PRELIMINARY RESULTS OF RESERVOIR TEMPERATURE AND INSTREAM ICE RUNS

SUS
340

DRAFT

To: Larry Gilbertson
From: E.J. Gemperline
Subject: Preliminary Results of Reservoir Temperature and Instream Ice Runs

The attached exhibits are preliminary results of reservoir temperature and mstream ice runs described below:

~~Figures 1 and 2 show~~
Figures 1 through 4 show inflow and simulated outflow temperatures and ice thicknesses for Watana Reservoir for the period November 1, 1981 to October 30, 1982. Reservoir outflows and water levels ~~ar~~ were based on simulated reservoir operation for 1996 ~~load~~ ~~power~~ energy demand levels (4700 GWH)

Figure 5 shows the simulated ~~&~~ ~~to~~ ice front progression ~~below~~ upstream of Talkeetna for the period November, 1981 to April 1982 based on simulated outflows ~~conditions~~ and temperatures for Watana operation and 1996 energy demands.

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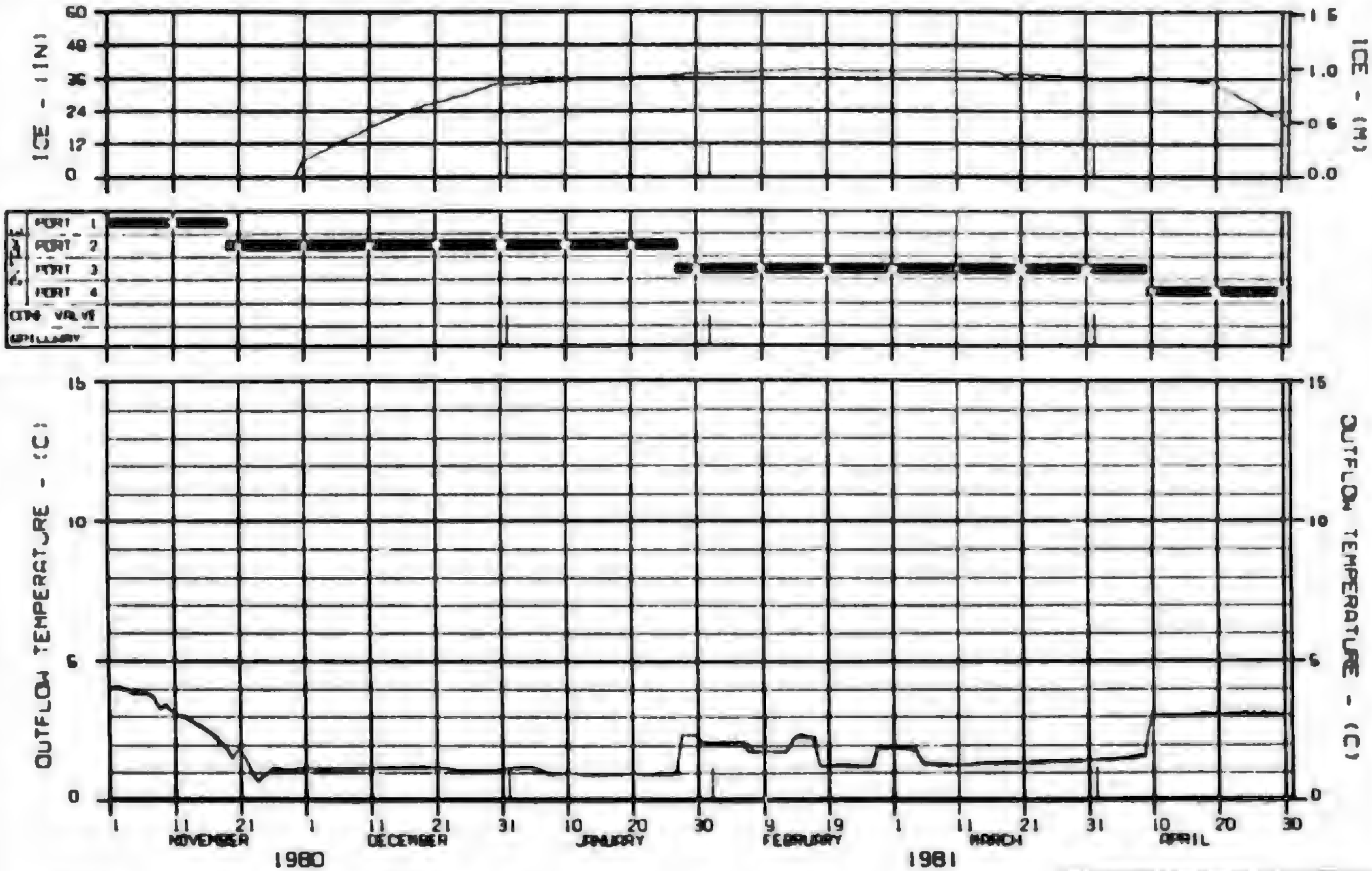
Figures 6 - 10 show the maximum water levels, ~~ice the~~ and ice thicknesses for the reach upstream of Talkeetna and downstream of Devil Canyon for the period November, 1981 to April 1982 based on simulated outflows and temperatures for Watana operation and 1996 energy demands.

Figures 11 - 30 show the time history of stream temperature, water level and ice thickness at 20 locations near the upstream ends of various side sloughs and side channels (identified by river mile # - see index) for the period November, 1981 to April 1982 for simulated Watana operation and 1996 energy demands.

~~Similar exhibits will be~~



LEGEND: CASE: WA8I9GE

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (664.7 M)

ALASKA POWER AUTHORITY

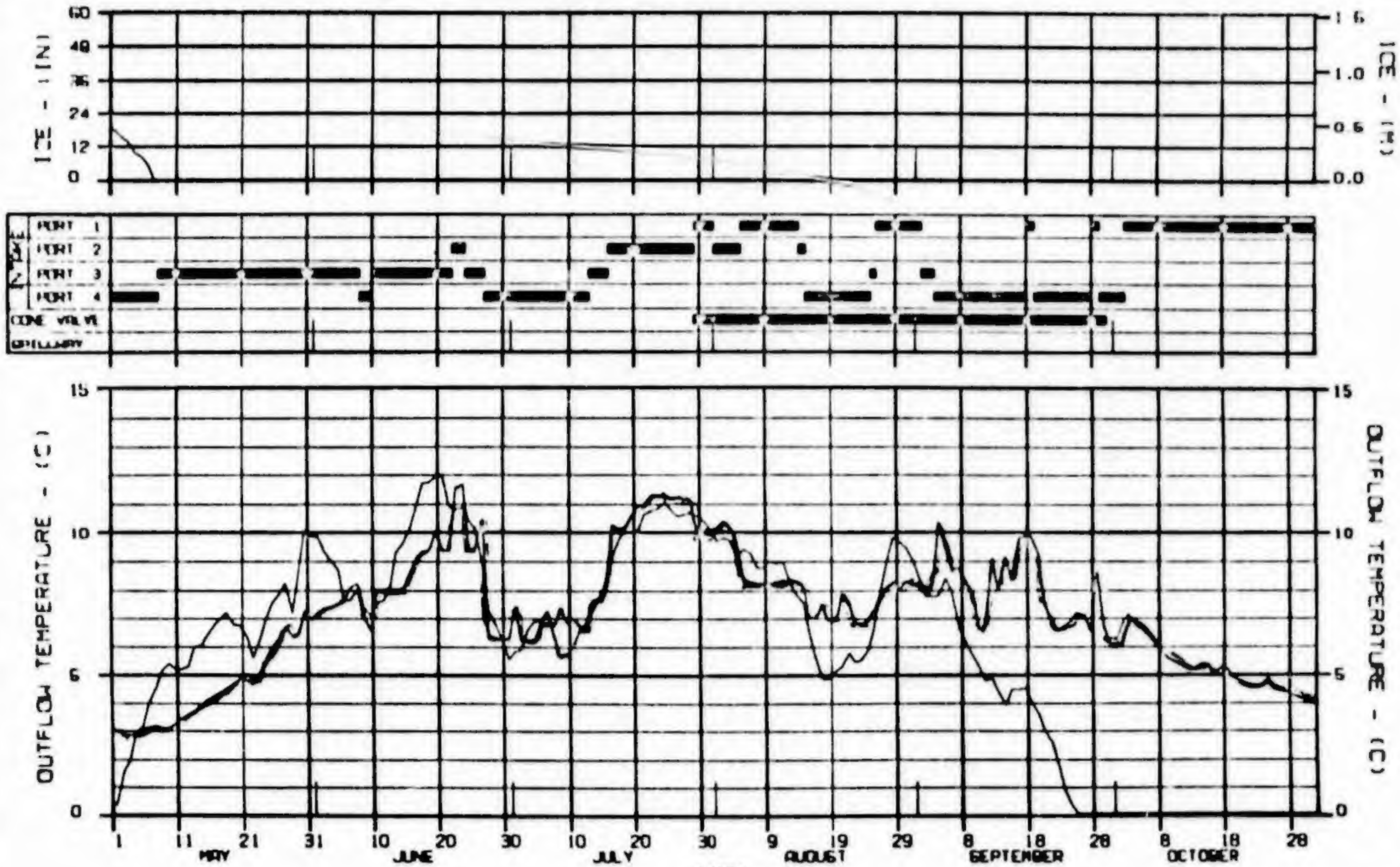
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

OLTION?

Figure



LEGEND: CASE: ▬▬▬ WAB19GE ▬▬▬

▬▬ PREDICTED OUTFLOW TEMPERATURE

—— INFLOW TEMPERATURE

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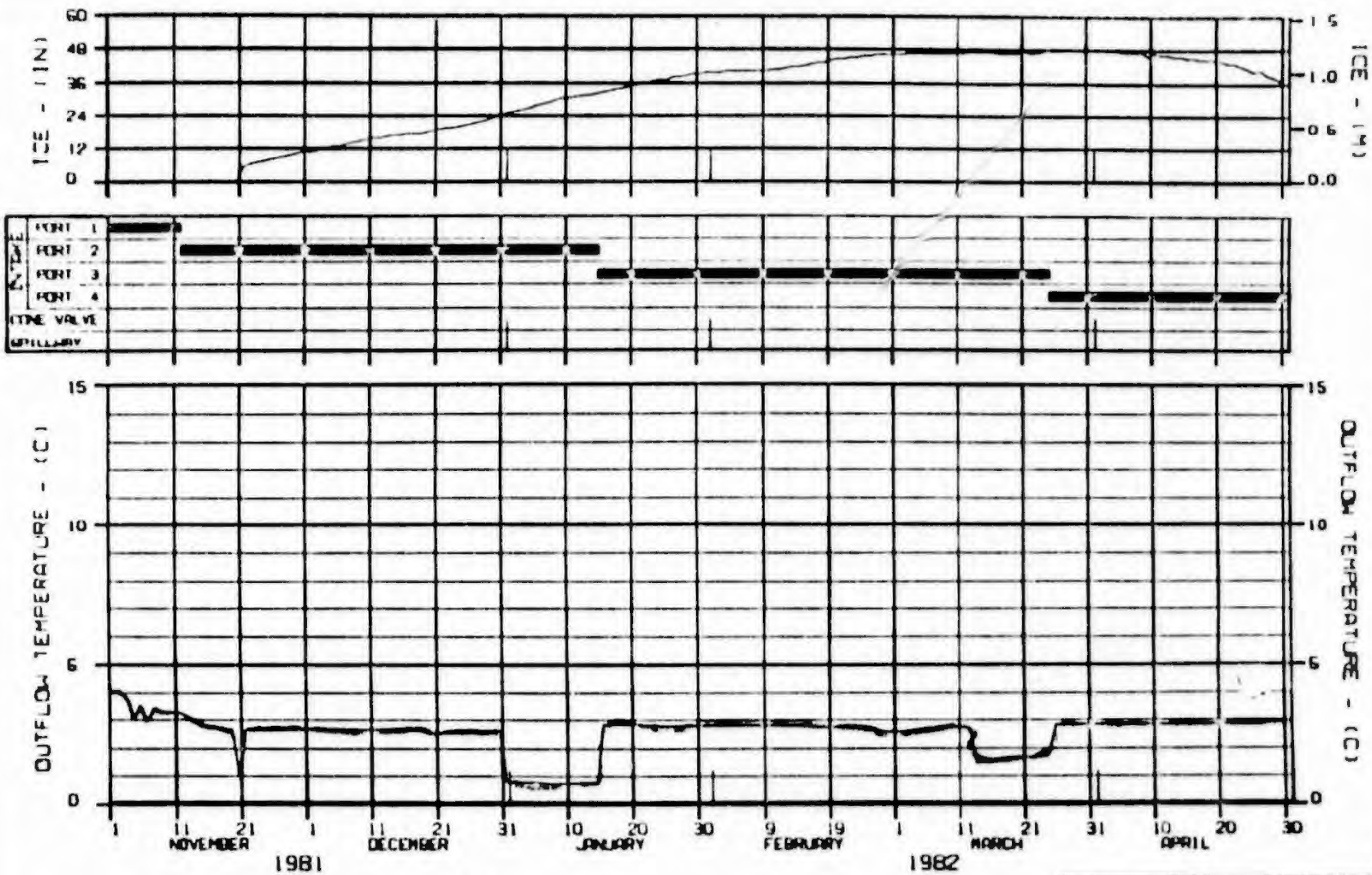
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

OPTION?



LEGEND: CASE: ▪▪▪▪▪ WA8196E ▪▪▪▪▪

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
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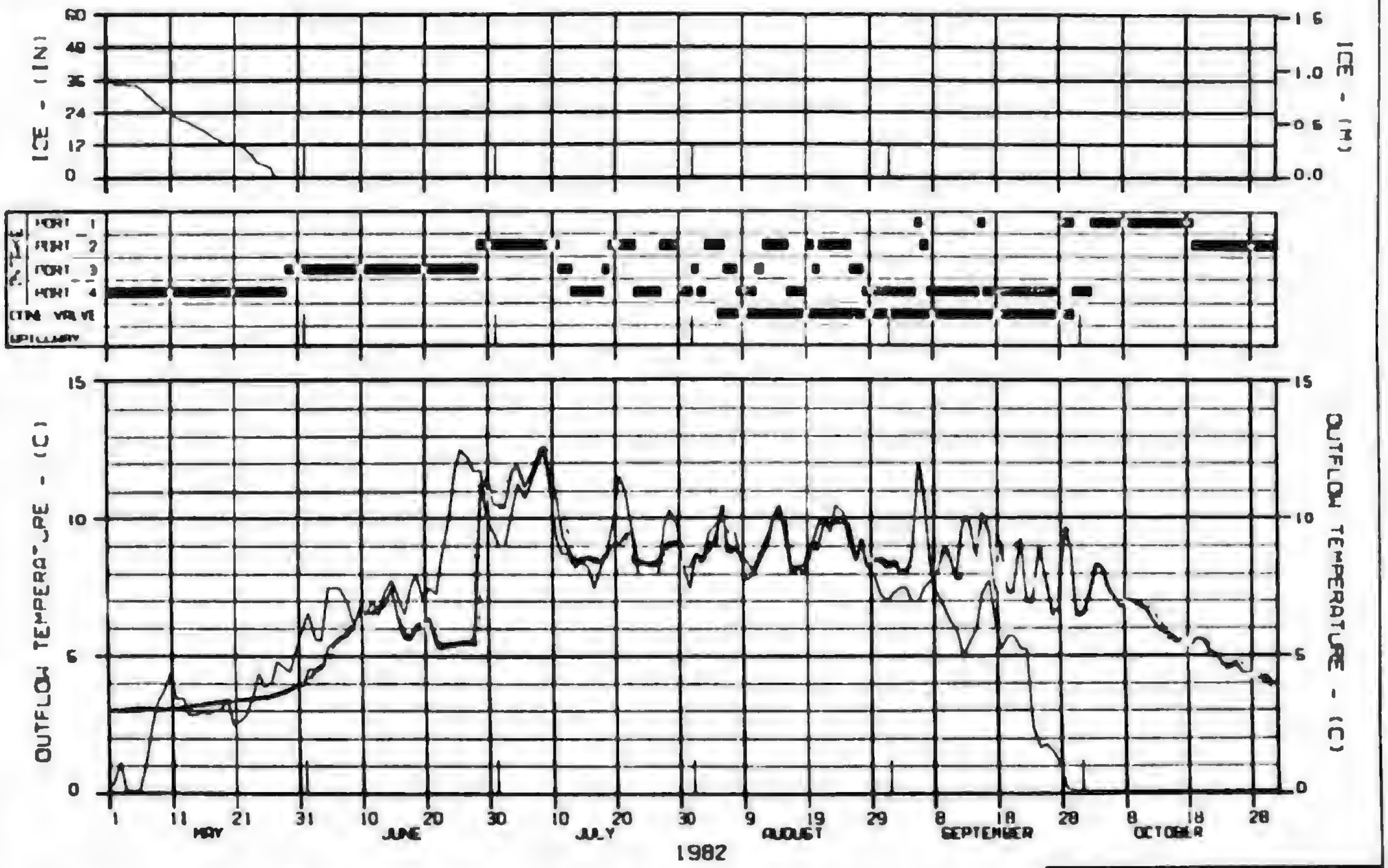
OPTION?

ALASKA POWER AUTHORITY		
SUSITNA PROJECT	DYRESM MODEL	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH		
HARZA-EBASCO JOINT VENTURE		
CHICAGO, ILLINOIS	[illegible]	[illegible]



LEGEND: CASE: WA0196E

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (665.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
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OPTION?

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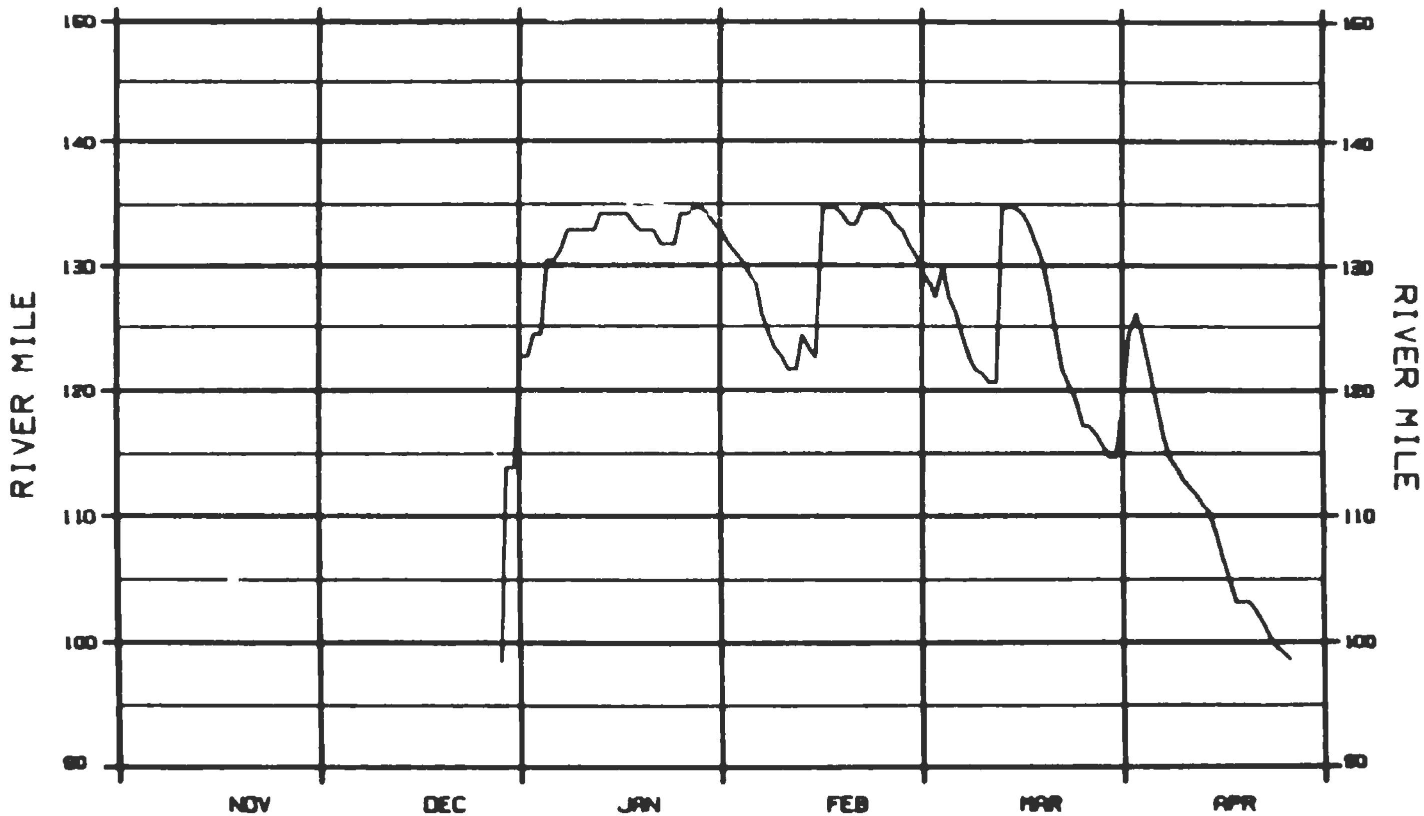
SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



WEATHER PERIOD : 1 NOV 81 - 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8198E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
PROGRESSION OF
ICE FRONT

HARZA-EBASCO JOINT VENTURE

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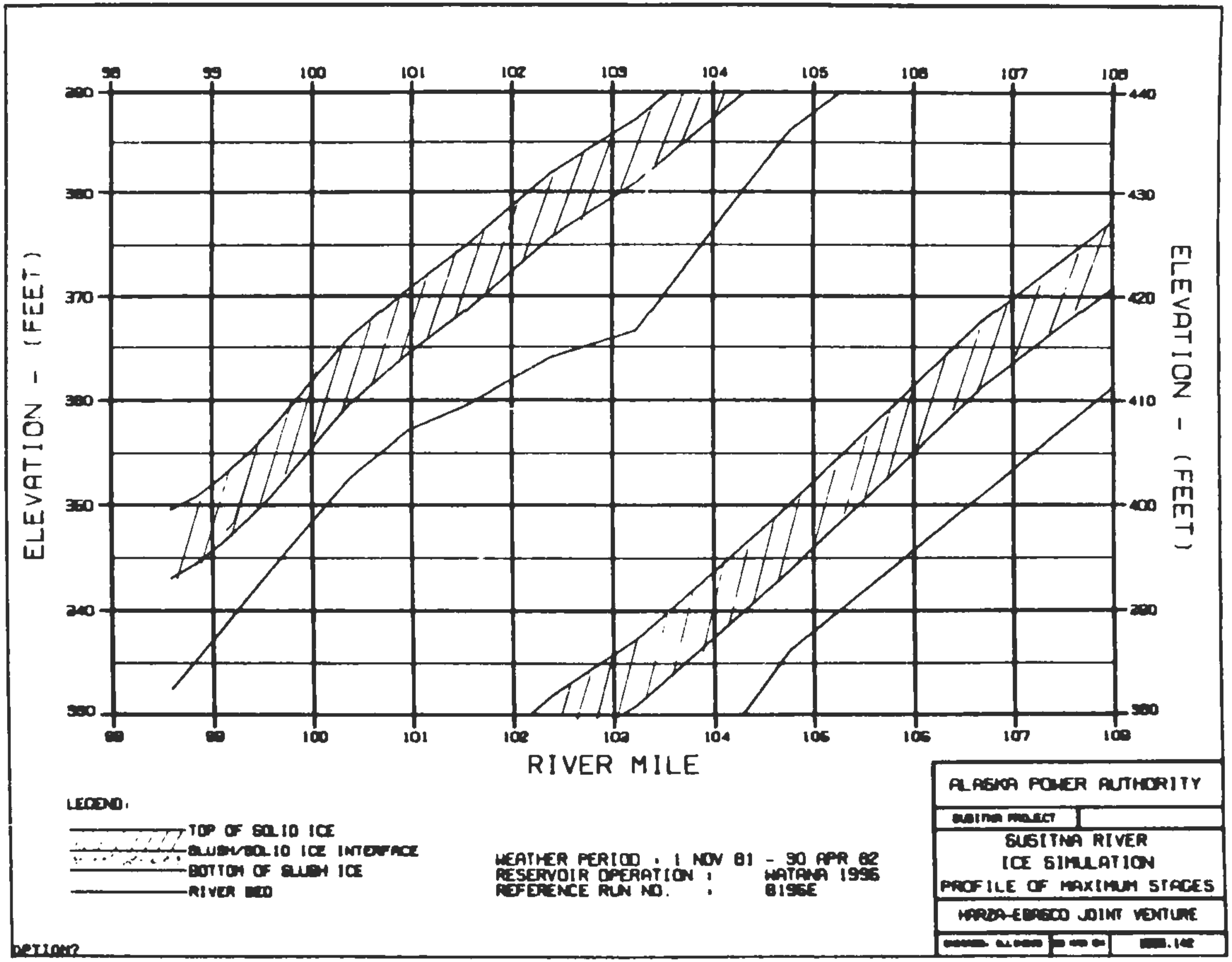

ELEVATION - (FEET)
RIVER MILE
ELEVATION - (FEET)
LEGEND:
TOP OF SOLID ICE
SLUSH/SOLID ICE INTERFACE
BOTTOM OF SLUSH ICE
RIVER BED
WEATHER PERIOD : 1 NOV 81 - 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
ICE SIMULATION
PROFILE OF MAXIMUM STAGES
HARZA-EBASCO JOINT VENTURE

OPTION?

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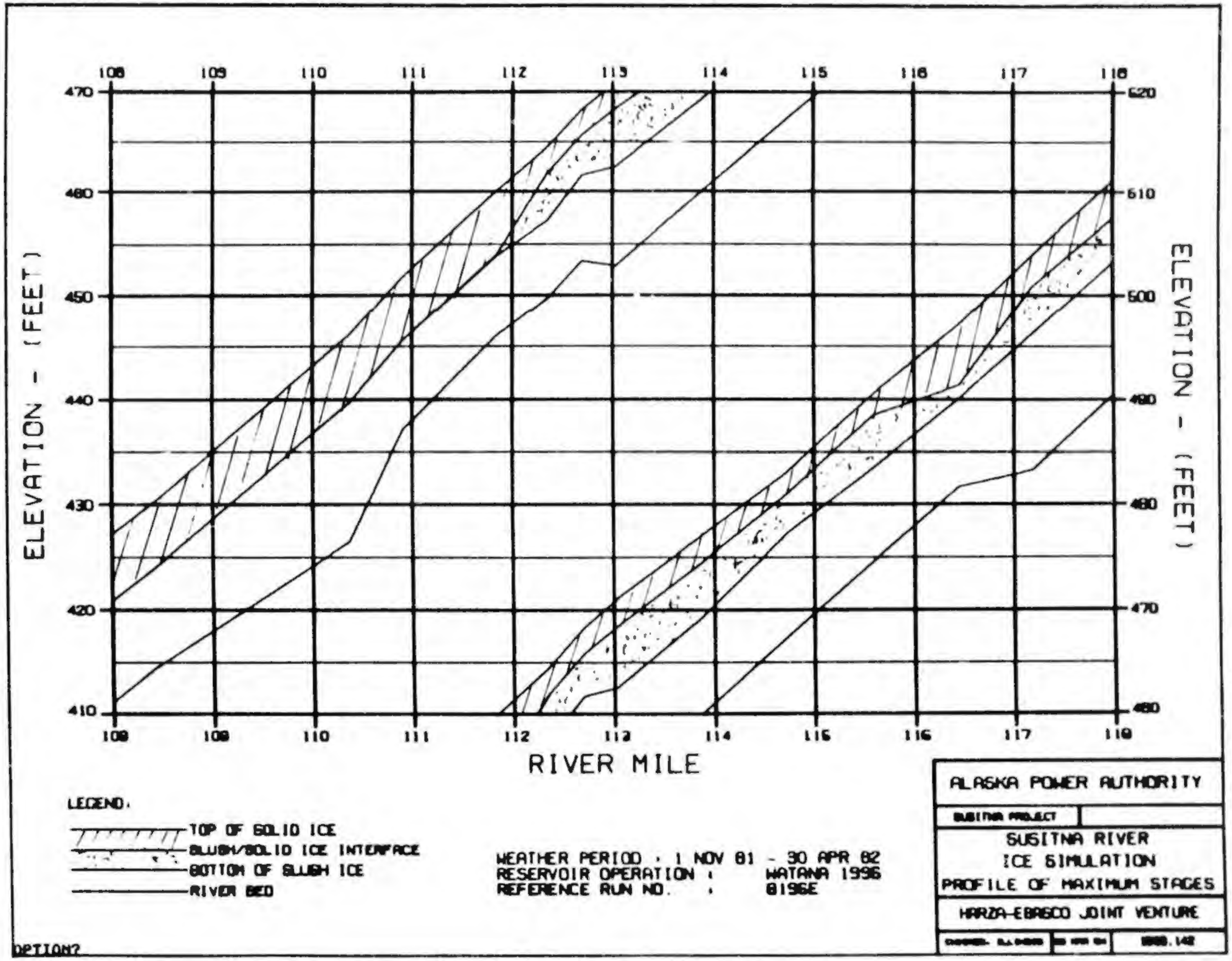

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ELEVATION - (FEET)
ELEVATION - (FEET)
RIVER MILE
LEGEND:
TOP OF SOLID ICE
SLUSH/SOLID ICE INTERFACE
BOTTOM OF SLUSH ICE
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WEATHER PERIOD : 1 NOV 81 - 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E
ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
ICE SIMULATION
PROFILE OF MAXIMUM STAGES
HARZA-EBASCO JOINT VENTURE
OPTION?

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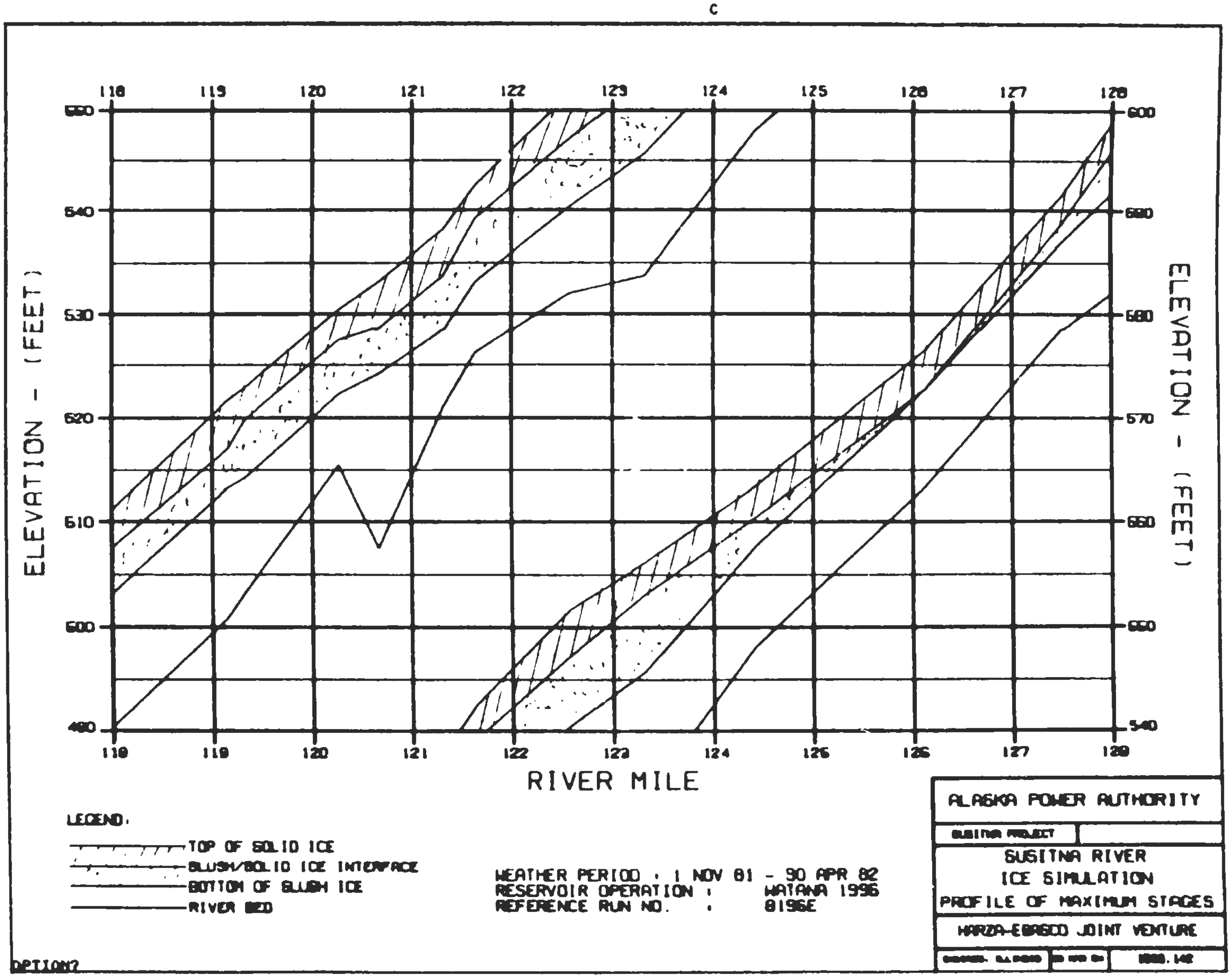
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ELEVATION - (FEET)
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RIVER MILE
LEGEND:
TOP OF SOLID ICE
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ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
ICE SIMULATION
PROFILE OF MAXIMUM STAGES
HARZA-EBASCO JOINT VENTURE
OPTION7

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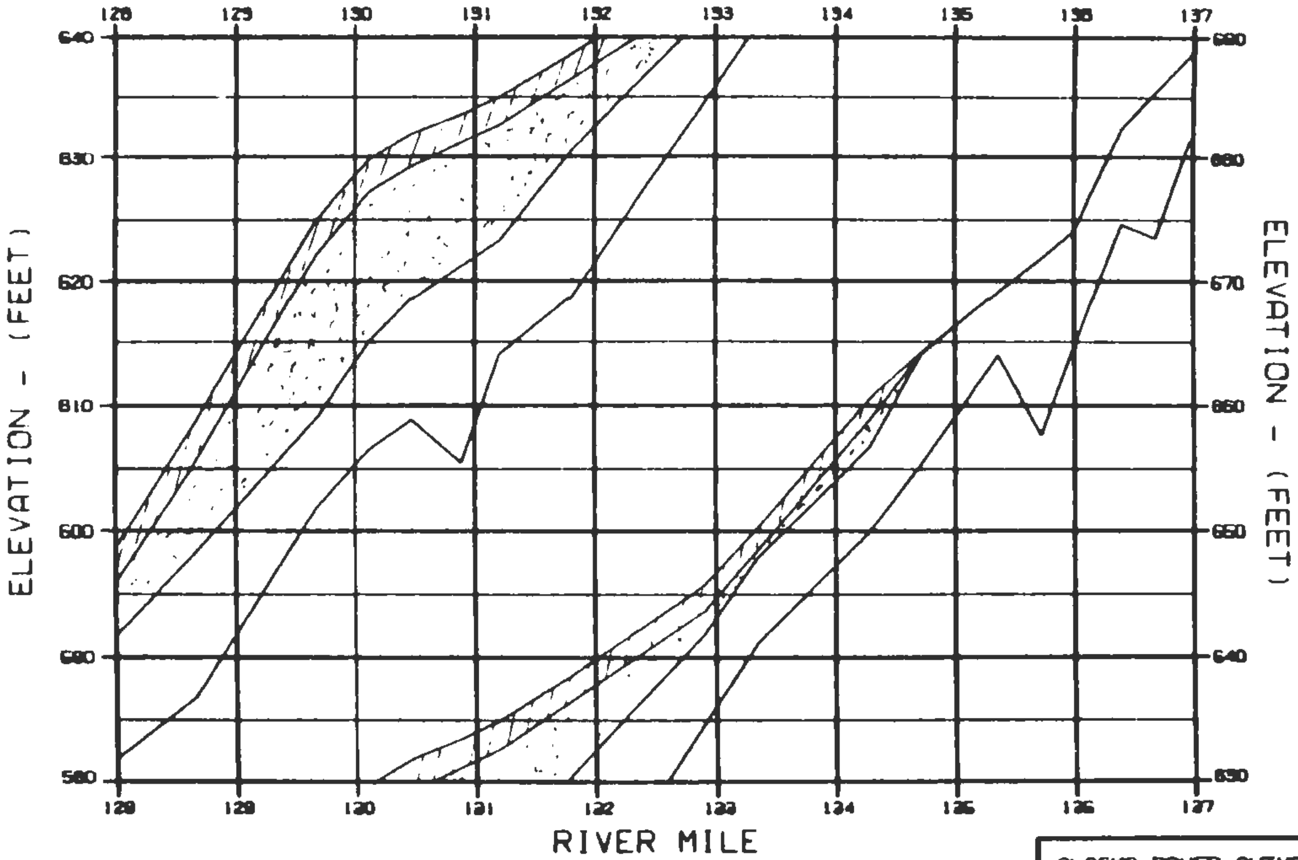


LEGEND:

- TOP OF SOLID ICE
- SLUSH/SOLID ICE INTERFACE
- BOTTOM OF SLUSH ICE
- RIVER BED

WEATHER PERIOD : 1 NOV 81 - 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

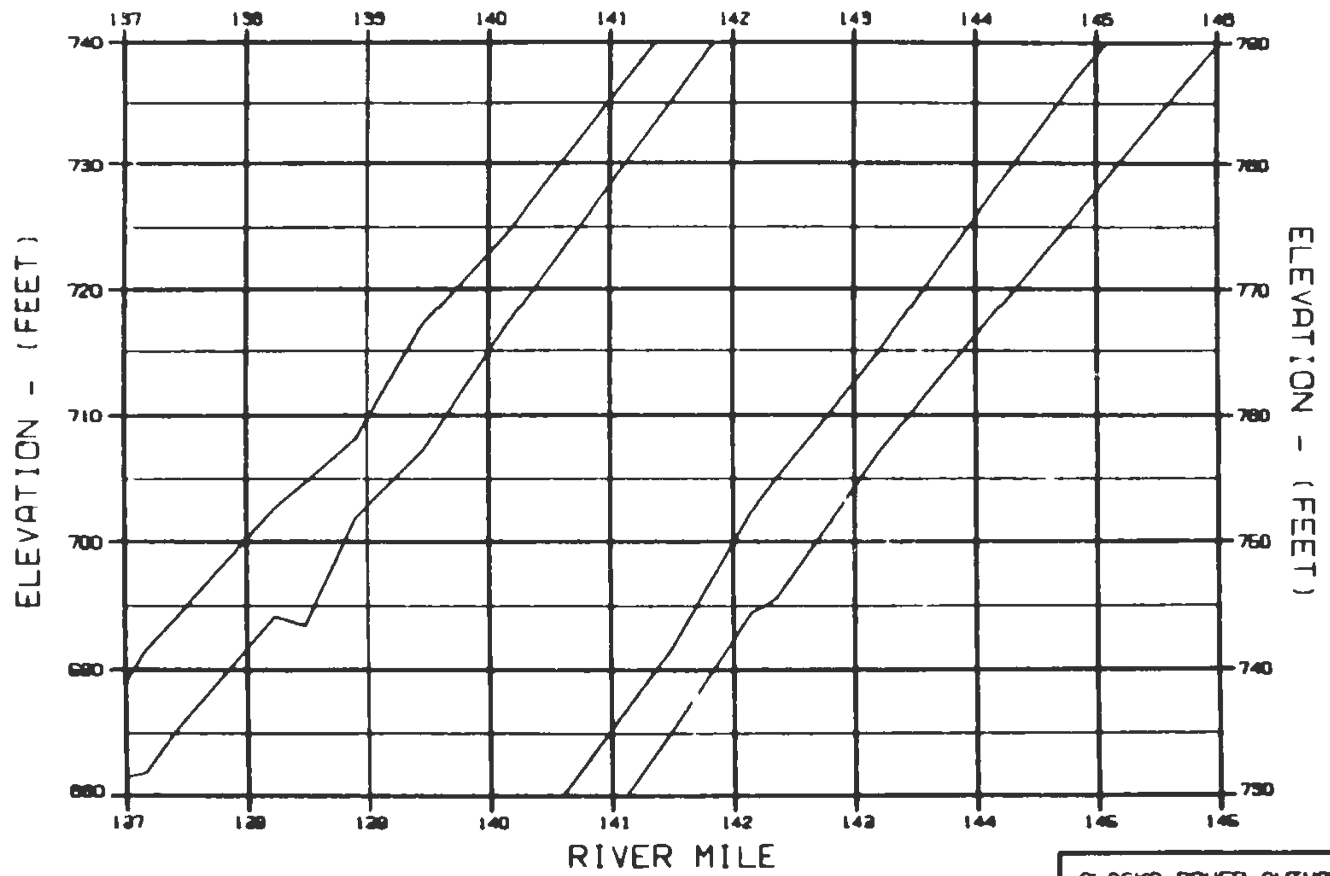
SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
PROFILE OF MAXIMUM STAGES

HARZA-EBASCO JOINT VENTURE

1988.142

OPTION?



LEGEND:

TOP OF SOLID ICE
SLUSH/SOLID ICE INTERFACE
BOTTOM OF SLUSH ICE
RIVER BED

WEATHER PERIOD : 1 NOV 81 - 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

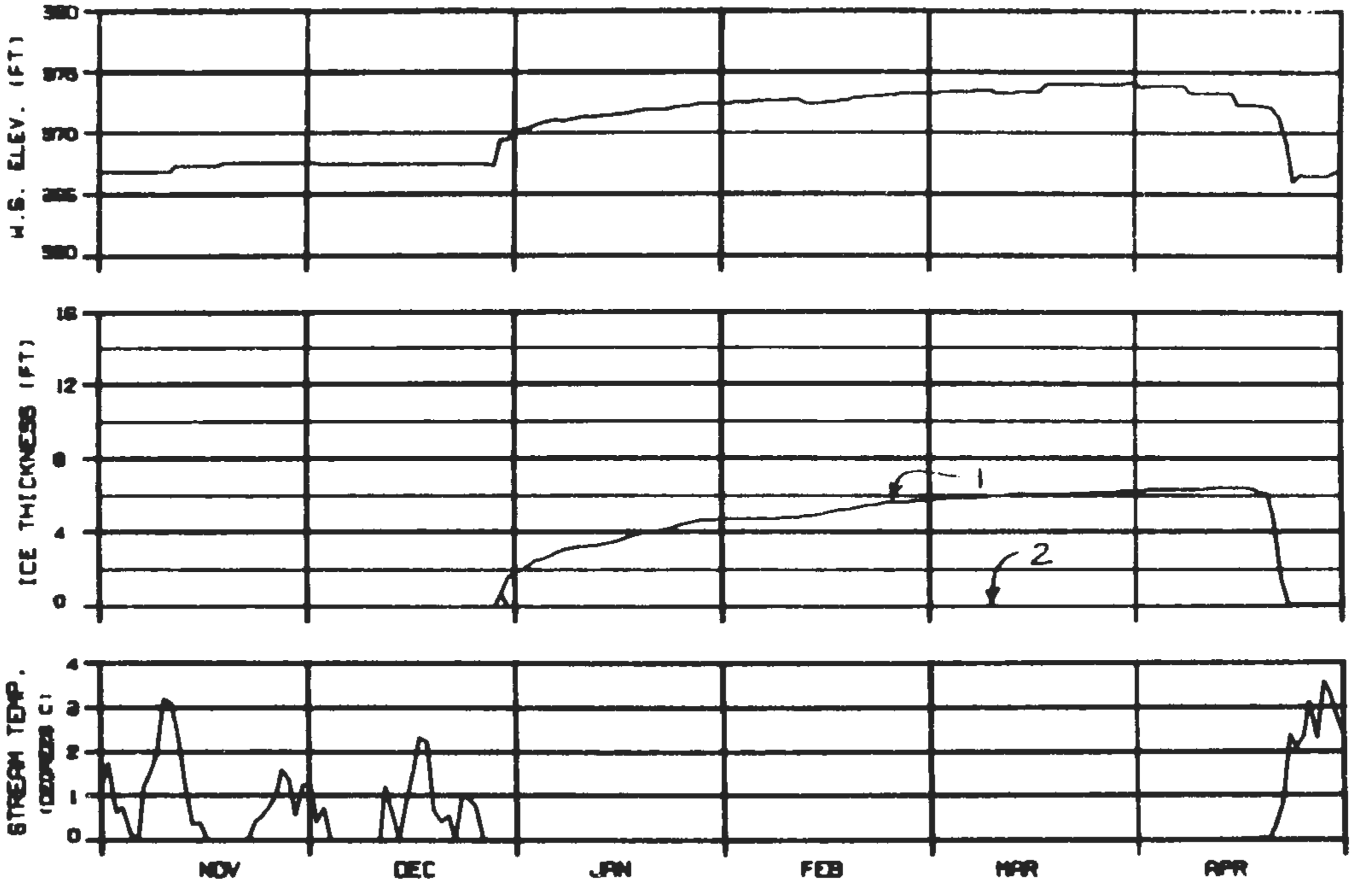
ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
PROFILE OF MAXIMUM STAGES

HARZA-EBASCO JOINT VENTURE

OPTION2



RIVER MILE : 101.50

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
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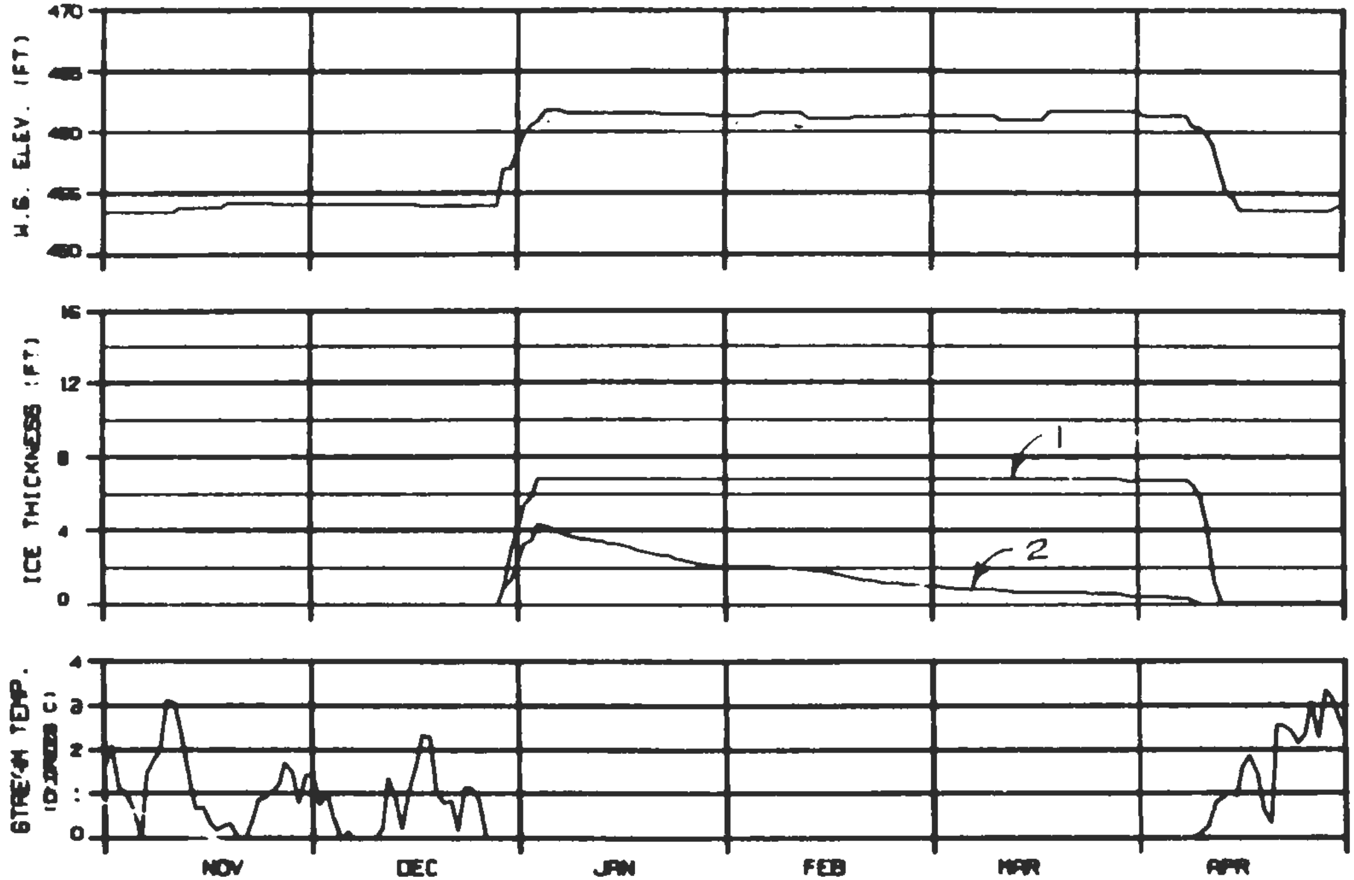
HARZA-EBASCO JOINT VENTURE



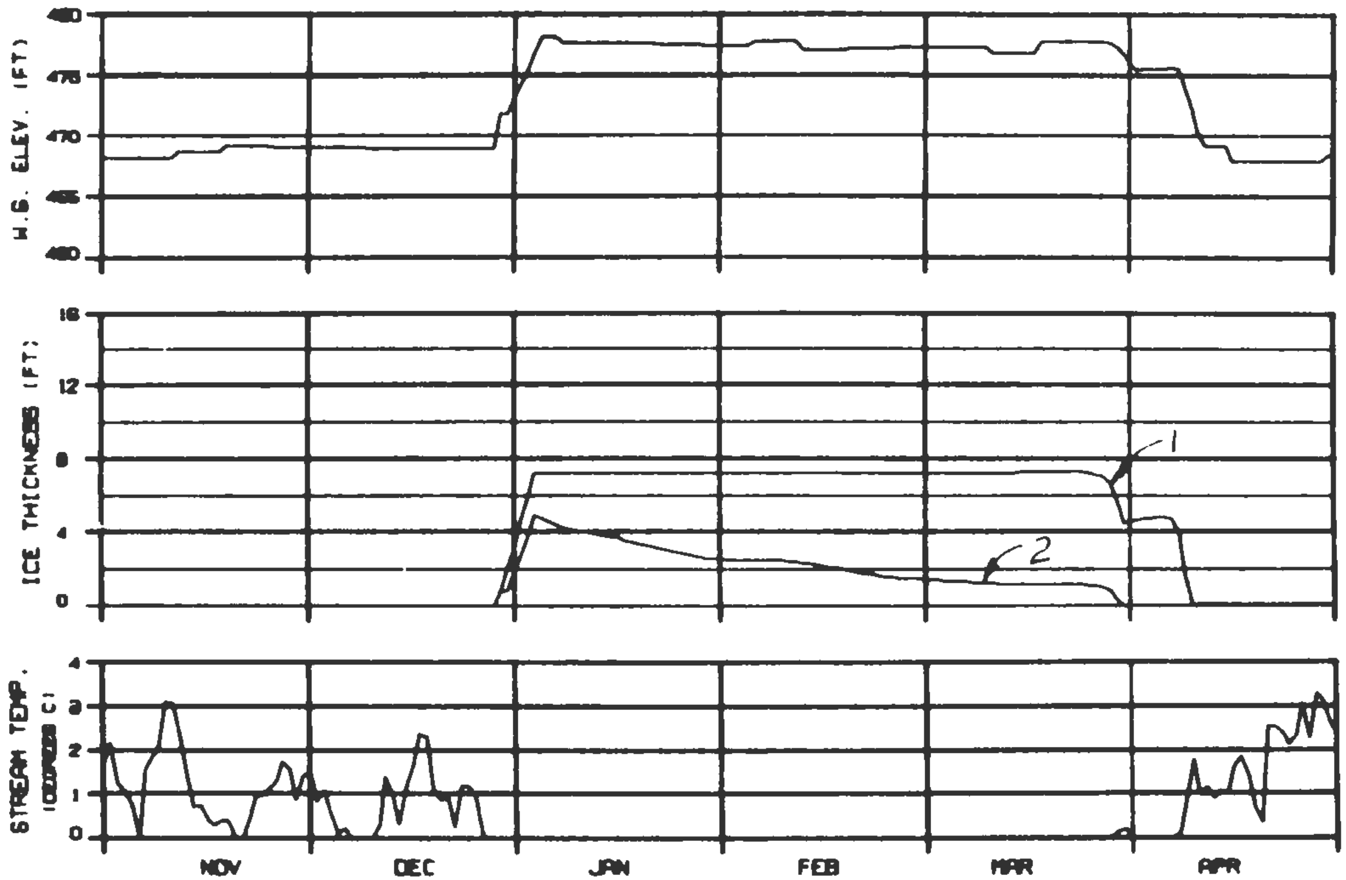
RIVER MILE : 112.10

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER ICE SIMULATION TIME HISTORY
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 114.10

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA RIVER
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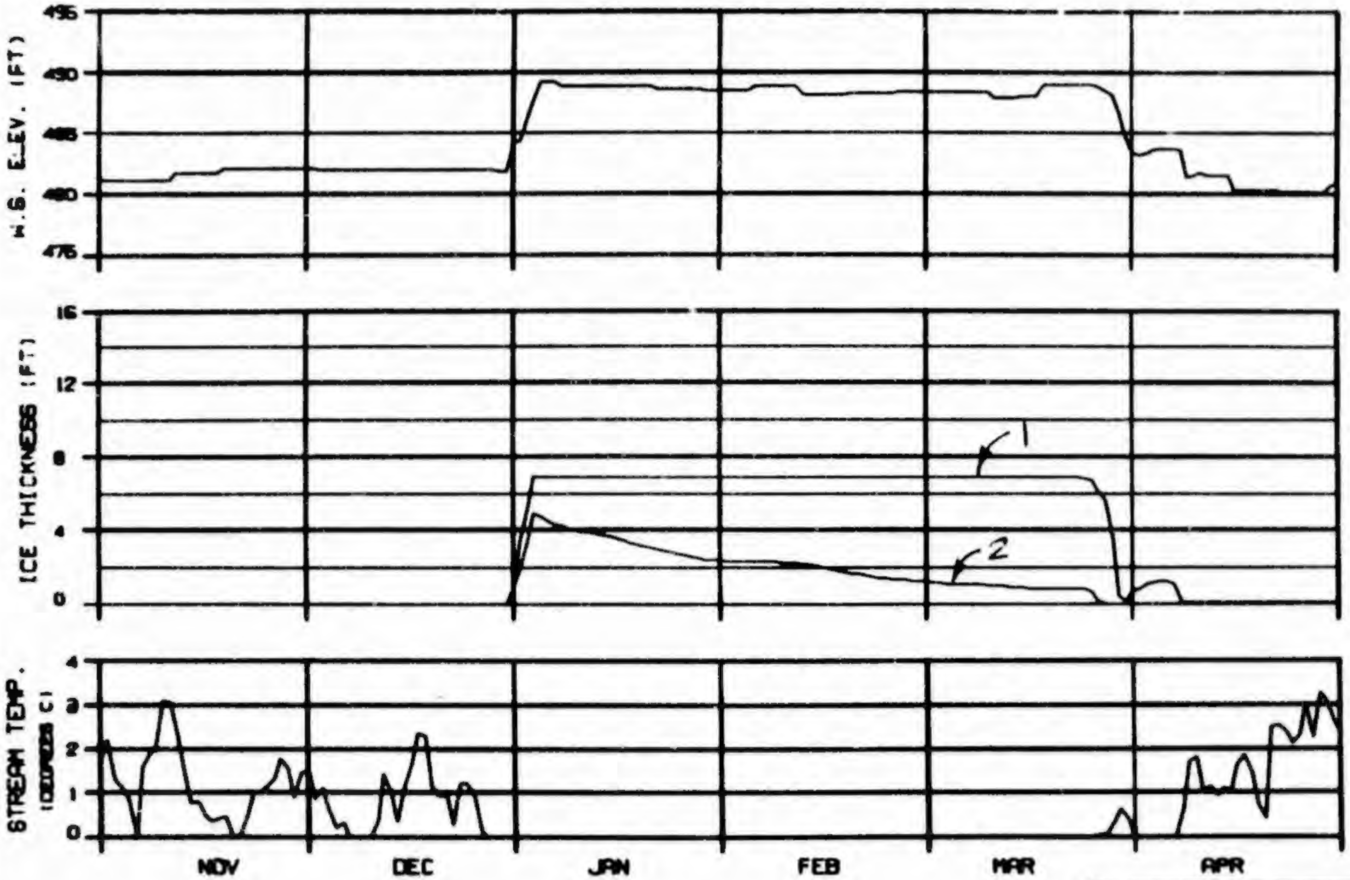
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



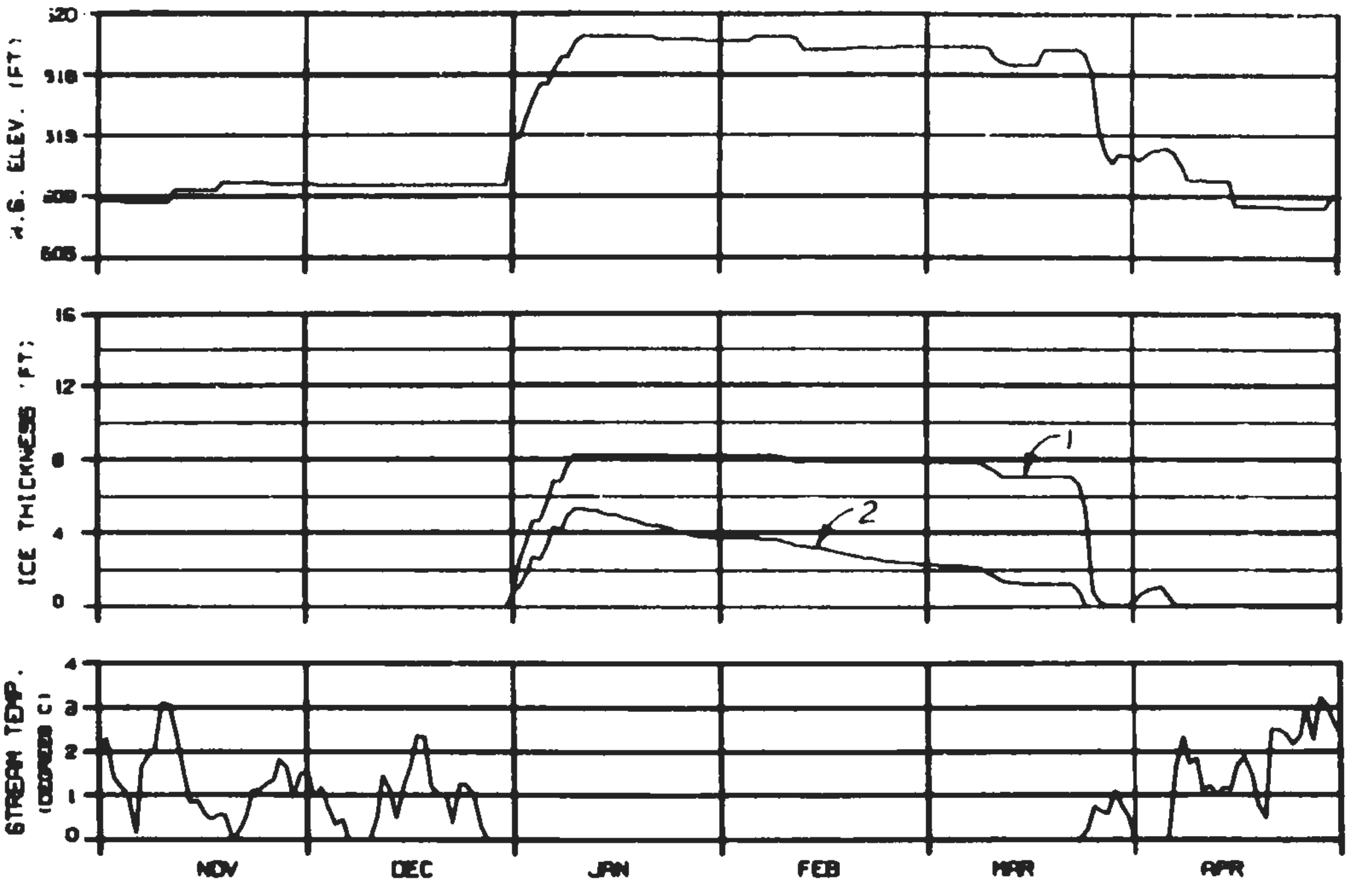
RIVER MILE : 115.50

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER ICE SIMULATION TIME HISTORY
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 118.90

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

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SUSITNA RIVER
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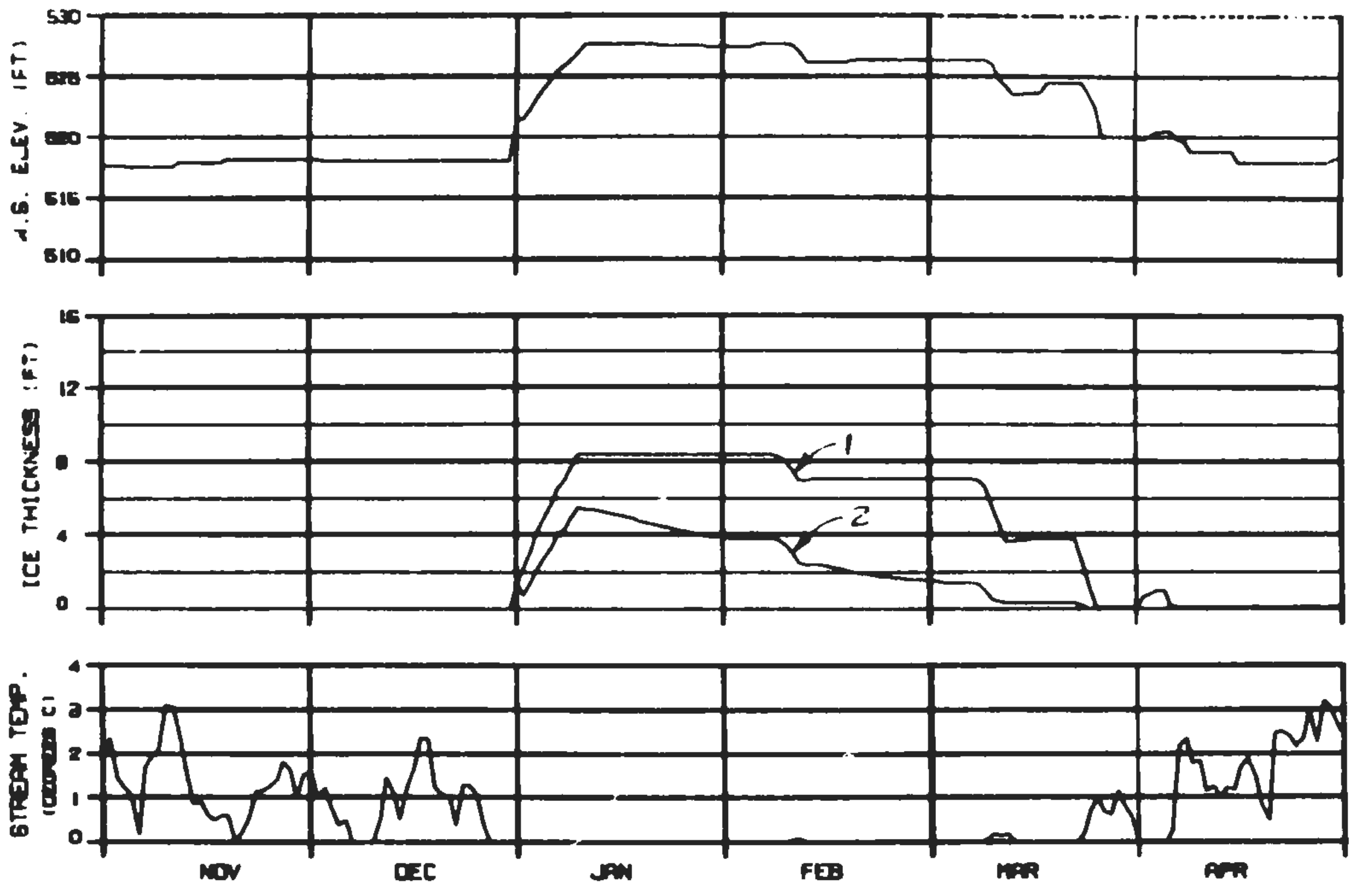
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 120.00

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA RIVER
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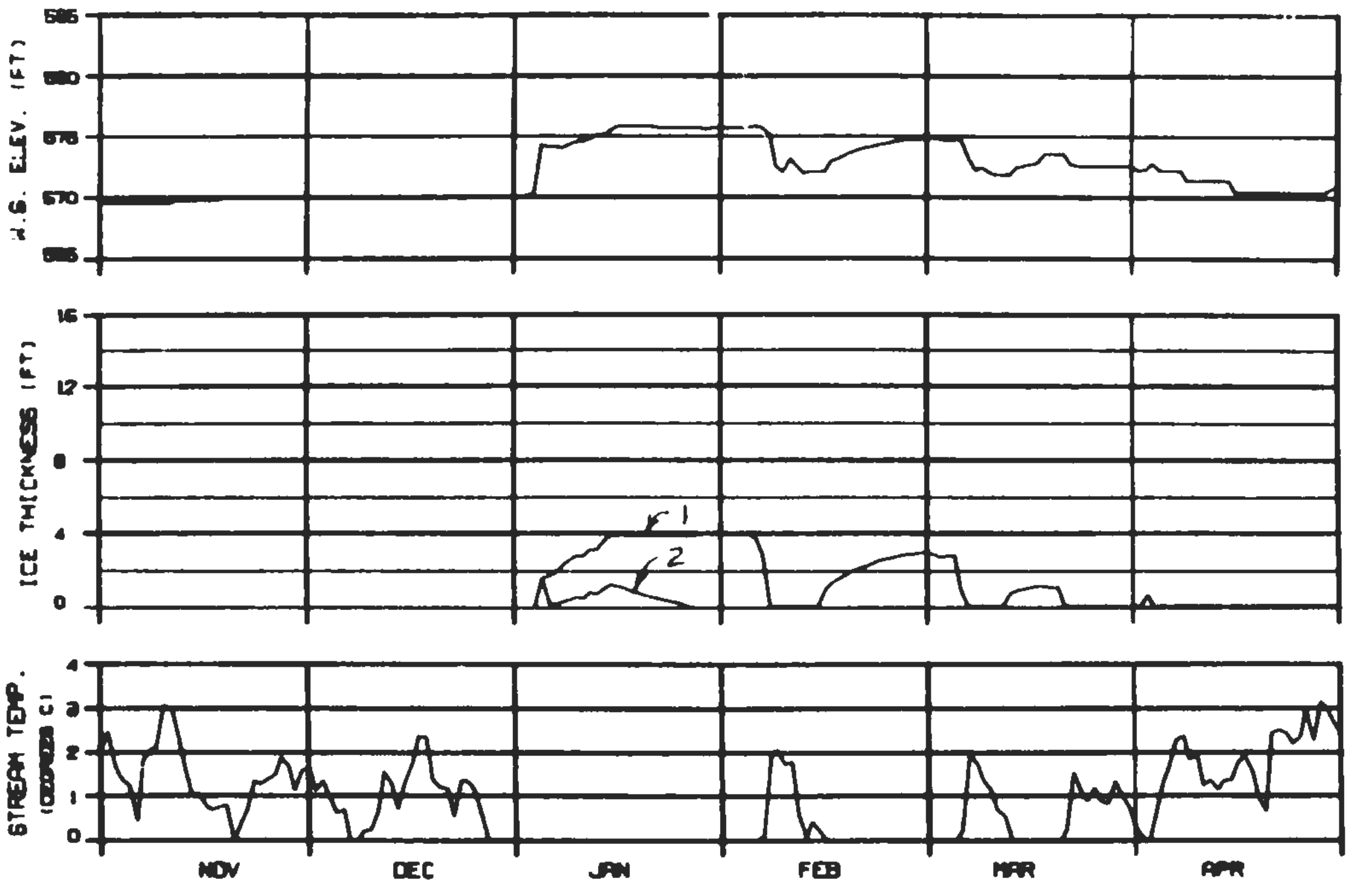
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



RIVER MILE : 126.10

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
REFERENCE RUN NO. : 8196E
RESERVOIR OPERATION : WATANA 1996

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
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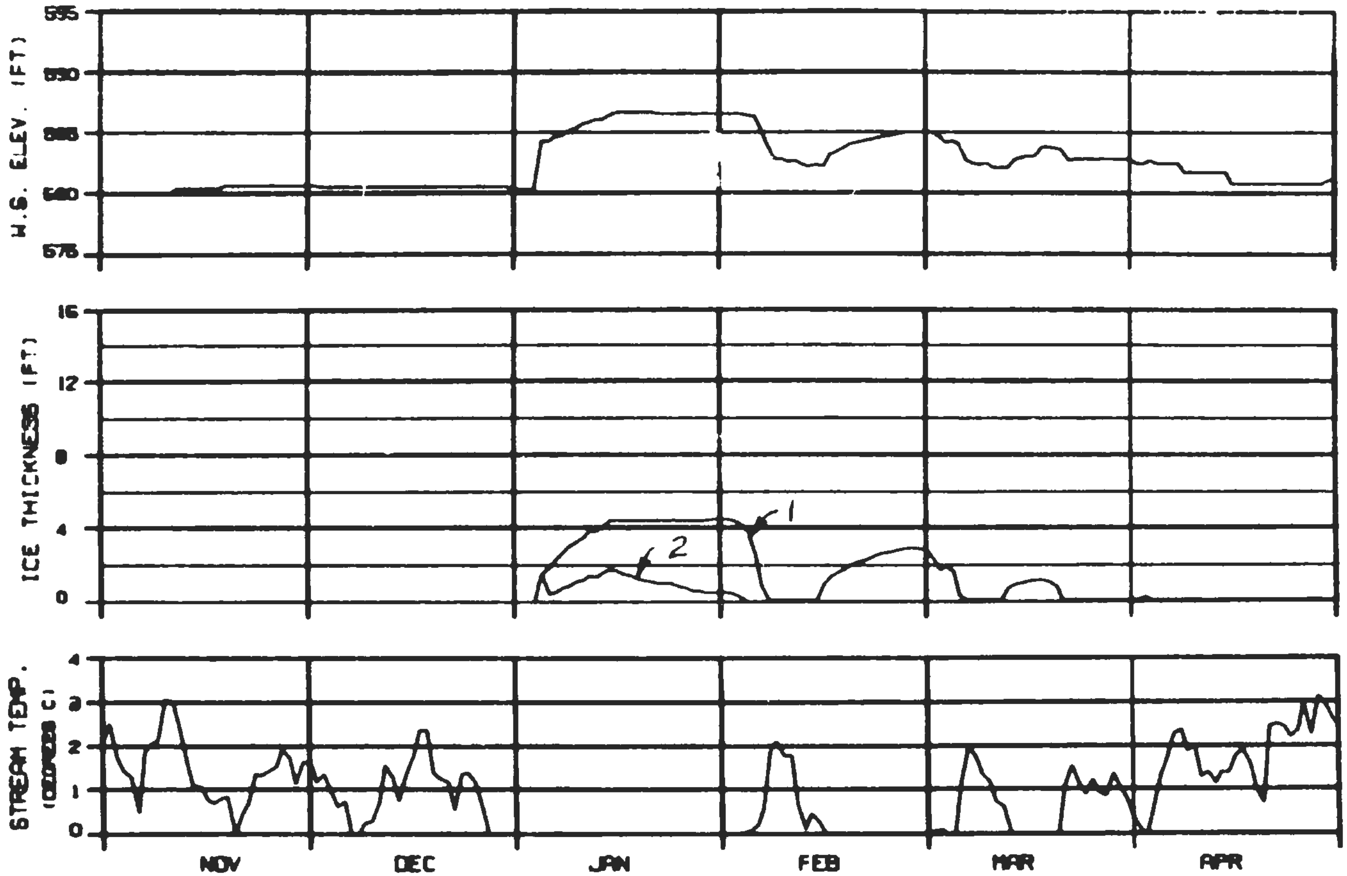
HARZA-EBASCO JOINT VENTURE



ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
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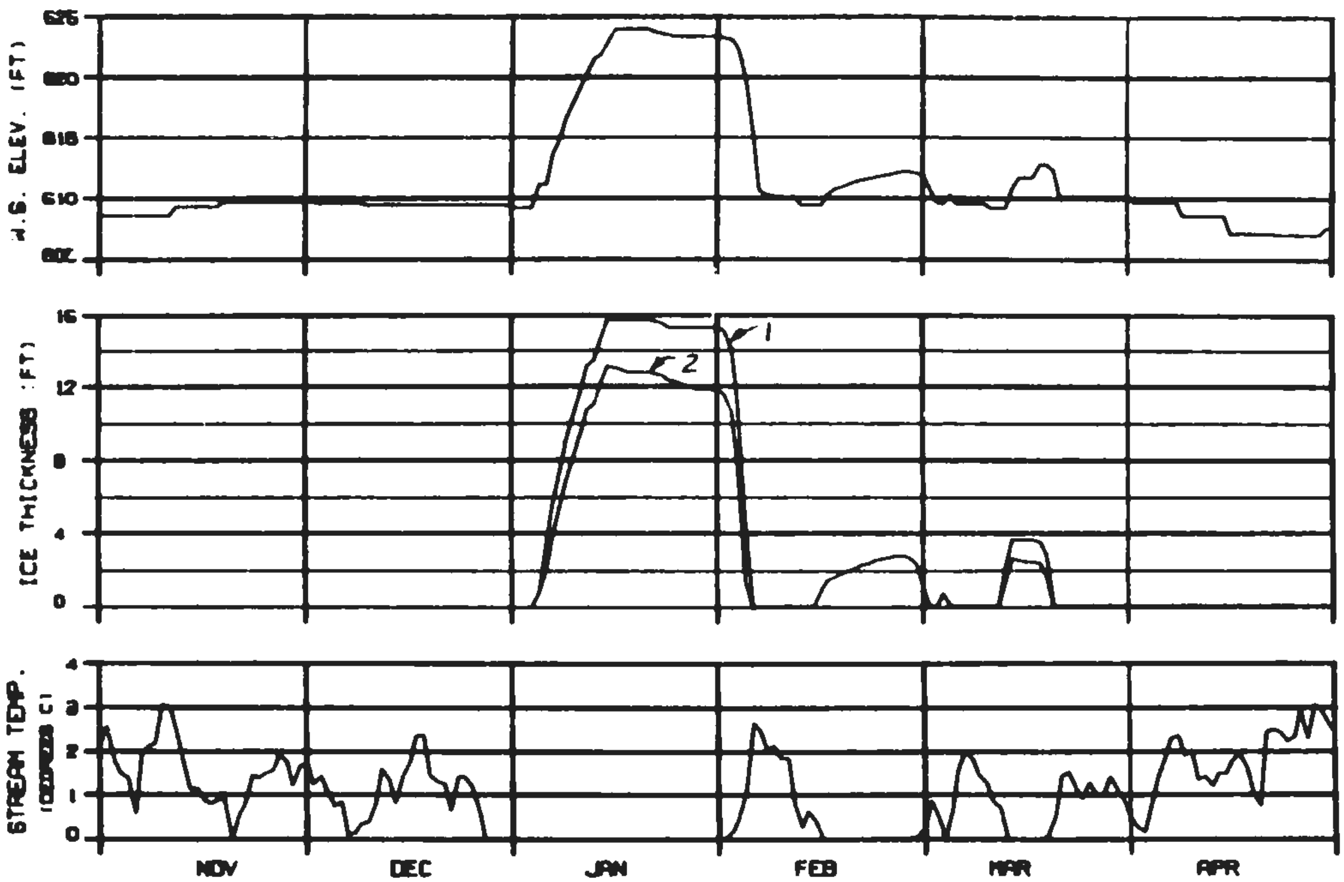
HARZA-EBASCO JOINT VENTURE

RIVER MILE : 127.10

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E



RIVER MILE : 129.70

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
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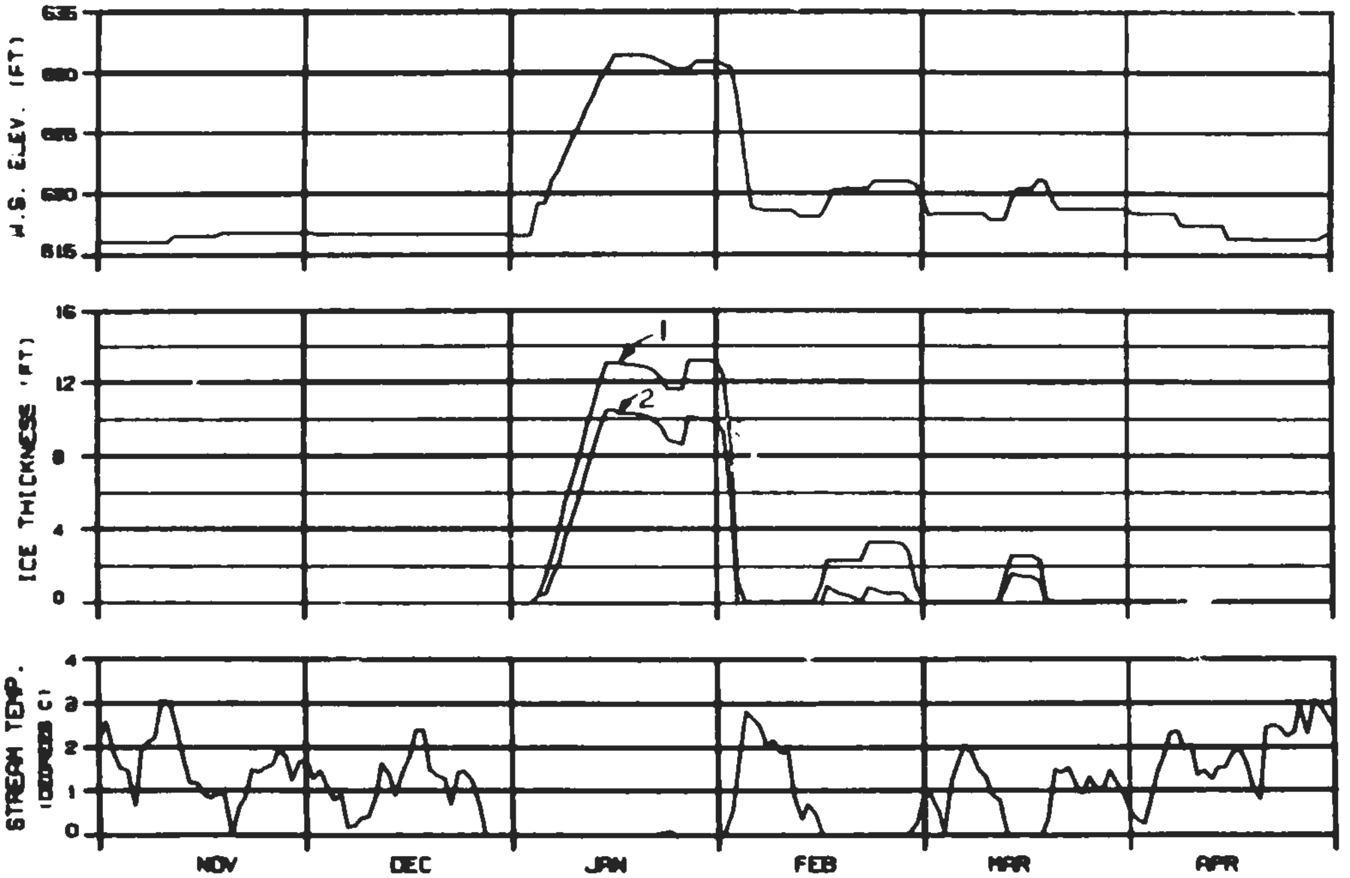
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 130.60

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
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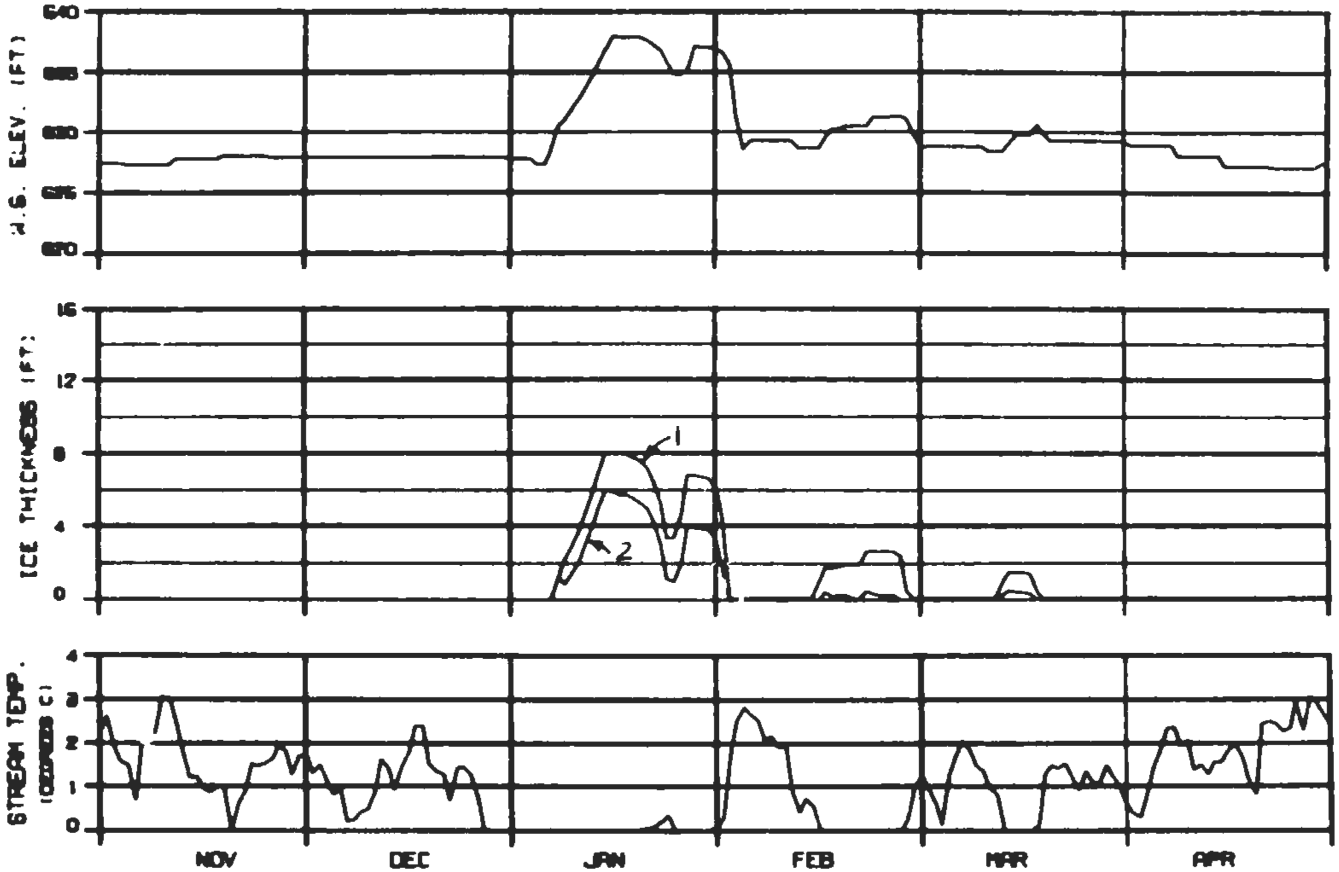
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 131.80

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

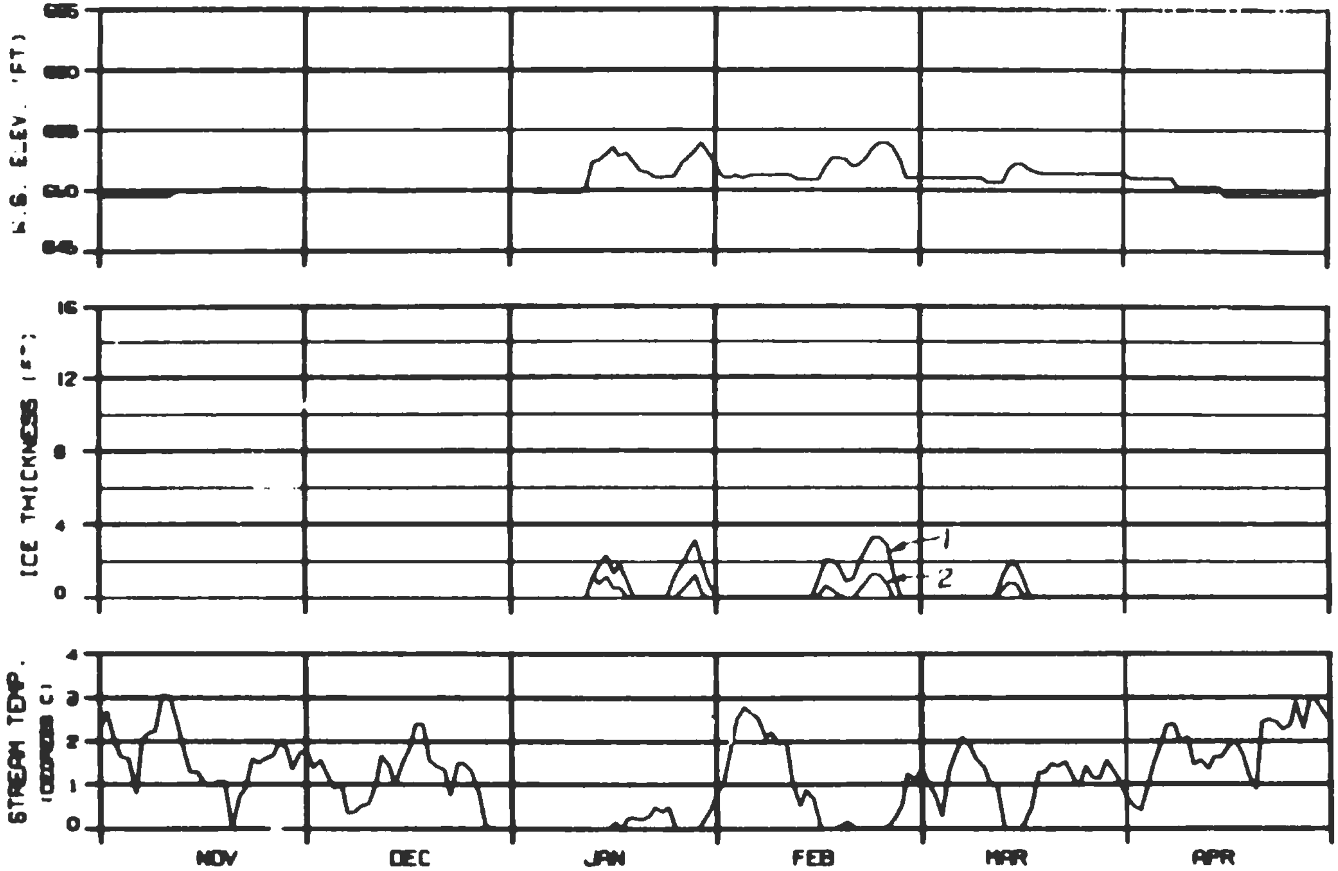
WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE

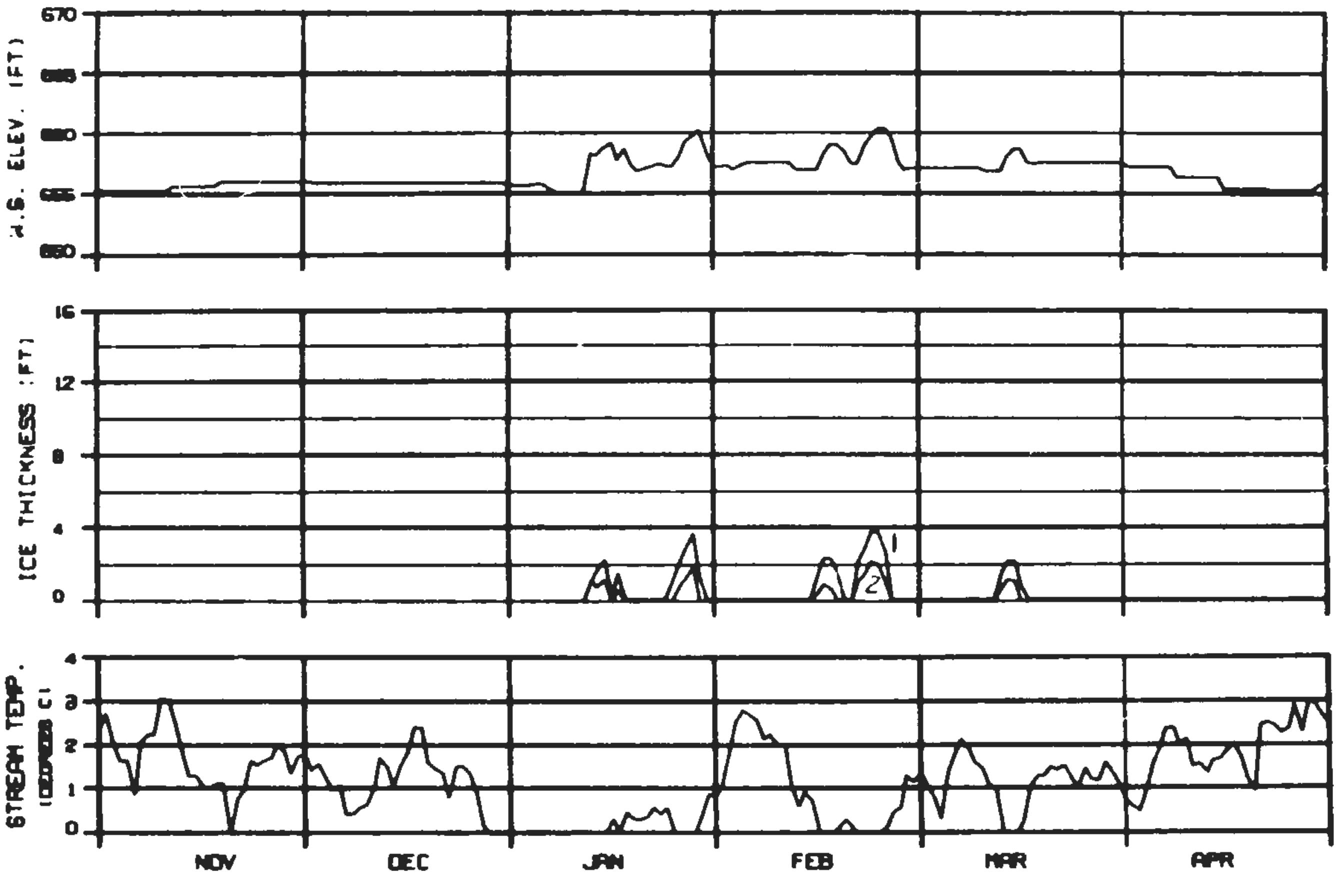


RIVER MILE : 133.70

ICE THICKNESS LEGEND:
1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY
SUSITNA PROJECT
SUSITNA RIVER
ICE SIMULATION
TIME HISTORY
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 134.30

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

ALASKA POWER AUTHORITY

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ICE SIMULATION
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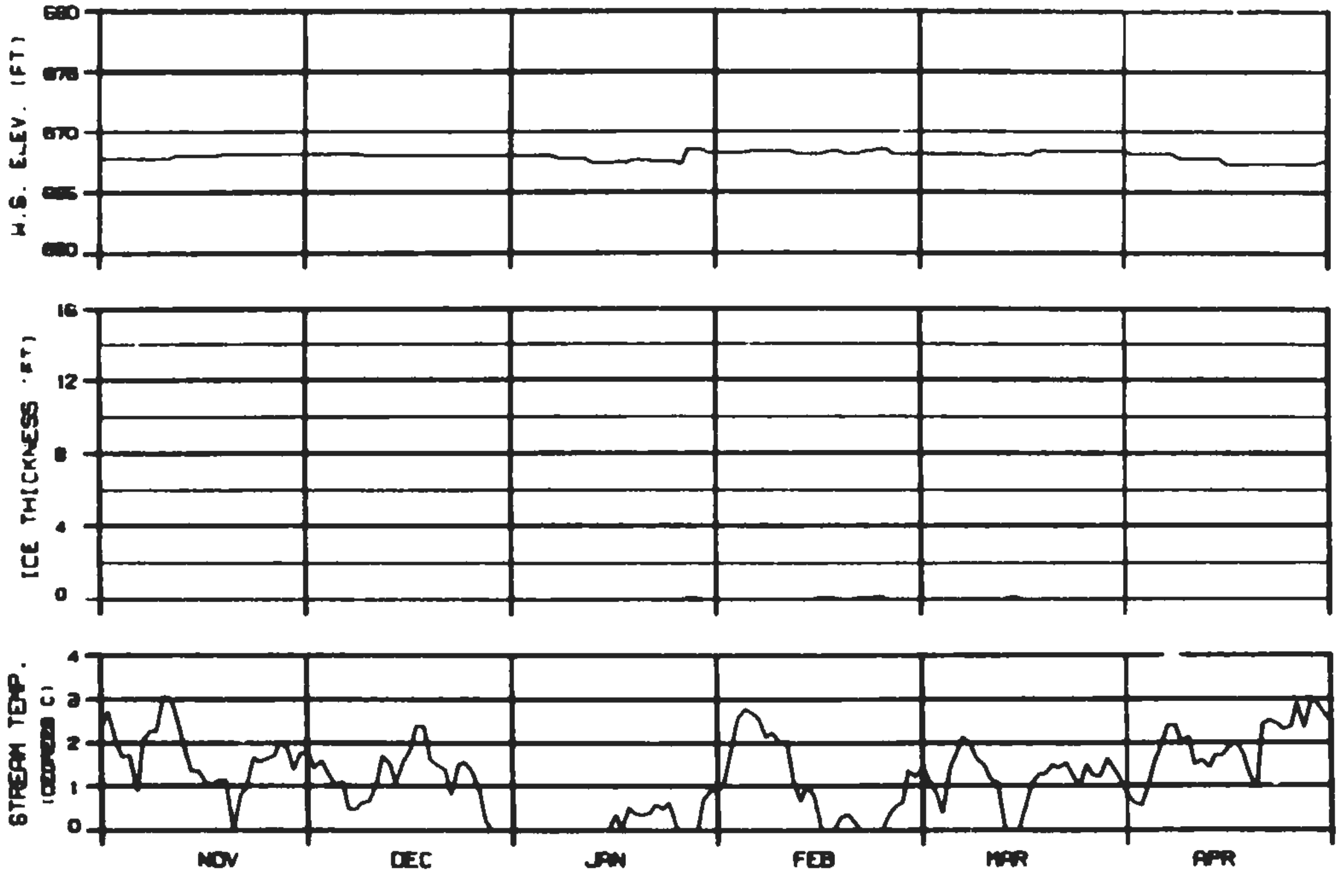
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 135.30

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

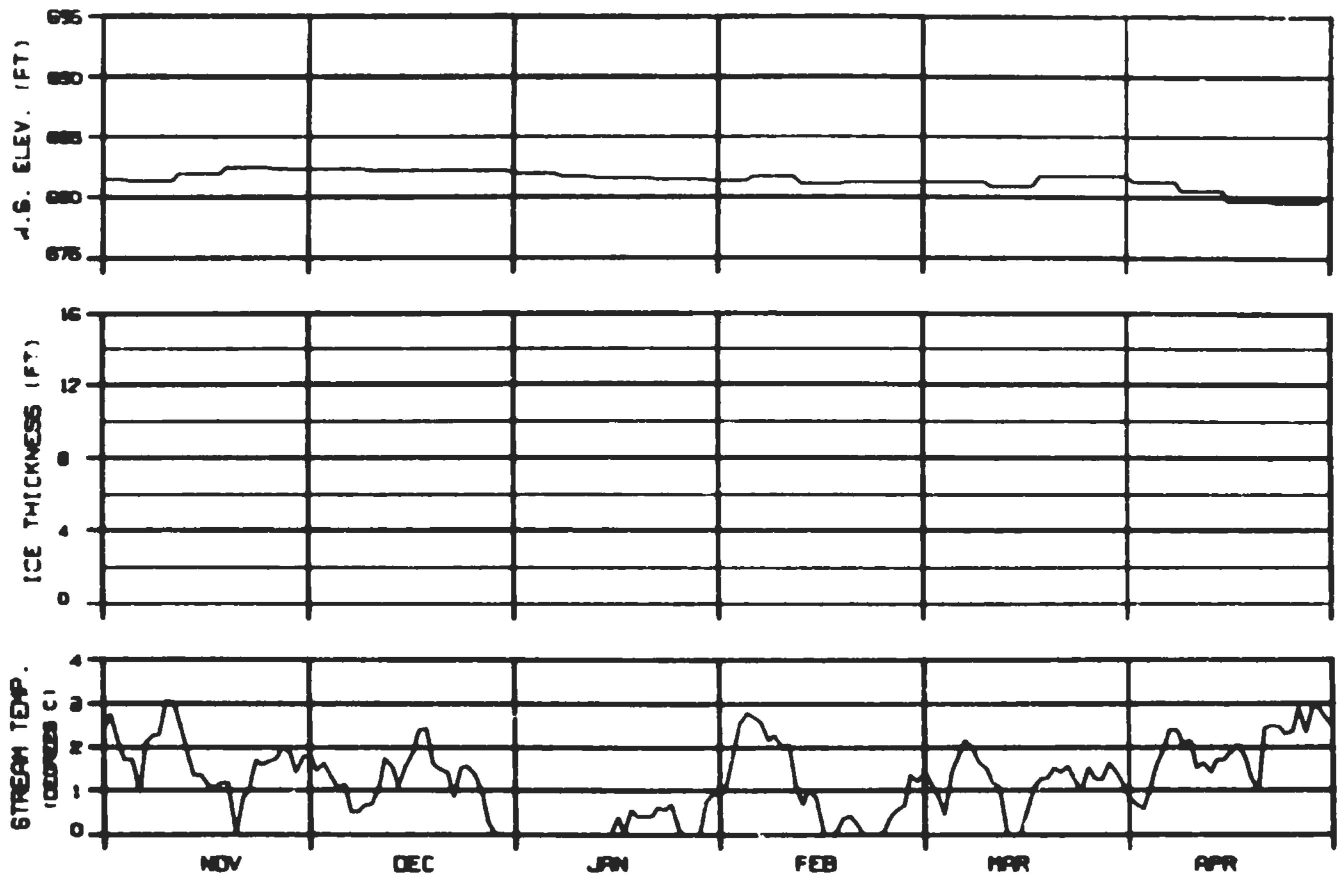
WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



RIVER MILE : 136.40

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

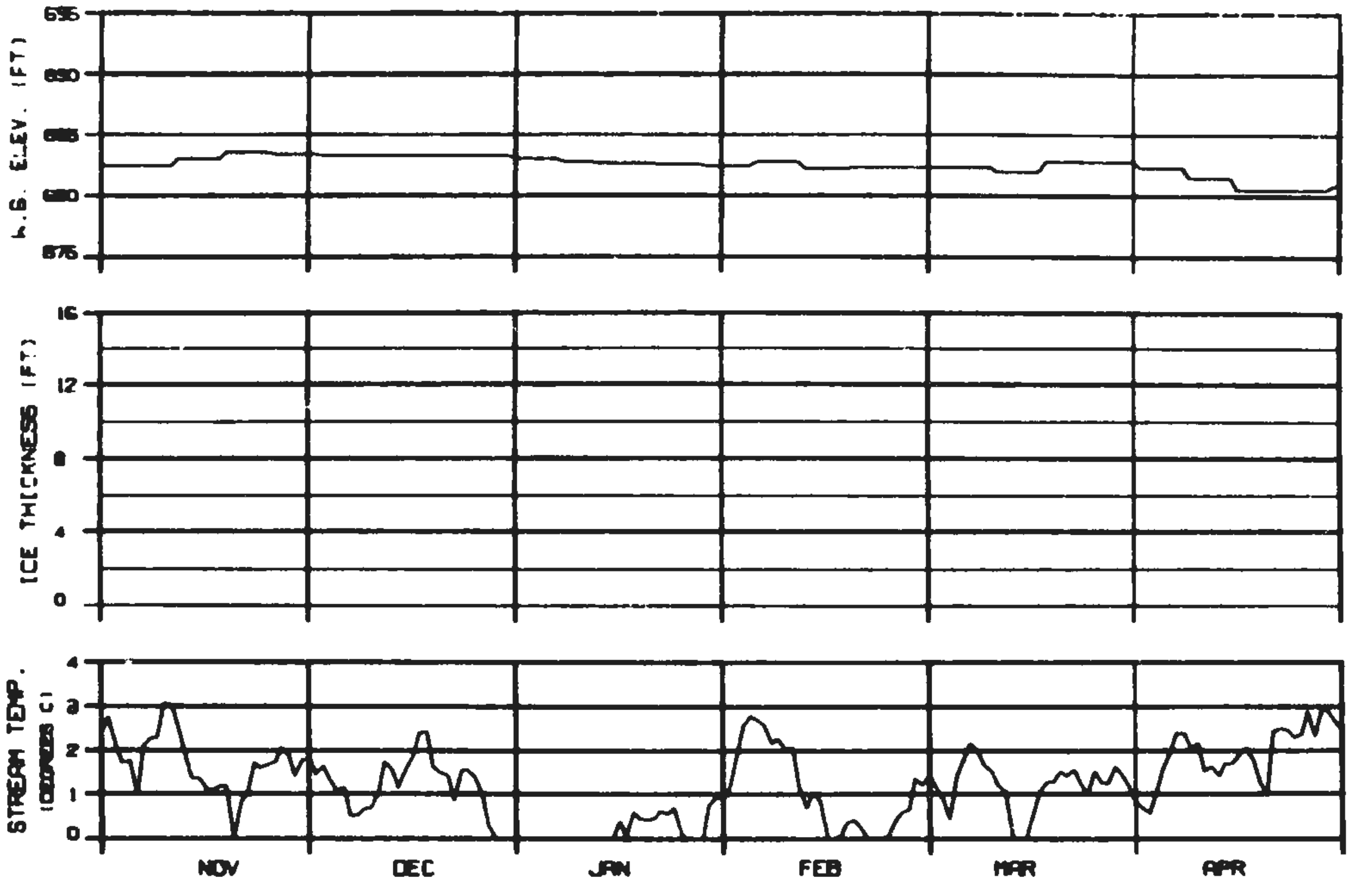
WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

RIVER MILE : 136.50

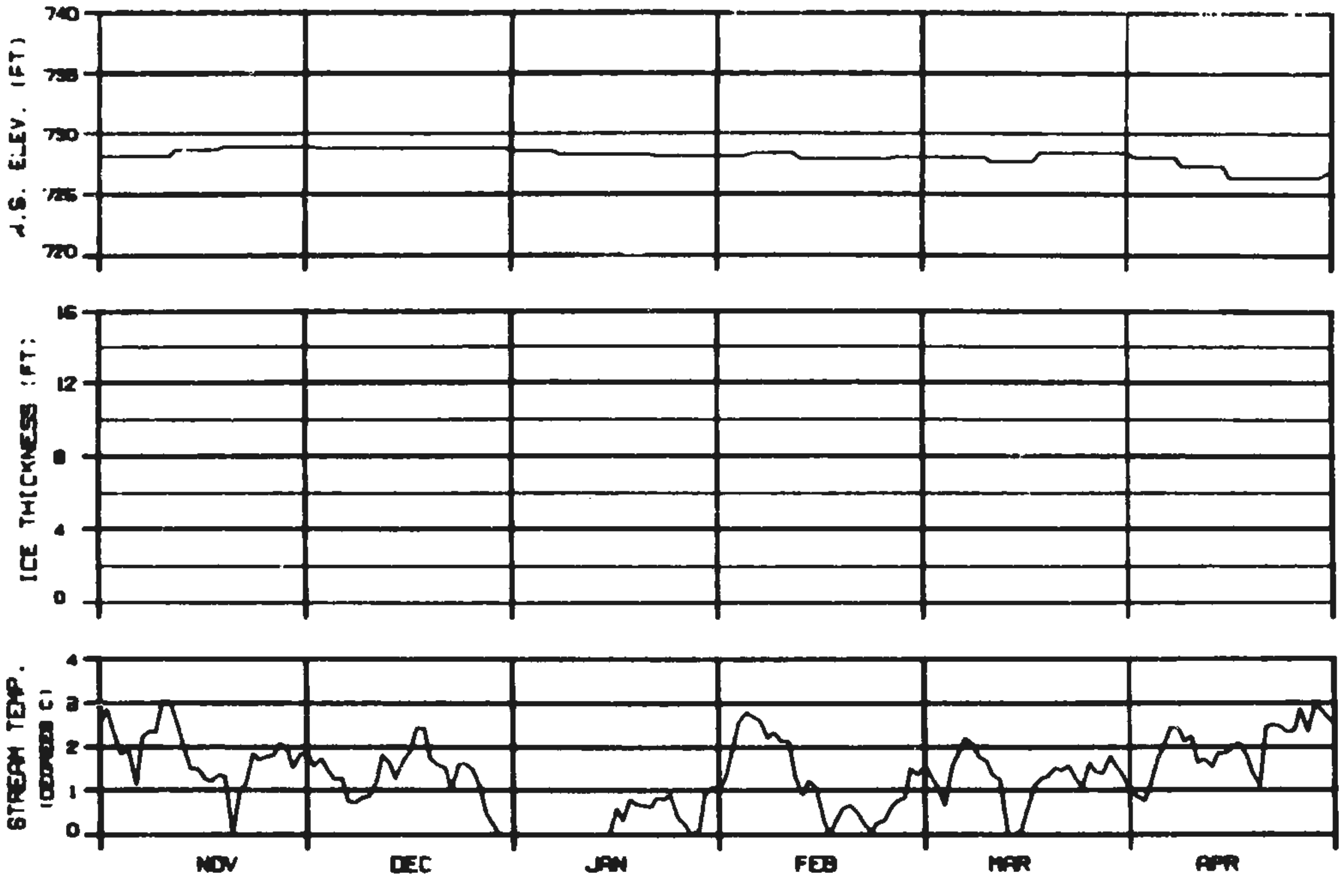
WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



RIVER MILE : 140.50

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

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SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
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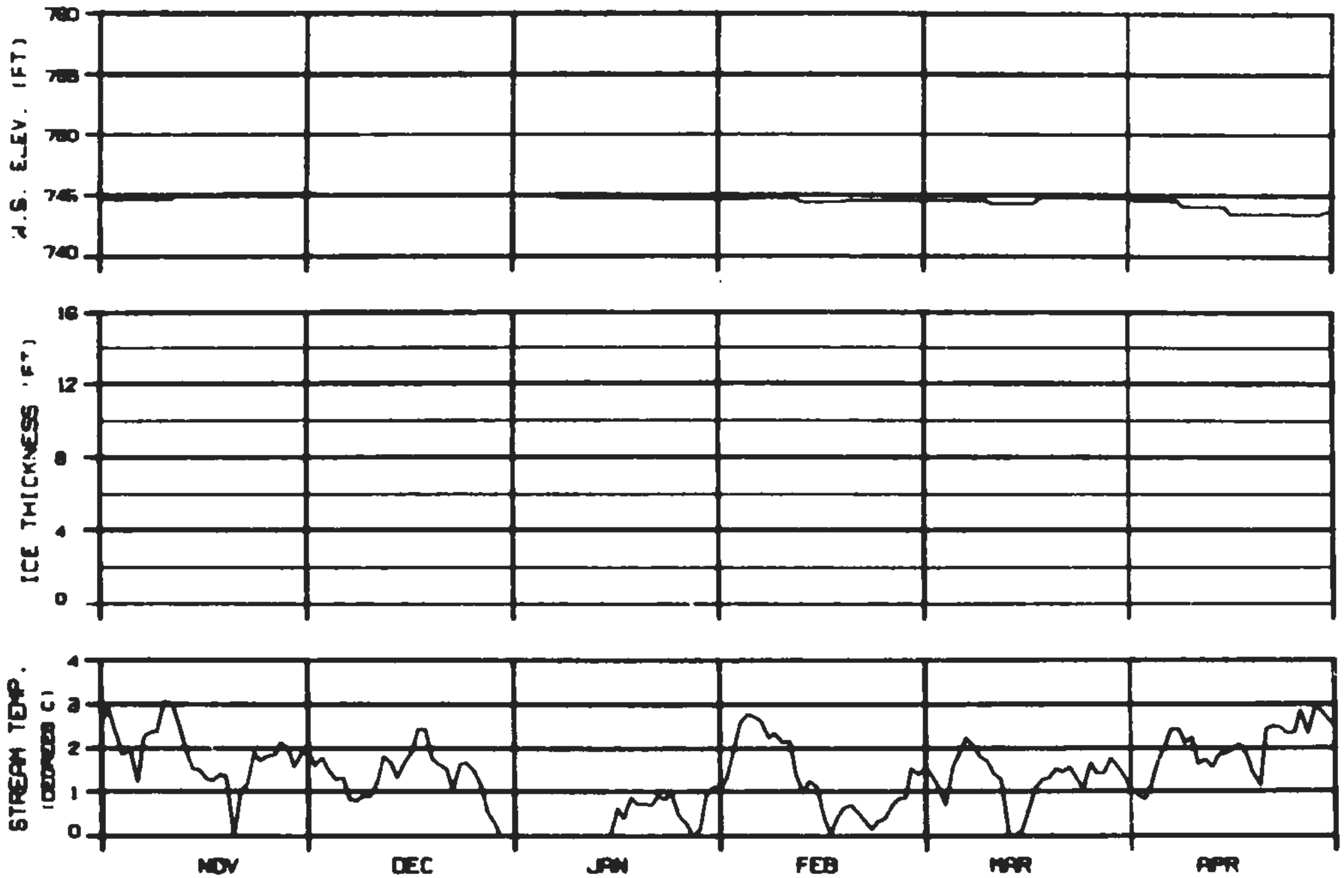
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 141.70

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

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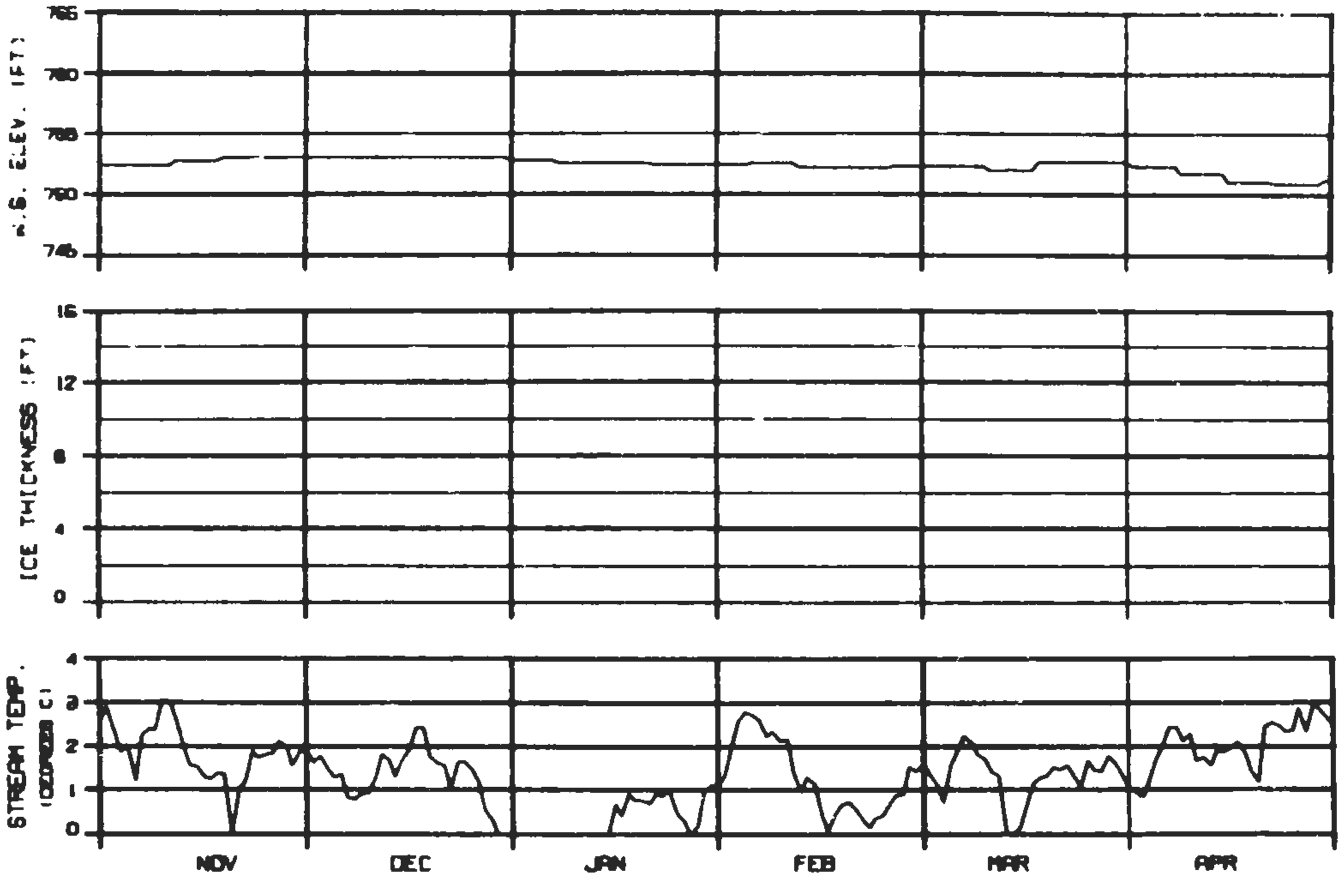
SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE



RIVER MILE : 142.20

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD : 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

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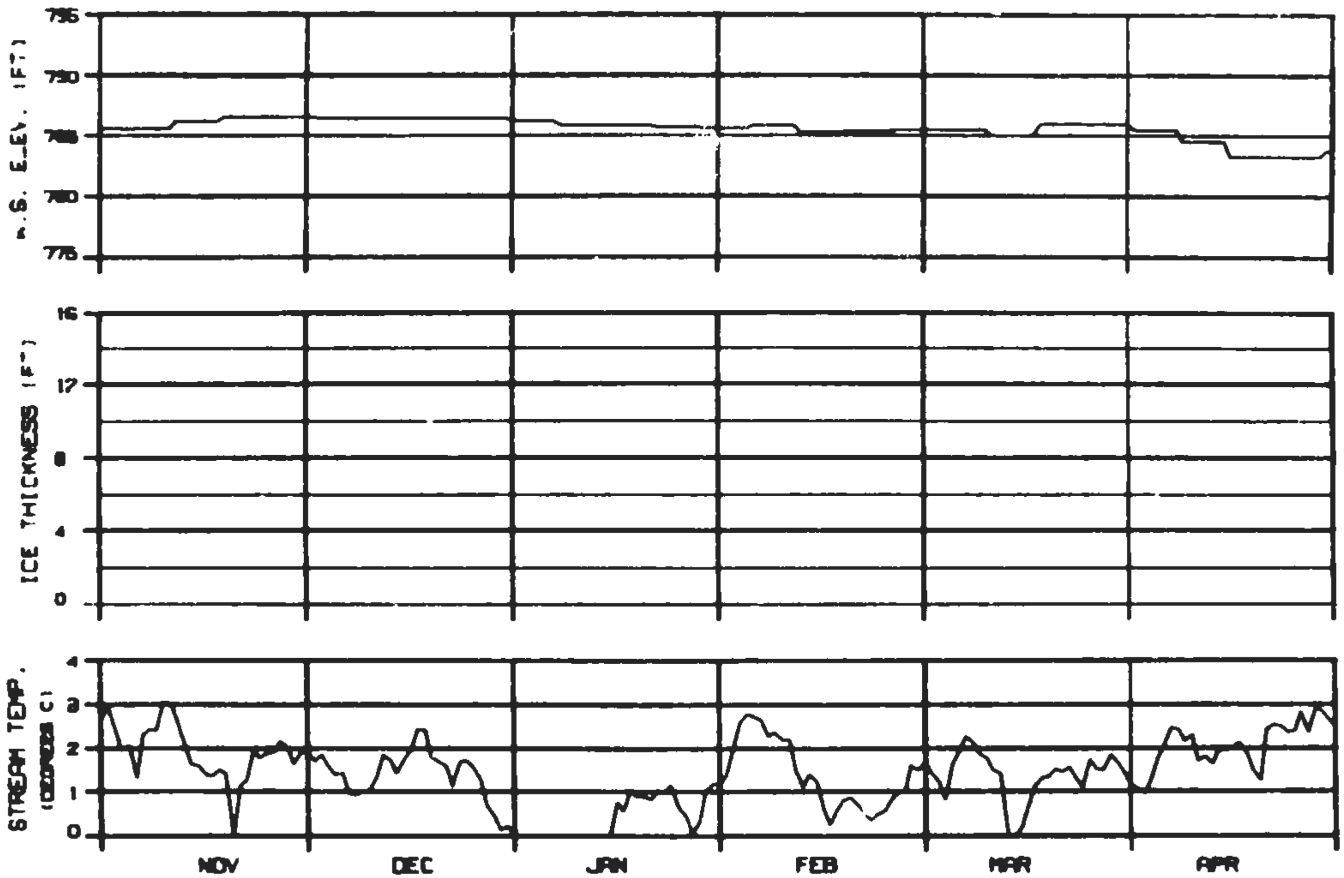
HARZA-EBASCO JOINT VENTURE



RIVER MILE : 144.80

ICE THICKNESS LEGEND:

1. TOTAL THICKNESS
2. SLUSH COMPONENT

WEATHER PERIOD 1 NOV 81 TO 30 APR 82
RESERVOIR OPERATION : WATANA 1996
REFERENCE RUN NO. : 8196E

ALASKA POWER AUTHORITY

SUSITNA PROJECT

SUSITNA RIVER
ICE SIMULATION
TIME HISTORY

HARZA-EBASCO JOINT VENTURE

OPTION?

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HARZA-EBASCO SUSITNA JOINT VENTURE
711 H STREET ANCHORAGE ALASKA 99501 TEL (907) 272 5585

April 11, 1984
4.3.1.2/42.2.2

Arctic Environmental Information
and Data Center
707 A Street
Anchorage, Alaska 99501

Attention: Mr. William J. Wilson
Principal Investigator

Subject: Susitna Hydroelectric Project
Reservoir and Instream Temperature
and Instream Ice Models

Dear Mr. Wilson:

Enclosed is a memorandum from Mr. E.J. Gemperline which outlines the production runs of the DYRESM, SNTEMP and ICECAL models which will be used to respond to a request from FERC. This memorandum should be provided to Mr. Voos for his use in developing the required SNTEMP model production runs necessary to provide the information to FERC.

If you have questions, please contact me or Mr. Gemperline.

Very truly yours,

J.R. Bizer, PhD
Contract Manager

hg

Enc. as noted

cc w/Enc:
L. Gilbertson, HE
E. Gemperline, HE

41652

HARZA-EBASCO *SUSITNA JOINT VENTURE*

MEMORANDUM

LOCATION Anchorage DATE March 22, 1984

TO L. Polivka, W.E. Larson, J. Robinson, J. Thrall, J. Bizer B.H. Wang, C.Y. Wei, H.W. Coleman NUMBER 42.1.1

FROM E.J. Gemperline

Page 1 of 3

SUBJECT Material to be supplied to FERC as requested in Schedule B Request for Supplemental Information of April 12, 1983

FERC, on April 12, 1983, requested information on DYRESM/HEATSIM simulations of the reservoir and stream temperatures and ICESIM simulations of river ice processes. These requests and our responses are attached hereto.

The requests and our responses call for a large amount of information to be compiled and transmitted to FERC. Basically we have promised:

1. Results of calibration of DYRESM, SNTEMP, and ICECAL, and

2. Production runs of weekly longitudinal temperature profiles for wet, dry and average years and for various power operation schemes.

The purpose of this memorandum is to outline how we intend to complete our response to these requests.

Calibration

DYRESM and ICECAL calibration studies have been completed and the reports have been finalized. These will be transmitted to FERC as soon as they are printed. The SNTEMP model was documented in "Stream Flow and Temperature Modeling in the Susitna Basin, Alaska" by AEIDC and this has been transmitted to FERC.

Production Runs

The following matrix represents the 23 cases which would be simulated with reservoir (DYRESM) and stream temperature models (SNTEMP) and the instream ice model (ICECAL).

HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

LOCATION Anchorage
DATE March 22, 1984
TO L. Polivka, W.E. Larson, J. Robinson, J. Thrall
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NUMBER
FROM E.J. Gemperline

SUBJECT Material to be supplied to FERC as requested in Schedule B Request for Supplemental Information of April 12, 1983

	First year of Watana Operation (1996)	Last year of Watana only Operation	First year Devil Canyon Operation	A year representing full utilization of ~~both projects~~	Second year of Watana filling
Dry year (1974)					
Wet year (1982)					
Avg. year Average winter (1983)					
Warm winter (1976-77)					NA
Cold winter (1971-72)					NA

For each of these cases the following information must be supplied to FERC:

1. Listings of inputs used and assumptions made for each simulation,

2. Meteorological conditions used as model parameters,

3. Parameter values used in each simulation and source of values,

4. A chart showing reservoir outflow temperatures and a comparison with pre-dam temperatures in the river at the respective dam site (s), and

5. Longitudinal profiles of natural (measured if available, predicted if not) and with project predicted weekly average temperatures downstream of the project (s).

Since production runs are now begining the following guidelines are suggested to allow orderly preparation of this response:

1. Thoroughly document runs of DYRESM, SNTEMP and ICECAL as they are made,

2. Label input data files so that meteorologic and hydrologic data are clearly marked, and

HARZA-EBASCO *SUSITNA JOINT VENTURE*

MEMORANDUM

LOCATION Anchorage DATE March 22, 1984

TO L. Polivka, W.E. Larson, J. Robinson, J. Thrall J. Bizer B.H. Wang, C.Y. Wei, H.W. Coleman NUMBER

FROM E.J. Gemperline

SUBJECT Material to be supplied to FERC as requested in Schedule B Request for Supplemental Information of April 12, 1983

3. Prepare the requested material for each run as it is made.

In order to limit the number of exhibits required to show the weekly longitudinal temperature profiles it is sugested that they be grouped by month. Thus each chart will show four or five simulated weekly with project temperature profiles and the corresponding number of measured (or simulated if measurements are unavailable) natural (pre-project) temperature profiles.

As the requested material for each run becomes available it should be thoroughly reviewed and transmitted to Harza-Ebasco.

It is recognized that close coordination is required between the reservoir temperature, stream temperature and instream ice studies.

This is provided in the following manner.

1. Reservoir outflows and temperatures are simulated with DYRESM in Chicago and an output file is transmitted to AEIDC's account at Boeing in Seattle,

2. AEIDC generates stream temperature using SNTEMP and provides output on the location of the freezing point isotherm in the river to the ice study, and

3. Ice processes are simulated in Chicago and the output transmitted to AEIDC for use in their analyses of impacts. The location of the ice front leading edge provides the upstream boundary of the open water temperature simulation during break-up or melt-out.

The open water temperature profiles generated by AEIDC will be modified in the following manner.

1. During the freeze-up period the profiles will be truncated where the water temperature reacnes the freezing point

2. During the break-up or melt-out period the profiles will be truncated at the location of the leading edge of the ice.

EXHIBIT E

2. Water Use and Quality

Comment 28 (p. E-2-87, para. 1)

Provide longitudinal profiles of predicted weekly average temperatures downstream of Watana Dam and Devil Canyon/Watana using the DYRSEM and HEATSIM models. Simulations for stations with pre-project temperature data should be provided with Watana in operation and Devil Canyon/Watana in operation using data for an average water year and for conditions of minimum releases (i.e., using data for a minimum flow year) from Watana and from Devil Canyon. Listings of inputs used and assumptions made in each simulation should also be provided. Outflow temperature from each reservoir used in the HEATSIM model should include the temperatures that would have to be available at the multilevel intakes in order to match pre-dam temperatures that would have to be available at the multilevel intakes in order to match pre-dam temperatures. Meteorological conditions used as model parameters should be provided. These simulated average weekly temperatures should be compared to pre-project temperatures measured during low-flow and average flow years. Provide parameter values used in each simulation and document the source of the values used.

Response:

Daily simulations of reservoir and river temperatures had been prepared to provide the longitudinal profiles of temperatures downstream of Watana dam and Watana/Devil Canyon using the DYRESM and HEATSIM models for a wet year (1981) condition (Acres American Inc., 1983a, 1983b). Selected profiles from the daily simulations are given as Figures 8.44 to 8.56 (attached) in Acres 1983b. Figures 8.44 through 8.56 (see pages 2-28-6 to 2-28-18) correspond to Figures E.2.176 through E.2.178, E.2.180 through E.2.183, and E.2.217 through E.2.222 of Exhibit E, Chapter 2 of the license document.

To provide average weekly temperatures, for comparisons with pre-project temperatures during low-flow and average flow years, additional studies will be conducted in 1983. A work plan to carry out the studies and to provide the updated parameter values and their sources is presented as follows:

1. The parameter values of DYRESM used (in Acres 1983a) will be updated through additional calibration using Eklutna Lake data, including data collected after January 1, 1983. This calibrtion effort will be completed by January 1, 1984.

2. Water temperature profiles downstream from Watana will be determined by SNTEMP model[1/] (Stream Network Temperature Model). The calibration of SNTEMP will be made using existing streamflow, stream temperature, and meteorological data.

3. The reservoir temperature profiles will be determined using the DYRESM model and the updated parameter values. Outflow temperatures from the reservoir temperature model will be used as inputs for the SNTEMP model to provide longitudinal profiles of temperatures downstream from the reservoir. This study will be completed by June 30, 1984.

Weekly simulations will be made for comparison with pre-project temperatures measured during low-flow and average flow years for the following cases:

[1/] AEIDC will perform river temperature studies using SNTEMP model.

(a) Filling of Watana reservoir

(b) Watana in operation

(c) Watana/Devil Canyon in operation

Although not specifically requested case (a), filling of Watana Reservoir is included because the cited paragraph (E-2-87, para. 1) is in the section entitled "Impoundment of Watana Reservoir".

Weekly simulations of the reservoir thermal behavior will be performed under various power operation schemes for low-flow, average-flow, and high-flow (1981) years. The resulting outflow temperatures at the multilevel intakes, will be used as inputs to the downstream temperature simulations using the SNTEMP model.

The computed temperatures will be compared with the measured pre-project temperatures. Results of the 1983 Study (Acres 1983b) for wet year conditions will also be verified.

The representative years for low-flow (dry), average-flow (average), and high-flow (wet) years conditions are selected based on the available streamflow data. From a frequency analysis of annual flow volumes at Gold Creek, water years 1974, 1982 and 1981 may be considered as dry, average, and wet years, respectively.

At the completion of the study, a summary report will be prepared. The report will include:

(a) A listing of inputs used in the study.

(b) The assumptions made in each simulation.

(c) The parameter values used in each simulation and documentation of their sources.

(d) The outflow temperatures from each reservoir.

(e) A comparison of simulated average weekly temperatures with measured pre-project temperatures.

Outflow temperatures will include the temperatures that would have to be available at the multilevel intakes in order to match pre-dam temperatures. The study will be completed by June 30, 1984.

The parameter values used for the 1983 reservoir thermal simulations are given in the following table:

PARAMETER	VALUE
Convective overturn, CK	0.125
Mechanical stiring, ETA	1.230
Temporal effects, CT	0.510
Shear production, CS	0.200
Diffusion constant	
W = Wedderburn number	
W > 1 (for general condition)	0.048
W $\leq$ 1 (for high wind condition)	0.096
Drag coefficients	0.015

These parameters values were derived from calibration of the model to Eklutna Lake (Acres 1983b).

References

Acres American Incorporated, "Susitna Hydroelectric Project, License Application, Volumes 5A, and 5B," prepared for Alaska Power Authority, 1983(a).

Acres American Incorporated, "Susitna Hydroelectric Project Feasibility Report - Supplement, Chapter 8: Reservoir and River Temperature Studies," prepared for Alaska Power Authority, 1983(b).

2. Water Use and Quality

Comment 40 (p. E-2-121, para. 5, fig. E.2.179)

Provide parameter values used in the DYRESM/HEATSIM simulation of river temperatures in Fig. E.2.179 and document the source of parameter values used.

Response

The parameter values used in the DYRESM simulation of reservoir temperatures can be found in the "Susitna Hydroelectric Project, Feasibility Report - Supplement" (Acres, 1983) and are given in Table 1.

Table 1

DYRESM Parameters for Watana Reservoir

PARAMETER	VALUE
Convective overturn, CK	0.125
Mechanical stirring, ETA	1.230
Temporal effects, CT	0.510
Shear production, CS	0.200
Shear instability, AKH	0.300
Diffusion constant	
W = Wedderburn number	
W > 1 (general condition)	0.048
W ≤ 1 (high wind condition)	0.096
Drag Coefficients	0.015

These parameter values were determined through the calibration of the DYRESM model using Eklutna Lake data (R&M Consultants 1982).

The parameter values used in HEATSIM are documented in the "Susitna Hydroelectric Project, Feasibility Report - Volume 4, Appendix A - Hydrological Studies, Final Draft" (Acres, 1982) and are shown in Table 2.

Table 2

HEATSIM Parameters for Susitna River

PARAMETER	VALUE
Insolation Coefficient	0.97
Emissivity Coefficient	0.97
Albedo for Water	0.10
Ratio of bright sunshine to maximum possible sunshine	
Clear Days	0.9
Partly Cloudy Days	0.5
Cloudy Days	0.2

Long term climatic records at Talkeetna and Summit stations, operated by NOAA, were used as inputs in the analysis. The principal climatic parameters used were: average daily air temperature, ratio of recorded sunshine to maximum possible sunshine, wind speed, precipitation, barometric pressure, and relative humidity. Air temperature and the sunshine ratio were the two most important parameters of this data set.

However, as stated in the response to Water Quality Question No. 28, the Eklutna Lake study will be updated using the additional data available after January 1, 1983, and the SNTEMP model (Stream Network Temperature Model) will be used for the river temperature studies. Therefore, refined parameter values in the models and documentation of the source of parameter values used will be presented at the completion of a study outlined in the work plan.

2. Water Use and Quality

Comment 41 (p. E-2-124-para. 2)

Provide documentation for ICESIM model. Provide validation of ICESIM model by comparing model predictions with ice observations on the Susitna River.

Response

Documentation for ICESIM is not available because the model is proprietary. However, as part of the on-going environmental studies, a comprehensive ice simulation model will be employed to verify results given in the application. This model will be fully available for documentation and will be verified for pre-project winter flow regimes on the Susitna, and, if sufficient information can be obtained, for other rivers with winter flow regimes similar to the post-project conditions.

The proposed work plan for the ice simulation modeling is given below:

Work Plan

The proposed work plan will be accomplished in three steps: model vertification, preliminary studies, and final studies.

Model Verification: A state-of-the-art mathematical model will be used to estimate ice production and ice cover progression and thickening. The mathematical model will first be calibrated with ice observation data on the Susitna River. In previous studies using ICESIM, it became apparent that the model could not simulate the ice regime at numerous cross sections where critical or near critical velocities occur in the river during low flow conditions. However, since the post-project winter discharge will be significantly higher than pre-project winter flows, this verification to the available ice observation data would be useful only to demonstrate the accuracy of the model for extreme low winter releases. Therefore, other rivers with higher winter flow rates and stages will be considered if sufficient data can be obtained.

Preliminary Studies: Previous studies will be reviewed with an assessment of necessary changes to the scope of work. These studies will proceed as follows:

a. Review reservoir discharge quantity and temperature presented in the License Application for comparison with results from the most recent studies. Also compare open-river water profiles presented in the License Application with the latest available results.

b. Use available open-water surface and temperature profiles to proceed with preliminary ice-model runs. Compare results to runs common to both License Application level studies and current studies. The ice model will include an open-water temperature algorithm which will be used to determine both the temporal and spatial distribution of ice production. When the river temperature profiles from the instream temperature modeling using the SNTEMP model are available (see response to Comment 40), the starting location and timing of ice production may be adjusted.

c. Review the adequacy of License Application ice simulation runs especially in view of the difficulty in calibrating the model.

d. Review the adequacy of limiting hydraulic and ice studies to the reach upstream of Talkeetna.

e. Review the adequacy of assumptions made with regard to tributaries of the Susitna River between Watana dam site and Talkeetna.

Final Studies: Following verification of the model and preliminary runs, final runs will commence. Final runs will require temperature output data at Watana and Devil Canyon from the reservoir operation and reservoir temperature models and water profile data from the river hydraulic model. Results of instream temperature modeling using SNTEMP model will be considered and adjustment of the location of ice production may be required.

Typical production runs would include the following:

a. Open-water surface and temperature profiles downstream from the dam(s), for various power discharge hydrographs and for average and extreme winter weather conditions. These runs will estimate the initial location and timing of ice production in the river for the study conditions described.

b. Ice development runs for the time and location of ice production downstream from the dam(s) during the winter, including ice thickening, areal extent, "staging," and ice-cover break-up.

The expected schedule for completion of the new studies is as follows:

Model Verification	-	Dec. 1983
Preliminary Runs	-	Mar. 1984
Final Runs	-	June 1984

All documentation, model verification, and study results will be supplied as they become available.

HARZA-EBASCO SUSITNA JOINT VENTURE
711 H STREET ANCHORAGE, ALASKA 99501 TEL. (907) 272 5585

April 10, 1984
4.3.1.2/42.2.5

Arctic Environmental Information
and Data Center
University of Alaska
707 A Street
Anchorage, Alaska 99501

Attention: Mr. William J. Wilson
Principal Investigator

Subject: Susitna Hydroelectric Project
Evaluation of Impacts on Aquatic
Resources due to Changes in
Ice Processes

Dear Mr. Wilson:

We have read your letter of March 12, 1984 and agree that a concerted effort utilizing personnel from ADF&G SuHydro, Harza-Ebasco, R&M Consultants, E. Woody Trihey and Associates and AEIDC will be required to accomplish the subject evaluation. We believe that AEIDC should take the lead in this assessment and we suggest the approach to the study outlined in Enclosure 1 would most efficiently utilize the available resources.

We do not believe the memorandum called for in Enclosure 1 should be a lengthy document. We prefer that it contain concise definitions of impacts and brief explanations of how these impacts can be addressed. The finalized memorandum will guide future ice studies and will be very useful to the instream ice processes simulation study being carried out in Chicago. We anticipate that the physical processes which would result in impacts to aquatic resources will be discussed in the Harza-Ebasco report documenting our instream ice study. AEIDC and other Aquatic Study Team Members identified in the memorandum would evaluate the impacts of the ice processes on aquatic resources. The final report would be prepared by AEIDC for the Harza-Ebasco Susitna Joint Venture and reviewed by the Aquatic Study Team.

We have also enclosed the following material to assist in the development of the Memorandum:

Enclosure 2 - Alaska Power Authority "Susitna Hydroelectric Project - Issues List" March 6, 1984

Enclosure 3 - Harza-Ebasco interoffice memorandum from E.J. Gemperline to H.W. Coleman on Presentation of results from Instream Ice Simulation Model, March 12, 1984.

We would appreciate your comments on this methodology and we look forward to meeting with you to discuss them at the earliest opportunity.

Very truly yours,

Larry Gilbertson
Aquatic Group Leader

hg

Enc: as noted

cc w/ Enc:

J. Thrall, HE
E. Woody Trihey, EWT
W. Dyok, HE
E. Gemperline, HE
T. Trent, ADF&G
S. Bredthauer, R&M
H. Coleman, HE

420203

Suggested Approach for
Evaluation of Ice-Related Impacts
To Aquatic Resources

A. AEIDC would prepare a comprehensive list of potential ice-related impacts to aquatic resources with concise explantions. For each of the issues AEIDC would propose a method of analysis.

We suggest that this list of potential impacts be drawn from the following documents:

1. Alaska Power Authority, "Application for License for Major Project, Susitna Hydroelectric Project" Exhibit E, Vol 5A, Chapter 2, Vols. 10A and 10B, Chapter 11, February 1983.

2. Alaska Power Authority, "Susitna Hydroelectric Project - Issues List", March 6, 1984.

3. Alaska Power Authority, "Application for License of Major Project, Susitna Hydroelectric Project, Responses to Agency Comments on License Application" January 19, 1984 and Vols. I and II, February 15, 1984.

4. AEIDC, "Methodological Approach to Quantitative Impact Assessment For The Proposed Susitna Hydroelectric Project", for the Alaska Power Authority, March 12, 1983.

5. R&M Consultants Inc., "1982-1983 Susitna River Ice Study", for the Alaska Power Authority, January, 1984

6. R&M Consultants Inc., "Susitna Hydroelectric Project Winter 1981-82 Ice Observations Report", for the Alaska Power Authority, December, 1982.

7. R&M Consultants Inc., "Susitna Hydroelectric Project Ice Observations 1980-81", for the Alaska Power Authority, August, 1981.

Other documents may also provide information but we believe that a review of these should suffice to generate a comprehensive impacts list.

AEIDC should draw on the experience of the Aquatic Study Team when proposing methods of analyses. In compiling the methods of analyses AEIDC should consider:

1. The capabilities and limitations of the ICECAL model as documented in Harza Ebasco Susitna Joint Venture, "Susitna Hydroelectric Project-Instream Ice, Calibration of Computer Model" draft report for the Alaska Power Authority, January, 1984.

2. The ICECAL runs which have been requested by FERC identified in the following matrix:

	First year of Watana operation	Last year of Watana only operation	First year of Devil Canyon Operation	Full Utilization of both developments	Second year of Watana filling
Wet Year (1981-82)					
Dry Year (1974)					
Avg. Year and Avg. Winter Temp (1982-83)					
Cold Winter Temp. (1971-72)					NA
Warm Winter Temp. (1976-77)					NA

E. Woody Trihey and Wayne Dyok have also identified several other runs which would provide extreme conditions as follows:

a. cold winter and low flows (1971-72) to give maximum upstream progression of the ice front.

b. warm winter (1976-77) and synthesized outflows from reservoir to determine minimum progression of leading edge under possible maximum weekly flows

c. cold winter (1971-72) and very low flow (1979 drought) to determine extreme maximum upstream progression of ice

3. The proposed method for analyzing ice stageing impacts on sloughs documented in the attached memorandum from E.J. Gemperline to H.W. Coleman and discussed with AEIDC and ADF&G.

B. Upon completion of this draft memorandum it would be transmitted to the Ice Study Team for review.

C. Ice Study Team members would transmit review comments to AEIDC

D. AEIDC would prepare a revised draft memorandum which would be transmitted to Ice Study Team members for final review.

E. A meeting of the Ice Study Team would be held to finalize the memorandum and to define the list of potential issues and method of analyses.

Alaska Power Authority
Susitna Hydroelectric Project

Issues List

March 6, 1984

Fishery Issues (F)

F-1. Significance of altered flow regime on salmon and resident fish habitats and populations downstream of the dams, including effects on migration/access, spawning, and rearing during summer months, and effects on incubation and rearing during winter months.

F-2. Significance of changes in water quality parameters (turbidity, pH, heavy metals, dissolved nitrogen, temperature, nutrients) on salmon and resident fish habitats and populations downstream of the dams.

F-3. Significance of altered ice processes on salmon and resident fish habitats and populations downstream of the dams, including effects on fish access and changes due to staging.

F-4. Significance of changes in stream morphology on salmon and resident fish habitats and populations downstream of the dams.

F-5. Significance of impoundment effects on resident fish habitat and populations upstream of the dams.

F-6. Significance of physical effects of access corridors on fish habitats.

F-7. Significance of physical effects of transmission line corridors on fish habitats.

F-8. Significance of water quality and quantity effects of construction camp and permanent village on fish habitats.

F-9. Significance of water quality and stream morphology effects of borrow and spoil areas on fish habitats.

F-10. Significance of disturbance effects of human instream activities on fish.

F-11. Feasibility and desirability of specific mitigation options, including structural modifications, flow allocation, physical habitat modification, hatcheries, and management options.

F-12. Formulation and implementation of post-construction plan to monitor significant impacts and the efficacy of specific mitigation measures.

Wildlife Issues (W)

W-1. Significance of reduction in moose carrying capacity directly attributable to the project.

W-2. Significance of reduction in black bear denning and foraging habitat.

W-3. Significance of reduction in brown bear spring foraging habitat.

W-4. Significance of habitat reduction for middle basin furbearers and birds.

W-5. Significance of Dall sheep habitat modification at Jay Creek lick.

W-6. Significance of increase in accidents and inhibition of movements of big game mammals due to reservoir open water and ice conditions.

W-7. Significance of inundation or other disturbance to bald eagle, golden eagle, and other raptor nests.

W-8. Significance of changes in wildlife habitat and movements downstream of the dams due to changes in flow and ice cover.

W-9. Significance of reduction in wildlife habitat due to construction camps/villages, permanent town, and airstrips.

W-10. Significance of access road presence and use effects on caribou movements and behavior.

W-11. Significance of increased accidental big game deaths from vehicle collisions due to increased access.

W-12. Significance of reductions in big game and furbearer populations from increased hunting/trapping pressure due to increased accessibility of project area.

W-13. Significance of other disturbances to wildlife due to human activities, such as aircraft overflights and construction noise.

W-14. Formulation and implementation of construction worker transportation plan.

W-15. Formulation and implementation of post-construction access policy.

W-16. Feasibility and desirability of refinement of timing of construction and operation activities to reduce wildlife impacts.

W-17. Feasibility and desirability of specific mitigation options, including moose and bear habitat enhancement, Jay Creek lick expansion, raptor nest habitat enhancement, revegetation of disturbed areas, downstream beaver habitat enhancement.

W-18. Feasibility and desirability of types of mitigation options, including design or structural modifications, replacement lands/habitat, enhancement of lands/habitat, rehabilitation of disturbed lands, management options (scheduling or restrictions) to reduce disturbance or direct impacts, preventive measures.

W-19. Formulation and implementation of post-construction plan to monitor significant impacts and the efficacy of specific mitigation measures.

Recreation Issues (R)

R-1. Significance of impacts on fishing, including availability of fish, access, and quality of experience.

R-2. Significance of impacts on hunting and recreational trapping, including availability of resource, access, and quality of experience.

R-3. Significance of loss of whitewater resource.

R-4. Significance of impacts to boating downstream of Devil Canyon Dam, including access to the water and on the water (impediments to navigation).

R-5. Significance of impacts on non-consumptive activities (e.g., bird-watching and hiking), including availability of the resource, access to the resource, and quality of experience.

R-6. Significance of recreational activities of project construction workers on fish and wildlife resources in the Susitna River watershed.

R-7. Formulation and implementation of a specific recreational opportunities/recreation plan.

R-8. Feasibility and desirability of restrictions of recreational opportunities in order to reduce impacts to fish and wildlife resources in the Susitna River watershed.

Aesthetic Issues (AE)

AE-1. Significance of impacts of borrow and spoil areas, transmission lines, access roads and rail lines, construction camps and villages, and dams on scenic resources.

AE-2. Feasibility and desirability of incorporating specific aesthetic mitigation measures into project plans.

Cultural Resource Issues (C)

C-1. Identification and significance of loss of affected cultural/historical sites.

C-2. Formulation and implementation of cultural resources mitigation plan.

Air Quality Issues (AQ)

AQ-1. Significance of ambient air quality impacts during project construction.

AQ-2. Formulation and implementation of air quality mitigation measures.

Dam Safety Issues (D)

D-1. Determination of significance of risk and effects of catastrophic dam failure.

D-2. Formulation of emergency warning plan.

Socioeconomic Issues (S)

S-1. Significance of changes in subsistence opportunities relating to fish and wildlife resources in the Susitna River watershed.

S-2. Significance of project impacts on life style in area communities.

S-3. Significance of changes in commercial opportunities related to fishing, hunting, trapping, etc.

S-4. Significance of changes in employment in area communities.

S-5. Significance of increased burden on Mat-Su Borough and affected communities for providing public services and facilities in response to project-related demands.

S-6. Significance of secondary development impacts on Native corporation undeveloped lands.

S-7. Feasibility and desirability of specific mitigation options, including worker transportation plan, worker housing plan, local aid plan, local hire plan.

S-8. Formulation and implementation of a construction and post-construction plan to monitor significant impacts and the efficacy of specific mitigation measures.

Land Acquisition Issues (L)

L-1. Development of a feasible and desirable land acquisition program.

HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

LOCATION Anchorage

DATE March 12, 1984

TO H.W. Coleman

NUMBER

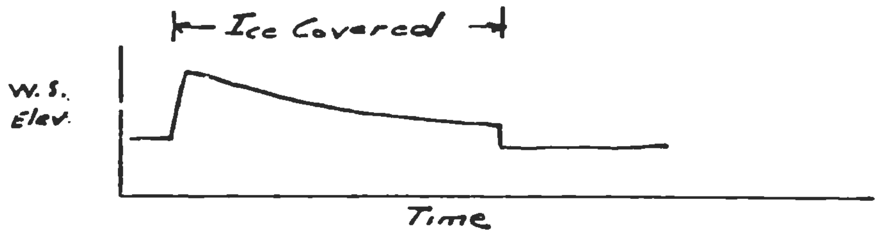
FROM E.J. Gemperline

SUBJECT Presentation of results from Instream Ice Simulation Model

Based on my conversation with Wayne Dyok, represtatives of AEIDC and ADF&G, I recommend that results of the ice simulation studies be presented in the manner and at locations described below.

Manner of Presentation

It appears that the most useful manner of presenting the results would be a plot of the time history of stage at significant locations. As shown in Figure 1.



It is suggested that this plot can be generated in the following manner:

A. For important habitat locations which are between two cross-sections in the ice model and for which an open water rating curve (see data from ADF&G) exists:

1. Compute the ice induced staging at both upstream and downstream cross sections and linearly interpolate to estimate the staging at the significant location.

2. Add this staging to the open water rating for the given discharge at the significant location to determine the water surface elevation at the significant location.

3. Plot the water surface computed in 2. above as a function of time.

Alternate 2

1. If for hydraulic reasons, it is not considered appropriate to interpolate staging between cross sections - then based on judgement estimate the staging

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HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

LOCATION Anchorage

DATE March 12, 1984

TO H.W. Coleman

NUMBER

FROM E.J. Gemperline

SUBJECT Presentation of results from Instream Ice Simulation Model

at the significant location to be equal to the staging at either the upstream or downstream cross section.

2-3 Continue as in Alternate 1 steps 2 and 3.

Alternate 3

1. Linearly interpolate the staged water surface elevations at cross sections upstream and downstream of the significant location to obtain the water surface elevation at the significant location

2. Adjust the water surface elevation obtained in 1. above by the difference between the computed and observed open water surface elevations.

3. Plot the water surface computed in 2. above as a function of time, or plot the water surface computed in 1. above and provide an adjustment factor.

B. For important habitat locations which are at a cross section in the model simply plot the time history of water surface elevation at the location.

C. For important habitat locations which are not at a cross section in the model and for which a rating curve does not exist - estimate the water surface at the significant location by linearly interpolating between the nearest upstream and downstream cross sections and plot this time history of water surface elevation.

Superimpose on the plots the control elevation for the significant location if this is known or the open water surface elevation corresponding to the berm overtopping flow if this is known.

It would also be useful to add information on these plots to show water temperatures at the given locations. This should be simple since temperature will be at the freezing point for most of the period. Additional data which should be plotted include:

HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

LOCATION Anchorage

DATE March 12, 1984

TO H.W. Coleman

NUMBER

FROM E.J. Gemperline

SUBJECT Presentation of results from Instream Ice Simulation Model

1. The time history of progression of the ice front.

2. The profile of the stream showing the maximum water surface attained and the ice thickness.

Significant Locations

Based on analyses carried out by W. Dyok the sloughs which we believe it would be most beneficial to present results for are denoted 11 21, 8A, 9, 8 and 9A. Sufficient hydraulic information is available for these sloughs to allow a quantitive estimate of ice related impacts due to berm overtopping . Whiskers Slough, Slough 20 and Slough 22 are not nearly as productive as the above 6 sloughs, but since sufficient information is available, we could present results for these locations.

Results can also be presented for the side channels shown in Attachment 2 since sufficient data are available.

Storage of Results

Results of all final ICECAL runs should be saved on tape so that additional analyses of results can be made at a later date.

In addition, FERC has shown a tendency to request input and output files of PMF runs. It would be prudent, therefore, to save input and output files and to label them in such a manner that FERC does not ask us a lot of questions.

Please also discuss this last point with C.Y. Wei regarding his DYRESM runs.

Attachment 1

Physical Data Needed for Impact Studies

Sloughs

LEGEND

X - denotes data requested be provided by ADF&G

NA - denotes data which we understand was not obtained and is not available

If any data marked NA is available please supply this also

Slough	Location (river Mile) 1/	Mainstem Staff Gage 2/	Control Elev 3/	Mainstem Cross Section 4/	Berm Cross Section	Overtopping Flow 5/
S11	136.4	136.2H2	X	LRX-44	X	40,000-42,000
S21	142.2	142.1M1	X	LRX-56	X	26,000
S8A	126.1	125.3M3	X	LRX-29	X	26,000
S8A	127.1	125.3M6	X	LRX-29	X	30,000
S9	129.7	129.7M1	X	NA	X	20,000
S8	114.1	NA	X	LRX-18.1	X	25,000
S9A	133.7	NA	NA	NA	NA	19,600
Moose	123.3	NA	NA	NA	NA	NA
S17	123.5	NA	NA	NA	NA	NA
S8B	123	NA	NA	NA	NA	NA
SA'	124.7	NA	NA	NA	NA	NA
S9B	129.2	NA	NA	NA	NA	NA
S20	140.5	140.6M1	X	NA	X	20,000
S2	100.2	NA	NA	NA	NA	NA
S8C	121.9	NA	NA	NA	NA	NA
SB	126.3	NA	NA	NA	NA	NA
S22	144.8	144.3M1	X	NA	X	21,000
Whiskers	101.5	101.5M6	X	LRX-7	X	18,000

1/ at upstream end

2/ at berm subject to overtopping

3/ water level at which berm is overtopped

4/ Susitna River discharge at which berm is overtopped

5/ at berm location

420162

Attachment 2

Physical Data Needed for Impact Studies

Side Channels

LEGEND

X - denotes data requested be provided by ADF&G

NA - denotes data which we understand was not obtained and is not available

If any data marked NA is available please supply this also

Side Channels	Location (river Mile) 1/	Mainstem Staff Gage 2/	Control Elev 3/	Mainstem Cross Section 4/	Berm Cross Section	Overtopping Flow 5/
MS II	118.9	119.5M2	X	LRX18.2	X	26,000
MS II	115.5	115.5M4	X	LRX18.2	X	14,000
RM 120	120.0	X	X	NA	NA	NA
S.C. u/s S9	130.6	130.5M1	X	LRX34	X	NA
S.C. u/s S10	134.3	134.3M1	X	LRX40	X	16,200
S.C. d/s S11	135.3	135.3M1	X	LRX42	NA	NA
S.C. u/s S11	136.5	135.3M1	X	LRX44	X	12,200-18,500
S.C. u/s S21	141.7	141.6M1	X	LRX55	X	24,200
S.C. u/s 4th of July Cr.	131.8	131.8M1	X	LRX37	NA	NA
S.C. at head Gash Cr.	112.1	112.1M1	X	NA	NA	NA

1/ at upstream end

2/ at berm subject to overtopping

3/ water level at which berm is overtopped

4/ Susitna River discharge at which berm is overtopped

5/ at berm location

HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

Larry, here are more recent DYRESM runs
EJG

LOCATION Chicago Office

DATE April 3, 1984

TO E.J. Gemperline

NUMBER 1563.142.42-010-04

FROM C.Y. Wei, M.F. Rogers

two copies of each intermixed give one to whomever
EJG

SUBJECT Transfer of DYRESM Results to AEIDC

Please find enclosed two copies of the DYRESM results for the study periods of May 1981 to May 1982 and May 1982 to May 1983. These results represent Run Id's WA8196E and WA8296E respectfully. The file WA8196E was sent to Boeing Computer Services (BCS) for AEIDC on 29 March 1984 and file WA8296E was sent on 2 April 1984. The file names on BCS are also WA8196E and WA8296E respectfully which represent the following simulation conditions:

Watana Reservoir Simulation Only
Weekly Reservoir Operation
Energy Demand = 4712 GWh (1996)
Case C downstream flow requirements
4 or 6 units in the powerhouse
Rule curve per memo by N. Pansic (17 feb 84)
Reservoir allowed to surcharge to 2193 ft.
Frazil Ice inflow from 1 Nov (5%) to 1 Dec (0%) for 80 and 81
Powerhouse multilevel intake design per Acres

Spillway Crest	2148 ft. (654.71 m)
Spillway Approach Channel Elev.	2125 ft. (647.7 m)
Powerhouse Approach Channel Elev.	2025 ft. (617.2 m)
Offtake No. 1 Elevation	2151 ft. (655.6 m)
Offtake No. 2 Elevation	2114 ft. (644.3 m)
Offtake No. 3 Elevation	2077 ft. (633.1 m)
Offtake No. 4 Elevation	2040 ft. (621.8 m)
Cone Valve Elevation	2040 ft. (621.8 m)

These results have also been forwarded to N. Paschke for the river ice simulation (ICECAL).

C. Y. Wei

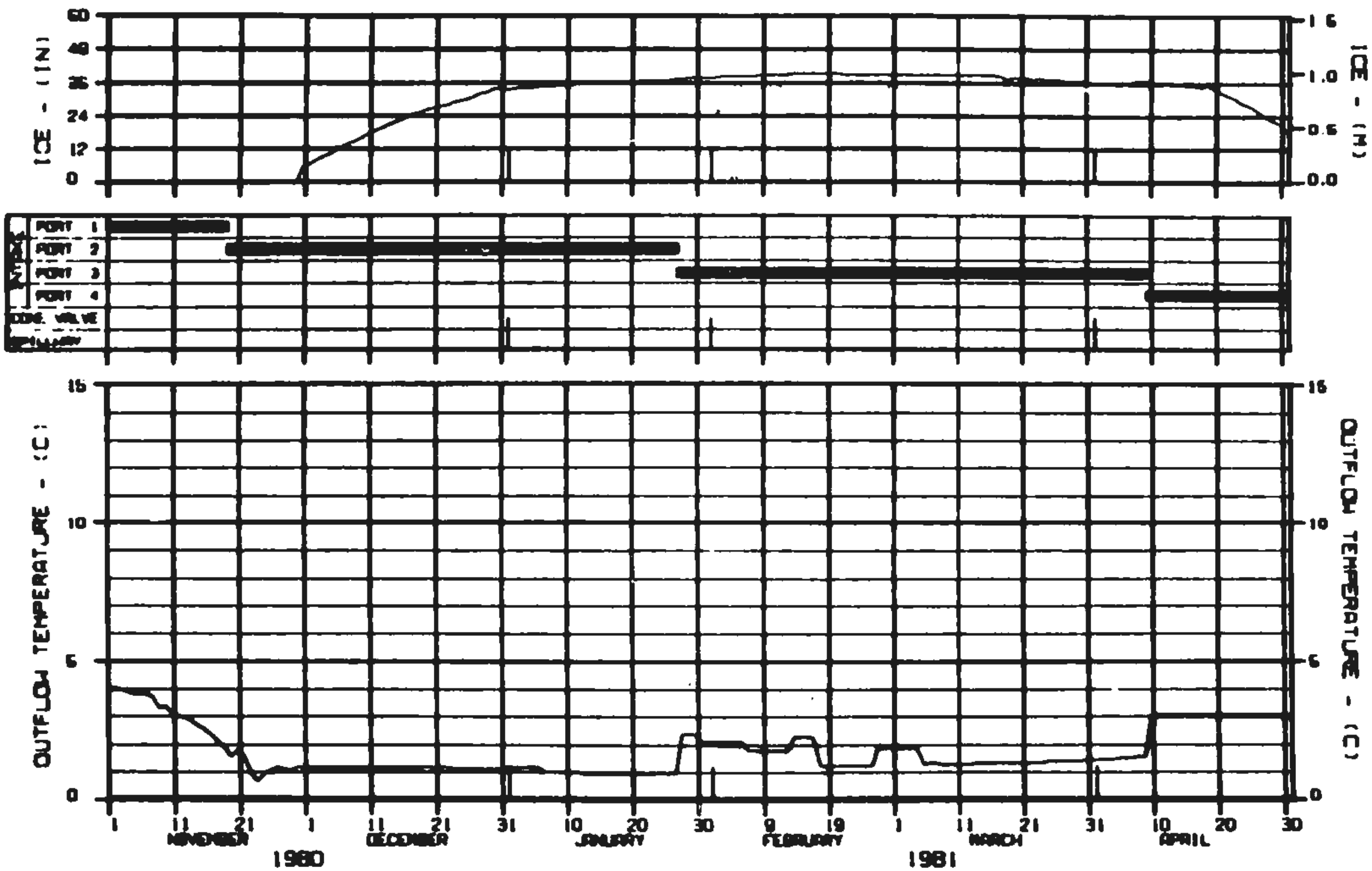
C. Y. Wei

M. F. Rogers

M. F. Rogers

EJG,

I have also enclosed the plotted results of WA8196E and WA8296E for your records.



LEGEND: CASE: WA8106E

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

OPTION7

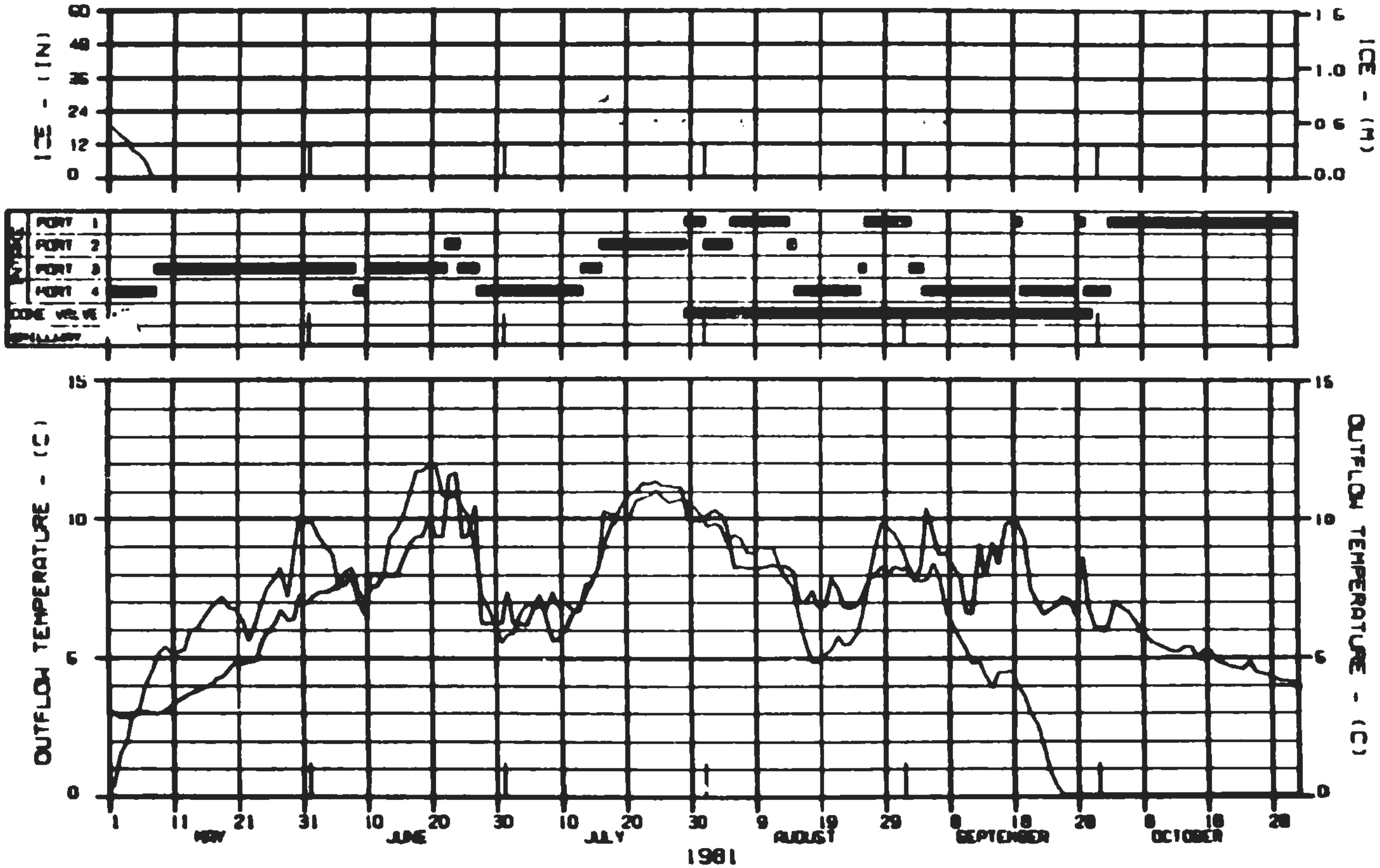
ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

PRELIMINARY



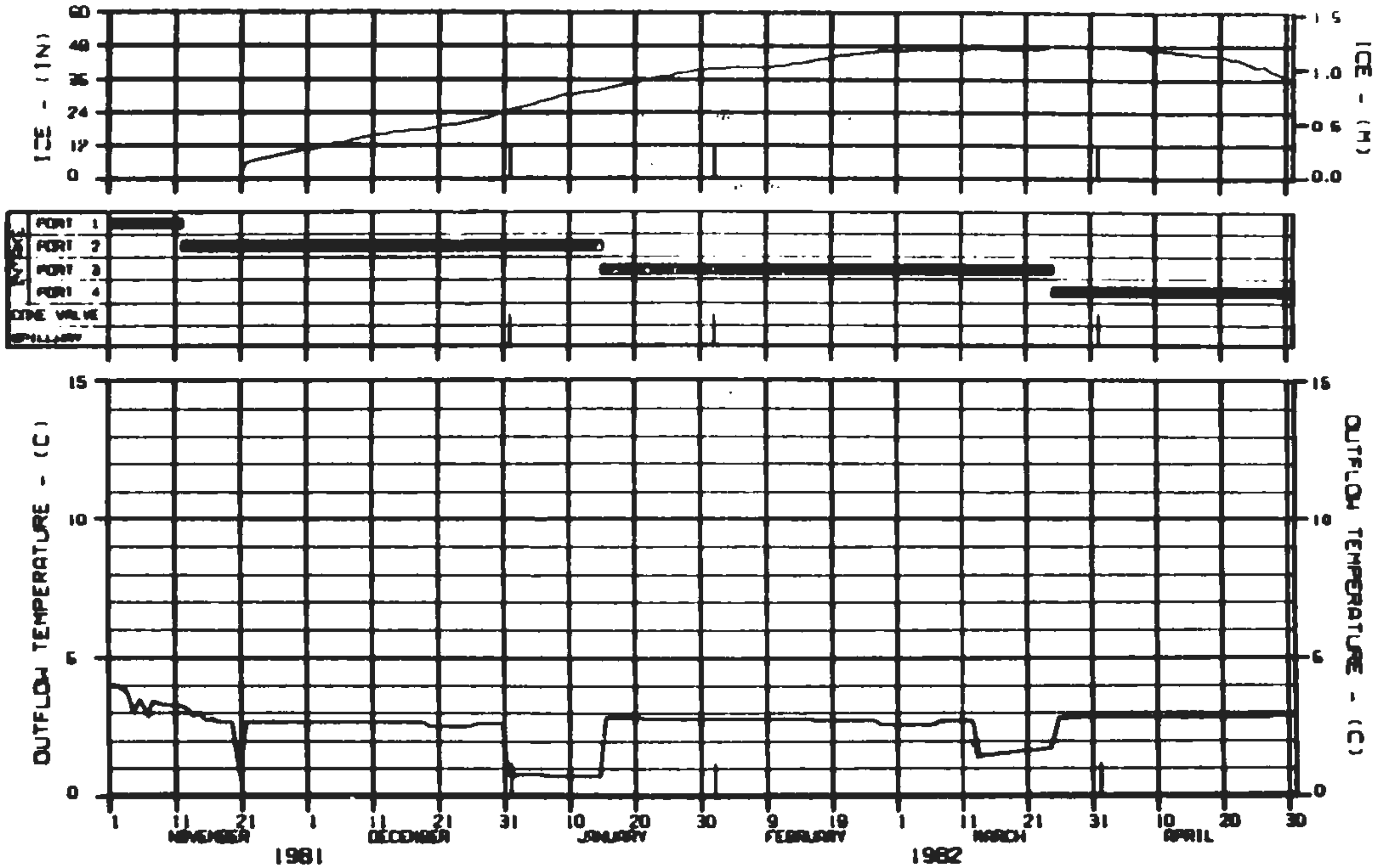
LEGEND: CASE: WABIGSE

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	

OPTION2



LEGEND: CASE: WA8106E

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

OPTION?

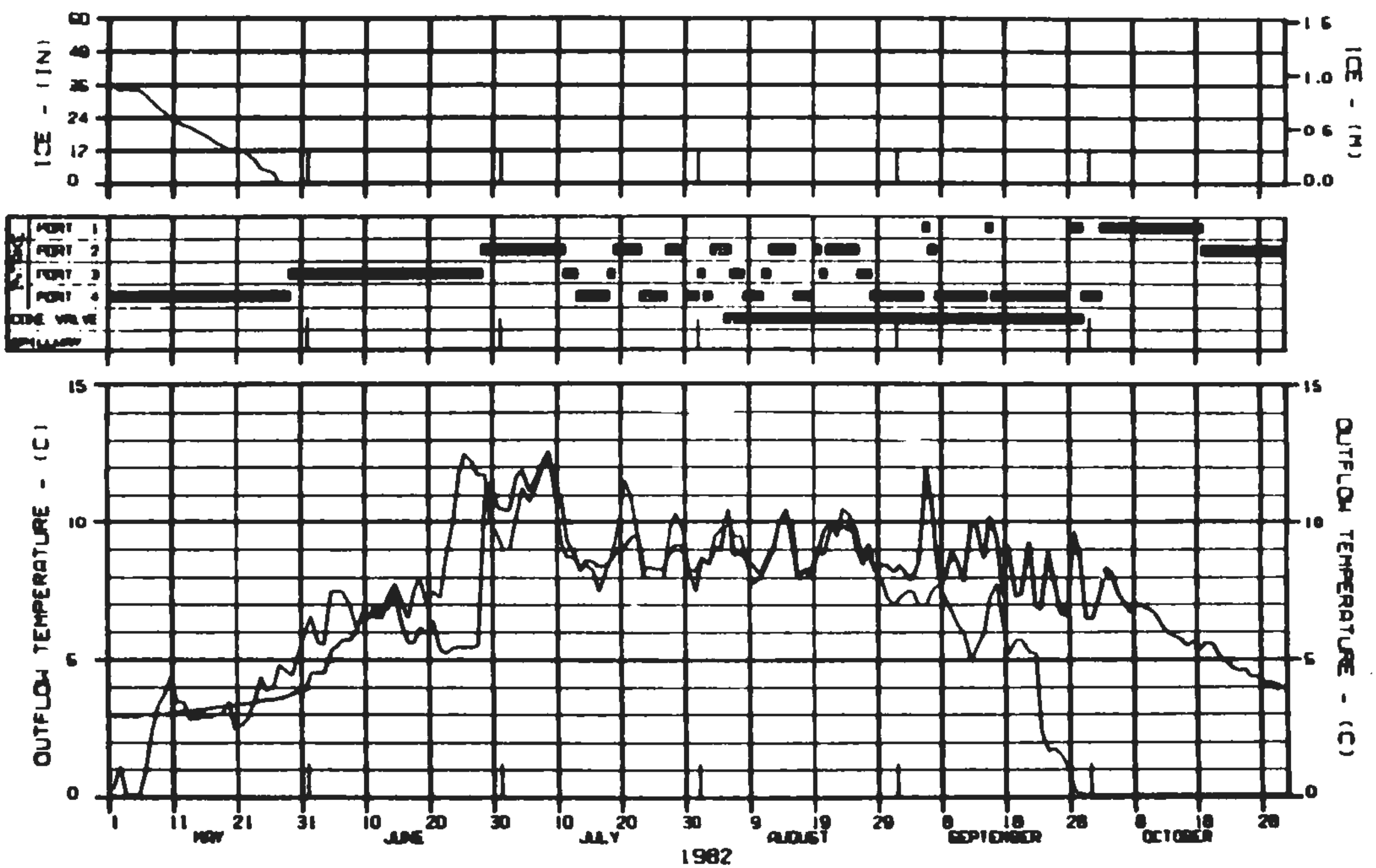
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

PRELIMINARY



LEGEND: CASE: WADISGE

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

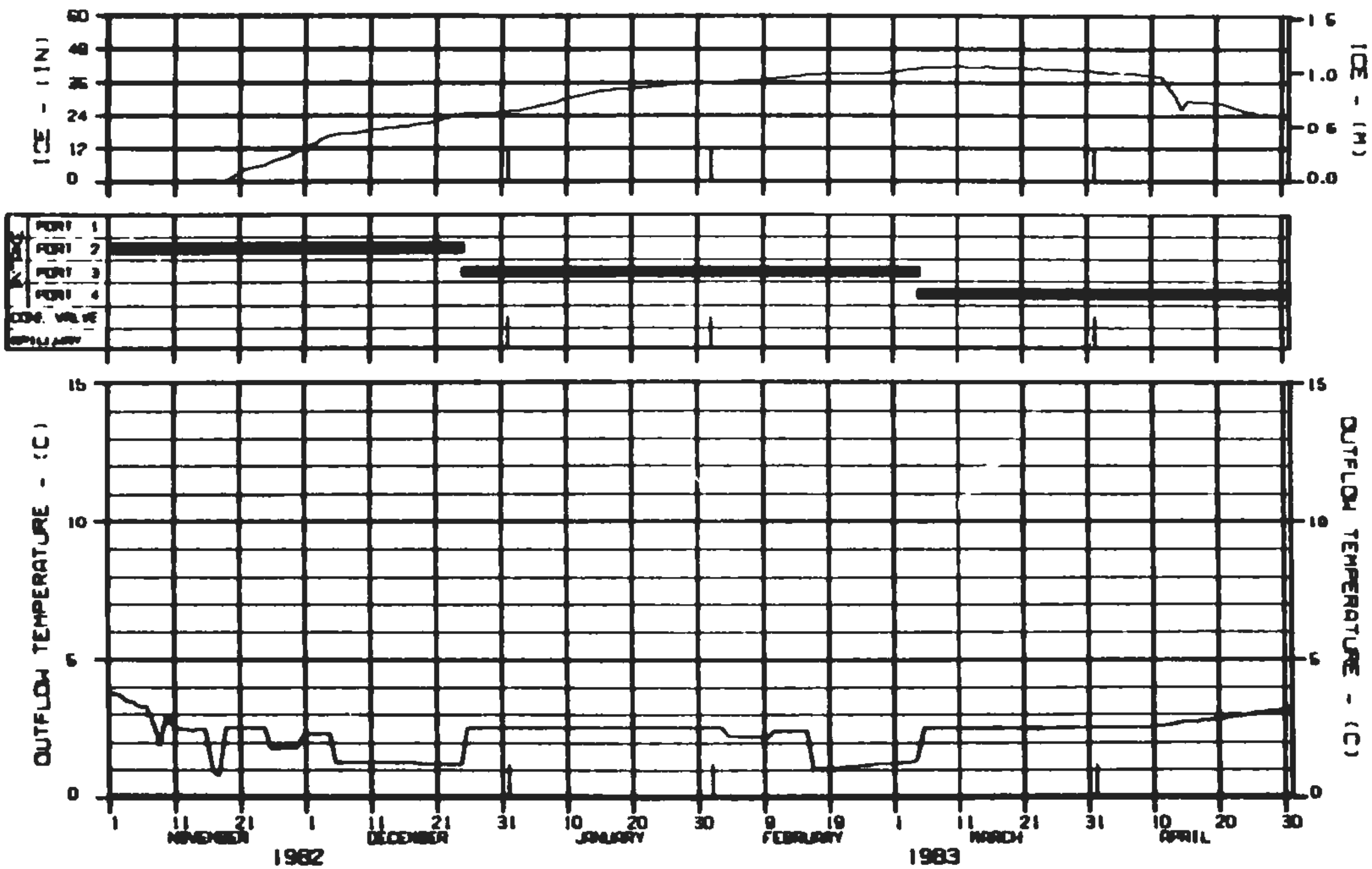
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

OPTION2



LEGEND: CASE: WA8106E

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES: 1. INTAKE PORT 1 AT ELEVATION 2161 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

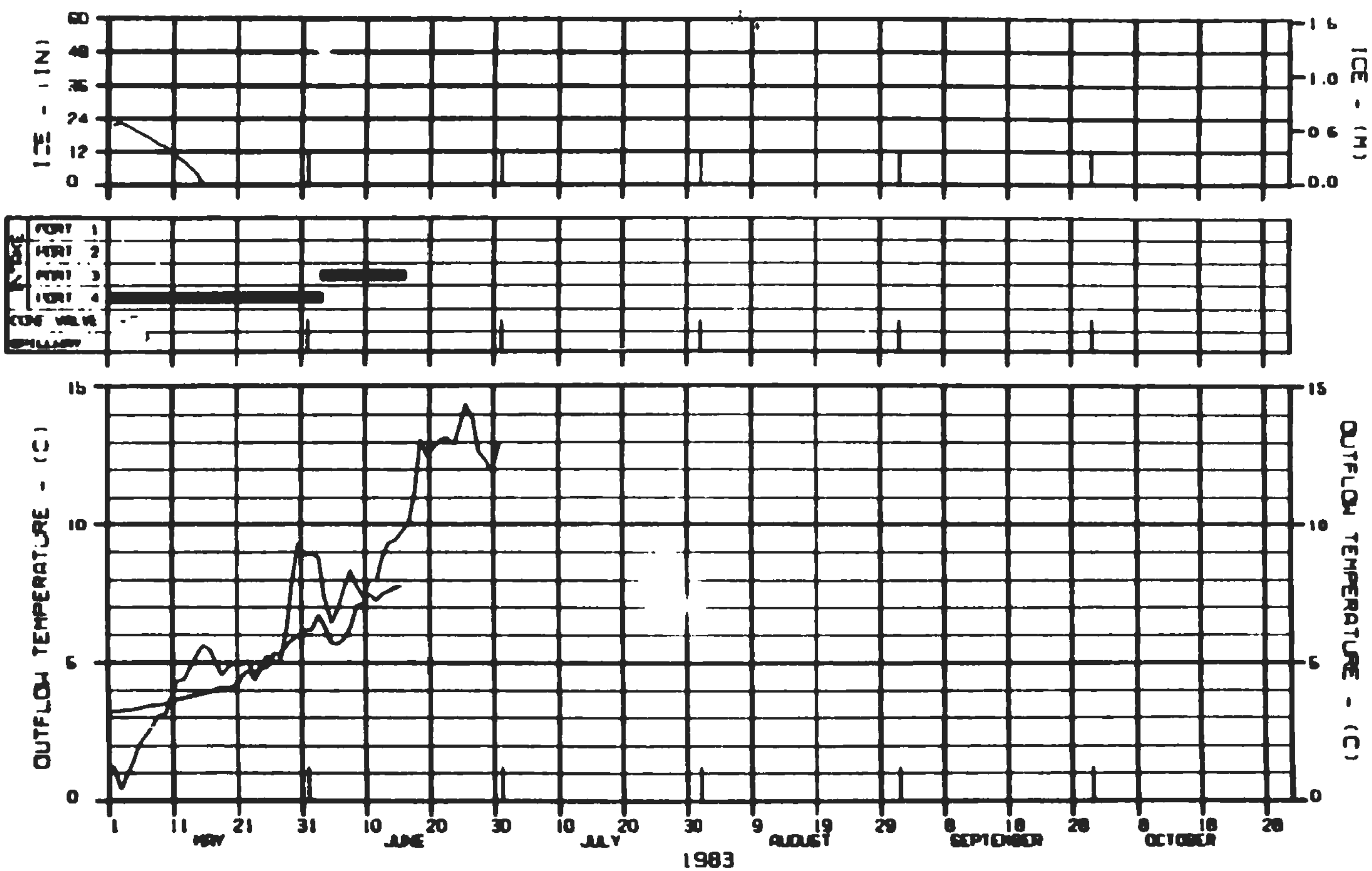
OPTION2

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE:

——— PREDICTED OUTFLOW TEMPERATURE
——— INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (666.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2140 FT (664.7 M)

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

OPTION2

HARZA-EBASCO *SUSITNA JOINT VENTURE*

MEMORANDUM

LOCATION: Chicago Office

DATE: April 6, 1984

TO: E.J. Gemperline

NUMBER: 1563.142.42-010-04

FROM: C.Y. Wei, M.F. Rogers

SUBJECT: Transfer of DYRESM Results to AEIDC

Please find enclosed two copies of the DYRESM results for the study period of May 1974 to May 1975. These results represent Run Id WA7496A and was sent to Boeing Computer Services (BCS) for AEIDC on 6 April 1984. The file name on BCS is also WA7496A which represents the following simulation conditions:

Watana Reservoir Simulation Only
Weekly Reservoir Operation
Energy Demand = 4712 GWh (1996)
Case C downstream flow requirements
4 or 6 units in the powerhouse
Rule curve per memo by N.Pansic (17 feb 84)
Reservoir allowed to surcharge to 2193 ft.
Frazil Ice inflow from 1 Nov (5%) to 1 Dec (0%) for 73 and 74
Powerhouse multilevel intake design per Acres

Spillway Crest	2148 ft.	(654.71 m)
Spillway Approach Channel Elev.	2125 ft.	(647.7 m)
Powerhouse Approach Channel Elev.	2025 ft.	(617.2 m)
Offtake No. 1 Elevation	2151 ft.	(655.6 m)
Offtake No. 2 Elevation	2114 ft.	(644.3 m)
Offtake No. 3 Elevation	2077 ft.	(633.1 m)
Offtake No. 4 Elevation	2040 ft.	(621.8 m)
Cone Valve Elevation	2040 ft.	(621.8 m)

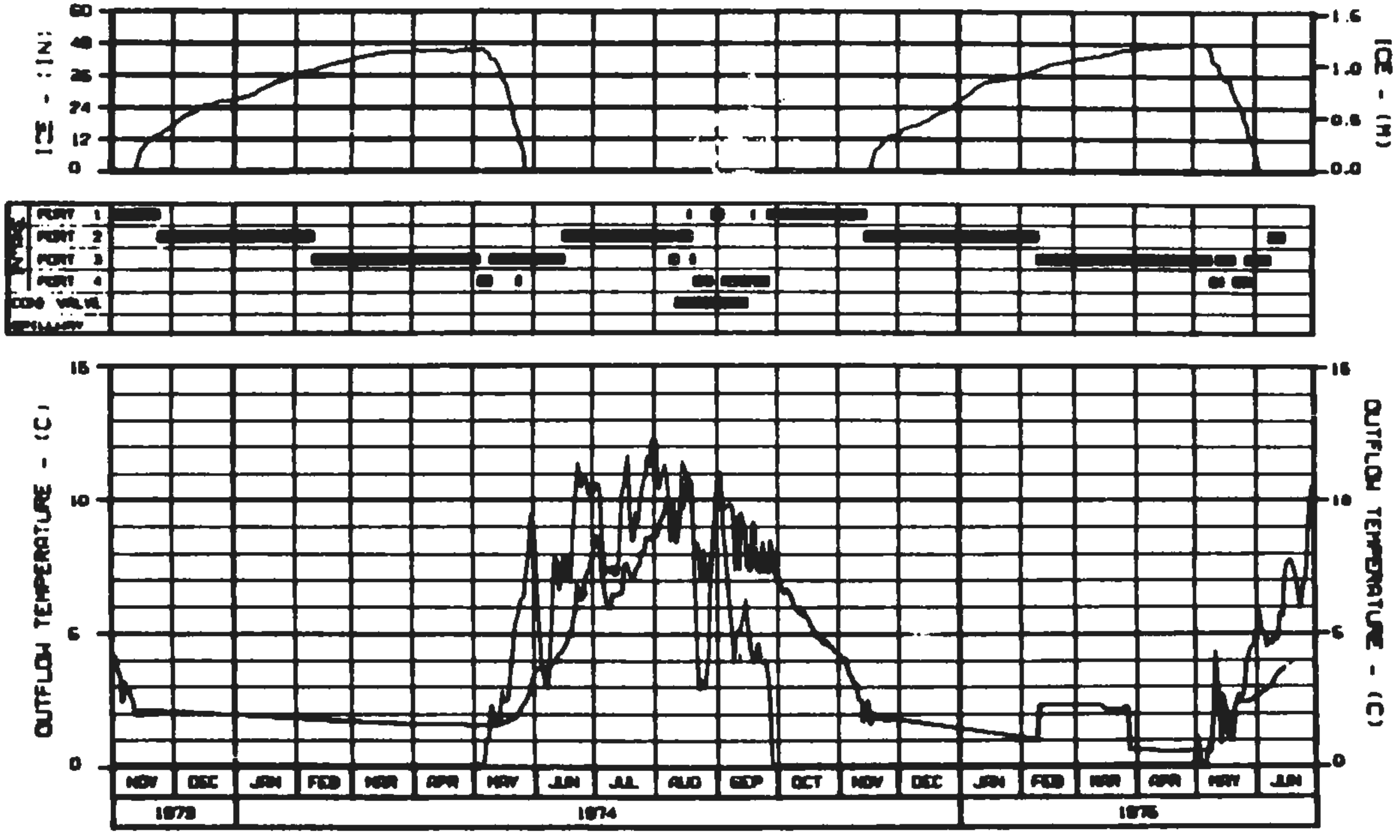
These results have also been forwarded to N. Paschke for the river ice simulation (ICECAL).

C. Y. Wei

C. Y. Wei

M. F. Rogers

M. F. Rogers

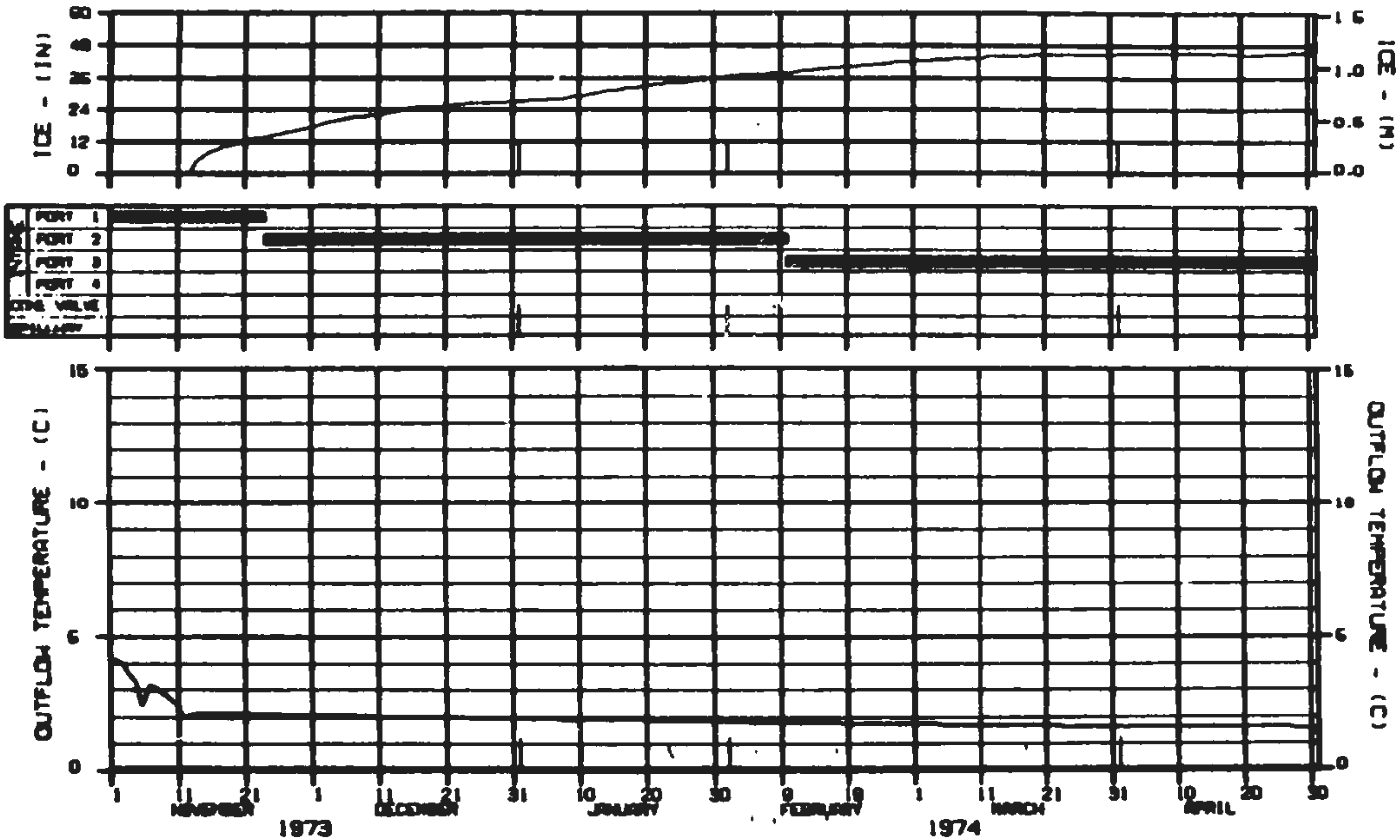


LEGEND: CASE:

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	



LEGEND: CASE: [illegible]

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

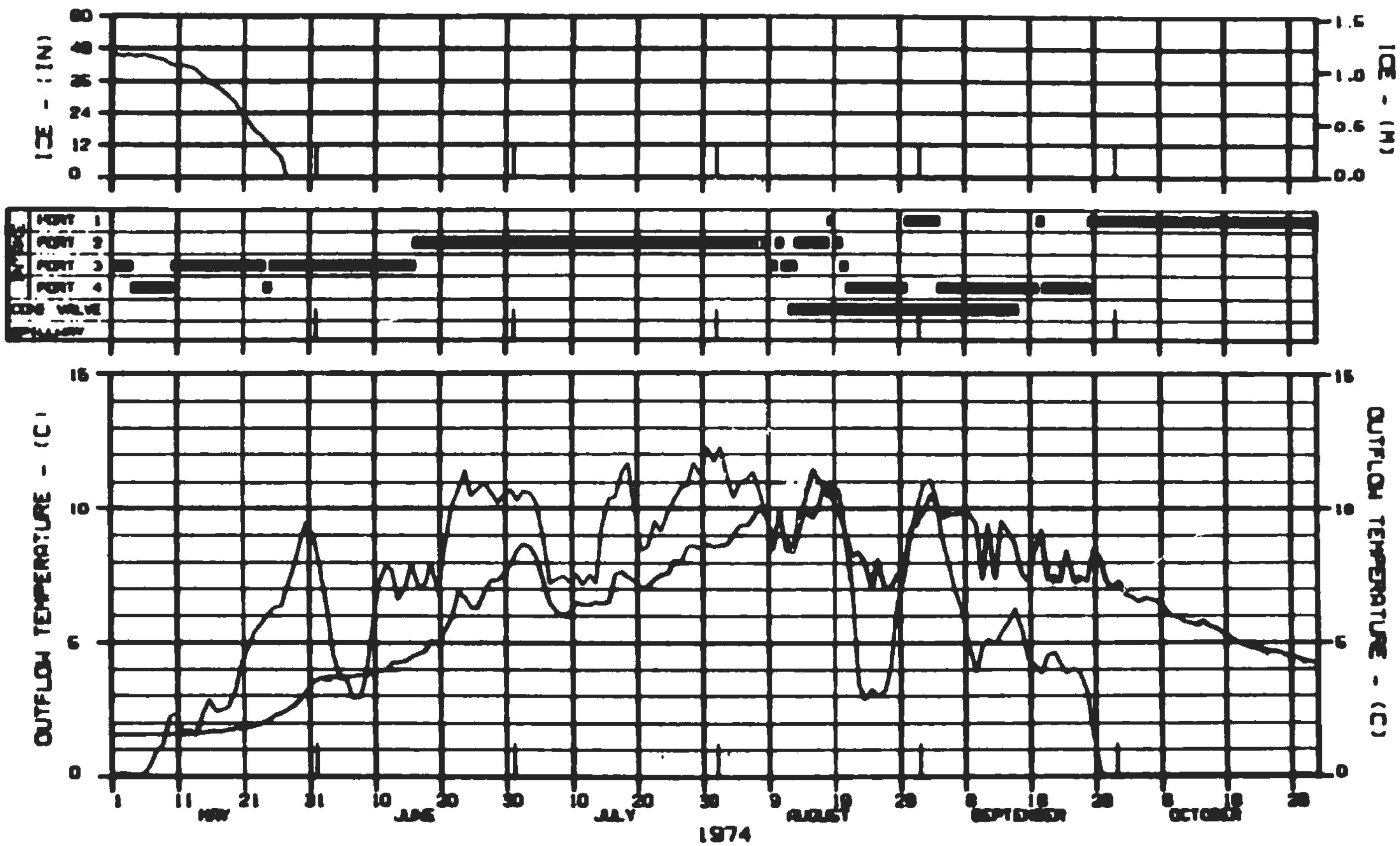
OPTION?

ALASKA POWER AUTHORITY

SUSITNA PROJECT | [illegible]

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: WA7488A

PREDICTED OUTFLOW TEMPERATURE

INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2146 FT (654.7 M)

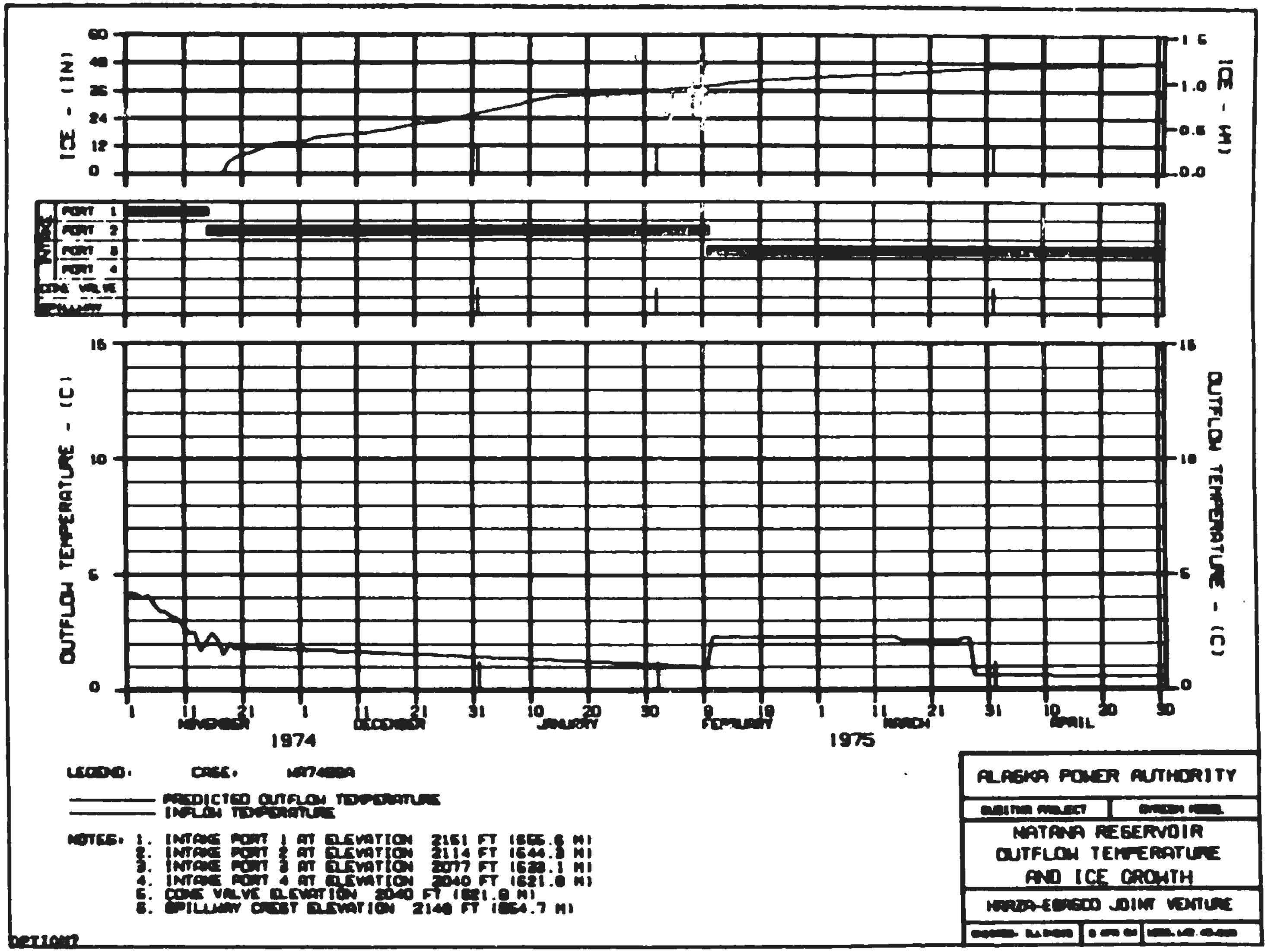
OPTION2

ALASKA POWER AUTHORITY

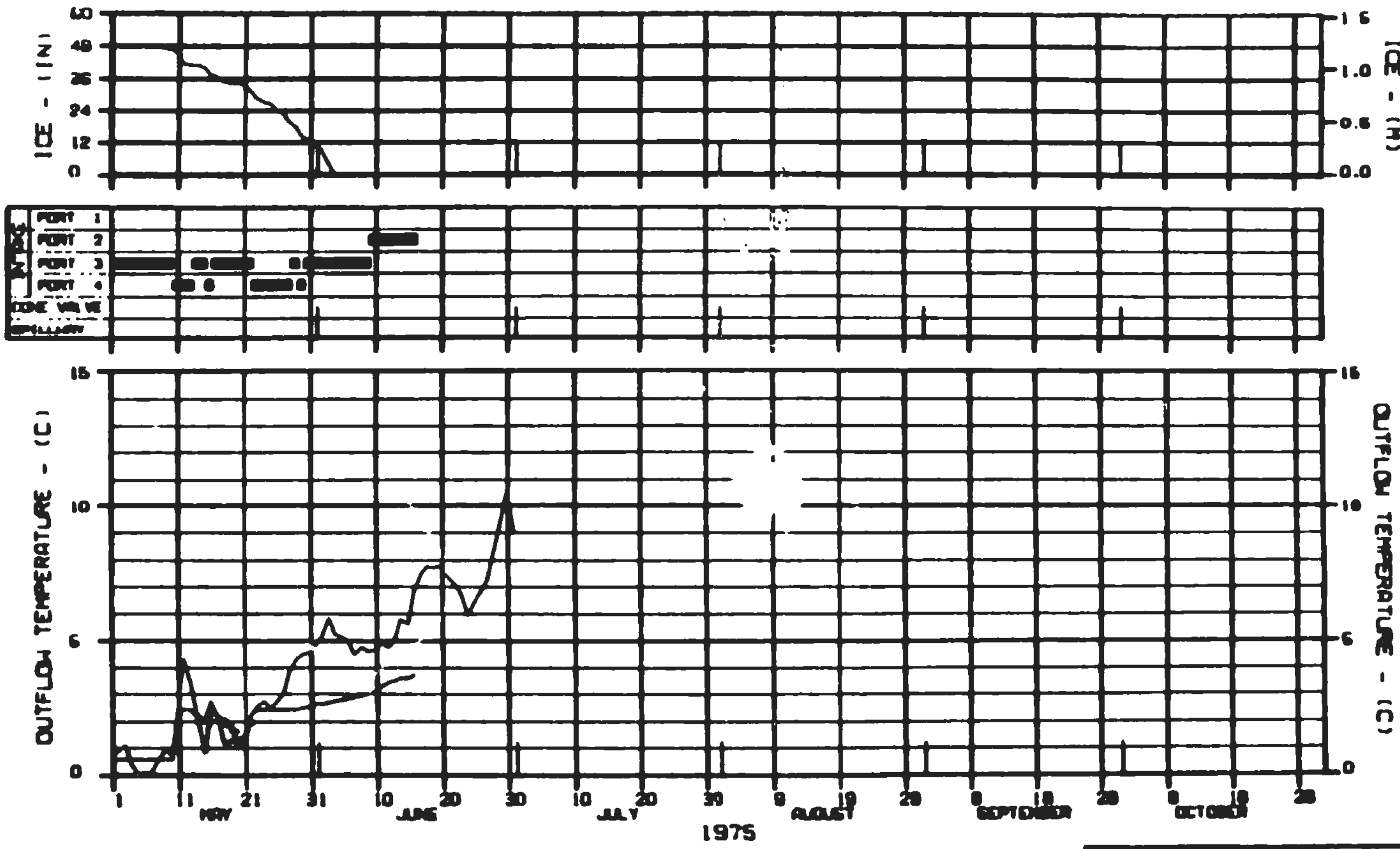
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE

PRELIMINARY



PRELIMINARY



LEGEND: CASE: [illegible]

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

OPTION[illegible]

ALASKA POWER AUTHORITY
SUSITNA PROJECT | [illegible]
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE
[illegible] | [illegible] | [illegible]

HARZA-EBASCO SUSITNA JOINT VENTURE

MEMORANDUM

LOCATION Chicago Office

DATE April 10, 1984

TO E.J. Gemperline

NUMBER 1563.142.42-010-04

FROM C.Y. Wei, M.F. Rogers

SUBJECT Transfer of DYRESM Results to AEIDC

Please find enclosed two copies of the DYRESM results for the study period of May 1974 to May 1975. These results represent Run Id WA7401A and was sent to Boeing Computer Services (BCS) for AEIDC on 10 April 1984. The file name on BCS is also WA7401A which represents the following simulation conditions:

Watana Reservoir Simulation Only
Weekly Reservoir Operation
Energy Demand = 5164 GWh (2001)
Case C downstream flow requirements
4 or 6 units in the powerhouse
Rule curve per memo by N.Pansic (17 Feb 84)
Reservoir allowed to surcharge to 2193 ft.
Frazil Ice inflow from 1 Nov (5%) to 1 Dec (0%) for 73 and 74
Powerhouse multilevel intake design per Acres

Spillway Crest	2148 ft.	(654.71 m)
Spillway Approach Channel Elev.	2125 ft.	(647.7 m)
Powerhouse Approach Channel Elev.	2025 ft.	(617.2 m)
Offtake No. 1 Elevation	2151 ft.	(655.6 m)
Offtake No. 2 Elevation	2114 ft.	(644.3 m)
Offtake No. 3 Elevation	2077 ft.	(633.1 m)
Offtake No. 4 Elevation	2040 ft.	(621.8 m)
Cone Valve Elevation	2040 ft.	(621.8 m)

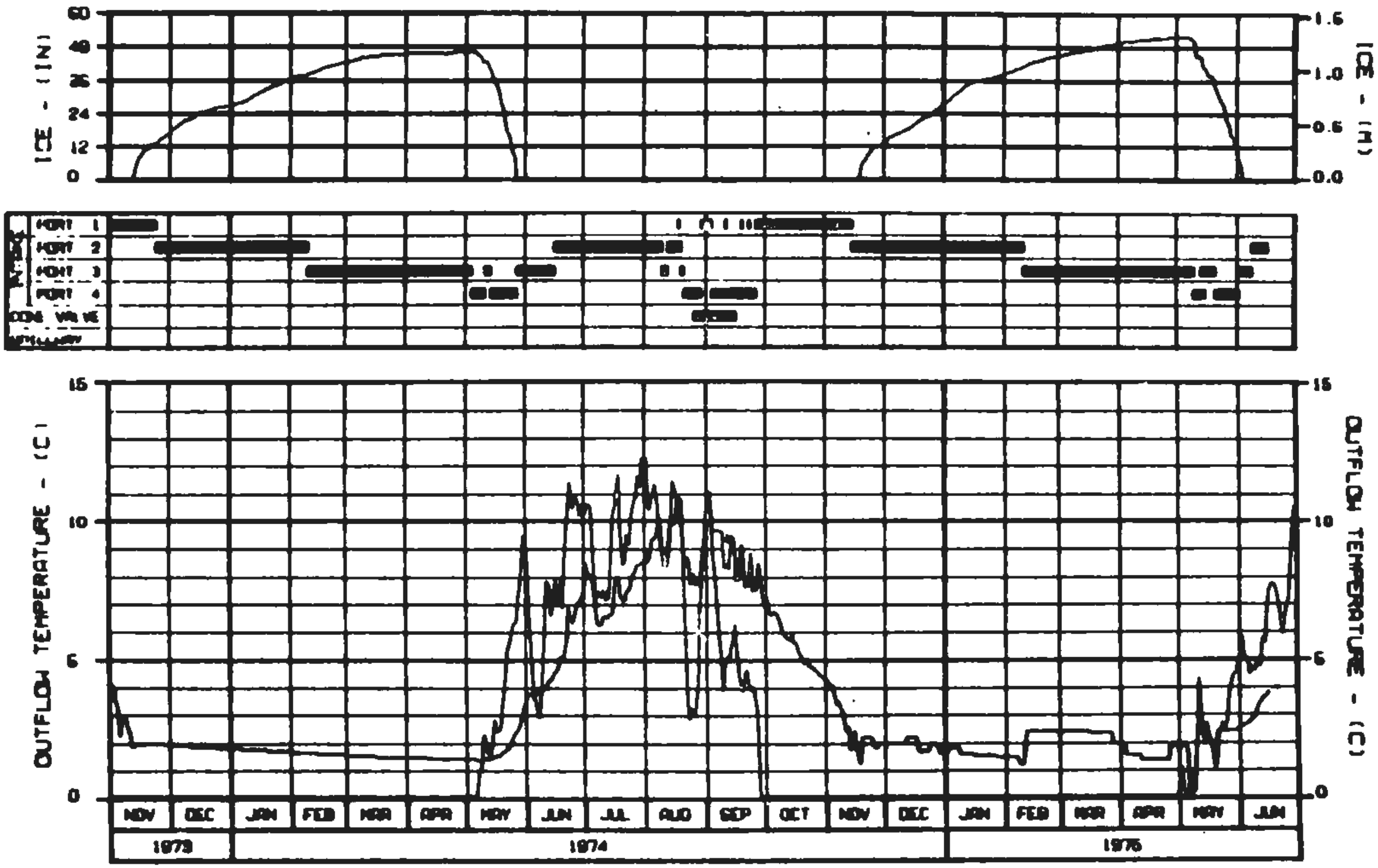
These results have also been forwarded to N. Paschke for the river ice simulation (ICECAL).

C. Y. Wei

C. Y. Wei

M. F. Rogers

M. F. Rogers



LEGEND: CASE: **** WA7401A ****

——— PREDICTED OUTFLOW TEMPERATURE
——— INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

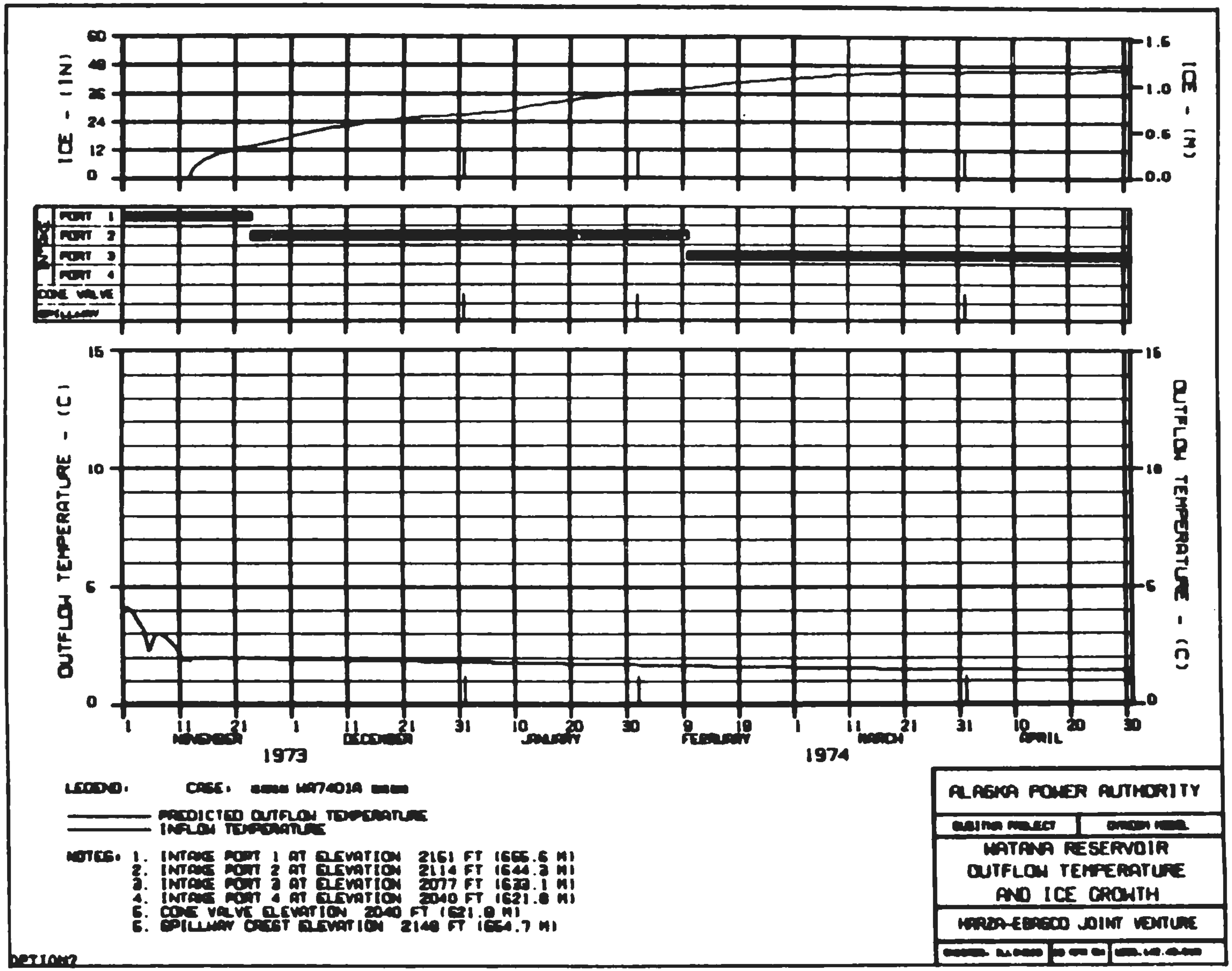
OPTION?

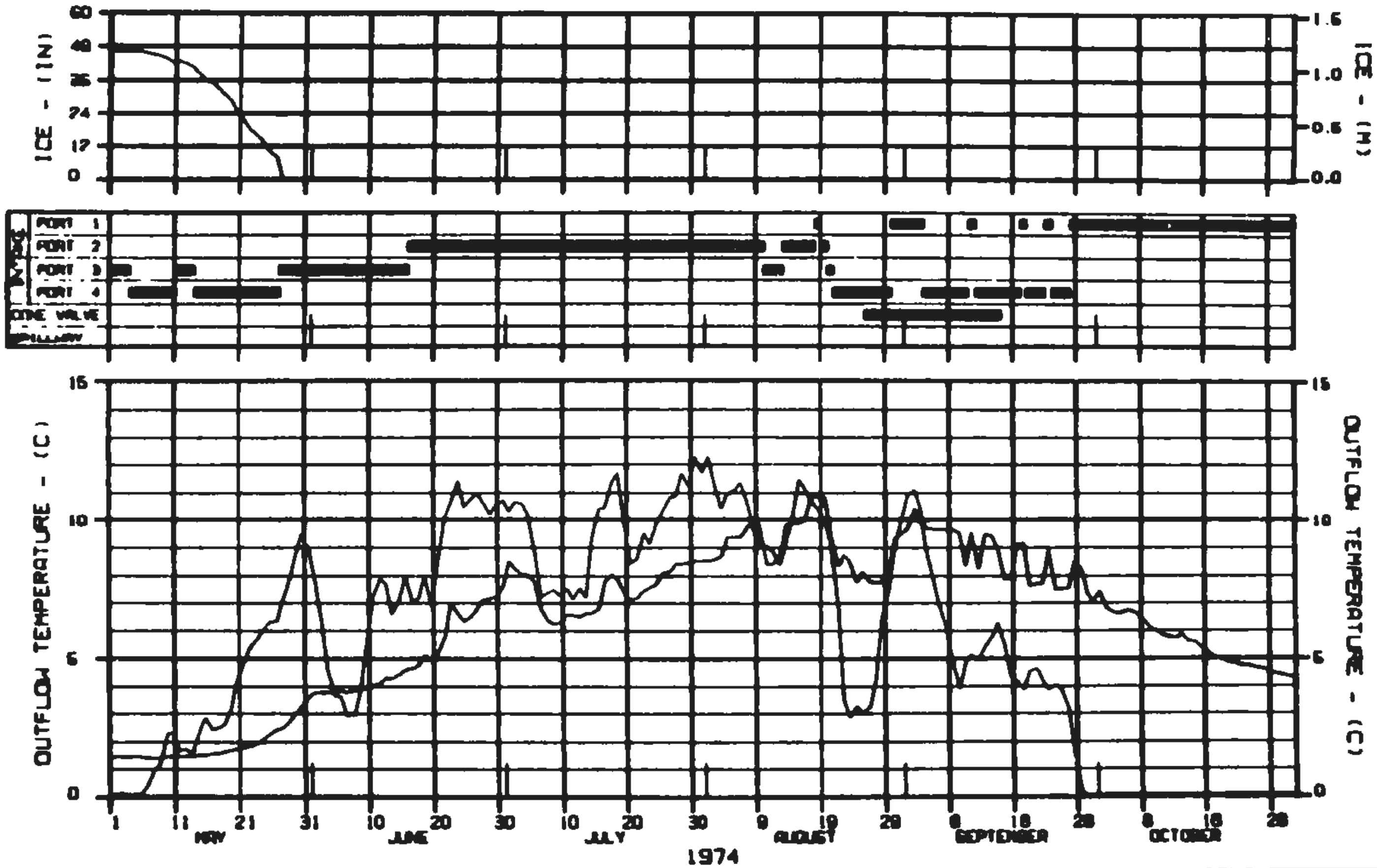
ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE


ICE - (IN)
ICE - (M)
INTAKE
PORT 1
PORT 2
PORT 3
PORT 4
CONE VALVE
SPILLWAY
OUTFLOW TEMPERATURE - (C)
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
1973
1974
LEGEND: CASE: WA7401A
PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE
NOTES: 1. INTAKE PORT 1 AT ELEVATION 2161 FT (658.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)
ALASKA POWER AUTHORITY
SUSITNA PROJECT
WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH
HARZA-EBASCO JOINT VENTURE
OPTION2



LEGEND: CASE: HA7401A

PREDICTED OUTFLOW TEMPERATURE
INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2161 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

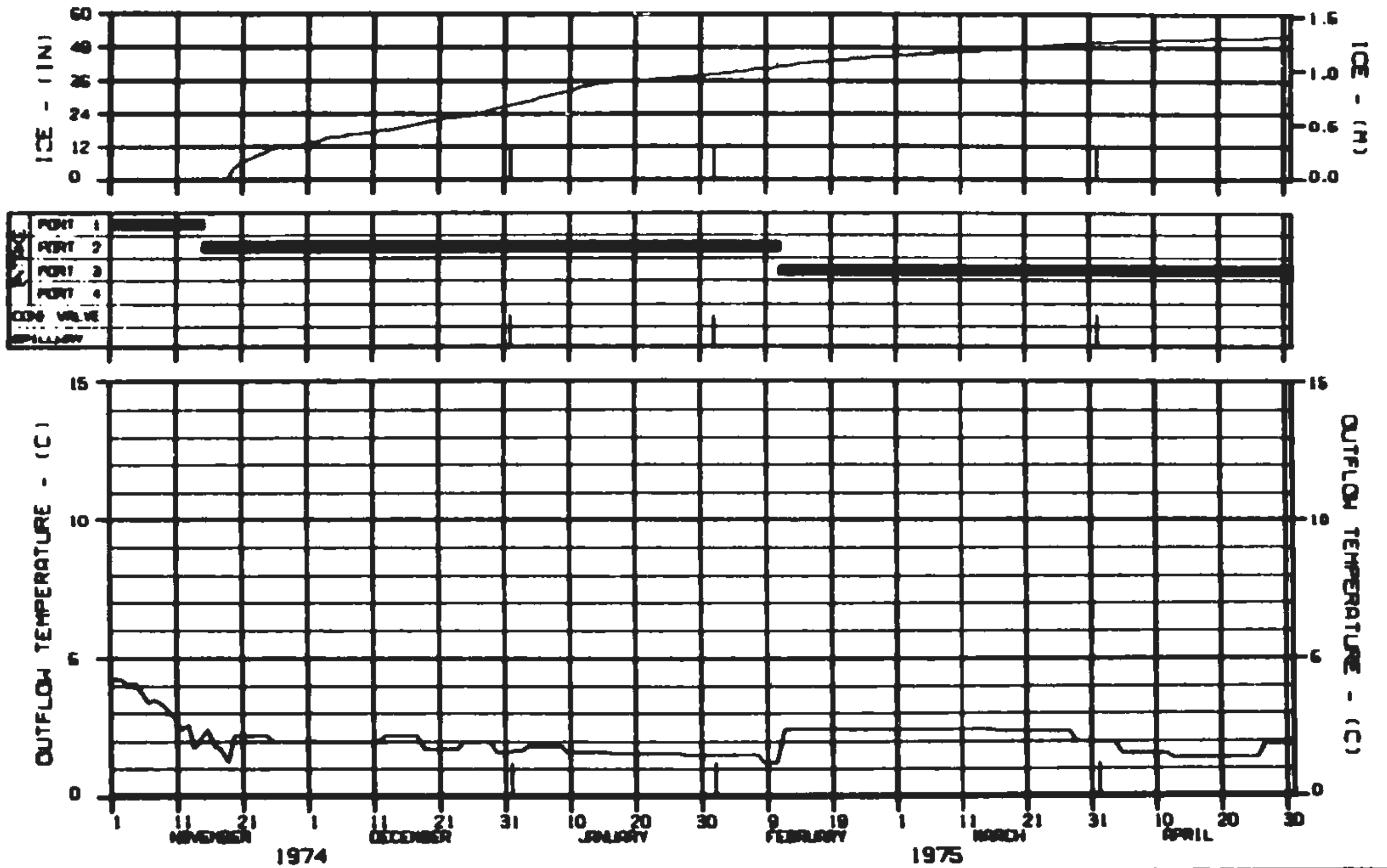
OPTION2

ALASKA POWER AUTHORITY

SUSITNA PROJECT

WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: **** WA7401A ****

——— PREDICTED OUTFLOW TEMPERATURE
——— INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

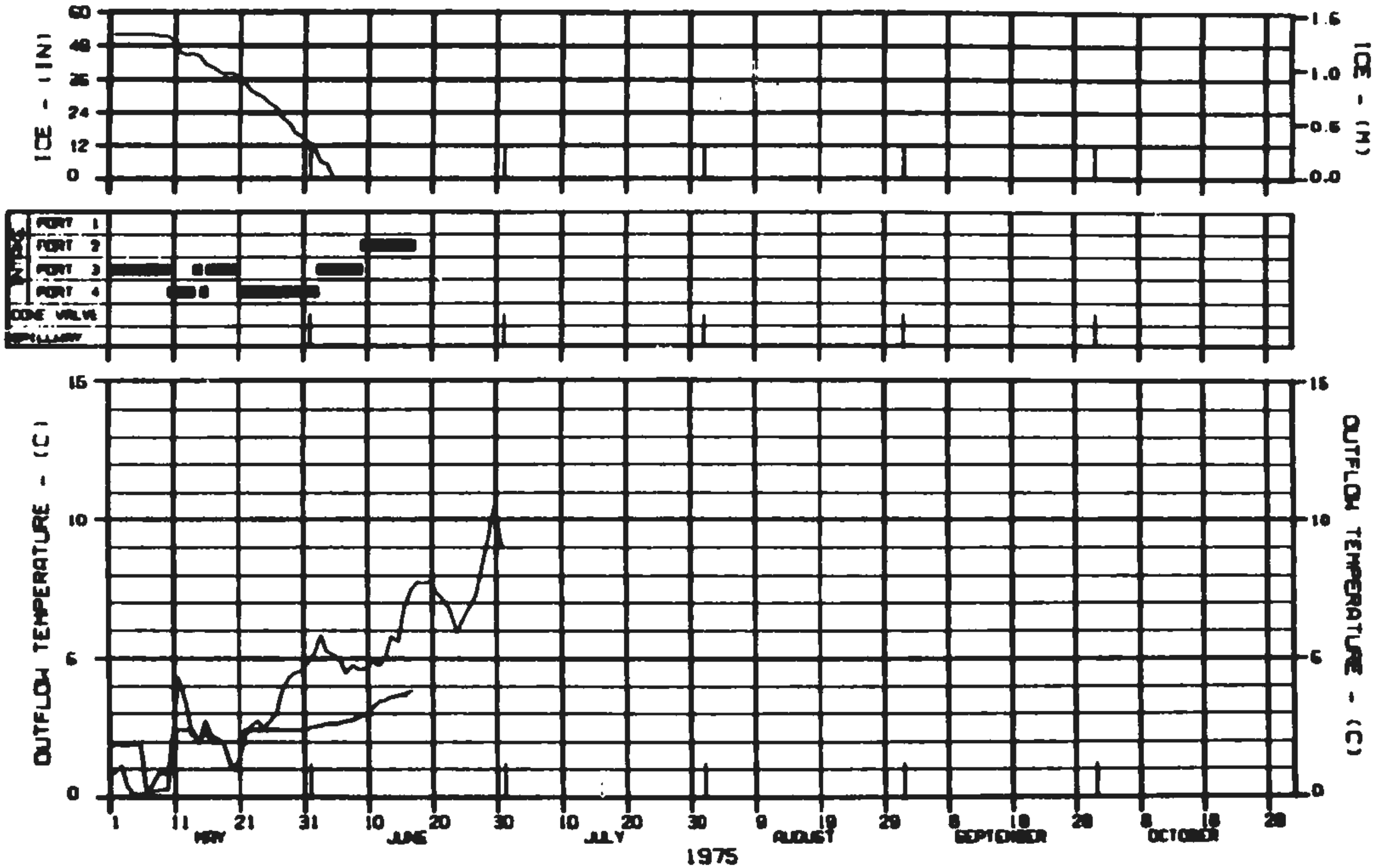
OPTION2

ALASKA POWER AUTHORITY

SUSITNA PROJECT | DYRESM MODEL

WATANA RESERVOIR
OUTFLOW TEMPERATURE
AND ICE GROWTH

HARZA-EBASCO JOINT VENTURE



LEGEND: CASE: **** WA7401A ****

PREDICTED OUTFLOW TEMPERATURE

INFLOW TEMPERATURE

NOTES:
1. INTAKE PORT 1 AT ELEVATION 2151 FT (655.6 M)
2. INTAKE PORT 2 AT ELEVATION 2114 FT (644.3 M)
3. INTAKE PORT 3 AT ELEVATION 2077 FT (633.1 M)
4. INTAKE PORT 4 AT ELEVATION 2040 FT (621.8 M)
5. CONE VALVE ELEVATION 2040 FT (621.8 M)
6. SPILLWAY CREST ELEVATION 2148 FT (654.7 M)

OPTION2

ALASKA POWER AUTHORITY	
SUSITNA PROJECT	
WATANA RESERVOIR OUTFLOW TEMPERATURE AND ICE GROWTH	
HARZA-EBASCO JOINT VENTURE	