SUSITNA
HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

ALASKA POWER AUTHORITY
COMMENTS
ON THE
FEDERAL ENERGY REGULATORY COMMISSION
DRAFT ENVIRONMENTAL IMPACT STATEMENT
OF MAY 1984

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-AQUATIC RESOURCES

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Land Use	ALT046, ALT050, ALT062 SSC020, SSC032, SSC051, SSC053, SSC054, SSC073, SSC074, SSC075, SSC076, SSC077

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Levelized Costs	NFP053, NFP055, NFP060, NFP061, NFP062, NFP068, NFP069, NFP070
Load Forecast	NFP013, NFP023, NFP024, NFP025, NFP027, NFP028, NFP029, NFP030, NFP031, NFP061, NFP083, NFP084, NFP085, NFP086, NFP096, NFP097
MAP Model	NFP029, NFP083, NFP097
Mainstem	AQR019, AQR027, AQR035 AQR039, AQR041, AQR045 AQR105, AQR115, AQR117
Mitigation	ALT019 AQR063, AQR064, AQR065 TRR002, TRR048 SSC001, SSC004, SSC005, SSC069, SSC078, SSC102, SSC142, SSC149, SSC159, SSC160
MJSENSO Model	NFP083
Monopoly Profit	NFP088, NFP090
Moose	TRR003, TRR021, TRR022, TRR023, TRR024, TRR034, TRR064, TRR065, TRR070, TRR074, TRR077
Multilevel Intake	AQR003, AQR032
Natural Gas Plants	NFP055, ALT007, ALT008 TRR012, TRR034, TRR076, TRR077 SSC017, SSC044, SSC045, SSC046, SSC088, SSC089
Natural Gas Price	NFP004, NFP015, NFP016, NFP058, NFP099, NFP100, NFP101
Natural Gas Resources	NFP015, NFP016, NFP017, NFP038, NFP047, NFP098
Net Benefits	NFP055, NFP060, NFP062, NFP063
Nitrogen Supersaturation	ALT039 AQR001, AQR004, AQR031 AQR075
OGP Model	NFP002, NFP003, NFP005, NFP050, NFP051, NFP054, NFP063

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Oil (See World Oil)	
OPCOST Model	NFP002, NFP050, NFP051, NFP053, NFP063, NFP070,
Peat	NFP044, NFP105
Peregrine Falcon	TRR001, TRR002, TRR010, TRR011, TRR018, TRR032, TRR058
Pink Salmon	AQR055, AQR092, AQR093 AQR131, AQR144
Planning Horizon	NFP050
Population	TRR004, TRR025, TRR052 SSC008, SSC010, SSC028, SSC030, SSC057, SSC066, SSC106, SSC109, SSC111, SSC112
Population Projections	SSC008, SSC029, SSC033, SSC071, SSC103, SSC107, SSC113
PRODCOST Model	NFP003, NFP005, NFP050, NFP054, NFP055, NFP060, NFP062, NFP063, NFP068, NFP069, NFP070
Proposed Project	ALT057, ALT058, ALT059, ALT066, ALT067 AQR021 TRR010, TRR041, TRR046, TRR047, TRR064 SSC006, SSC007, SSC009, SSC011, SSC024, SSC025, SSC026, SSC033, SSC034, SSC035, SSC074, SSC075, SSC078, SSC080, SSC081, SSC083, SSC086, SSC097, SSC104, SSC108, SSC111, SSC112
Railbelt Economy	NFP009, NFP010, NFP011,
Raptors	TRR008, TRR030, TRR031, TRR045, TRR057, TRR067, TRR072, TRR076, TRR081
Rate Design	NFP049
Rearing	AQR081, ACR087, ACR097 ACR108
Recreation Resources	SSC007, SSC018, SSC021, SSC024, SSC026, SSC039, SSC044, SSC045, SSC047, SSC048, SSC052, SSC056, SSC064, SSC065, SSC079, SSC080, SSC081, SSC082,

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Recreation Resources	SSC083, SSC084, SSC085, SSC086, SSC087, SSC088, SSC089, SSC090, SSC091, SSC092, SSC093, SSC094, SSC095
RED Model	NFP084, NFP085
Reliability	NFP034, NFP035
Reservoir	NFP065, NFP071, NFP073, NFP074, NFP075, NFP076 AQR002, AQR032, AQR038 AQR052, AQR061, AQR062 AQR064, AQR065, AQR076 AQR109, AQR131, AQR132 AQR133, AQR143 TRR019, TRR058, TRR068
Reservoir Temperature Model	AQR030, AQR038
Retirement Schedule	NFP032
Rime Ice	TRR020, TRR050
River Temperature Model	AQR033, AQR046, AQR066 AQR074, AQR098, AQR109 AQR122, AQR124
Salmon	ALT019, ALT030, ALT031, ALT032, ALT033, ALT049 AQR012, AQR013, AQR053 AQR054, AQR056, AQR063 AQR078, AQR080, AQR096 AQR100, AQR106, AQR115 AQR119, AQR126, AQR127 AQR129, AQR137, AQR141 AQR142
Salmon Access	AQR025, AQR058, AQR060 AQR072, AQR103, AQR107 AQR112, AQR114, AQR135
Salmon Growth	AQR042, AQR043, AQR046 AQR049, AQR050, AQR057 AQR082, AQR086, AQR101 AQR102, AQR110, AQR111 AQR123, AQR125, AQR138 AQR139
Salmon Outmigration	AQR051, AQR088, AQR128
Sediment	AQR006, AQR010, AQR023 AQR025, AQR026, AQR028 AQR121
Side Channel	AQR041
Side Slough	AQR007, AQR023, AQR068
Slough	AQR011, AQR014, AQR020 AQR022, AQR029, AQR035 AQR036, AQR047, AQR058

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Slough	AQR070, AQR071, AQR072 AQR073, AQR103, AQR104 AQR105, AQR112, AQR113 AQR115, AQR116, AQR118 AQR120
Slough Access	AQR020, AQR024, AQR040 AQR044
Sockeye (Kokanee) Salmon	AQR052, AQR065, AQR083 AQR084, AQR085, AQR086 AQR087, AQR088, AQR133
Spawning	AQR013, AQR014, AQR039 AQR040, AQR041, AQR048 AQR079, AQR080, AQR083 AQR084, AQR085, AQR089 AQR090, AQR091, AQR092 AQR093, AQR095, AQR104 AQR107, AQR113, AQR115 AQR130, AQR132
Speculative In-migration	SSC030
Spiking Releases	NFP079, NFP081 AQR002, AQR060, AQR061
Subsistence	ALT029 SSC009, SSC010, SSC031, SSC104, SSC108
Sunshine Station	AQR005, AQR016
Susitna River	AQR005, AQR006, AQR008 AQR009, AQR012, AQR018 AQR033, AQR034, AQR037 AQR074, AQR094
Susitna Station	AQR069
Temperature	AQR003, AQR011, AQR032 AQR034, AQR035, AQR036 AQR042, AQR043, AQR045 AQR047, AQR048, AQR049 AQR051, AQR056, AQR057 AQR066, AQR077, AQR082 AQR086, AQR088, AQR099 AQR100, AQR101, AQR102 AQR107, AQR108, AQR109 AQR110, AQR111, AQR117 AQR118, AQR119, AQR120 AQR123, AQR124, AQR125 AQR127, AQR128, AQR129 AQR134, AQR137, AQR138 AQR139, AQR140, AQR141

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Thermal	ALT020, ALT061 TRR059 SSC016, SSC019, SSC049, SSC063
Threatened/Endangered Species (See Endangered Species)	
Tidal Power	NFP046, NFP107
Transmission Lines and Corridors	NFP033, NFP056, NFP068 NFP069, NFP070 ALT012, ALT013, ALT014, ALT034, ALT035, ALT081 TRR001, TRR002, TRR009, TRR011, TRR024, TRR029, TRR032, TRR051, TRR074, TRR075 SSC027, SSC032, SSC036, SSC039, SSC061, SSC072, SSC073, SSC087, SSC098, SSC102, SSC129, SSC169, SSC170
Tributary	AQR025, AQR026, AQR107 AQR114, AQR115
Turbidity	AQR010, AQR030, AQR076 AQR126
Vegetation	TRR014, TRR019, TRR020, TRR024, TRR035, TRR042, TRR046, TRR049, TRR050, TRR051, TRR074
Visual Impacts	ALT020, ALT045 SSC027, SSC034, SSC035, SSC036, SSC049, SSC055, SSC096, SSC097, SSC098, SSC099, SSC100, SSC102
Visual Resources	SSC011, SSC016, SSC019, SSC022, SSC027, SSC099, SSC101
Watana	NFP064, NFP071, NFP072, NFP073, NFP074, NFP075, NFP076 ALT039 AQR002, AQR015, AQR032 AQR099, AQR114, AQR135 AQR136 SSC082, SSC144
Water Quality	NFP066, NFP077, NFP081, NFP082 ALT028, ALT047, ALT063 AQR004
Water Quantity	NFP066, NFP077, NFP081, NFP082, ALT027, ALT063

SUBJECT	TECHNICAL COMMENT REFERENCE NUMBERS
Wetlands	TRR043
Wildlife Resources	TRR012, TRR013, TRR017, TRR020, TRR033, TRR035, TRR036, TRR037, TRR039, TRR041, TRR047, TRR050, TRR059, TRR060, TRR061, TRR078
Wood	NFP020
Work Force	SSC112
World Economy	NFP089
World Oil Price	NFP023, NFP024, NFP026, NFP027, NFP042, NFP087, NFP088, NFP089, NFP090, NFP091, NFP092, NFP093, NFP094, NFP095, NFP096, NFP102
World Oil Production	NFP087, NFP095
World Oil Resources	NFP092

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TOPIC AREA: Nitrogen Supersaturation, Cone Valves

LOCATION IN DEIS: Vol 1 Page xxv Summary (Water Quality and Quantity)

COMMENT IN REFERENCE TO: Occurrence of nitrogen supersaturation in nearly every year of operation

TECHNICAL COMMENT: This statement contradicts statements in the main text and appendices of the DEIS to the effect that the cone valves will, in fact, perform as intended, thus essentially eliminating any significant gas supersaturation problems and, in fact, provide some benefit.

See especially Volume 1, Page 4-19, Paragraph 1 of the DEIS, which discusses the net benefit of operating Watana in terms of reducing the natural recurrence of nitrogen supersaturation in and below Devil Canyon.

FERC Staff should be consistent throughout the DEIS in its discussion of nitrogen supersaturation.

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TECHNICAL COMMENT FORM

TOPIC AREA: Watana, Reservoir, Spiking Releases

LOCATION IN DEIS: Vol 1 Page xxvi Summary Section Last Paragraph of page

COMMENT IN REFERENCE TO: Spiking releases from Watana

TECHNICAL COMMENT: Please refer to Technical Comment AQR061.

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TOPIC AREA: Multilevel Intake, Temperature

LOCATION IN DEIS: Vol 1 Page 2-23 Section 2.1.12.1 Paragraph 7 of the page

COMMENT IN REFERENCE TO: Multi-Level intake for temperature control would not be operational during reservoir filling

TECHNICAL COMMENT: The multi-level intake would not be available for temperature control during filling. However, the License Application (p. E-2-86 and Fig. E-2-138) indicates that sometime in August of the second summer of filling, the reservoir may be sufficiently full that the midlevel outlet works intake can be used to draw water from the reservoir for discharge through the cone valves. Exactly when this intake will become available is dependent on the preceding flows during the reservoir filling process. The midlevel outlet works intake is located at the same level as the lowest level of the multi-level intake. Thus, when this intake is in use, water will be drawn from the stratified upper level of the reservoir. The resulting outflow temperatures during the second winter of filling and the third summer of filling will be similar to operational temperatures. Please see Applicant's discussion of reservoir stratification during filling (Comment AQR032) and reservoir outflow temperature simulations during filling (Appendix IV).

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TOPIC AREA: Nitrogen Supersaturation, Water Quality

LOCATION IN DEIS: Vol 1 Page 2-23 Section 2.1.12.2 Paragraph 8 of the Page

COMMENT IN REFERENCE TO: "Nitrogen supersaturation of turbine flows would be mitigated by having subsurface discharge to minimize air entrainment."

TECHNICAL COMMENT: The Application discusses nitrogen supersaturation causes and mitigation measures in the following locations:

Exhibit E, Chapter 3, Volume 6A, Sections 2.4.4 (d) (i), 2.4.4 (d) (ii), and 2.4.4 (d) (iii), pages 4-3-174 and E-3-175.

Exhibit E, Chapter 3, Volume 6A, Sections 2.4.5 (b) (ii), page E-3-161 and 2.6.2 (b) (iv), page E-3-185.

Exhibit E, Chapter 3, Volume 6B, Tables E.3.38, E. 3.39, and E.3.40.

Turbines are not mentioned as causes of nitrogen supersaturation, nor is turbine mitigation proposed. The cause of nitrogen supersaturation in the tailrace of a dam is stated in the Application. Further downstream, high velocities from steep slopes increase nitrogen saturation. Francis turbines, the type that will be used in the project, do not cause nitrogen supersaturation. Such turbines discharge water below the tailrace water surface to improve operating efficiency.

The sentence should be deleted from the FEIS.

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Susitna River, Sunshine Station

LOCATION IN DEIS: Vol 1 Page 3-5 Section 3.1.3.1 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Proportion of flow from Chulitna and Susitna Rivers at Susitna Station

TECHNICAL COMMENT: The proportions of flow from the Susitna and Chulitna Rivers given herein are the proportions to the Susitna River (flow measured) at Sunshine gaging station at the Parks Highway Bridge. The Yentna River joins the Susitna upstream of the Susitna Station. The Yentna River contributes approximately 40% of the flow of the Susitna River measured at Susitna Station. The proportions of flow for the Chulitna and Susitna (upstream of the Chulitna confluence) rivers to the flow measured at Susitna Station would be approximately 23% and 26%, respectively.

The proportionate contributions of the Chulitna and Middle Susitna River to lower basin flows are not correct as stated. The proportions given are in percent of total flow at Sunshine Station, not Susitna Station. The correct proportions for contribution to Susitna Station flow are 23% and 26% for the Chulitna and Susitna Rivers, respectively.

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Sediment, Susitna River

LOCATION IN DEIS: Vol 1 Page 3-5 Section 3.1.3.1 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Indication that sediment yield from Chulitna River is 15 times greater than from the Susitna River.

TECHNICAL COMMENT: More recent studies by the U.S. Geological Survey (USGS 1983) and the Applicant (HE 1984c) indicate that, for water year 1982, the total sediment (suspended and bed load) estimated to be transported on the Chulitna River was approximately 3 times that estimated to be transported on the Susitna River. The following table illustrates the results of the analysis presented in Applicant's report (HE 1984c). The results presented by the USGS are similar. The net imbalance between the amounts transported on the three rivers upstream of the confluence area with that transported at Sunshine is within the accuracy of the estimate. It may also represent input of sediment between the measuring points on the three rivers and the Sunshine location.

Sediment Balance for 1982, Lower Reach

	Suspended Load (tons/yr)	Bed Load (tons/yr)		Total Load (tons/yr)
Susitna R. nr Talkeetna	2,610,000	43,400		2,653,400
Chulitna R. nr Talkeetna	7,410,000	1,220,000		8,630,000
Talkeetna R. nr Talkeetna	1,640,000	197,000		1,837,000
		Sum	=	13,120,400
Susitna R. at Sunshine	13,330,000	423,000		13,753,000
		Difference	=	633,400

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Side Slough, Flow Regime, Hydraulics

LOCATION IN DEIS: Vol 1 Page 3-5 Section 3.1.3.1 Paragraph 5 of the page

COMMENT IN REFERENCE TO: Description of side slough hydraulic regimes.

TECHNICAL COMMENT: This description of hydraulic regimes of the sloughs is misleading. When mainstem flow is less than that required for overtopping of upstream berms, water levels in the sloughs may be controlled by many factors. It is only near the slough mouths that water levels are controlled by mainstem backwater. Other factors controlling slough water levels would be the slope of the slough bed, constrictions, ponds or rapids in the sloughs. The same factors may control slough water levels when upstream berms are overtopped. Only when extreme high flows are present in the slough and the upstream berm is overtopped do the sloughs become similar to side channels of the river. The more accurate description found in the DEIS in Volume 2, Appendix H, Page 12, Paragraph 3 should be used.

SUSITNA HYDROELECTRIC PROJECT
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TOPIC AREA: Flow Regime, Susitna River, Gold Creek Station

LOCATION IN DEIS: Vol 1 Page 3-9 Section 3.1.3.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Definition of dominant or bank-full discharge as annual flood with a recurrence interval of 1-5 years and reference to License Application Exhibit E., Vol 5A, Chap 2, Table E-2.29.

TECHNICAL COMMENT: The definition of dominant discharge is given in the Applicant's document HE 1984c as follows:

"The dominant discharge is defined as the discharge which, if allowed to flow constantly, would have the same overall channel shaping effect as the natural fluctuating discharges would (USBR 1977). The dominant discharge used in computing channel degradation is usually considered to be either the bankfull discharge or the mean annual flood."

The U.S. Bureau of Reclamation (USBR 1977) considers the dominant discharge used in channel stabilization work to be either the bank-full discharge or that peak discharge having a recurrence interval of approximately 2 years on an uncontrolled stream.

The recurrence interval of the mean annual flood may be taken to be 2.33 years (Chow 1964).

In addition, the reference to Table E-2-29 appears incorrect. The correct reference should be to Fig. E-2-29.

The mean annual flood for the project is defined in the License Application (p. E-2-110).

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Ice Processes, Susitna River

LOCATION IN DEIS: Vol 1 Page 3-9 Section 3.1.3.1 Paragraph 3-4 of the page

COMMENT IN REFERENCE TO: Descriptions of ice formation and breakup

TECHNICAL COMMENT: The following points should be incorporated into the discussions of ice to amplify and correct the DEIS discussion.

1. First frazil observed on the river is generally in late September or early October, per Applicant's reports for 1980, 1981, 1982 and observations in 1983 (R&M 1981b, R&M 1982f, R&M 1984a).

2. The ice from the upper Susitna and from the Yentna generally combine to form a bridge at the mouth of the Susitna sometime in October. This is the beginning of ice accumulation on the lower river.

3. Although shore ice does begin to develop in late October in the lower river, the lower river generally closes by accumulation of slush from upstream. Initial closure in a given reach often is followed by leads reopening downstream of the ice progression. In many cases, open leads remain throughout the winter in the lower river.

4. Progression of the ice front generally closes the river up to Gold Creek (RM 137). However, between Gold Creek and Devil Canyon, the river generally closes by growth of shore ice.

5. The freeze up of the Susitna from its mouth to Devil Canyon generally takes 5-10 weeks.

6. Staging in the Lower River during progression is generally 2-4 feet. In the middle reach, staging can be 4-6 feet.

7. The Susitna contributes 70-80% of the ice to the confluence area. However, the Yentna supplies roughly 50% of the ice to the river downstream of its confluence with the Susitna.

8. Solid ice thickness of 2-4 feet is typical in the middle reach, slush thickness under solid ice can be up to 10 feet.

9. The first effects of breakup are usually seen during April when open leads develop and flow begins to increase. The river is generally open by mid-May, with grounded shore ice which may last until late June.

Please see Technical Comments AQR071 and AQR037 and Appendix VI for Applicant's simulations of river ice under natural and with-project conditions.

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TOPIC AREA: Turbidity, Sediment

LOCATION IN DEIS: Vol 1 Page 3-10 Section 3.1.3.2. Paragraph 6 of the page

COMMENT IN REFERENCE TO: Concentrations of both dissolved and suspended solids tend to decrease downstream due to both dilution from inflowing, clearwater tributaries and settling of suspended solids from the water.

TECHNICAL COMMENT: It should be noted that this description only applies to the reach of the Susitna River upstream of the Susitna-Chulitna confluence. The large input of suspended sediment by the Chulitna and Talkeetna Rivers causes an increase in the suspended sediment concentration in the Susitna River.

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TOPIC AREA: Sloughs, Groundwater, Temperature

LOCATION IN DEIS: Vol 1 Page 3-15 Section 3.1.3.2 Paragraph 5 of the page

COMMENT IN REFERENCE TO: Description of sources of groundwater to sloughs

TECHNICAL COMMENT: Please see Comments AQR105, AQR082 and AQR036 and Appendix VII, "Susitna Hydroelectric Project, Slough Geohydrology Studies" for the most current information on relationships between mainstem flows and groundwater upwelling and temperatures of the upwelling flows.

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TOPIC AREA: Escapement, Salmon, Susitna River

LOCATION IN DEIS: Vol 1 Page 3-17 Section 3.1.4 Paragraph 4 of page (Figures 3-11 and 3-12)

COMMENT IN REFERENCE TO: Information presented in the figures does not include 1983 data.

TECHNICAL COMMENT: Figures 3-11 and 3-12 presented in the DEIS should be updated to include 1983 data. Please see Technical Comments AQR079 and AQR080, AQR085, AQR089, AQR091, AQR092.

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TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Spawning

LOCATION IN DEIS: Vol 1 Page 3-24 Section 3.1.3.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Chinook spawn in tributaries, other species spawn in side channels, sloughs or tributary mouths.

TECHNICAL COMMENT: A vast majority of spawning in the Talkeetna to Devil Canyon reach is in clearwater tributaries (ADF&G 1984b pp. 180-218). Extensive spawning ground surveys have been conducted during 1981-1983. The following conclusions are based on these observations:

1. Chinook salmon spawning has been observed only in clearwater tributaries.

2. Second-run sockeye were observed spawning in side sloughs. They were not observed in any other habitat during 1981 and 1982. In 1983, a small number (11) were observed spawning at a mainstem site. An estimated 1600 spawned in the side sloughs in 1983.

3. Pink salmon spawn almost exclusively in clearwater tributaries. During 1981-83 no pink salmon were observed spawning in mainstem or side channel habitats and only a total of 335 spawned in side sloughs.

4. Chum salmon spawn about equally in side sloughs and clearwater tributaries. A few spawn in mainstem and side channel sites associated with upwelling.

5. Coho salmon spawn almost exclusively in clearwater tributaries. One mainstem spawning coho was observed in 1981, none in 1982, and one spawning site was observed in 1983. In 1982, two coho were observed spawning in a side slough. None were observed in 1981 and 1983.

The results of these spawner surveys clearly characterize the distribution of spawning in the middle river. The large majority of spawning, averaged over odd and even years, occurs in clearwater tributaries followed by utilization of sidesloughs. The use of mainstem and side-channel habitats is very limited and probably associated with groundwater upwelling.

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Groundwater, Spawning

LOCATION IN DEIS: Vol 1 Page 3-24 Section 3.1.3.2 Paragraph 1 of the page

COMMENT IN REFERENCE TO: High winter stages preventing dewatering and freezing of spawning sites.

TECHNICAL COMMENT: It has been observed that overtopping of sloughs by cold water (near 0°C) can cause embryo mortality and tends to retard growth. Hence, the reduction in slough overtopping in winter due to the proposed project operation may prove beneficial. See Technical Comment AQR134.

SUSITNA HYDROELECTRIC PROJECT
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TECHNICAL COMMENT FORM

TOPIC AREA: Watana, Filling, Flow Regime

LOCATION IN DEIS: Vol 1 Page 4-7 Section 4.1.3.1.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Description of Watana filling flow regime

TECHNICAL COMMENT: The description of the filling flow regime:

1. implies that the Case C flows are releases from the reservoir, and

2. neglects the period September 15 to 30.

The description of the minimum target flows during filling is given in the License Application (pp. E-2-78, E-2-79). Note that the minimum target flows will be as measured at Gold Creek. The release from Watana will be only that flow which, when added to the flow from the intervening drainage between Watana and Gold Creek, equals the minimum target flow. A minimum release from Watana of 1000 cfs will be maintained for May-September.

During the period September 15 to 20 minimum target flows will be reduced by 1000 cfs/day to 6000 cfs. From September 20-27 they will be maintained at 6000 cfs, and then reduced to 2000 cfs by October 1.

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TECHNICAL COMMENT FORM

TOPIC AREA: Sunshine Station

LOCATION IN DEIS: Vol 1 Page 4-7 Section 4.1.3.1.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Reference to "Sunshine and Sunshine Station"

TECHNICAL COMMENT: Reference should be corrected to read ".... Sunshine and Susitna Station..."

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DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Gold Creek Station

LOCATION IN DEIS: Vol 1 Page 4-7 Section 4.1.3.1.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: DEIS defines mean annual flood as 40,000 cfs under natural conditions and 15,000 cfs with Watana only operating.

TECHNICAL COMMENT: The statement is incorrect. The License Application (p. E-2-108) defines the mean annual flood as 49,500 cfs, under natural conditions. This is based on an assumed recurrence interval for the mean annual flood of approximately 2 years and the natural flood frequency curve (Fig. E-2-29). For the combined Watana and Devil Canyon operation, the mean annual flood would be reduced to approximately 15,000 cfs (p E-2-110).

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TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Susitna River

LOCATION: Vol 1 Page 4-7 Section 4.1.3.1.1 Paragraph 3 of page

COMMENT IN REFERENCE TO: Winter powerhouse discharge (14,700 cfs) plus intevening flow would be more than five times greater than the maximum historical monthly flows for December, January, or February.

TECHNICAL COMMENT: The maximum historical monthly flow for December was 3264 cfs at Gold Creek, in December 1957 (License Application Table E-2-8). Thus, the winter high flow is only slightly more than four times greater than the maximum historical monthly flow.

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TECHNICAL COMMENT FORM

TOPIC AREA: Habitat, Flow Regime, Mainstem

LOCATION IN DEIS: Vol 1 Page 4-9 Section 4.1.1.2 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Side sloughs and tributary mouths are most sensitive to changes in mainstem flow.

TECHNICAL COMMENT: The basis for this statement is unclear. Mainstem and side-channel habitats are more directly affected and would be more responsive to changes in mainstem discharge.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Hydraulics, Slough Access

LOCATION IN DEIS: Vol 1 Page 4-9 Section 4.1.3.1.1 Paragraph 3 of page (Figure 4-4).

COMMENT IN REFERENCE TO: Reference to changes in sloughs wetted-surface area during filling and operation

TECHNICAL COMMENT: The evaluation of wetted-surface area should be revised as indicated in Technical Comments AQR073 and AQR105.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Proposed Project, Flow Regime

LOCATION IN DEIS: Vol 1 Page 4-17 Section 4.1.3.1.1 Paragraph 2 of page (Figure 4-2)

COMMENT IN REFERENCE TO: Reference to Table E.2.24 in License Application

TECHNICAL COMMENT: The correct reference should be to Table E.2.8, E.2.54 and E.2.44.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Hydraulics

LOCATION IN DEIS: Vol 1 Page 4-9 Section 4.1.3.1.2 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Reference to side slough hydraulic regimes

TECHNICAL COMMENT: The frequency of overtopping varies from slough to slough. The determination using the averages of 3 sloughs discussed in Appendix E.2.A should be reexamined as suggested in Technical Comment AQR071.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sediment, Side Slough

LOCATION IN DEIS: Vol 1 Page 4-13 Section 4.1.3.1.2 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Natural flushing of fine materials in side sloughs would be reduced with reduction in flood peaks

TECHNICAL COMMENT: Deposition of fine materials in sloughs under natural conditions may result from mainstem water levels overtopping upstream berms. Sediments in the mainstem water may tend to settle in low velocity areas in the sloughs (pools) and in back water areas near slough mouths. Under with-project conditions the suspended sediment concentration of the mainstem water will be reduced markedly. In addition, the sediment which will be carried in the mainstem will not settle rapidly due to its very small size (PND 1982).

Therefore, there may be considerably less deposition of fine materials in sloughs with project, reducing the need for sediment flushing by high flows.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Slough Access

LOCATION IN DEIS: Vol 1 Page 4-13 Section 4.1.3.1.2 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Acute slough accessibility problems throughout year.

TECHNICAL COMMENT: Salmon generally migrate into the sloughs between 1 August 1 and September 15 each year (ADF&G 1984b). Adequate access conditions in other months are not necessary since salmon are not present.

Refer to Technical Comment AQR072 concerning to the evaluation of access conditions.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Tributary, Salmon Access, Sediment

LOCATION IN DEIS: Vol 1 Page 4-13 Section 4.1.3.1.2 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Identification of Jack Long, Sherman and Deadhorse Creeks as having potential fish passage problems during operational flows.

TECHNICAL COMMENT: As indicated in R&M's report (R&M 1982h), quantitative analyses were not made for Jack Long or Deadhorse Creeks. A bed material sample is not available for Jack Long Creek. Further analyses by Harza-Ebasco (HE 1984c) indicates the bed material of Deadhorse Creek is smaller than the size transportable by with-project flows at the Deadhorse Creek mouth and so Deadhorse Creek would probably not become perched or have fish access problems. It is not possible to say whether Jack Long Creek would become perched since bed material sizes are not known. However, its bed material may be similar to that for Gold Creek ($^{d}50$ = 36 mm) or 4th of July Creek ($^{d}50$ = 25 mm) two nearby and hydrologically and hydraulically similar streams. Since the size transportable at Jack Long Creek is 36 mm, Jack Long Creek may not become perched.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sediment, Tributary

LOCATION IN DEIS: Vol 1 Page 4-13 Section 4.1.3.1.2. Paragraph 7 of the page

COMMENT IN REFERENCE TO: Aggravation of bridge foundation erosion problems by backcutting at Skull Creek and unnamed creeks at River Mile 123.9 and 101.1. Possible endangerment of railroad bridges over these streams.

TECHNICAL COMMENT: The report by R&M (R&M 1982h) indicates the potential for backcutting to the railroad bridges at Skull Creek and two unnamed creeks at River Mile 127.3 and River Mile 110.1. The tributary at RM 123.9 is thought to be well armored. There is no tributary on the south bank at River Mile 101.1.

As indicated in the report, it is not clear whether back cutting will endanger the bridges. The occurrence of geologic features in the tributary streambed might arrest backcutting before it reaches the piers. If the piers are founded at a sufficient depth, some erosion may be acceptable. In addition, erosion endangering the piers may be prevented by armoring of the tributary streambed with sufficiently large material.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Habitat, Flow Regime, Mainstem

LOCATION IN DEIS: Vol 1 Page 4-13 Section 4.1.3.1.2 Paragraph 8 of the page

COMMENT IN REFERENCE TO: Mainstem flow changes would have greater effects on side sloughs and tributary mouths than side channels and the mainstem.

TECHNICAL COMMENT: The context of this statement should be clarified. The statement is probably true if it refers to the total usable quantity of available habitat types. However, "hydraulic effects" (e.g. velocity and depth) on particular reaches of mainstem or side channel habitats would be greater than for the other habitat types (See Technical Comment AQR019).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Hydraulics, Flow Regime, Sediment

LOCATION IN DEIS: Vol 1 Page 4-15 Section 4.1.3.1.3 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Channel-width reduction colonization of dewatered portion of bank by vegetation.

TECHNICAL COMMENT: It does not appear that the cited method of regime theory would apply to the Susitna River in the reach between the Chulitna-Susitna confluence and the Watana damsite. As indicated in Chow (1964), the method of regime theory was developed for the design of irrigation canals and regime equations have limited applicability to the design of stable channels which have mobile beds and carry a relatively small bed-material load. The bed of the Susitna River between the damsites and the Chulitna River-Susitna River confluence is armored and is expected to degrade on the order of 0.2 feet as a result of sediment trapping in the reservoir (HE 1984c). Thus, the riverbed can be considered a fixed bed.

For a fixed bed stream, an alternate method of computing the reduction in channel width would be to examine the simulated channel width at existing cross sections with the dominant discharges for natural and with-project conditions. This can be done using HEC-2 water-surface profiles provided in R&M 1982b. The following table provides the estimated water-surface areas for natural and with-project dominant discharges of 50,000 cfs and 15,000 cfs, respectively (See Technical Comment AQR008 for the definition of dominant discharges).

Estimated Water-Surface Areas
Watana Damsite to Susitna-Chulitna Confluence
For Natural and With-Project Conditions

	Water-Surface Area (Acres)	
	Natural	With Project
Dominant discharge(cfs)	50,000	15,000
Reach		
Watana Dam to Devil Canyon	1,783	1,557
Devil Canyon to Susitna-Chulitna Confluence	6,655	4,162

This table indicates that there would be net reductions in water surface areas of approximately 13% and 37% in the reaches upstream and downstream of Devil Canyon, respectively. The overall reduction in both reaches would be about 32%.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Flow Regime, Ice Model

LOCATION IN DEIS: Vol 1 Page 4-15 Section 4.1.3.1.3 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Statement that almost all overtopping of slough berms would be eliminated by regulated flows.

TECHNICAL COMMENT: Berms can still be overtopped in winter when the river is ice covered in the vicinity of the slough berm. The instream ice simulations provided with these comments indicate the conditions under which this would occur (See Technical Comment AQR071 and AQR037).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir Temperature Model, Turbidity

LOCATION IN DEIS: Vol 1 Page 4-18 Section 4.1.3.2.1 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Warming of water below depth of wind mixing in reservoir would be minimal due to high turbidity in reservoir.

TECHNICAL COMMENT: Relatively high turbidity is expected from glacial inflows to the reservoir such that the summer light extinction coefficients are sufficiently high to trap the solar heating near the surface as has been demonstrated in the DYRESM summer simulations. In the Eklutna Lake study, the turbidity effect was incorporated through the light extinction coefficients which were obtained from field experiments and reasonable results were obtained (HE 1984e). The study also indicates that the turbidity effect is not significant in the temperature study. Since the inflow temperatures and suspended sediment concentrations to the Watana reservoir are similar to that of the Eklutna Lake, the same light extinction coefficients can be used without significant loss in accuracy.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Nitrogen Supersaturation, Cone Valves

LOCATION IN DEIS: Vol 1 Page 4-18 Section 4.1.3.2.1 Paragraphs 6-7 of the page

COMMENT IN REFERENCE TO: Use of cone valves as opposed to spillways for discharge to avoid nitrogen supersaturation.

TECHNICAL COMMENT: The indicated mechanism causing nitrogen supersaturation is somewhat misleading. As water leaves the cone valves or the spillway flip bucket it will begin to break into small particles. As this jet of water travels it will entrain air. When the jet impacts the water surface, it will plunge to a depth dependent on the angle of impact, the velocity of flow and the intensity of the flow (flow per unit area at impact). Air entrained in the flow will also be carried to depth. The pressure on the water increases linearly with depth. The amount of dissolved gas the water can hold at saturation is directly proportional to the absolute pressure on the water (Johnson 1975). The driving force for the dissolution of nitrogen and oxygen from the entrained air to the surrounding water, therefore, increases with increasing depth of plunge of the water jet. Therefore, a jet of water which has entrained air and which plunges into the tailwater is likely to contain gas concentrations which are supersaturated with respect to the gas concentration of the surface water. Water at a depth of 34 feet will hold 50 percent more gas than water at the surface with the atmosphere (Johnson 1975).

Cone valves work to reduce gas concentration levels in the water downstream of the dam by dispersing flow releases over a large area. The flow from the cone valves breaks up into small particles as it disperses. Friction with the air may reduce the particle flow velocity. Additionally, the intensity of the flow as it enters the tailwater is reduced due to the large dispersal area. These two effects combine to prevent a deep plunge of the jet, thus preventing significant amounts of gas from dissolving into the flow.

Flip lips, such as on Columbia River project spillways, work in a slightly different manner. They are designed simply to prevent flow over the spillway from plunging to depth by deflecting it along the surface of the water in the stilling basin (U.S. Army COE 1979). Flip lips are used on stilling basin types of spillways. The flip-bucket spillways at Watana and Devil Canyon Dams are fundamentally different than the stilling basin type of spillways for which a flip lip is applicable. The effect of the flip bucket on flows released through the spillway would be similar to the effect of the cone valves on flow. Air would be entrained in the jet as it travels from the flip bucket to the tailwater. However, the flip buckets are not designed to disperse the flow nearly as much as cone valves would. Thus, it is anticipated that operation of the spillway to pass flows would result in plunging to greater depths resulting in greater gas concentrations than if the cone valves were operated to pass the same flow.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Reservoir, Multilevel Intake, Watana

LOCATION IN DEIS: Vol 1 Page 4-21 Section 4.1.3.3 Paragraph 5 of the page

COMMENT IN REFERENCE TO: FERC "Staff believes that the vertical thermal structure in Watana reservoir would be too weak to allow effective selective withdrawal."

TECHNICAL COMMENT: The following comments on the DEIS are made based on the Applicant's analysis carried out for the Watana and Devil Canyon reservoirs using the dynamic reservoir simulation model DYRESM. The model simulates not only the average thermal structure in the reservoir but also the growth of ice cover in the winter season. The ice cover prevents wind energy from mixing the cold water beneath the ice. The model has been calibrated and verified under southcentral Alaskan conditions with 18 months of field data (daily) obtained from Eklutna Lake, which is a lake - tap hydroelectric development located approximately 100 miles south of the Proposed Project site. The lake is approximately 6.5 miles long and 180 feet deep. The results of the Eklutna Lake study are described in a report submitted to FERC in April 1984 (HE 1984e). In the analyses of the Watana and Devil Canyon reservoirs, various flow and meteorological conditions and energy demand levels for Case C minimum target flows have been considered. The filling of the Watana Reservoir has also been studied.

The statements given in the DEIS will be quoted and commented upon sequentially.

4.1.3.3.1 RESERVOIRS:

DEIS 4.1.3.3.1-1: During the early stages of Watana filling, there would be little change in the thermal structure upstream of the dam. As the reservoir became deeper and more static, a seasonal vertical thermal structure would develop and persist after filling was complete.

Comment: During the early stages of filling, for example the first summer in 1991, (see License Application Fig E.2.132) analyses using 1982 and 1983 daily flow and meteorological data indicate that the reservoir would become stratified within two months after commencement of filling operations. At that time the reservoir would have reached an approximate depth of 400 feet, would be approximately 30 miles long and would contain approximately 1,877,000 acre-feet of water. During the summer as the surface is heated by solar insolation, a 50-foot thick epilimnion layer would develop as the surface temperature approached a maximum of approximately 55 degrees F (13 degrees C). A relatively thick metalimnion (thermocline) of approximately 130 to 200 feet would also develop. The metalimnion would overlie approximately 160 feet of bottom hypolimnetic water at about 48 degrees F (9 degrees C). The temperature in the hypolimnion would increase gradually from approximately 39 to 41 degrees F (4 to 5 degrees C) at the beginning of the filling in May toward a maximum of approximately 48 degrees F (9 degrees C) near the end of summer in 1991. As the filling continues into the fall, the hypolimnion temperature would gradually decrease toward the stable 39 degrees F (4 degrees C) temperature as the depth and volume of the reservoir are increased.

DEIS 4.1.3.3.I-2: During the winter months, Watana reservoir would be near isothermal at 39 degrees F (4 degrees C) with a thin layer of cold water at the surface.

Comment: Applicant's analyses indicate that the near isothermal condition at approximately 39 degrees F (4 degrees C) would occur twice a year in early November and late May. Both Watana and Devil Canyon reservoirs would be dimictic in that they mix twice a year. Mixing would occur between ice-cover meltout and the onset of thermal stratification in late spring and between the breakdown of the thermal stratification in fall and the onset of winter ice cover. The fall overturn and winter ice cover would occur in the first year of filling. With the air temperature and solar insolation decreasing rapidly in October and November, mixing and further cooling would continue until the surface of the reservoir freezes. The presence of ice cover prevents further wind mixing and conserves the heat remaining in the reservoir. Snow cover would further insulate the reservoir surface. In general, for both reservoirs, the ice cover would form in November and a total meltout would occur in May, and a total ice thickness of two to five feet can be expected. With the formation of ice cover in the relatively long subarctic winter, an inverse stratification in the reservoir would also occur. The water at the contact surface with the ice would be near 0 degrees C and the temperature would then increase with depth toward a maximum of approximately 4 degrees C at a depth of approximately 250 to 350 feet from the surface depending upon the weather forcing conditions in the period between the fall overturn and the formation of ice cover in the reservoir. The near isothermal condition of 39 degrees F (4 degrees C) would then be maintained in the hypolimnion.

DEIS 4.1.3.3.I-3: As air temperatures warmed into the summer, the reservoir would develop a greater thermal structure, with a warm layer (approximately 50 degrees F to 54 degrees F, or 10 degrees C to 12 degrees C) near the surface, decreasing linearly to 39 degrees F (4 degrees C) near mid-depth. Much of Watana reservoir would be at 39 degrees F (4 degrees C) year-round.

Comment: The results of the Power Authority's analysis agree with the statement that a greater thermal structure would develop in the summer with a warm layer near the surface. It shows that the temperature near the surface would be about 45 to 55 degrees F (7 to 13 degrees C) with a thickness of approximately 80 to 210 feet depending upon various forcing conditions. Temporal thermo- clines would also form from time to time in this layer. At times a temporal thermoclines can have an appearance of an ordinary thermocline. The thickness of the underlying metalimnion would vary from about 60 to 180 feet. The approximate 39 degree F (4 degree C) hypolimnion would be located below a depth of approximately 230 to 560 feet. Therefore, the summer hypolimnion is generally from one-quarter to one-half of the overall reservoir depth. This represents approximately 5% to 20% of the total reservoir volume.

The winter hypolimnion is generally three-quarters of the overall reservoir depth which represents approximately 45% of the total volume. Hence, the majority of the Watana reservoir volume would be located in the epilimnion and subject to stratification and mixing. The amount of Watana reservoir volume at 39 degrees F (4 degrees C) year round would represent only about 20% to 40% of the overall reservoir volume.

DEIS 4.1.3.3.1-4: Vertical temperature gradients that exist during the summer would be relatively weak. As a result, vertical mixing is expected in areas with large shears, such as the powerhouse intake and river inflow region. Intermittent mixing could occur over much of the reservoir during the summer as a result of forcing by meteorological events.

COMMENTS: The average vertical temperature gradients that would exist in subarctic reservoirs such as the Watana and Devil Canyon reservoirs would be relatively weak as compared to temperate zone reservoirs such as Lake Mead in Arizona. However, while the average temperature greadient may be weaker, there exist strong local temperature gradients near the level of the powerhouse intakes. Power Authority analyses indicate that these vertical temperature gradients are strong enough to induce sufficient buoyancy forces such that significant vertical mixing would not occur except in the times of spring and fall overturns. This conclusion is based on stability criteria given by the "local" internal Froude number (Chandrasekhar 1961), and the "global" internal Froude number (Patterson et al. 1984). Also, experience with the DYRESM model during Eklutna Lake calibration studies, (HE 1984e) verified modifications made to the model to account for approach channel effects and periods of strong meteorological wind forcing. The wind forcing has an effect of temporal thickening of the epilimnion at the intake structure.

Instability is indicated by internal Froude number criteria during short periods of high flow through the cone valves at the Watana dam site and during the winter season at both project sites due to high flows and reservoir drawdown. A "local" internal Froude number greater than 5 as defined by Chandrasekhar and a "global" internal Froude number greater than 3 as defined by Patterson et al. are present during the unstable periods stated above. The criteria for stability are that the "local" internal Froude number must be less than 2 and the "global" internal Froude number must be less than 0.2. The "local" internal Froude number is defined at a point in the fluid continuum and is based on the Kelvin-Helmholtz stability criterion. The "global" internal Froude number is defined for a stratified fluid column and is based on withdrawal layer thickness in the outflow theory (Eqs. 68 and 72 of Imberger and Patterson 1981).

The approach channel effects on the internal Froude number are primarily responsible for this instability indication. However, these effects have been compensated for, to a limited extent, in the DYRESM model. This compensation is most evident in the successful simulation of Eklutna Lake during the calibration of the model to south-central Alaskan conditions (HE 1984e). The intake at Eklutna Lake has an approach channel similar to those in the Susitna projects. Early simulations of Eklutna Lake, before approach channel modifications to DYRESM, indicated that water was being drawn from stratified layers below the channel. After modifications, the model produced outflow temperatures which almost perfectly matched the measured values. Therefore, the DYRESM model outflow dynamics are capable of modeling the intake structure with an approach channel in both summer and winter simulations.

Addionally, while the approach channel is long enough to reduce the amount of water drawn from deeper portions of the reservoir the channel length is short relative to the length of the reservoir. Therefore, the stratification in the upper reservoir would act in such a manner as to stabilize the stratification in the channel due to the stable internal Froude numbers present in the reservoir.

<u>DEIS 4.1.3.3.1-5:</u> The thermal evolution of the Devil Canyon reservoir would be similar to that of Watana reservoir; however, the shorter residence time expected for water passing through this reservoir would likely produce a thermal structure less pronounced than for Watana.

Comment: Analyses also indicate that the thermal evolution of the Devil Canyon reservoir would be similar to that of the Watana reservoir. With a shorter residence time and low level outlet facilities (cone valves) located 400 to 500 feet below the surface, the temperature structure in the Devil Canyon reservoir would be more dynamic than that of the Watana reservoir, especially in the hypolimnion. Since the summer outflow in excess of power house flow would be passed through the low level outlet facilities, and due to warmer fall inflow from the Watana reservoir, the period of fall total mixing or overturn would last longer. The temperatures in some fall overturns could approach approximately 45 degrees F (7.2 degrees C) when the summer inflows are relatively high. The winter temperature structure and the timing of the ice cover formation and meltout would be similar to that of the Watana reservoir. However, the maximum ice thickness of the ice cover would be approximately 6 to 12 inches less than that of the Watana reservoir.

4.1.3.3.2 MAINSTEM SUSITNA RIVER

DEIS 4.1.3.3.2-1: During the initial phases of the Watana filling, the reservoir would be shallow and exhibit little thermal structure. Consequently, discharge water would parallel preconstruction water temperature.

Comment: Results indicate that a weak thermal structure in the reservoir could develop within the first two months of filling. Please see comment on DEIS 4.1.3.3.1-1 (page 2 of this Comment). The discharge water temperature would approximate preconstruction water temperature relatively well using the low-level outlet facilities during the first summer of filling. Applicant's simulations (see Appendix IV and Appendix V of this document) show there would be approximately a one month delay between inflow and outflow temperatures in June and in September and October of the first year of filling.

DEIS 4.1.3.3.2-2: As the reservoir deepens, a thermal structure would develop. There would be a period during filling when a weak vertical thermal structure would exist; however, the reservoir would not be sufficiently full to allow the upper level intake to be used. As a result, discharge water would be somewhat cooler during the summer and warmer during the winter as compared with preconstruction conditions.

<u>Comment:</u> The reservoir would not be sufficiently full to allow safe operation of the midlevel outlet works (cone-valves) until early August of the second summer of filling. The hydrothermal conditions in the reservoir during filling are described in the comment on DEIS 4.1.3.3.1-1 (page 2 of this comment). During the first summer of filling, the discharge temperature would approximate the inflow temperature then maintain a constant temperature of approximately 3 to 4 degrees C in the first winter and the following summer until the switch from low-level outlet work to midlevel outlet work occurs.

<u>DEIS 4.1.3.3.2-3:</u> During the final stages of Watana filling and during Watana operation, the upper-level intake would be used to regulate discharge temperatures in order to more closely simulate preconstruction temperatures. The Applicant has estimated operational discharge temperatures ranging from approximately 51 degrees F (10.5 degrees C) in the summer to approximately 35 degrees F (1.5 degrees C) in the winter. The extent of the control expected by the Applicant is believed to be overly optimistic. The Staff believes that the vertical thermal structure in Watana reservoir would be too weak to allow effective selective withdrawal.

<u>Comment:</u> During the ice-free seasons, the river inflow temperatures respond rather rapidly to the changing meteorological forcing conditions. Therefore, not only the upper-level intake alone, but the entire four levels of intake ports would be operated. At a given time, the intake ports at a selected level would be operated in order to closely simulate preconstruction (inflow) temperature. The results of additional analyses indicate that the operational discharge temperature would range from about 40 to 55 degrees F (5 to 12 degrees C) in the summer and approximately 33 to 38 degrees F (0.5 to 3 degrees C) in the winter. As described in comments on DEIS 4.1.3.3.I-1 and DEIS 4.1.3.3.1-2 (pages 2 and 3 of this comment) during the final stages of Watana filling and during Watana operation under the subarctic meteorological forcing conditions, a clear thermal

stratification would develop in the summers and an inverse stratification would develop under the ice cover in the winter. These stratifications may be considered as relatively weak compared with more temperate lakes.

However, with a weaker temperature gradient, if water is withdrawn from the outlet at smaller discharges, the vertical density gradient would produce buoyancy forces sufficiently strong to prohibit extensive vertical motions so that the water withdrawn comes from a thin horizontal layer at the level of the intake. At larger discharges the effects of buoyancy may be completely overwhelmed and the ouflow could induce a flow pattern in the reservoir similar to that of potential flow. Therefore, the outflow discharge, the density gradient in the reservoir, the size of the reservoir, and the approach channel effect are taken into account in computing the outflow temperatures in the DYRESM model. The approach channel to the proposed Watana intake structure is approximately 1000 feet long which would act as a barrier and to reduce the efficiency of the intake to withdraw the water from the deeper portion of the reservoir. Since the depth to the approach channel is well within the ranges of the summer stratification and winter inverse stratification, and the local temperature gradients at the intake level are generally large, the intake structure can be operated effectively to regulate the outflow temperature within the range of temperature in the stratified zone as has been demonstrated in the DYRESM simulations.

<u>DEIS 4.1.3.3.2-4:</u> The thermal structure in Watana reservoir is expected to be too weak to remain stable under the withdrawal-induced shear, so that water having a range of temperatures would be withdrawn.

<u>Comment:</u> As described in comments on the DEIS 4.1.3.3.1-4 and 4.1.3.3.2-3 (pages 4 and 7 of this comment), Applicant's results do not support the above statement. Additionally, the approach channel effect is not taken into account in the analysis shown in Figure 4-5 in the DEIS.

<u>DEIS 4.1.3.3.2-5:</u> Consequently, Watana discharge temperatures would be warmer during the winter and colder during the summer than under

preconstruction conditions. Discharge temperatures are expected to be near 39 degrees F (4 degrees C) or less during the winter. Summer discharge temperatures would be highly transient, depending on short-term dam operation and local meteorological conditions. As a result, summer discharge temperatures cannot be quantified at this time but could range from 41 degrees F (5 degrees C) to 50 degrees F (10 degrees C).

Comment: With the intake ports located at four levels, the Watana discharge temperatures can be controlled to approximate the inflow temperatures as the preconstruction conditions. In the summer, the river inflows are more responsive to variations in the meteorological conditions than the reservoir due to the shallowness of the river. The river inflow warms up in the early summer and cools down in the late summer more rapidly than does the reservoir. Hence, the Watana discharge water would be colder in the early summer and warmer in the early fall than preconstruction conditions. However, in most of the summer months the Watana discharge temperatures could be regulated to approximate inflow temperatures through operation of the multilevel intake. In the winter, inflow temperatures would be near 32 degrees F (0 degrees C) and the temperatures in the inverse stratification zone would range from near 32 degrees F (0 degrees C) at the contact face with the ice cover to approximately 39 degrees (4 degrees C) at the hypolimnion. Therefore, the Watana discharge temperatures would be slightly warmer during the winter than under preconstruction conditions. As a result, the discharge temperatures would range from approximately 41 degrees F (5 degrees C) to 54 degrees F (12 degrees C) in the summer and approximately 33 degrees F (0.5 degrees C) to 39 degrees F (4 degrees C) in the winter depending on the meteorological condition, energy demand level, downstream flow requirements, and the intake operation scheme.

DEIS 4.1.3.3.2.-6: The Applicant has estimated that under combined Watana/Devil Canyon operation, Devil Canyon discharge temperatures would range from approximately 46 degrees F (8 degrees C) to approximately 38 degrees F (3.5 degrees C). As in the case of Watana operation alone, outflow temperatures from the Devil Canyon dam would be regulated via selective withdrawal through multilevel intakes. The thermal structure of

The Devil Canyon reservoir would be weaker than for the Watana reservoir. Consequently, it is expected that the multilevel intake would offer very little control over outlet temperature. As a result, winter outlet water temperatures are expected to be near 39 degrees F (4 degrees C), and summer outlet temperatures, although unquantifiable at this time, are expected to be somewhat colder than those estimated by the Applicant.

Comment: Additional analyses have been carried out for the combined Watana/Devil Canyon operating condition under the year 2002 and year 2020 energy demand levels. The flow and meteorological conditions applied include periods of May 1981 to May 1983, May 1971 to May 1972, May 1974 to May 1975, and May 1976 to May 1977. The results indicate that the thermal structure developed in the Devil Canyon reservoir would be similar to that of the Watana reservoir. In high flow years, stronger mixing would exist in the hypolimnion where the outlet facilities are located. However, strong temperature gradients would exist near the intake level and would facilitate control of outflow temperatures in a similar manner to Watana operations alone through selective operation of the multilevel intake. Hence, the Devil Canyon discharge temperatures would range from approximately 39 degrees F (4 degrees C) to 55 degrees F (13 degrees C) in the summer and approximately 33 degrees F (0.5 degrees C) to 38 degrees F (3.5 degrees C) in the winter.

4.1.3.4. Ice Processes:

DEIS 4.1.3.4-1: Once filling of Watana was complete, the impoundment would be expected to ice over in winter. As air temperatures increased in the spring and summer, the ice should decay in place. Ice formation and decay in the Devil Canyon impoundment would be similar to that expected for the Watana impoundment.

Comment: Please see comment on DEIS 4.1.3.3.1-2 and DEIS 4.1.3.3.1-5 (pages 2-5 of this comment).

In order to aid the FERC Staff in its analysis of environmental impacts, and to provide the reservoir and stream temperature simulations requested in April, 1983, Appendix IV has been compiled. This Appendix contains results of DYRESM reservoir temperature projections for Watana filling, Watana operating, and Watana and Devil Canyon operating. Case C minimum target flows were utilized. The following table lists the simulations presented in the Appendix.

Please see Technical Comment AQR119 with regard to an analysis of temperature impacts on fish utilizing temperature simulations provided in Appendix IV and Appendix V.

DYRSEM Reservoir Temperature Simulations
Compiled for the
Susitna Hydroelectric Project

	Energy Demand Year				Filling[1]		
	1996	2001	2002	2020	1991-92	1992-93	1993-94
Hydrologic Condition							
Average Year (May 1982-May 1983)	x	x	x	x	x		x
Wet Year (May 1981-May 1982)	x	x	x	x	x	x	
Dry Year (May 1974-May 1975)	x	x	x	x			
Winter Meteorologic Condition							
Cold Winter (May 1971-May 1972)	x	x	x	x			
Average Winter (May 1976-May 1977)	x	2/	x	x			

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1 See License Application Figure E.2.138

2 Reservoir temperature simulation was not made for 2001 energy demands for the May 1976-May 1977 period because comparisons of previously made runs for 1996 and 2001 energy demands for other weather conditions were similar. It is believed that temperatures for 2001 energy demands for 1976 -1977 would be similar to those for 1996 energy demands.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Model, Susitna River

LOCATION IN DEIS: Vol 1 Page 4-23 Section 4.1.3.3.2 Paragraph 1 & 2 of page

COMMENT IN REFERENCE TO: River temperature simulation used in the DEIS which was in lieu of the License Application temperature simulation

TECHNICAL COMMENT: It appears that in the temperature model employed in the DEIS, the sign of the atmospheric long wave radiation term was incorrectly shown as heat flux from water to the atmosphere rather than from the atmosphere to the water or that the time interval was incorrectly computed. See Technical Comment AQR074 for further explanation of this.

The Alaska Power Authority made computations using the formulation employed in the DEIS but with the corrected formulation. These analyses yielded warming and cooling rates for midsummer and late fall/early winter respectively, which were similar to those given in the License Application, Figures E.2.176, E.2.217 and E.2.219. Therefore, it appears that there is no basis for the comments made in the DEIS questioning the validity of the river temperature simulations. (See Vol. 1, Page 5-11, Para. 3, Vol. 4, Page I-58, Para. 3, Vol. 4 Page I-48 Para. 6, Vol. 4, Page I-43, Para. 2).

An apparent error has also been discovered in the DYRESM simulations of the Devil Canyon reservoir in the License Application. The elevation area-volume relationship used to describe the reservoir apparently utilized volumes which were high by a factor of 6. This would tend to cause Devil Canyon reservoir simulations to show greater temperature variations between natural and with-project conditions than would actually occur. This error has been corrected in all the Devil Canyon temperature simulations attached to these comments (See Appendix IV).

In order to aid FERC Staff in its analysis of river temperatures, the Power Authority has prepared a series of refined river temperature simulations. These simulations were requested by FERC in its Schedule B Request for Supplemental Information of April 1983 (Number 2.28 asking for longitudinal profiles of river temperatures during years of high, average and low releases). These simulations are attached as Appendix V. They are based on reservoir temperature simulations presented in Appendix IV. The SNTEMP river temperature model description and validation is presented in AEIDC (1983b) which was supplied to FERC on December 5, 1983.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Susitna River

LOCATION IN DEIS: Vol 1 Page 4-23 Section 4.1.3.3.2 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Similarities between temperature impacts downstream with Watana or with Watana/Devil Canyon

TECHNICAL COMMENT: The statement that downstream water temperatures with Watana operation alone are expected to be similar to those anticipated under combined operation is ambiguous and contradicts other statements and figures in the DEIS.

It is not clear if downstream refers to the area downstream of the Chulitna - Susitna confluence or if it refers to the entire area downstream of the dams. DEIS Figure 4-8 shows temperature differences in the reach between the confluence of the Chulitna and Susitna Rivers and Devil Canyon. Paragraphs 3 and 4 on Page 4-30 of DEIS Vol. 1 indicate that temperature-related impacts will increase when Devil Canyon begins operation, based on a comparison of temperatures in the reach downstream of the Chulitna - Susitna confluence.

This statement should be clarified based on results of refined temperature modeling attached hereto as Appendices IV and V.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Temperature, Groundwater, Mainstem

LOCATION: Vol 1 Page 4-23 Section 4.1.3.3.3 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Groundwater originating from the mainstem would be at or near the mean annual mainstem temperature

TECHNICAL COMMENT: A recently prepared report entitled "Susitna Hydroelectric Project Slough Geohydrology Studies" (HE 1984a) concludes that the temperature of the component of slough flow resulting from groundwater upwelling from the mainstem "...appears to remain relatively constant at a value approximately equal to the mean annual (time-weighted) river temperature. Changes in mean annual river temperature resulting from project operation will probably be reflected in the temperature of the groundwater upwelling component..."

This study confirms previous conclusions that heat exhange between groundwater and soil materials, and mechanical dispersion during groundwater transport through the aquifer, are reasonable mechanisms to account for the observed groundwater temperatures.

An analysis of simulated mainstem temperatures for the period May 1982 to April 1983 is shown in the following table.

Mean Annual Temperatures (Simulated)
Susitna River at Slough 9
for May 1982 - April 1983
Case C Minimum Target Flows

Condition	Temperature
Natural	3.9°C
Watana operation	4.3°C
Watana/Devil Canyon	4.1°C

A comparison at other slough locations would have similar results. It appears that the temperature of mainstem infiltration to the sloughs will remain at approximately natural levels when the project is in operation. A copy of the report describing these studies is attached as Appendix VII.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Sloughs, Groundwater

LOCATION IN DEIS: Vol 1 Page 4-23 Section 4.1.3.3.3 Paragraph 5 of the page

COMMENT IN REFERENCE TO: There are insufficient data regarding groundwater discharge and mainstem infiltrations to sloughs.

TECHNICAL COMMENT: It has been possible to isolate periods when overtopping of upstream berms by mainstem water levels and local runoff into the sloughs from tributaries and rainfall do not contribute significantly to slough flow (Appendix VII - Slough Geohydrology Studies). Using statistical analyses, inferences can be drawn of the relationships between mainstem discharge and the apparent groundwater upwelling in the sloughs for these periods. The derived relationships for Sloughs 8A, 9 and 11 are shown on the attached Figures 1 through 3, which are from Appendix VII of this document.

The relationships shown are felt to be strongest for Slough 11, because of its unique nature. Slough 11 did not experience any periods when overtopping of its upstream berm occurred. In addition, Slough 11 has a very small tributary drainage area and local runoff into the slough is generally insignificant.

Slough 9 is subject to overtopping at discharges in excess of 16,000 cfs (ADF&G 1984c). Therefore, the relationship shown in Figure 2 is based solely on those points for which mainstem discharges were less than 16,000 cfs at Gold Creek. Two points were not considered in the analysis. It is possible these represent local runoff from storms.

The relationship shown for Slough 8A is statistically the weakest of the relationships. The data was drawn from the period June 6 - August 7 when the mainstem flow was less than 30,000 cfs and the upstream berm was not overtopped. Approximately one-third of the points (all those representing slough flows in excess of 3 cfs) were removed from the analysis as possibly representing variations due to local runoff. There was no physical reason for removing these data from the record. It is not possible, from the available weather data, to determine if local runoff could have been significant on these days. However, a statistical analysis of the remaining data points gives a good correlation and a line having a slope similar to that shown for Slough 11. Caution should be used in extrapolating the indicated relationship at Slough 8A to mainstem discharges less than 16,000 cfs because of the lack of data below this point.

The indicated relationships can be used with mainstem discharge as the independent variable or can be converted to relationships based on water level at a convenient location near the sloughs without loss of accuracy.

A relationship between mainstem flow (Q) and slough flow (q_s) at Slough 21 was developed as follows:

$$q_s=0.000788Q - 2.49$$

The Slough 21 berm is overtopped for mainstem discharges in excess of 24,000 cfs. The indicated relationship was derived from measurements of slough discharges between approximately 22,000 cfs and 6,000 (9/22/82 - 10/22/82) and had a coefficient of correlation of 0.96.

Further analyses were undertaken to estimate the components of slough groundwater flow resulting from:

1. Groundwater transport in the downstream direction within alluvial materials comprising the Susitna River valley, and
2. Groundwater transport toward the river from glacial till and sedimentary rocks upland comprising the Susitna valley walls and basin.

For an assumed hydraulic conductivity of 500 gallons per day (gpd) per square foot, a saturated thickness of 100 feet, an aquifer width of 3000 feet, (incuding the active channel and the alluvial floodplain), and an average downstream groundwater level gradient of 0.003, the average rate of downstream transport of groundwater would be about 0.7 cubic feet per second (cfs). Even if this estimate is significantly low, it would appear that regional groundwater transport within the Susitna River alluvium would not be sufficient to provide all of the groundwater discharge apparently observed in the various sloughs. This tends to support hypotheses that large proportions of the slough discharge may be derived from shallow lateral flow from the river, or local runoff from tributary streams, rather than regional groundwater underflow within the Susitna River valley-fill materials (Trihey 1982).

Although no local hydrologic data are available for the glacial till and sedimentary bedrock forming the valley walls, an estimate of potential groundwater flow through them has been based on formation properties for similar materials reported in the literature, and estimates of the local hydraulic gradient and saturated aquifer thickness.

Davis and DeWiest (1966) have summarized formation properties for a wide variety of aquifer materials. They report typical hydraulic conductivity values of about 2×10^{-6} cm/sec for glacial till, and about 8×10^{-6} for sedimentary bedrock. For purposes of the present analysis, a value of 5×10^{-6} cm/sec was assumed for the hydraulic conductivity of the valley wall materials, the groundwater level surface within natural materials generally reflects the land surface. Thus, the land surface slope toward the Susitna River valley, which averages about 0.3 in the vicinity of sloughs 8A and 9, has been taken as an approximation of the hydraulic gradient. Finally, the effective saturated thickness of groundwater flow through the valley wall materials toward the river has been assumed to be 500 feet.

All of the above approximations and assumptions have been selected so as to provide a reasonable estimate of the maximum groundwater flow through the valley wall materials. Based on these assumptions, the potential groundwater inflow into the river valley from the adjacent valley walls would be about 2.5×10^{-5} cfs per linear foot of valley length. This would provide about 0.2 cfs of discharge to either of sloughs 8A or 9, and a total inflow of only 4 cfs to the entire Susitna River valley in the reach between sloughs 21 and 8A. These estimates of the maximum potential inflow to sloughs 8A and 9 from the valley wall materials are about an order of magnitude less than the inferred groundwater upwelling component of slough discharge, as discussed above. These results again tend to support hypotheses that large proportions of slough discharge may be derived from shallow lateral flow from the river, or local runoff from tributary streams.

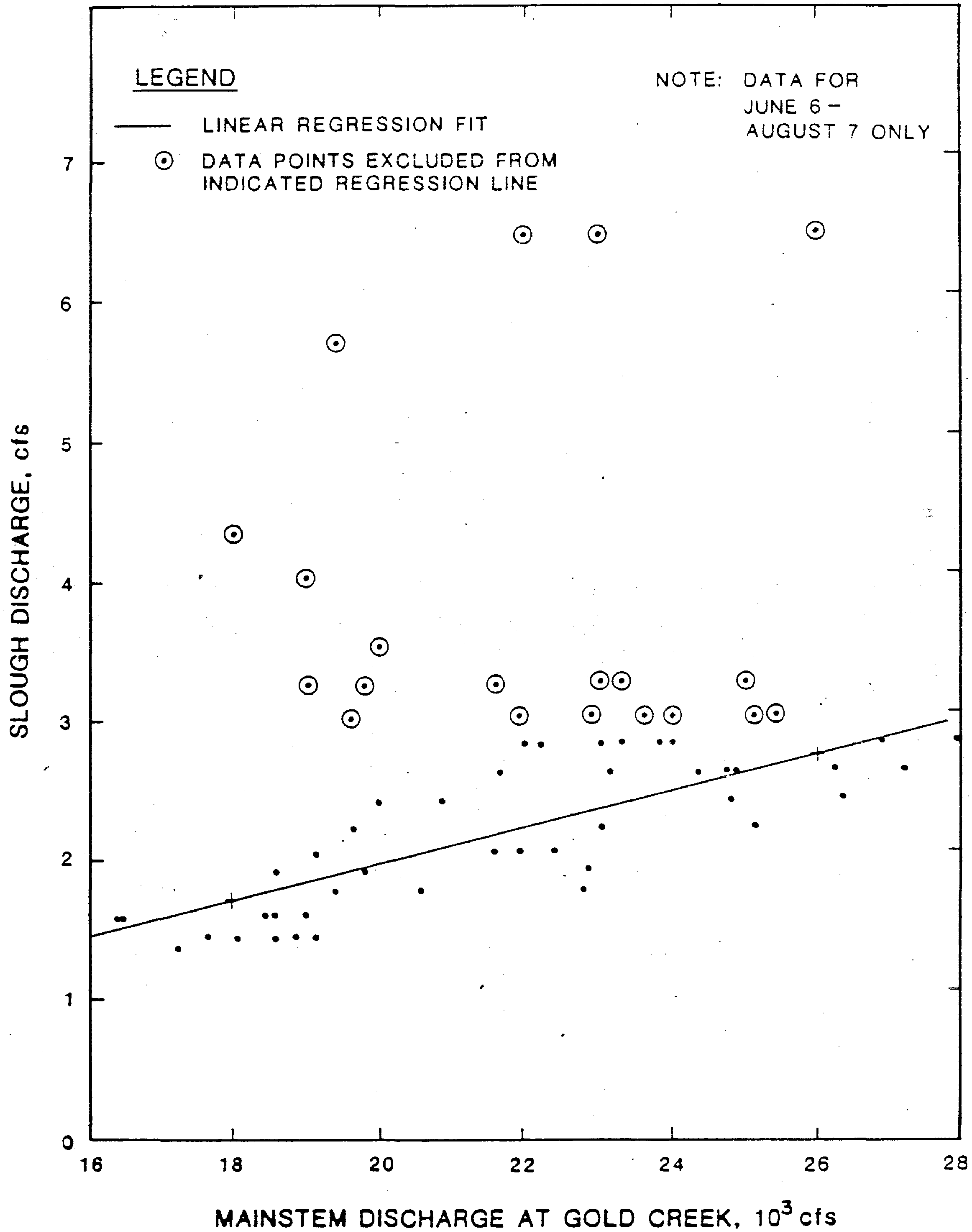
Based on the available data and analyses, it appears the relationship between slough discharge and mainstem discharge obtained for Slough 11 is most representative of the behavior of the groundwater upwelling due to mainstem infiltration. Similar relationships would be expected of other sloughs, however, the slopes and intercepts would vary. A chart has been prepared (Figure 4) showing the simulated groundwater upwelling at Slough 11 for natural, Watana and Watana/Devil Canyon conditions for the period May 1982 to April 1983. This figure is based on the relationship between mainstem flow and slough upwelling shown in Figure 1.

Groundwater upwelling estimated for ice cover periods is computed for a mainstem discharge which would give a water level equivalent to the water level caused by ice staging.

It should be noted that the relationship between mainstem flow and upwelling was developed for open water flows in excess of 8000 cfs and the great concentration of mainstem flows were in excess of 12,000 cfs. Many of the with-project discharges used to plot Figure 4 are at the low end of this range and a few points are below 8000 cfs. The relationship was simply extrapolated to fit.

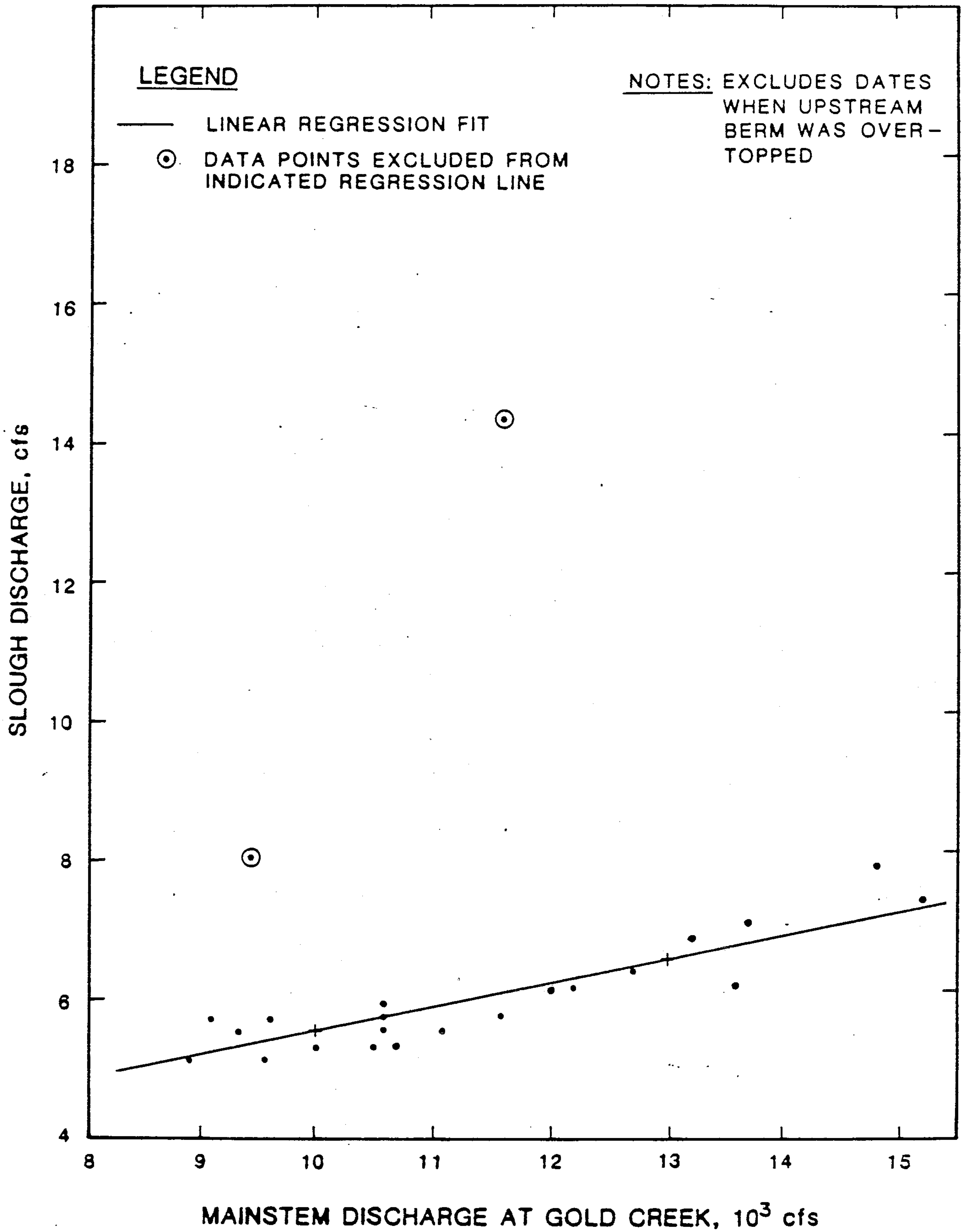
The report "Susitna Hydroelectric Project Slough Geohydrology Studies" is attached as Appendix VII.

FIGURE 1



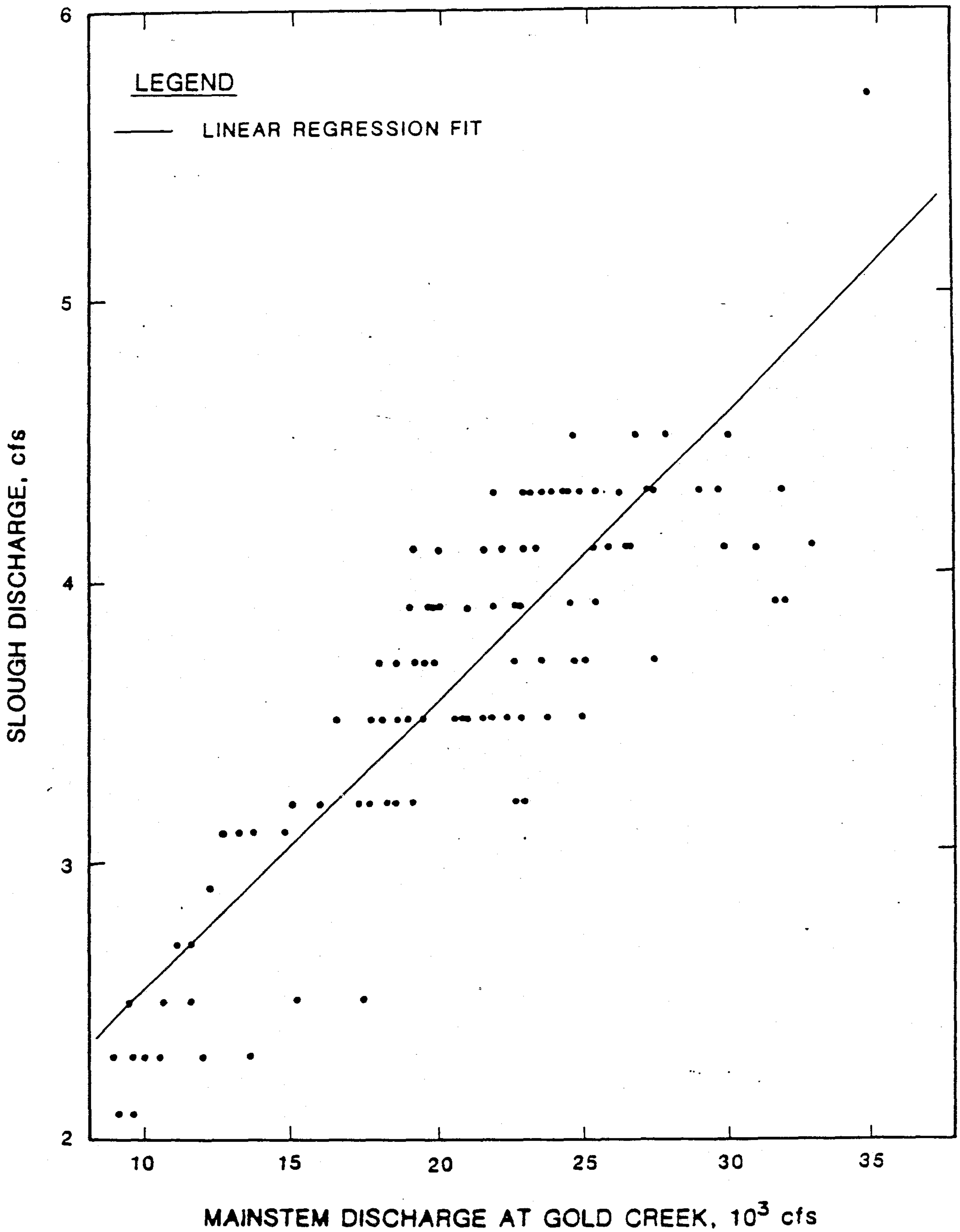
SLOUGH 8A DISCHARGE VS. MAINSTEM DISCHARGE AT GOLD CREEK, SUMMER 1983

FIGURE 2

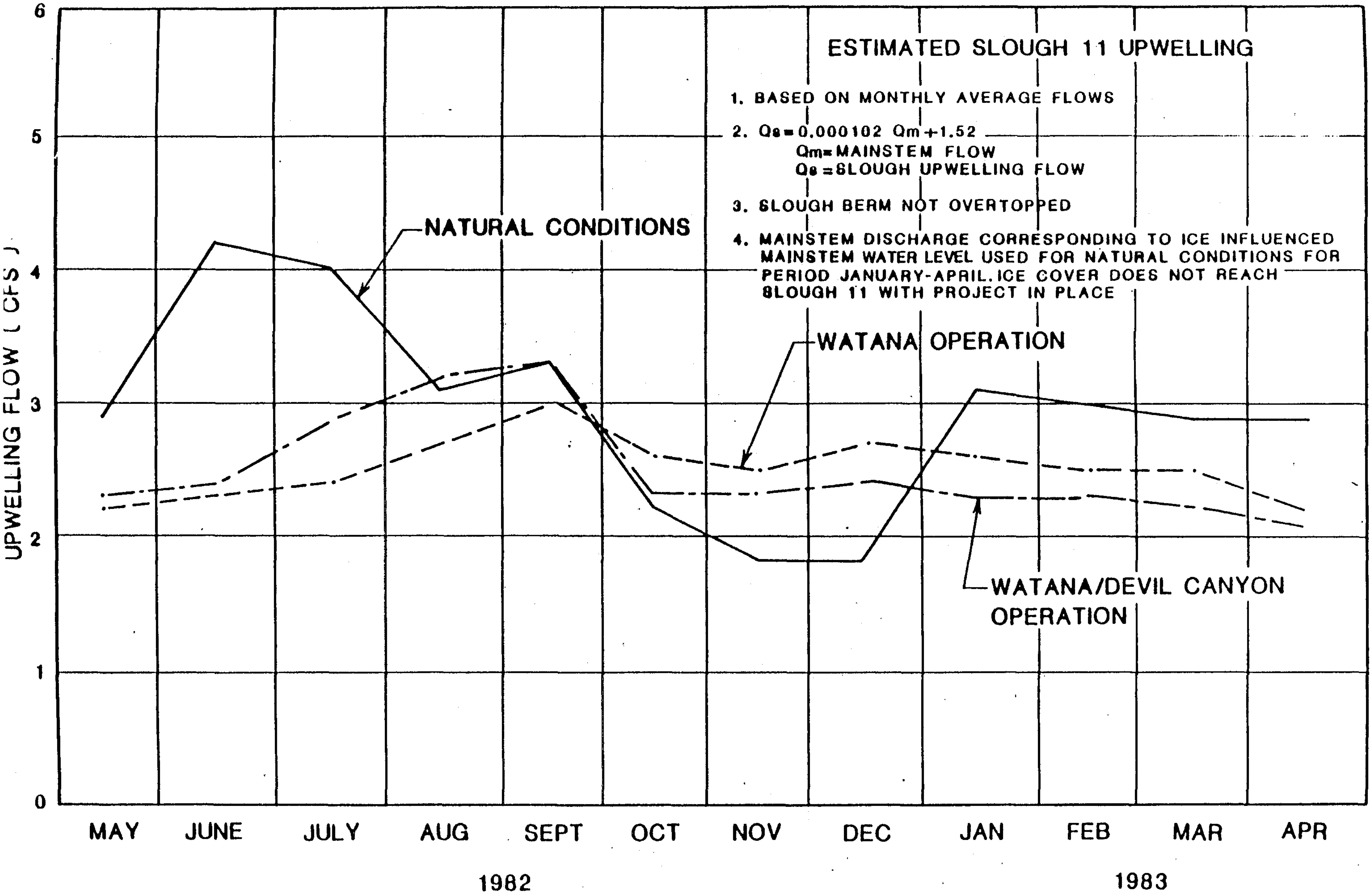


SLOUGH 9 DISCHARGE VS. MAINSTEM DISCHARGE AT GOLD CREEK, SUMMER 1983

FIGURE 3



SLOUGH 11 DISCHARGE VS. MAINSTEM DISCHARGE
AT GOLD CREEK, SUMMER 1983



Technical Comment AQR036
FIGURE 4

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Ice Processes, Susitna River

LOCATION IN DEIS: Vol 1 Page 4-23 Section 4.1.3.4 Paragraph 7 of the Page

COMMENT IN REFERENCE TO: Effect of higher winter flows on ice processes.

TECHNICAL COMMENT: The Applicant agrees that operation of the project would affect the ice regime on the Susitna River. The following discussion is provided to supplement the information in the DEIS by summarizing the results of river ice modeling undertaken by the Power Authority and presented in Appendix VI. A discussion of the impacts resulting from the altered ice regime is given in Technical Comment AQR071.

The Watana and Devil Canyon dams would cut off the flow of ice from upstream reaches of the river. This may delay the formation of an ice cover in the Susitna River near Cook Inlet and, ultimately, in the reach upstream of the Chulitna-Susitna confluence. Increased winter flows for power production and warmer winter water temperatures from the reservoirs would also affect ice processes.

In order to evaluate the effects of these and other changes resulting from project implementation, river ice simulations have been carried out using the ICECAL model (HE 1984d). The simulated reach extends from the Chulitna-Susitna confluence to Devil Canyon The simulations were carried out in coordination with reservoir temperature simulations (Appendix IV) and open water temperature simulations (Appendix V).

Ice cover progression on the Susitna River normally begins in October when an ice bridge forms near River Mile 9 upstream of Cook Inlet (See Technical Comment AQR009). This bridge and the ice cover between this location and the Yentna River confluence are formed by ice generated in the Susitna and Yentna Rivers. With the project the ice contribution from the Susitna River will be reduced, but the ice production from the Yentna River will remain same. Therefore, the formation of an ice bridge at River Mile 9 may be delayed. However, other factors which will not be affected by project implementation, including tides and extremely cold weather may be as important as the amount of influent ice to the formation of the initial ice bridge. Therefore, in order to provide for conservatism in the simulations it has been assumed that the ice front reaches the Yentna-Susitna confluence on November 1.

In order to simulate ice processes in the study reach between the Chulitna-Susitna confluence and Devil Canyon, the time when the ice front reaches the Chulitna-Susitna confluence must be known. Observations have shown that the ice front progresses past the confluence when the ice capacity of the downstream reach is nearly full. Therefore, the ice study included computations of the time required to fill this reach based on ice production in the Chulitna, Talkeetna and Susitna (middle and lower reaches) Rivers.

The results of instream ice simulation runs including time histories of water level, ice thickness, and water temperature at significant habitat locations are included in Appendix VI. These simulations were requested by FERC in April 1983 as part of their Schedule B Request for Supplemental Information No. E.2.41. See Technical Comment AQR071 for further descriptions of ice simulations. The attached Exhibits A-R are from Appendix VI of this document.

River ice simulations were made for natural conditions and for with-project conditions for the winters of 1982-1983 and 1976-1977 representing winters with average air temperatures, and 1981-1982 and 1971-1972 representing winters with colder than average air temperatures. The ice simulation model ICECAL was calibrated to observed conditions for 1982-1983 and 1983-1984 (HE 1984d). With project conditions were not modeled for 1983-1984 because of its similarity to 1982-1983. Simulations for natural conditions were limited to the reach between river mile 139 and the Susitna-Chulitna confluence for reasons discussed in Appendix VI. Therefore comparisons between natural and with-project ice simulations cannot be made for the reach upstream of river mile 139.

For the 1982-83 freezeup (natural conditions, average winter temperatures), the observed beginning for progression up the middle reach was around November 2 (Exhibit A). With Watana only, the progression is expected to begin on December 10 (Exhibit B).

Higher winter flows with-project are expected to result in generally thinner ice, but slightly higher water levels (with less staging) than preproject. The most significant difference is the zone of open-water downstream of Watana with-project. For instance, simulations using the 1982-83 winter climate data indicate that the open-water zone would extend approximately 60 miles downstream of Watana (Exhibit B). Even with the higher winter power demand in year 2001, and with the addition of Devil Canyon operation in 2002, the ice front is expected to advance only approximately 25 miles upstream of the Chulitna confluence. (Exhibits C, D, and R).

Using the 1976-77 winter hydrological and meteorological data, with average air temperatures similar to 1982-83 for simulated natural conditions the ice front would reach Gold Creek (River Mile 136.6) in late February (Exhibit B). With Watana only operating the ice front would reach Gold Creek in late March (Exhibit E). With Watana and Devil Canyon operating the ice front would advance only approximately 25 miles upstream of the Chulitna confluence (Exhibit F).

In cold winters such as 1981-1982, under natural conditions the ice front would be expected to reach Gold Creek in early January (Exhibit Q). With Watana only operating the ice front would advance to Gold Creek in late January (Exhibit G). With Devil Canyon operating the ice front would only advance to near River Mile 125, downstream of Slough 8A (Exhibit J).

The winter of 1971-1972 provided the fastest and furthest upstream progression of the ice front. For natural conditions the ice front would reach Gold Creek in mid-December (Exhibit O). With Watana only operating the ice front would reach Gold Creek in early to late January (Exhibits H and I) depending on the energy demand. With Devil Canyon operating the ice front would reach Gold Creek in early March for 2002 energy demands (Exhibit K). For Devil Canyon operating and 2020 energy demands the ice front would only advance to River Mile 133 (Exhibit L).

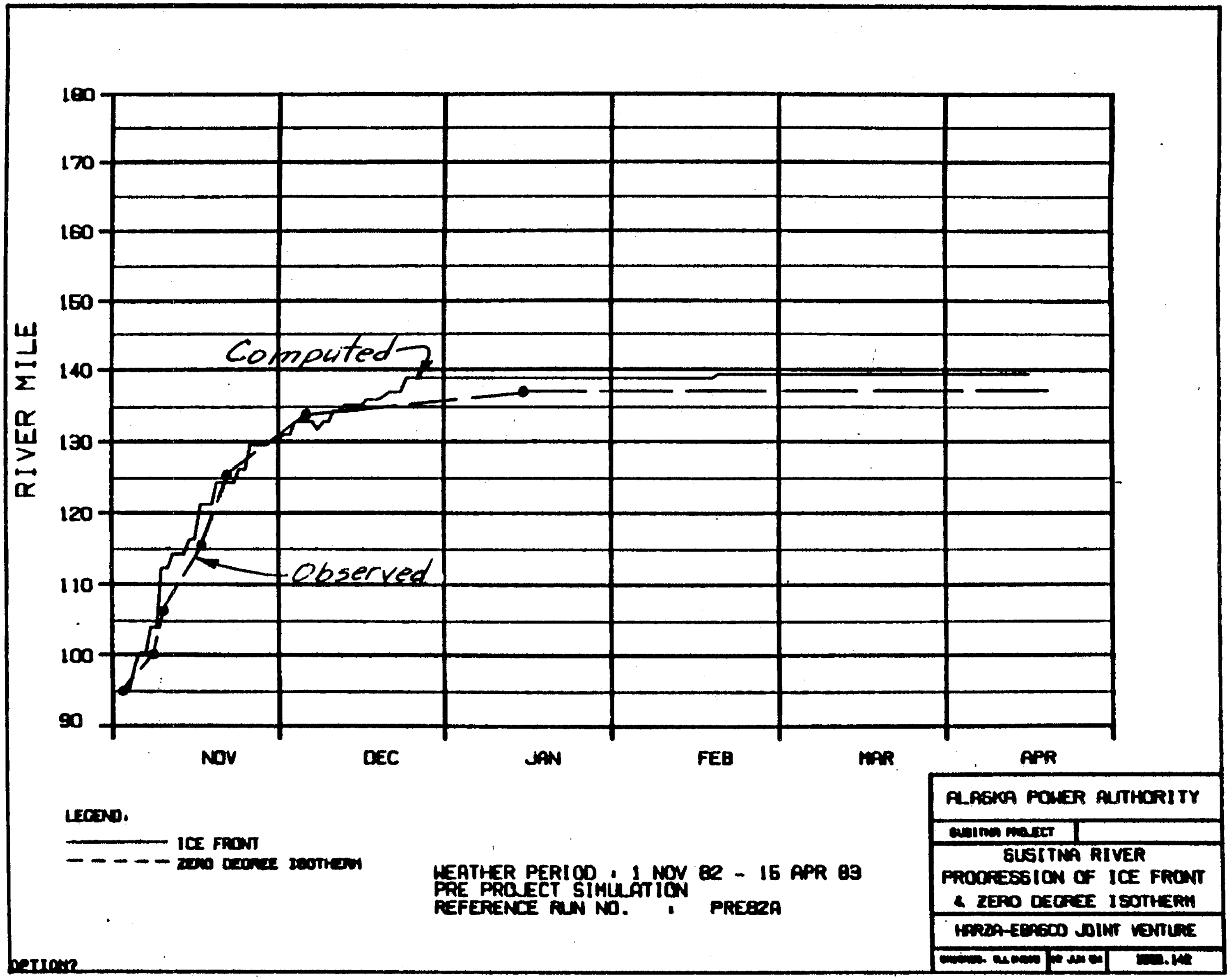
River ice simulations have also been made for the first and second winters of Watana filling. For the first winter when outflow would be made from the low level outlet and temperatures would be relatively warm the simulation was made using the 1982-1983 meteorological data which provide the mildest weather simulated. For this case the ice front would be expected to advance to near Gold Creek (River Mile 135) by mid-February. Maximum water levels would be similar to natural conditions. For the second winter of filling, outflows would be made from the midlevel outlet works (intake located at El. 2027), and outflow temperatures would be colder than in the first winter of filling. The winter of 1981-1982, a relatively cold winter was used to simulate river ice for this year. For this case the ice front would be expected to advance to near Gold Creek (River Mile 135) by early February (Exhibit N). For both the first and second winters of filling, border ice is expected to have a predominant influence on ice cover formation upstream of Gold Creek. This would be similar to natural conditions. Sufficient information was not available to allow accurate simulation of this process upstream of approximately River Mile 139 for the filling years.

The ice breakup (meltout) is expected to occur earlier with-project than under natural conditions. As indicated in Technical Comment AQR009 under natural conditions the river is generally open by mid-May. With-project the river upstream of the Chulitna-Susitna confluence may be open as early as mid-March for average winters such as 1982-1983 or as late as mid-May in very cold winters such as 1971-1972. With Devil Canyon operating with 2002 energy demands the river will generally be open 2 to 3 weeks earlier than with Watana only operating. With Devil Canyon operating and 2020 energy demands, the river upstream of the Chulitna-Susitna confluence would be open 2 to 3 weeks earlier than with 2002 demands. For filling of Watana reservoir the river would probably be open in mid-May similar to natural conditions.

With-project the ice is expected to be removed from the middle reach by meltout rather than breakup. The melting occurs generally before solar radiation becomes important. The melting is accomplished by above 0°C water reaching the ice front when air temperatures are not low enough to cool the reservoir outflow to 0°C.

The breakup (meltout) with-project is expected to be mild compared to pre-project becaue it will progress from upstream to downstream. In addition, the regulted releases would prevent the structural failure of the ice cover, which occurs under natural conditions.

The with-project meltout will generally take place over a longer time period than pre-project breakup. Exhibits A-R show meltout occurring in 2-4 weeks, whereas pre-project breakup generally occurs in 1-2 weeks.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WEATHER PERIOD : 1 NOV 82 - 15 APR 83
PRE PROJECT SIMULATION
REFERENCE RUN NO. : PRE82A
ALASKA POWER AUTHORITY
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PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
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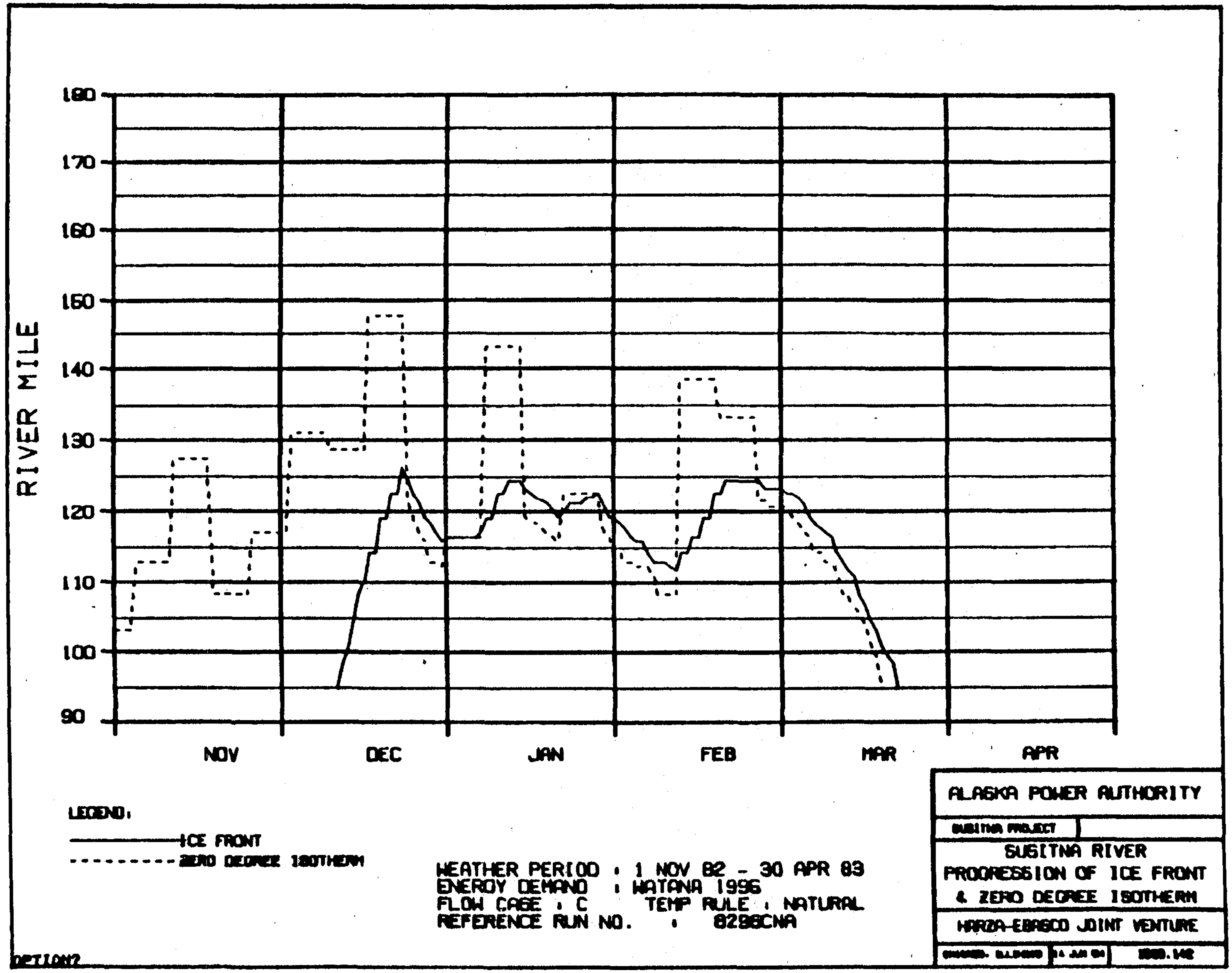
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WEATHER PERIOD : 1 NOV 82 - 30 APR 83
ENERGY DEMAND : WATANA 1996
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 8286CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
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PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
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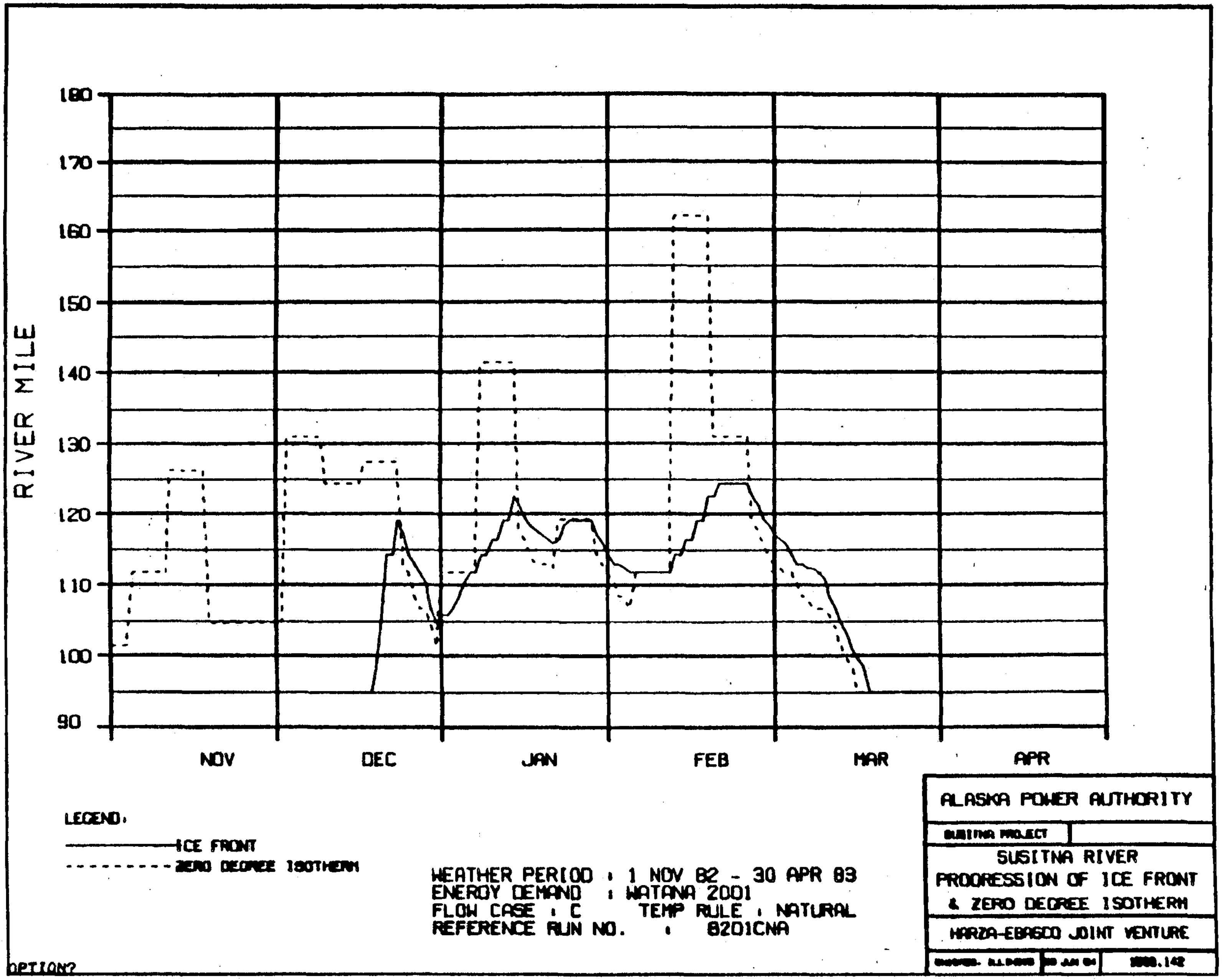
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WEATHER PERIOD : 1 NOV 82 - 30 APR 83
ENERGY DEMAND : WATANA 2001
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 8201CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
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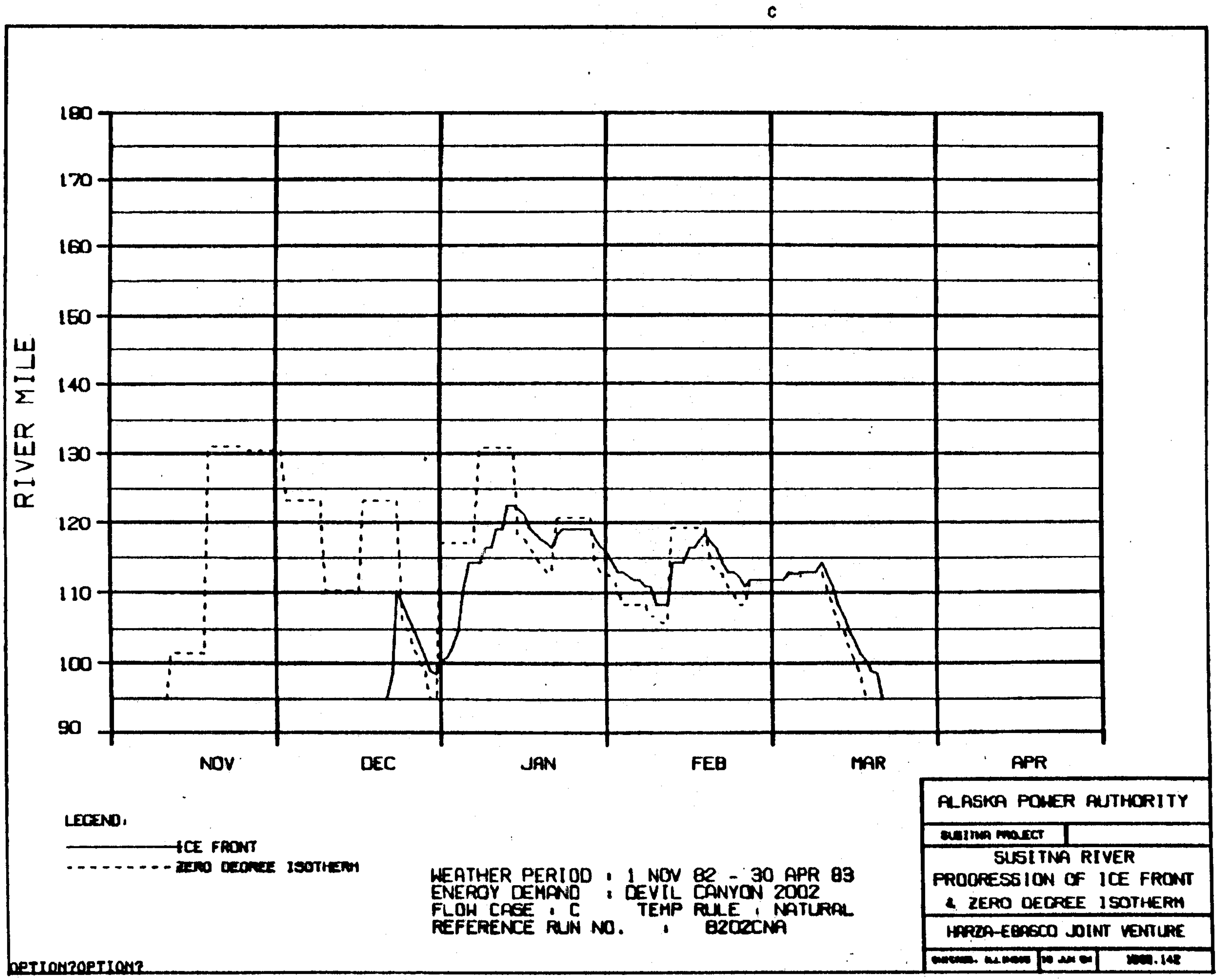
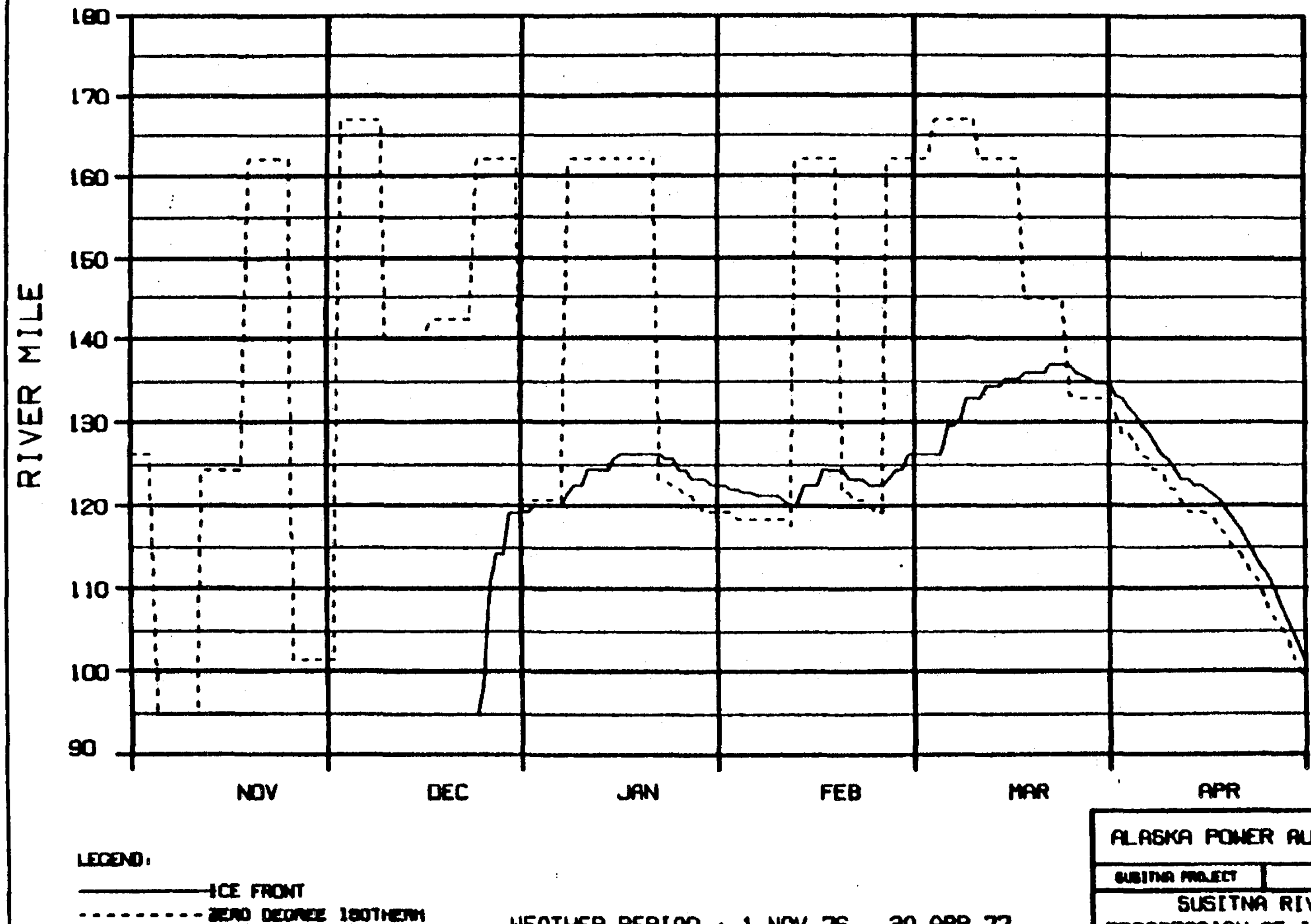
Technical Comment AQR037
Page 9
Exhibit D





WEATHER PERIOD : 1 NOV 76 - 30 APR 77
ENERGY DEMAND : WATANA 1996
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7696CNA

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
PROGRESSION OF ICE FRONT
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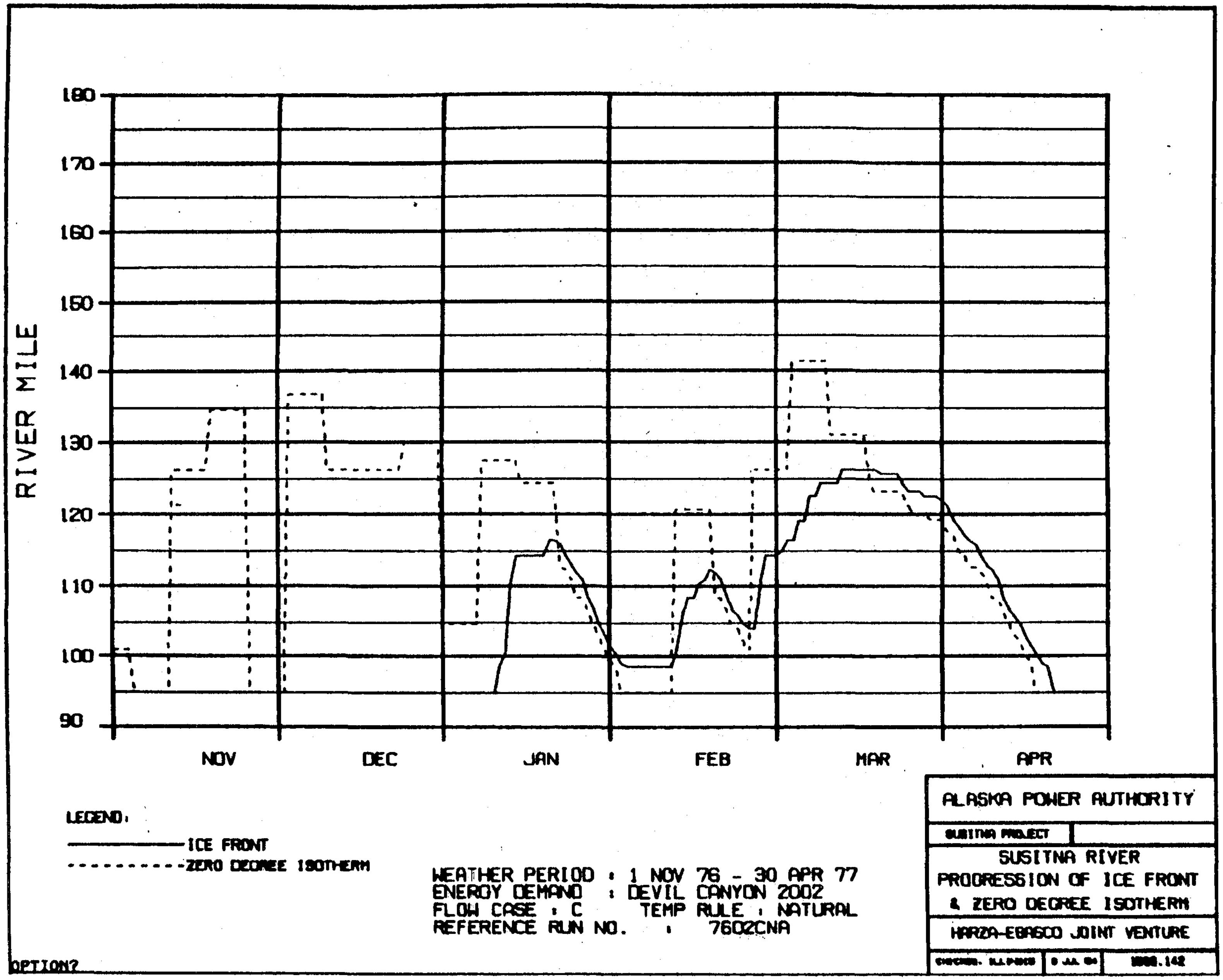
HARZA-EBASCO JOINT VENTURE

OPTION?OPTION?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WEATHER PERIOD : 1 NOV 76 - 30 APR 77
ENERGY DEMAND : DEVIL CANYON 2002
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7602CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
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PROGRESSION OF ICE FRONT
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HARZA-EBASCO JOINT VENTURE
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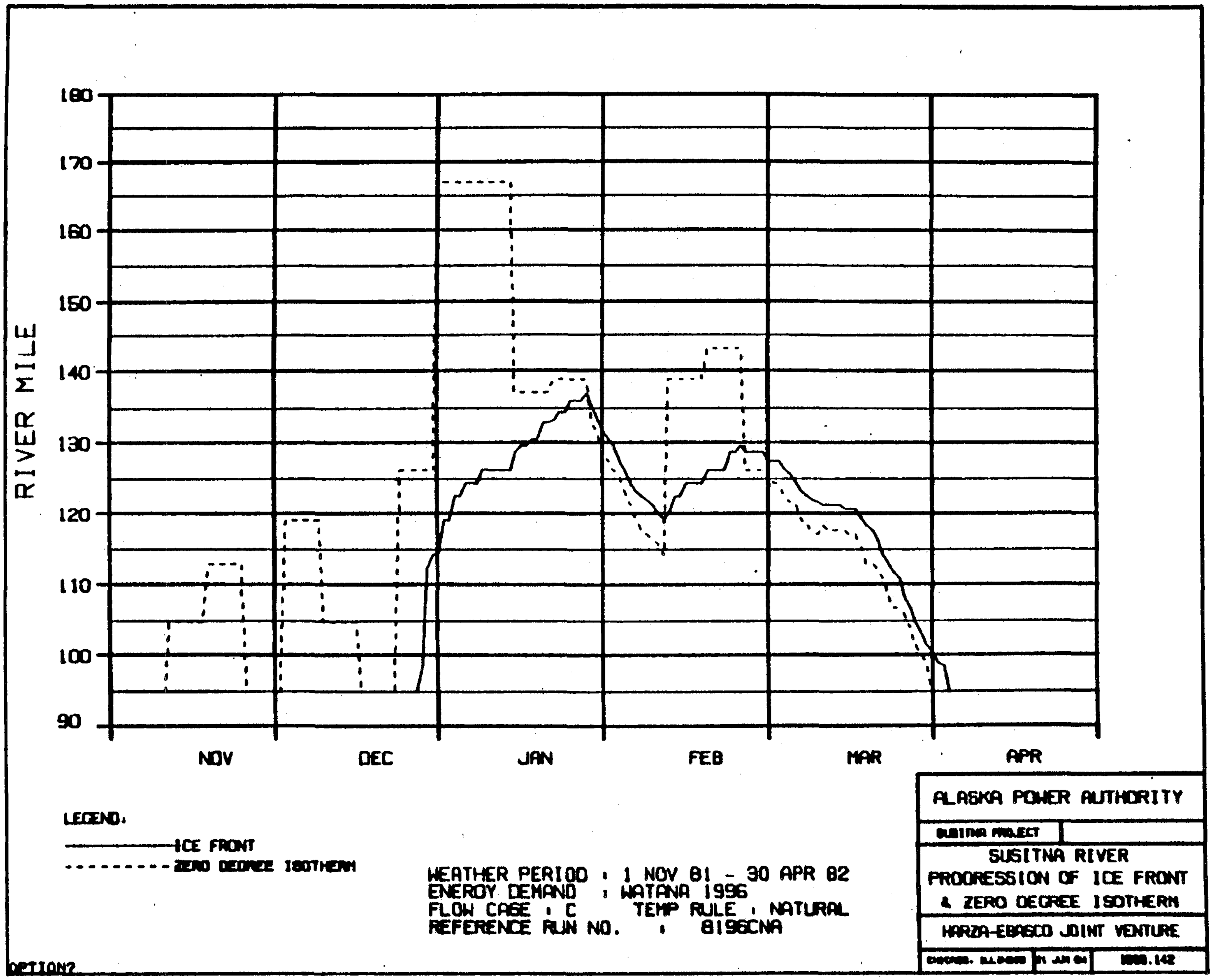
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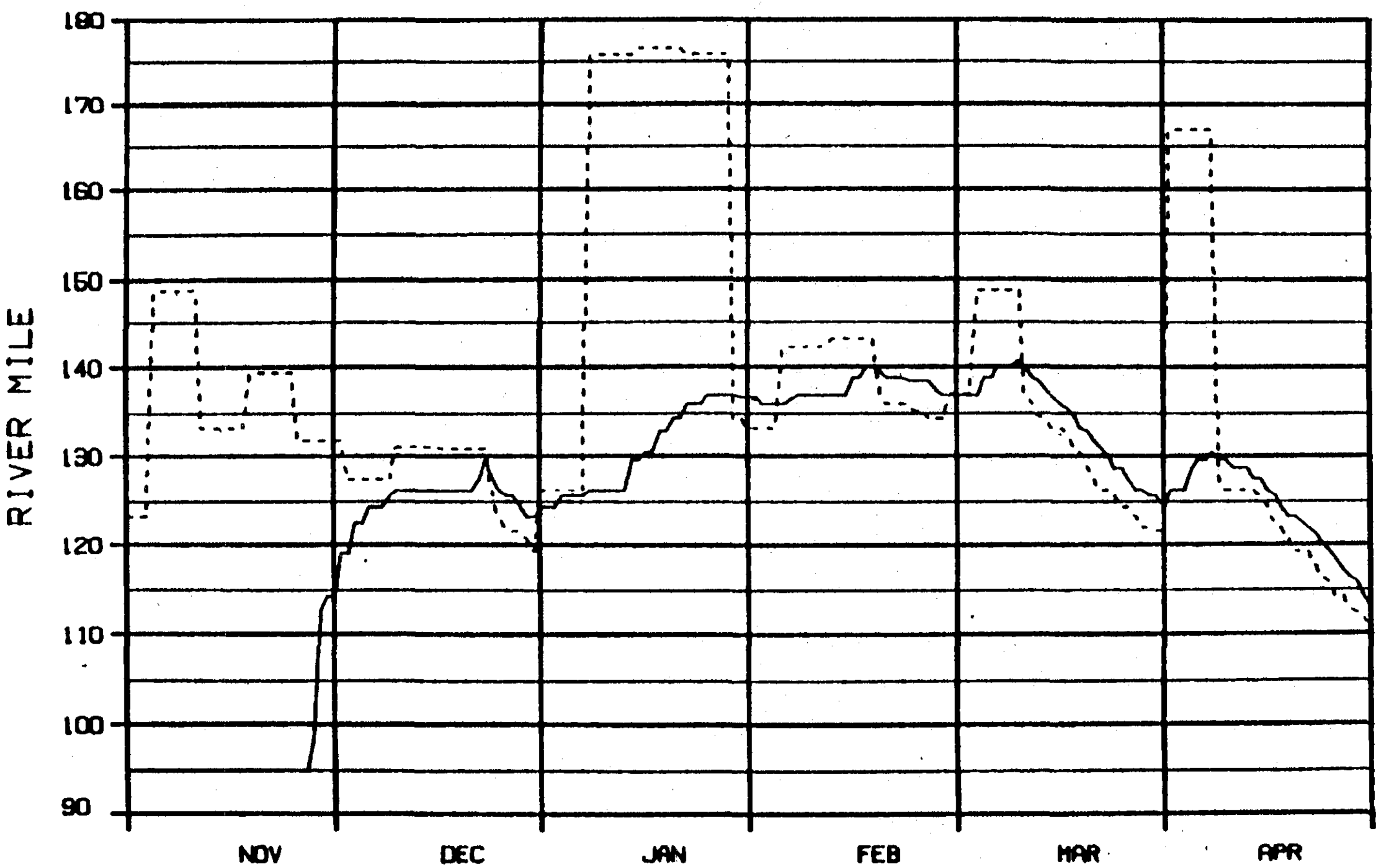
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 81 - 30 APR 82
ENERGY DEMAND : WATANA 1996
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 8196CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
OPTION2



LEGEND:

——— ICE FRONT

- - - - - ZERO DEGREE ISOTHERM

WEATHER PERIOD : 1 NOV 71 - 30 APR 72
ENERGY DEMAND : WATANA 1996
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7196CNA

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
SUSITNA RIVER PROGRESSION OF ICE FRONT & ZERO DEGREE ISOTHERM	
HARZA-EBASCO JOINT VENTURE	
CHICAGO, ILLINOIS [illegible]	1988.142

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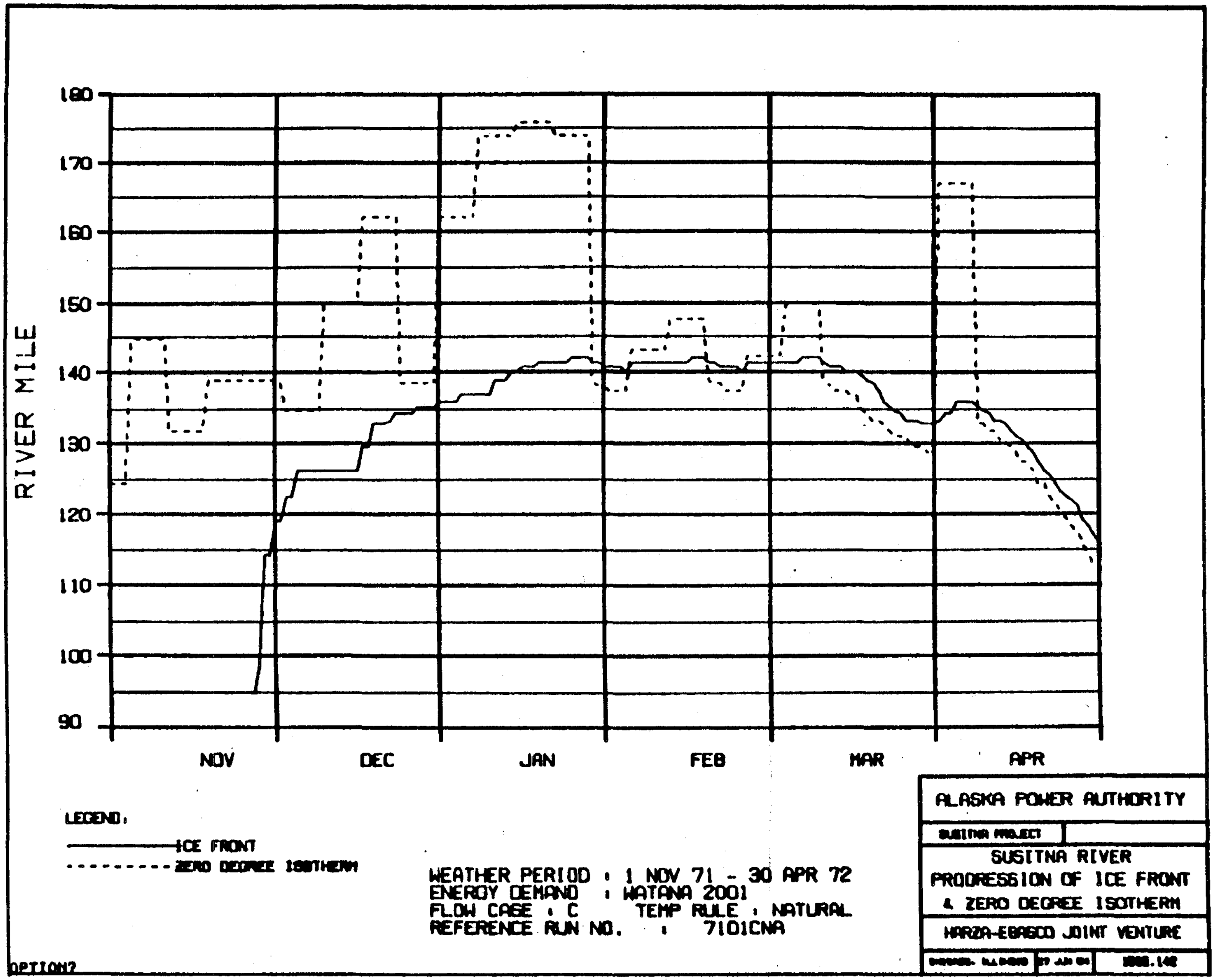
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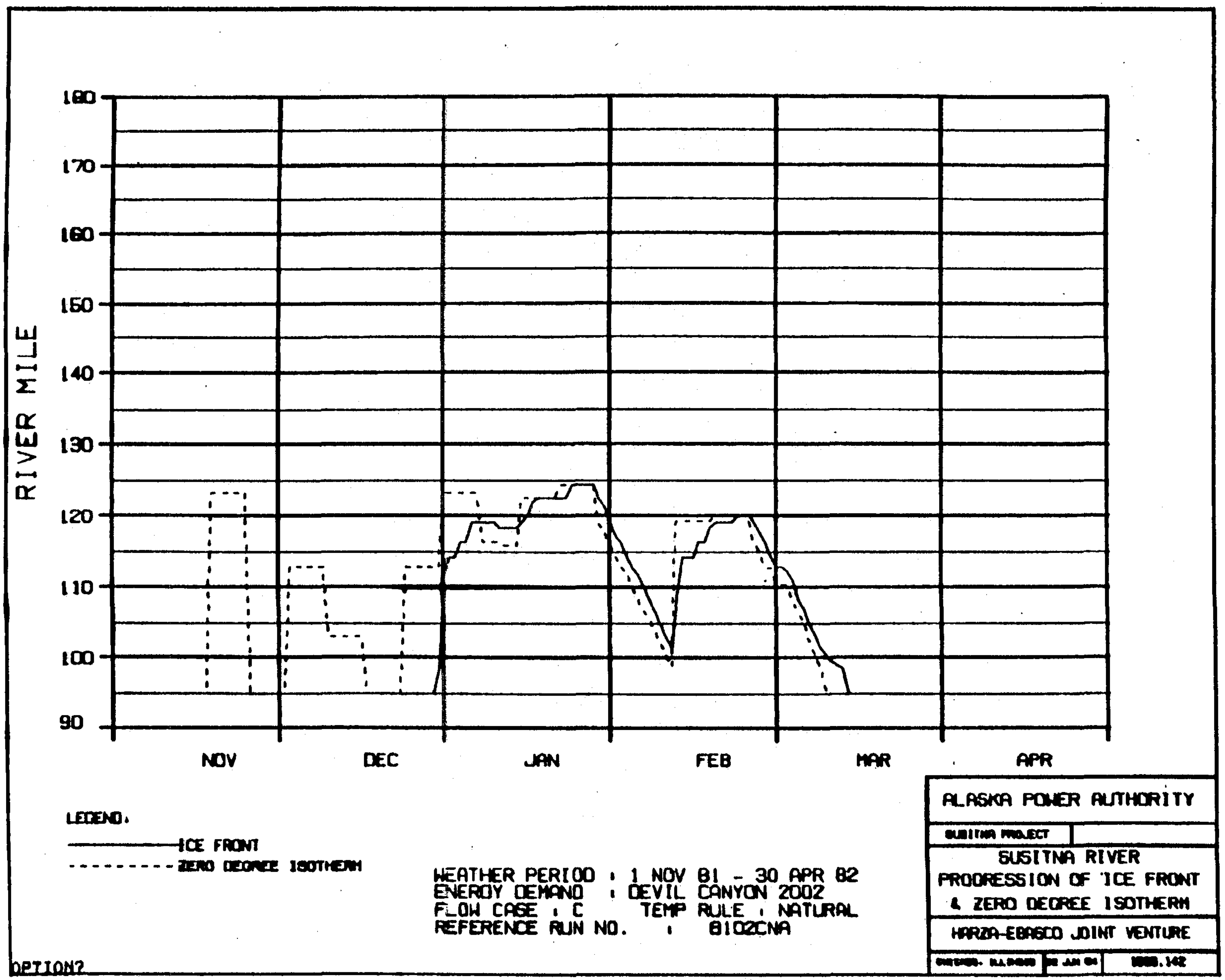
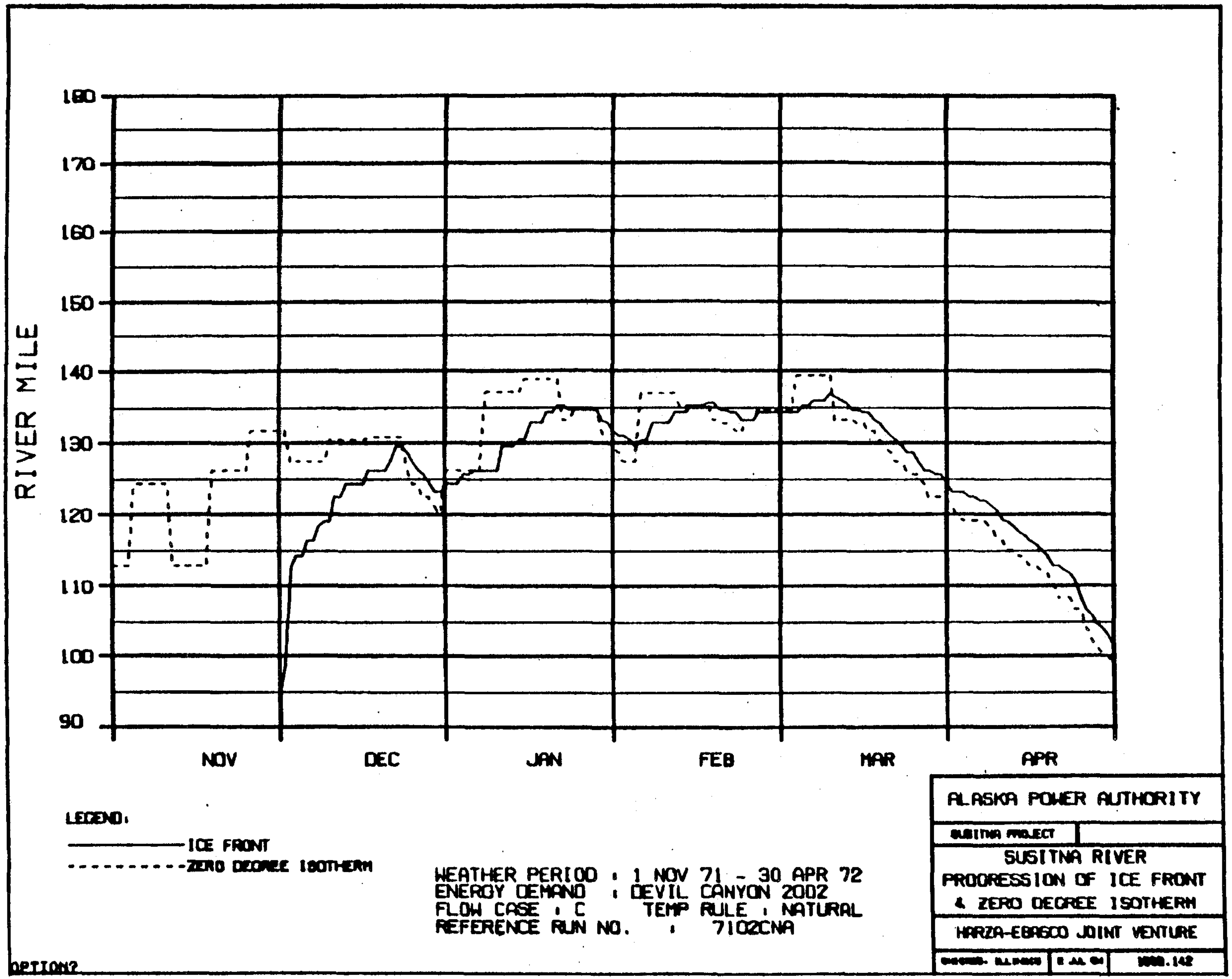
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 71 - 30 APR 72
ENERGY DEMAND : WATANA 2001
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7101CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
OPTION?


180
170
160
150
140
130
120
110
100
90
RIVER MILE
NOV
DEC
JAN
FEB
MAR
APR
LEGEND:
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 81 - 30 APR 82
ENERGY DEMAND : DEVIL CANYON 2002
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 8102CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
OPTION?


RIVER MILE
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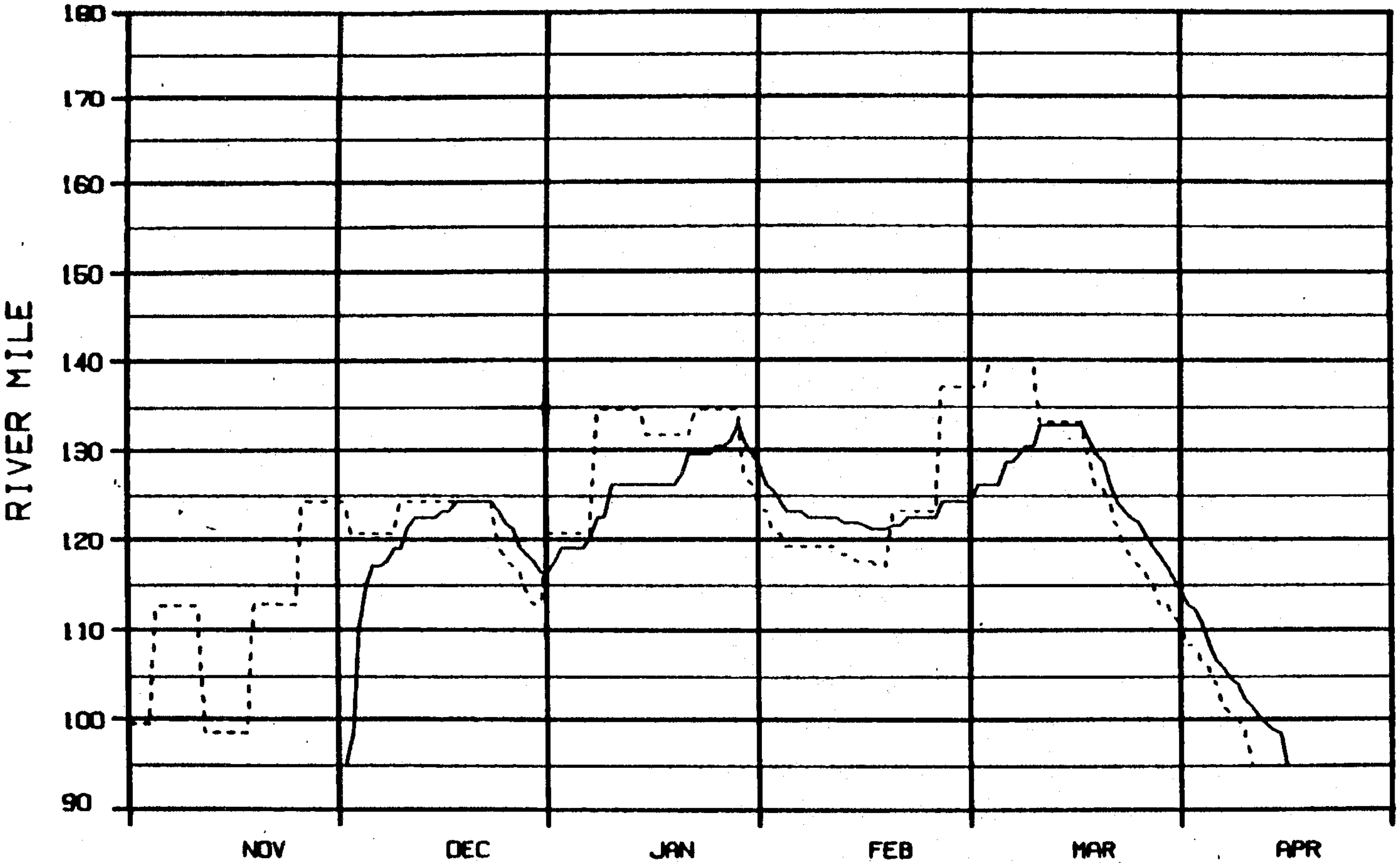
LEGEND:
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 71 - 30 APR 72
ENERGY DEMAND : DEVIL CANYON 2002
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7102CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
OPTION?

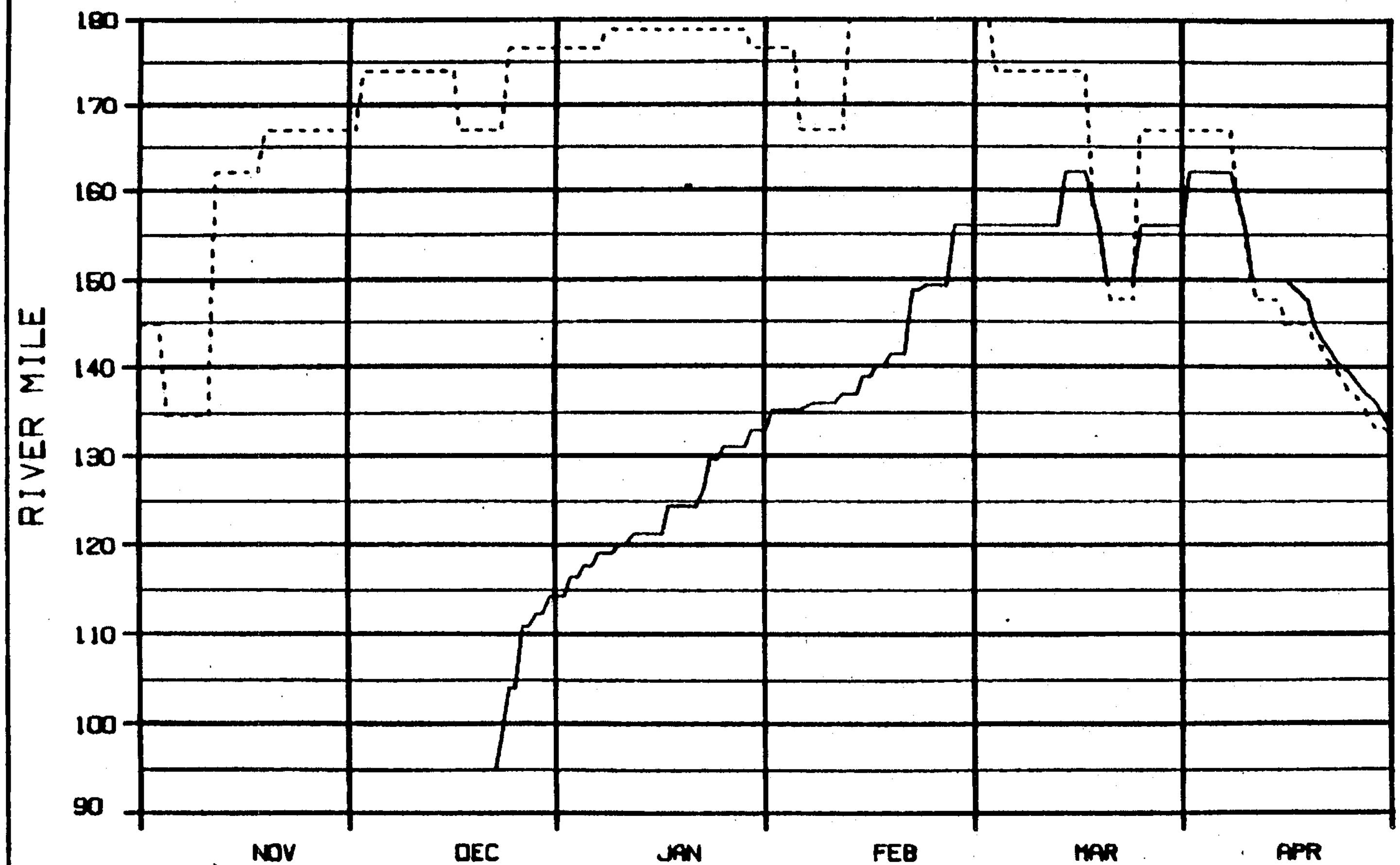


LEGEND:
——— ICE FRONT
- - - - ZERO DEGREE ISOTHERM

WEATHER PERIOD : 1 NOV 71 - 30 APR 72
ENERGY DEMAND : DEVIL CANYON 2020
FLOW CASE : C TEMP RULE : NATURAL
REFERENCE RUN NO. : 7120CNA

ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE

OPTION?



LEGEND:

——— ICE FRONT

- - - - - ZERO DEGREE ISOTHERM

WEATHER PERIOD : 1 NOV 81 - 30 APR 82
ENERGY DEMAND : WATANA 2ND YR FILLING
FLOW CASE : C
REFERENCE RUN NO. : 81F2C-A

ALASKA POWER AUTHORITY

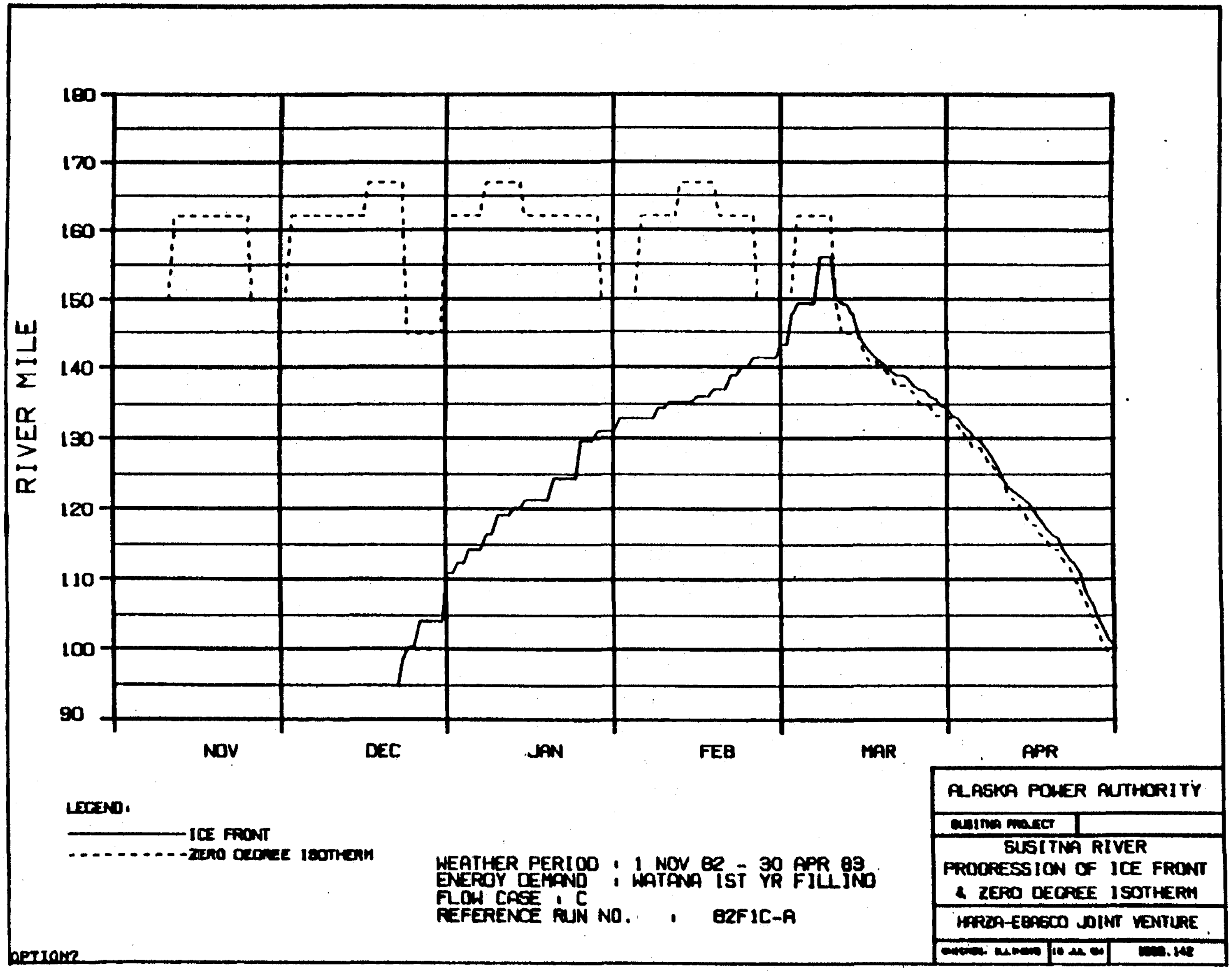
SUSITNA PROJECT

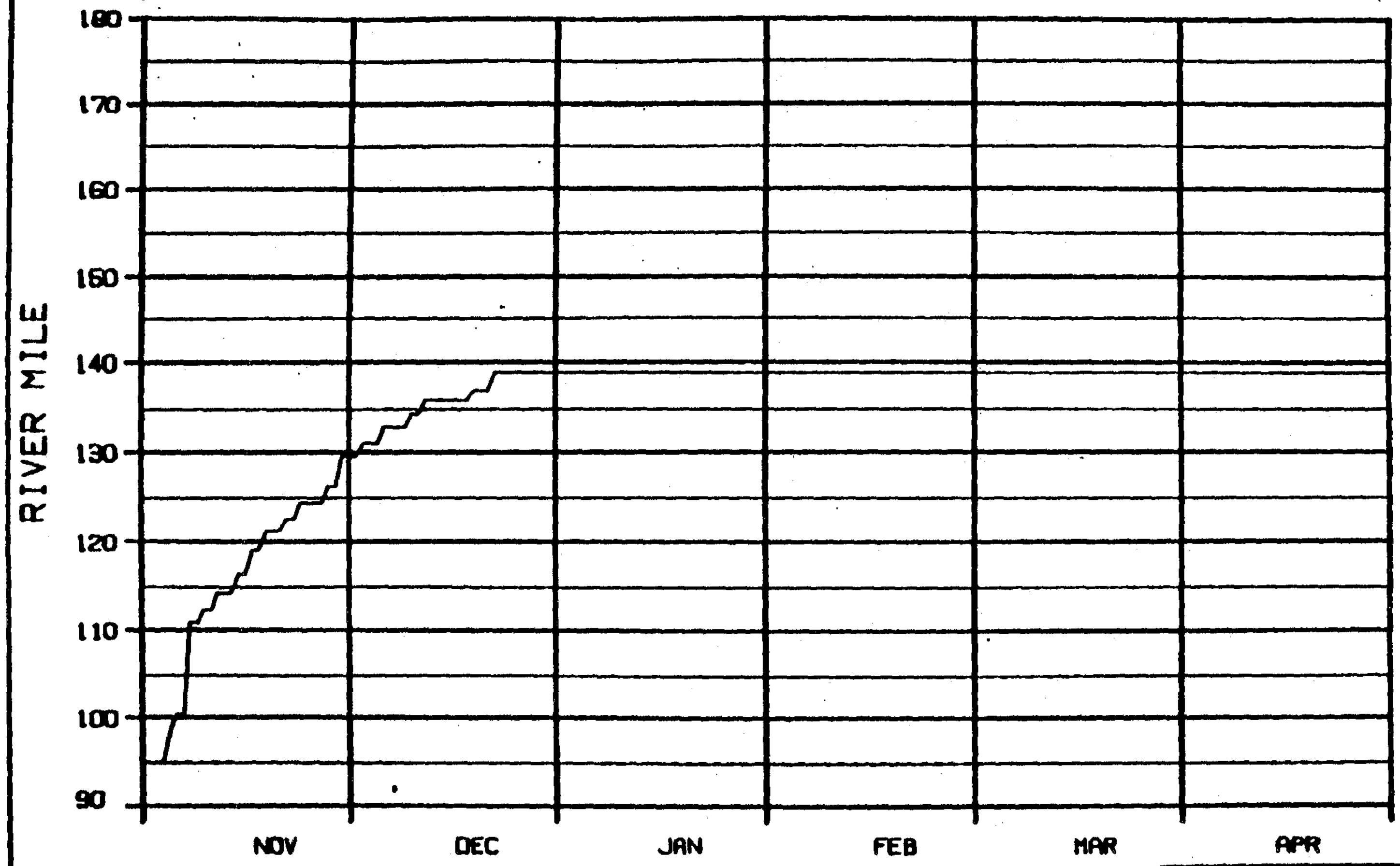
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM

HARZA-EBASCO JOINT VENTURE

OPTION?

Technical Comment AQR037
Page 19
Exhibit N



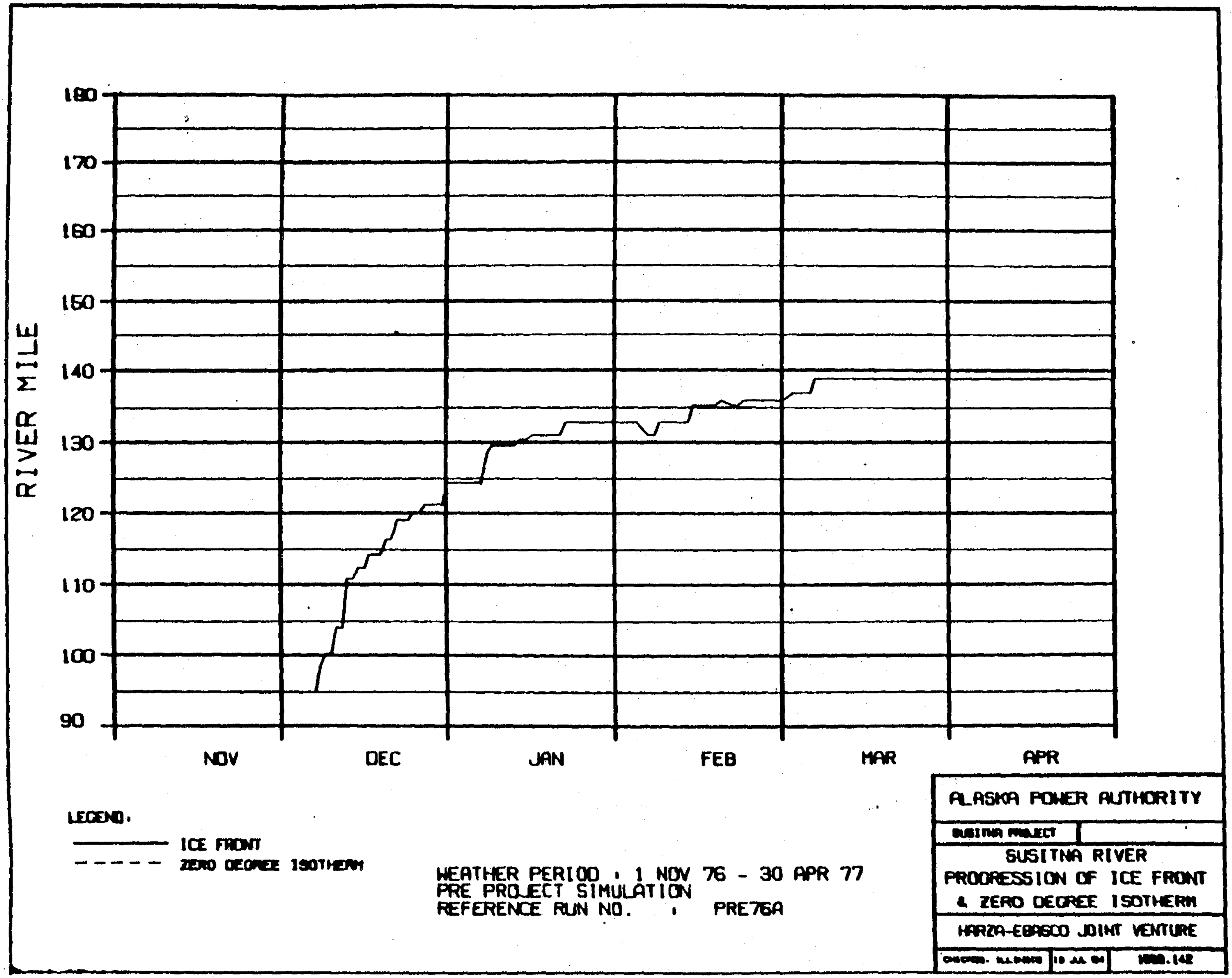


LEGEND:
——— ICE FRONT
– – – – ZERO DEGREE ISOTHERM

WEATHER PERIOD : 1 NOV 71 - 30 APR 72
PRE PROJECT SIMULATION
REFERENCE RUN NO. : PRE71A

ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE

OPTION?


180
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RIVER MILE
NOV
DEC
JAN
FEB
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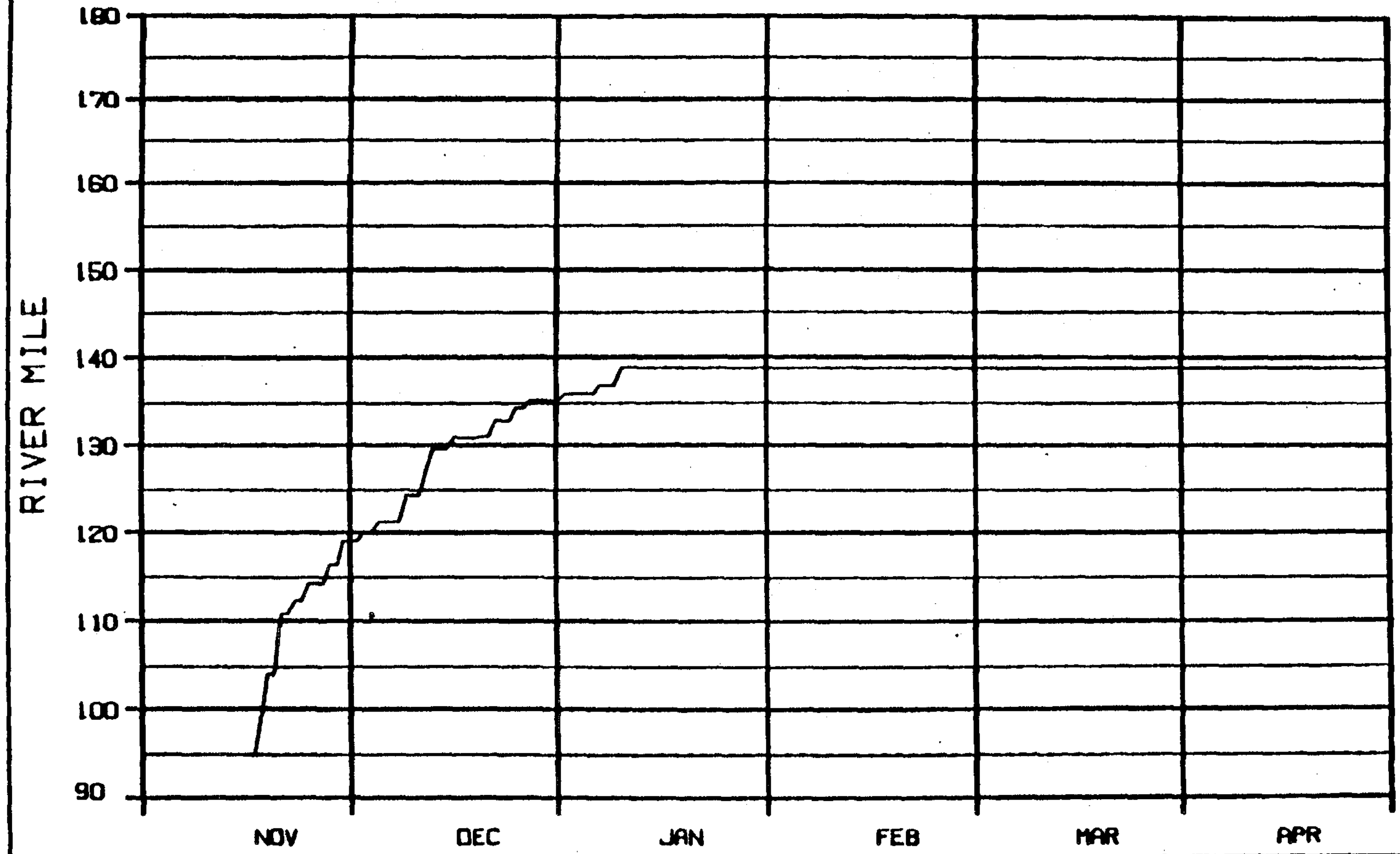
APR
LEGEND:
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 76 - 30 APR 77
PRE PROJECT SIMULATION
REFERENCE RUN NO. : PRE76A
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE



LEGEND:

——————— ICE FRONT

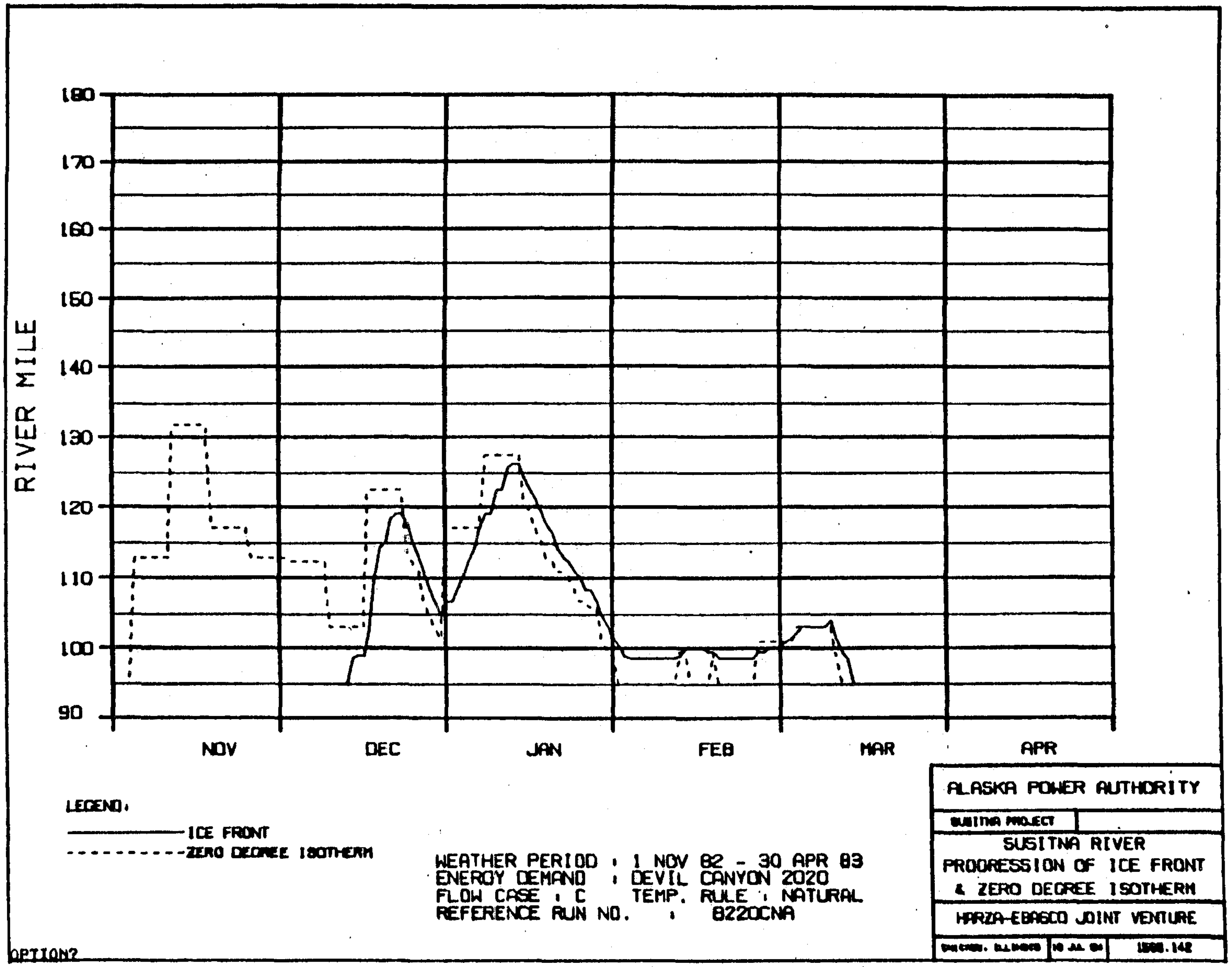
- - - - - - - - - - ZERO DEGREE ISOTHERM

WEATHER PERIOD : 1 NOV 81 - 30 APR 82
PRE PROJECT SIMULATION
REFERENCE RUN NO. : PREB1A

ALASKA POWER AUTHORITY		
SUSITNA PROJECT		
SUSITNA RIVER PROGRESSION OF ICE FRONT & ZERO DEGREE ISOTHERM		
HARZA-EBASCO JOINT VENTURE		
[illegible]	[illegible]	[illegible]

OPTION?

Technical Comment AQR037
Page 22
Exhibit Q


RIVER MILE
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NOV
DEC
JAN
FEB
MAR
APR
LEGEND:
ICE FRONT
ZERO DEGREE ISOTHERM
WEATHER PERIOD : 1 NOV 82 - 30 APR 83
ENERGY DEMAND : DEVIL CANYON 2020
FLOW CASE : C TEMP. RULE : NATURAL
REFERENCE RUN NO. : 8220CNA
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
PROGRESSION OF ICE FRONT
& ZERO DEGREE ISOTHERM
HARZA-EBASCO JOINT VENTURE
OPTION?

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Ice Cover, Reservoir Temperature Model

LOCATION IN DEIS: Vol 1 Page 4-23 Section 4.1.3.4 Paragraph 8 of the Page

COMMENT IN REFERENCE TO: Similarity of ice cover on Devil Canyon reservoir to Watana reservoir

TECHNICAL COMMENT: The Devil Canyon temperature simulations shown in Appendix IV include a time history of ice cover formation on the reservoir. Thus, similarities with Watana can be judged from these simulation runs.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Mainstem, Spawning, Flow Regime

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.2.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Pink, chum and coho spawning in mainstem would be adversely affected by filling flows.

TECHNICAL COMMENT: The potential loss of mainstem spawning habitat for pink, chum and coho salmon in the mainstem and side channel areas must first be tempered by the fact that the number of salmon using these habitats is quite low, normally less than 1000 fish. It is acknowledged that the reduced discharges during filling will impede the use of some currently used habitats. However, it must also be stated that some other areas will in all likelihood become suitable and, therefore, may be used to benefit the fishery.

The reduction in depths and velocities in some side channels may result in an increase in the suitability of these habitats for spawning. Under present conditions, water depths and velocities in many side channels are in excess of those shown to be acceptable for spawning in mainstem or side slough situations (ADF&G 1983a). By reducing the discharges, both water depth and velocity will be reduced in those side channels to ranges which are suitable for spawning. The major concern within these areas are whether appropriate substrates and groundwater upwelling are available.

A further consideration in evaluating the potential for mainstem spawning under filling discharges is that once filling begins, the reservoir will begin to serve as a sediment trap. Therefore, some areas which are currently unusable because of constant accumulation of sediments may become useable because of the reduced influx of additional sediments.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Slough Access, Spawning, Hydraulics

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.2.1 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Slough access and wetted-surface area would be restricted under filling flows.

TECHNICAL COMMENT: The accessibility of sloughs by adult salmon will be reduced to some degree but probably not to the extent indicated by the analysis presented in DEIS Appendix H. (See Technical Comment AQR073). Similarly, the area of spawning habitats in sloughs may be reduced to some extent, but not as indicated by the analysis presented in Appendix H. (See Technical Comment AQR073).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Mainstem, Side Channel, Spawning

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.2.1 Paragraph 5 of the page

COMMENT IN REFERENCE TO: Reductions in mainstem and side-channel spawning areas in lower river.

TECHNICAL COMMENT: Based on surveys to identify salmon spawning habitats in the lower river, very few areas have been identified in mainstem or side-channel habitats which support salmon spawning. Most spawning apparently occurs in the tributaries with some minor spawning activity occurring in side sloughs (ADF&G 1983).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth, Filling

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.2.1 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Severe effects of low temperatures on salmon fry growth.

TECHNICAL COMMENT: Please see Technical Comment AQR123.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.21 Paragraph 6 on the page (Table 4-2)

COMMENT IN REFERENCE TO: Projections of filling and operational temperatures and growth rates downstream of Chulitna-Susitna confluence and comparison with pre-project temperatures.

TECHNICAL COMMENT: DEIS Table 4-2 and its footnote contain statements with regard to assumptions used in temperature simulations which make the comparison of growth rates invalid.

The assumptions used in the DEIS result in an overestimation of negative impacts on fish by overestimating temperature differences between natural and with project conditions. See Technical Comment AQR123 for an evaluation of growth based on temperature simulations carried out by the Power Authority.

The first inaccurate assumption is ".....Temperatures for the Susitna River assume maximum downstream warming from release temperatures (4°C during filling)...". This is apparently a reference to the method adopted in the DEIS for estimating river temperatures during filling. This method is explained in DEIS Volume 4, Page I-48 Paragraph 6. The explanation given DEIS is that maximal rates of warming were taken from the License Application, Exhibit E, Fig E-2-176, which illustrates warming rates occurring during operation. The maximal rate of warming adopted by FERC staff was for a release temperature greater than 4°C. As acknowledged in the DEIS (Vol. 4 Page 4-26 Para. 6) the actual rate of warming from 4°C would be greater. An illustration of just how much greater is shown in the License Application, Figures E-2-145 and E-2-146. Since the assumption was made for the DEIS that filling release temperatures would be near 4°C, these two figures should have been consulted for warming rates, rather than Figure E-2-176. Using Figures E-2-145 and E-2-146, the additional amount of warming between the Watana Dam and the confluence would be between 1°C and 4°C, with a mean of approximately 2°C.

The statement in the DEIS (Vol. 1, page 4-26, para. 6, sentence 2) also implies that it is not expected that the reservoir outlet temperatures during the third summer of filling will be similar to operational, as indicated in the License Application (p. E-2-86). This also results in an underestimation of river temperatures during filling and subsequent overestimation of negative impacts. To substantiate Applicant's position that third summer filling temperatures will be similar to operational temperatures, the Power Authority is supplying with these comments reservoir and stream temperature simulations for the Watana filling case (See Appendices IV and V and Technical Comment AQR032 and AQR033).

The second questionable assumption in the DEIS is "warming from Talkeetna to the mouth has not been considered, but would change little due to the project." Water temperatures presented in this table appear to have been recorded by the U.S. Geological Survey (USGS 1974-1983) at Susitna Station. Comparisons between these temperatures and temperatures recorded by the USGS at Sunshine (60 miles upstream) indicate significant warming in the reach between Sunshine and the Yentna-Susitna confluence. Records of the Alaska Department of Fish and Game (ADF&G 1984b) also show a clear warming trend in the summer in this reach. Downstream of the Yentna Susitna confluence, relatively cold water from the Yentna River tends to reduce the average river temperature and may offset the temperature increase due to warming. However, the temperatures recorded at Susitna Station are not affected by Yentna River temperatures and only reflect warming between Talkeetna and the Yentna-Susitna confluence. Therefore, it is not correct to compare estimated temperatures at Talkeetna with recorded temperatures at Susitna Station without accounting for the warming which normally occurs between the two locations.

The temperature comparison shown in DEIS Table 4-2 can be corrected by comparing natural and with-project temperatures at Sunshine (River Mile 84).

This will be facilitated by using the data and exhibits presented in Appendix V of this document. Technical Comment AQR123 contains comparisons of growth based on these temperatures. The following discussion provides additional information on temperature warming rates between Talkeetna and the Susitna-Yentna confluence.

Water temperatures recorded by the USGS (1974-1983) and ADF&G (1984b) indicate that there is considerable warming of river temperatures in the reach downstream of the Chulitna-Susitna confluence to Susitna Station. Average water temperatures for the June to September period are higher at Susitna Station than at Sunshine by approximately 2°C as shown by the attached Table 1. The periods of records for the two gages only overlap for the period of May 20, 1983 to August 13, 1983. An examination of the records during this period (attached as Table 2) also shows that temperatures at Susitna Station are generally warmer than at Sunshine which is approximately 60 miles upstream. The average increase in temperature from Sunshine to Susitna Station is approximately 2°C in June and July and approximately 3°C for the first 13 days of August.

Temperature cross sections measured by the U.S. Geological Survey at the Sunshine Station gaging station on June 25, 1981; July 23, 1981; August 28, 1981; July 2, 1982; and August 17, 1982 showed the temperature along the left bank of the river to be between 1.5°C and 1.8°C warmer than along the right bank where the recorder is located. Temperature cross sections measured on May 28, 1981; September 29, 1981; June 3, 1982; and September 15, 1982 show generally uniform temperatures. The variation in temperatures may result from incomplete mixing of the Chulitna, Talkeetna and Susitna Rivers. It appears that the recorder at Sunshine may give temperature readings which would be approximately 0.5°C to 1.0°C less than the mean temperature of the river during the period from late June through August.

The Yentna River enters the Susitna River approximately 1.5 miles upstream of the Susitna Station recorder and generally follows the right bank of the river. The Yentna River temperatures as measured upstream of the Yentna-Susitna confluence are generally colder than the temperatures of the Susitna River recorded at Susitna Station, and the temperature variation at Susitna Station would appear to be due to incomplete mixing of the water from the

Yentna and Susitna Rivers. The temperature measured at the recorder at Susitna Station would appear to reflect the temperature of the Susitna upstream of the Yentna confluence. The difference in temperatures between the Susitna Station recorder and the Sunshine recorder would appear to be primarily the result of warming between the two stations.

This conclusion is supported by data collected by ADF&G in 1982 (ADF&G 1984h). Temperature data were also collected by ADF&G in 1983 at stations on the Susitna River upstream of the Yentna River and at Sunshine on the opposite side of the river from the USGS recorder. These data (ADF&G 1984b) verified that:

1. Temperatures recorded by the USGS at Susitna Station represent Susitna River temperatures upstream of the Yentna confluence and;

2. There is significant warming between Talkeetna and Susitna Station.

In addition to the warming between Sunshine and Susitna Station, water temperatures would also increase between the Chulitna-Susitna confluence and the Sunshine gage. The amount of this increase can be estimated from the river temperature simulations presented in Appendix V of this document.

Additionally, the warming rate experienced under pre-project conditions would be lower than the expected warming rate with project during summer. Since water temperatures in the confluence area will be less with project than under natural coditions, the heat flux from the atmosphere to the river will increase with project implementation, resulting in an increase in the rate of warming.

In conclusion, the DEIS comparison of temperatures should account for:

a. accurate reservoir outflow temperatures for the filling case;
b. accurate rate of warming between the dam and the confluence and;
c. warming between the confluence and Susitna Station.

Not accounting for these effects results in an over estimation of temperature-related impacts (as noted in Technical Comment AQR123). It would be more accurate to compare the simulated with-project temperatures at Sunshine with the measured natural or simulated natural temperatures at Sunshine. This can be done using the simulations provided in Appendix V of this document. These simulations for filling and operational cases assume the multilevel and midlevel outlets are effective in selectively withdrawing temperatures stratified flow as discussed in Technical Comment AQR032.

Table 1

Range of Monthly Average Temperatures 1/
Sunshine and Susitna Station (°C)

	Sunshine Station 2/			Susitna Station 3/		
Month	Maximum 4/	Minimum	Mean	Maximum	Maximum	Mean
Jun	9	9	9	11	10	10.5
Jul	10	9.5	10	13	11.5	12
Aug	9	8.5	9	12	10.5	11.5
Sep	6.5	6	6	9	7	7.5

1/ Average monthly temperatures computed as mean of extreme daily temperatures, recorded by U.S. Geological Survey and available in Water Resources Data for Alaska (USGS, 1974-1983) and as provisional data for 1983.

2/ Period of record June 1981, July 1982 to September 1982, June 1983 to September 1983.

3/ Period of record May 1975 to October 1980 (seasonal), May 1983 to August, 1983.

4/ Maximum, minimum and mean of the monthly average temperatures computed as in 1/

Table 2

SUSITNA RIVER AT SUSITNA STATION, AK [1]

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983 *FINAL 1983 WY*

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1			---	---	11.0	9.0	12.5	12.0	13.0	11.0		
2			---	---	10.0	9.0	12.5	11.0	14.0	12.0		
3			---	---	9.5	8.5	14.0	11.5	14.0	12.5		
4			---	---	8.5	7.5	14.0	12.5	13.5	12.0		
5			---	---	10.0	7.0	13.5	12.0	12.0	11.0		
6			---	---	11.5	9.5	13.5	12.5	11.0	10.0		
7			---	---	12.0	10.5	13.0	11.5	11.0	10.0		
8			---	---	13.0	11.5	12.0	11.5	10.0	9.5		
9			---	---	13.0	11.5	12.0	11.0	11.0	9.5		
10			2.5	0.5	12.0	10.5	13.0	11.0	11.0	10.0		
11			4.5	2.5	11.5	10.5	13.0	12.0	11.0	10.0		
12			5.5	4.0	12.0	11.0	12.0	11.0	11.0	10.5		
13			6.0	4.5	13.0	11.0	12.5	10.5	11.0	10.0		
14			6.0	5.0	13.5	12.0	13.0	11.5	---	---		
15			6.5	5.5	13.0	12.0	14.0	12.0	---	---		
16			6.5	5.0	13.0	12.0	13.5	12.5	---	---		
17			6.0	5.0	14.0	12.0	13.0	12.0	---	---		
18			6.5	5.0	14.5	12.5	12.0	11.0	---	---		
19			7.5	5.5	14.5	13.5	13.5	11.0	---	---		
20			9.0	6.5	15.0	13.0	13.5	12.0	---	---		
21			9.0	8.5	15.0	13.5	13.5	12.5	---	---		
22			8.5	7.5	15.0	13.5	14.0	12.0	---	---		
23			8.5	8.0	15.0	13.5	14.0	12.5	---	---		
24			9.0	7.5	14.5	13.0	12.5	11.5	---	---		
25			10.0	8.0	14.5	13.0	12.5	11.0	---	---		
26			10.0	9.0	14.0	13.5	13.0	11.5	---	---		
27			9.0	8.0	13.5	12.0	13.5	12.0	---	---		
28			10.0	8.5	13.0	11.5	15.0	13.0	---	---		
29			10.5	9.5	12.5	11.0	14.5	13.0	---	---		
30			11.0	9.5	13.5	11.0	13.5	12.5	---	---		
31			11.0	10.0	---	---	13.0	12.0	---	---		
MONTH			11.0	0.5	15.0	7.0	15.0	10.5	14.0	9.5		

[1] Source: USGS

Table 2 (continued)

YENTNA R NR SUSITNA STATION, AK USGS

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983

DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
	APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER	
1			---	---	7.0	6.5			11.5	9.0	8.5	8.0
2			---	---		---	---	---	12.0	10.0	8.5	7.5
3			---	---	---	---	---	---	12.5	10.0	8.0	7.5
4			---	---	---	---	---	---	12.0	10.0	8.0	7.0
5			---	---	---	---	---	---	10.0	8.5	7.5	6.5
6			---	---	---	---	---	---	9.0	8.0		
7			---	---	---	---	---	---	8.5	8.5		
8			---	---	---	---	---	---	8.5	8.0		
9			---	---	---	---	---	---	9.0	8.0		
10			6.5		---	---	---	---	9.0	8.0		
11			6.5	5.0	---	---	---	---	9.0	8.5		
12			6.5	5.5	---	---	---	---	8.5	8.0		
13			6.5	5.5	---	---	---	---	9.0	8.0		
14			6.5	6.0	---	---	---	---	9.0	8.0		
15			6.0	5.5	---	---	---	---	9.0	7.5		
16			5.5	5.5	---	---	---	---	9.0	7.5		
17			5.5	5.0	---	---	---	---	9.5	9.0		
18			6.0	5.5	---	---	---	---	9.5	9.0		
19			7.0	6.0	---	---	---	---	10.5	9.0		
20			8.0	6.5	---	---	---	---	10.5	9.5		
21			7.5	7.0			---	---	9.5	7.5		
22			7.0	6.5	13.0	11.0	---	---	8.0	7.5		
23			6.5	6.5	12.0	11.0	---	---	8.5	8.0		
24			6.5	6.0	11.5	10.5	---	---	8.5	8.0		
25			8.0	6.5	11.5	10.0	---	---	8.5	7.5		
26			9.0	8.0	11.0	10.0			8.5	7.5		
27			8.0	8.0	10.0	8.5	9.5	8.5	10.0	8.5		
28			9.0	7.5	10.5	8.5	12.0	9.5	10.0	9.5		
29			9.0	8.0	11.0	9.5	12.0	10.5	10.0	9.0		
30			8.0	7.5	11.0	9.5	11.5	10.5	9.0	8.0		
31			7.5	7.0	---	---	11.0	9.5	8.5	7.5		
MONTH			9.0	5.0	13.0	6.5	12.0	8.5	12.5	7.5		

Source: USGS

Table 2 (continued)

SUSITNA RIVER AT SUNSHINE, AK — USGS

TEMPERATURE, WATER (DEG. C), WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983 — FINAL 1983 WY

DAY	APRIL MAX	APRIL MIN	MAY MAX	MAY MIN	JUNE MAX	JUNE MIN	JULY MAX	JULY MIN	AUGUST MAX	AUGUST MIN	SEPTEMBER MAX	SEPTEMBER MIN
1			---	---	9.0	7.5	10.0	8.0	11.0	8.5	8.0	6.5
2			---	---	8.5	8.0	10.0	7.5	11.0	9.0	7.5	6.0
3			---	---	8.0	6.5	10.5	8.5	11.0	9.5	7.0	5.5
4			---	---	6.5	5.5	10.5	9.0	11.0	8.5	6.5	5.5
5			---	---	8.5	6.0	11.5	8.5	8.5	8.0	6.5	5.0
6			---	---	10.0	8.0	11.0	8.5	8.5	7.5	6.5	5.0
7			---	---	11.0	8.5	9.0	7.5	8.5	8.0	6.5	5.0
8			---	---	11.5	9.5	8.5	8.0	8.0	7.0	7.0	6.0
9			---	---	10.0	8.5	9.5	7.5	8.5	6.5	7.0	6.5
10			---	---	10.0	8.5	11.0	8.5	8.5	6.5	7.5	6.5
11			---	---	10.5	9.0	10.5	9.5	8.5	7.0	7.5	6.5
12			---	---	11.0	8.0	10.0	9.0	8.5	8.0	8.0	7.0
13			---	---	11.5	10.0	10.5	9.0	8.0	7.0	8.0	7.0
14			---	---	11.5	10.0	10.5	8.0	8.5	7.0	7.0	5.5
15			---	---	11.0	9.5	11.0	9.0	8.5	7.0	6.5	5.0
16			---	---	11.0	9.0	10.5	9.5	9.0	7.0	7.0	6.5
17			---	---	11.5	9.5	10.5	9.0	9.0	8.0	---	---
18			---	---	12.0	10.0	10.0	8.5	10.0	8.0	---	---
19			---	---	12.0	10.5	11.0	9.0	10.0	8.5	---	---
20			8.5	5.5	12.0	10.5	11.0	9.5	9.5	8.0	10.0	5.5
21			8.0	6.5	12.0	10.5	11.0	9.0	8.0	7.5	7.0	5.5
22			8.0	6.0	12.0	11.0	11.5	9.5	8.5	7.5	7.0	6.0
23			8.0	7.0	12.0	10.5	11.5	8.5	8.5	7.5	---	---
24			8.5	6.5	11.5	10.0	9.5	8.0	8.5	7.5	---	---
25			9.0	7.0	11.5	10.0	10.5	9.0	7.5	6.5	---	---
26			9.0	7.5	11.5	10.0	10.5	9.5	9.0	7.0	---	---
27			8.5	7.0	10.0	8.5	12.0	10.0	9.0	7.5	---	---
28			9.5	7.5	10.0	7.5	12.5	10.5	9.5	8.0	---	---
29			9.5	8.5	10.0	8.5	12.0	11.0	9.0	8.0	---	---
30			10.0	9.0	10.0	8.0	11.5	9.0	9.0	8.0	3.5	1.5
31			9.5	8.0	---	---	9.5	8.0	8.5	7.0	---	---
MONTH			10.0	5.5	12.0	5.5	12.5	7.5	11.0	6.5	10.0	1.5

Source: USGS

Table 2 (continued)

UNITED STATES DEPARTMENT O INTERIOR - GEOLOGICAL SURVEY
15294350 - SUSITNA RIVER AT SUSITNA STATION AK

PROCESS DATE 01,
DISTRICT CODE 02

WATER QUALITY DATA, WATER YEAR OCTOBER 1982 TO SEPTEMBER 1983

1983 WY

DATE	TIME	STREAM WIDTH (FT) (00004)	SAMPLE LOC-ATION, CROSS SECTION (FT FM L BANK) (00009)	TEMPER-ATURE (DEG C) (00010)	TEMPER-ATURE, AIR (DEG C) (00020)	BARO-METRIC PRES-SURE (MM OF HG) (00025)	AGENCY COL-LECTING SAMPLE (CODE NUMBER) (00027)	AGENCY ANA-LYZING SAMPLE (CODE NUMBER) (00028)	STREAM-FLOW, INSTAN-TANEOUS (CFS) (00061)	TUR-BID-ITY (NTU) (00076)
OCT										
05...	1540	1865 --	--	2.5	--	746	--	80020	51300	1.3
APR										
05...	1300	840	--	.0	--	758	1028	80020	6520	.70
05...	1301	--	280	.0	--	758	1028	80020	--	--
05...	1302	--	380	.0	--	758	1028	80020	--	--
05...	1303	--	480	.0	--	758	1028	80020	--	--
JUN										
22...	1900	1880	--	--	--	787	1028	80020	111000	200
22...	1901	--	90.0	14.8	--	787	1028	80020	--	--
22...	1902	--	190	14.7	--	787	1028	80020	--	--
22...	1903	--	290	14.2	--	787	1028	80020	--	--
22...	1904	--	540	13.5	--	787	1028	80020	--	--
22...	1905	--	940	12.9	--	787	1028	80020	--	--
JUL										
27...	1100	1850	--	--	--	--	1028	80020	83300	170
27...	1101	--	95.0	13.0	--	--	1028	80020	--	--
27...	1102	--	195	11.8	--	--	1028	80020	--	--
27...	1103	--	370	11.4	--	--	1028	80020	--	--
27...	1104	--	570	9.7	--	--	1028	80020	--	--
27...	1105	--	970	8.4	--	--	1028	80020	--	--
SEP										
30...	1230	940	--	--	4.0	--	1028	80020	42500	23
30...	1232	--	115	3.1	--	--	1028	80020	--	--
30...	1233	--	190	3.2	--	--	1028	80020	--	--
30...	1234	--	265	3.2	--	--	1028	80020	--	--
30...	1235	--	440	3.4	--	--	1028	80020	--	--
30...	1236	--	690	3.6	--	--	1028	80020	--	--

Source: USGS

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Slough Access, Hydraulics

LOCATION IN DEIS: Vol 1 Page 4-26 Section 4.1.4.2.1 Paragraph 8 of the page

COMMENT IN REFERENCE TO: Operational flows would restrict access and reduce spawning area in sloughs.

TECHNICAL COMMENT: See Technical Comment AQR073.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Mainstem

LOCATION IN DEIS: Vol 1 Page 4-27 Section 4.1.4.21 Paragraph 5 of the page

COMMENT IN REFERENCE TO: Effects of temperature on mainstem incubation.

TECHNICAL COMMENT: The DEIS evaluation of temperature effects on incubation should be revised based on the following conclusions:

a. Only a small proportion of the runs spawn in mainstem habitats directly influenced by mainstem temperatures. Most of these fish are chum salmon and apparently spawn in areas of upwelling.

b. Mainstem spawning occurs between September 2-19.

c. Predicted mainstem natural temperatures are too cold for successful incubation.

d. Predicted mainstem with-project temperatures are in the range for successful incubation.

e. From a temperature standpoint only, the mainstem Susitna River would provide better incubation with-project than under natural conditions.

See Technical Comments AQR117 and AQR119.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Model, Salmon Growth

LOCATION IN DEIS: Vol 1 Page 4-27 Section 4.1.4.2.1 Paragraph 5 of the page (Figure 4-8)

COMMENT IN REFERENCE TO: Predicted temperatures for November and December for Devil Canyon operation.

TECHNICAL COMMENT: The river temperatures shown in DEIS Figure 4-8 of Volume I for the November-December period of Watana/Devil Canyon operation are apparently based on temperature simulations presented on pages 4-23 and 4-24 and described in Appendix H page H-44 of the DEIS. The Power Authority believes these temperature simulations are in error (see Technical Comments AQR074 and AQR033) and that the temperature simulations shown in the License Application are accurate. The DEIS has also assumed that the Devil Canyon reservoir outflow temperatures will be 4°C for this period rather than the temperatures predicted by DYRESM and shown in the License Application, Figure E.2.216. The Power Authority has responded to the DEIS criticisms of its reservoir temperature simulations (see Technical Comment AQR032) and is providing simulations of reservoir and stream temperatures in Appendices IV and V, to this submittal, respectively. These simulations support the river temperatures shown in the License Application for the November-December period of Watana/Devil Canyon operation.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Temperature, Incubation

LOCATION IN DEIS: Vol 1 Page 4-27 Section 4.1.4.2.1 Paragraph 5 of the page (Figure 4-9)

COMMENT IN REFERENCE TO: Slough temperatures

TECHNICAL COMMENT: See Technical Comment AQR035 and Appendix VII of this document for projections of with-project temperatures of groundwater upwelling.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Spawning

LOCATION IN DEIS: Vol 1 Page 4-30 Section 4.1.4.2.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Temperature effect on early spawning pink and chum salmon.

TECHNICAL COMMENT: See Technical Comment AQR119.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 1 Page 4-30 Section 4.1.4.2.1 Paragraph 3, 4 of the page

COMMENT IN REFERENCE TO: Potential severe impacts on growth due to lower summer temperatures.

TECHNICAL COMMENT: Please see Technical Comment AQR123.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Habitat, Salmon Growth

LOCATION IN DEIS: Vol 1, Page 4-30 Section 4.1.4.2.1 Paragraph 7 of the page

COMMENT IN REFERENCE TO: Loss of woody debris would cause degradation of rearing habitat.

TECHNICAL COMMENT: This paragraph is not consistent with the discussion of debris jams presented in DEIS Appendix I, page I-57. It is stated in Appendix I that sufficient debris from the tributaries would be available to sustain debris jams in the river between Portage Creek and Talkeetna.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Outmigration, Ice Processes

LOCATION IN DEIS: Vol 1 Page 4-30 Section 4.1.4.2.1 Paragraph 9 of the page

COMMENT IN REFERENCE TO: Warmer winter temperatures might cause early breakup and warming in spring and thereby induce early outmigration.

TECHNICAL COMMENT: Smolt outmigration timing is affected by at least the following factors: length-weight condition factors; possible cues from photoperiod and/or lunar phase cycles; temperature; internal hormonal cues; previous food stability and availability; discharge velocities; and other possible interspecific and intraspecific behavioral factors (see Technical Comment AQR088). Assuming that any single one of these factors has an overriding control or influence may be taking too simplistic a position. In addition, warmer winter temperatures and variable timing of warming and breakup in spring are all a part of the natural environmental variability with which salmon have evolved.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sockeye (Kokanee) Salmon, Reservoir

LOCATION IN DEIS: Vol 1 Page 4-32 Section 4.1.4.2.1 Paragraph 5 of the page

COMMENT IN REFERENCE TO: DEIS discussion of potential kokanee populations in reservoirs.

TECHNICAL COMMENT: Introduction of kokanee into Watana Reservoir is not a preferred mitigation option. See Technical Comment AQR133, for a detailed explanation.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Salmon, Habitat

LOCATION IN DEIS: Vol 1 Page 4-32 Section 4.1.4.2.1 Paragraph 8 of the page

COMMENT IN REFERENCE TO: DEIS analysis of run strength vs. environmental factors.

TECHNICAL COMMENT: Reference to this test should be deleted. See Technical Comment AQR141 for a detailed review of the DEIS analysis.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Filling

LOCATION IN DEIS: Vol 1 Page 4-32 Section 4.1.4.2.1 Paragraph 9 of the page

COMMENT IN REFERENCE TO: Salmon production in middle river would be greatly reduced during filling of Watana reservoir.

TECHNICAL COMMENT: Large decreases of salmon production in the middle river are not indicated (see Technical Comment AQR142).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Pink Salmon, Filling

LOCATION IN DEIS: Vol 1 Page 4-33 Section 4.1.4.2.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: DEIS implies near total loss of pink salmon in middle river during filling years.

TECHNICAL COMMENT: There should be little change in pink salmon production. See Technical Comments AQR100, AQR117, AQR119 and AQR131.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Salmon

LOCATION IN DEIS: Vol 1 Page 5-2 Section 5.1.1.4 Paragraph 5 of the page

COMMENT IN REFERENCE TO: Temperature-induced premature emergence by early spawners.

TECHNICAL COMMENT: See Technical Comments AQR117 and AQR119.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 1 Page 5-2 Section 5.1.1.4 Paragraph 6 of the page

COMMENT IN REFERENCE TO: DEIS conclusion regarding salmon survival rates due to effects of temperature induced retarded growth.

TECHNICAL COMMENT: The DEIS statement assumes juveniles and smolts will have lower accumulated growth rates due to reduced instream temperature and that survival rates of smolts are positively related to accumulated growth. Both statements are speculative at best. Growth in salmonids is driven by food ration size and quality; controlled by such variables as genetics, temperature and pH; directed by cues such as photoperiod; and restricted by food supply, need for activity, weight, neuroendocrine state, etc. (Brett 1982). The factors controlling, driving, limiting and restricting growth are extraordinarily complex and intertwined. Survival of juvenile salmonids is determined by a multitude of interrelated, complex and dynamic factors. The referenced DEIS statement is an oversimplification and is very speculative.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Salmon Access, Sloughs

LOCATION IN DEIS: Vol 1 Page 5-8 Section 5.2.2 Paragraph 1 & 2 of the page

COMMENT IN REFERENCE TO: Recommendation regarding flow regime.

TECHNICAL COMMENT: This recommendation should be revised after review of the access analyses presented in Technical Comment AQR072 and the analysis of surface areas of sloughs presented in Technical Comment AQR073.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Flow Regime, Instream Flow

LOCATION IN DEIS: Vol 1 Page 5-8 Section 5.2.2 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Suggestion to Reevaluate Summer Minimum Flows of Case C Flow Regime

TECHNICAL COMMENT: The Case C flow regime presented in the License Application (Exhibit B, Vol 2, Chapter 2, Page B-2-121-124 and Table B.54) represents a combination of power demand flows and instream flow requirements for maintenance of downstream critical habitats. Winter (October-April) flows reflect power demands while summer (May-Sept.) flows are based on minimum instream flow requirements. Power demand flows are designed to redistribute water from the natural summer high flow period to the winter high energy demand period and provide for protected Railbelt demand beyond the year 2010. The instream flow requirements are a set of limits placed on operational flow releases for the purpose of achieving a particular habitat condition. The Case C flow regime includes minimum flow requirements during May-July for upstream passage of migrating adult salmon and minimum flow requirements during July-September to provide access into side sloughs for spawning salmon. These minimum flow requirements represented an acceptable limit of potential habitat loss based on the information available at that time.

Results of several studies and analyses have become available since submission of the Application. These new data and information provide the Power Authority with additional resources for developing more detailed and refined instream flow requirements. The information base is presently adequate to describe annual environmental flow regimes designed to set maximum and mimimum flow criteria for achieving particular management goals. The Power Authority held a session with its Aquatic Study Team to formulate environmental flow regimes based on specific management goals. Four alternative regimes were constructed in the session (Tables 1-4) and a fifth was derived later by editorial combination of alternatives II and IV (Table 5). These alternatives are based on the best collective judgement of the Aquatic Study Team and must be treated as preliminary. The alternatives will be revised and refined as new information becomes available and analysis is completed. However, these alternatives do represent a more refined and sophisticated approach to defining instream flow requirements than Case C.

Alternative I presents flow requirements necessary to maintain existing habitat quality and quantity. Maintenance of existing habitat does not require exact duplication of natural flow patterns. In fact, some benefit may accrue to downstream fisheries resources through more stable, regulated flows.

Alternative II represents flow requirements necessary to maintain 75% of the existing chum salmon slough spawning habitats in the middle river reach. The requirements shown in Table 2 are conservative. For example, the June spiking flows would not have to occur every year. Flushing flows to clean spawning areas can be provided once every several (3-4) years; preferably in "wet" years when excess water is available. The summer spiking flows to achieve access to spawning sloughs may be in excess of flows necessary to maintain 75% of the existing habitat (see Technical Comment AQR072). These requirements will be refined with results of further analyses.

Alternative III represents flow requirements necessary to maximize chinook production. The most important consideration for this alternative is availability of usable side channel rearing habitat for juveniles, since chinook spawning occurs in tributaries. Therefore, the strictest requirement is set for minimum flows during the summer rearing period.

Alternative IV represents flow requirements necessary to maintain 75% of the chinook salmon side channel rearing habitat in the middle river reach. The possibility of habitat enhancement and creation of new side channels at lower, more stable flows was not considered. Alternative IV is based on assessments of habitat quantity and does not imply a necessary, correlated reduction in productivity. This would occur only if the rearing habitat was limiting and fully utilized. There is some evidence that the Susitna River production of chinook salmon was historically greater than at present. Chinook salmon harvest in the 1950's by the upper Cook Inlet commercial fisheries was approximately four times greater than during the 1970's (License Application, Exhibit E, Vol. 6B, Table E.3.3). Part of this decline may be due to changes in harvest regulations, however, at least part of the reduction is likely a reflection of reduced run sizes.

Alternative V represents flow requirements necessary to maintain 75% of the chum slough spawning habitat and 75% of the chinook side channel rearing habitat in the middle river reach (Alternative II and IV combined).

Alternative I-V represent a range of instream flow requirements necessary to achieve particular resource management goals. The actual flow requirements incorporated into the final operating flow regime will be local subjects for negotiations with the resource agencies. However, these alternatives provide an important basis for further definition, evaluation and refinement of operational limits and guidelines and demonstrate some of the latitude available to negotiate and economically feasible flow regime with acceptable environmental constraints. For example, incorporation of all the requirements contained in Alternative IV into an operational flow regime would be economically feasible while maintaining 75% of the existing chinook salmon side channel rearing habitat and also provide for unrestricted access to sloughs for more than 50% of the existing chum salmon spawning (see Technical Comment AQR072, Figure 1).

Mean numbers of chum salmon spawning in middle river sloughs were 4,200 during 1981-83. The mean estimated Susitna River escapement during the same period was 340,000 (ADF&G 1984b). Therefore, a 50% reduction in middle river slough spawning chum amounts to 0.5% of the total or approximately 2,000 fish. Some of this potential loss could be reduced by simple modification of the sloughs. The remainder could be replaced with relatively small egg incubation or spawning channel type facilities.

A reduction of chinook side channel rearing habitat in the middle river may have little impact on actual productin. Since 22.6% of the middle river rearing occurs in the side channels, Alternative IV would actually reduce chinook rearing habitat by approximately 6%.

TABLE 1 Technical Comment AQR059

I. MAINTENANCE OF EXISTING FISH HABITAT - "NO LOSS"

X=No Requirement

Month	Weekly	Mean Q at Gold Creek	Max Q	Min Q	Notes
Jan.		1,440 cfs	14,000 cfs	X	
Feb.		1,210	14,000	X	
Mar.		1,090	14,000	X	
April		1,340	14,000	X	
	1st				
May	2nd	13,400	14,000	X	
	3rd				
	4th				
	1st			10,000	1/ Spike somewhere
June	2nd	28,150	X	10,000 1/	in here up to
	3rd			14,000	45,000 cfs to flush
	4th			14,000	& clean sloughs;
	1st				3 days up, 3 days
July	2nd	23,990	X	14,000	down
	3rd				
	4th				2/ Spike up to
	1st			14,000	23,000 cfs; one
					day up, one day
					down.
August	2nd	21,950	40,000	14,000	3/ Spike up to
	3rd			14,000 2/	18,000; one day
	4th			14,000 3/	up, one day down.
	1st			12,000	4/ Maximum allowable
Sept.	2nd	13,770	14,000 4/	10,000	from here on is
	3rd			8,000	14,000 cfs to
	4th			6,000	avoid overflows
Oct.		5,580	14,000	X	of spawned redds
Nov.		2,430	14,000	X	
Dec.		1,750	14,000	X	

TABLE 2

II. MAINTENANCE OF 75% OF CHUM SPAWNING HABITAT

X=No Requirement

Month	Weekly	Mean Q at Gold Creek	Max Q	Min Q	Notes
Jan.		1,440 cfs	16,000 cfs	X	
Feb.		1,210	16,000	X	
Mar.		1,090	16,000	X	
Apr.		1,340	X	X	
May	1st	13,400	X	X	
	2nd				
	3rd				
	4th				
June	1st	28,150	X	10,000	1/ 35,000 cfs spike to flush out sediments and clean slough spawning areas.
	2nd			10,000	
	3rd			1/	
	4th			X	
July	1st	23,990	X	X	
	2nd				
	3rd				
	4th				
August	1st	21,950	X	X	
	2nd		30,000	12,000	
	3rd		30,000	12,000	
	4th		30,000	12,000	
Sept.	1st	13,770	30,000	12,000 2/	
	2nd		16,000	X	2/ Spike up to 18,000 cfs for slough #21 access by Chums; one day up, one day down.
	3rd		16,000	X	
	4th		16,000	X	
Oct.		5,580	16,000	X	
Nov.		2,430	16,000	X	
Dec.		1,750	16,000	X	

TABLE 3 Technical Comment AQR059

III. MAXIMIZE CHINOOK PRODUCTION

X=No Requirement

Month	Weekly	Mean Q at Gold Creek	Max Q	Min Q	Notes
Jan.		1,440 cfs	14,000 cfs	X	
Feb.		1,210	14,000	X	
Mar.		1,090	14,000	X	
Apr.		1,340	14,000	X	1/ No flows to de-
May	1st	13,400	14,000	X	stabilize slough
	2nd		14,000 1/	X	gravels
	3rd		14,000	6,000	
	4th		14,000	8,000	
June 2/	1st	28,150	X	10,000	
	2nd			10,000	2/ No peak needed
	3rd			14,000	to move 1+Chinooks
	4th			14,000	
July	1st	23,990	X	14,000	
	2nd			14,000	
	3rd			14,000	
	4th			14,000	
August	1st	21,950	X	14,000	
	2nd			14,000	
	3rd			14,000	
	4th			14,000	
Sept.3/	1st	13,770	X	12,000	
	2nd			10,000	3/ Drop flows slowly-
	3rd			8,000	but maintain
	4th			6,000	enough to guide
Oct.		5,580	14,000	X	rearing Chinook to
Nov.		2,430	14,000	X	rearing habitat
Dec.		1,750	14,000	X	

TABLE 4 Technical Comment AQR059

IV. MAINTAIN 75% OF CHINOOK SIDE CHANNEL HABITAT 1/

X=No Requirement

Month	Weekly	Mean Q at Gold Creek	Max Q	Min Q	Notes
Jan.		1,440 cfs	16,000 cfs	X	1/ Basically same as III but with 9000 cfs replacing 14,000 cfs to maintain 75% of chinook
Feb.		1,210	16,000	X	
Mar.		1,090	16,000	X	
Apr.		1,340	16,000	X	
May	1st	13,400	16,000	X	
	2nd			X	
	3rd			6,000	
	4th			6,000	
June	1st	28,150	X	9,000	
	2nd			9,000	
	3rd			9,000	
	4th			9,000	
July	1st	23,990	X	9,000	
	2nd			9,000	
	3rd			9,000	
	4th			9,000	
August	1st	21,950	X	9,000	
	2nd			9,000	
	3rd			9,000	
	4th			9,000	
Sept.	1st	13,770	X	8,000	
	2nd			7,000	
	3rd			6,000	
	4th			6,000	
Oct.		5,580	18,000	X	
			17,000		
			16,000		
			16,000		
Nov.		2,430	16,000	X	
Dec.		1,750	16,000	X	

TABLE 5 Technical Comment AQR059

II. MAINTENANCE OF 75% OF CHUM SPAWNING AND CHINOOK REARING HABITAT

X=No Requirement

Month	Weekly	Mean Q at Gold Creek	Max Q	Min Q	Notes
Jan.		1,440 cfs	16,000 cfs	X	
Feb.		1,210	16,000	X	
Mar.		1.090	16,000	X	
Apr.		1,340	16,000	X	
	1st			X	
May	2nd	13,400	16,000	X	
	3rd			6,000	
	4th			6,000	
	1st			10,000	
June	2nd	28,150	X	10,000	
	3rd			9,000	1/ 35,000 cfs spike
	4th			9,000	to flush out
	1st				sediments
July	2nd	23,990	X	9,000	and clean slough
	3rd				spawning areas.
	4th				
	1st		X	X	
August	2nd	21,950	30,000	12,000	
	3rd		30,000	12,000	
	4th		30,000	12,000	
	1st		30,000	12,000 2/	
Sept.	2nd	13,770	16,000	7,000	2/ Spike up to
	3rd		16,000	6,000	18,000 cfs for
	4th		16,000	6,000	slough #21 access
Oct.		5,580	16,000	X	by Chums; one day
Nov.		2,430	16,000	X	up, one day down.
Dec.		1,750	16,000	X	

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TOPIC AREA: Flow Regime, Spiking Releases, Salmon Access

LOCATION: Vol 1 Page 5-9 Section 5.3.3 Paragraph 7 & 8 of the page

COMMENT IN REFERENCE TO: Recommendation regarding flow regime.

TECHNICAL COMMENT: These recommendations and conclusions should be modified in light of the discussion presented in Technical Comments AQR072, AQR073 and AQR062.

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TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Spiking Releases

LOCATION IN DEIS: Vol Page 5-9 Section 5.3.3 Paragraph 9 of the page

COMMENT IN REFERENCE TO: Spike releases and volume of live storage which represents 9 days of 24,000 cfs spiking flows. Development of strategy for allocating reservoir volume to this use.

TECHNICAL COMMENT: The discussion of spiking releases here and in the summary (page xxvi) are inconsistent. In the summary it is stated that:

> "The Staff recommended that if the proposed project is authorized, the minimum releases from project dams proposed by the Applicant (12,000 cubic feet per second (cfs) or 340 cubic meters per second (m^3/s) be augmented with periodic spiking flows up to a combined total release of 20,000 cfs (566 m^3/s)during the salmon spawning season (August 1 to September 15). These spike releases should occur for at least three continuous days, and should occur during at least three different periods during the indicated spawning season."

Whereas in Chapter 5 (p-5-9) it is stated that:

> "Therefore, the Staff recommends that spike flows in excess of 20,000 cfs (566m^3/s) be implemented, along with the minimum release, during the salmon spawning period. These increased releases should occur during different periods between August 1 and September 15, with each peak being held for at least three days. Some overtopping of sites such as Slough 9 would begin to occur if these peak flows reached 23,000 cfs (680 m^3/s). Nine days of spiked releases of 24,000 cfs

> (680 m^3/s) represent an additional 107,000 ac-ft (1.32 x 10^8 m^3) over the minimum flow regime, or 3% of the live storage of Watana reservoir. A strategy for allocating reservoir volume of this magnitude, especially in wet years, should be developed as part of project mitigation."

The Summary uses the words "...up to...20,000 cfs..." whereas Chapter 5 uses the words "...in excess of 20,000 cfs...". The volume of water indicated in Chapter 5 (107,000 ac-ft) is not consistent with providing continuous flows of 24,000 cfs at Gold Creek for 9 days. To provide a block of 24,000 cfs continuously for 9 days would require approximately 321,000 ac-ft of water over the minimum flow regime or approximately 9% of the live storage at Watana. This assumes Watana releases would be raised and lowered at rates of 8000 cfs/day for $1^1/_2$ days prior to and after the 3 - 3 day periods to meet the spiking requirement.

These inconsistencies should be corrected. Additionally, we have estimated the economic consequences of using the indicated volumes of water (107,000 ac-ft and 321,000 ac-ft) for non-power related uses.

The economic consequences of using 107,000 ac-ft of water over the minimum flow regime would be similar to the economic consequences of adding 1,000 cfs to the Case C minimum target flows between August 1 and September 16 and 600 cfs to the minimum target flows between September 16 and October since the volumes of water in excess of the Case C minimum flow regime would be approximately equal. The resulting minimum target flows would be midway between those estimated for Case C and Case C1 (License Application Table E.2.34). The long term present worth of net benefits for Cases C and C1 are shown in Table B.57 of the revised License Application. Linear interpolation midway between the net benefits for the two cases would give a reduction in benefits for the lifetime of the project of approximately $50,000,000 in 1982 dollars. If the actual volume of water to be allocated for spiking is on the order of 321,000 ac-ft, the reduction in net benefits would be similarly computed to be approximately $200,000,000.

Mitigation planning refinement studies being undertaken by the Power Authority are investigating spiking flows of different magnitudes than in the DEIS as a method to provide for salmon access into the side sloughs. It is not yet clear that spikes are needed, but the volumes of water and the environmental and economic consequences are being investigated.

The Susitna Hydroelectric Project is designed to provide low cost energy and accompanying dependable capacity to meet the projected Railbelt system loads. Continuing studies of reservoir operation and resultant energy production indicate that it is impractical to allocate reservoir storage for mitigation purposes since such allocation would significantly reduce energy production in critical low flow years.

The FERC recommendation to provide spike flows of 20,000 or 24,000 cfs for 3 three-day periods during the August 1-September 15 period is designed to facilitate adult salmon access into slough spawning areas. The econonmic costs of providing these spike flows must be gaged against the number of adult salmon which might be benefitted by these increased flows. A discussion of mainstem discharges versus access conditions at sloughs is presented in Comment AQR072. Based on the analyses presented in Comment AQR072 nearby two thirds of the spawning habitats evaluated have unrestricted access conditions at 12,000 cfs with only one third of the spawning habitat having access conditions which would be considered at least somewhat restricted. Less than 10 percent of the spawning habitats have acute access conditions when mainstem discharge is 12,000 cfs. Of the sloughs listed in Table H.3-4, those sloughs which do not have unrestricted access conditions when mainstem discharge is 12,000 cfs include Sloughs 9, 16B, 20, 21 and 22 (see Table H.3-4 and Comment AQR072). The number of adult salmon observed in these sloughs in 1981, 1982 and 1983 are as follows:

	Sockeye			Pink			Chum		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Slough 9	18	13	0	0	18	0	645	603	430
Slough 16B	0	0	0	0	0	0	5	0	0
Slough 20	0	0	0	0	75	0	20	20	103
Slough 21	63	87	294	0	9	0	657	1737	481
Slough 22	0	0	0	0	0	0	0	0	105

Of these sloughs, only sloughs 16B, 20 and 22 have acute access conditions at 12,000 cfs. The total number of fish which would have been affected by the spiked flows by unrestricted access conditions to the five sloughs in each of the three years are 1408 in 1981, 2570 in 1982 and 1413 in 1983. During the three years of study these five sloughs provided spawning habitat for an average of 1800 adult salmon. Therefore, providing spikes of flow for maintaining access conditions over the life of the project this would affect approximately 90,000 fish. It is interesting to note that the largest numbers of fish using these 5 sloughs occurred in 1982, a year when mainstem discharge during the August 1 - September 15 period was less than 18000 cfs and approximated the proposed with-project discharges during the time when most of the fish gained access to the sloughs (See Technical Comment AQR072).

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TOPIC AREA: Flow Regime, Instream Flow, Forecasting, Reservoir

LOCATION IN DEIS: Vol 1 Page 5-10 Section 5.3.3 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Development of a water resource modeling program; "The implementation of a water-resource modeling program within the Susitna River Basin should be included in mitigation planning. The objectives of such a program should be to achieve state-of-the-art forecasting of streamflows within the basin and to improve reservoir operation by allocating streamflows in excess of power demands to optimize fisheries production below the dams."

TECHNICAL COMMENT: The Power Authority is continuing efforts to improve reservoir operation to optimize power and energy and fisheries. This is being done in three ways. 1) Reservoir operations on a monthly or weekly basis are being refined to utilize operating guides which define optimal power releases to be made based on reservoir level and instream flow requirements. The operating guides provide more stable flows on a monthly or weekly average basis and generally maintain instream flow requirements. This improves power and energy benefits and is expected to have a positive effect on the fisheries. 2) Hourly operation studies are being conducted to further optimize the energy and power benefits while maintaining acceptable rates of hourly and daily water level changes downstream from the dams. The hourly studies utilize the results of weekly or monthly reservoir operations. The benefits of providing spiking flows (i.e. Short-term increased reservoir release for a specific purpose, e.g. as recommended in the DEIS; Vol 1, Page 5-8, Sec. 5.2.2, Paragraph 1 of the page) for the downstream fish habitats are being investigated in the hourly operation studies. 3) Studies utilizing the reservoir operations program are being conducted to optimize instream flow uses including downstream fisheries and power and energy benefits. These studies are being conducted not only to allocate streamflows in excess of power demands for fisheries purposes, but to provide optimized reservoir operation for all uses.

The Power Authority acknowledges the potential benefits of state-of-the-art forecasting of streamflows within the basin to improve reservoir operation for all instream flow uses. The Power Authority is investigating the feasibility of developing streamflow forecasting methods to provide for the optimal allocation of water resources.

If a method for predicting reservoir inflow could be developed for the Susitna Project, it is questionable whether it could predict late summer storm related flows for allocation to mitigation. If predicted late summer storms would not not materialize, then in an average flow year the storage carryover into the winter for energy when it is most needed would be reduced. Because of the variability and unpredictability of late summer storm events, the Susitna Project reservoirs must be operated to be full in mid to late September in order to provide reliable energy for the upcoming winter.

It should be noted that, while long-term forecasting of inflows is in use on many projects and may be beneficial, there have been some notable failures on short-term bases. For example, the flooding in the Colorado Basin in 1983 was the result of under prediction of spring snowmelt due to unusual weather conditions and a reservoir operating policy designed to store the runoff for later use for water supply and irrigation. The desired water level in the reservoir of Glen Canyon Dam was determined by the predicted downstream demands and predicted reservoir inflow. In the spring the reservoir is generally kept as full as possible consistent with predicted inflow and adequate flood storage. However, in the spring of 1983, the actual snowmelt runoff greatly exceeded predicted values due to unusually heavy late spring snows and sudden warming on Memorial Day. The reservoirs could not store the runoff safely and spillways had to be operated.

This was a failure to accurately predict snowmelt runoff which would normally be considered part of a long-term forecasting procedure. However, the effect was the same as a failure to predict a short-term occurrence with a full reservoir since the snowfall and snowmelt occurred over a short period. Similar consequences could result from over filling of Watana reservoir.

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TOPIC AREA: Mitigation, Salmon, Filling

LOCATION IN DEIS: Vol 1 Page 5-10 Section 5.3.4 Paragraph 8 of the page

COMMENT IN REFERENCE TO: Need to mitigate for losses during filling.

TECHNICAL COMMENT: Salmon production in the middle river reach will not be greatly reduced during filling (see Technical Comment AQR142). Reductions of growth will be less than predicted in the DEIS (see Technical Comment AQR123). The need to mitigate for lost growth will depend on the effect this has on subsequent survival and overall adult production.

Mitigation measures for other impacts during operation will be effective during the filling years.

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TOPIC AREA: Mitigation, Reservoir

LOCATION IN DEIS: Vol 1 Page 5-10 Section 5.3.4 Paragraph 9 of the page

COMMENT IN REFERENCE TO: Mitigation opportunities in the impoundment areas.

TECHNICAL COMMENT: Mitigation opportunities with resident fishes in the impoundment area recommended by the DEIS are more limited and less desirable than those put forward by the Applicant. Lack of littoral areas and other problems associated with large water level fluctuations, poor access and long distance from the user population make mitigations through management of stocks in the impoundment area unattractive. The Applicant's plan, which focuses on species more desirable to anglers and includes options to make the benefits more available to the fishing public would provide a greater "pay-back" for lost production (see Technical Comment AQR133).

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TOPIC AREA: Mitigation, Reservoir, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 1 Page 5-11 Section 5.3.4 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Potential for stocks in reservoirs

TECHNICAL COMMENT: Introduction of kokanee into Watana Reservoir is not a preferred mitigation option. See Technical Comment AQR133.

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TOPIC AREA: Temperature, River Temperature Model, Groundwater

LOCATION IN DEIS: Vol 1 Page 5-11 Section 5.3.4 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Uncertainties regarding prediction of river temperature and groundwater flow.

TECHNICAL COMMENT: The Alaska Power Authority has addressed the questions in the DEIS regarding river temperatures and groundwater flow in comments related to specific issues. The Power Authority's comments are summarized briefly below.

The Alaska Power Authority questions the DEIS temperature simulations. The Power Authority checked the derivation of the late fall/early winter profile shown in the Main Text, Chapter 4 Figure 4-7 (see Technical Comments AQR033 and AQR074) using the heat flux components listed in Appendix H, page H 44. Computations indicate a cooling rate similar to those shown in the License Application for the November period. This supports the License Application and the river temperatures shown in Appendix V and contradicts the DEIS. In addition, using the same methods a midsummer warming rate similar to a midsummer profile estimated for the License Application was calculated.

The DEIS has also questioned the efficiency of the multilevel intake based on a belief that the reservoir will not be strongly stratified. Comments on this are included in Technical Comment AQR032. The Power Authority analyses show that the multilevel intake and the midlevel outlet will provide effective control of temperatures during reservoir operation and during Watana filling when the reservior water level reaches approximately elevation 2,065 feet.

As requested by FERC in its Schedule B Request for Supplemental Information, April 1983 (Exhibit E, No. 2-41), state-of-the-art forecasting of stream water levels and ice front locations for several cases of Watana filling, Watana operation and Watana/Devil Canyon operation was completed. Please see our Technical Comments AQR071, AQR037, and Appendix VI.

In order to aid the DEIS's analysis of temperature-related impacts for the EIS, several refined simulations of reservoir and stream temperatures were completed. These simulations were requested by FERC in April 1983 in its Schedule B Request for Supplemental Information (Exhibit E, No. 2-28). The results are shown in Appendices IV and V for reservoir temperature and stream temperature, respectively.

Additionally, refined our analyses of slough geohydrology are presented. Please see our Technical Comments AQR035, AQR036, and Appendix VII, a report on slough geohydrology. It has been possible, using professional judgment, to isolate apparent components of slough flow, resulting from shallow infiltration from the mainstem at Sloughs 8A, 9 and 11. Statistical inferences on the nature of the relationship of mainstem discharge to slough flow have been made.

Investigations also indicate that the temperature of the groundwater upwelling is near the mean annual temperature of the river at a given location. Temperature simulations carried out to date indicate that mean annual Susitna River temperature at Slough 9 would be 3.9°C, 4.3°C and 4.1°C for natural, Watana operation and Watana/Devil Canyon operation, respectively, for the period May 1982 to April 1983. This indicates that with-project temperatures of the groundwater component of slough flow would not be significantly different than under natural conditions. This can be explained by heat transfer within the alluvial aquifer materials and mechanical dispersion.

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TOPIC AREA: Instream Flow, HEC-2 Model

LOCATION IN DEIS: Vol 4 Page H-7 Section H.1.2 Paragraph 6 of the page (Reference to) Table H.1-2

COMMENT IN REFERENCE TO: Water levels in reach from Devil Canyon to Talkeetna

TECHNICAL COMMENT: More recent simulations of water-surface profiles in the reach of the Susitna River between the Chulitna-Susitna confluence and Devil Canyon Dam have been reported (HE 1984b). These data were requested by FERC on November 3, 1983 and were transmitted to FERC by the Power Authority on April 30, 1984. A draft of this document was transmitted to FERC on December 5, 1983. The profiles in HE 1984b are considered more accurate than the profiles in R&M 1982b (cited in the DEIS) and the Power Authority is utilizing them in its ongoing studies.

An examination of the water-surface profiles presented in the DEIS shows significant variations in predicted water-surface elevations between Table H.1-2 of the DEIS and the referenced document. These differences are greatest at low discharges. More extensive data were available for calibration and additional cross sections were surveyed when the HEC-2 simulations were made for HE 1984b than when HEC-2 was run for R&M 1982b. The water-surface profiles contained in HE 1984b are considered more accurate. The Power Authority requests that FERC utilize profiles in HE 1984b in order to avoid inconsistencies possibly leading to confusion and errors. Table 5 of this report is attached.

Table 5

WATER SURFACE ELEVATIONS

Cross Section	River Mileage	Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)								
		3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
0.001	83.90	272.1	272.7	273.3	274.1	275.1	275.9	277.2	279.3	282.2
0.01	84.83	276.6	278.2	279.0	281.4	281.6	282.3	284.8	291.7	292.4
0.02	86.93	281.7	282.8	283.5	285.5	285.7	286.4	288.5	294.1	295.3
0.03	88.13	285.1	286.0	286.4	288.0	288.1	288.6	290.4	294.9	296.3
0.04	89.83	291.4	292.2	292.7	294.0	294.1	294.5	295.9	298.8	300.3
0.05	91.63	298.7	299.4	299.7	300.9	301.0	301.3	302.5	304.7	305.9
0.3	94.23	314.3	315.3	315.7	316.7	316.7	317.1	318.2	318.7	319.7
0.4	94.55	316.1	317.0	317.5	318.7	318.8	319.2	320.3	321.6	322.7
0.5	94.92	317.3	318.5	319.1	320.7	320.8	321.2	322.4	323.9	325.0
0.6	95.37	319.2	320.8	321.5	323.4	323.6	324.2	325.5	327.0	327.8
0.7	95.76	323.5	324.3	324.8	326.3	326.5	326.9	328.2	329.6	330.4
0.8	96.13	326.5	327.2	327.6	328.8	328.9	329.3	330.4	331.9	332.6
0.9	96.61	330.5	331.1	331.4	332.4	332.5	332.8	333.6	334.8	335.4
1.0	97.02	332.0	332.9	333.4	334.6	334.7	335.0	335.9	336.9	337.7
1.1	97.31	332.9	333.9	334.5	335.7	335.8	336.2	337.2	338.4	339.2
1.2	97.62	335.0	335.7	336.1	337.3	337.4	337.7	339.0	340.3	341.0
2.0	97.93	336.7	338.0	338.3	339.3	339.4	339.7	340.9	342.1	342.9
2.1	98.03	337.1	338.3	338.7	339.7	339.8	340.1	341.3	342.7	343.6
2.2	98.23	337.7	338.9	339.3	340.5	340.5	340.9	342.3	344.1	345.0
2.3	98.42	338.5	340.0	340.5	342.5	342.7	343.5	345.4	347.1	347.9
3.0	98.59	339.7	341.2	341.8	344.1	344.5	345.3	346.9	348.4	349.1
3.1	98.75	340.9	342.1	342.7	344.6	345.1	346.0	347.5	348.9	350.0
3.2	98.93	343.4	344.1	344.6	345.2	345.8	346.8	348.0	349.4	350.8
3.3	99.10	344.8	345.5	346.0	346.1	346.8	347.7	348.6	350.0	351.6
3.4	99.31	345.9	346.4	346.9	347.2	348.0	348.8	349.8	351.1	352.8
4.0	99.58	347.1	347.5	348.0	348.6	349.5	350.3	351.7	352.9	354.6
4.1	99.75	351.0	351.4	351.7	351.9	352.6	353.2	354.3	355.3	356.7
4.2	99.94	351.9	352.5	352.8	353.0	353.8	354.4	355.5	356.6	358.0
4.3	100.17	352.5	353.1	353.5	353.8	354.7	355.5	357.0	358.2	359.7
4.4	100.28	353.1	353.9	354.2	354.5	355.5	356.3	357.9	359.0	360.3
5.0	100.36	356.5	356.9	357.2	357.4	358.0	358.5	359.6	360.8	362.1
6.0	100.96	360.2	360.9	361.3	361.9	362.7	363.3	364.4	365.6	367.3
7.0	101.52	363.1	364.0	364.6	365.3	366.5	366.6	368.2	369.5	371.0
8.0	102.38	370.2	371.2	371.7	372.4	373.4	374.0	375.1	376.6	378.4
9.0	103.22	374.9	376.2	376.9	378.0	378.6	379.8	381.2	383.3	385.8
9.1	104.12	381.9	383.0	383.7	384.9	385.8	386.6	387.7	389.7	391.8
10.0	104.75	391.1	391.6	391.8	392.2	392.2	392.8	393.6	395.0	396.7
10.1	105.01	393.5	394.2	394.6	395.1	395.3	395.8	396.6	397.9	399.4
10.2	105.81	399.7	400.2	400.8	401.4	401.7	402.2	403.0	404.2	405.6
10.3	106.34	403.8	404.9	405.4	406.0	406.3	406.8	407.7	409.0	410.8
11.0	106.68	406.3	407.4	407.8	408.3	408.7	409.3	410.2	411.5	413.2

Source: HE 1984b

Table 5 (Continued)

WATER SURFACE ELEVATIONS

Cross Section	River Mileage	Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)								
		3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
12.0	108.41	419.0	419.7	420.4	420.8	421.7	422.6	423.7	425.6	428.0
13.0	110.36	433.2	434.3	435.6	436.2	437.6	438.1	439.6	441.5	444.9
14.0	110.89	441.3	442.0	442.4	442.9	443.4	443.9	445.0	446.7	449.3
15.0	111.83	450.2	451.2	451.6	452.1	452.6	452.9	453.7	454.9	456.3
16.0	112.34	453.4	454.2	454.8	455.4	456.3	456.6	457.7	459.0	460.8
17.0	112.69	457.6	458.1	458.6	459.0	459.9	460.4	461.1	462.4	463.9
18.0	113.02	459.1	459.7	460.2	460.7	461.8	462.4	463.2	464.9	466.6
18.1	114.11	471.9	472.8	473.4	474.2	474.5	475.3	476.0	477.0	478.9
18.2	115.08	477.0	478.1	479.1	480.2	481.2	481.8	482.9	484.2	486.1
18.3	115.86	480.4	481.6	482.5	483.9	484.7	485.5	487.0	488.6	490.9
19.0	116.44	484.3	485.1	485.7	486.8	487.6	488.5	490.1	491.6	494.2
19.1	116.89	490.7	491.4	492.1	492.7	493.5	494.0	495.5	496.8	499.0
20.0	117.19	492.0	493.0	493.9	494.8	495.8	496.4	497.9	499.0	501.0
20.1	117.61	497.8	498.7	499.4	500.1	501.0	501.5	502.5	503.5	504.9
20.2	118.31	502.1	503.3	504.1	504.8	505.5	506.1	507.2	508.2	509.8
21.0	119.15	506.0	507.3	508.3	509.2	510.2	510.9	512.2	513.5	515.7
22.0	119.32	508.9	509.8	510.5	511.5	512.3	512.9	514.0	515.3	517.3
23.0	120.26	518.1	518.8	519.3	519.7	520.4	520.9	521.8	522.9	524.6
24.0	120.66	519.2	520.1	520.7	521.2	522.2	523.0	524.1	525.4	527.2
24.1	120.85	520.0	521.2	522.0	522.7	524.0	524.4	525.4	526.8	529.8
25.0	121.63	530.9	531.4	532.0	533.2	533.8	533.9	534.6	537.8	539.6
25.1	122.05	532.5	533.1	533.7	534.8	535.5	535.6	536.7	539.6	541.7
26.0	122.57	535.6	536.4	536.9	537.6	538.2	538.9	540.1	542.0	544.2
27.0	123.31	540.2	541.3	542.0	542.8	543.3	544.4	545.5	547.2	549.4
28.0	124.41	551.6	552.7	553.6	554.4	555.2	556.1	556.8	558.1	560.1
28.1	125.54	563.6	564.3	564.9	565.3	566.0	566.8	567.6	568.3	570.1
29.0	126.11	567.5	568.4	568.8	569.4	570.4	571.2	572.0	573.1	574.9
30.0	127.50	584.7	585.6	586.0	586.7	587.3	587.7	588.0	589.2	590.8
31.0	128.66	592.0	593.3	594.3	595.3	596.2	597.1	598.2	599.6	601.4
32.0	129.67	604.0	604.6	605.2	606.1	607.0	607.7	608.4	610.0	611.8
33.0	130.12	610.6	611.3	611.7	612.2	613.0	613.5	613.8	614.6	615.9
34.0	130.47	614.1	614.7	615.2	615.7	616.6	617.2	617.9	619.1	620.4
35.0	130.87	615.0	616.0	616.6	617.4	618.4	619.1	620.1	621.7	623.6
36.0	131.19	616.4	617.1	617.8	618.9	620.2	621.0	622.4	624.2	626.6
37.0	131.80	625.1	626.0	626.5	627.1	627.8	628.1	628.9	629.4	630.4
38.0	132.90	637.0	637.7	638.2	638.9	640.0	640.7	641.8	643.4	645.6
39.0	133.33	644.5	645.1	645.4	645.9	646.4	646.7	647.4	648.2	649.7
40.0	134.28	653.1	653.8	654.4	655.2	655.9	656.5	657.5	658.6	660.4
41.0	134.72	657.9	658.6	659.2	659.9	660.6	661.2	662.3	663.6	665.8
42.0	135.36	667.4	668.0	668.4	668.8	669.4	669.8	670.4	671.5	672.8

Table 5 (Continued)

WATER SURFACE ELEVATIONS

Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
43.0	135.72	668.4	669.4	670.2	671.2	672.1	672.7	673.8	675.3	676.9
44.0	136.40	678.8	679.6	680.2	681.2	682.2	683.0	684.2	685.4	687.4
45.0	136.68	681.1	682.2	683.0	684.0	685.1	686.0	687.2	688.4	690.5
46.0	136.96	684.1	685.1	685.9	686.9	687.9	688.8	690.2	691.7	694.1
47.0	137.15	687.5	688.6	689.3	690.4	691.3	691.9	692.9	694.2	696.3
48.0	137.41	689.8	690.9	691.7	692.9	693.9	694.6	695.5	697.0	699.1
49.0	138.23	698.6	699.6	700.2	700.9	702.7	703.4	704.3	705.2	706.6
50.0	138.48	700.2	701.3	702.0	702.7	704.3	705.1	706.2	707.3	708.6
51.0	138.89	705.4	706.0	706.5	706.9	707.6	708.5	709.7	711.4	711.7
52.0	139.44	713.0	714.4	715.8	717.1	717.8	718.2	718.6	719.5	720.1
53.0	140.15	719.9	720.8	722.1	722.7	723.7	724.4	725.4	726.5	728.8
54.0	140.83	730.2	730.8	731.3	731.8	732.3	733.1	734.1	735.8	737.6
55.0	141.59	740.7	741.6	742.2	742.9	743.4	743.9	744.3	745.3	746.8
56.0	142.13	749.5	750.2	750.5	751.4	751.4	752.1	753.2	755.0	756.9
57.0	142.34	751.7	752.7	753.1	754.2	754.4	755.0	756.0	757.8	759.9
58.0	143.18	762.4	763.5	764.1	764.8	765.7	766.2	766.2	767.9	769.2
59.0	144.83	783.0	784.3	785.4	786.8	787.8	789.2	790.4	791.2	792.3
60.0	147.56	816.4	817.5	818.5	819.5	820.6	821.6	823.4	823.8	825.8
61.0	148.73	828.7	830.3	831.3	833.1	834.3	834.8	836.4	838.7	840.5
62.0	148.94	831.4	832.9	833.7	835.4	836.6	837.1	838.5	841.0	843.0
63.0	149.15	834.4	835.6	836.4	837.9	839.0	839.7	841.0	843.2	845.2
64.0	149.35	836.2	837.6	838.5	839.9	841.1	841.9	843.2	845.4	848.0
65.0	149.46	839.0	840.0	840.6	841.9	842.9	843.5	844.7	847.0	850.0
66.0	149.51	842.3	843.0	843.6	844.5	845.2	845.8	846.8	848.5	850.9
67.0	149.81	845.7	846.8	847.5	848.7	849.6	850.2	851.1	852.4	854.7
68.0	150.19	847.3	848.6	849.5	851.0	852.1	852.8	854.0	855.8	858.8

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TOPIC AREA: Habitat, Side Slough

LOCATION IN DEIS: Vol 4 Page H-12 Section H.1.2 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Side slough is most biologically significant habitat and most responsive to changes in mainstem flow.

TECHNICAL COMMENT: The rationale for describing side-slough habitat as the most biologically significant is not clear. Depending on the criteria used, tributary habitat could be judged more significant since essentially all coho, chinook and pink salmon and a large proportion of the chum salmon spawning occurs in tributaries (ADF&G 1984b, pp 177-218). In addition, tributaries provide major rear habitat for chinook, coho and chum salmon juveniles (ADF&G 1983d, pp 238-248).

The basis for stating that side-slough habitat is the most responsive to charges in mainstem discharge is also unclear. Mainstem and side channel habitats are more directly affected and would be more responsive to changes in mainstem discharge (See Technical Comment AQR027).

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TOPIC AREA: Gold Creek Station, Susitna Station

LOCATION IN DEIS: Vol 4 Page H-21 Section H.2.1 Paragraph 2 of the page (Reference Section H.2.1).

COMMENT IN REFERENCE TO: Flow duration curves at Gold Creek and Susitna Station

TECHNICAL COMMENT: The legend appears to be incorrect. The dashed line should refer to Susitna River at Gold Creek, the solid line should refer to Susitna River at Susitna Station. The flow duration curves for Susitna River at Gold Creek appear to give discharges which are high by a factor of ten. Please see the License Application Fig. E.2.39.

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TOPIC AREA: Sloughs, Hydraulics

LOCATION IN DEIS: Vol 4 Page H-26 Section H.3 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Analysis of slough hydraulic regimes and their frequency of occurence.

TECHNICAL COMMENT: The DEIS statement which defines the hydraulic regimes within the sloughs as they are influenced by mainstem discharge is correct. Further, the frequency analysis of each regime for the sloughs presented in the DEIS is generally indicative of how Susitna project operation will alter these regimes in the sloughs. However, the DEIS presents no evaluation of how these changes relate to the fish habitats.

According to the evaluation of the importance and contribution of the sloughs to fish populations presented in Section I.1.4.2.2 of Appendix I (p. I-29), the reduction in frequency of overtopping of the sloughs could be a benefit by reducing the amount of time turbid water is conveyed through the sloughs. This potentially beneficial impact should be noted in the DEIS.

SUSITNA HYDROELECTRIC PROJECT
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TOPIC AREA: Sloughs, Ice Processes, Hydraulics

LOCATION IN DEIS: Vol 4 Page H-36 Table 4.3.3 Section 4.3 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Winter overtopping is likely to be a frequent phenomenon with-project.

TECHNICAL COMMENT: The Alaska Power Authority has prepared simulations of river ice processes in response to the FERC's Schedule B Request for Supplemental Information of April 1983 (Exhibit E, Nos. 2.28 and 2.41), and as part of the ongoing settlement process.

A general discussion of the simulations and expected with-project effects on ice is included in Technical Comment AQR037. Appendix VI to these comments contains the simulations of the Susitna River as affected by ice for the conditions shown in Table 1.

Natural conditions were simulated for the period September 1982 through May 1983 for the purpose of calibrating the model and for comparison with simulated with-project conditions for that period. This simulation is also included in Appendix VI. In the calibration report (HE 1984d) natural conditions were also simulated for the period September 1983 through May 1984 for calibration purposes. With-project conditions were not simulated for this period, as weather and hydrologic conditions were similar to 1982-1983.

Additionally, natural conditions were simulated for the winters of 1971-1972, 1976-1977 and 1981-1982 for comparison with project conditions. The

Table 1
River Ice Simulations

	Watana Operation		Watana/Devil Canyon Operation		Watana Filling	
Estimated Energy Demand for	1996	2001	2002	2020	First Winter	Second Winter
Simulated Period						
Nov. '82-May '83 Avg.Year Avg. Winter Temps.	+	+	+	+	+	0
Nov. '71-May '72 Wet Year Cold Winter Temps.	+	+	+	+	0	0
Nov. '76-May '77 Dry Year Avg. Winter Temps.	+	0	+	0	0	0
Nov. '81-May '82 Wet Year Cold Winter Temps.	+	0	+	0	0	+

\+ Simulated
0 Not simulated

upstream boundary for these simulations was River Mile 139 (upstream of Gold Creek) to allow estimation of frazil ice influent to the study reach. This limitation is explained in Appendix VI. Observations of water levels, ice thicknesses, and ice front progression are not available for those years for comparison with natural condition simulations.

SUMMARY

NATURAL CONDITIONS

Observations of river ice (R&M 1981b, 1982f, 1983, 1984a) and slough hydrology (R&M 1982i) undertaken by R&M Consultants, Inc. indicate that:

1. Overtopping of the upstream berm of Slough 8A occurs under natural conditions as observed in the winter of 1982-83. This overtopping allows slush ice to flow into the slough and form an ice cover. The ice cover eventually deteriorates due to warm upwelling water in the slough, leaving open leads.

2. Overtopping of the berm at Slough 9 appears to have occurred during December of 1982-1983 when flows were estimated to be 2500 cfs. Maximum water levels attained during the ice-covered period were equivalent to an open water flow of 30,000 to 40,000 cfs, (R&M 1982i) which would result in overtopping of the berm.

3. Overtopping of the upstream slough berm at Slough 21 was not reported in 1982-83. However, maximum ice-affected water surface levels reported for 1982-83 (R&M 1983) indicate staging in the vicinity of this slough which caused maximum water levels to be near overtopping of the berm.

The observations of 1982-1983 water levels near Slough 8A and Slough 9 verify the simulation results for natural conditions, which show overtopping of the upstream berms of both sloughs. The simulation of natural conditions was not extended upstream of Gold Creek because of the lack of data on ice production, so a comparison of simulated and observed conditions is not possible at Slough 21.

The mechanism of upstream berm overtopping at Slough 8A in the winter is described in R&M 1982i. In 1982-1983 the formation of an ice cover on the river caused elevated water levels and overtopping of a berm or berms in the vicinity of River Mile 127 resulting in flow into the side channel upstream of the northeast berm of Slough 8A. The downstream end of this side channel (also identified as Slough B) was obstructed by ice and thus the flow was shunted over the northeast berm at the upstream end of Slough 8A, near River Mile 126.7. Overtopping of the northwest berm at Slough 8A at River Mile 126.1 was not reported.

The R&M (1982i) study indicates that overtopping of the berm at the head of the side-channel at River Mile 127.1 occurs at a mainstem flow of approximately 17,000 cfs. This would require a mainstem water level of approximately El. 582.5 (HE 1984b, Exhibit 4-G). The simulation of natural conditions for the winter of 1982-1983 indicates a maximum water level of El. 582 at this same location. In order to provide consistency between the natural condition simulations and the observations that the Slough 8A berm was overtopped in 1982-1983 it has been assumed that cold mainstem water will enter Slough 8A when the water surface at River Mile 127.1 reaches the Threshold El. 582.

SIMULATIONS

Instream ice simulations have been made for Watana filling, Watana operating for 1996 and 2001 energy demands and for Watana and Devil Canyon operating for 2002 and 2020 energy demands. A range of winter meteorologic conditions have been simulated to indicate the range of with-project ice affected water levels.

Meteorology and hydrology for the winters of 1971-1972, 1976-1977, 1981-1982 and 1982-1983 were used in the simulations. The winter of 1982-1983 generally gave the lowest water levels and shortest ice cover. The 1976-1977 and 1981-1982 winters gave similar results and had somewhat more ice and higher water levels. The winter of 1971-1972 resulted in the greatest ice accumulation and furthest progression of the ice front. In the simulations discussed herein the winters of 1982-1983 and 1976-1977 represent average winters and 1981-1982 and 1971-1972 represent cold winters.

The following general conclusions have been reached.

Winter of 1982-1983 (Average Air Temperatures)

As indicated above, it appears that under natural conditions berms at Sloughs 8A and 9 were overtopped. Water levels at Slough 21 were close to overtopping the berm. The simulation for 1982-1983 natural conditions is verified by these observations. With-project simulations indicate that berms at Sloughs 9 and 21 would not be overtopped for all the energy demands simulated. Simulations indicated the berm at Slough 8A would be overtopped for a period of 3 days for Watana operation for 1996 energy demands. For 2001 energy demands, it may be overtopped. For Watana and Devil Canyon operating and 2002 energy demands, the berm at Slough 8A would not be overtopped, but for 2020 energy demands the berm at Slough 8A may be overtopped.

Winter of 1976-1977 (Average Air Temperatures)

Simulations of natural conditions indicate that berms at Slough 8A and Slough 9 would not be overtopped. With-project simulations indicate that berms at Sloughs 8A and 9 would be overtopped with Watana operating. Berms at Sloughs 9 and 21 would not be overtopped with Watana and Devil Canyon operating. The berm at Slough 8A may be overtopped with Watana and Devil Canyon operating.

Winter of 1981-1982 (Cold Air Temperatures)

Simulations of natural conditions indicate that berms at Sloughs 8A and 9 would be overtopped. Berms at Sloughs 8A and 9 would also be overtopped with Watana only operating. The berm at Slough 21 would not be overtopped with Watana only operating. The berms at Sloughs 8A, 9 and 21 would not be overtopped with Watana and Devil Canyon operating.

Winter of 1971-1972 (Cold Air Temperatures)

The simulations of 1971-1972 produced the highest water levels and maximum upstream extent of the ice cover of all the winters simulated. For natural conditions, simulations indicate that berms at Sloughs 8A and 9 would be overtopped. With Watana operating and with Watana and Devil Canyon operating simulations indicate that berms at Sloughs 8A and 9 would also be overtopped. Simulations indicate that the berm at Slough 21 may only be overtopped for Watana operating alone for 2001 energy demands. When Devil Canyon begins operation Slough 21 would not be overtopped. It is not known whether the berm at Slough 21 was overtopped in 1971-1972. However, it may have been since maximum water levels were near overtopping during the winter of 1982-1983 which was warmer than 1971-1972.

Watana Filling

Simulations were made for the first and second winters of Watana filling. The Watana powerhouse would be operational by the third winter and winter conditions would be similar to operation. For the first winter of filling, reservoir outflow would be through the low level outlet works (License Application Plate F11). The outflow temperature would be relatively warm (near 4°C) for a winter condition. For the second winter of filling, reservoir outflow would be through the mid-level outlet works intake located near the reservoir surface (License Application Plate F17). Outflow temperatures would be near operational. For both conditions, discharges would be similar to natural conditions. To provide approximate bounds on the water levels and ice front advance, the winter of the first year of filling was simulated with an average air temperature year - 1982-1983. The winter of the second year of filling was simulated with a cold year - 1981-1982.

Natural condition simulations for 1981-1982 and 1982-1983 are given above. For the first winter of filling using 1982-1983 weather data, berms at Sloughs 8A, 9 and 21 would not be overtopped. For the second year of filling using the winter of 1981-1982, the berm at Slough 8A may be overtopped but the berms at Sloughs 9 and 21 would not be overtopped.

The following table summarizes the results for the winter simulations undertaken:

Table 2

Summary of Slough Berm Overtopping

Sloughs 8A, 9 and 21 3/

	Slough 8A berm	Slough 9 berm	Slough 21 berm
Winter of 1982-1983 (Average)			
Natural Conditions	OT 1/	OT 1/	1/ 2/
Watana Only (1996)	EQ	NOT	NOT
Watana Only (2001)	EQ	NOT	NOT
Watana/Devil Canyon (2002)	NOT	NOT	NOT
Watana/Devil Canyon (2020)	EQ	NOT	NOT
1st year of filling	NOT	NOT	NOT
Winter of 1976-1977 (Average)			
Natural Conditions	NOT	NOT	2/
Watana Only (1996)	OT	OT	NOT
Watana/Devil Canyon (2002)	EQ	NOT	NOT
Winter of 1981-1982 (Cold)			
Natural Conditions	OT	OT	2/
Watana Only (1996)	OT	OT	NOT
Watana/Devil Canyon (2002)	NOT	NOT	NOT
2nd year of filling	EQ	NOT	NOT
Winter of 1971-1972 (Cold)			
Natural Conditions	OT	OT	2/
Watana Only (1996)	OT	OT	NOT
Watana Only (2001)	OT	OT	EQ
Watana/Devil Canyon (2002)	OT	OT	NOT
Watana/Devil Canyon (2020)	OT	OT	NOT

Legend: OT indicates maximum water level exceeds threshold elevation
EQ indicates maximum water level equals threshold elevation
NOT indicates maximum water level is below threshold elevation

1/ See discussion in text of comment
2/ Natural condition ice simulations did not extend to Slough 21 so it cannot be determined if Slough 21 would have been overtopped.
3/ Comparisons are based on threshold levels and simulated water levels rounded to nearest foot. See Tables 3-13 in Appendix VI.

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TOPIC AREA: Sloughs, Salmon Access

LOCATION IN DEIS: Vol 4 Page H-37 Section H.3 Paragraph 1 of the page

COMMENT IN REFERENCE TO: DEIS analysis of slough access

TECHNICAL COMMENT: The analysis of accessibility of sloughs by spawning salmon which has been performed by FERC and presented in Appendix H of the DEIS is based on an over-simplified interpretation of the data base. The result of this over-simplified interpretation is much too high an estimate of required access flows. Since the accessibility of sloughs by adult salmon is a prime consideration in the development of the Case C operational scenario proposed by the Applicant and is a principal consideration in the FERC proposed modifications to it, a more detailed analysis of access conditions seems warranted.

This more detailed analysis should include a more critical review of: 1) the method for determination of the threshold discharges for acute and unrestricted access conditions; 2) the location at the critical passage reaches in relation to the spawning areas in the sloughs; 3) the timing of when adult salmon were observed in the sloughs relative to daily average mainstem discharges; and, 4) the method used for weighting the evaluation of individual sloughs to determine the impact of various mainstem discharges on accessibility of the sloughs. Each of these aspects is considered in more detail below.

1. <u>Determination of Access Conditions</u>

The threshold mainstem discharges for acute and unrestricted access conditions as established by ADF&G were based on comparison of a water depth and reach length criterion of 0.3 ft depth for 100 ft in length (ADF&G 1983e, and Trihey 1982) with plots of water-surface elevations and thalweg profiles of specific reaches within the sloughs. It was assumed that if the depth-length criterion is exceeded (i.e. water depth is 0.3 ft or less for more than 100 ft), acute access conditions prevail. If the water depth is greater than 0.5 ft for the entire reach, unrestricted conditions were assumed to prevail (ADF&G 1983a, Appendix B). However, ADF&G has clarified the method for determining how these conditions were established. The threshhold discharges were determined utilizing secondary data and not established directly in the field. That is, water depths and reach length were measured from water-surface elevation profiles and thalweg profiles for various mainstem discharges after these profiles had been plotted in the office. The potential for considerable error is inherent in these determinations because a) the threshold determinations are dependent upon the accuracy of the plots of water-surface and thalweg elevations and b) the depths and lengths measured are dependent upon the accuracy of the measurement and the scale of the plots used (e.g. the thickness of the line could equal 0.1 ft or more depending upon the scale used).

Therefore, the determination of threshold mainstem discharges for acute and unrestricted passage conditions must be tempered by referral to the field data, the temporal sequence of mainstem discharges and observation of salmon in the sloughs (See 3 below).

2. <u>Location of Spawning Areas Relative to Critical Passage Reaches</u>
Where the salmon spawn relative to where the critical passage reach is located within the slough must be considered in determining the threshold mainstem discharges required to provide access to the sloughs. For example, the critical access reach in Slough 21, as depicted in the thalweg profile (Appendix B, Figure B-12, ADF&G 1983a), is located approximately midway between the mouth of the slough and the confluence of the two upstream channels of the slough. However, the majority of the salmon spawning areas in Slough 21 are located downstream of this critical passage reach as shown on Figure C-11 (Appendix C, ADF&G 1983a). Hence, the critical passage reach is not critical to the majority of the salmon and adults are able to gain access to spawning areas below this passage reach at mainstem discharges considerably less than that indicated in Table H.3-4 of Appendix H of the DEIS.

3. Comparison of Salmon Observations and Daily Average Mainstem Discharge

During August and the first part of September 1982, mainstem discharge in the Susitna River as measured at Gold Creek approximated with-project discharges, thus fortuitously allowing direct observation of the accessibility of various sloughs by salmon, particularly chum salmon, at with-project flows.

As a matter of convenience for this discussion the daily average discharges at Gold Creek for the period August 1 through September 30, 1982 are presented in the attached Table 1. Also presented in the Table are the peak live and dead chum salmon counts observed in Slough 9 and Slough 21 during the corresponding period. Based upon these data and comparison with the threshold discharges for acute and unrestricted access to Slough 9 and 21 presented in Table H.3-4 of the DEIS, several observations can be made:

a. Between August 6 and September 13, 1982, mainstem discharge at Gold Creek did not exceed 18,000 cfs. Therefore, one would not expect to see large numbers of adult salmon entering Sloughs 9 and 21 given the acute threshold discharges of 18,000 and 20,000 cfs, respectively.

b. During the period August 23 through August 30, 1982, at least 150 chum salmon entered Slough 9. Mainstem discharge for this period ranged from 12,200 cfs to 13,600 cfs, well below the "acute" access condition threshold. Based upon the estimated total escapement to Slough 9 of 600 chum salmon (ADF&G 1984b, Appendix Table 2-G-13), the 150 chum salmon which gained access during this period accounted for approximately 25 percent of the total escapement. The remaining 75 percent of the Slough 9 escapement gained access prior to September 19 after which time no salmon were observed in the sloughs.

c. During the period August 22 through August 29, more than 300 adult chum salmon gained access to Slough 21. Mainstem discharge ranged from 12,200 cfs to 13,600 cfs. Again, the mainstem discharge was well below 20,000 cfs which is the threshold for acute access conditions into Slough 21.

Based on these observations, it is evident that the threshold mainstem discharge for acute access conditions at Sloughs 9 and 21 are considerably less than the 18,000 and 20,000 cfs thresholds presented in Table H.3-4. Since large numbers of salmon gained access to both sloughs in 1982 when mainstem discharge was near 12,000 cfs, it is reasonable to establish 12,000 cfs as the threshold for acute conditions of both sloughs. This is supported through the analysis presented by Trihey (Trihey 1982) and the ADF&G data report (ADF&G 1983e).

Revision of the threshold mainstem discharge for unrestricted conditions is considably by less supportable. Trihey (Trihey 1982) and ADF&G (ADF&G 1983e) present evidence for unrestricted access conditions at Slough 9 at a mainstem discharge of 18,000 cfs. There is no direct support for revising the unrestricted access threshold for Slough 21.

A further consideration in establishing the threshold mainstem discharges for access conditions is the influence of discharge from the slough. The depth of water and length of the passage reach is dependent not only upon mainstem backwater affects at the mouth of the sloughs, but also the amount of water flowing out of the sloughs. The threshold discharges presented in Table H.3-4 assume a base discharge from the sloughs. However, if discharge from the sloughs increases then the mainstem discharge necessary to provide adequate depth through the passage reaches decreases. This is exemplified in Slough 9 whereby if slough discharge is between 10 and 15 cfs, then unrestricted access conditions are present at mainstem discharges less than 12,000 cfs (ADF&G 1983a, Appendix B, Page B-38).

Based on these observations, it is evident that the threshold discharges for acute conditions at Slough 9 is probably closer to 12,000 cfs as indicated by Trihey (Trihey 1982) and ADF&G (ADF&G 1983e). Similarly, unrestricted access conditions into Slough 9 are probably more accurate as described by Trihey (Trihey 1982) and ADF&G (ADF&G 1983e).

Access to the major spawning areas of Slough 21 is likely to be acute at mainstem discharges less than 12,000 cfs; unrestriced access conditions are likely at 20,000 cfs. Further, these mainstem discharge thresholds for access into the sloughs can be modified depending upon discharge within the sloughs. The thresholds presented in the ADF&G 1983a report assume a base discharge level within the slough. However, if slough discharge is increased (e.g. to 10-15 cfs in Slough 9), the mainstem discharge necessary to provide adequate access conditions is considerably less (ADF&G 1983a, Appendix B).

Hence, a mainstem discharge of 20,000 cfs for providing access to sloughs is unnecessary. A revision of the analysis of impacts on salmon is appropriate.

4. Weighting of Individual Sloughs for Evaluation

The use of weighting factors of 1, 2/3, 1/3 and 0 for the relative utilization of sloughs by the three salmon species could be refined considerably by using the actual proportions of slough-spawning salmon utilizing each slough cited in Table H.3-4. The proportions of salmon utilizing the nine sloughs identified are summarized for 1981, 1982, and 1983 in Table 2 (attached). In revising the analyses used to develop Figure H.3-1 of Appendix H, weighting of the evaluation of individual sloughs can be accomplished in several ways. The method chosen here is to sum the proportions of slough-spawning salmon in each slough for all years and rescale the proportions to 100 percent as follows:

$$W_k = \frac{\sum_{j=1}^{3} \sum_{i=1}^{3} p_{i,j,k}}{\sum_{k=1}^{9} \sum_{j=1}^{3} \sum_{i=1}^{3} p_{i,j,k}} \times 100$$

Where W_k = the weighted value for slough k, p is the proportion of slough-spawning salmon, j is the species of salmon and i is the year. The resultant weighted values using this method are:

Slough	$\sum_j \sum_i p_{i,j,k}$	Weighted Value W_k
Whiskers Creek	0	0
Slough 6A	0.5	0.1
Slough 8A	67.2	11.2
Slough 9	58.5	9.8
Slough 11	334.4	55.8
Slough 16B	0.5	0.1
Slough 20	29.7	5.0
Slough 21	104.9	17.5
Slough 22	3.5	0.5
Total ($\sum \sum \sum p_{i,j,k}$)	599.2	100

It is important to recognize that the derivation of weighted values for the sloughs in this manner treats each species of salmon equally regardless of the total number of fish in the escapement estimates.

Using the weighted values for the sloughs as derived above, revised cumulative responses of slough accessibility is determined as in Figure H.3-1, Appendix H of the DEIS. Figure 1 below presents the accumulation of spawning areas for which unrestricted access conditions predominate as discharge increases. Figure 2 below depicts the reduction in the proportion of slough-spawning areas for which accute access conditions prevail.

Based on these analyses, it could be concluded that more than 50 percent of the weighted spawning habitats in the sloughs studied have unrestricted access at mainstem flows of 6,000 cfs or more and nearly two thirds of the weighted spawning habitats have unrestricted access at 12,500 cfs. The remaining 33 percent of the weighted spawning habitat has acute access conditions up to mainstem discharges of 18,000 cfs to 20,000 cfs.

The above analyses have assumed that the threshold values for access conditions presented in Table H.3-4 are valid. The analysis could be further refined if consideration is given to the observational data described in Part 3 of this comment. By revising the threshold discharges for acute access conditions at Slough 9 and 21, cumulative responses of access to slough spawning areas are altered as presented in attached Figure 2. Based on the revised acute thresholds, less than 10 percent of the slough spawning areas represented by the 9 sloughs presented in Table H.3-4 have acute access conditions at a mainstem discharge of 12,000 cfs.

Table 1

Comparison of Mainstem Discharge and Observed Number of Chum Salmon

Date	Mainstem Discharge 1/ (cfs)	Chum Salmon Counts 2/ Slough 9			Chum Salmon Counts 2/ Slough 21		
		Live	Dead	Total	Live	Dead	Total
August 1	26400						
" 2	22500						
" 3	19800						
" 4	18500						
" 5	17400						
" 6	16800	1	0	1			
" 7	16500				7	0	7
" 8	16600						
" 9	17000						
" 10	16700						
" 11	15400						
" 12	14400						
" 13	13600						
" 14	13600						
" 15	14800						
" 16	15600						
" 17	15100	21	0	21			
" 18	14200						
" 19	13300						
" 20	12500						
" 21	12200						
" 22	12200				231	4	235
" 23	12300	45	2	47			
" 24	12500						
" 25	13400						
" 26	13600						
" 27	12900						
" 28	12400						
" 29	12200				568	45	613
" 30	13100	195	16	211			
" 31	16000						

Table 1 cont'd

Date		Mainstem Discharge 1/ (cfs)	Chum Salmon Counts 2/					
			Slough 9			Slough 21		
			Live	Dead	Total	Live	Dead	Total
September	1	17900						
"	2	16000						
"	3	14600						
"	4	14400				615	121	736
"	5	13600	242	58	300			
"	6	12200						
"	7	11700						
"	8	11900						
"	9	13400						
"	10	14400						
"	11	13600						
"	12	13200				341	167	508
"	13	15200	109	186	295			
"	14	20200						
"	15	28200						
"	16	32500						
"	17	32000						
"	18	26800				28	8	36
"	19	24100	0	0	0			
"	20	24000						
"	21	24200						
"	22	22300						
"	23	19400				17	14	31
"	24	17100						
"	25	15000	0	0	0			
"	26	14000						
"	27	13800						
"	28	12900						
"	29	12400				2	1	3
"	30	12500						

1/ Mainstem discharges obtained from USGS. Water Resources Data, Alaska, Water Year 1981, AK-81-1

2/ ADF&G 1982b Table 2-G-1.

Table 2
Relative Utilization of Sloughs
by Spawning Adult Salmon 1/

Slough	Sockeye 1981	Sockeye 1982	Sockeye 1983	Pink 1981	Pink 1982	Pink 1983	Chum 1981	Chum 1982	Chum 1982
	Proportion of Slough Escapement (%)								
Whiskers Creek 2/	—	—	—	—	—	—	—	—	—
Slough 6A	—	—	—	—	—	—	0.4	0.1	—
Slough 8A	9.0	8.8	12.3	—	1.7	—	10.6	21.0	3.8
Slough 9 3/	10.5	0.9	—	—	6.1	—	14.3	12.1	14.6
Slough 11	74.4	80.6	53.2	—	57.2	—	24.8	21.3	22.9
Slough 16B	—	—	—	—	—	—	0.5	—	—
Slough 20	—	—	—	—	25.2	—	0.5	0.5	3.5
Slough 21	2.9	5.9	27.8	—	3.0	—	14.6	34.4	16.3
Slough 22	—	—	—	—	—	—	—	—	3.5
Other Sloughs	3.2	3.8	6.7	100	6.8	0	34.3	10.6	35.4
Total	100	100	100	100	100	0	100	100	100

1/ Adapted from ADF&G 1984b, Tables 2-3-29 and 2-3-44 and Appendix Tables 2-G-9, 2-G-10, 2-G-11, 2-G-12, and 2-G-13.

2/ Whiskers Creek Slough provides access to Whiskers Creek which is used primarily by coho salmon.

3/ Slough 9 includes the proportions of salmon using Slough 9B.

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TOPIC AREA: Sloughs, Hydraulics

LOCATION IN DEIS: Vol 4 Page H-37 Section H.3 Paragraph 3 of the page

COMMENT IN REFERENCE TO: DEIS analysis of wetted-surface area inside sloughs

TECHNICAL COMMENT: The frequency analysis of wetted-surface areas in sloughs presented in Appendix H of the DEIS underestimates the total wetted-surface areas of sloughs and overestimates the response of slough surface area to mainstem discharge.

In the assessment of effects of the Proposed Project on salmon species presented in Appendix I of the DEIS, considerable importance is placed on the evaluation of changes to the total wetted-surface areas presented in Tables H.3-6 and H.3-7. Therefore several comments are appropriate with respect to the assumptions, data and methods of analysis used to prepare Figures H.3-2 and H.3-3. (Noted: it is assumed that the titles and graphs for these figures have been transposed in DEIS Appendix H).

Evaluation of the effects of with-project discharge on total wetted-surface areas in sloughs as presented on page DEIS H-37 is dependent upon using an appropriate data base. To determine the appropriateness of the data base to be used to determine percent change in wetted-surface area, the data should conform to a basic premise describing the relationship between mainstem discharge and the wetted-surface area of the sloughs. The effect of mainstem discharge on wetted-surface areas in sloughs is shown schematically in the attached Figure 1.

The basic premise which should be used is a corollary to the description of the hydraulic regimes in the sloughs as described on page H-26. The wetted-surface area of the sloughs vs. mainstem discharge is a function of the hydraulic regimes in the slough. Using this as a basic assumption, it is predicted that for Regime I (overtopping) there is a strong correlation between mainstem discharge and slough wetted-surface area since with more discharge through the slough, there is more wetted-surface area. For Regime II (Backwater), only the backwater areas at the mouths of the sloughs would be affected by mainstem discharge and the remainder of the wetted-surface area would be unaffected by the mainstem discharge. The strength of the relationship then would be dependent upon the proportion of the slough which would be affected by backwater. For Hydraulic Regime III (Isolation), little or no relationship between mainstem discharge and slough wetted-surface area is expected. The only factor affecting slough-wetted surface area in Regime III is discharge in the slough arising from groundwater, runoff or tributaries. The effect of mainstem discharge on wetted-surface areas in sloughs is shown schematically in Figure 1.

The data presented in Tables H.3-6 and H.3-7 are taken from the ADF&G Synopsis Report Appendix E (ADF&G 1983a). Using the functional relationship between hydraulic regime and surface area described above, review of the surface area data presented in Table H.3-6 indicates that the apparent relationships are not all consistent with the results presented in Table H.3-1 which defines the hydraulic regimes for three of the sloughs analyzed for surface areas. This is especially true for Slough 21 for which the Isolation threshold defining Regime III is at 21,400 cfs.

The results presented in Table H.3-6 indicate that the wetted-surface area of Slough 21 decreases with mainstem discharge from 20,000 cfs to 12,500 cfs. Based on the relation presented in Figure 1, such a decrease would not be expected. The principal reason for the apparent discrepancy is that the study area encompassed by the wetted areas presented in Table H.3-6 include both a portion of Slough 21 and a portion of the side channel complex downstream from the mouth of the slough (ADF&G 1983a, Appendix Plate E-1 delineates the study boundaries for the surface area measurements). Because of the inclusion of some side channel area, conclusions reached pertaining to loss of wetted-surface areas in sloughs are not completely substantiated.

The analysis at Slough 21 includes reduction of surface area not only in side slough habitat but also side channel habitat. If the isolation threshold for Slough 21 is 21,400 cfs, then the reduction of wetted-surface area in Slough 21 from 20,000 cfs to 12,500 cfs constitutes reduction in side channel habitat rather than side slough habitat. Review of the boundaries of all study areas presented in Table H.3-6 and H.3-7 indicates that the measured total wetted-surface areas encompass only portions of the sloughs (ADF&G 1983a, Appx. Plates E-1 through E-14).

In cases where the measured section of a slough consists almost entirely of areas which are affected by mainstem backwater, the proportional change in water surface area may be exaggerated. For example, the measured area for Slough 11 is located at the lower end of the slough (ADF&G 1983a, Appx. Plate E-4) and comprises only about 20 percent of the total length of the slough. It is in the delineated study area that mainstem backwater effects are the greatest. The remaining 80 percent of the length of the slough is relatively unaffected by mainstem discharges less than 42,000 cfs, the threshold mainstem discharge distinguishing Regimes I and II (ADF&G 1983e, Table 4I-3-2 p. 45. Also see Appendix VII to this document). Therefore, the percent area changes calculated from Table H.3-6 considerably over-estimate the relative effect of mainstem discharge on side slough surface areas.

As stated in the ADF&G Report (ADF&G 1983a Appx. E, p. E-3) the study areas evaluated were centered on those reaches where mainstem backwater zones were a dominant feature. Therefore, the analyses presented in Figure H.3-2 are not totally representative of the true percent change in wetted-surface areas of sloughs expected as a result of project operation.

The total wetted-surface areas presented in Appendix E.2.A. of the License Application for Sloughs 8A, 9, and 21, were obtained from aerial photographs and interpolated to the incremental mainstem discharges. Analyses of these data in the same manner as accomplished for the data presented in Table H.3-6 would yield different results, and possibly different conclusions, since the relative proportion of the slough influenced by mainstem discharge is considerably less when the entire slough is considered.

Since the License Application was submitted, the analysis of total slough wetted area as represented in the Appendix E.2.A of the License Application has been considerably expanded to include the wetted-surface areas of all side sloughs through a range of mainstem discharge of 9,000 cfs to 23,000 cfs. The results of this expanded analysis (Trihey 1984) indicate that the wetted-surface area of side slough habitat is actually greater at lower mainstem discharge than at higher mainstem discharge. The major reason for this is due to the definitions of side slough vs side channels used by Klinger and Trihey (Trihey 1984). They assume that if the upstream end of a side slough is overtopped, (Hydraulic Regime I) it is considered to be a side-channel. Similarly if the upstream end of a side channel is not overtopped, (Hydraulic Regimes II or III) it is assumed to be a side slough. The transformation of side sloughs into side channels and vice versa is expected to occur not only under existing conditions, but also under with-project conditions.

The conclusion reached using this analysis is that there will be more side slough habitat available more of the time under with project conditions than under existing conditions.

The surface areas of aggregate type H II habitats presented in Table H.3-6 are those areas which are directly connected to and affected by the mainstem (ADF&G 1983e, pg. 225 and 231). The statement on DEIS page H-37 defining H-II zone surface areas presented in Table H.3-6 is not clear. It is assumed that the H-II surface areas are interpolated from the graphs presented by ADF&G (ADF&G 1983a, Appendix E).

The analysis of the response of surface areas in the sloughs under existing and with-project conditions is accomplished from the relationships presented in Table H.3-6. The incremental surface areas presented are for a range of mainstem discharges of 12,500 cfs to 27,500 cfs. Pre-project monthly average discharges at Gold Creek have ranged from a low of 3,700 cfs (May) to over 50,000 cfs (June) as shown in DEIS Table H.2-3. With-project predicted monthly average discharges at Gold Creek have ranged from a low of 6,000 cfs to a maximum of over 26,000 cfs (Table H.2-6). In order to evaluate the changes in wetted-surface areas in the sloughs over these ranges of observed and predicted discharges, it is necessary to extrapolate the response of surface area to mainstem discharges presented in Table H.3-6 to the ranges observed and predicted. The method for this extrapolation is not presented in DEIS Appendix H. Therefore, it is not possible to judge whether or not the analysis presented in Figure H.3-2 is truly accurate. In addition, the extreme variance in the percent changes shown in Table H.3-2 for the surface areas of sloughs upstream of Talkeetna in the months of May, September, and October are such that any assessment of effects due to the project are not meaningful.

The assumed mainstem discharges for the filling period used in the analyses presented in Figure H.3-2 are not presented in DEIS Appendix I. It is assumed that the mainstem discharges during filling were obtained from the License Application.

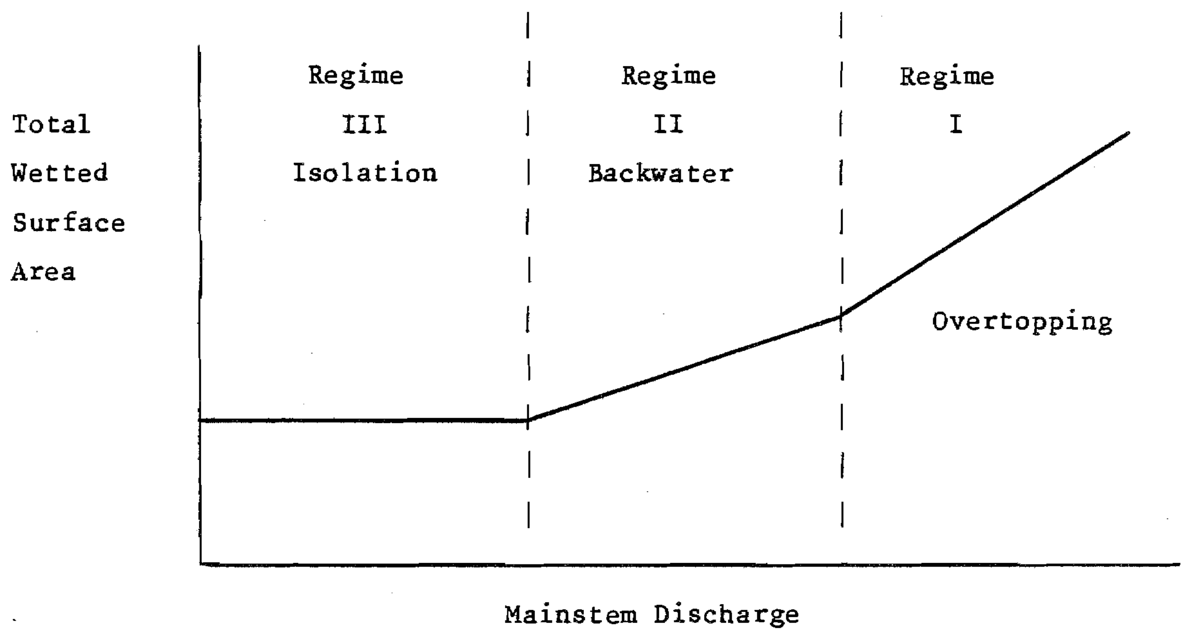

Figure 1: Hypothetical Relationship between Mainstem Discharge and Total Wetted-Surface Area in a Slough

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TOPIC AREA: River Temperature Model, Susitna River

LOCATION IN DEIS: Vol 4 Page H-44 Section H.4 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Description of FERC thermal model

TECHNICAL COMMENT: The development of the formula for atmospheric long-wave radiation is not included in the model explanation, however, a term in the formula for B would appear to represent the atmospheric long-wave radiation. This term is $-4.4 \times 10^9 \sigma$. The value of this term should be different for winter and summer.

The sign of this term appears to be incorrect. As shown, the term represents a heat flux out of the water instead of the reverse as is correct. Additionally, the value of t_{i+1} as used in the formula for T_{i+1} represents the length of time required for the water temperature to change from T_i to T_{i+1}. Therefore, the formula for t_{i+1} is incorrect because it includes the value t_i. The formula for t_{i+1} may be corrected by removing t_i from the equation for t_{i+1}. These may be typographical errors. However, the Power Authority was not able to reproduce the results in the DEIS (Vol. 1 page 4-23, para. 1-2, and Vol 1 Fig. 4-7) with the correct formulas for B and t_{i+1}. When the sign of the term $4.4 \times 10^9 \sigma$ is changed to positive to represent the heat flux from the atmosphere to the stream, and the formula for t_{i+1} is corrected the rate of cooling for the late fall/early winter case given by the equation is reduced from 4°C in 17 miles to 1.2°C in 19 miles. This latter rate is similar to those shown in the License Application on Figure E.2.219 for November 15 conditions. In checking the computations the mean November discharge of 9700 cfs (License Application Table E.2.45), an average depth of 5.5 ft. and an average velocity of 4.25 ft/sec were used. Computations using the corrected DEIS formulas were also made for extreme conditions represented by the minimum monthly November flows of approximately 7000 cfs (License Application Table E.2.45) and the minimum target flow for November of 5000 cfs (License Application Table E.2.34). These computations were made using depths and velocities provided in existing documents (HE 1984b Vol 1 & 2) and resulted in temperatures at River Mile 131 of 2.2°C and 2.5°C for 5000 cfs and 7000 cfs, respectively for 4°C outflow temperatures from Devil Canyon Reservoir and the meteorological conditions given on page H-44 of Vol. 4 of the DEIS. The equivalent depths and velocities are given in the following table:

Flow	Equivalent Depth	Equivalent Velocity
cfs	ft	ft/sec
5000	4.51	3.33
7000	4.97	3.78
9700	5.50	4.25

Additionally, computations were made to check the summer rate of warming using the corrected formulas. The mean with-project July flow of 8,400 cfs at Gold Creek was used (License Application Table E.2.45). The computations indicated a rate of warming of 1.7°C in the reach between Devil Canyon Dam and River Mile 131. This is somewhat greater than the warming rates shown on Figure E.2.217 of the License Application and results from the assumptions on air temperature, wind velocity and relative humidity made to simplify the analysis. The value of air temperature (15.5°C) used in the DEIS analysis for midsummer conditions is warmer than the mean monthly air temperatures recorded at Devil Canyon and Sherman stations (R&M 1982b, 1982c, 1982d, 1984c) in the past two years, although the daily mean air temperature does reach this value on occasion. Computations were also made for flows of 12,000 cfs and 13,400 cfs using the depths and velocities from the R&M studies (R&M 1984b, Vol 1 & 2), the summer weather conditions described in the DEIS, and an outflow temperature of 7.75°C from Devil Canyon Reservoir. The results are summarized in the following table:

Flow	Equivalent Depth	Equivalent Velocity	Water Temperature at River Mile 131
cfs	ft	ft/sec	°C
8400	5.25	4.00	9.5
12000	5.95	4.70	9.1
13400	6.23	4.96	8.9

Similarly, the winter air temperature used in the DEIS analysis (-12.2°C) is lower than the mean monthly temperatures recorded at Sherman and Devil Canyon stations for the past two years. Air temperatures can reach this value on a daily average basis.

The result of these computations provide strong support for the river temperature simulations provided in the License Application. There is, therefore, no basis for the comments in the DEIS which question the validity of the License Application temperature studies. See Technical Comment AQR098 for a list of locations in the DEIS where the validity is questioned. Additionally, several additional temperature simulations have been made using a state-of-the-art model (SNTEMP) and are attached hereto as Appendix V. These simulations were made for a wide range of hydrological and meteorological conditions and system energy requirements as described in Appendix V.

There are numerous typographical errors on this page as enumerated below:

1. The units of Qsr should be W/m^2, instead of W/m^2-°k.

2. The value A is missing from the denominator in the formula for B.

3. The late fall/early winter air temperature is given as 12.2°C rather than -12.2°C.

4. The value of the Stefan-Boltzman constant is omitted.

5. In the formula for A the value $6.5 \times 10^7 \rho$ should probably be $1.6 \times 10^7 \sigma$.

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TECHNICAL COMMENT FORM

TOPIC AREA: Nitrogen Supersaturation, Cone Valves

LOCATION IN DEIS: Vol 4 Page H-49 Section H.5.3 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Nitrogen supersaturation

TECHNICAL COMMENT: The entire discussion presented here should be deleted and replaced with a technically accurate discussion of the gas supersaturation issue as it pertains to the Susitna Hydroelectric Project. See Technical Comment AQR031 for a discussion of the mechanisms which would cause supersaturation at Susitna. Additionally, please see Volume 1, Page 4-19, paragraph 1 of the DEIS which states "Thus, there would be a net benefit to operating Watana in terms of reducing the natural recurrence of nitrogen supersaturation in the below Devil Canyon to levels exceeding the Alaska statute for water quality." Also note that on pages H-49 and H-50 the following specific technical deficiencies should be addressed in preparing the Final EIS:

1). The purpose of the fixed cone valves is not to reduce "hydraulic momentum" per se. Rather, it is to reduce the depth of plunge to which water released via these structures is subjected. As explained in Technical Comment AQR031, the amount of dissolved gas that water will hold at saturation is directly proportional to the absolute pressure to which the gas/water mixture is subjected. By plunging to some depth where the pressure significantly exceeds one atmosphere, water having entrained air can become supersaturated. Water having entrained air but never subjected to pressure significantly above atmospheric, will not become supersaturated.

2). The statement on page H-50 to the effect that water leaving the cone valves would have nitrogen levels in excess of 110% ".... if the cone valves were ineffective in preventing air entrainment..." is incorrect as per 1) above. The cone valves will "entrain" air (i.e. mix air into the water jet) precisely for the purpose of dispersing the water, dissipating the energy in air friction and turbulence and reducing the depth of plunge.

3). The repeated use of technically unsupported phrases such "... if the cone valve is ineffective..." combined with the basic misunderstanding of the function of the cone valves and with long discussions of hypothetical water quality violations provide the reader with the impression that gas supersaturation is a serious problem for the Susitna Project. In fact, no evidence to support this is provided in this discussions. The fact that Devil Canyon produces supersaturated flows under natural conditions probably almost every year is not mentioned, further misleading the reader in this regard.

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TOPIC AREA: Reservoir, Turbidity

LOCATION IN DEIS: Vol 4 Page H-50 Section H.5.4 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Watana Reservoir will be oligotrophic based on spring phosphorus concentrations.

TECHNICAL COMMENT: The applicant is in agreement with the DEIS conclusion (Vol. 4, Page H-50, Section H.5.4, paragraph 4 of that page) that both Watana and Devil Canyon reservoirs will exhibit an oligotrophic status with respect to primary productivity. However, examination of limnological data collected since the report by Peterson et al (1982) indicates that reservoir primary productivity is more likely to be limited by high suspended sediment concentrations (PND 1982) and ice and snow cover (i.e. light limitation) than by spring phosphorus concentrations. Low temperatures, short hydraulic residence time, and relatively large volume to surface area ratios would likely also contribute to limitation of primary productivity in the reservoirs.

The applicant questions the validity of the method used by Peterson et al. (1982) for estimating the reservoir's spring N:P ratios of 28:1 by using the limited data from the R&M Consultants Water Quality Report (R&M 1981e. Tables 3.1 and 4.1 - data for 19 June 1980 and 18 and 30 June 1981) which merely indicates two "non-detectable" and one admitted "overestimate" of ortho-phosphorus.

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TOPIC AREA: Incubation, Temperature

LOCATION IN DEIS: Vol 4 Page I-4 Section I.1.2.1 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Definition of a temperature unit.

TECHNICAL COMMENT: The definition given; "...the cumulative number of degrees (F) times each 24-hour day of exposure...", is not correct.

A Fahrenheit temperature unit or degree day is the mean daily water temperature in excess of 32°F. A mean temperature of 40°F for one day (24 hours) would be equivalent to 8 degree days. "Temperature units" is the sum of the degree days.

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TOPIC AREA: Salmon

LOCATION IN DEIS: Vol 4 Page I-6 Section I.1.2.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Total age versus ocean age

TECHNICAL COMMENT: The DEIS apparently confused total age and ocean age. Pink and coho salmon spend one year (12-18 months) in ocean residence (excluding precocious males). Sockeye salmon spend two to four years (Forster 1968, pp 7-13). The range for salmon is from one year for pink and coho to three to five years for chum and chinook (McPhail and Lindsey 1970, pp 165-185).

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TOPIC AREA: Chinook Salmon, Spawning

LOCATION IN DEIS: Vol 4 Page I-6 Section I.1.2.1 Paragraph 2 of the page (Reference Figure I.1-3)

COMMENT IN REFERENCE TO: 1983 data is not presented.

TECHNICAL COMMENT: Figure I. 1-3 should be updated to include data for 1983. The reported chinook salmon escapements (ADF&G 1984b, p. 178) are:

	1981	1982	1983
Sunshine Sta.	NA	52,900	90,100
Talkeetna Sta.	NA	10,900	14,400
Curry Sta.	NA	11,300	9,600

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TOPIC AREA: Escapement, Salmon, Spawning

LOCATION IN DEIS: Vol 4 Page I-6 Section I.1.2.1 Paragraph 3 of the page (Reference Figure I.1-4)

COMMENT IN REFERENCE TO: Information presented in the figure does not include 1983 data.

TECHNICAL COMMENT: Figure I. 1-4 should be updated to include 1983 data (ADF&G 1984b, p. 178). The summarized data, expressed as percent of escapement to Sunshine Station, are:

	1981	1982	1983
Yentna Sta.			
Chinook	NA	NA	NA
Sockeye	104.4	75.1	146.0
Coho	85.9	74.6	58.6
Chum	7.5	6.5	4.1
Pink	72.9	100.9	149.9
Talkeetna Sta.			
Chinook	NA	20.6	16.0
Sockeye	3.6	2.1	5.9
Coho	16.7	11.2	15.8
Chum	7.9	11.4	19.0
Pink	4.7	16.5	23.5
Curry Sta.			
Chinook	NA	21.4	10.7
Sockeye	2.1	0.9	2.7
Coho	5.6	5.3	5.3
Chum	5.0	6.8	7.9
Pink	2.0	13.3	13.6

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TOPIC AREA: Rearing, Habitat, Chinook Salmon

LOCATION IN DEIS: Vol 4 Page I-10 Section I.1.2.1 Paragraph 3

COMMENT IN REFERENCE TO: Major chinook nursery areas are in clearwater tributary mouths and sloughs

TECHNICAL COMMENT: Clearwater habitats are the most important to chinook salmon for rearing. However, studies conducted during the 1983 open-water season demonstrated a level of rearing in turbid water side channels much greater than anticipated. Rearing juvenile chinook were approximately twice as densely distributed in turbid water, low velocity side channel sites than in clearwater side sloughs. This information is reported in the ADF&G report on resident and juvenile anadromous fish studies for 1983 (ADF&G 1984b).

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TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-10 Section I.1.2.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Juvenile growth is temperature dependent with optimum near 15°C.

TECHNICAL COMMENT: Temperature optima for juvenile growth depend on several factors including food ration, ambient temperatures and individual stock adaptation to local conditions (Brett, et.al. 1982). The optimum of 15°C cited in the DEIS was undoubtedly (no reference given) derived for stocks from southern British Columbia, Canada, or Washington. Susitna stocks, being from a more northerly latitude, probably have temperature optima for growth somewhat less than 15°C.

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TOPIC AREA: Spawning, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-11 Section I.1.2.1 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Second run sockeye entering Susitna, Chulitna and Talkeetna are not distinct stocks based on scale analysis.

TECHNICAL COMMENT: The referenced report is inconclusive. The results in no way excluded the possibility that the Susitna fish are a distinct stock from those in the Chulitna and Talkeetna Rivers. Growth patterns and scale analyses are not the only criteria for stock separation. For example, homing behavior is an important factor in Pacific salmon (Forster 1968, pp 18-42). The presence of viable sockeye stocks in rivers without lakes for rearing habitat is not an uncommon occurrence (Foerster 1968, p.8). The fact that the Susitna sockeye travel 20 to 45 miles beyond the confluence, passing several sloughs along the way, to spawn consistently in the same three sloughs (majority) each year (ADF&G, 1984b, p. 93) strongly suggests these fish are homing rather than straying.

The Power Authority agrees with the DEIS conclusion stated in Appendix I, page I-35, regarding stock separation using the same and similar techniques. The methodologies are not sensitive enough to discriminate among unique stocks in all cases.

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TECHNICAL COMMENT FORM

TOPIC AREA: Spawning, Habitat, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-11 Section I.1.2.1 Paragraph 2 of the page (Reference Figure I.1-5)

COMMENT IN REFERENCE TO: References Fig I. 1-5 for suitability curves but there are none in the figure.

TECHNICAL COMMENT: Preferred habitat features or suitability curves are not presented in Figure I. 1-5 as referenced.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Escapement, Spawning, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-10 Section I.1.2.1 Paragraph 2 of the page (Reference Figure I. 1-5)

COMMENT IN REFERENCE TO: Information presented in the figure does not include 1983 data.

TECHNICAL COMMENT: The figure should be updated to include 1983 data. The reported (ADF&G 1984b, p. 178) sockeye salmon escapements are:

	1981	1982	1983
Sunshine Sta.	133,500	151,500	71,500
Talkeetna Sta.	4,800	3,100	4,200
Curry Sta.	2,800	1,300	1,900
Total Escapement	272,900	265,300	175,900

These estimates are for second run sockeye only.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-11 Section I.1.2.1 Paragraph 4 of page

COMMENT IN REFERENCE TO: DEIS treatment of temperature/growth literature

TECHNICAL COMMENT: DEIS summaries describing the effects of temperature variations on the growth, energetics and performance of sockeye salmon are based on data from studies of lacustrine populations at British Columbia, Canada latitudes and includes both hatchery and naturally produced juveniles. In contrast, the Susitna stocks are riverine populations from a more northern latitude and are exclusively from natural production. The Susitna stocks are exposed to a completely different set of environmental demands and adaption to the local conditions will produce innate tolerances, preferences and optima different from the British Columbia stocks (see Technical Comment AQR123).

The data and results used by the DEIS were from laboratory tests in which important environmental factors such as temperature and salinity were controlled at nearly constant levels. These conditions would seldom, if ever, occur in the Susitna River.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Rearing, Habitat, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I Section I.1.2.1 All paragraphs

COMMENT IN REFERENCE TO: Rearing sites of sockeye salmon spawned in the middle reach are unknown. Fate of rearing juveniles is unknown.

TECHNICAL COMMENT: Populations of sockeye restricted to riverine habitats with no apparent access to lakes for rearing are not uncommon (Forster 1968, p. 8). Given the annual and relatively stable spawning populations (ADF&G 1984b, p. 193) and the observations of overwintering juveniles as well as juveniles utilizing particular rearing habitats (ADF&G 1983c, pp. 248-252) there is no good reason to doubt that the stocks are viable. This is true even though the total area or range of rearing habitat is unknown at this time.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Outmigration, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-13 Section I.1.2.1 Paragraph 1 of page

COMMENT IN REFERENCE TO: Outmigration of sockeye smolts may be triggered by temperature changes.

TECHNICAL COMMENT: Outmigration of sockeye smolts may be influenced in part by temperature. However, a wide variety of biological, physical, hydrological, physiological and other environmental cues are thought to interact to cause outmigration of juvenile salmonids (Lagler, Bardach and Miller 1962; Grau, Dickhoff, Nishioka, Bern, and Folmer 1981; Forster 1968). It is unlikely that temperature alone provides an all-inclusive, overriding cue to juvenile outmigration. See Technical Comment AQR051.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Escapement, Spawning, Coho Salmon

LOCATION IN DEIS: Vol 4 Page I-13 Section I.1.2.1 Paragraph 3 of the page (Reference Figure I.1-6)

COMMENT IN REFERENCE TO: Information presented in the figure does not include 1983 data

TECHNICAL COMMENT: The figure should be updated with 1983 data. The reported coho salmon escapements (ADF&G 1984b, p. 178) are:

	1981	1982	1983
Sunshine Sta.	19,800	45,700	15,200
Talkeetna Sta.	3,300	5,100	2,400
Curry Sta.	1,100	2,400	800
Total Escapement	36,800	79,800	24,100

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Spawning, Habitat, Coho Salmon

LOCATION IN DEIS: Vol 4 Page I-13 Section I.1.2.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Coho spawn in mainstem

TECHNICAL COMMENT: The reference to mainstem spawning by coho should be qualified. Mainstem Susitna spawning by coho is rare (ADF&G 1984b, pp. 212-218).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Escapement, Spawning, Chum Salmon

LOCATION IN DEIS: Vol 4 Page I-15 Section I.1.2.1 Paragraph 2 of the page (Reference Figure I.1-7)

COMMENT IN REFERENCE TO: Information presented in the figure does not include 1983 data.

TECHNICAL COMMENT: The figure should be updated with 1983 data. The reported (ADF&G 1984b, p. 178) chum salmon escapements are:

	1981	1982	1983
Sunshine Sta.	262,900	430,400	265,800
Talkeetna Sta.	20,800	49,100	50,400
Curry Sta.	13,100	29,400	21,100
Total Escapement	282,700	458,200	276,600

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Escapement, Spawning, Pink Salmon

LOCATION IN DEIS: Vol 4 Page I-17 Section I.1.2.1 Paragraph 2 of the page (Reference Figure I.1-8)

COMMENT IN REFERENCE TO: Update with 1983 data

TECHNICAL COMMENT: The figure should be updated with 1983 data. The reported (ADF&G 1984b, p. 178) pink salmon escapements are:

	1981	1982	1983
Sunshine Sta.	49,500	443,200	40,500
Talkeetna Sta.	2,300	73,000	9,500
Curry Sta.	1,000	58,800	5,500
Total Escapement	85,600	890,500	101,200

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Spawning, Pink Salmon

LOCATION IN DEIS: Vol 4 Page I-17 Section I.1.2.1 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Tributary percentages for pink salmon spawning.

TECHNICAL COMMENT: The statement should be clarified. The percentages given for each tributary refer to proportions of all tributary spawners, not the total spawners in all habitats.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Bering Cisco, Susitna River

LOCATION IN DEIS: Vol 4 Page I-20 Section I.1.2.2 Paragraph 1 of the page

COMMENT IN REFERENCE TO: A small fishery for Bering Cisco in the Susitna River.

TECHNICAL COMMENT: There is no known and documented fishery for Bering Cisco in the Susitna River.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Bering Cisco, Spawning

LOCATION IN DEIS: Vol 4 Page I-20 Section I.1.2.2 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Repeat spawning by the Susitna stock of Bering Cisco is unusual.

TECHNICAL COMMENT: There is little known about the biology of Bering Cisco (Morrow 1980), however, repeat spawning is likely the norm rather than the exception.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon

LOCATION IN DEIS: Vol 4 Page I-25 Section I.1.3 Paragraph 2 of the page

COMMENT IN REFERENCE TO: The stickleback's principal economic importance is as a predator on salmon eggs and as a competitor with young salmonids.

TECHNICAL COMMENT: This statement is unfounded in factual study and, at best, the subject is controversial. This statement should be deleted or presented as speculative.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Rearing, Habitat, Coho Salmon

LOCATION IN DEIS: Vol 1 Page I-27 Section I.1.4.2.1 Paragraph 11 of the page

COMMENT IN REFERENCE TO: "During winter, coho are most abundant in the mainstem. During summer, they are slightly less abundant in the mainstem than at tributary mouths."

TECHNICAL COMMENT: This statement may be misleading. Data are not clear regarding the relative abundance of juvenile coho among habitats during the winter. It is correct to say that coho utilize the mainstem during the winter, but data for comparisons among habitats are not available (ADF&G 1983c, p. 245). The summer distribution in mainstem habitats would be better stated, "tributary mouths associated with side channels had a greater abundance of coho juveniles than tributary mouths associated directly with the mainstem (ADF&G 1983c, p. 243).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Modeling, Ice Processes

LOCATION IN DEIS: Vol 4 Page I-43 Section I.2 Paragraph 5 of the page

COMMENT IN REFERENCE TO: "Current uncertainty over the accuracy of modeling reservoir and river temperatures, ice processes, and changes in river morphology lends uncertainty to discussions of aquatic impacts."

TECHNICAL COMMENT: Refer to Technical Comments AQR032, AQR033, AQR037, AQR043, AQR046, AQR071 and AQR074 regarding the accuracy of Applicant's reservoir and river temperature and river ice modeling. In summary, the Power Authority disagrees with the statements in the DEIS regarding the uncertainty of this modeling.

The Power Authority's river and reservoir temperature and ice simulation models are state-of-the-art and provide accurate information. However, as noted in Technical Comments AQR033 and AQR046 there was an apparent error in the Devil Canyon reservoir temperature modeling made for the License Application. This error would affect reservoir and stream temperature and river ice results presented in the License Application. This error has been corrected in the most recent Devil Canyon reservoir temperature results presented herein as Appendix IV. The general effect of correcting the error is to increase summer outflow temperatures and decrease winter temperatures.

The reservoir temperature simulations in Appendix IV were made for projected energy demands in 2002 and 2020, whereas the simulations in the License Application (APA 1983, Fig. E.2.215) were made for 2010 energy demands (APA 1983, p.E.2.165). Thus, outflow temperatures from the two sources are not comparable. However, as a result of the correction, Devil Canyon outflow temperatures would more nearly reflect Watana outflow and natural temperatures, but with some smoothing of peaks and some lag in spring and fall.

With regard to modeling changes in river morphology; the factors influencing river morphology are complex and do not lend themselves to accurate or comprehensive modeling. Instead, the Power Authority has addressed specific issues related to river morphology in as much detail as is presently possible. With regard to the stability of the Susitna River streambed, potential perching of tributary mouths, and sedimentation in the reservoir, the Power Authority has made available to the Federal Energy Regulatory Commission several reports (USGS 1983, R&M 1982i, R&M 1982h, HE 1984c, Trihey 1983, and Acres 1983).

Additionally, data reports containing surveyed cross sections and bed material samples are available (R&M 1981c, R&M 1982e, R&M 1981d). Reports on ice observations are also available for the last four winters (R&M 1982b, R&M 1981b, R&M 1982f, R&M 1982j, and R&M 1984a). See Technical Comments AQR025 and AQR026 regarding tributary stability, Technical Comment AQR023 on flushing of fine sediments in sloughs, and Technical Comment AQR028 on channel width reduction and vegetation encroachment.

Applicant has addressed the question of breakup ice jam effects on river morphology, as noted in the License Application and in Technical Comment AQR121.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Watana, Filling

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 3 of page

COMMENT IN REFERENCE TO: Instream temperatures during reservoir filling.

TECHNICAL COMMENT: Reservoir and river temperature simulations were not provided for the second and third year of Watana filling in the License Application. River temperature simulations were provided for the second year of filling based on an assumed reservoir thermal structure (License Application p. E-2-85 to p. E-2-88 and Figs. E.2.141 to E.2.146). Reservoir and stream temperatures for the third year of filling were assumed to be similar to operational cases (License Application p. E.2.85 to p. E.2.88). The DEIS has questioned the Applicant's assumptions regarding the reservoir thermal structure during the third year of filling (DEIS Vol. 1, Page 4-21, Para. 5).

In response, the Alaska Power Authority has refined the License Application estimates by simulating reservoir thermal performance and stream temperatures during the second and third years of Watana filling. These simulations are included in Appendices IV and V for the reservoir and stream simulations, respectively. These reservoir temperature simulations show a clear stratification beginning in the first year of filling. During the latter part of the second year of filling and in the third year of filling, the reservoir water level will be high enough so that the midlevel outlet works intake to the cone valves can be operated. Therefore, in this period, reservoir outflow temperatures will be similar to project operation as stated in the License Application.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon, Filling

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Lower than normal temperatures during Watana filling will cause more milling at confluence and Susitna stocks will choose to spawn in the Talkeetna

TECHNICAL COMMENT: The tendency of adult salmon to return to their natal sites to spawn must have a strong innate basis since it is a basic characteristic of the entire genus of Pacific salmon. The DEIS suggests that adult salmon migrating to their natal tributaries and sloughs will abandon this migration and choose alternative, non-natal spawning sites if they are "confronted" with instream temperatures less than normal but within their range of tolerance. This suggestion is weak at best. First, the literature cited by the DEIS does not report of migration delays or blocks caused by low water temperatures but by high water temperatures. Second, there is no literature or other information that suggests Pacific Salmon will stop their upstream migration or abandon their return to a natal site just to avoid low water temperatures outside a "preferred" range, but well within their range of tolerance (AEDIC 1983a, p. 33). The lower temperatures encountered during Watana filling may slow upstream movement somewhat but there are no reasons to suggest the fish will choose the Talkeetna system over their natal Susitna for spawning.

Finally the Power Authority does not agree with the temperatures quoted by the DEIS for with-project midsummer conditions at the confluence. Reservoir release temperatures will be similar to operation conditions by the latter part of the second year of filling (See Technical Comment AQR099) and temperatures at the confluence will be 7-8°C in midsummer (See Appendix V).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-47 Section I.2.1.3.1 Paragraph 3 of the page (Reference Table I.2.1)

COMMENT IN REFERENCE TO: Projections of filling and operational temperatures and growth rates downstream of Chulitna-Susitna confluence and comparison with pre-project temperatures.

TECHNICAL COMMENT: Please refer to Technical Comment AQR043 on the same subject.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 3 of the page (Table I.2-1)

COMMENT IN REFERENCE TO: DEIS estimated reductions in growth in the lower river.

TECHNICAL COMMENT: The water-temperature regime displayed in Table I.2-1 is outdated. Temperature predictions have been revised and estimates of the effets of temperature o growth have been revised. The reductions in growth from pre-project levels shown in this table are based on invalid assumptions. See Technical Comment AQR123 for explanation.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Slough, Salmon Access, Filling

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 6 of the page

COMMENT IN REFERENCE TO: There will be acute access problems at sloughs during filling flows (in the absence of mitigation).

TECHNICAL COMMENT: See Technical Comment AQR072 which discusses the analyses presented for access conditions. During filling of Watana Reservoir, minimum flow requirements during the months of June, July, August and September as proposed in the License Application are the same as for operation of the Watana facility. Therefore, access conditions at the sloughs will be no more severe during filling than during operation. As discussed in Comment AQR072, severe access conditions are anticipated to affect less than 50 percent of the slough spawning areas when mainstem discharge is 12000 cfs.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Hydraulics, Spawning, Habitat, Filling

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Filling flows will reduce usable spawning area in sloughs (without mitigation)

TECHNICAL COMMENT: Based on the data and assumptions presented in Appendix H, this would appear to be supported. However, see Technical Comment AQR073 which discusses the analyses, data and assumptions used in the analysis presented in Appendix H.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Filling, Groundwater, Mainstem

LOCATION IN DEIS: Vol 4 Page I-46 Section I.2.1.3.1 Paragraph 6 of page

COMMENT IN REFERENCE TO: Reduced mainstem flows may reduce amount or area influenced by upwelling.

TECHNICAL COMMENT: Reduced mainstem flows in summer may reduce summer upwelling and the area influenced by upwelling. However, as indicated in the "Slough Geohydrology Report", which is attached as Appendix VII, and Technical Comment AQR036, increased mainstem flows in October to December will result in increased slough upwelling flows and areal extent of upwelling in this period. In winter the occurrence of an ice cover in the vicinity of the slough will have a major effect on the increase or decrease in groundwater upwelling flow or areal extent influenced by upwelling.

A description of ice cover progression is included in Comment AF006. In general, with Watana only operating in warm or average winters, the ice front is expected to extend to between River Mile 125 and near Gold Creek (River Mile 137). Based on simulated conditions for the winter of 1982-1983, in areas where an ice cover would exist with-project, water levels would be somewhat higher than natural. This would cause higher upwelling flows and a greater areal extent of upwelling. In cold winters the ice front is expected to extend upstream of Gold Creek. It may reasonably be expected that water levels with-project would be higher than under natural conditions where an ice cover exists.

With Devil Canyon in operation, the ice front will not extend as far upstream as with Watana only operating. The simulations undertaken so far indicate that only in the most severe winter simulated (1971-1972) would the ice front extend upstream of Slough 8A. Thus, mainstem water levels upstream of Slough 8A would be reduced in all but the coldest winters resulting in reductions in groundwater upwelling and possibly in the areal extent of upwelling.

As noted in the report on Slough Geohydrology Studies, reduced fluctuations in mainstem flows and temperatures occasioned by project operation is expected to result in a stabilization in groundwater upwelling flows and temperatures. This could be beneficial to spawning salmon if the limiting factor in reproduction in sloughs is the minimum amount of groundwater upwelling or the minimum areal extent of upwelling.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Escapement

LOCATION IN DEIS: Vol 4 Page I-47 Section I.2.1.3.1 Paragraphs 1-4 of the page

COMMENT IN REFERENCE TO: DEIS discussion of potential impacts assuming certain catch: escapement ratios.

TECHNICAL COMMENT: The Applicant has compiled and analyzed data regarding runsize, harvest and escapement for Susitna salmon stocks. The results are presented in the following tables. These are the most recent and accurate estimates available and should be incorporated in the DEIS.

Table 1

Estimated monthly mean water temperature for the proposed Susitna Hydroelectric Project-Middle River Reach downstream to Sunshine

Month	Natural Temperature	Temperature with Watana 1996	Temperature with Devil Canyon 2002
	(°C)	(°C)	(°C)
		RM 130 - Sherman	
June	9.6	7.1	6.4
July	10.7	10.0	7.8
Aug.	10.7	9.9	7.9
Sept.	6.4	8.0	8.4
Oct.	0.7	4.0	6.2
		RM 98 - Chulitna Confluence	
June	10.1	8.5	8.0
July	11.4	11.2	9.2
Aug.	11.4	10.8	9.0
Sept.	6.7	8.2	8.4
Oct.	.6	3.2	4.5
		RM 84 - Sunshine	
June	9.1	8.1	8.5
July	9.9	9.3	8.3
Aug.	9.7	9.3	8.4
Sept.	6.1	6.6	6.7
Oct.	0.9	2.1	2.6

Table 2

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 130 in the Susitna River

Water			Natural 1982		Watana 1996		Devil Canyon 2002	
Year	Month	Week	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt
				0.20g		0.20g		0.20g
1982		28	<3.0	—	<3.0	—	3.0	.22
		29	4.6	.23	3.9	.22	3.8	.24
		30	5.8	.27	4.4	.25	4.2	.28
	May	31	5.5	.32	4.1	.28	4.2	.31
		32	4.7	.35	3.5	.31	4.2	.35
		33	6.7	.43	3.9	.34	4.6	.39
		34	6.6	.50	4.0	.38	4.8	.44
	June	35	8.4	.64	5.0	.44	5.2	.50
		36	8.9	.80	5.8	.50	5.3	.57
		37	8.0	.97	6.4	.59	5.7	.64
		38	9.6	1.21	7.3	.72	6.8	.74
		39	11.8	1.51	9.0	.91	7.8	.88
	July	40	10.6	1.86	10.5	1.17	8.5	1.06
		41	11.1	2.32	10.2	1.43	10.2	1.31
		42	11.2	2.79	10.2	1.76	6.9	1 45
		43	10.0	3.30	9.3	2.13	5.6	1.58
	Aug.	44	11.0	3.87	9.8	2.48	6.2	1.75
		45	11.2	4.53	10.1	2.92	7.4	2.00
		46	11.0	5.24	10.0	3.45	8.3	2.33
		47	11.0	6.02	10.4	3.99	9.0	2.71
	Sept.	48	9.5	6.77	9.1	4.59	8.7	3.07
		49	8.0	7.41	8.9	5.09	8.6	3.43
		50	6.7	7.82	8.5	5.65	8.5	3.83
		51	6.6	8.27	7.5	6.14	8.3	4.28
		52	4.4	8.51	7.2	6.63	8.0	4.75

Table 2 cont'd

1983	Oct.	1	<3.0	6.0	7.01	7.6	5.20
		2		5.0	7.33	6.9	5.53
		3		3.6	7.51		5.80
		4				5.9	6.01
	Nov.	5				3.8	6.17
		6				3.2	6.34
Reduction from pre-project growth (%)					12		25

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1 Growth calculations based on specific growth-rate data from Brett 1974.

Table 3

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 96.6 in the Susitna River

Water			Natural 1982		Watana 1996		Devil Canyon 2002	
Year	Month	Week	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt
				0.20g		0.20g		0.20g
1982		29	6.0	.25	4.9	.23	4.8	.23
		30	7.4	.32	5.7	.27	5.5	.27
	May	31	6.6	.39	5.2	.32	5.3	.32
		32	5.3	.45	4.4	.35	4.9	.35
		33	7.3	.56	5.2	.41	5.8	.41
		34	7.2	.68	5.2	.47	6.0	.49
	June	35	9.0	.87	6.6	.55	6.7	.58
		36	9.3	1.10	7.1	.67	6.7	.68
		37	8.5	1.28	7.4	.80	6.9	.78
		38	10.2	1.58	8.7	.97	8.5	.96
		39	12.5	2.03	10.8	1.23	9.9	1.19
	July	40	11.4	2.53	11.7	1.54	10.2	1.47
		41	11.7	3.05	11.5	1.91	11.5	1.83
		42	12.0	3.75	11.6	2.39	8.5	2.13
		43	10.6	4.34	10.1	2.82	6.7	2.31
	Aug.	44	11.7	5.02	10.9	3.33	7.4	2.58
		45	12.0	5.97	11.2	3.90	8.7	2.93
		46	11.6	6.86	10.8	4.51	9.3	3.41
		47	11.8	7.82	11.3	5.22	10.0	3.94
	Sept.	48	10.1	8.74	9.8	5.87	9.4	4.53
		49	8.4	9.44	9.2	6.61	8.9	5.03
		50	7.1	10.04	8.7	7.23	8.7	5.58
		51	6.8	10.56	7.7	7.67	8.4	6.15
		52	4.6	10.81	7.1	8.32	7.7	6.64

Table 3 cont'd

1983	Oct.	1	<3.0	5.7	8.66	6.9	7.02
		2		4.3	8.92	5.6	7.34
		3		<3.0		4.1	7.57
Reduction from pre-project growth (%)					17		30

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[1] Growth calculations based on specific growth-rate data from Brett 1974.

Table 4

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 84 (Sunshine) in the Susitna River

Water			Natural 1982		Watana 1996		Devil Canyon 2002	
Year	Month	Week	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt
				0.20g		0.20g		0.20g
1982		29	5.5	.24	5.5	.24	5.0	.24
		30	6.7	.29	5.9	.28	5.8	.28
	May	31	6.1	.36	5.4	.33	5.5	.33
		32	5.2	.42	4.7	.37	4.9	.37
		33	7.0	.52	5.9	.43	6.1	.44
		34	6.9	.60	5.9	.49	6.2	.52
	June	35	8.4	.75	7.3	.61	7.3	.63
		36	8.6	.91	7.7	.73	7.7	.76
		37	7.6	1.07	6.9	.83	6.8	.87
		38	9.0	1.34	7.9	.98	7.8	1.02
		39	11.0	1.66	9.9	1.22	9.7	1.28
	July	40	9.8	2.00	9.3	1.47	8.9	1.49
		41	10.1	2.47	9.2	1.77	9.1	1.79
		42	10.5	2.91	9.7	2.13	9.1	2.16
		43	9.3	3.39	8.8	2.42	8.0	2.44
	Aug.	44	10.2	3.92	9.7	2.82	8.8	2.77
		45	10.1	4.54	9.7	3.28	9.0	3.22
		46	9.7	5.14	9.3	3.77	8.9	3.60
		47	9.9	5.78	9.7	4.33	9.3	4.14
	Sept.	48	8.5	6.37	8.3	4.80	8.2	4.59
		49	7.6	6.88	7.8	5.26	7.8	5.03
		50	6.6	7.28	7.0	5.71	7.2	5.50
		51	5.8	7.59	6.0	6.07	6.3	5.85
		52	4.5	7.83	5.5	6.37	5.6	6.14

Table 4 cont'd

1983	Oct.	1	<3.0	4.1	6.59	3.8	6.30
		2		<3.0		3.4	6.47
Reduction from pre-project growth (%)					16		17

[1] Growth calculations based on specific growth-rate data from Brett 1974.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Tributary, Spawning, Salmon Access, Temperature

LOCATION IN DEIS: Vol 4 Page I-48 Section I.2.1.3.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Spawning in tributary habitats may be reduced because the number of spawners reaching tributaries may be less.

TECHNICAL COMMENT: The DEIS does not provide any explanation for the assertion made that there will be fewer spawners reaching the tributaries. If it is based upon the unlikely straying of individuals to non-natal spawning sites in the Talkeetna system due to unusually low water temperature in the Susitna River (DEIS, page I-46, para. 1), please see Technical Comment AQR100.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Rearing, Filling

LOCATION IN DEIS: Vol 4 Page I-48 Section I.2.1.3.1 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Lower filling temperatures would cause "induced" winter behavior

TECHNICAL COMMENT: The assumption that a behavorial threshold exists at 41°F (5°C) for juvenile salmon in the Susitna River should be revised somewhat. Although the 41°F threshold is applicable to salmon populations in the Pacific Northwest, salmon of the more northerly latitudes are likely to have a somewhat lower behavorial threshold. A lower temperature threshold for "inducement" of winter behavior is indicated by the collection of juvenile chinook and coho salmon from the Indian River in September. Both the chinook and coho juveniles collected in late September were found to have food in their stomachs from which electivity indices were calculated (ADF&G 1983d, Appendix C, Tables 3-C-12 and 3-C-19). Water temperature in Indian River on the days the juveniles were collected ranged from 4.0°C to 6.0°C (ADF&G 1983d, Table 4-A-4 pg. 4-A-104).

Similarly, stomach content analysis and calculated electivity indices for chinook, coho and sockeye juveniles indicate feeding behavior in Slough 11 during September 1982 (ADF&G 1983d, Appendix C, Appendix Table 3-C-06, 3-C-15 and 3-C-23). Surface water temperatures recorded in Slough 11 were consistently less than 4°C throughout September (ADF&G, 1983g, Table 4-C-61).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Modeling, Reservoir, Temperature

LOCATION IN DEIS: Vol 4 Page I-48 Section I.2.1.3.1 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Maximal rates of downstream warming projected by Applicant and use of warming rates for release temperatures other than 39.2°F and questioning of summer heating expected by Applicant.

TECHNICAL COMMENT: See Technical Comments AQR074 and AQR033 with regard to questions in the DEIS concerning the Alaska Power Authority's simulation of summer heating rates. The Power Authority believes the analysis shown in the DEIS is incorrect and there is no reason to question heating rates projected for Watana filling in the License Application on Figures E.2.145 and E.2.146.

Additionally, the Power Authority is providing with these comments simulations of reservoir and stream temperatures during the second and third summers of filling in Appendices IV and V. As indicated therein and as discussed in Technical Comment AQR032, the reservoir simulations show that reservoir outflow temperatures during the third summer of filling are similar to operational temperatures as indicated in the License Application (p. E-2-86).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth, Filling

LOCATION IN DEIS: Vol 4 Page I-48 Section I.2.1.3.1 Paragraph 7 of the page

COMMENT IN REFERENCE TO: There will be insignificant growth by salmon fry in middle river during Watana filling.

TECHNICAL COMMENT: The DEIS suggestion that insignificant salmon growth will occur in the middle Susitna River section during Watana filling assumes the following:

a. Juvenile salmon fry will be rearing in habitats completely impacted by the cold mainstem water; and

b. No growth will occur at mainstem "filling" temperatures (i.e., 0-4°C).

Both of these assumptions may be in error: see Technical Comment AQR123.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth, Filling

LOCATION IN DEIS: Vol 4, Page I-48 Section I.2.1.3.1 Paragraph 8 of page

COMMENT IN REFERENCE TO: Lower filling temperatures would reduce juvenile salmon growth in the lower river.

TECHNICAL COMMENT: See Technical Comments AQR123, AQR110, AQR042, and AQR032.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Salmon Access

LOCATION IN DEIS: Vol 4 Page I-44 Section I.2.1 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Decreased summer flows will cause access problems

TECHNICAL COMMENT: The frequency of occurrence of reduced access conditions is dependent upon the mainstem discharge necessary to provide adequate backwater at the mouths of the sloughs to allow salmon to inmigrate. See Technical Comment AQR072 with respect to the analysis presented in DEIS Appendix H.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Spawning, Habitat, Hydraulics

LOCATION IN DEIS: Vol 4 Page I-49 Section I.2.1.3.2 Paragraphs 4 & 5 of the page

COMMENT IN REFERENCE TO: Decreased summer flows will cause reduction of spawning area in sloughs

TECHNICAL COMMENT: The wetted-surface areas presented in DEIS Appendix H do not include the entire wetted-surface areas of the sloughs. Much of the area used by salmon for spawning in the sloughs is not included in the surface area analysis, as presented in the DEIS. Please refer to Technical Comment AQR073 for a more detailed discussion of this consideration.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Tributary, Salmon Access, Watana

LOCATION IN DEIS: Vol 4 Page I-49 Section I.2.1.3.2 Paragraph 6 of the page

COMMENT IN REFERENCE TO: Jack Long, Sherman and Deadhorse Creeks will be affected by operational flows.

TECHNICAL COMMENT: Please refer to Technical Comment AQR025 on the same subject.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Spawning, Habitat, Mainstem, Slough Tributary

LOCATION IN DEIS: Vol 4 Page I-50 Section I.2.1.3.2 Paragraph 3 of the page

COMMENT IN REFERENCE TO: Susitna is used for mainstem and slough spawning by all five species of pacific salmon except chinook.

TECHNICAL COMMENT: This statement is incorrect. Mainstem or slough spawning by chinook and pink salmon is non-existent, or at least rare (ADF&G 1984b). Mainstem or slough spawning by coho is rare. Spawning by all three of these species is virtually limited to tributary habitats (ADF&G 1984b).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Incubation, Ice Cover

LOCATION IN DEIS: Vol 4 Page I-50 Section I.2.1.3.2 Paragraph 3 of the page

COMMENT IN REFERENCE TO: A reduction in overtopping during winter will have a negative impact on incubating eggs.

TECHNICAL COMMENT: The amount of natural redd dewatering during winter above Sherman (R.M. 131) is unknown. Normal (pre-project) ice cover and ice damming is not suspected of keeping redds watered, or of having any beneficial side effects for spawning sloughs during egg and alevin incubation. Ice damming and consequent flooding with mainstem waters of potentially high velocities and cold temperatures may have negative impacts on incubating salmon eggs if it occurs early in the winter.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Mainstem

LOCATION IN DEIS: Vol 4 Page I-51 Section I.2.1.3.1 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Focus on mainstem temperatures for incubation impacts.

TECHNICAL COMMENT: The use of mainstem temperatures to characterize with-project incubation conditions lacks factual support. Mainstem spawning is sparse (See Technical Comment AQR119). This is in contrast to the study cited in the DEIS where the species of interest, Skagit River chinook, is a mainstem spawner. The major spawning habitat in the Susitna system, the tributaries, will not be affected by changes of mainstem temperatures. Incubation in sloughs is largely dependent on upwelling temperatures unless the upstream berm is overtopped (See Technical Comment AQR071). The mean temperature of upwelling in the sloughs is approximately equal to the mean annual mainstem temperature (approx. 4°C) and will change only slightly under with-project conditions (See Technical Comment AQR035 and Appendix VII).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Groundwater, Sloughs

LOCATION IN DEIS: Vol 4 Page I-51 Section I.2.1.3.2 Paragraph 1 of the page

COMMENT IN REFERENCE TO: Analysis focused on altered mainstem temperatures

TECHNICAL COMMENT: Refer to Technical Comments AQR035, AQR036, AQR066 and to Appendix VII of this document regarding temperatures of groundwater upwelling in sloughs and the apparent relationship between mainstem discharge and groundwater upwelling.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Salmon

LOCATION IN DEIS: Vol 4 Page I-51 Section I.2.1.3.1 Paragraph 2 of page

COMMENT IN REFERENCE TO: Early spawning pink and chum would develop too rapidly

TECHNICAL COMMENT: The DEIS analysis of impacts of with-project temperatures on incubation of early spawned pink and chum salmon is in error for the following reasons.

RESOURCE: ADF&G has conducted mainstem spawning surveys in 1981 and 1982 using portable and boat-mounted electroshockers (ADF&G 1981, 1983b). In 1983 no inclusive mainstem spawning surveys were conducted, however, 6 spawning areas were found during stream and slough surveys (ADF&G 1984b). Two hundred and eighty-six chum salmon were observed at these sites, 11 sockeyes at one site, and two coho salmon at one site. In 1981, six mainstem sites were observed above the Chulitna River confluence at which 14 chum salmon were observed at 4 sites and 7 coho at two sites. In 1982, 10 mainstem spawning sites were observed between RM 114 and 148.2. Five hundred and fifty chum salmon were observed at 9 sites, and 6 coho at 3 sites. These surveys indicate only a small percentage of the run use mainstem areas for spawning. These areas are used mainly by chum salmon and appear to be areas influenced by groundwater upwelling. No pink salmon spawning in the mainstem has been observed. Essentially all pink salmon spawning occurs in tributaries (ADF&G 1984b) away from the influence of mainstem temperatures. Therefore, this comment will focus on chum salmon.

SPAWNING DATES: Chum salmon have been observed to spawn in the mainstem between September 2-19. This is later than what has been observed in the tributaries (August 5 - September 10), but is closer to the peak slough spawning dates of August 20 - September 25. This could be due to both the mainstem and the slough spawning areas being under warmer groundwater influence during the incubation period.

TEMPERATURE RANGES AND EMERGENCE TIME: Embryo incubation rates increase as temperature rises. Wangaard and Burger (USFWS 1983) incubated Susitna chum eggs in a laboratory experiment under four separate temperature regimes until complete yolk absorption. In a related study, the Alaska Department of Fish and Game determined the timing to fifty percent emergence for chum salmon under natural conditions. Development times for chum salmon were computed and plotted for data from these studies and from data available in the literature (Figure 1 attached). A calculated regression gave a linear relationship between mean incubation temperature and development rate for chum salmon development times between approximately 2 and 10°C. Variation in incubation time of at least 10% of the mean can occur within a species and further variation may be caused by fluctuating temperatures during incubation (Crisp 1981).

The calculated regression can give an approximate estimate of incubation time. A simplified way of estimating emergence time is to make a nomagraph from the development time graph (Figure 2 attached). If the spawning date and average incubation temperature are known, the approximate emergence date can be calculated. For example, chum salmon spawned on September 1 at an average incubation temperature of 3°C would emerge between May 1 and 10. Mean incubation temperatures for the four primary spawning Susitna sloughs ranged from 2.0 to 4.3°C (ADF& G 1983f). Predicted natural mainstem mean temperatures during the incubation period under average climatological conditions was around 1.2°C (Figure 3 attached). Referring to the nomagraph (Figure 2) using a spawning date of September 1 at 1.2°C would show fish emerging much later than June 10. This would be too late to assure a viable population and indicates that temperature is a limiting factor in the mainstem under natural conditions. Predicted mainstem temperatures under the one and two-dam scenarios (Figure 3) approach that recorded in the successful slough spawning areas and fish spawned on September 1 would emerge in late May.

CONCLUSIONS:

a. Only a small proportion of the runs spawn in mainstem habitats directly influenced by mainstem temperatures. Most of these fish are chum salmon and apparently spawn in areas of upwelling.

b. Mainstem spawning occurs between September 2 - 19.

c. Predicted mainstem natural temperatures are too cold for successful incubation.

d. Predicted mainstem with-project temperatures are in the range for successful incubation.

e. From a temperature standpoint only, the mainstem Susitna River would provide better incubation habitat with-project than pre-project.

Figure 1. Development time to emergence for chum salmon at various temperatures.

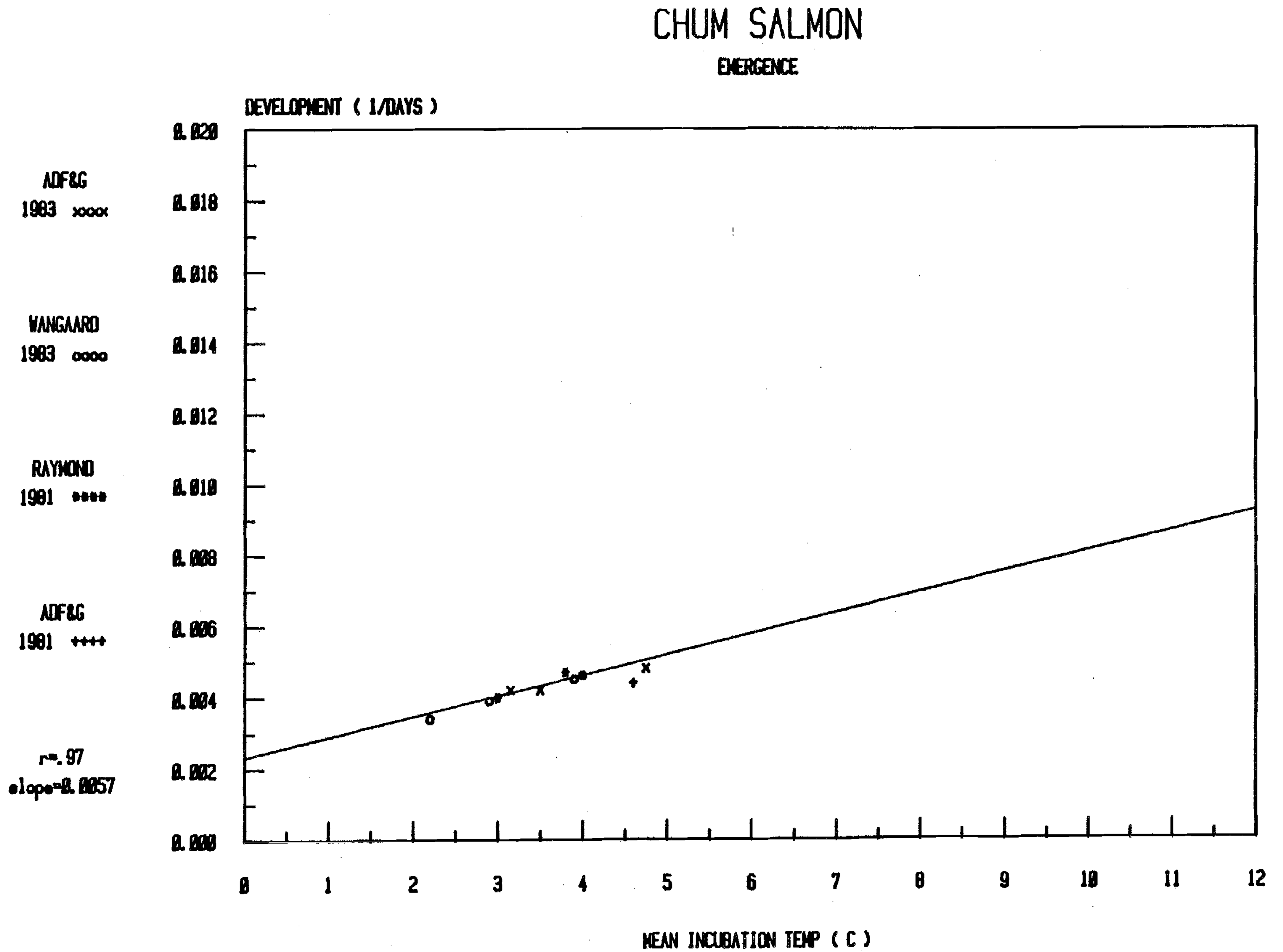

Figure 2. CHUM SALMON NOMOGRAPH

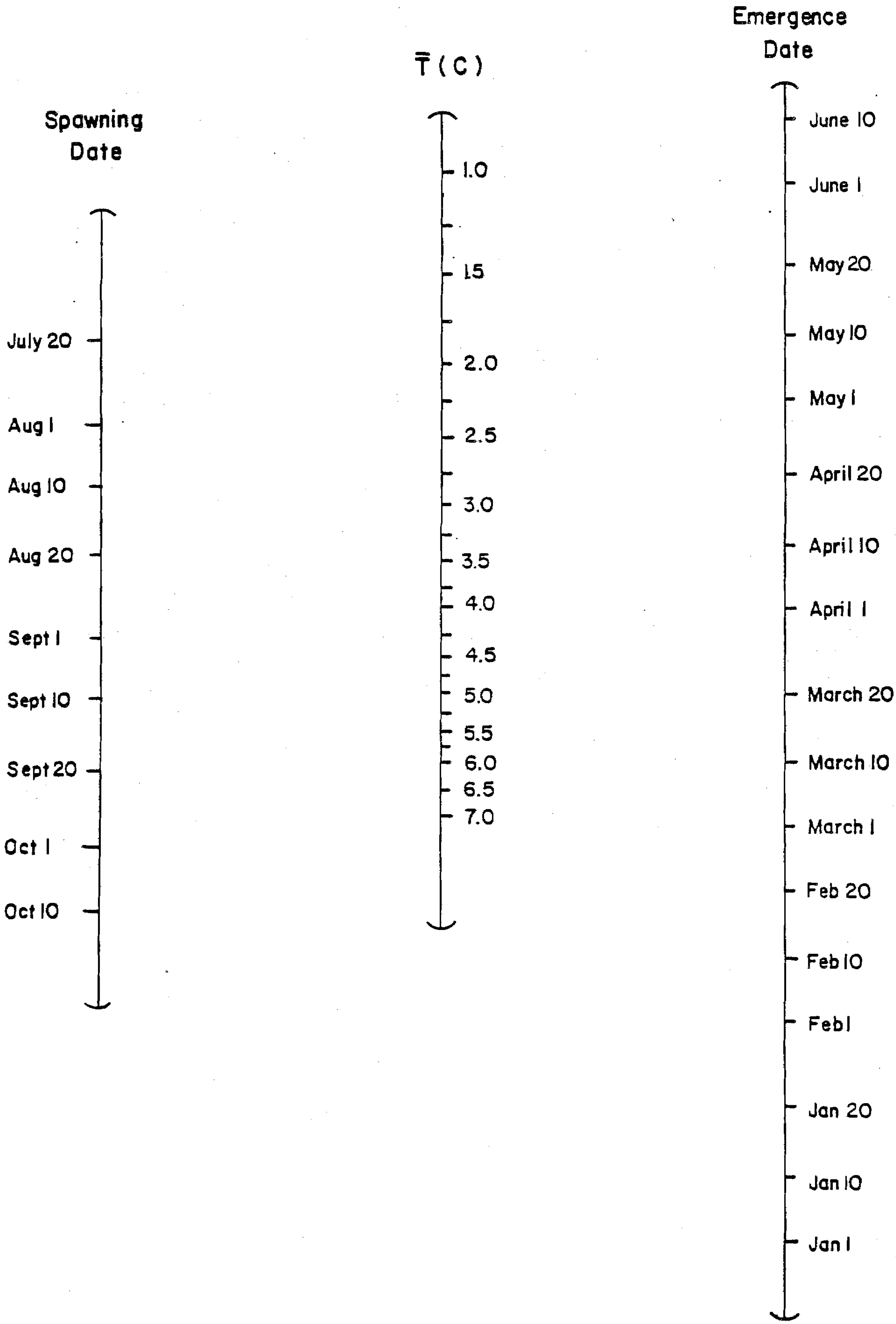

Figure 3. Predicted Susitna River temperatures °C September - April 1982-83 Meteorology & Hydrology

	Natural		Watana 1996		Devil Canyon 2002	
RM	Range	Mean	Range	Mean	Range	Mean
150	0 - 7.9	1.1	0.1 - 9.0	2.7	0.9 - 8.6	3.5
130	0 - 8.0	1.2	0 - 8.9	2.3	0 - 8.6	2.8
100	0 - 8.4	1.3	0 - 9.2	2.0	0 - 8.9	2.2

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Sloughs, Ice Process

LOCATION IN DEIS: Vol 4 Page I-51 Section I.2.1.3.2 Paragraph 4 of the page

COMMENT IN REFERENCE TO: Increased or decreased overtopping would have a negative effect on incubation and survival.

TECHNICAL COMMENT: The upstream extent of ice progression will be less under with-project conditions. One result of this will be a net decrease in the frequency of overtopping in middle river sloughs as a whole. See Technical Comment AQR071 for a more complete discussion of with-project winter ice conditions.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Ice Cover, Incubation, Sediment

LOCATION IN DEIS: Vol 4 Page I-55 Section I.2.1.3.2 Paragraph 2 of the page

COMMENT IN REFERENCE TO: Winter flow and ice conditions could cause heavy erosion of banks, islands and gravel bars. The resulting sediments could affect egg incubation in side channels and overtopped sloughs.

TECHNICAL COMMENT: Refer to Technical Comments AQR071 and AQR037 for discussions of river ice simulations. Although water levels in the winter will be generally higher than natural where an ice cover forms, this will not necessarily lead to increased erosion of banks, islands and gravel bars. As indicated in the License Application (p. E-2-25) flooding and erosion caused by ice jamming at breakup are believed to be the primary factors influencing river morphology in the reach between Devil Canyon and Talkeetna. Regulation of spring floods by the project and release of warmer waters from the reservoirs will tend to cause the river ice cover to melt in place rather than breakup (See Technical Comment AQR037). This will reduce the potential for ice jamming and subsequent flooding and erosion. Additionally, the potential for ice cover breakup and jamming in the vicinities of sloughs will be reduced since in many cases the ice cover will not extend upstream to the vicinities of the sloughs. Therefore, project implementation is expected to reduce erosion of banks, island and gravel bars by reducing ice cover breakup jamming.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Model

LOCATION IN DEIS: Vol 4 Page I-55 Section I.2.1.3.2 Paragraph 4 of the page

COMMENT IN REFERENCE TO: "FERC staff estimated instream temperatures changes markedly different from ... applicant."

TECHNICAL COMMENT: See Technical Comments AQR032, AQR033, AQR046, AQR074, and AQR098 regarding instream temperatures.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-55 Section I.2.1.3.2 Paragraph 4 of the page

COMMENT IN REFERENCE TO: DEIS assumptions regarding temperature-growth relationships

TECHNICAL COMMENT: The predicted changes in growth rates of juvenile salmon as a result of alterations in river temperature below the proposed Project are less than indicated by the DEIS because: 1) some of the calculations for fish growth in the DEIS were based on a water-temperature regime predicted by the applicant that has since been found in error (See Technical Comment AQR033), 2) the assumption that all fish in the wild would feed to satiation is invalid, and 3) the assumption that all fish rearing in the Susitna River would be affected by temperature alteration in the mainstem is not realistic. These points are discussed below.

1. Corrected estimates of water temperature are more similar to the natural temperature regime (Table 1 attached) than the temperature regime estimates in the License Application. Consequently, estimates of fish growth (calculated with the same method and assumptions as made in the DEIS) based on the new temperature regime are also more similar to the predicted natural growth rate (Tables 2, 3, 4 attached). Estimated reductions in growth range from 12% to 17%, depending on location, with the one-dam project, and 17% to 30%, depending on location, for the two-dam project. Impacts on growth are greatest in the lower portion of the middle river reach (RM 98.6) and decrease below the confluence with the Chulitna and Talkeetna Rivers (RM 97). Potential growth reductions in the lower river reach (Talkeetna to Cook Inlet) would be less than 17% with either a one-dam or two-dam project (Table 4 attached).

2. Growth is limited by food supply in addition to the controlling effects of temperature. In nature, the growth of salmon and trout most often occurs at ration levels lower than the maximum (Brett, et al. 1982, Wurtsbaugh and Davis 1977). Juvenile salmon in the Susitna are also likely feeding at less than maximum ration levels. The average length of juvenile chinook, coho, and sockeye in the middle reach at the end of September 1982 was 69 mm, 65mm, and 59 mm, respectively (ADF&G 1983c Tables 3-3-27, 31, and 35). The estimated weight of a 70 mm individual is 3.8 g (calculated from Bell 1980, Chapter 19, Table J). Thus the actual size of juvenile salmon in the Susitna River during late September 1982 is less than one-half the predicted size of fish growing under the natural-temperature regime and feeding on a maximum ration (Tables 2 & 3). This large difference in fish size, suggests that fish in the Susitna River are not feeding to satiation during the summer growth period.

The effect of temperature on growth is a function of ration level (Figure 2, attached). For juvenile sockeye, the optimum temperature for growth decreased progressively from about 15°C at maximum rations to about 5°C at a ration size just above the maintenance ration (Brett, et al., 1969). A similar relation was found for brown trout with a decrease from about 13°C at rations close to the maintenance level (Elliott 1975). Changes in temperature result in relatively smaller changes in growth at reduced rations compared to maximum rations because of differences in the shape of ration versus growth relation. Consequently small drops in temperature during midsummer from 10°-11°C to 8°-9°C (Table 1, July and August) will result in relatively small changes in growth for fish feeding at reduced ration levels (Fig. 1). Since fish in the Susitna River are feeding on a low ration level, the expected changes in growth due to temperature reductions would likely be smaller than predicted in Tables 2, 3, and 4.

3. Temperature changes predicted for the mainstem Susitna River (Table 1 attached) may or may not affect the temperature regime in sloughs and tributary mouth habitats. If temperatures in these habitats are affected by the river temperature, the magnitude of effects would be less than shown in Table 1 because of groundwater upwelling and/or tributary inflow.

Temperature in side channels receiving direct river flow would have the greatest response to changes in river temperature. Side sloughs and upland sloughs would be less affected by river temperatures (See Technical Comments AQR035, AQR036 and Appendix VII) and tributary mouths would be least affected by river temperature. Therefore the extent of temperature effects on fish growth would depend upon the distribution of fish among different habitats. In the Susitna river, only a small proportion of all juvenile salmonids (chinook 22.6%, coho 3.4%, chum 4.1% and sockeye 8.6%) rear in mainstem or side channel habitats (ADF&G 1984b) during the summer. The majority of all juvenile salmon rear in sloughs or tributary habitats where the potential for temperature impacts on growth would be small.

Based on these points (1-3), the DEIS has overstated the impact of lowered mainstem temperatures upon rearing juvenile salmon. The actual impact may be negligible depending on actual ration levels. As a worse case, 23%, 3.4%, 4.1% and 8.6% of the middle reach chinook, coho, chum and sockeye salmon juveniles, respectively, would experience a 12-30% reduction in growth.

Table 1

Estimated monthly mean water temperature
for the proposed Susitna Hydroelectric Project
Middle River Reach downstream to Sunshine

Month	Natural Temperature (°C)	Temperature with Watana 1996 (°C)	Temperature with Devil Canyon 2002 (°C)
RM 130 - Sherman			
Jun	9.6	7.1	6.4
Jul	10.7	10.0	7.8
Aug	10.7	9.9	7.9
Sep	6.4	8.0	8.4
Oct	0.7	4.0	6.2
RM 98 - Chulitna Confluence			
Jun	10.1	8.5	8.0
Jul	11.4	11.2	9.2
Aug	11.4	10.8	9.0
Sep	6.7	8.2	8.4
Oct	.6	3.2	4.5
RM 84 - Sunshine			
Jun	9.1	8.1	8.5
Jul	9.9	9.3	8.3
Aug	9.7	9.3	8.4
Sep	6.1	6.6	6.7
Oct	0.9	2.1	2.6

Table 2

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 130 in the Susitna River.

Water Year	Month	Week	Natural 1982 Temp.(°C)	Natural 1982 Cum. Wt.	Watana 1996 Temp.(°C)	Watana 1996 Cum. Wt.	Devil Canyon 2002 Temp.(°C)	Devil Canyon 2002 Cum. Wt.
				0.20g		0.20g		0.20g
1982		28	<3.0	__	<3.0	__	3.0	.22
		29	4.6	.23	3.9	.22	3.8	.24
		30	5.8	.27	4.4	.25	4.2	.28
	May	31	5.5	.32	4.1	.28	4.2	.31
		32	4.7	.35	3.5	.31	4.2	.35
		33	6.7	.43	3.9	.34	4.6	.39
		34	6.6	.50	4.0	.38	4.8	.44
	June	35	8.4	.64	5.0	.44	5.2	.50
		36	8.9	.80	5.8	.50	5.3	.57
		37	8.0	.97	6.4	.59	5.7	.64
		38	9.6	1.21	7.3	.72	6.8	.74
		39	11.8	1.51	9.0	.91	7.8	.88
	July	40	10.6	1.86	10.5	1.17	8.5	1.06
		41	11.1	2.32	10.2	1.43	10.2	1.31
		42	11.2	2.79	10.2	1.76	6.9	1 45
		43	10.0	3.30	9.3	2.13	5.6	1.58
	Aug.	44	11.0	3.87	9.8	2.48	6.2	1.75
		45	11.2	4.53	10.1	2.92	7.4	2.00
		46	11.0	5.24	10.0	3.45	8.3	2.33
		47	11.0	6.02	10.4	3.99	9.0	2.71
	Sept.	48	9.5	6.77	9.1	4.59	8.7	3.07
		49	8.0	7.41	8.9	5.09	8.6	3.43
		50	6.7	7.82	8.5	5.65	8.5	3.83
		51	6.6	8.27	7.5	6.14	8.3	4.28
		52	4.4	8.51	7.2	6.63	8.0	4.75

Table 2 cont'd

Water Year	Month	Week	Natural 1982 Temp.(°C)	Natural 1982 Cum. Wt.	Watana 1996 Temp.(°C)	Watana 1996 Cum. Wt.	Devil Canyon 2002 Temp.(°C)	Devil Canyon 2002 Cum. Wt.
1983	Oct.	1	<3.0		6.0	7.01	7.6	5.20
		2			5.0	7.33	6.9	5.53
		3			3.6	7.51		5.80
		4					5.9	6.01
	Nov.	5					3.8	6.17
		6					3.2	6.34
Reduction from pre-project growth (%)						12		25

[1] Growth calculations based on specific growth-rate data from Brett (1974)

Table 3

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 96.6 in the Susitna River.

Water			Natural 1982		Watana 1996		Devil Canyon 2002	
Year	Month	Week	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt.	Temp.(°C)	Cum. Wt
				0.20g		0.20g		0.20g
1982		29	6.0	.25	4.9	.23	4.8	.23
		30	7.4	.32	5.7	.27	5.5	.27
	May	31	6.6	.39	5.2	.32	5.3	.32
		32	5.3	.45	4.4	.35	4.9	.35
		33	7.3	.56	5.2	.41	5.8	.41
		34	7.2	.68	5.2	.47	6.0	.49
	June	35	9.0	.87	6.6	.55	6.7	.58
		36	9.3	1.10	7.1	.67	6.7	.68
		37	8.5	1.28	7.4	.80	6.9	.78
		38	10.2	1.58	8.7	.97	8.5	.96
		39	12.5	2.03	10.8	1.23	9.9	1.19
	July	40	11.4	2.53	11.7	1.54	10.2	1.47
		41	11.7	3.05	11.5	1.91	11.5	1.83
		42	12.0	3.75	11.6	2.39	8.5	2.13
		43	10.6	4.34	10.1	2.82	6.7	2.31
	Aug.	44	11.7	5.02	10.9	3.33	7.4	2.58
		45	12.0	5.97	11.2	3.90	8.7	2.93
		46	11.6	6.86	10.8	4.51	9.3	3.41
		47	11.8	7.82	11.3	5.22	10.0	3.94
	Sept.	48	10.1	8.74	9.8	5.87	9.4	4.53
		49	8.4	9.44	9.2	6.61	8.9	5.03
		50	7.1	10.04	8.7	7.23	8.7	5.58
		51	6.8	10.56	7.7	7.67	8.4	6.15
		52	4.6	10.81	7.1	8.32	7.7	6.64

Table 3 cont'd

Water Year	Month	Week	Natural 1982 Temp.(°C)	Natural 1982 Cum. Wt.	Watana 1996 Temp.(°C)	Watana 1996 Cum. Wt.	Devil Canyon 2002 Temp.(°C)	Devil Canyon 2002 Cum. Wt
1983	Oct.	1	<3.0		5.7	8.66	6.9	7.02
		2			4.3	8.92	5.6	7.34
		3			<3.0		4.1	7.57
Reduction from pre-project growth (%)						17		30

[1] Growth calculations based on specific growth-rate data from Brett (1974)

Table 4

Temperature and cumulative growth on a maximum ration[1] for representative juvenile salmon under average (water year 1982-83) natural and with-project meteorologic conditions at RM 84 (Sunshine) in the Susitna River.

Water Year	Month	Week	Natural 1982 Temp.(°C)	Natural 1982 Cum. Wt.	Watana 1996 Temp.(°C)	Watana 1996 Cum. Wt.	Devil Canyon 2002 Temp.(°C)	Devil Canyon 2002 Cum. Wt.
				0.20g		0.20g		0.20g
1982		29	5.5	.24	5.5	.24	5.0	.24
		30	6.7	.29	5.9	.28	5.8	.28
	May	31	6.1	.36	5.4	.33	5.5	.33
		32	5.2	.42	4.7	.37	4.9	.37
		33	7.0	.52	5.9	.43	6.1	.44
		34	6.9	.60	5.9	.49	6.2	.52
	June	35	8.4	.75	7.3	.61	7.3	.63
		36	8.6	.91	7.7	.73	7.7	.76
		37	7.6	1.07	6.9	.83	6.8	.87
		38	9.0	1.34	7.9	.98	7.8	1.02
		39	11.0	1.66	9.9	1.22	9.7	1.28
	July	40	9.8	2.00	9.3	1.47	8.9	1.49
		41	10.1	2.47	9.2	1.77	9.1	1.79
		42	10.5	2.91	9.7	2.13	9.1	2.16
		43	9.3	3.39	8.8	2.42	8.0	2.44
	Aug.	44	10.2	3.92	9.7	2.82	8.8	2.77
		45	10.1	4.54	9.7	3.28	9.0	3.22
		46	9.7	5.14	9.3	3.77	8.9	3.60
		47	9.9	5.78	9.7	4.33	9.3	4.14
	Sept.	48	8.5	6.37	8.3	4.80	8.2	4.59
		49	7.6	6.88	7.8	5.26	7.8	5.03
		50	6.6	7.28	7.0	5.71	7.2	5.50
		51	5.8	7.59	6.0	6.07	6.3	5.85
		52	4.5	7.83	5.5	6.37	5.6	6.14

Table 4 cont'd

Water Year	Month	Week	Natural 1982 Temp.(°C)	Natural 1982 Cum. Wt.	Watana 1996 Temp.(°C)	Watana 1996 Cum. Wt.	Devil Canyon 2002 Temp.(°C)	Devil Canyon 2002 Cum. Wt.
1983	Oct.	1	<3.0		4.1	6.59	3.8	6.30
		2			<3.0		3.4	6.47
Reduction from pre-project growth (%)						16		17

[1] Growth calculations based on specific growth-rate data from Brett (1974).

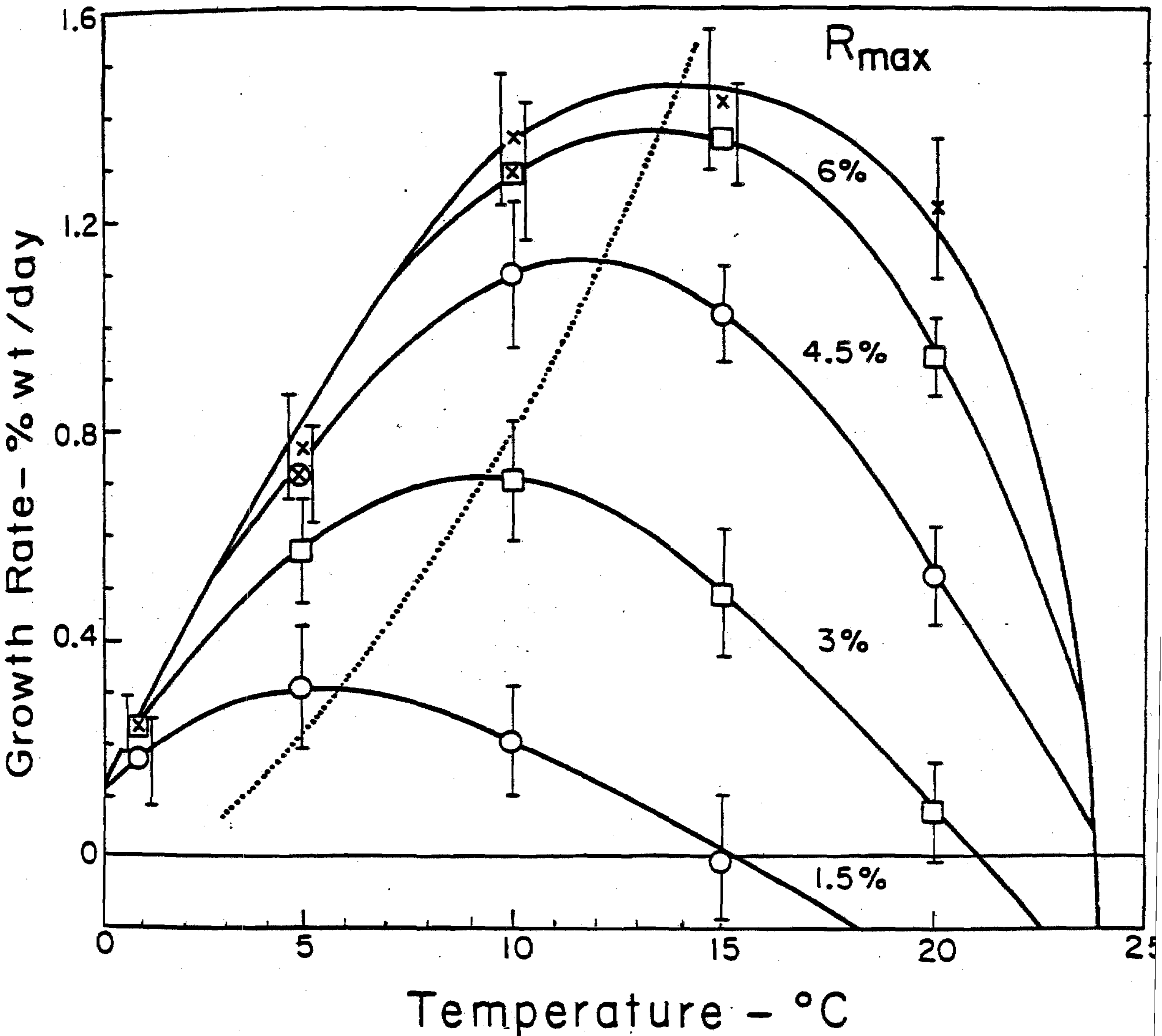

Fig. 1. The relation of growth rate (±2 SE) of sockeye salmon juveniles to temperature for different levels of ration. Determinations computed in terms of dry weights (% per day). Dotted line passes through the optimum temperature and maximum growth rate for each ration level. R_{max} = maximum daily ration. From Brett et al., 1969.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: River Temperature Model, Temperature

LOCATION IN DEIS: Vol 1 Page I-55 Section I.2.1.3.2 Paragraph 5 of page

COMMENT IN REFERENCE TO: The DEIS questions "whether warmer waters will persist in the [Susitna] river in the autumn..."

TECHNICAL COMMENT: Refer to Technical Comments AQR032, AQR033, AQR046, AQR074, and AQR098 regarding statements in the DEIS questioning the temperature simulations presented in the License Application.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-55 Section I.2.1.3.1 Paragraph 5

COMMENT IN REFERENCE TO: "... if temperatures do not remain warm [in the fall], ... annual growth for chinook and coho salmon would be reduced."

TECHNICAL COMMENT: See Technical Comment AQR123.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Turbidity

LOCATION IN DEIS: Vol 4 Page I-57 Section I.2.1.3.1 Paragraph 3 of page

COMMENT IN REFERENCE TO: Decreased turbidity may result in increased predation on salmon juveniles.

TECHNICAL COMMENT: Current estimates of with-project turbidity changes do not fall within the range of NTU's where increased predation on juvenile salmonids is expected to be a problem. Minimum suspended sediment and turbidity estimates for with-project conditions are approximately 15-30 mg per liter TSS and 30-90 NTU's, respectively. Many salmonids are believed to lose visual feeding cues and the ability to feed optimally at low to moderate turbidities which fall within the minimal estimated post-project ranges of turbidity (Bell 1980; Sigler, Bjorn, and Everest 1984).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon

LOCATION IN DEIS: Vol 4, Page I-57 Section I.2.1.3.1 Paragraph 7 of page

COMMENT IN REFERENCE TO: Application of 41°F threshold for inducing overwintering behavior to Susitna stocks.

TECHNICAL COMMENT: Refer to Technical Comment AQR108 for a discussion of juvenile behavior at temperatures less than 5°C (41°F).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Outmigration

LOCATION IN DEIS: Vol 4 Page I-58 Section I.2.1.3.1 Paragraph 4 of page

COMMENT IN REFERENCE TO: Timing and variability of emigration poorly characterized.

TECHNICAL COMMENT: The beginnings of smolt emigration may remain similar to what they have been pre-project. Concluding that an increase in temperature of the mainstem (which is not where most presmolting juveniles are apparently rearing) would lead to premature emigration is too simplistic. Juvenile smolting and emigration are influenced by at least the following: temperature; length-weight and condition factors; food availability; photo period and lunar phase periods plus neuroendocrine, behavioral, and physiological changes (See Technical Comment AQR051).

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon

LOCATION IN DEIS: Vol 4 Page I-58 Section I.2.1.3.1 Paragraph 6 of page

COMMENT IN REFERENCE TO: Advancement in river temperatures in spring may cause a concommitant advancement in emigration of salmon juveniles.

TECHNICAL COMMENT: Temperature is only one environmental parameter which may be linked to smoltification and smolt emigration. Other important influences include photoperiod, interspecific and intraspecific competition or aggressive behavior, physiological hormone status, length-weight condition factors, food supply, water velocity, turbidity and water chemistry.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Slough, Spawning

LOCATION IN DEIS: Vol 4 Page I-59 Section I.2.1.3.1 Paragraph 2 of page

COMMENT IN REFERENCE TO: Chum and sockeye salmon could be most severely impacted by operation due to potential loss of spawning in sloughs.

TECHNICAL COMMENT: Refer to Technical Comments AQR073 and AQR104. These statements must be put into perspective. The number of chum salmon potentially affected in the sloughs is about 4000 to 5000 fish out of a total of 25000-35000 chum salmon which enter the middle Susitna (ADF&G 1984b). The total number of sockeye salmon utilizing sloughs in the Devil Canyon to Talkeetna reach is approximately 1000-1500 fish (ADF&G 1984b). Not all of these fish will be adversely affected. Thus, this impact (if any) is insignificant.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Filling, Pink Salmon

LOCATION IN DEIS: Vol 4 Page I-59 Section I.2.1.3.1 Paragraph 2 of page

COMMENT IN REFERENCE TO: Pink may be severely impacted by reservoir filling and fail to recover due to the short life cycle.

TECHNICAL COMMENT: The DEIS suggests impacts of filling flows will be severe on pink salmon stocks in the middle river reach (Devil Canyon to Talkeetna). The basis for this assertion is not clear. During 1981, 1982 and 1983 only a maximum of 1, 7 and 5 percent, respectively, of the Susitna pink salmon run entered the middle river (estimated at Curry Station)(ADF&G 1984b, Tables 2-4-1 and 2-4-4).

The DEIS evaluation placed greatest filling flow impacts on slough and mainstem spawning habitats in the middle river. No pink salmon spawning was observed in the mainstem during 1981-83 (ADF&G, 1984b p. 199). Pink salmon spawning in sloughs is also limited. Only an estimated 335 pink salmon spawned in middle river sloughs during 1981-83, or 0.03 percent of the total escapement during the same period. Tributary streams supported essentially all the pink salmon spawning in the middle river reach during 1981-83 (ADF&G 1984b, p. 200). Spawning habitat in tributaries will not be affected by project filling or operational flows. With-project conditions are not expected to limit access to tributaries (Trihey 1983) or prevent migration of adults into the middle river reach (see Technical Comment AQR100).

The DEIS statement that pink salmon may be severely impacted by reservoir filling and that these stocks may fail to recover is without factual basis and should be deleted.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Spawning

LOCATION IN DEIS: Vol 4 Page I-59 Section I.2.1.3.2 Paragraph 6 of page

COMMENT IN REFERENCE TO: "Rainbow trout [spawning], not evaluated by the applicant, will likely be restricted ..."

TECHNICAL COMMENT: Rainbow trout do not occur above Devil Canyon (Lic. App. E-3-11, Section 2.1.4) and so would not be in the Watana Reservoir. The Applicant did not evaluate rainbow trout for that reason.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Sockeye (Kokanee) Salmon

LOCATION IN DEIS: Vol 4 Page I-60 Section I.2.1.3.1 Paragraph 1 of page

COMMENT IN REFERENCE TO: DEIS suggestion of putting kokanee in reservoir.

TECHNICAL COMMENT: Introduction of kokanee into the Watana reservoir area should not be considered a preferred mitigation option. Sockeye salmon do not occur above Devil Canyon and so kokanee would be considered an exotic species in the upper basin. Kokanee would have access to neighboring lakes from the reservoir and could adversely affect resident populations through competition.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Habitat, Groundwater

LOCATION IN DEIS: Vol 4 Page I-61 Section I.2.2.3.2 Paragraph 8 of page

COMMENT IN REFERENCE TO: Most significant downstream impact with Devil Canyon may be caused by change in winter water temperature. Dewatering of habitats during winter due to reduced overtopping, selection of groundwater upwelling areas by salmon.

TECHNICAL COMMENT: See Technical Comments AQR105, AQR035, and AQR036 concerning the effect of project operation on groundwater upwelling. Also, see Appendix VII of this document.

Please see Technical Comments AQR070 and AQR037 and Appendix VI of this document concerning with-project ice simulations.

It is not apparent that non-overtopping of slough habitats in the winter is detrimental. In fact, it has been observed that overtopping of sloughs by cold water (near 0°C) can cause embryo mortality and tends to retard growth. Non-overtopping would appear to be beneficial. The ice simulations carried out to date indicate that overtopping of Sloughs 8A, 9 and 21 will be reduced with Devil Canyon in operation and so negative impacts of overtopping will also be reduced.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Salmon Access, Watana, Devil Canyon

LOCATION IN DEIS: Vol 4 Page I-61 Section I.2.2.3.2 Paragraph 9 of page

COMMENT IN REFERENCE TO: DEIS analysis of access problems with Devil Canyon on line

TECHNICAL COMMENT: The frequency evaluation of access conditions with Devil Canyon in operation should be revised in light of Technical Comment AQR072.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Sloughs, Hydraulics, Watana, Devil Canyon

LOCATION IN DEIS: Vol 4 Page I-62 Section I.2.2.3.2 Paragraph 1 of page

COMMENT IN REFERENCE TO: DEIS analysis of wetted-surface area in sloughs with Devil Canyon on line.

TECHNICAL COMMENT: The evaluation of salmon spawning areas in terms of wetted-surface areas should be revised in light of Technical Comment AQR073.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Incubation, Salmon

LOCATION IN DEIS: Vol 4 Page I-62 Section I.2.2.3.2 Paragraph 3 of page

COMMENT IN REFERENCE TO: Early spawning pink and chum salmon will emerge too early

TECHNICAL COMMENT: See Technical Comment AQR119.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-62 Section I.2.2.3.2 Paragraph 4 of page

COMMENT IN REFERENCE TO: Expected summer temperatures with Devil Canyon in operation will reduce growth in salmon juveniles.

TECHNICAL COMMENT: Please see Technical Comment AQR123.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Salmon Growth

LOCATION IN DEIS: Vol 4 Page I-62 Section I.2.2.3.2 Paragraph 4 of page

COMMENT IN REFERENCE TO: The DEIS concludes that autumn temperatures will fall more rapidly than the applicant estimated

TECHNICAL COMMENT: Refer to Technical Comments AQR074, AQR098, AQR032, AQR033, and AQR046 regarding statements in the DEIS questioning the temperature simulations presented in the License Application.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Temperature, Habitat

LOCATION IN DEIS: Vol 4 Page I-62 Section I.2.2.3.2 Paragraph 5 of page

COMMENT IN REFERENCE TO: Summer temperature reductions, with Devil Canyon in operation, may be sufficiently severe to retard growth of benthic food organisms.

TECHNICAL COMMENT: A summer temperature reduction in the mainstem of 2-4°C (such as that depicted in Figure I.2-3) should not severely reduce growth of benthic periphyton and/or invertebrates. The mainstem benthos, even with both dams in place, should still be primarily limited by high suspended sediment load, sedimentation of fines into substrate interstitial spaces and high turbidity resulting in a very shallow photic zone.

Habitats peripheral to the mainstem should not experience the same degree of cooling as the mainstem through the summer. Habitats peripheral to the mainstem may benefit substantially from lessened mainstem overtopping, lessened sedimentation, and possible extension of a slightly warmer habitat into early fall.

The extent to which the mainstem presently serves as habitat for fish or fish food organisms is poorly understood. Reductions of velocity, suspended sediment and substrate motility due to spates may benefit numbers of species and standing crop of invertebrates in the mainstem, especially if fine sediments are removed and periphyton growth is able to increase.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Habitat, Flow Regime, Temperature

LOCATION IN DEIS: Vol 4 Page I-63 Section I.2.2.3.2

COMMENT IN REFERENCE TO: DEIS analysis of year/class strength correlation with environmental factors.

TECHNICAL COMMENT: The DEIS analysis of year class strength vs. Susitna River flows should be deleted. The negative result, while not surprising, is not meaningful. A majority of the Susitna salmon stocks spawn in habitats other than sloughs (ADF&G 1984b, pp 177-218) and would not experience the hypothesized effect. Even sockeye and chum salmon, species that utilize sloughs extensively for spawning, have large fractions of their total annual populations that spawn in other habitats. Variations in production from these other habitats could be great enough to "mask" the hypothesized relationship if it did exist.

The stated assumptions could be violated beyond the robustness of the statistical test used. The assumption that commercial catch figures for upper Cook Inlet are reasonable indicators of run strength is heavily dependent on historic regulation and composition of the fishing fleet (Gulland 1974, pp. 127-154). Catch is related to both effort and stock abundance in complex ways (Ricker 1975, pp. 328-332).

The assumption that each annual fishery harvests a single year class of each species is true for pink salmon, but invalid for all others. The potential variance from this assumption can be evaluated using age composition data from adult sampling in the Susitna River (ADF&G 1984b). Estimated frequencies for the age classes cited by the DEIS were calculated as weighted mean percents for samples collected at Yentna and Sunshine

Stations. Estimated frequencies (%) for the "dominant" age class were 69.6, 40.3, 39.0 and 30.0 for coho, chum, chinook and sockeye salmon, respectively, in 1983. Therefore, the assumption is invalid in some years for more than half of each run. This would mask the hypothesized relationship if it did exist.

The DEIS evaluates the results of the tests and then points out, "there is no sound basis for judging the validity of extrapolating the results of this analysis to these lower (with-project) flows." This would seem to negate the purpose of doing the test at all and, combined with the above discussed flows in the analysis, certainly negates the value of including the analysis in the DEIS text.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Salmon, Filling

LOCATION IN DEIS: Vol 4 Page I-64 Section I.2.2.3.2 Paragraph 3 of page

COMMENT IN REFERENCE TO: Middle river production of all five species will be greatly reduced. Offset by Susitna fish "straying" to Talkeetna River.

TECHNICAL COMMENT: Salmon production will not be greatly reduced in the middle river reach during filling nor will straying increase. See Technical Comments AQR072, AQR073, AQR100, AQR108, AQR115, AQR117, AQR119, AQR123, AQR129, AQR131, AQR013, and AQR051.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Reservoir, Impacts

LOCATION IN DEIS: Vol 4 Page I-66 Section I.2.2.3.2 Paragraph 1 of page

COMMENT IN REFERENCE TO: Monitoring of mercury levels in fish will be necessary.

TECHNICAL COMMENT: Mercury methylation by microbes and bioaccumulation by resident fisheries in the newly inundated Susitna reservoirs is an agreed upon possibility. A baseline program to begin assessing the total mercury levels of resident predatory sportfish from a variety of Susitna River basin habitats has been proposed by the Applicant for FY85 Aquatic Studies.

The sportfish proposed for the initial baseline monitoring of mercury content are grayling, lake trout, dolly varden, burbot, and rainbow trout.

SUSITNA HYDROELECTRIC PROJECT
DRAFT ENVIRONMENTAL IMPACT STATEMENT
TECHNICAL COMMENT FORM

TOPIC AREA: Pink Salmon, Filling

LOCATION IN DEIS: Vol 4 Page I-64 Section I.2.2.3.2 Paragraph 4 of page

COMMENT IN REFERENCE TO: Recovery of pink salmon stocks after third year of filling would be slow due to two year life history.

TECHNICAL COMMENT: The DEIS has overestimated project impacts on the Susitna pink salmon stocks (see Technical Comments AQR100, AQR107, and AQR131). Pink salmon would likely be the first of the salmon species to re-establish themselves or invade new habitats since they have a greater behavioral tendency to stray from natural spawning sites (Morrow 1980).

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Alaska Power Authority
Comments on the Federal Energy Regulatory Commission
Draft Environmental Impact Statement
of May 1984

This Bibliography is organized according to the five categories of the Technical Comments. Within each category, the references are listed alphabetically by author. For brevity, the following acronyms are used in the citations.

Acronym	Affiliation
Acres	Acres American, Inc.
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AEIDC	Arctic Environmental Information and Data Center
AIEE	American Institute of Electrical Engineers
AK	State of Alaska (General)
ALUC	Alaska Land Use Council
APA	Alaska Power Authority
ASL	Alaska State Legislature
Battelle	Battelle Pacific Northwest Laboratories
BLM	Bureau of Land Management
BP	British Petroleum
COE	Corps of Engineers
DCED	Alaska Department of Commerce and Economic Development
DOE	U.S. Department of Energy
EBASCO	Ebasco Services, Inc.
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission

Acronym	Affiliation
FNSB	Fairbanks - North Star Borough
FOA	Frank Orth and Associates
HE	Harza-Ebasco Susitna Joint Venture
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers, Inc.
ISER	Institute of Social and Economic Research
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
O&GCC	Oil and Gas Conservation Commission
PND	Peratrovich, Nottingham & Drage, Inc.
R&M	R&M Associates
SHCA	Sherman H. Clark Associates
SHP	Susitna Hydroelectric Project
TES	Terrestrial Environmental Specialists
UAM	University of Alaska - Museum
USBR	U.S. Bureau of Reclamation
USDASCS	U.S. Department of Agriculture, Soil Conservation Service
USGS	U.S. Geological Survey

AQUATIC RESOURCES

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