or side River. channels by well vegetated bars. An exposed alluvial berm often separates the head of the slough from mainstem discharge or side channel flows. The controlling streambed/bank elevations at the upstream end of the side sloughs are slightly less than the water surface elevations of the mean monthly discharges of the mainstem Susitna River observed for June, July, and August. At intermediate and low-discharge periods, the side sloughs convey clear water from small tributaries and/or upwelling groundwater. 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. 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 discharges the water surface elevations of the mainstem river is sufficient to overtop the upper end of the slough. 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.
- Staff Gage A non-recording staff, marked in graduations of tenths of feet, used to monitor stage through observation.
- Stage The height of the water surface above an established datum plane. Stage can be converted to true water surface elevation if the observations are converted into project datum.
- Streamflow Same as discharge but refers specifically to side channel, slough and tributary habitats whereas discharge denotes streamflow in mainstem habitats. See Discharge.
- Tributary Habitat Consists of the full complement of hydraulic and morphologic conditions that occur in the tributaries. Their seasonal flow, 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.
- Turbid The condition of water quality at a site when water clarity is decreased by inorganic and/or organic suspended materials.

um - a millionth of a meter.

Upland Slough Habitat - Differs from side slough habitat in that the upstream end of the slough does not interconnect with the surface waters of the mainstem Susitna River or its side channels even at high mainstem discharges. These sloughs are characterized by the presence of beaver dams and an accumulation of silt covering the substrate resulting from the absence of mainstem scouring discharges. Upper Reach (of the Susitna River) - The segment of the Susitna River between Devil Canyon and the headwaters (See also lower reach and middle reach).

Water Surface Elevation - The elevation of the water at a point of measurement referenced to project datum.

WSEL - Abbreviation for water surface elevation.

6.0 CONTRIBUTORS

PROJECT LEADER

Aquatic Habitat and Instream Flow Project Leader

PRIMARY AUTHORS

REPORT COORDINATORS

EDITORS

DATA PROCESSING

DATA COLLECTION

DRAFTING

TYPING

Christopher Estes

Gene Sandone Tim Quane

Douglas Vincent-Lang Tim Quane

Douglas Vincent-Lang Pat Morrow

Allen Bingham Camille Stephens

Pat Morrow Isaac Queral Tommy Withrow Chris Kent Jody Miller

Sally Donovan

Skeers Word Processing

7.0 ACKNOWLEDGEMENTS

Funding for this study was provided by the State of Alaska, Alaska Power Authority. Input into study design was provided by E.W. Trihey & Associates.

11

SER A

8.0 LITERATURE CITED

- Alaska Department of Fish and Game (ADF&G). 1982. Aquatic Studies Procedures Manual. Phase II Final Draft. Alaska Department of Fish and Game/Susitna Hydro Aquatic Studies Program. Anchorage Alaska.
- _____. 1983. Aquatic habitat and instream flow studies, 1982. Volume 4 of Phase II Basic Data Report. Alaska Department of Fish and Game/Susitna Hydro Aquatic Studies Program. Anchorage, Alaska.
- _____. 1984. Procedures Manual, Final Draft (May 1983 June 1984). Alaska Department of Fish and Game/Susitna Hydro Aquatic Studies Program. Anchorage, Alaska.
- Wetzel, Robert G. 1975. <u>Limnology</u>. W.B. Saunders Company Philadelphia. 743 pp.

9.0 APPENDIX 4-A

(, , , , , ,

, manag

			<u>Temper</u> Air	<u>rature</u> Water		<u>Dissolve</u>	d Oxygen C	onductiv	<u>/ity</u> Turbidity
Location	Date	Time	<u>(C°)</u>	<u>(C°)</u>	рН	<u>(mg/1)</u>	Saturation	<u>(unno)</u>	<u>(NTU)</u>
PARKS HIGHWAY EAST	830715	1730	022.3	13.3	7.3	09.3	089	114	288
River Mile 083.9	830723	1548	015.0	12.4	7.4	09.8	092	111	252
	080810	1255	015.0	10.2	7.5	11.0	098	098	288
	830821	1330	012.5	09.0	7.4	11.7	099	111	78
	830911	1330	012.8	07.7	7.6	11.6	097	137	43
	830927	1434	002.2	-0.2	7.3	12.9	087	150	13
	831001	1215	008.6	04.1	7.4	12.5	095	108	16
TALKEETNA RIVER	830715	1630	023.5	11.7	6.8	09.0	090	092	120
River Mile 097.1	830722	1930	019.0	11.9	7.2	10.0	093	092	125
TRM 0.5	830810	1110	015.5	09.1	7.2	11.4	100	081	154
	830822	1115	011.4	08.8	7.4	11.5	101	094	17
	830917	1255	012.2	05.2	7.6	12.2	096	128	3
	831001	1430	012.2	04.6	7.3	12.2	094	085	3
CHULITNA RIVER	830706	1430		06.8	7.8	10.6	089	092	
River Mile 098.0	830715	1450	020.2	07.4	7.3	11.5	095	108	624
TRM 0.6	830722	1915	018.2	10.0	7.8	10.2	091	106	590
-	830723	1318		06.5	7.7	12.7	101	092	671
	830810	1150	015.5	05.9	8.3	12.3	100	097	520
	830822	1030	011.4	06.1	7.6	12.9	104	098	264
	830913	1545	013.0	06.2	7.4	12.2	097	118	120
	831003	1000	004.6	01.8	7.7	13.0	094	102	24

Table 4-A-1 Water quality data collected at selected Susitna mainstem and tributary locations for the 1983 open water field season.

.

Table 4-A-1 Continued

1

Location	Date	Time	<u>Temp</u> Air (C°)	werature Water (C°)	_рН	Dissolve (mg/1)	d Oxygen Percent Saturatio	<u>Conductiv</u> (umho/ on <u>cm)</u>	<u>vity</u> Turbidity <u>(NTU)</u>
TALKEETNA FISHWHEEL	830518	1600		05.0					
CAMP	830519	1000	010.0	04.2					58
River Mile 103.0	830520	1245	014.0	06.1					46
	830521	1000	011.0	07.0					31
	830522	1000	010.0	06.7					32
	830523	0800	008.0	06.5					28
	830524	0800	010.0	06.5					24
	830525	0830	008.0	06.5					29
	830526	0830	009.0	07.1					24
	830527	0830	007.8	06.9					22
	830528	0830	011.0	07.0					30
	830529	0830	012.0	07.9					21
	830530	0830	017.0	09.1					27
	830531	0830	010.0	08.0	· .				108
	830601	0800	010.0	07.8					136
	830602	0810	010.0	07.8					114
	830603	0830	009.0	08.0					81
	830604	0900	008.0	07 5					160
	830605	0900	009.0	07.3					170
	830606	0900	013.0	08.9					122
	830607	0800	012.0	09.4					100
	830608	0830	009 5	09.4					88
	830609	0800	010 0	09 4					82
	830610	0830	012 0	09 4					65
	830611	0900	011.0	09.5					54

- -----

- Ford

P

4-A-3

٨

			Temper	rature		Dissolve	d Oxygen C	onductiv	<u>vity</u>
Location	Date	Time	_(C°)		рН	<u>(mg/1)</u>	Saturation	(unino) (m)	<u>(NTU)</u>
TALKEETNA FISHWHEEL	830612	0900	012.4	09.4	7.4	11.1	09 8	117	44
CAMP	830613	0900	011.0	09.3	7.4	11.2	099	118	60
River Mile 103.0	830614	0915	014.8	09.9	7.4	11.0	097	117	55
	830615	0930	012.0	10.2	7.4	10.8	100	118	47
	830616	0900	014.0	10.3	7.4	10.8	100	117	49
	830617	0920	016.4	10.1	7.5	10.8	100	109	71
	830618	0900	013.8	10.7	7.5	10.7	100	114	100
	830619	0830	011.6	11.6	7.4	10.5	099	112	92
	830620	0900	012.0	11.7	7.4	11.1	104	094	90
	830621	0900	014.0	11.4	7.3	10.9	102	108	158
	830622	0800	013.0	12.3	7.4	11.1	104	116	132
	830623	0820	012.0	12.7	7.4	10.9	100	122	142
	830624	0825	013.0	12.1	7.3	10.9	104	120	190
	830625	0830	015.0	12.8	7.3	10.8	103	131	200
	830626	0800	015.0	13.5	7.4	10.5	102	135	245
	830627	0800	013.0	13.1	7.4	11.2	108	142	308
	830628	0800	014.0	12.0	7.1	10.8	100	146	356
	830629	0900	012.0	11.1	7.6	11.3	105	130	324
	830630	0800	012.0	11.5	7.1	11.1	103	137	288
	830701	1200	013.0	12.7	7.2	11.5	110	138	280
	830702	1000	014.0	12.6	7.2	11.1	102	140	308
	830703	1000	016.0	12.8	7.2	11.8	110	132	324
	830704	0900	017.0	13.1	7.1	11.8	112	132	304
	830705	1000	018.0	12.9	7.2	11.4	110	134	268
	830706	1100	015.0						340

•

1

100

	· · · ·		Temper	rature		Dissolve	d Oxygen C	onductiv	<u>'ity</u>
Location	Date	Time	A1r (C°)	Water (C°)	рН	<u>(mg/1)</u>	Percent Saturation	(umno/ (umno/	(NTU)
TALKEETNA FISHWHEEL	830707	0900	015.0	14.0	7.4	09.5	094	120	450
CAMP	830708	1200	014.0	12.6	7.3	09.6	094	117	450
River Mile 103.0	830709	1000	016.0						368
	830710	1000	014.0						400
	830711	1000	014.0						360
	830712	1000	013.0						300
	830713	1000	014.0						336
	830714	1000	015.0	12.5	7.7	10.3	099	146	278
	830715	1000	015.0	12.4	7.6	10.4	098	143	312
	830716	1950	016.0	12.6	7.1	09.9	094	135	256
	830717	0900	016.0	13.1	7.5	10.8	104	162	208
	830718	0900	015.0	12.4	7.4	10.2	097	154	216
	830719	0900	015.0	10.9	7.5	10.8	098	151	280
	830720	0900	017.0	12.7	7.3	10.7	101	145	224
	830721	0930	013.8	12.4	7.5	09.6	095	140	166
	830722	0900	011.8	12.1	7.3	09.6	090	139	168
	830723	1030	013.8	13.2	7.4	09.4	090	133	198
	830724	1010	014.0	12.1	7.5	10.2	095	160	216
	830725	0915	013.0	11.9	7.5	09.9	093	157	284
	830726	0910	016.0	12.5	7.5	09.9	094	164	240
	830727	0915	016.0	12.8	7.5	09.8	094	173	220
	830728	0920	016.0	13.2	7.5	09.6	093	168	268
	830729	0925	016.0	13.7	7.5	09.7	095	173	260
	830730	0840	016.0	14.1	7.6	09.4	092	180	276
	830731	1110	017.0	12.6	7.5	09.8	094	167	344

1

CONTRACT OF CONTRACT.

4-A-5

			Temper	rature		<u>Dissolve</u>	d Oxygen <u>C</u>	onductiv	<u>'ity</u> Tumbidity
Location	Date	Time	(C°)		рН	<u>(mg/1)</u>	Saturation	<u>(u</u> mo/ <u>cm)</u>	<u>(NTU)</u>
TALKEETNA FISHWHEEL	830801	0855	015.0	11.8	7.7	09.9	093	170	308
CAMP	830802	0910	015.0	12.2	7.6	09.7	090	168	268
River Mile 103.0	830803	0930	017.0	12.1	7.6	10.9	104	131	284
	830804	2010	014.0	12.7	7.6	10.5	100	129	300
	830805	0950	015.0	12.0	7.6	10.4	098	129	316
	830806	0920	013.0	10.8	7.4	11,0	100	127	324
	830807	0920	013.0	10.5	7.4	10.9	100	127	260
	830808	0905	011.0	10.7	7.3	11.1	102	124	232
	830809	0950	016.0	10.7	7.4	11.0	100	109	160
,	830810	0920	009.0	09.9	7.6	11.1	100	114	348
	830811	0850	012.0	10.2	7.4	11.3	102	117	308
	830812	0820	012.0	10.9	7.5	10.9	100	124	208
	830813	0745	010.0	10.2	7.4	11.0	100	125	176
	830814			10.2					156
	830815			10,1					136
	830816			09.9					116
	830817	1005	011.0	09.2	7.4	11.5	102	130	96
	830818	1005	013.0	09.2	7.4	11.5	102	130	76
	830819	0910	011.0	08.9	7.4	11.0	097	131	56
	830820	0855	010.0	09.8	7.4	11.0	099	137	61
	830821	0915	010.0	09.3	7.4	11.5	102	134	56
	830822	0910	012.0	09.4	7.3	11.4	102	128	62
	830823	0835	009.0	08.6	7.3	11.4	099	135	92
	830824	0815	0.800	08.6	7.3	11,2	098	132	62
	830825	0835	004.0	07.6	7.3	11.7	100	127	74
	830826	0815	0.800	07.4	7.3	11.8	100	120	104

1

I.

4-A-6

•

.

· · · · · · · · · · · · · · · · · · ·		· · · · · · · · · · · · · · · · · · ·	Tempe	erature Water		Dissolve	d Oxygen (Conductiv	<u>vity</u> Turbidity
Location	Date	Time	(°°)	(C°)	рН	(mg/1)	Saturation	i cm)	(NTU)
						<u> </u>		- <u> </u>	
IALKEEINA FISHWHEEL	830827	0/10	006.0	07.5	7.4	12.0	102	114	122
САМР	830828	0925	009.6	8,80	1.4	11.8	102	108	88
River Mile 103.0	830829	1715	012.0	09.8					44
	830830	1 140	012.0	09.5					42
	830911	0835	006.2	06.4	7.5	12.7	104	148	13
	830912	0845	007.2	06.6	7.5	12.4	102	151	11
	830913	1030	009.0	, 06. 8					17
	830914	0845	008.0	06.5					14
	830915	0935	006.7	05.6	7.6	12,4	100	152	14
	830916	0955	003.0	05.0					13
	830917	0820	000.2	04.0	7.6	13.0	100	156	12
	830921	1549	013.4	06.4	7.7	12.7	105	158	1
	830922	0858	008.8	06.1	7.6	11.8	097	158	4
	830923	0900	002.8	04.9	7.6	12.3	098	152	49
	830924	0830	-02 1	02 0	76	13 1	096	138	50
	830925	0915	000.0		/.0	10.1	000	100	31
	830927	0910	-02 0	-0.4	73	12 3	090	046	16
	831002	0841	004 7	03 0	7.5	12.6	090	131	2
	831002	11/0	004.7	03.0	7.8	13 3	000	134	4
	031003	1010	004.9	02.3	7.0 7.5	12.5	030	12/	т Л
	001004	1010	001.0	01.3	7.3	12.0	097	104	4
	031003	1045	003.0	01.1	/./	13./	100	101	2
	031103	1245	002.8	00.0	9.0	14,0	100	101	3

			Temper	rature		<u>Dissolve</u>	d Oxygen	Conductiv	/ity
Location	Date	Time	A1r (C°)	Water (C°)	_pH_	<u>(mg/1)</u>	Percent Saturatio	(umho/ on)	lurbidity <u>(NTU)</u>
CURRY (LRX24)	830619	1300		12.6	7.4	11.0	104	099	74
River Mile 120.0	830706	1220		13.1	7.5	09.7	087	117	512
	830716	1615	018.0	13.8	7.2	10.0	097	132	234
	830807	1255	012.6	10.8	7.6	11.0	100	125	224
	830824	1230	011.8	08.8	7.6	11.9	104	114	60
	830915	1645	010.8	06.8	7.4	12.2	100	154	10
	830924	1653	-01.2	01.5	7.6	13.7	098	136	36
	831004	1230		01.6					16
	831005	1315	003.3	01.3	7.5	13.7	098	141	2
LRX29	830615	1509		12.2	7.4	10.5	091	111	38
River Mile 125.3	830706	1200	014.0	13.2	7.5	09.9	095	125	448
	830716	1930	016.2	13.6	7.4	09.5	093	140	204
	830805	1130	013,6	12.1	7.6	10.5	100	140	266
	830823	1000	009.6	08.8	7.6	11.4	098	126	72
	830914	1715	006.4	06.0	7.6	12.2	097	157	11
	830924	1348	-00.2	01.5	7.3	13.5	097	140	42
	831102	1600	003.6	00.1	5.3	13.4	094	187	2
GOLD CREEK CAMP	830612	0930		08.2	6.8	12.0	105	086	34
River Mile 136.8	830613	0907		08.1	6.8	12.1	114	084	42
	830614	0838		08.6	6.9	11.9	102	086	34
	830615	0842		08.8	6.8	11.6	108	081	29
	830616	0855		08.7	7.2	11.7	102	078	37
	830617	1055		09.3	7.3	11.2	099	077	33

Table 4-A-1 Continued

brink

2012

			Temper	rature	<u> </u>	Dissolve	d Oxygen C	onductiv	ity
Location	Date	Time	Air (C°)	Water (C°)	_рН_	(mg/1)	Percent Saturation	(umho/ (umho/	(NTU)
GOLD CREEK CAMP	830618	0900		09.4	7.1	11.6	102	083	52
River Mile 136.8	830619	0925		10.0	7.2	11.4	102	076	50
	830629	1855	012.8	10.8	7.4	09.8	090	094	
	830630	0900	013.8	10.2	7.4	10.2	093	106	
	830701	0920	012.2	11.0	7.4	10.1	093	108	248
	830702	0855	012.8	11.2	7.3	10.1	093	106	272
	830703	1226	023.2	11.8	7.2	10.2	095	104	264
	830704	1107	023.0	12.2	7.2	10.1	095	097	280
	830705	0958	017.8	11.4	7.4	10.2	096	105	232
	830706	1000	013.8	12.7	7.4	09.8	093	102	368
	830707	1100	016.5	12.5	7.3	10.2	097	112	298
	830708	0930		11.0	7.2	10.7	098	114	365
	830709	0930		10.7	7.5	10.5	096	123	330
	830710	0930		11.0	7.4	10.9	100	123	312
	830711	0915		11.3	7.4	11.1	103	123	276
	830712	0930		11.2	7.4	12.1	110	132	270
	830713	1000		11.5	7.4	13.9	129	126	240
	830714	1030		11.7	7.3			125	204
	830716	1120	022.0	12.3	8.0	10.9	102	098	172
	830717	0856	016.8	12.4	7.7	10.8	102	104	172
	830718	0912	011.8	11.0	7.6	11.3	105	105	142
	830719	0930	015.2	10.0	7.6	11.5	102	107	186
	830720	1815	018.0	13.1	7.4	10.8	104	101	142
	830721	0950	015.6	12.2	7.5	11.2	105	114	136
	830722	1054	016.2	11.7	7.5	11.3	106	107	148
	830723	0945		12.1	7.6	11.0	104	121	156

1

ſ

4-A-9

			<u>Temper</u> Air	rature Water		Dissolve	d Oxygen Percent	Conductiv	<u>ity</u> Turbidity
Location	Date	Time	(C°)	(C°)	<u>pH</u>	(mg/1)	Saturatio	<u>on cm)</u>	<u>(NTU)</u>
GOLD CREEK CAMP	830725	0945		11.6	7.5	11.1	102	111	194
River Mile 136.8	830726	0915		11.6	7.5	10.9	101	112	152
	830727	0915		12.7	7.5	10.5	102	117	124
	830728	0800		12.5	7.5	10.7	102	117	180
	830729	1800	009.5						178
	830730	1215	012.0						194
	830802	1922	020.4	12.9	8.2	10.8	102	105	264
	830803	0915	017.0	11.4	7.8	11.2	104	111	192
	830804	0826	013.8	12.1	7.8	11.0	103	110	352
	830805	0930	013.4	11.5	7.4	11.3	105	094	248
	830806	0932	012.8	09.9	7.6	11.6	104	093	248
	830807	1145	015.0	10.5	7.2	11.4	103	099	240
	830808	1135	012.6	10.2	7.0	11.0	100	083	176
	830809	0937	011.4	09.8	7.3	11.2	098	061	108
	830810	0750	008.5	08.4	7.6	12.3	106	088	408
	830811	0700	010.5	09.2	7.7	11.4	106	094	270
	830812								104
	830813								94
	830814								60
	830815	1320	009.9	07.6	7.2	08.4	073	099	84
	830816	0900	008.0	07.0	7.1	08.4	070	101	66
	830817	0930	008.7	07.7	7.3	08.3	071	107	38
	830818	1630	016.2	09.9	7.2		_	108	48
	830819	1100	014.4	08.7	7.2	08.6	075	114	42

t

Table 4-A-1 Continued

Table 4-A-1 Continued

2

.

			Temper	<u>rature</u>		Dissolve	<u>d Oxygen</u> <u>C</u>	onductiv	vity Truck i di tu
Location	Date	Time	(C°)	(C°)	pH	<u>(mg/1)</u>	Saturation	(umno/)	<u>(NTU)</u>
GOLD CREEK CAMP	830820	1215	010.2	09.0	7.0	08.3	074	119	44
River Mile 136.8	830821	1220	010.4	08.6	7.6	11.6	102	104	42
	830822	0909	010.6	08.6	7.2	12.2	105	087	50
	830823	0916	010.6	08.1	7.4	12.2	103	082	64
	830824	0927	007.0	07.7	6.9	12.3	105	090	40
	830825	1629	010.6	08.0	7.3	12.5	108	085	68
	830826	0956	010.4	06.9	6.9	12.6	104	092	116
	830827	1000	010.2	07.3	6.5	13.0	108	092	80
	830828	0947	009.7	07.9	7.0	12.9	110	105	48
	830831	1120	010.0	07.8		11.6	100	081	
	830901	0905	009.1	07.4		11.6	099	095	35
	830902	1212	011.6	07.4		11.6	098	076	40
	830904	1259	012.0	06.2		12.2	100	095	40
	830906	1733	010.8	06.5		12.2	099	107	23
	830908	1216	010.8	06.4		12.0	098	113	17
	830910	1011	007.8	06.4	7.3	12.7	108	111	13
	830911	0917	006.8	06.5	7.3	12.2	100	118	14
	830912	0918	007.7	06.4	7.1	12.6	103	120	13
	830913	1147	008.2	06.6	7.2	12.6	102	121	12
	830914	0854	006.6	05.6	7.2	12.8	104	124	14
	830915	1045	008.4	05.7	7.2	12.7	102	122	11
	830916	1100	008.6	05.0	7.3	13.1	102	115	
	831003	1400	003.0	02.5	7.7	13.3	100	141	12
	831004	1645		02.3	7.5	14.3	106	142	12
	831005	1948		00.5	7.1	14.3	101	134	7

Ren B

E.

and the second

1

4-A-11

			Tempe	rature		Dissolve	d Oxygen Co	onductiv	/ity
Location	Date	Time	Air (C°)	Water (C°)	_рН_	<u>(mg/1)</u>	Percent <u>Saturation</u>	(umho/ _ <u>cm)</u>	Turbidity <u>(NTU)</u>
GOLD CREEK CAMP River Mile 136.8	831006 831102	1000 1330	005.2	01.0 00.1	7.5 6.3	13.9 15.0	100 105	132 125	12 1
LRX57 River Mile 142.0	830617 830630	1148	11.2	10.4	7.5	11.8	107	102	69 200
	830706 830721 830804	0928 1417 0856	012.6	13.0 13.3 12.2	7.5 7.2 7.7	10.4 10.8 11.5	100 104 109	123 111 118	448 168 288
	830822 830912	1033 1906	011.8	08.5	7.5 7.3	12.1 12.6	105 105 104	113 150	72 20
	831102 831003	1050	002.8	00.2	7.6	13.7 14.2	097 105	188 137	12
BACK EDDY River Mile 150.1	830704 830706 830805 830828 830915 831005	0915 1155 1041 1600 1100	014.4 013.2 009.7 008.8	13.4 11.0 07.9 05.7 00.1	7.5 7.7 7.0 7.2 7.4	10.4 11.5 12.9 13.5 15.1	100 106 110 109 105	124 113 105 153 163	392 448 320 58 10 13

4-A-12

Appendix Table 4-A-2. Comparisons of periodic water quality (temperature and turbidity), water surface elevations (WSEL) and streamflow collected at selected non-mainstem locations upstream of Talkeetna with mean daily mainstem discharge at Gold Creek (15292000)¹

Location	Date	Time	Temperatu <u>Water</u>	ure (°C) <u>Air</u>	Turbidity <u>NTU</u>	WSEL <u>(ft.)</u>	Estimate flow <u>(cfs)</u>	Susitna d ² River Discharge <u>(cfs)</u>
Whiskers Slough Q site gage no. 101.2S3 RM 101.4	830911 831001 830716 830722 830822 830618	0945 1520 1130 1840 1255 1225	7.1 4.8 10.8 16.4 7.4 14.6	9.0 9.3 18.8 21.6 14.6 NA	2 1 2 2 68	365.70 365.82 365.70 365.72 365.75 365.95	0.5 0.2 0.5 0.4 0.3 10.2	12200 13200 16400 18600 21600 22900
Slough 6A Mouth gage no. 112.3W1 RM 112.3	831004 830912 830716 830722 830822 830805 830826	1110 1145 1400 1720 1655 1510 1530	2.1 7.2 12.2 16.0 10.0 12.8 10.0	3.5 12.2 20.2 19.2 14.2 14.2 16.4	2 3 29 80 4 140 16	455.92 455.80 456.52 456.86 457.22 457.20 458.13	3/ 3/ 3/ 3/ 3/ 3/	11400 11600 16400 18600 21600 21700 31700
Slough 8 Q site gage no. 113.6S2 RM 113.7	831004 830912 830716 830722 830805 830825 830825 830826	1230 1600 1430 1730 1450 1710 1815 1610	4.2 7.4 9.2 10.2 8.2 7.4 11.8 8.9	5.8 12.7 19.2 22.2 14.4 12.4 15.8 18.6	1 1 1 1 2 140 60	468.01 467.94 467.98 468.15 468.70 470.58 470.36 470.58	2.0 1.9 2.2 3.4 12.5 10.9 12.5	11400 11600 16400 18600 21700 27400 29900 31700

¹/₂ USGS provisional data, 1983

Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report).

Stage/flow rating curve not developed for this site.

4-A-13

dimenti di

Location	Date	Time	Temperatu <u>Water</u>	ure (°C) <u>Air</u>	Turbidity <u>NTU</u>	WSEL <u>(ft.)</u>	Estimate flow <u>(cfs)</u>	1 ^{Susitna} d ¹ River Discharge <u>(cfs)</u>
Mainstem 2 Side Channel	830917	1025	3.0	3.9	1	478.84	33.7	10000
NW Channel Q site	831004	1340	3.9	8.2	2	479.10	48.6	11400
gage no. 114.4S5	830722	1405	13.8	20.4	220	480.64	350	18600
RM 115.4	830611	1830	9.9	15.6	53	480.66	359	19000
	830805	1315	12.3	14.1	294	481.31	758	21700
	830806	1730	11.1	18.8	280	481.60	1044	23800
	830808	1440	11.3	13.4	192	481.89	1426	26000
	830825	1300	8.4	13.4	84	481.97	1553	27400
Mainstem 2 Side Channel	830917	1040	3.9	5.2	1	480,41	3.4	10000
NE Channel Q site	831004	1450	3.2	8.1	1	480.38	3.1	11400
gage no. 114.4S8	830721	2000	15.0	16.2	2	480.44	3.6	18100
RM 115.5	830805	1335	14.0	13.8	3	480.46	3.7	21700
	830806	1900	14.8	14.4	156	480.57	4.8	23800
	830808	1530	11.4	14.2	168	481.28	21	26000
	830825	1605	9.3	12.4	76	481.31	22	27400
	830826	1925	8.2	12.6	184	482.88	432	31700
Slough 8A	830915	1515	9.4	10.2	2	566.01	0.6	10600
NW Channel Q site	831003	1350	6.2	7.8	2	566.10	1.0	13000
gage no. 125.3S3	830924	1246	2.4	0.2	1	566.08	0.8	15200
RM 125.3	830716	1800	14.0	18.0	1	566.11	1.0	16400
	830721	1150	13.4	18.5	1	566.00	0.5	18100
	830804	1130	9.4	13.2	1	566.03	0.6	20900
	830823	1340	9.0	11.4	1	566.05	0.7	22700
	830809	1245	11.7	15.9	126	566.44	7.3	29900
	830827	1320	9.3	19.0	75	566.80	8.1	31000

_ . _ _

¹ Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report).

4-A-14

Location	Date	Time	Temperat <u>Water</u>	ure (°C) <u>Air</u>	Turbîdîty <u>NTU</u>	WSEL (ft.)	Estimate flow <u>(cfs)</u>	¹ Susitna d ¹ River Discharge <u>(cfs)</u>
Slough 8A NE Channel Q site gage no. 125.3S1 RM 125.8	830915 830924 830716 830615 830804 830823 830630 830809 830827	1505 1315 1820 1250 1615 1220 1210 1404 1130 1125	9.8 0.6 15.4 15.6 NA 11.2 9.2 NA 11.6 9.6	10.6 1.0 18.0 18.7 NA 13.8 18.4 NA 16.2 15.2	1 1 1 1 1 2 1 1 1	567.22 567.29 566.20 566.33 566.09 566.60 566.97 566.08 566.91 566.91 567.07	2/ 2/ 2/ 2/ 2/ 2/ 2/ 2/ 2/	10600 15200 16400 18100 19600 20900 22700 24700 29900 31000
Slough 8A B/L Beaver Dam W. Channel gage no. 125.3S4 RM 125.7	831003 830924 830721 830804 830823 830827	1310 1224 1430 1320 1400 1427	6.2 1.4 6.2 NA 10.2 11.0	3.0 0.2 17.2 13.2 14.0 18.8	2 1 1 1 1 78	563.68 563.60 563.51 563.57 563.66 564.14	8.6 6.3 4.4 5.6 8.0 46.6	13000 15200 18100 20900 22700 31000
Slough 9 Q site gage no. 128.3S1 RM 128.9	830914 831003 830924 830716 830721 830805 830618 830630 830824 830809	0955 1515 2200 1745 0900 1450 1030 1135 1540	5.8 4.2 2.6 11.0 16.0 NA NA 12.1 9.0 11.9	9.9 6.6 1.0 14.6 15.4 NA NA NA 8.6 17.2	1 2 3 54 126 64 200 64 224	593.27 593.50 593.33 593.27 593.36 3/ 594.00 594.05 595.11	6.9 14.3 8.5 7.0 9.3 3/ 3/ 58.9 67.2 788	10700 13000 15200 16400 18100 18200 22900 24700 24700 29900

約費

100

1 Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report. 2

Stage/flow rating curve not developed for this site. Data not available. 3

								,Susitna
Location	Date	Time	Temperato <u>Water</u>	ure (°C) <u>Air</u>	Turbidity <u>NTU</u>	WSEL (ft.)	Estimate flow <u>(cfs)</u>	ed ¹ River Discharge <u>(cfs)</u>
Side Channel 10 Q site FHU 4 gage no. 133.8S3 RM 134.2	830911 831003 830717 830803 830823 830618 830808 830808 830629 830826 830810	1115 1225 1100 1703 1330 1600 1310 1610 1713 1233	8.4 6.4 8.2 13.6 8.8 NA 10.2 10.3 7.8 9.5	12.6 7.0 17.2 NA 12.6 NA NA 12.3 NA	1 2 304 64 89 184 200 152 440	654.27 654.30 655.18 655.54 -2^{2} 656.27 656.09 657.97 658.26	3.0 3.2 3.2 118 157 2 264 234 730 849	12200 13000 16500 21600 22700 22900 26000 26800 31700 31900
Slough 11 Q site gage no. 135.3S6 RM 135.7	830915 831004 830721 830718 830823 830618 830806 830829	1751 1340 1110 1040 1524 1530 1155 950	6.7 2.0 8.8 7.8 6.8 NA 7.8 8.0	8.8 4.8 17.8 17.2 12.7 NA 13.8 NA	2 2 1 12 1 3 1 1	670.67 670.67 670.72 670.72 670.73 - 2 670.73 670.73	$ \begin{array}{r} 1.5\\ 2.5\\ 2.5\\ 2.8\\ -2\\ 2.8\\ 3.8\\ 3.8\\ \end{array} $	10600 11400 18100 18900 22700 22900 23800 26800
Upper Side Channel 11 Q site gage no. 136.2S1 RM 136.5	830911 830720 830806 830808 830629 830826 830810	1745 0940 1345 1450 1255 1835 1438	7.9 11.6 10.5 10.4 10.9 7.8 10.5	14.1 16.2 NA 12.4 12.4	2 104 248 184 200 152 368	680.63 681.34 681.95 682.24 682.13 682.93 682.87	5.7 49 247 513 390 2615 2283	12200 18600 23800 26000 26800 31700 31900

1 Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report. Data not available. 2

Location	Date	Time	Temperat <u>Water</u>	ure (°C) <u>Air</u>	Turbidity <u>NTU</u>	WSEL (ft.)	Estimated flow <u>(cfs)</u>	1 ^{Susitna} River Discharge <u>(cfs)</u>
Slough 16B Q site gage no. 138.0S5 RM 138.0	830703	NA	11.2	NA	96	2/	2/	26200
Slough 19 Q site gage no. 140.0S4 RM 139.9	830914 831003 830721 830804 830616 830823 830629 830809	1110 1120 1833 1532 1555 1806 1635 1632	4.6 3.2 8.1 6.1 8.4 NA 6.0 10.8	7.8 1.4 16.6 13.8 NA 11.0 NA 17.8	2 1 1 1 2 3 1	720.04 _{2/} 720.29 720.80 NA 720.97 721.39 722.25	3/ 3/ 3/ 3/ 3/ 3/ 3/	10700 13000 18100 20900 21600 22700 26800 29900
Slough 20 Q site gage no. 140.1S5 RM 140.2	830913 831003 830721 830804 830701 830824 830809	1915 1100 1804 1511 1212 1258 1606	6.2 1.8 11.8 9.4 8.0 7.6 10.6	8.4 3.8 16.6 13.8 NA 17.0 17.8	2 1 3 2 2 14 168	726.75 727.00 726.64 726.69 726.77 726.93 727.65	5.4 11.0 4.0 4.5 5.7 9.0 62.0	11100 13000 18100 20900 23100 24700 29900

1

1

2

8

1 Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report. 2

3

Data not available. Stage/flow rating curve not developed for this site.

4-A-17

Location	<u>Date</u>	Time	Temperati <u>Water</u>	ure (°C) <u>Air</u>	Turbidity <u>NTU</u>	WSEL <u>(ft.)</u>	Estimate flow <u>(cfs)</u>	J ^{Susitna} d ¹ River Discharge <u>(cfs)</u>
Side Channel 21 Lower Q site and FHU 4 gage no. 140.6S4 RM 141.1	830912 830721 830804 830616 830822 830630 830809	1524 1735 1339 1330 1707 1430 1150	9.2 13.2 12.6 11.7 9.0 12.6 10.2	14.4 16.6 13.8 NA 16.4 NA 17.8	12 176 288 41 30 200 232	736.11 737.02 737.20 _{2/} 737.29 737.36 737.73	39.2 314 459 ₂ / 553 639 1333	12200 18100 20900 21600 21600 24700 29900
Slough 21 Q site gage no. 142.0S6 RM 142.0	830913 831003 830721 830804 830616 830822 830630 830809	1634 1030 1525 1113 1245 1352 1115 1510	$\begin{array}{c} 6.0 \\ 2.8 \\ 11.2 \\ 5.4 \\ 8.4 \\ 6.0 \\ 8.1 \\ 10.8 \end{array}$	9.8 0.2 16.6 13.8 NA 14.4 NA 17.8	2 1 3 2 1 3 1 204	745.02 745.02 744.99 745.00 _{2/} 745.07 745.03 746.03	3.9 3.9 3.9 3.9 _{2/} 3.9 3.9 3.9 32.2	11100 13000 18100 20900 21600 21600 24700 29900
Slough 22 Q site gage no. 144.3S6 RM 144.6	830702	1632	12.8	NA	288	784.04	13.5	24900

1 Flow estimated using stage/flow rating curve determined for the study site (refer to Chapter 1 of this report. Data not available. 2

4-A-18

Appendix Table 4-A-3. Incidental water quality data (temperature and turbidity) compared to tributary stream flow water surface for Indian River and Whiskers Creek for the 1983 open water field season.

Location	Date	<u>Time</u>	Temperatu <u>Water</u>	re (°C) <u>Air</u>	Turbidity <u>NTU</u>	Tributary²/ Streamflow <u>(cfs)</u>
Indian River Q site gage no. 138.6T2 RM 138.6	830913 831003 830721 830705 830827	0946 1615 1255 1140 1326	6.2 3.4 12.6 9.9 8.8	8.0 4.8 18.2 NA 18.3	1 1 7 2 1	244 1049 84 384 433
Whiskers Creek Q site gage no. 101.2T2 RM 101.4	830618	1225	13.4	2/	1	12

and a

¹ Streamflow estimated from observed water surface elevation utilizing the stage/flow rating curve developed for the study site (refer to Chapter 1 of this report).

² Data not available

10.3

100