

SUSITNA RIVER ICE PROCESSES: NATURAL CONDITIONS AND
PROJECTED EFFECTS OF HYDROELECTRIC DEVELOPMENT

VOLUME II

LIST OF FIGURES

Volume II
Page No.

Figure No.

1.	Basin Map.....	1
2.	Basin Map Upper River.....	2
3.	Basin Map Middle River.....	3
4.	Basin Map Lower River.....	4
5.	Average Historical Accumulated Freezing Degree Days 1980-1983.....	6
6.	Upper Susitna River Basin Air Temperature Variation.....	8
7a.	Middle River Mean Daily Air Temperature Record December 1984.....	10
7b.	Lower River Mean Daily Air Temperatures October-December 1984.....	10
8.	Monthly Precipitation Data.....	12
9.	Photo of Upper River Reach at Denali Highway Bridge.....	14
10.	Photo of slush ice at gold Creek October 17, 1983.....	16
11.	Photo of typical slush ice raft.....	18
12.	Photo of snow slush near the Chulitna River Confluence.....	20
13.	Photo of shore ice developing downstream of Vee Canyon.....	22
14.	Photo of shore ice on the left bank at the Chulitna River Confluence.....	24
15.	Photo of Susitna River mouth.....	26
16.	Photo of Yenta River Confluence.....	28
17.	Photo of Kashwitna River Confluence.....	30
18.	Photo of Goose Creek Confluence.....	32
19.	Typical ice cover development on lower and middle river.....	34
20.	Relative stage levels at selected sites during 1983 Susitna River freezeup.....	36
21.	Photo of Susitna-Chulitna-Talkeetna Confluence.....	38

LIST OF FIGURES (Continued)

Volume II

<u>Figure No.</u>	<u>Page No.</u>
22. Photo of Middle River ice bridge and Leading Edge.....	40
23. Photo of ice bridge at RM 105; November 4, 1984.....	42
24. Photo of RM 105 November 17, 1982.....	42
25. Photo of Whiskers Creek.....	44
26a. Photo of RM 103.3 December 28, 1983.....	45
26b. Photo of downstream of RM 103 Dec 28, 1983 ..	45
27a. Photo of Lane Creek area Nov, 1982 ..	48
27b. Photo of Lane Creek area Dec, 1982 ..	48
28. Photo of Shore Ice at Devil Canyon.....	50
29. Photo looking upstream from RM 134 December 1983.....	52
30. Photo of anchor ice dam near Slough 21.....	54
31. Photo looking downstream at anchor ice dam at RM 144.5.....	56
32. Photo Gold Creek November 17, 1982 and December 23, 1982.....	58
33. Photo of Anchor Ice Dam.....	60
34. Photo of Slough 8A November 17, 1982 and December 23, 1982.....	62
35a. Photo of Slough 9 November 17, 1982.....	64
35b. Photo of Slough 9 December 23, 1982.....	64

LIST OF FIGURES (Continued)

<u>Figure No.</u>	<u>Page No.</u>
36. Annual variation of freezing degree days from 1980-1984.....	66
37. Annual variation of stream flow during freezeup.....	68
38. Ice front progression relative to cumulative freezing degree days.....	70
39. Water temperatures at Gold Creek.....	72
40. Photo of Candling.....	74
41. Photo of simple ice jam, RM 134.....	76
42. Photo of an in situ ice cover melting during breakup.....	78
43. Photo of a grounded or dry jam at RM 131.....	80
44. Photo of ice jam producing island overtopping near RM 131, May 7, 1983.....	82
45. Photo of overtopped island and damage to mature vegetation.....	84
46. Photo of showing in an ice jam.....	86
47. Photo taken after release of ice jam at RM 101.....	88
48. Photo of a shear zone between flooding and grounded ice at RM 105.....	90
49. Photo of an ice shear wall, RM 137.....	92
50. Photo of rafting of large cobbles near Slough 21.....	94
51. Photo of sediment deposited by ice.....	96
52. Photo of formation of Slough 11 by ice scouring.....	98
53. Susitna - Talkeetna air temperatures November - March.....	100
54. Average monthly air temperatures at Talkeetna.....	102
55. Susitna River natural streamflow.....	103
56. Release constraints discharge for Susitna at Gold Creek.....	104

LIST OF FIGURES (Continued)

<u>Figure No.</u>	<u>Page No.</u>	Volume II
57. Watana Reservoir ice growth 1996 Case C.....	105	
58. Devil Canyon Reservoir ice growth 2002 Case C.....	106	
59. Watana Reservoir water levels.....	107	
60. Watana Reservoir water levels Watana and Devil Canyon operating 2002.....	108	
61. Watana Reservoir Water Levels; Watana and Devil Canyon Operating 2020 Simulation Case E-VI.....	109	
62. Devil Canyon Water Levels 2002 Simulation Case E-VI.....	110	
63. Devil Canyon Water Levels.....	111	
64. Photo reservoir bank erosion caused and influenced by ice cover.....	112	
65. Middle Reach Ice Front Maximum Progression.....	113	
66. Middle Reach Ice Cover Duration.....	114	
67. Su Hydro Maximum Simulated Winter River Stages.....	115	
68. Susitno Hydro - Total Ice Thickness Maximum Simulated Values.....	116	
69. Winter 1971-72 maximum slough stages.....	117	
70. Winter 1976-77 maximum slough stages.....	118	
71. Winter 1981-82 maximum slough stages.....	119	
72. Winter 1982-83 maximum slough stages.....	120	
73. Winter 1971-72 Total Ice Thickness.....	121	
74. Winter 1976-77 Total Ice Thickness.....	122	
75. Winter 1981-82 Total Ice Thickness.....	123	
76. Winter 1982-83 Total Ice Thickness.....	124	
77. Watana Filling Maximum Slough Stages.....	125	
78. Winter 1971-72 Filling Maximum Slough Stages.....	126	
79. Winter 1981-82 Maximum Slough Stages Case C vs.		

LIST OF FIGURES (Continued)

<u>Figure No.</u>	<u>Page No.</u>
Case E-VI 2001.....	127
80. Winter 1981-82 Maximum Slough Stages Case C Vs. Case E-VI 2002	128
81. Winter 1981-82 Middle Reach Freeze-up Simulated Pre-Project.....	129
82. Winter 1981-82 Middle Reach Freezeup With-Project-1996.....	130
83. Middle Reach Freeze-up With-Project Winter 1981-82.....	131
84. Middle Reach Freeze-up Simulated Preproject Winter 1982-83.....	132
85. Middle Reach Freezeup Simulated Preproject Winter 1982-83.....	133
86. Middle Reach freezeup with-project 1996 winter 1982-83.....	134
87. Plan view showing flow components typical slough.....	135
88. Detail of Intragravel Flow From Exhibit 34.....	136
89. Susitna River Drainage Basin Species by Study Zone.....	137
90. Month river crossing initiated.....	138
91. Nelchina caribout head estimates.....	139
92. Historical range of the Nelchina caribout herd.....	140
93. Dall sheep study area.....	141
94. The Jay Creek mineral lick complex.....	142

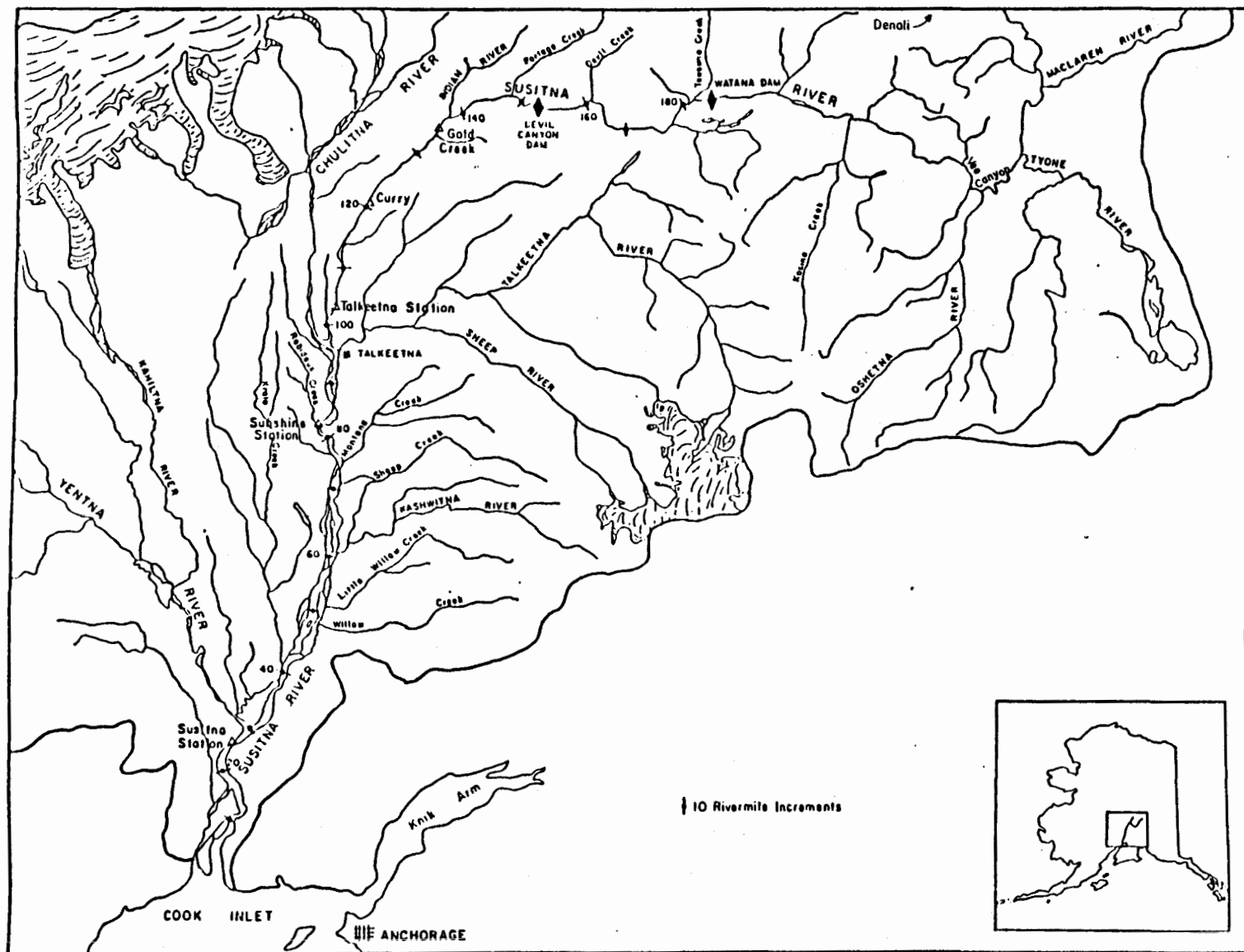


Figure 1. Map of the Susitna basin study region.

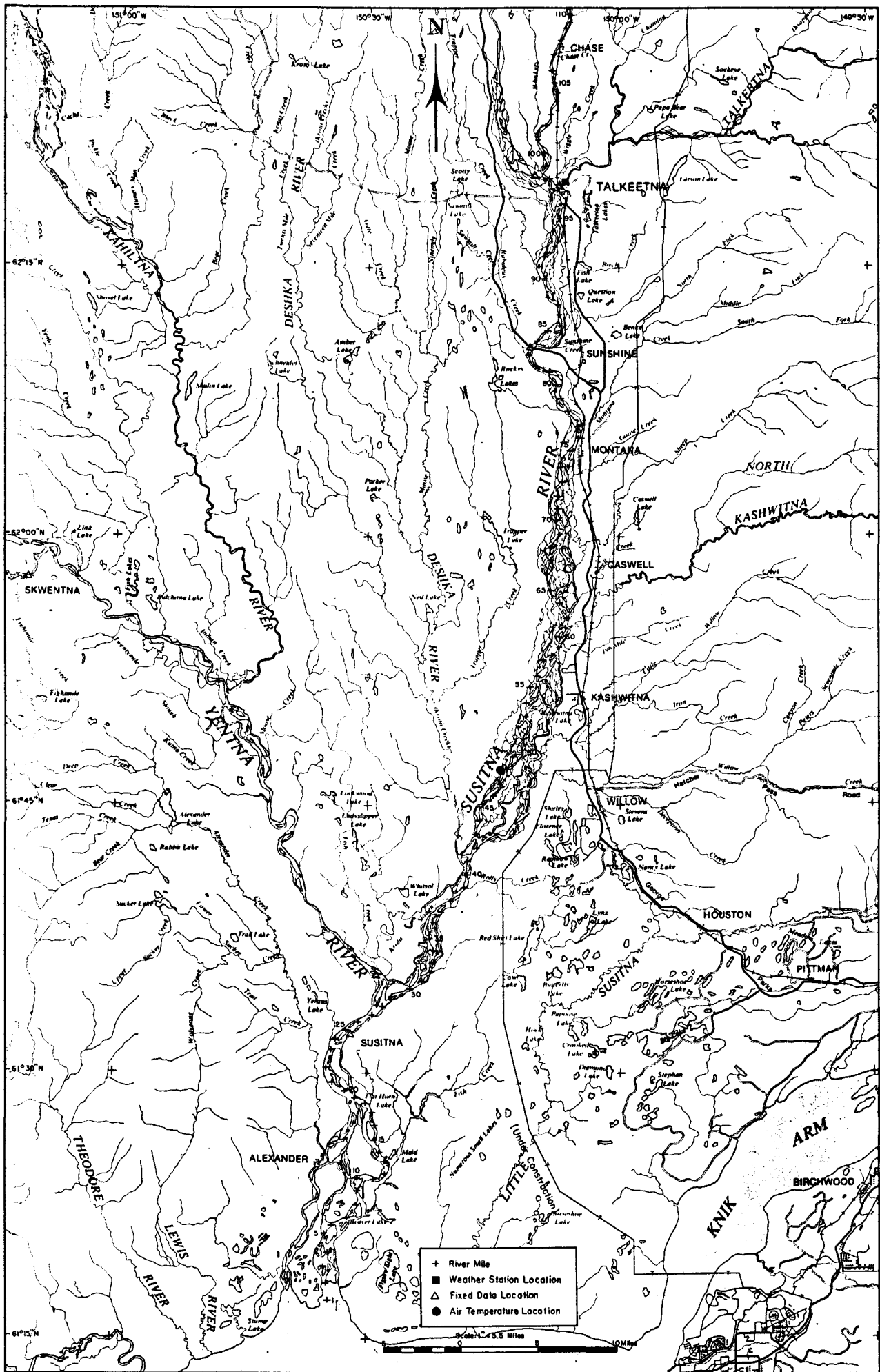


Figure 2. Lower River

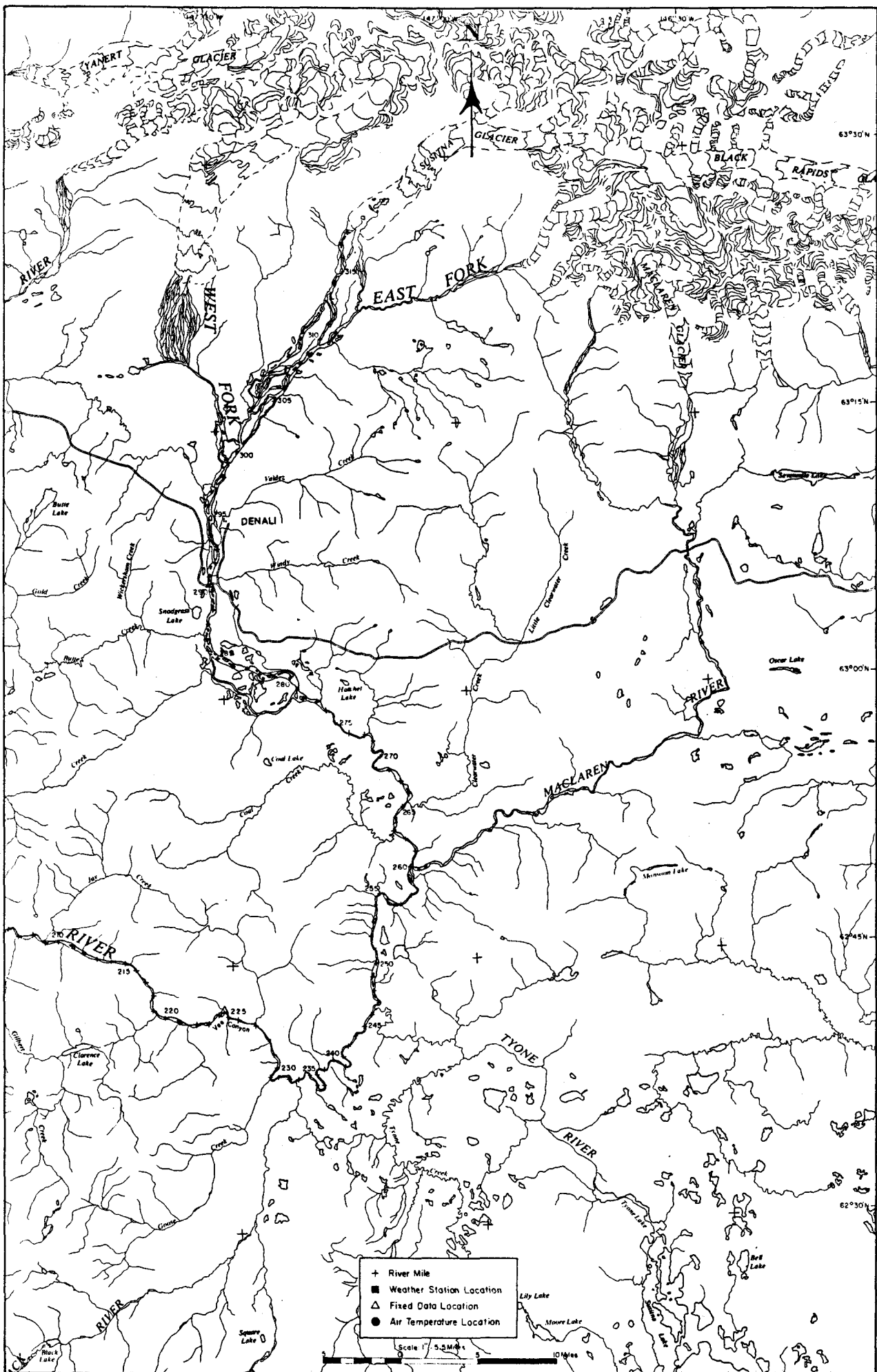
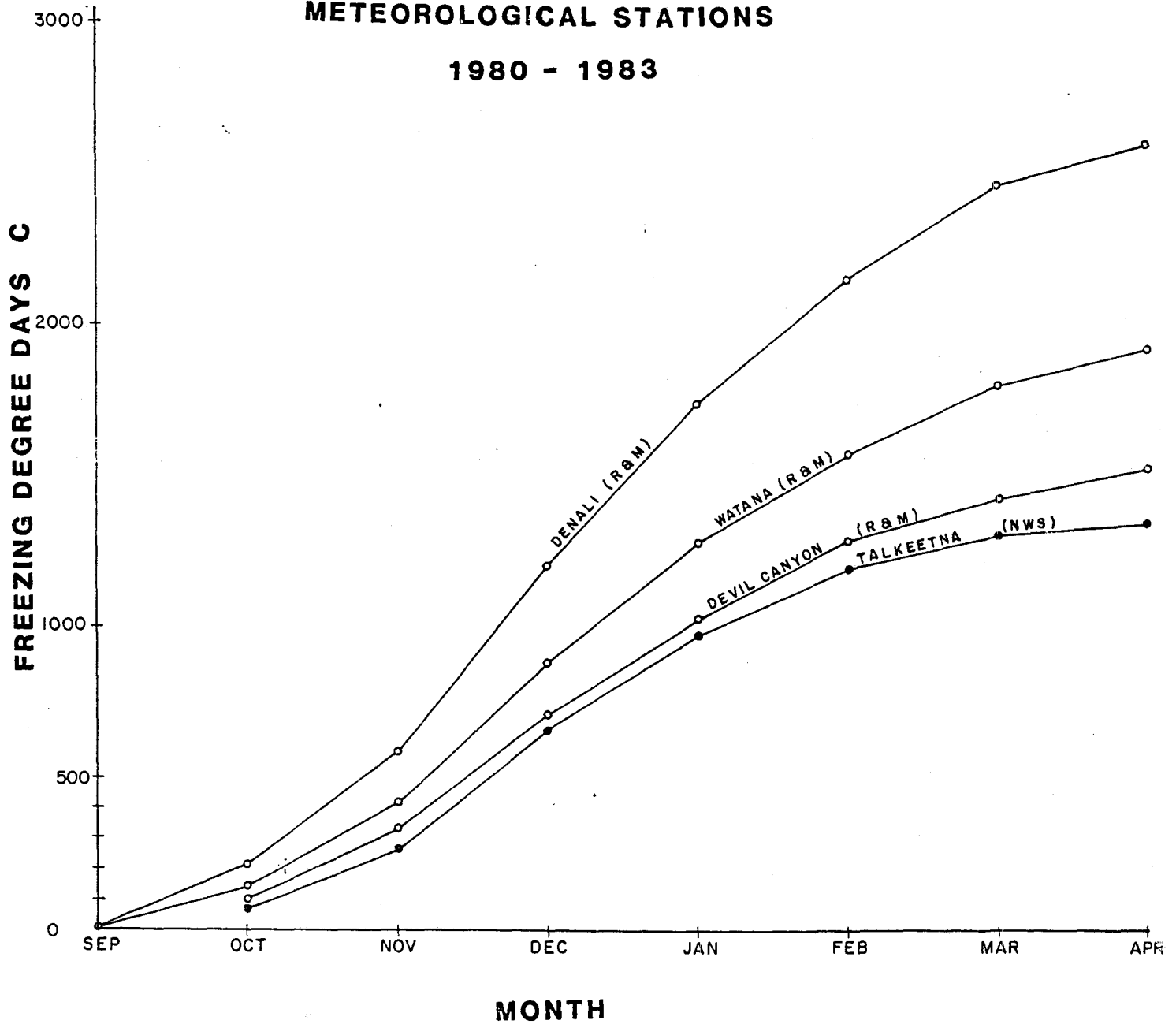


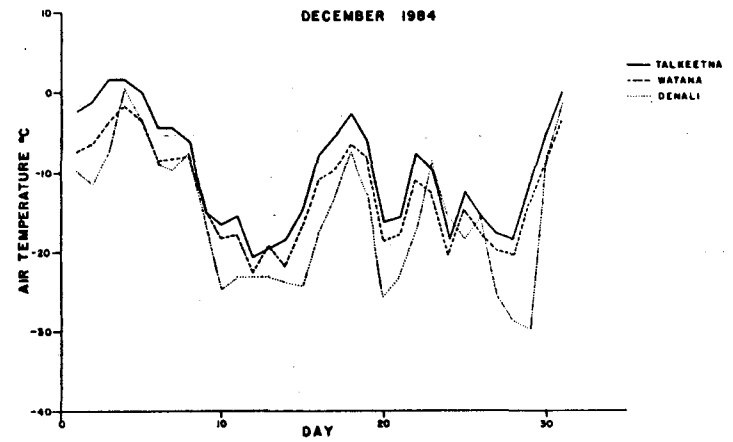
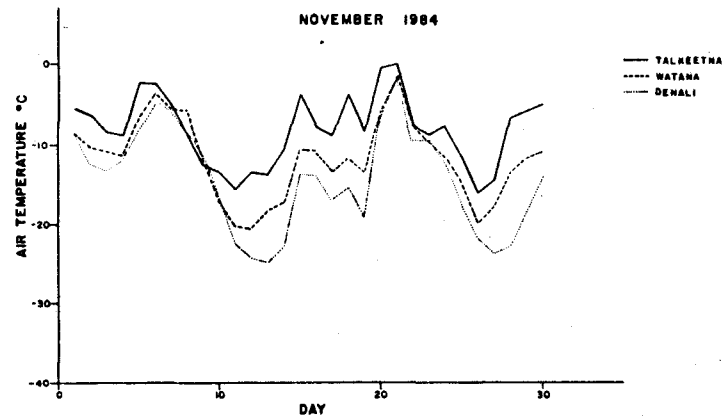
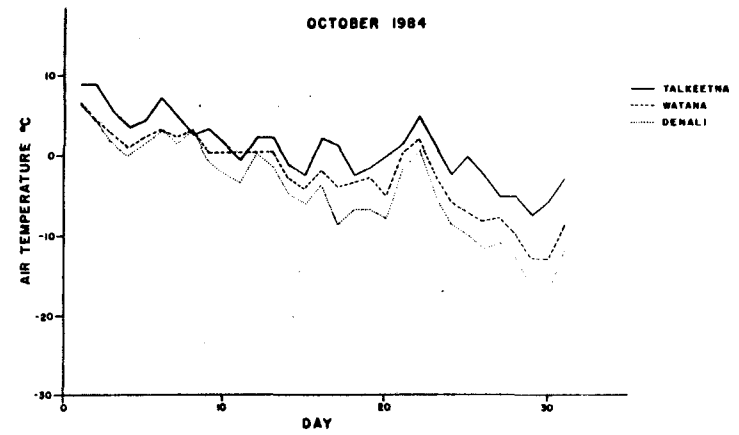
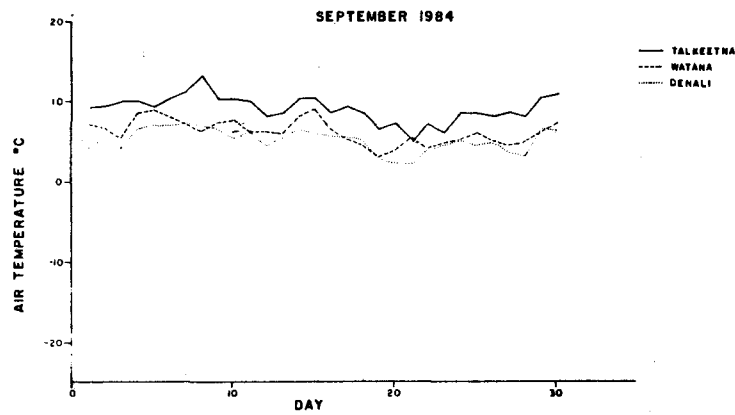
Figure 4. Upper River

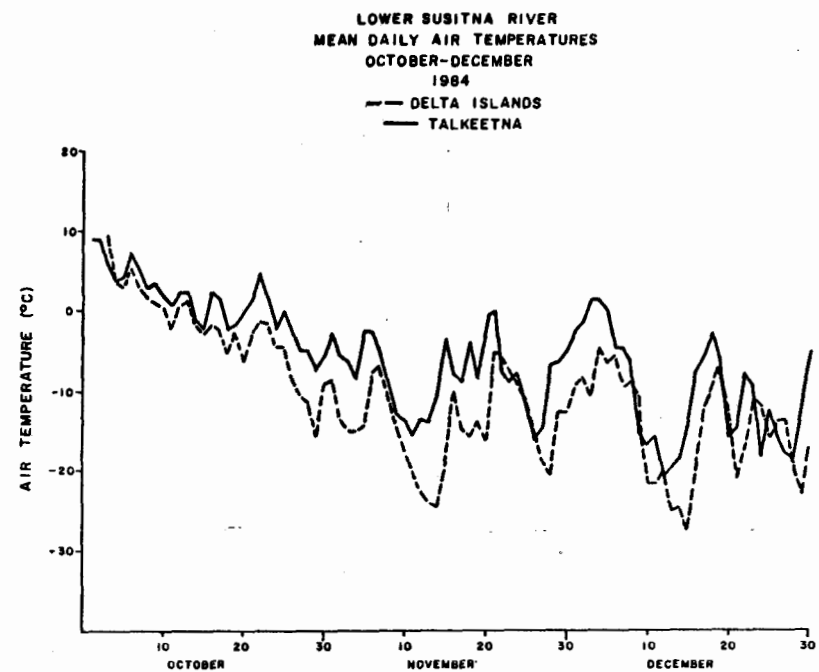
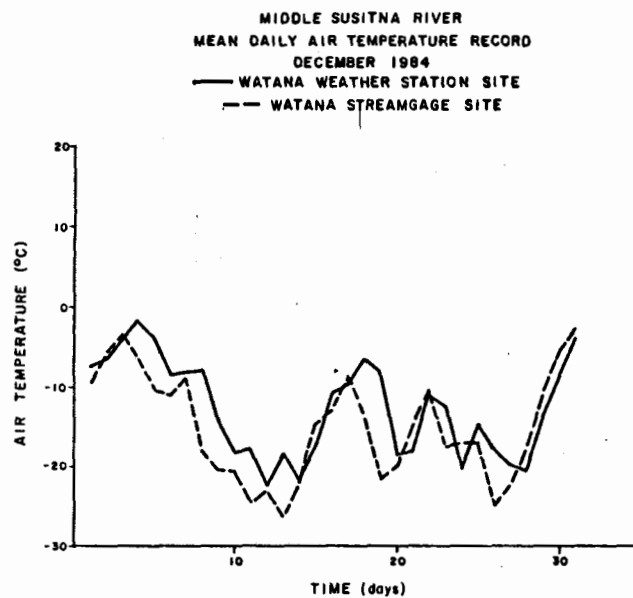
**AVERAGE HISTORICAL
ACCUMULATED FREEZING DEGREE DAYS
FOR SUSITNA RIVER BASIN
METEOROLOGICAL STATIONS
1980 - 1983**



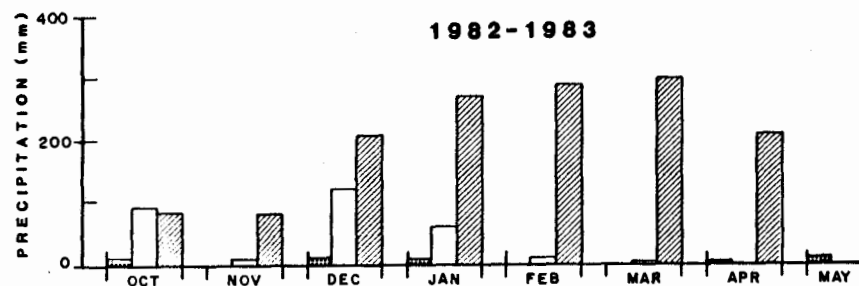
FIGURE

UPPER SUSITNA RIVER BASIN AIR TEMPERATURE VARIATION

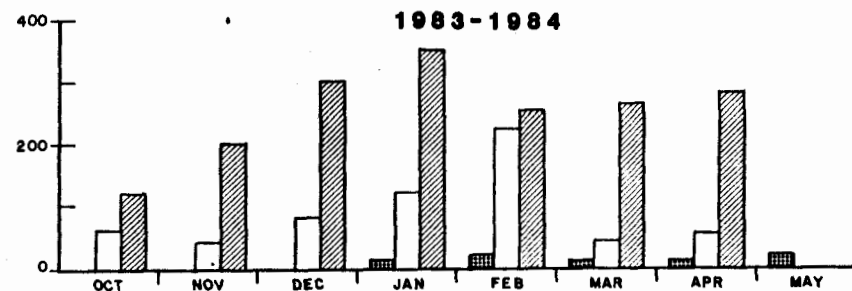




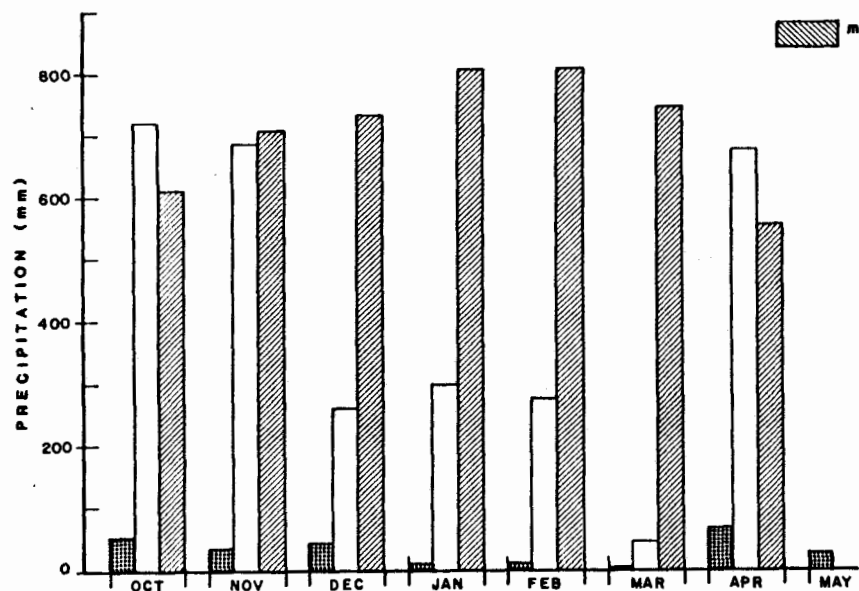
MONTHLY PRECIPITATION DATA



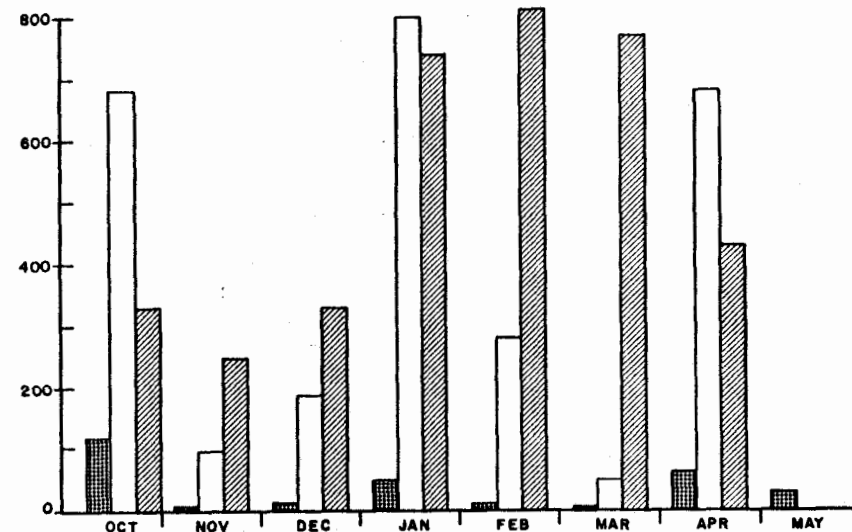
Location: WATANA



Location: WATANA



Location: TALKEETNA



Location: TALKEETNA

12



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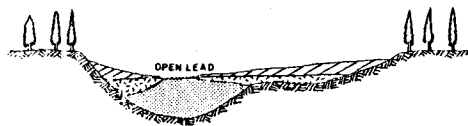
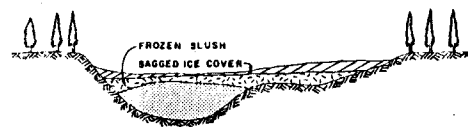
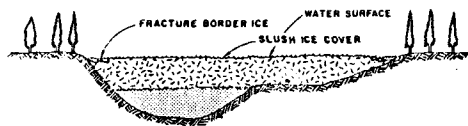
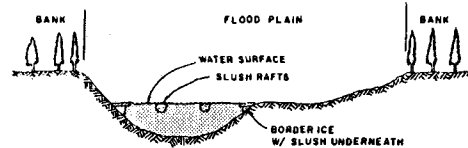




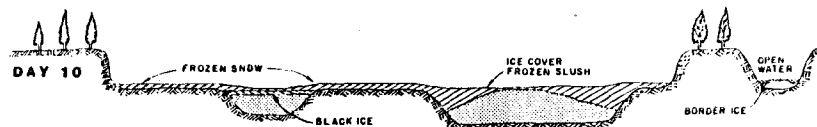
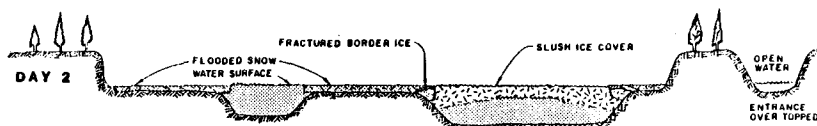
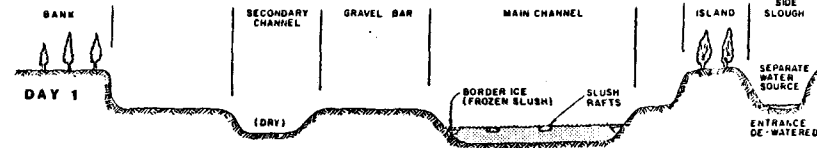




MIDDLE RIVER TYPICAL CROSS SECTION



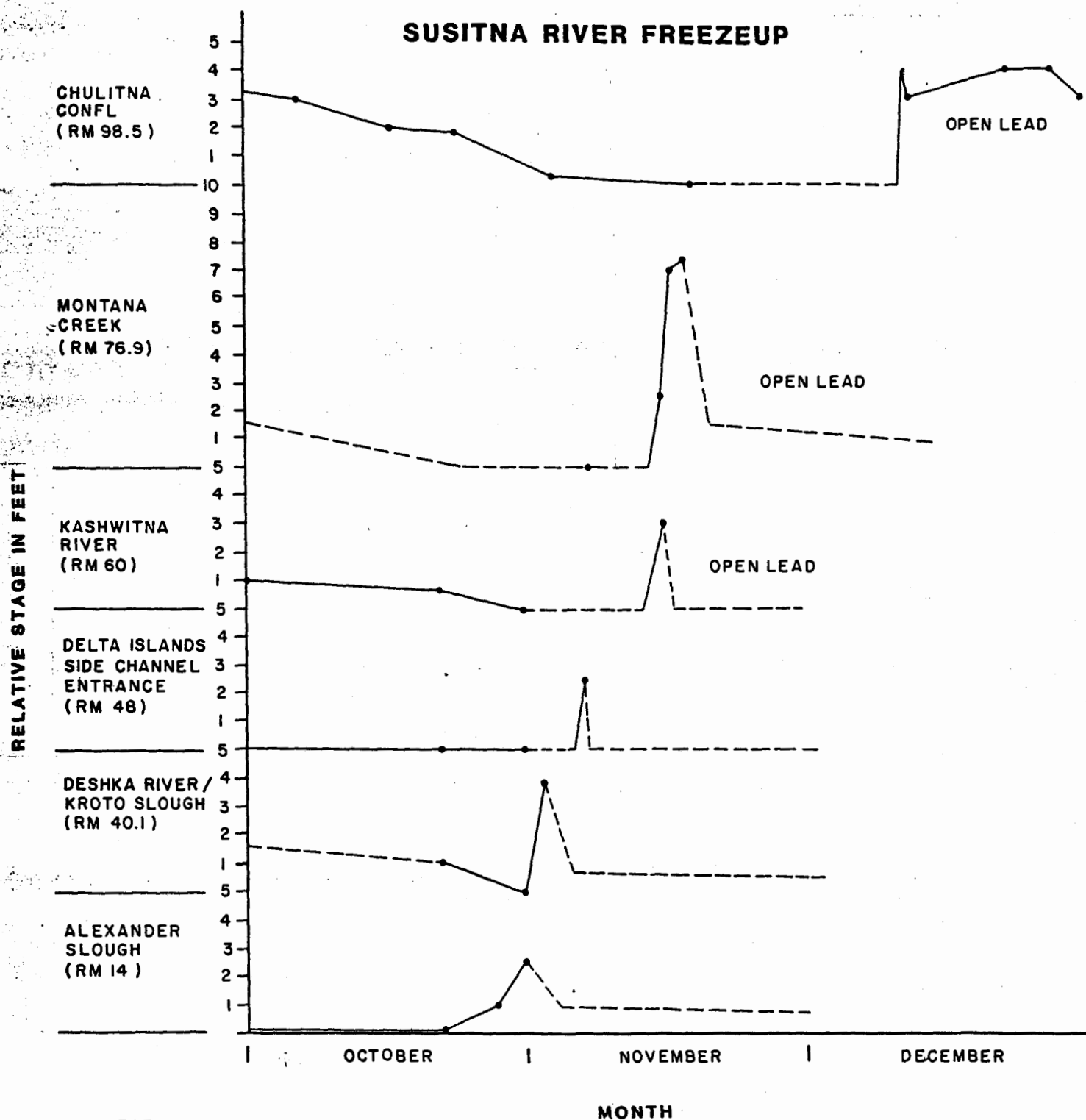
LOWER RIVER TYPICAL CROSS SECTION



34

RELATIVE STAGE LEVELS AT SELECTED SITES DURING 1983

SUSITNA RIVER FREEZEUP

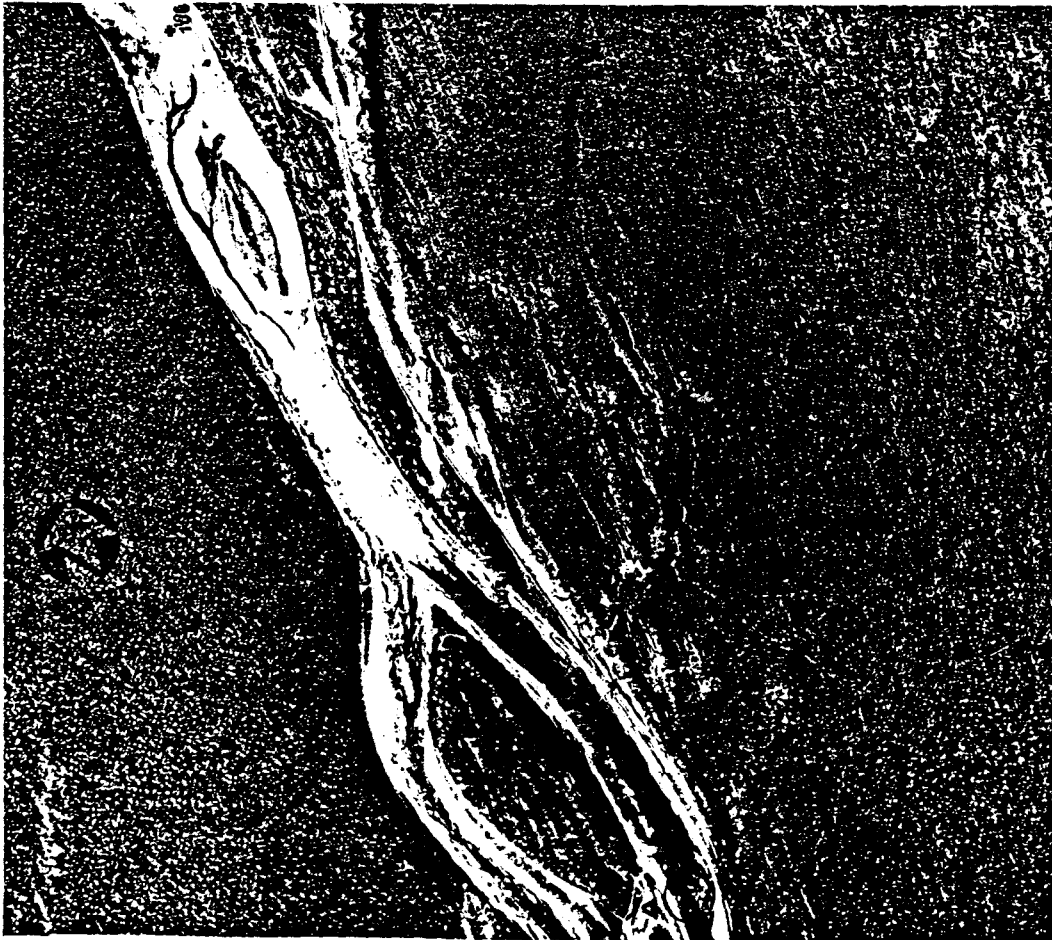


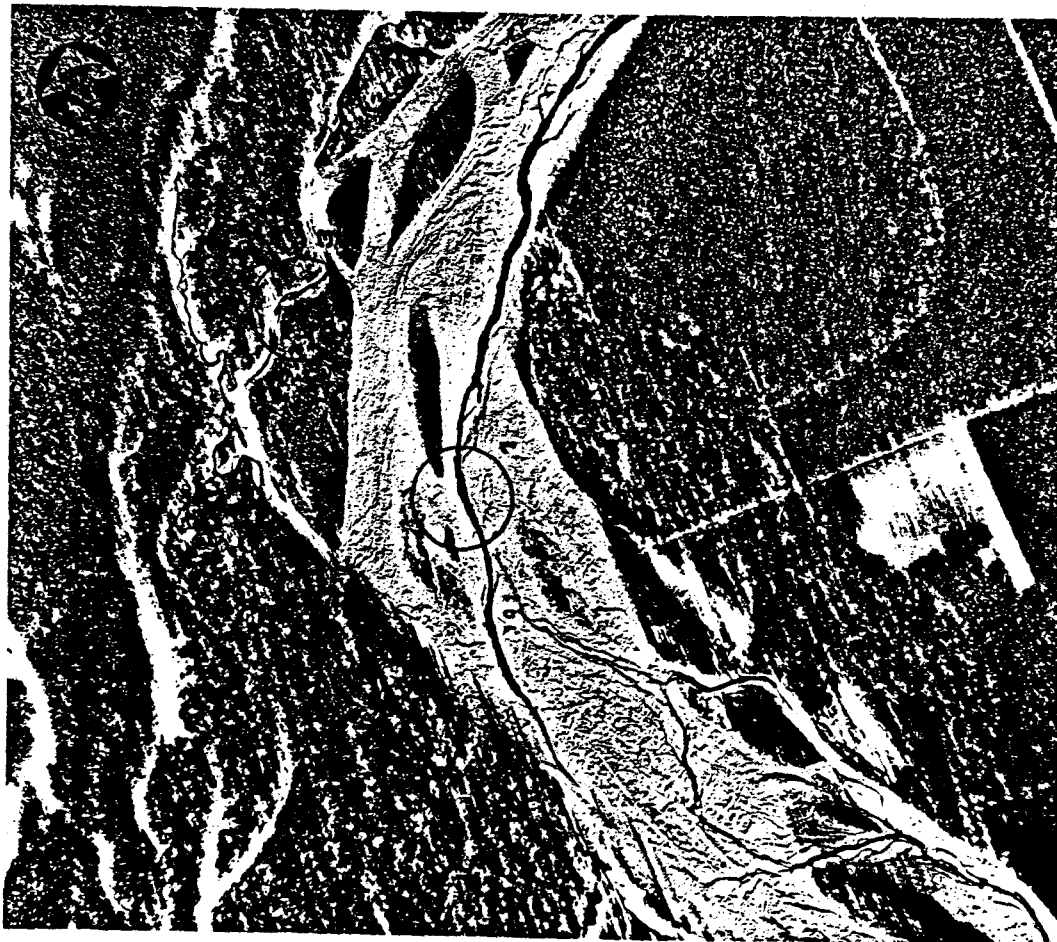
LEGEND

- INTERPRETATION BASED ON OBSERVATION
- INTERPRETED STAGE BETWEEN DATA POINTS
- SURVEYED DATA POINTS









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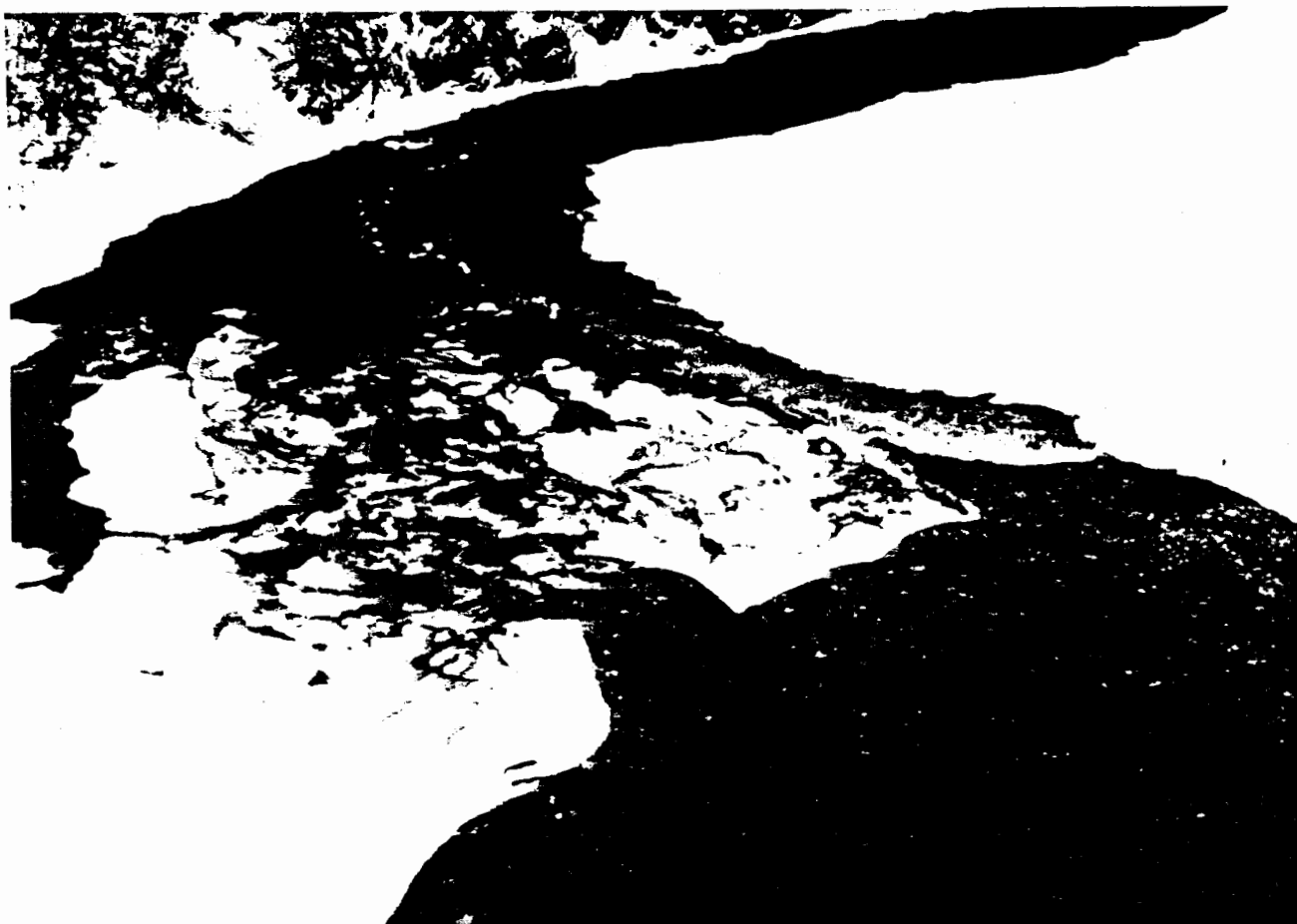
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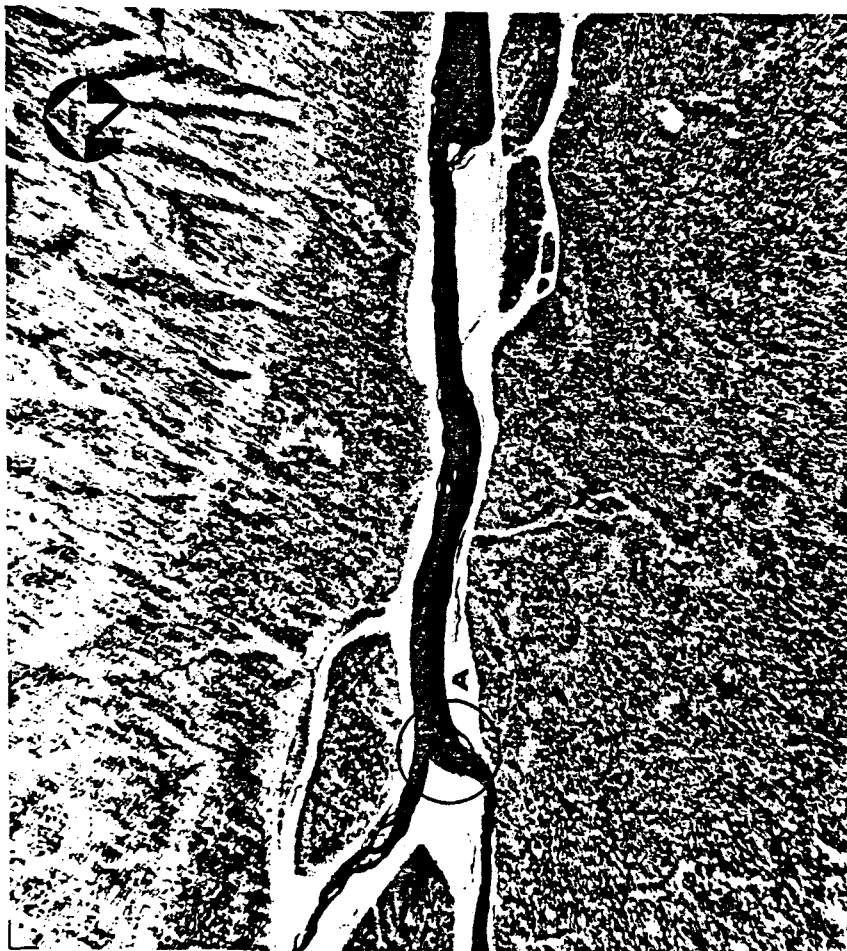
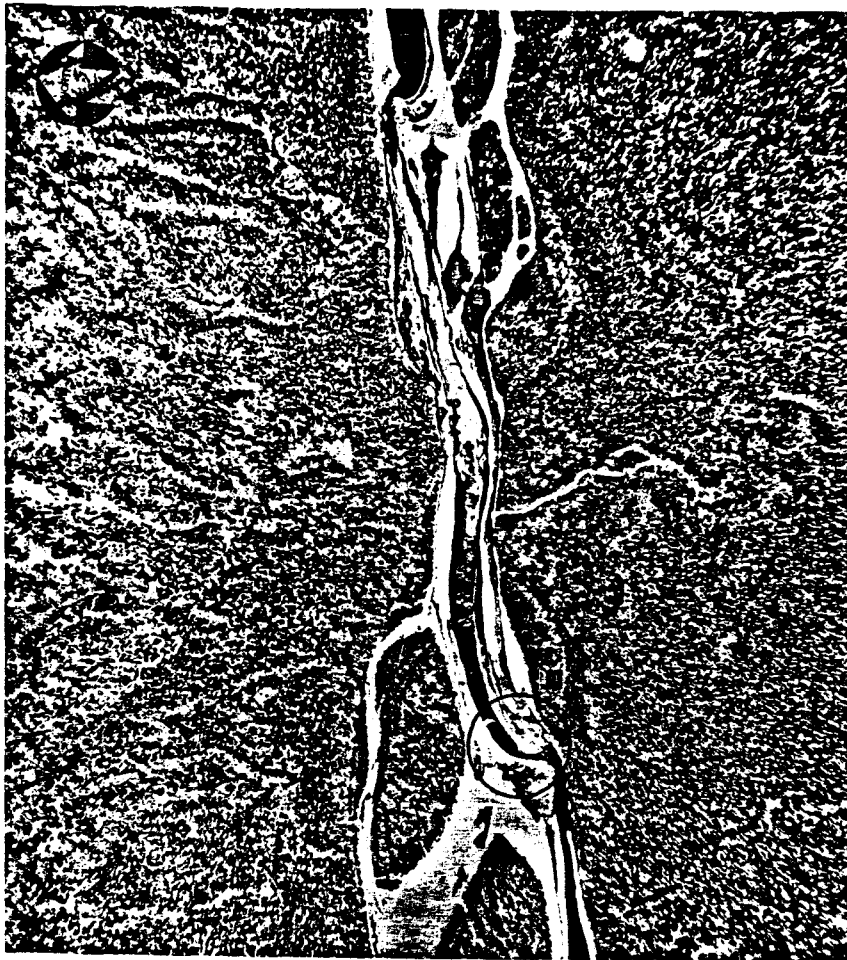
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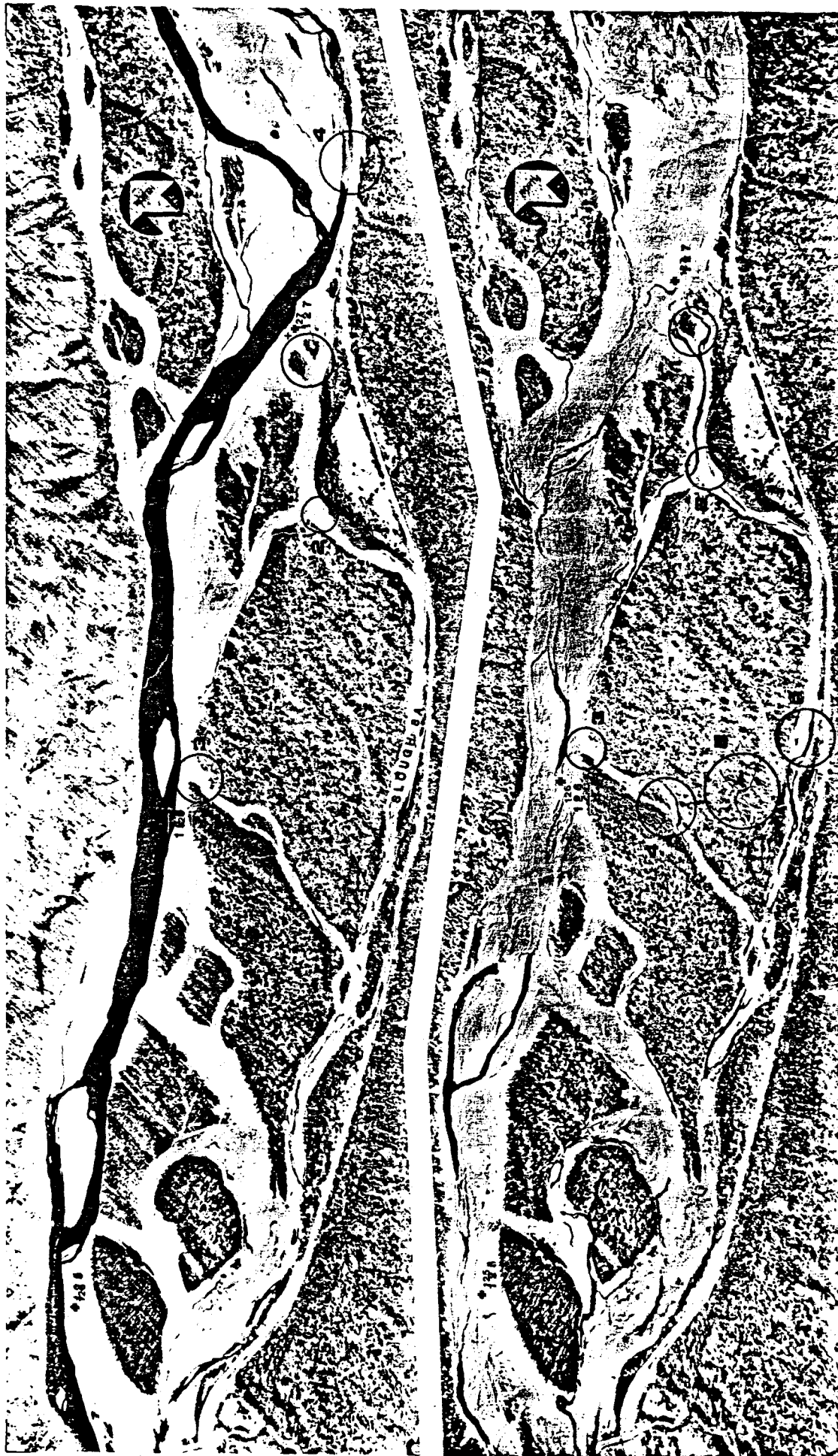
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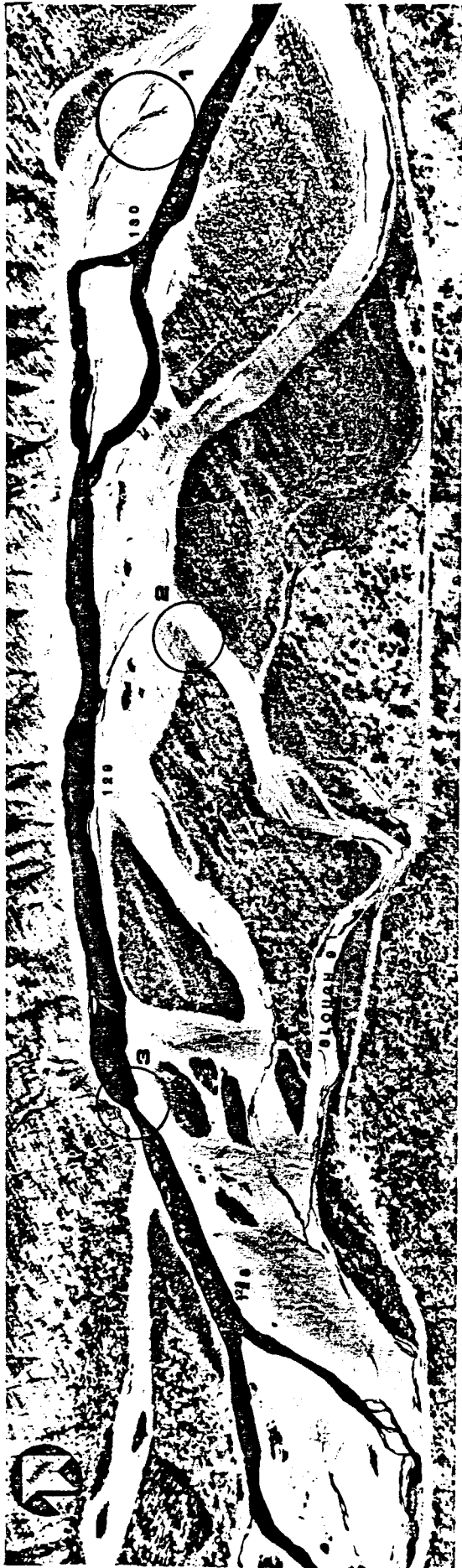
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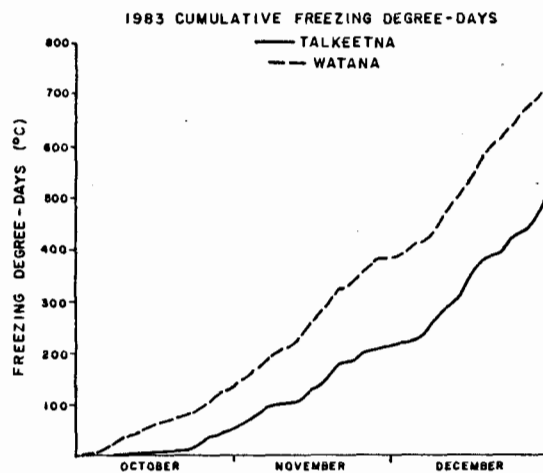
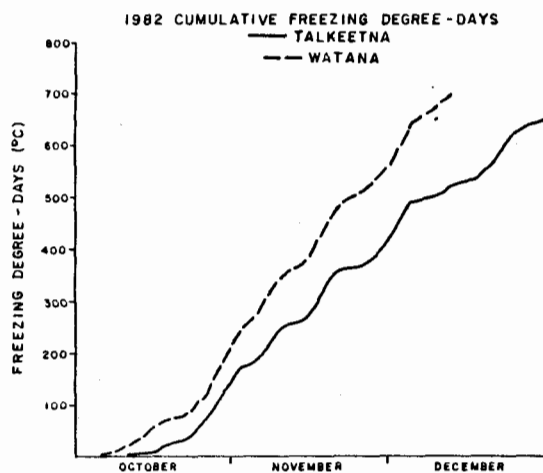
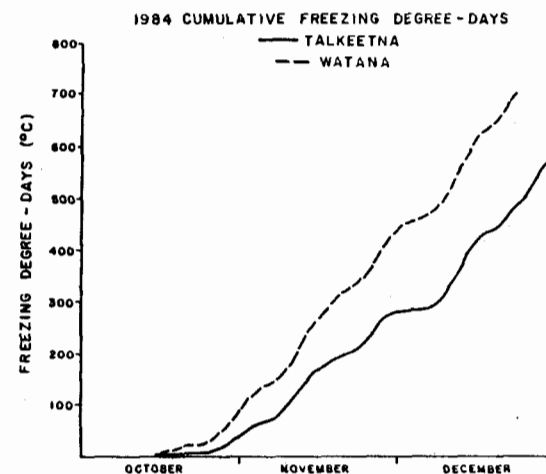
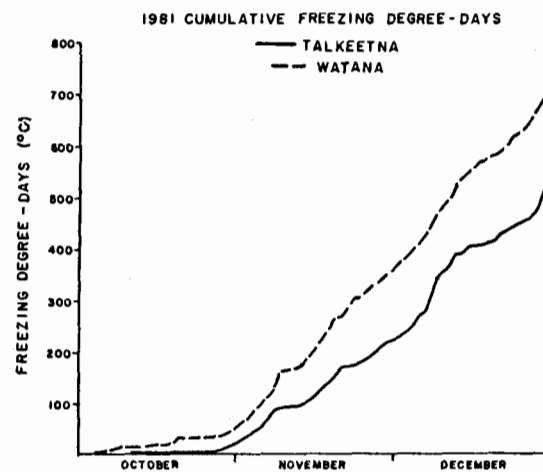
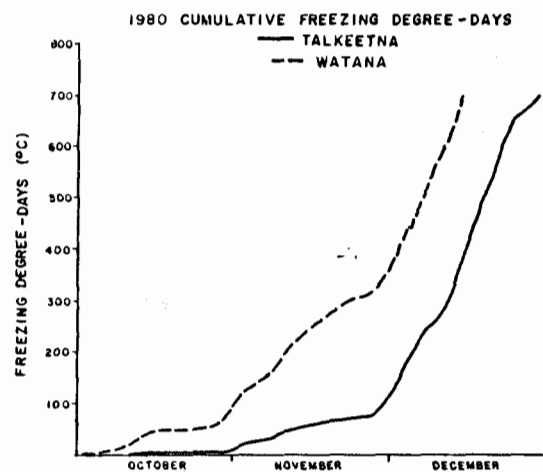




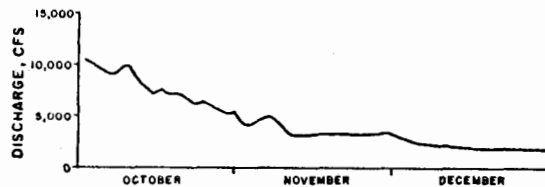




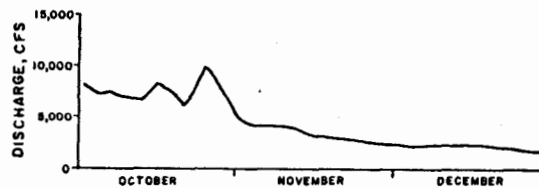
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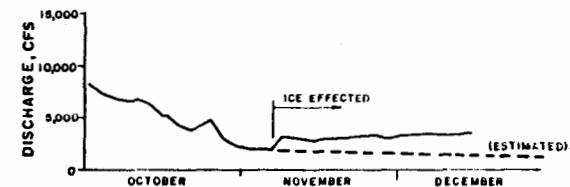
1980 USGS STREAMFLOW RECORD
GOLD CREEK



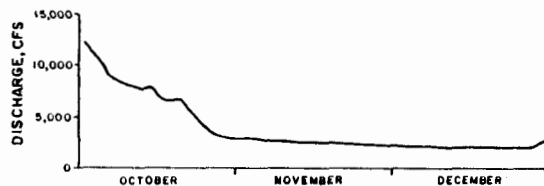
1981 USGS STREAMFLOW RECORD
GOLD CREEK



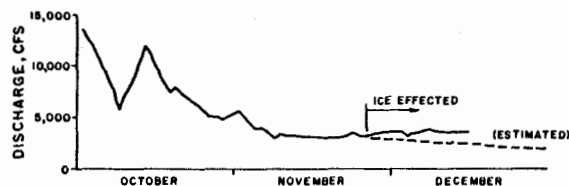
1984 R&M CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)



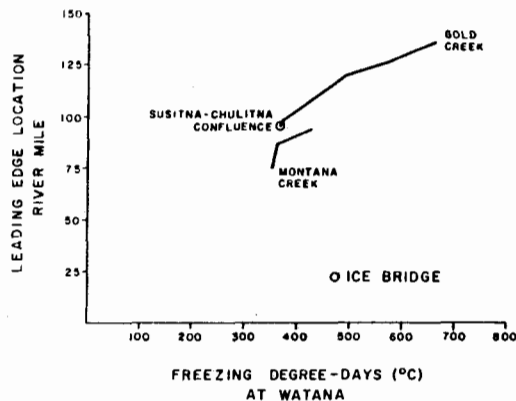
1982 USGS STREAMFLOW RECORD
GOLD CREEK



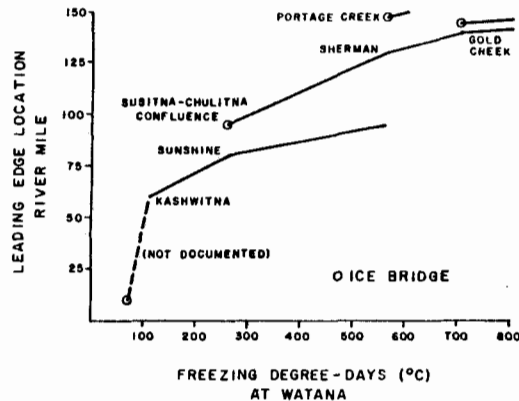
1983 R&M CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)



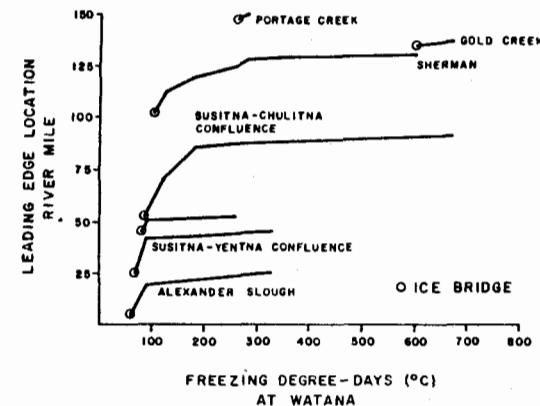
1980 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



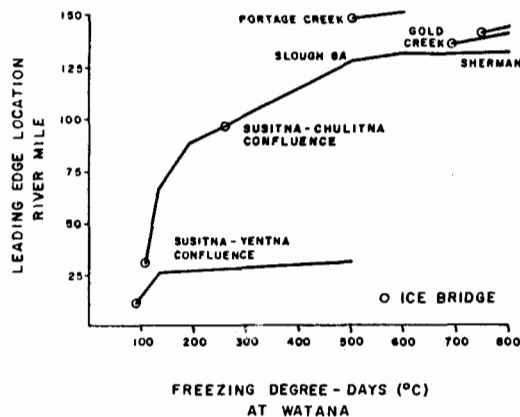
1981 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



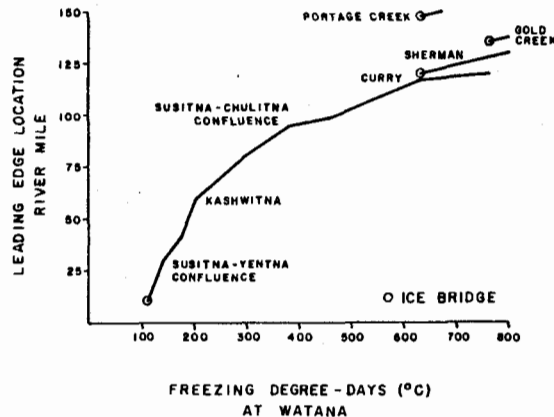
1984 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



1982 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



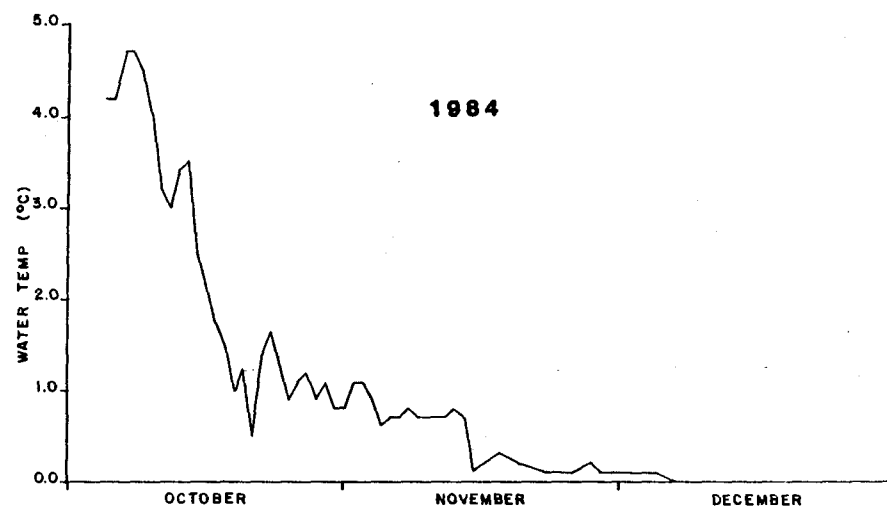
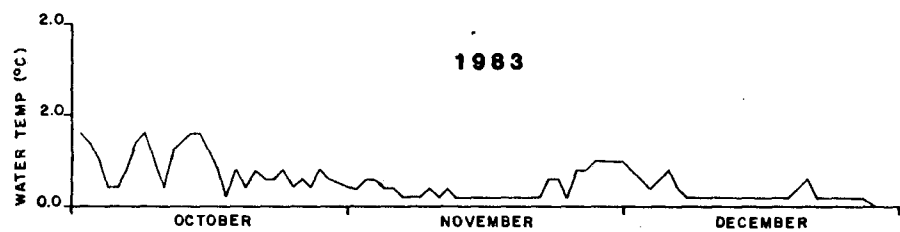
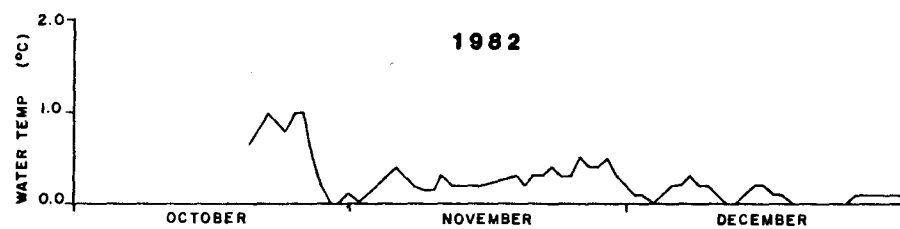
1983 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



LOCATION	RIVER MILE
ALEXANDER SLOUGH	RM 19
YENTNA RIVER CONFLUENCE	RM 26
KASHWITNA RIVER	RM 60
MONTANA CREEK	RM 76
SUNSHINE	RM 84
CHULITNA RIVER CONFLUENCE	RM 99.5
SLOUGH 8A	RM 126
SHERMAN	RM 130
GOLD CREEK	RM 136.6
PORTAGE CREEK	RM 149

70

WATER TEMPERATURES AT GOLD CREEK





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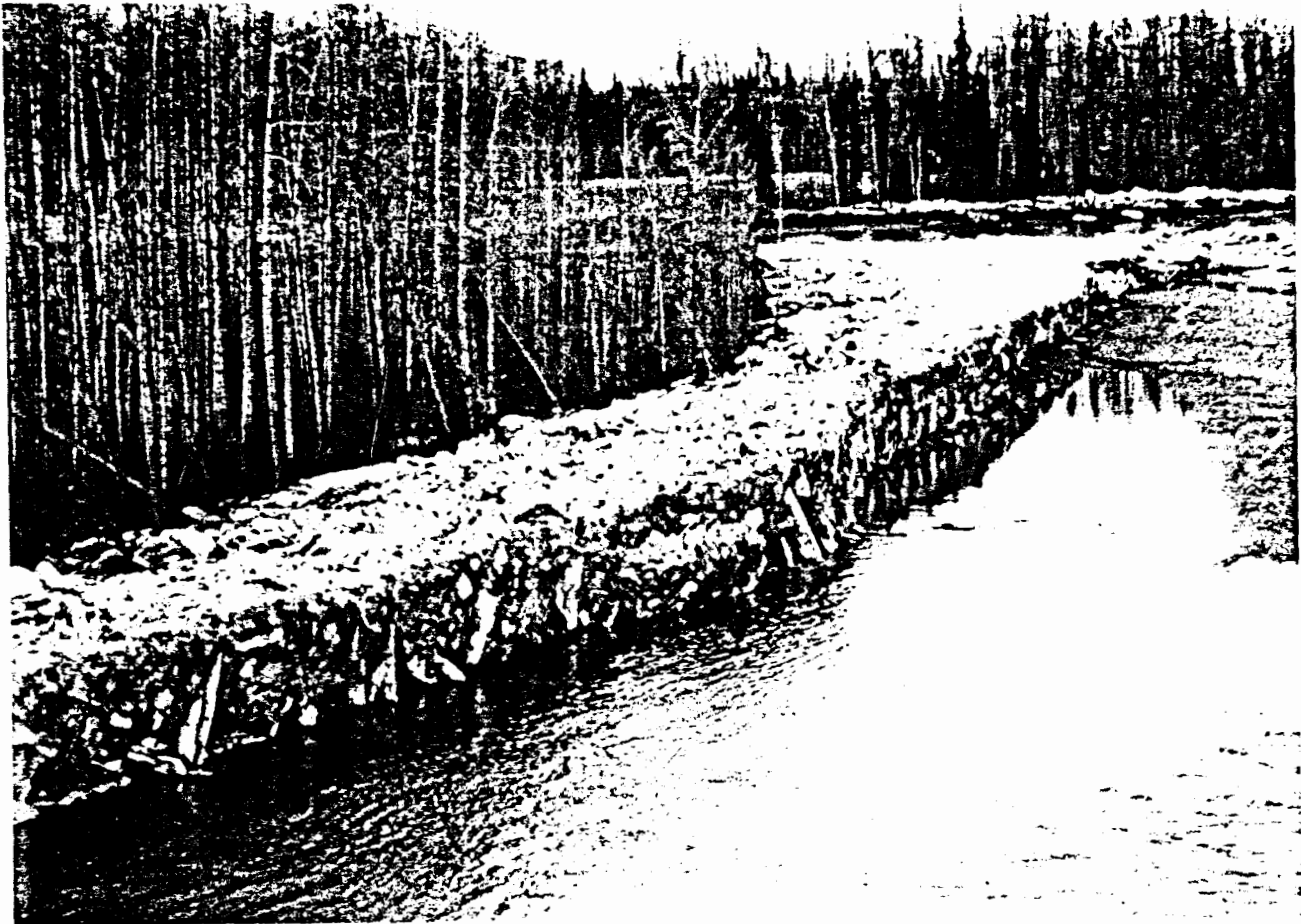


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PREPARED BY:

R&M

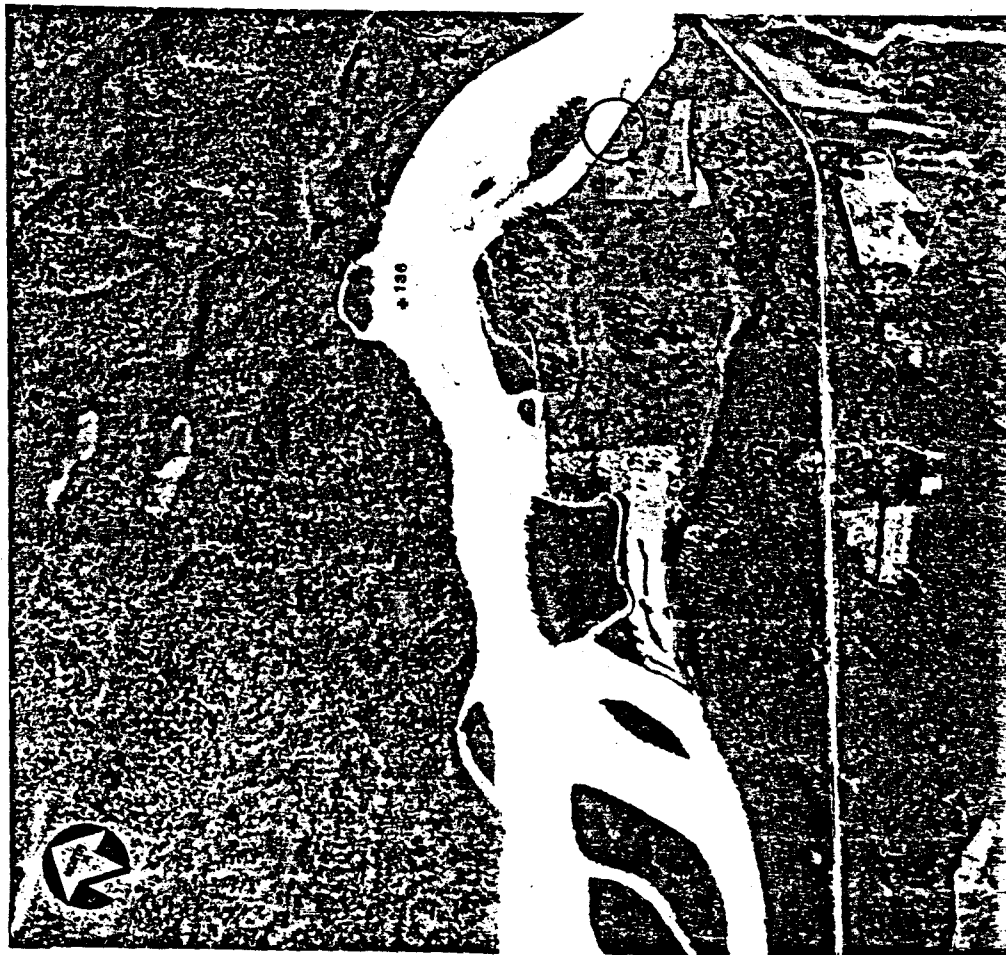
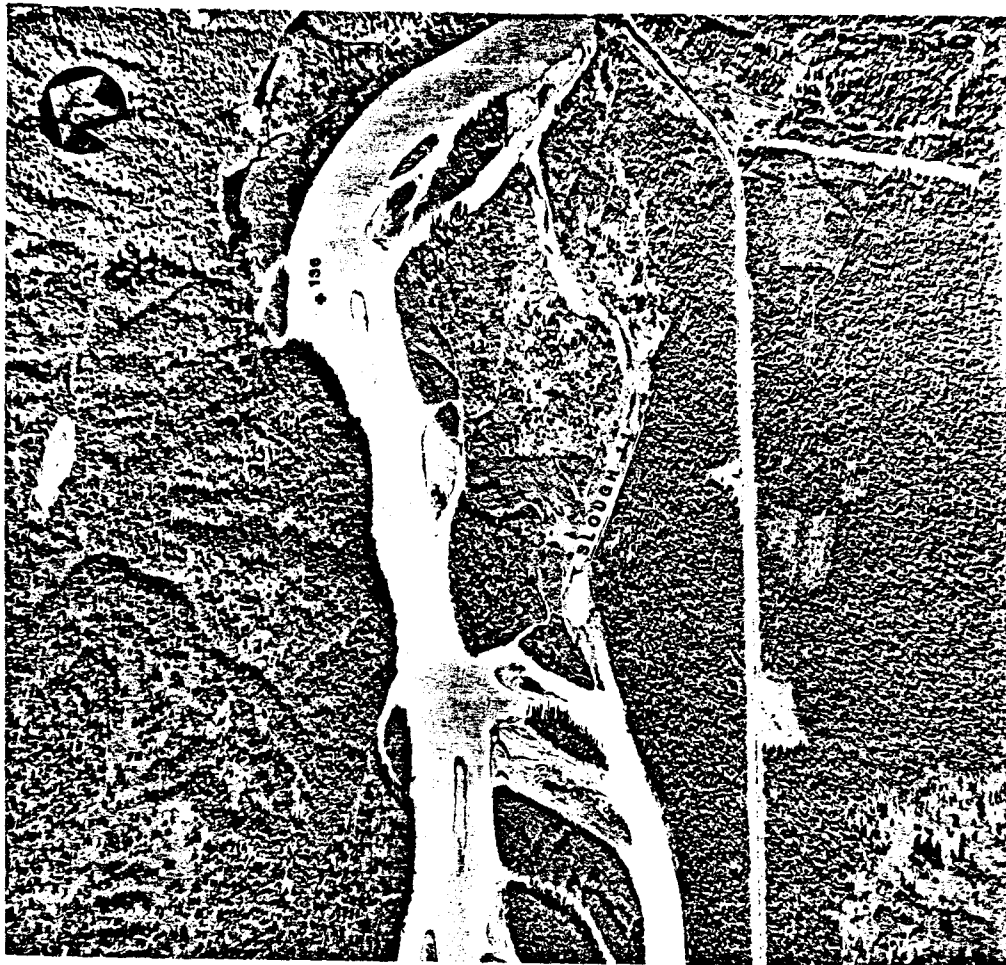
R&M CONSULTANTS, INC.

ENGINEERS GEOLGISTS HYDROLOGISTS SURVEYORS

PREPARED FOR:

HARZA-EBASCO

SUSITNA JOINT VENTURE



**SUSITNA PROJECT
TALKEETNA AIR TEMPERATURES
NOVEMBER - MARCH
1944 - 1983**

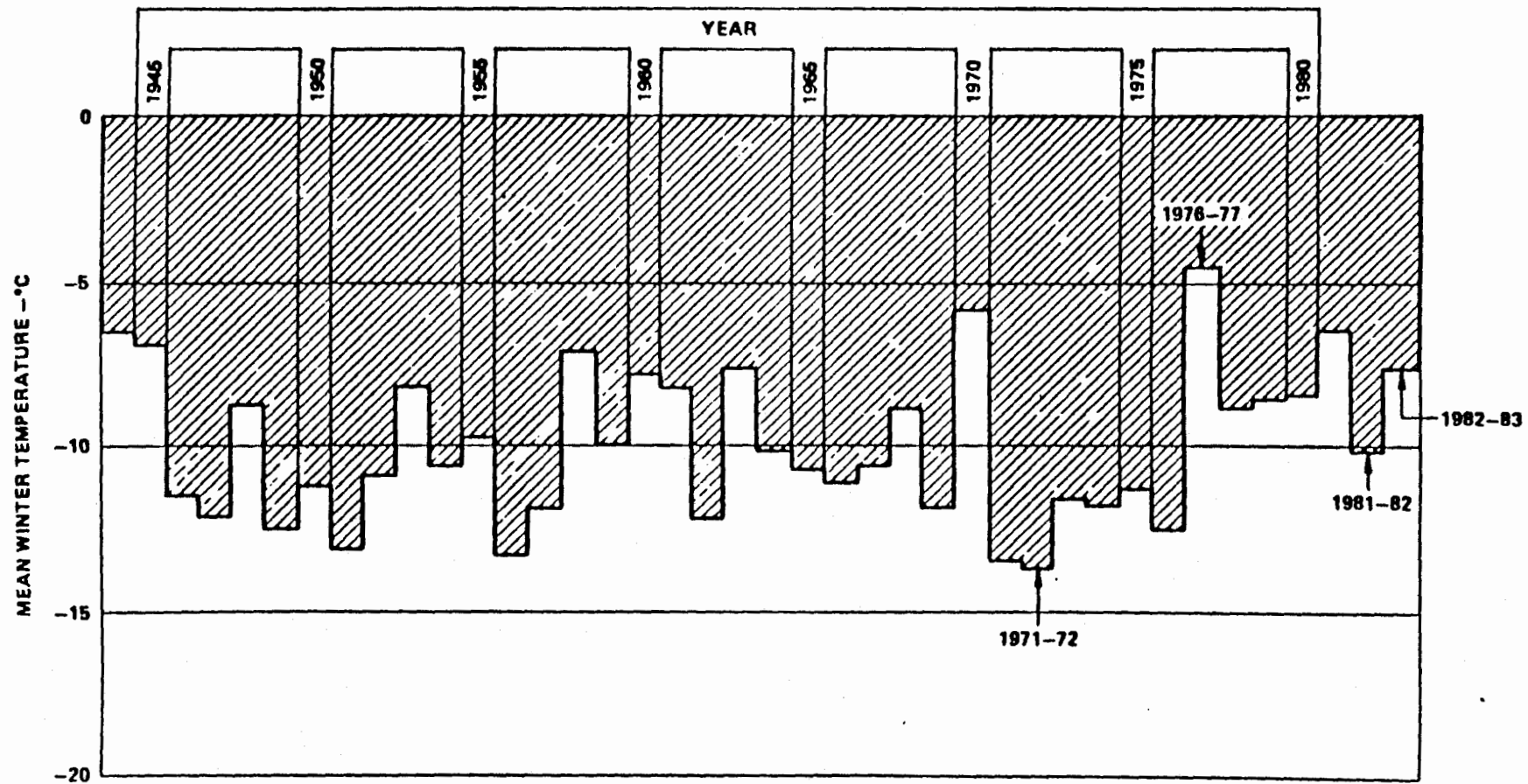


FIGURE 5

EXHIBIT 1.
FIG. 53

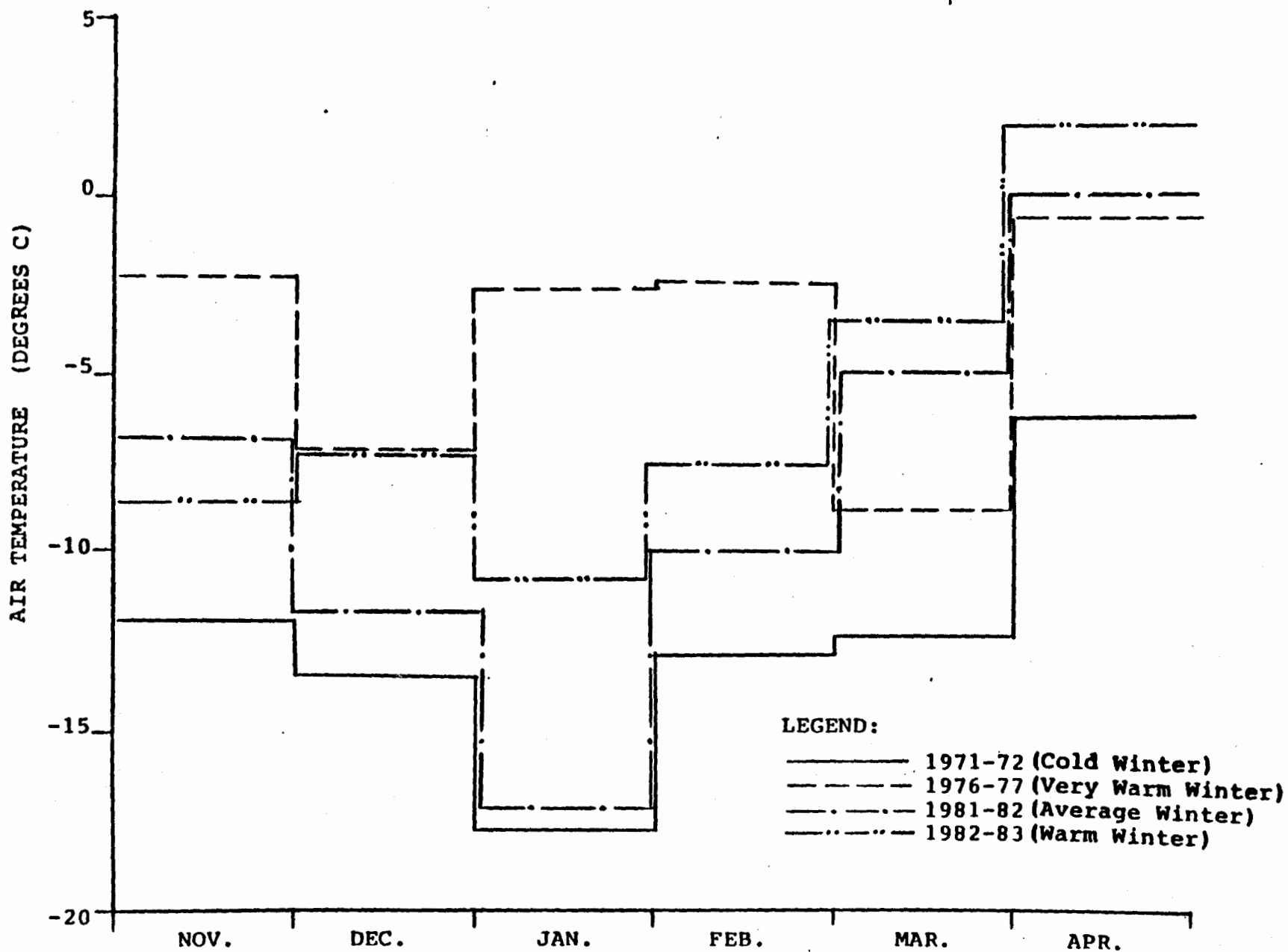


FIGURE 3 - AVERAGE MONTHLY AIR TEMPERATURES AT TALKEETNA

21 KEATINGE LON (CIS)
103

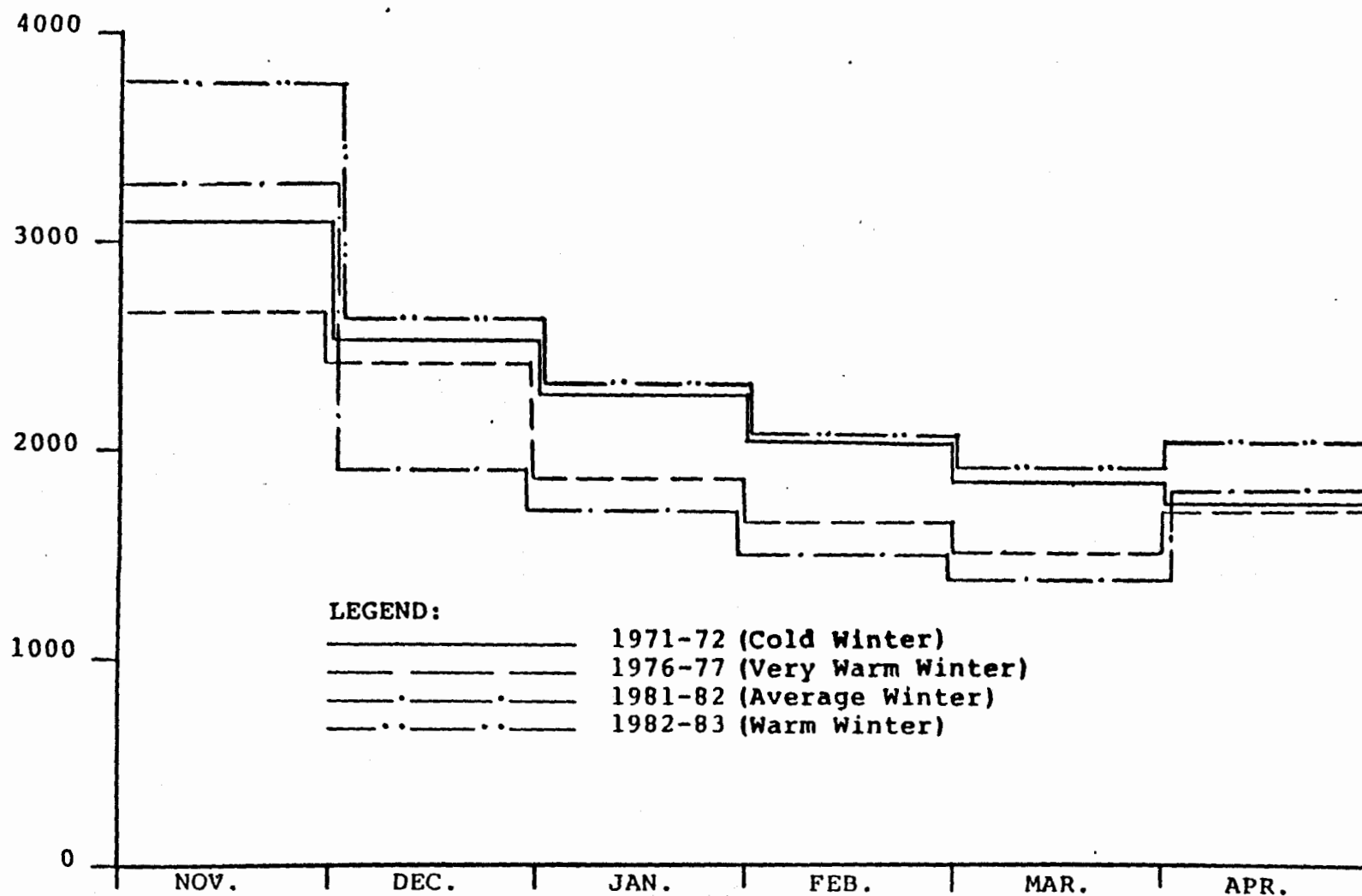
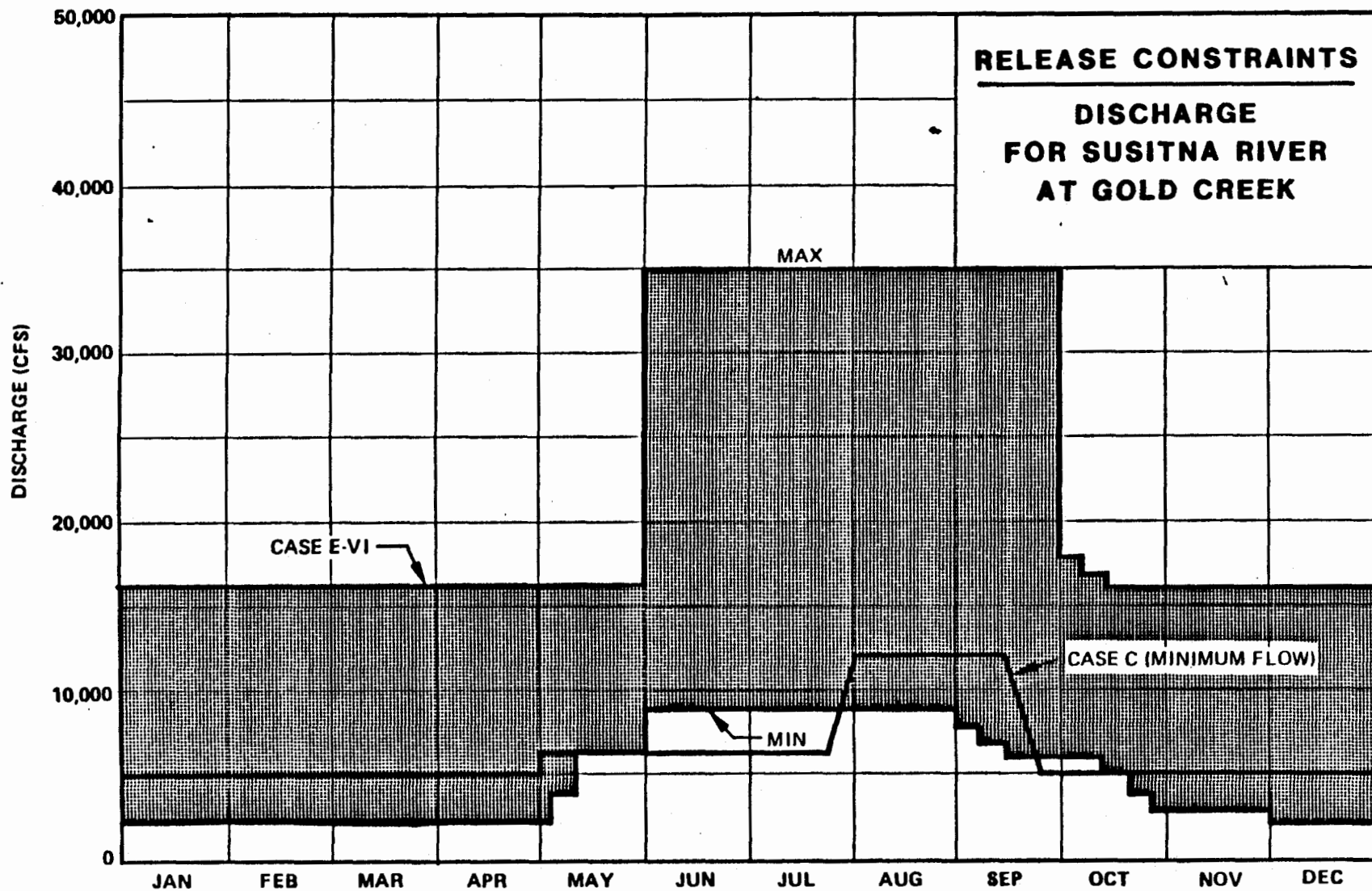
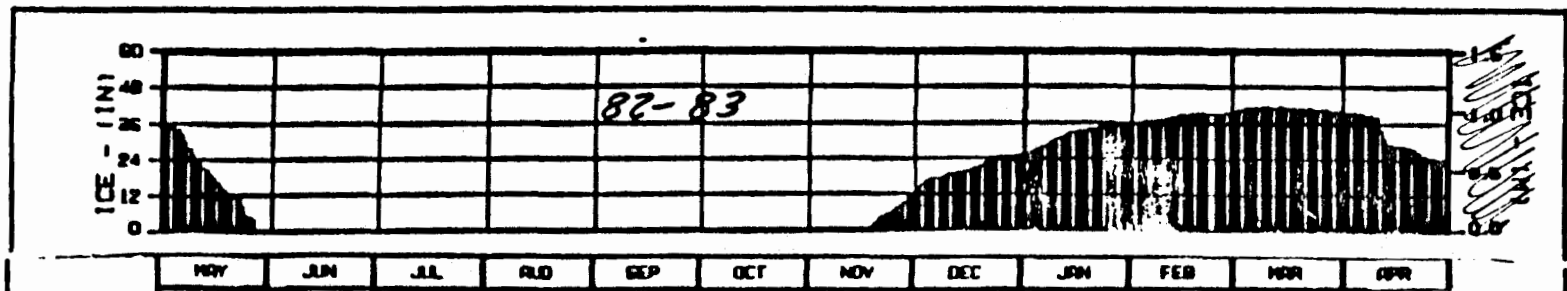
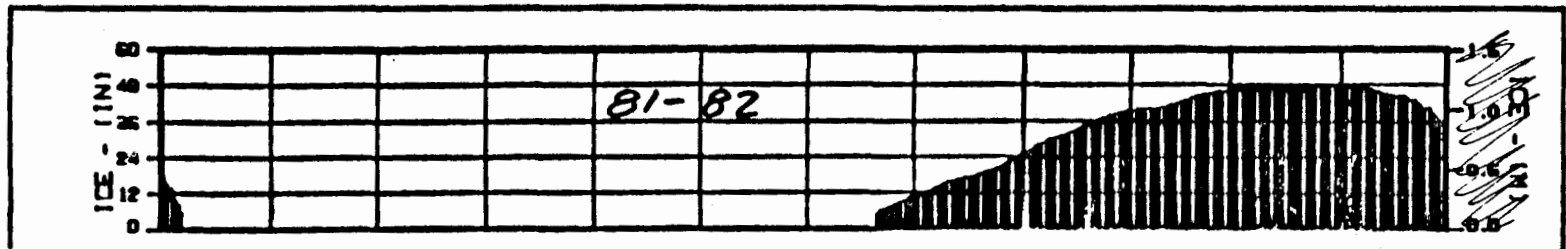
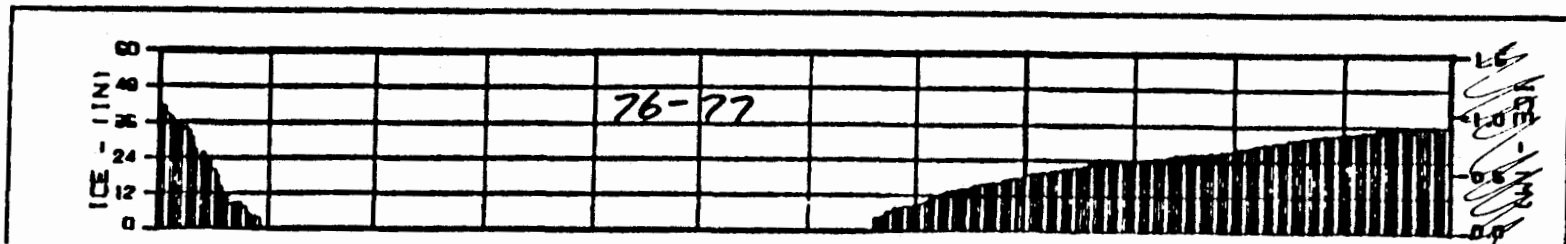
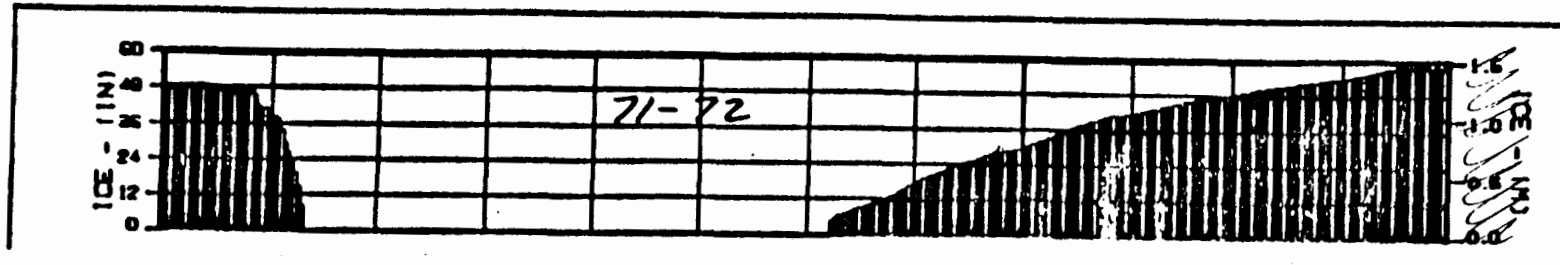


Figure 1 - SUSITNA RIVER NATURAL STREAMFLOWS AT GOLD CREEK - AVERAGE MONTHLY VALUES

601



105



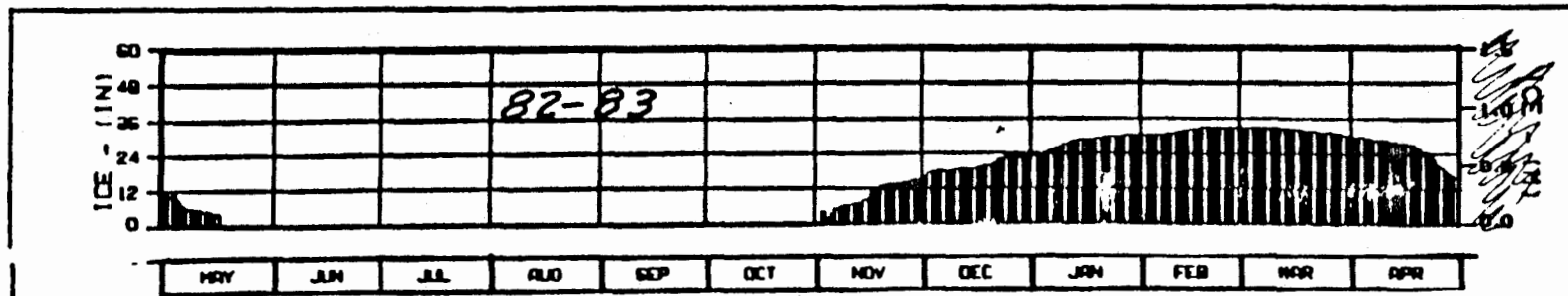
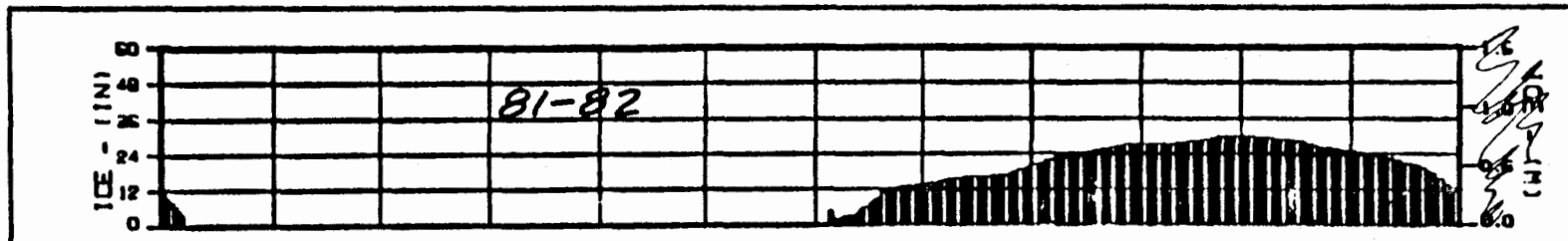
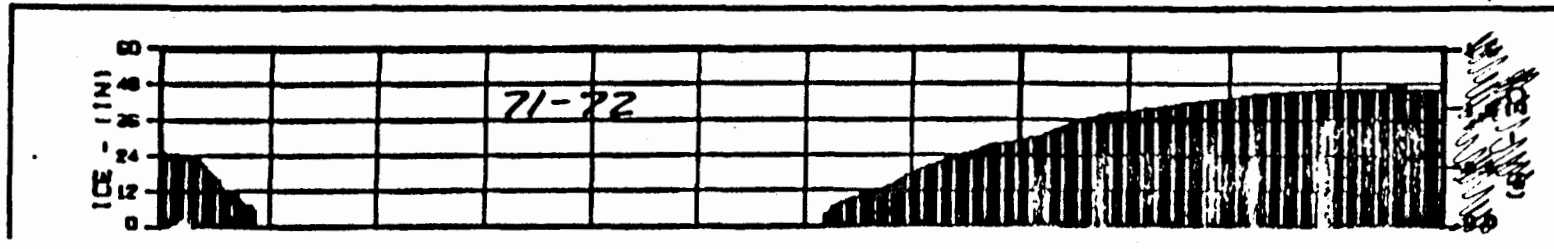
WARZA-EBERCO JOINT VENTURE
 PROJECT: 11-10000 0 JUN 83 11-10000-01

NATANA RESERVOIR

ICE GROWTH

1996-CASE C

ALASKA POWER AUTHORITY
 DESIGN PROJECT DESIGN MODEL



HARZA-EBRARD JOINT VENTURE
DESIGNED BY ALASKA POWER AUTHORITY
6 JAN 84

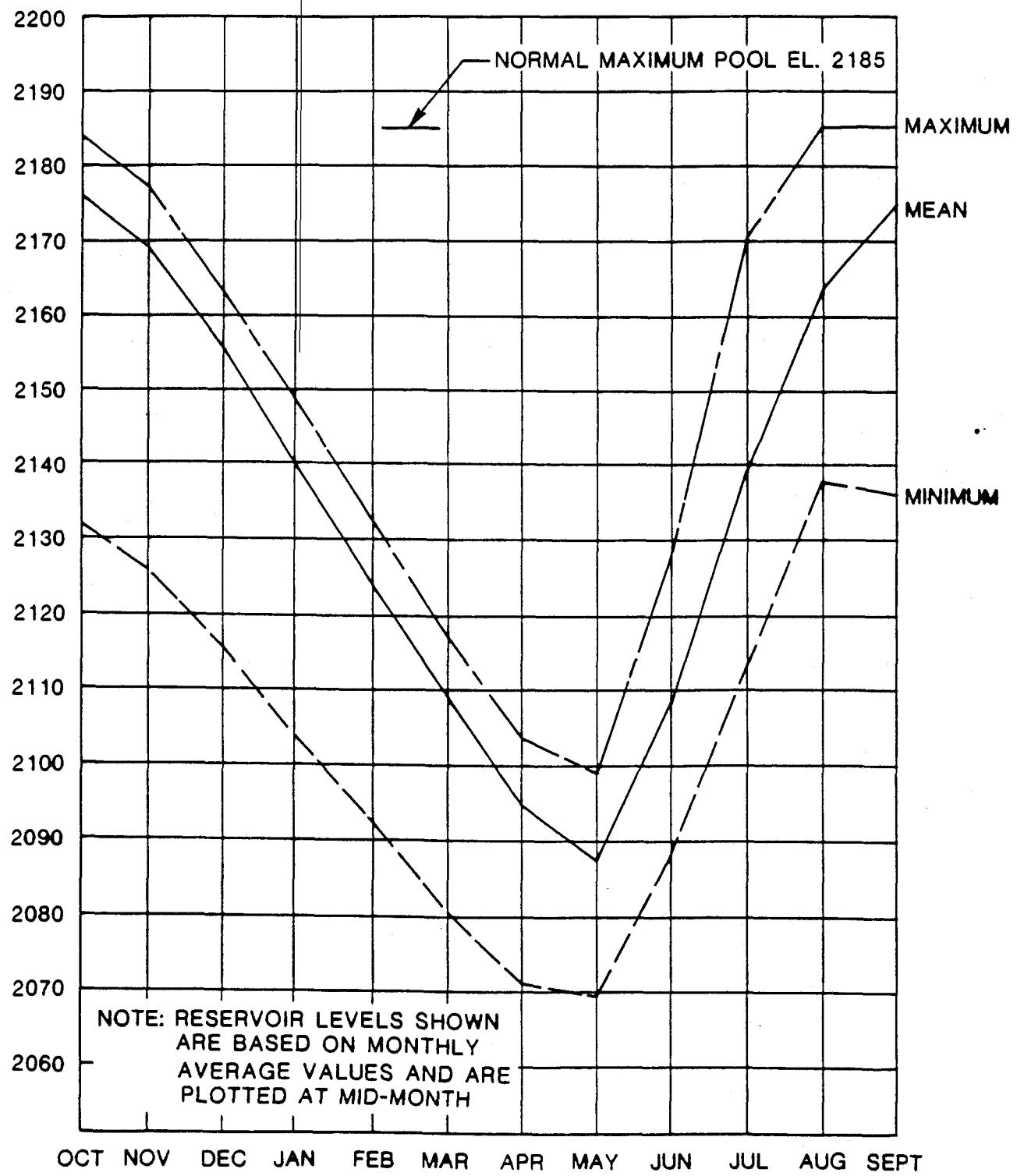
DEVIL CANYON RESERVOIR
ICE GROWTH

ALASKA POWER AUTHORITY
SUBSTATION PROJECT
DESIGN MODEL

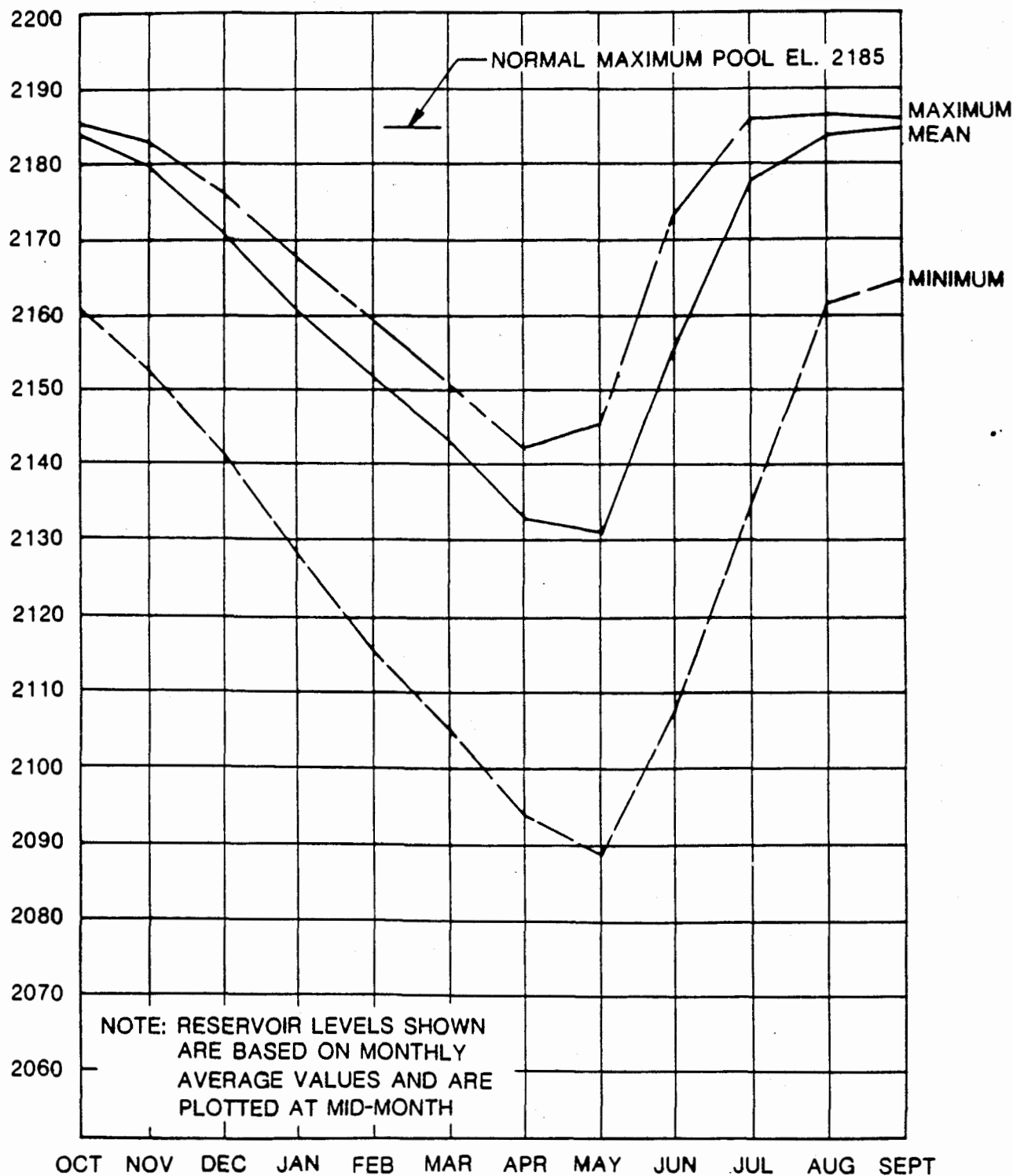
2002-CASE C

59

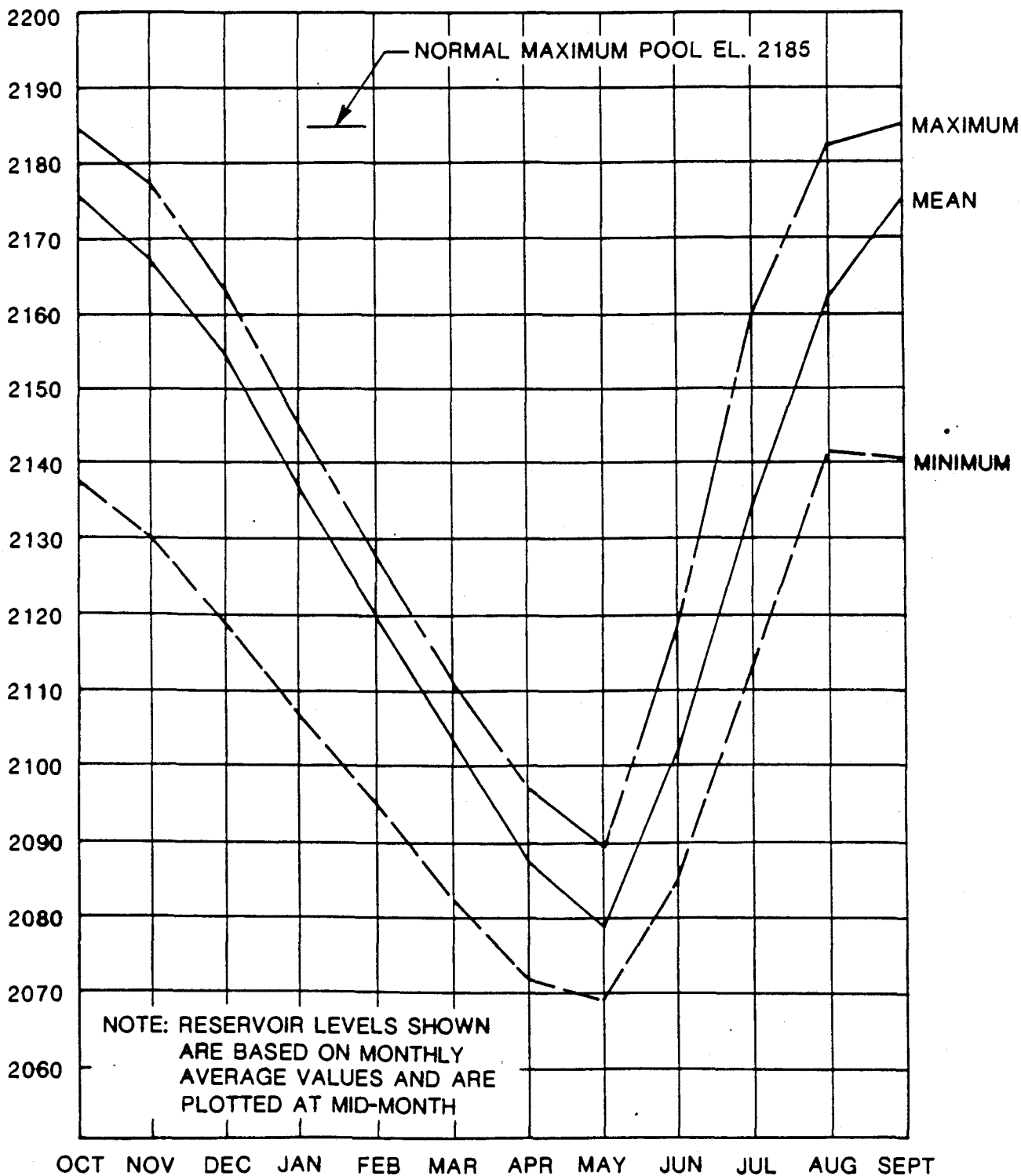
WATANA RESERVOIR WATER LEVELS WATANA ONLY OPERATING 2001 SIMULATION CASE E-VI



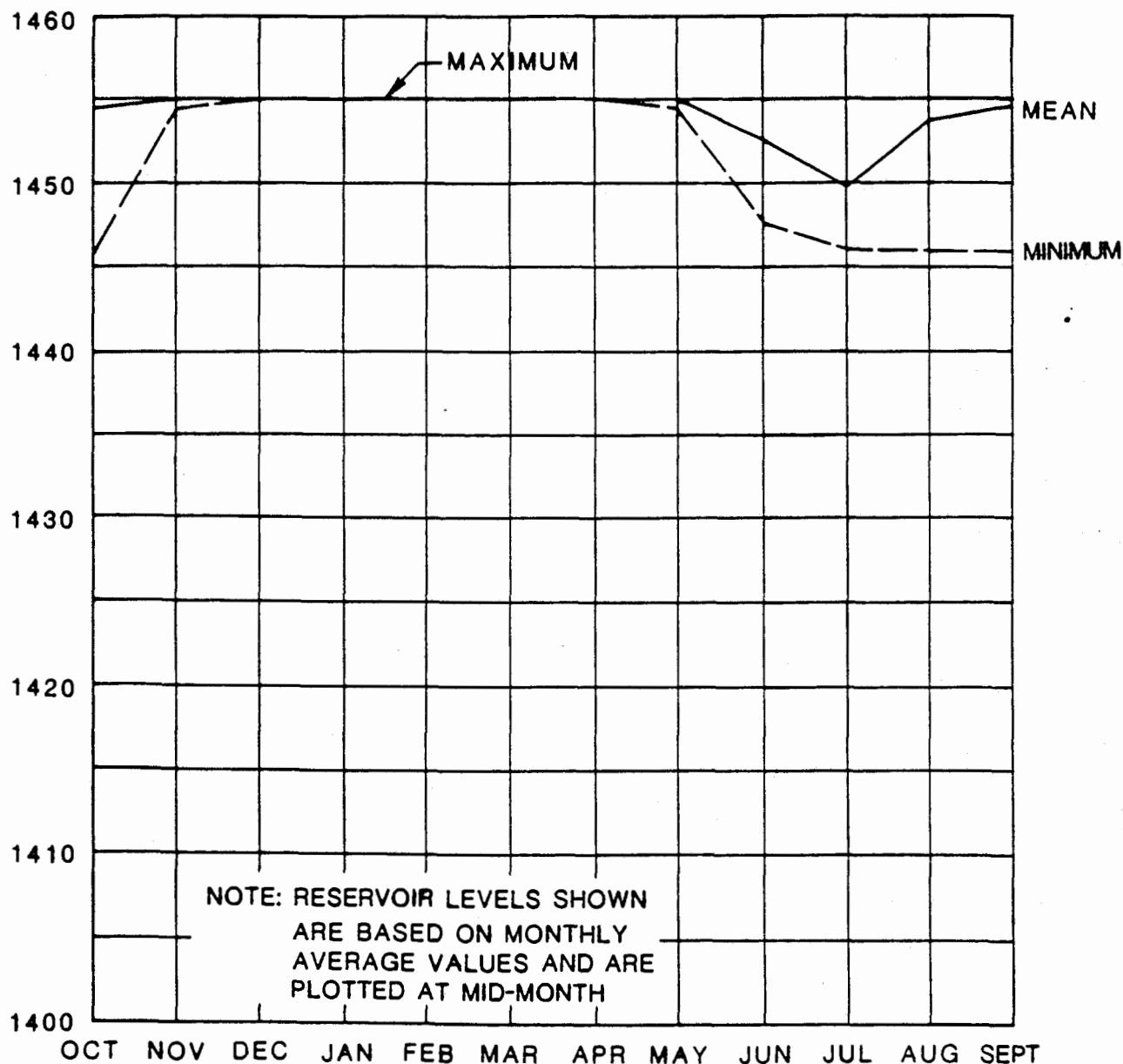
WATANA RESERVOIR WATER LEVELS WATANA AND DEVIL CANYON OPERATING 2002 SIMULATION CASE E-VI



WATANA RESERVOIR WATER LEVELS WATANA AND DEVIL CANYON OPERATING 2020 SIMULATION CASE E-VI



DEVIL CANYON WATER LEVELS 2002 SIMULATION CASE E-VI



63

DEVIL CANYON WATER LEVELS 2020 SIMULATION CASE E-VI

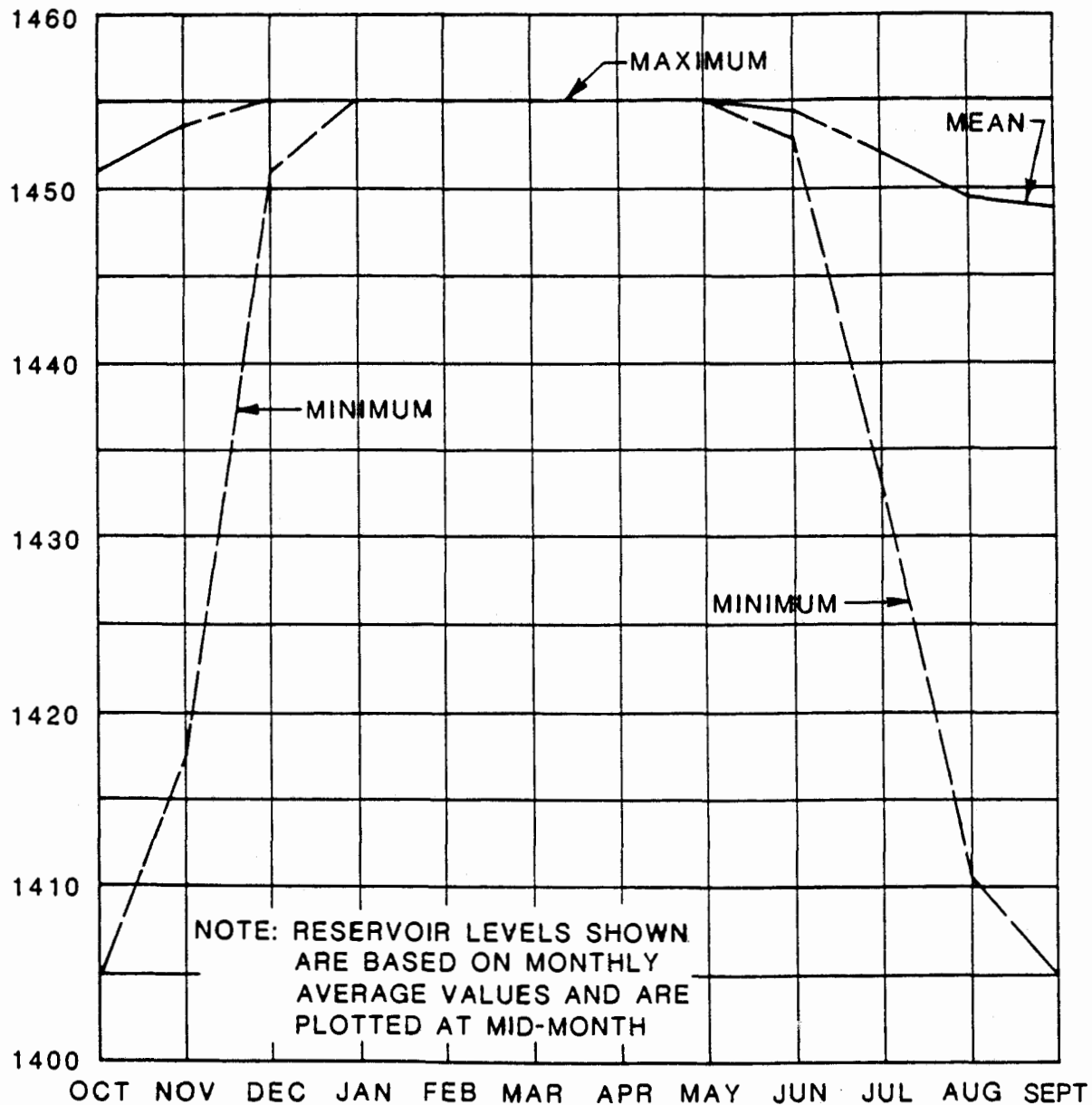


Photo 1.

Fig. 64



Figure 6. Reservoir ice cover (A) laid down onto the exposed reservoir bottom below the banks (B).

CYW

Special Report 82-31

December 1982

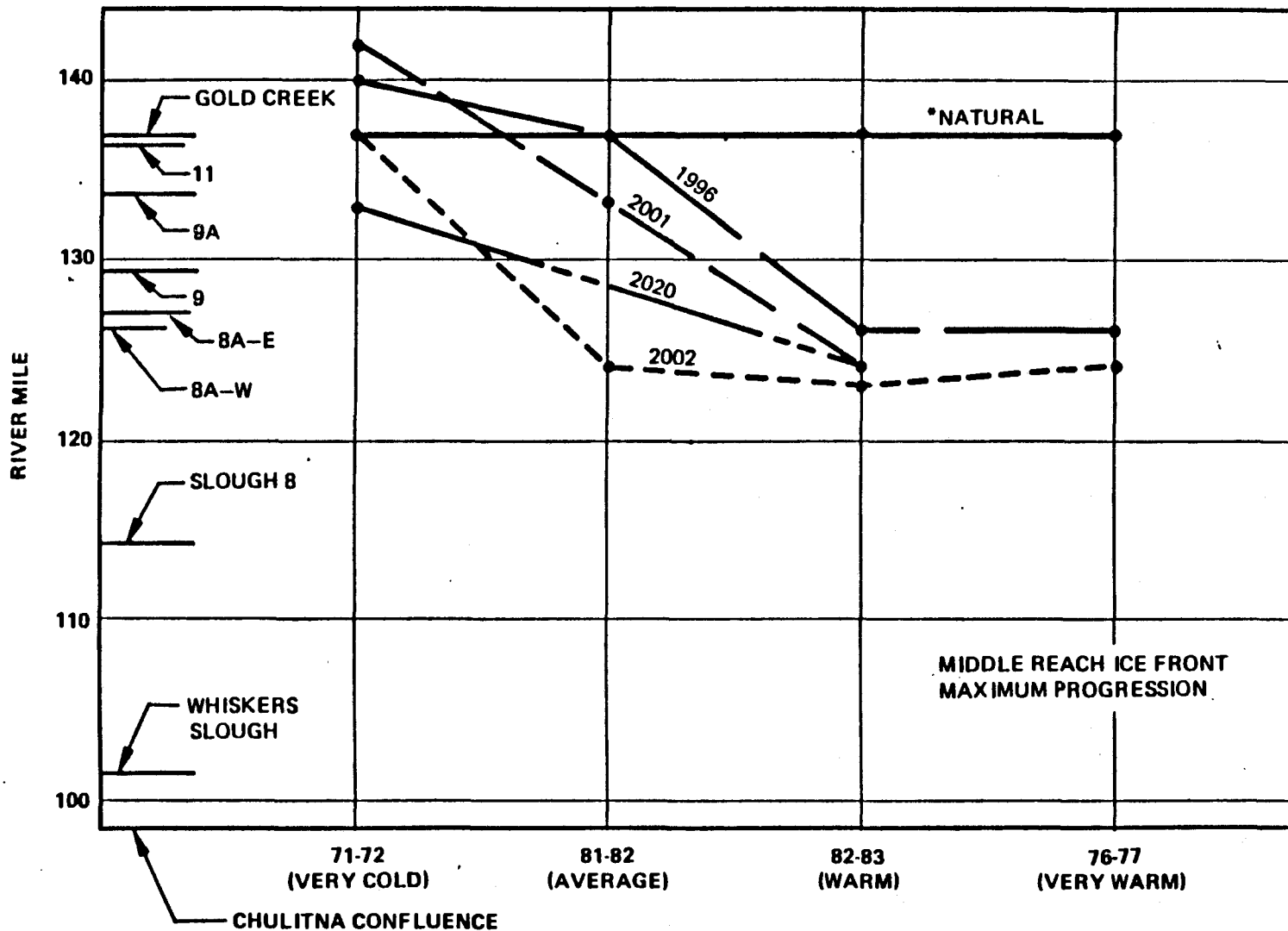


**US Army Corps
of Engineers**

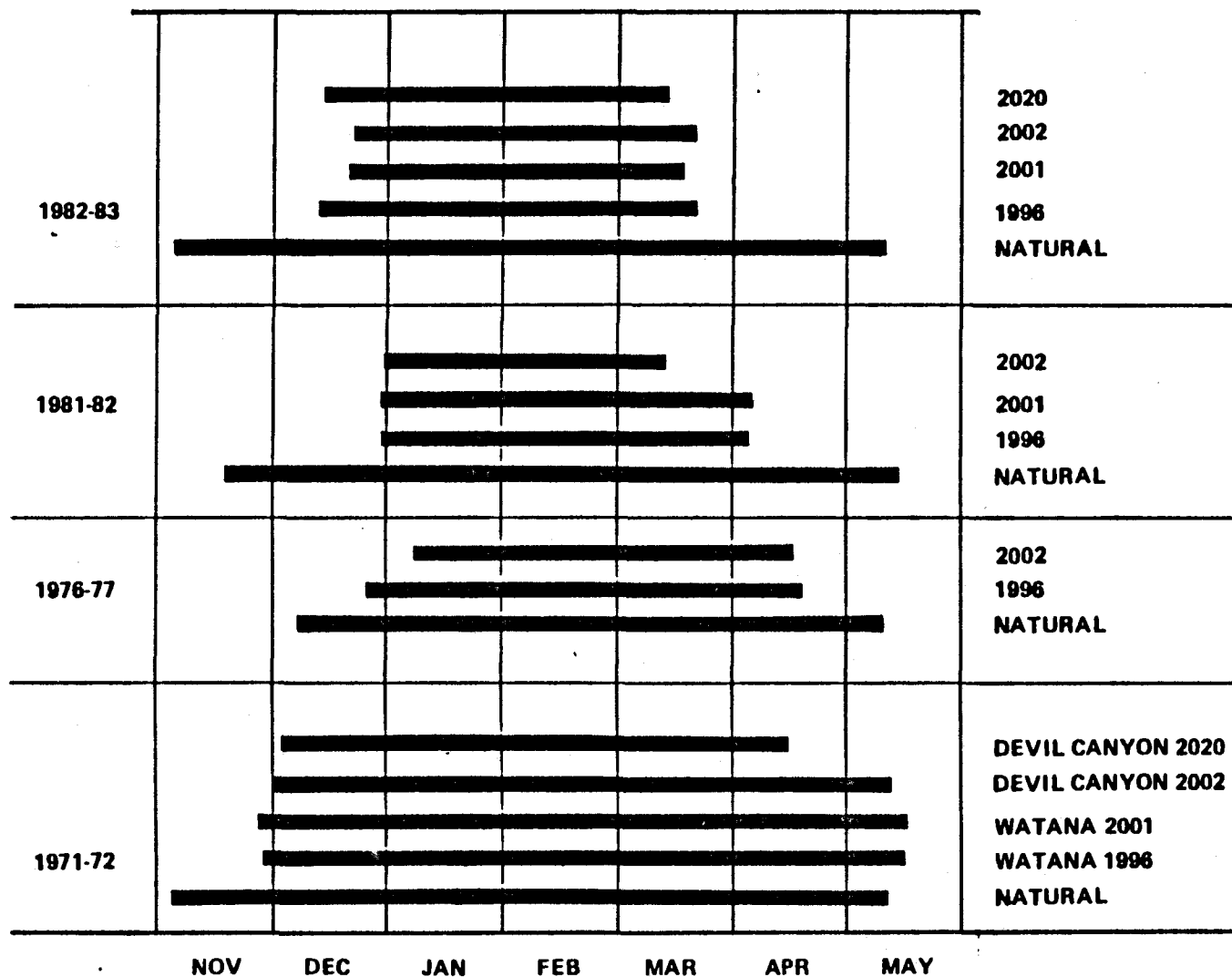
Cold Regions Research &
Engineering Laboratory

Reservoir bank erosion caused and influenced by ice cover

Lawrence W. Gatto



*Natural front progression has been observed to stop at Gold Creek. Ice cover upstream forms by closure from lateral ice.



**MIDDLE REACH
ICE COVER DURATION**

EXHIBIT 13

**SUSITNA HYDROELECTRIC PROJECT
MAXIMUM SIMULATED WINTER RIVER STAGES**

TABLE IV

Slough or Side Channel	River Mile	Threshold Elevation	NATURAL CONDITIONS		WATANA ONLY										WATANA AND DEVIL CANYON										WATANA FILLING	
							1998 DEMAND					2001 DEMAND		2002 DEMAND				2020 DEMAND		YR.1	YR. 2					
			✓ 1971-72	✓ 1976-77	✓ 1981-82	✓ 1982-83	✓ 1971-72	✓ 1976-77	✓ 1981-82	✓ 1982-83	✓ 1971-72 ^W	✓ 1971-72	✓ 1982-83	✓ 1971-72	✓ 1976-77	✓ 1981-82	✓ 1982-83	✓ 1971-72	✓ 1982-83	✓ 1982-83	✓ 1981-82					
Whiskers	101.5	367 ✓	368	366	368	367	372	370	371	370	371	372	370	371	368	368	368	369	372	370	367	367				
Gash Creek	112.0	Unknown	456	455	455	456	458	457	460	458	460	459	461		458	456	456	457	459	457	455	455				
6A	112.3	(Upland)	458	457	457	459	462	460	462	462	463	461	463		460	459	458	460	461	459	457	457				
8	114.1	476 ✓	474	472	472	474	478	475	477	478	477	476	478		475	474	475	475	✓ 476	475	473	473				
MS II	115.5	482	484	480	484	484	490	486	488	488	488	489	489		487	488	485	487	490	488	481	483				
MS II	115.8	487	485	482	486	486	492	489	481	481	490	491	492		489	489	488	490	492	490	485	486				
Curry	120.0	Unknown	522	520	523	520	526	525	527	525	523	525	521		522	520	520	520	525	523	520	521				
Moose	123.5	Unknown	552	546	549	548	556	552	565	550	552	555	550		553	547	548	545	555	550	546	548				
8A West	126.1	573 ✓	572	569	571	570	576	574	574	572	572	575	568		574	568	568	568	✓ 575	572	568	570				
8A East	127.1	582 ✓	584	581	583	582	587	583	585	582	582	586	581		584	581	580	581	✓ 585	582	580	582				
9	129.3	604 ✓	605	603	606	605	609	603	607	603	603	610	603		606	601	601	602	✓ 608	603	602	603				
9 u/s	130.6	Unknown	622	616	620	621	624	617	620	617	617	625	617		620	616	616	616	621	617	616	616				
4th July	131.8	Unknown	632	626	629	630	635	628	631	628	628	636	628		633	627	627	627	631	628	625	628				
9A	133.7	651 ✓	655	649	651	651	657	650	653	650	650	659	650		652	650	650	650	✓ 651	650	650	650				
10 u/s	134.3	657	662	654	657	656	663	656	659	656	656	665	656		659	655	655	655	657	656	658	655				
11 d/s	135.3	Unknown	673	667	670	672	675	667	670	666	666	676	666		670	667	667	667	668	666	670	666				
11	136.5	687 ✓	684	681	683	684	688	684	687	683	683	690	683		685	682	682	682	✓ 684	684	682	682				
17	139.3	Unknown	-	-	-	-	717	716	715	715	715	727	715		714	714	714	714	715	715	712	713				
20	140.5	730	-	-	-	-	732	728	729	729	729	741	729		728	728	728	728	729	729	727	729				
21 (A6)	141.8	747	-	-	-	-	746	746	746	746	745	751	746		746	746	745	746	747	747	745	745				
21	142.2	755	-	-	-	-	753	753	753	753	753	755	753		752	752	752	752	753	754	751	750				
22	144.8	788	-	-	-	-	787	787	787	788	787	787	786		785	785	785	785	787	787	782	782				

NOTES:

1. Indicates locations where maximum river stage equals or exceeds a known slough threshold elevation. See Exhibits A-T for duration of overtoppings.
2. "Case C" operating guide is assumed for with-project simulations.
3. 1971-72^W simulation assumes warm, 4° C reservoir releases. All other with-project simulations assume an "inflow-matching" temperature policy.
4. Upstream extent of simulated ice cover progression for Watana filling occurs upstream of River Mile 144.8.

Upstream Boundary of Natural Simulations

Upstream Extent of Ice Cover Progression

5. All river stages in feet.
6. Winter air temperatures:
1971-72 cold
1976-77 very warm
1981-82 average
1982-83 warm

EXHIBIT 7-4
14

**SUSITNA HYDROELECTRIC PROJECT
TOTAL ICE THICKNESS
MAXIMUM SIMULATED VALUES**

TABLE VIII

		NATURAL CONDITIONS				WATANA ONLY					WATANA AND DEVIL CANYON				WATANA FILLING								
		✓				✓	1996 DEMAND				2001 DEMAND	✓	2002 DEMAND			2020 DEMAND	YR. 1	YR. 2					
Slough or Side Channel	River Mile	1971-72	1976-77	1981-82	1982-83	1971-72	1976-77	1981-82	1982-83	1971-72 ^w	1971-72	1982-83	1971-72	1976-77	1981-82	1982-83	1971-72	1982-83	1982-83	1981-82			
Whiskers	101.6	5	2	4	3	5	1	3	2	3	5	2	5	1	2	2	4	1	2	3			
Gash Creek	112.0	5	4	4	4	5	3	5	5	6	5	7	5	2	2	3	4	1	3	4			
6A	112.3	6	5	4	5	5	3	5	4	6	5	7	5	3	3	4	4	1	5	5			
8	114.1	5	2	4	4	5	3	4	3	4	5	5	4	2	3	3	4	1	3	3			
MSII	115.5	5	2	5	5	6	2	5	5	4	5	6	4	4	3	4	4	2	3	5			
MSII	115.9	5	3	7	6	7	4	7	6	6	5	8	4	6	4	6	5	3	5	8			
Curry	120.0	6	5	7	4	7	5	8	5	3	5	1	4	1	1	1	4	2	4	6			
Moose	123.5	10	4	7	5	9	5	8	2	4	6	2	7	1	1		7	2	5	6			
8A West	126.1	5	2	3	3	5	2	3	1	1	5		3				3	1	1	2			
8A East	127.1	5	2	3	3	4		2			4		3				3		1	2			
9	129.3	6	4	7	5	5		3			6		3				3		2	4			
9 u/s	130.6	8	3	6	7	5		2			6		3				2		3	6			
4th July	131.8	7	1	3	5	5		2			7		3				2		1	3			
9A	133.7	7	1	3	3	6		2			6		3						3	2			
10 u/s	134.3	11	1	3	4	7		2			9		4						6	2			
11 d/s	135.3	6	1	3	5	6		2			8		3						3	3			
11	136.5	5	1	3	4	3		2			5		1						3	4			
17	139.3	Upstream Boundary of Natural Simulations				2						13								1	4		
20	140.5					2								12								1	4
21 (A6)	141.8					Upstream Extent of Ice Cover Progression									3							1	2
21	142.2														1						1	1	
22	144.8																					1	1

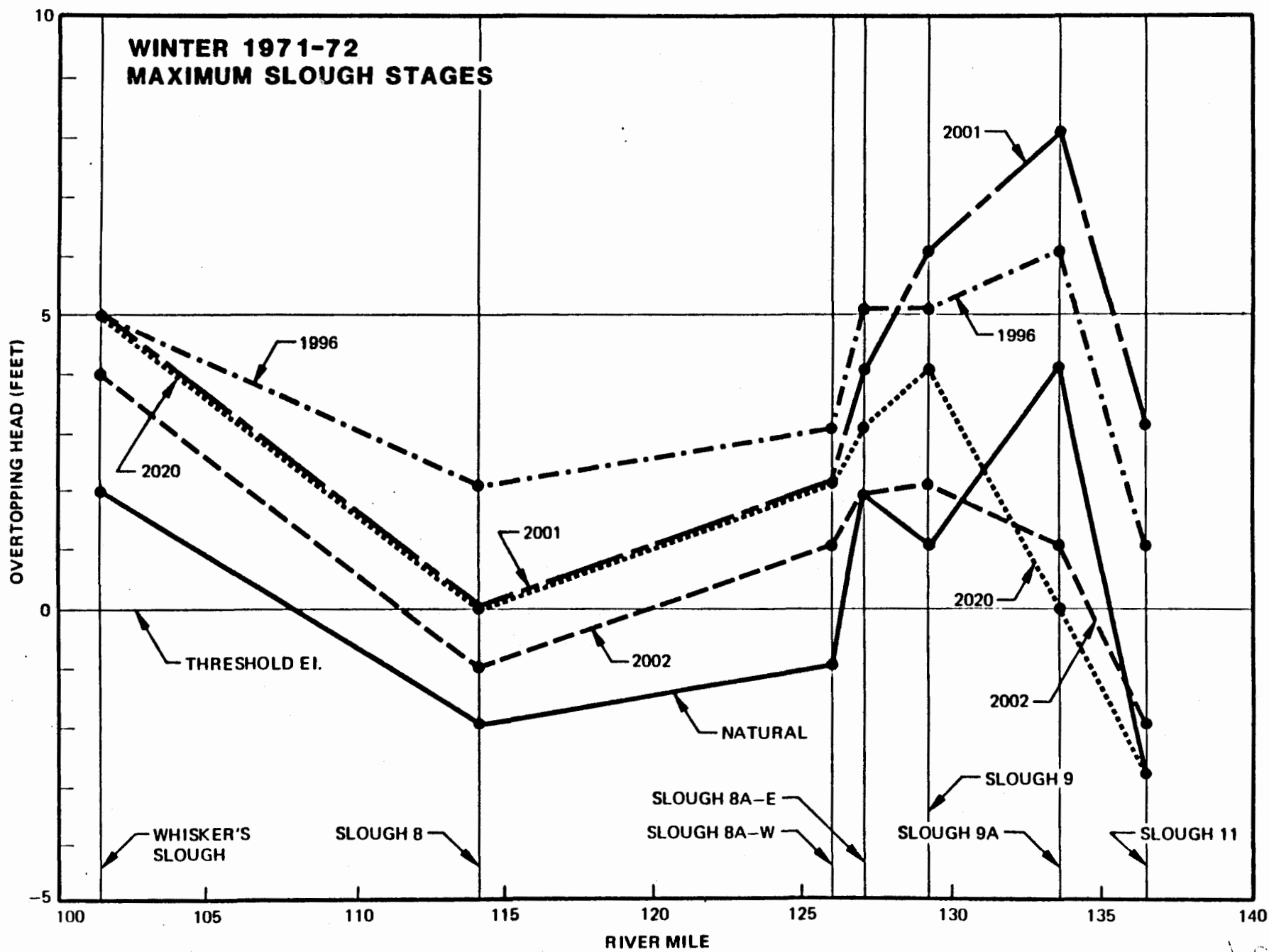
NOTES:

1. "Case C" operating guide is assumed for with-project simulations.
2. 1971-72^w simulation assumes warm, 4°C reservoir releases.
All other with-project simulations assume an "inflow-matching" temperature policy.
3. Upstream extent of simulated ice cover progression for Watana filling occurs upstream of River Mile 144.8.

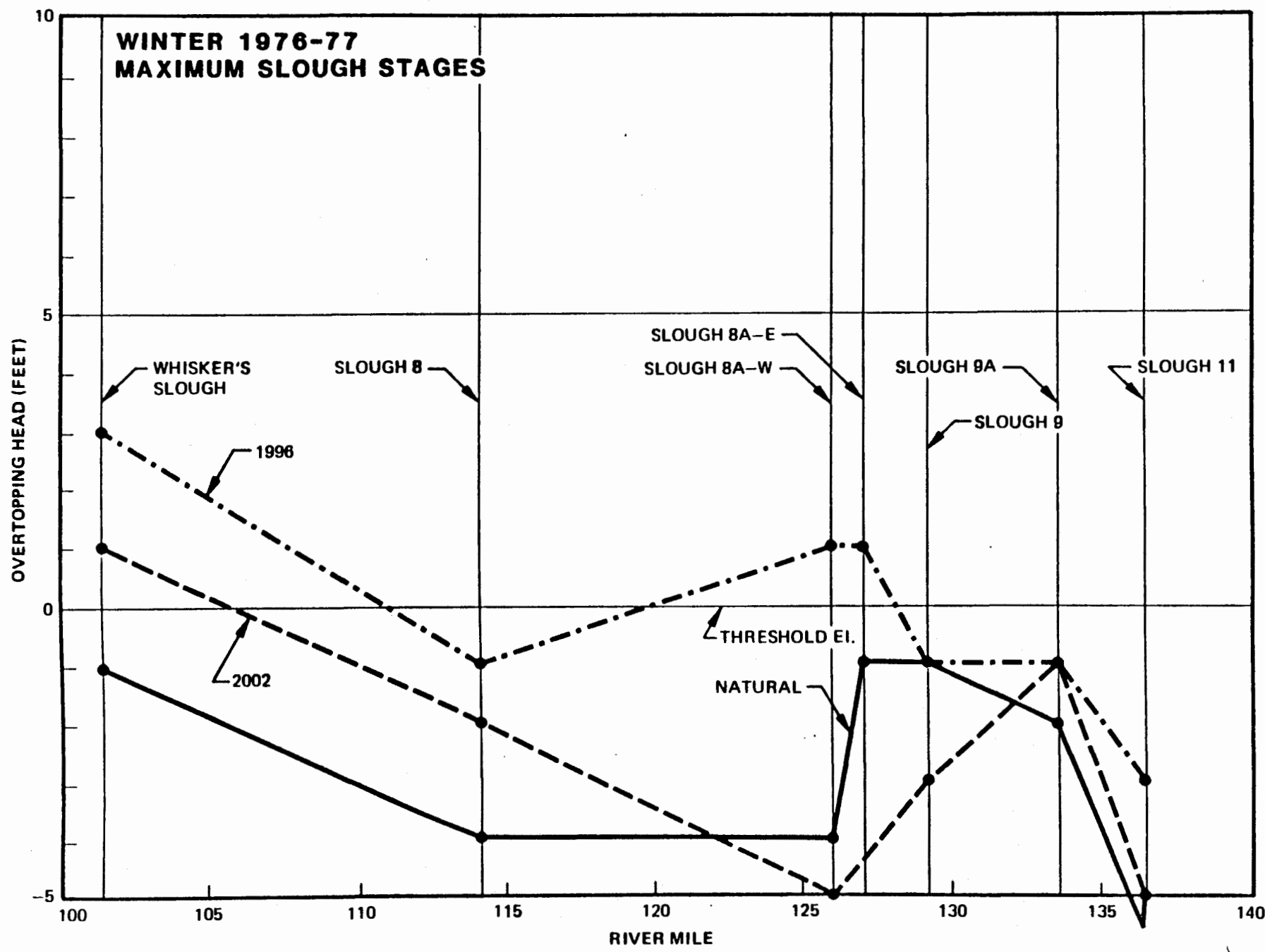
4. All ice thickness in feet.
5. Winter air temperatures:
1971-72 cold
1976-77 very warm
1981-82 average
1982-83 warm

711

62
10/15/10
15

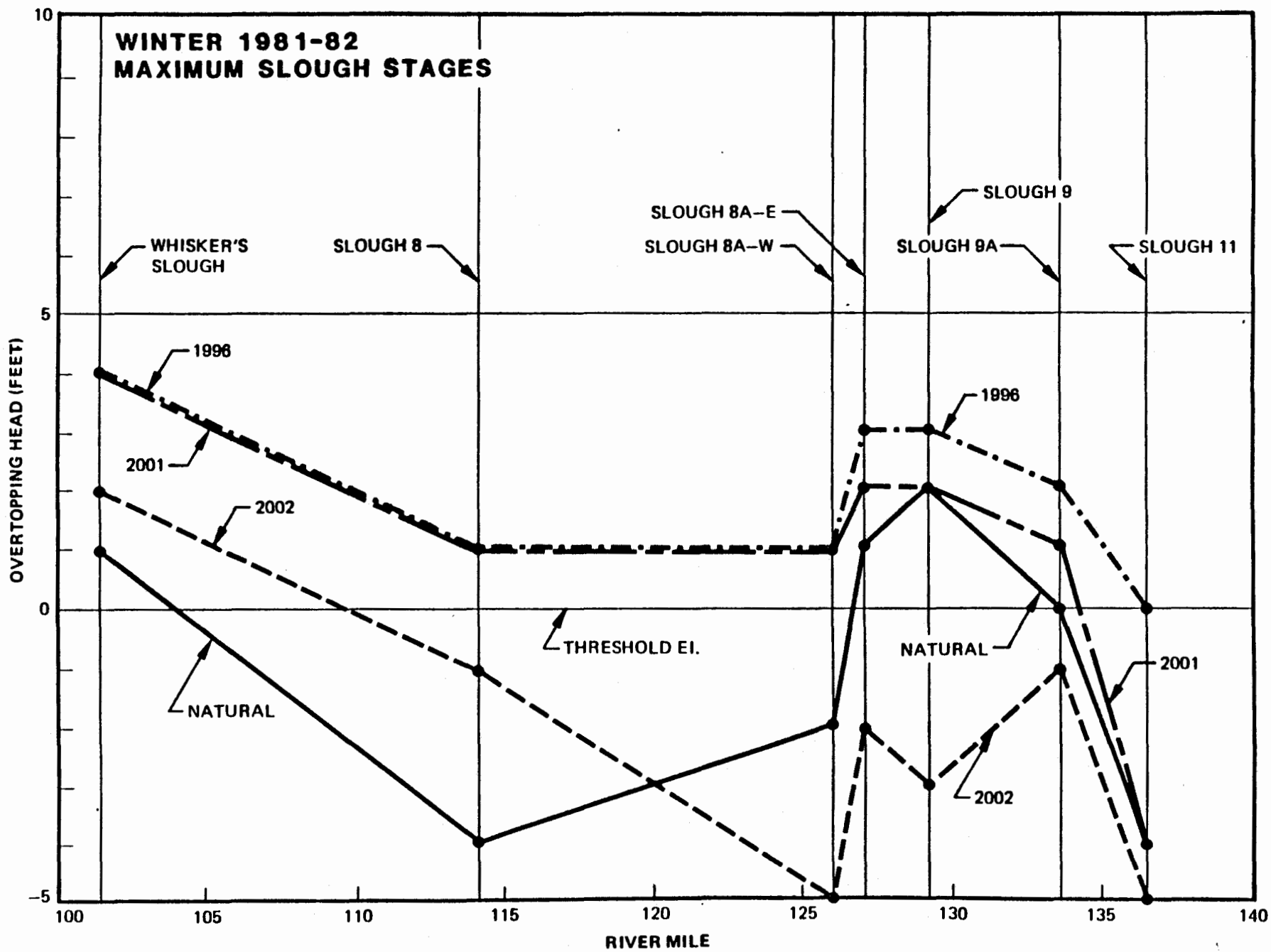


113



20

EXHIBIT 17
72



120

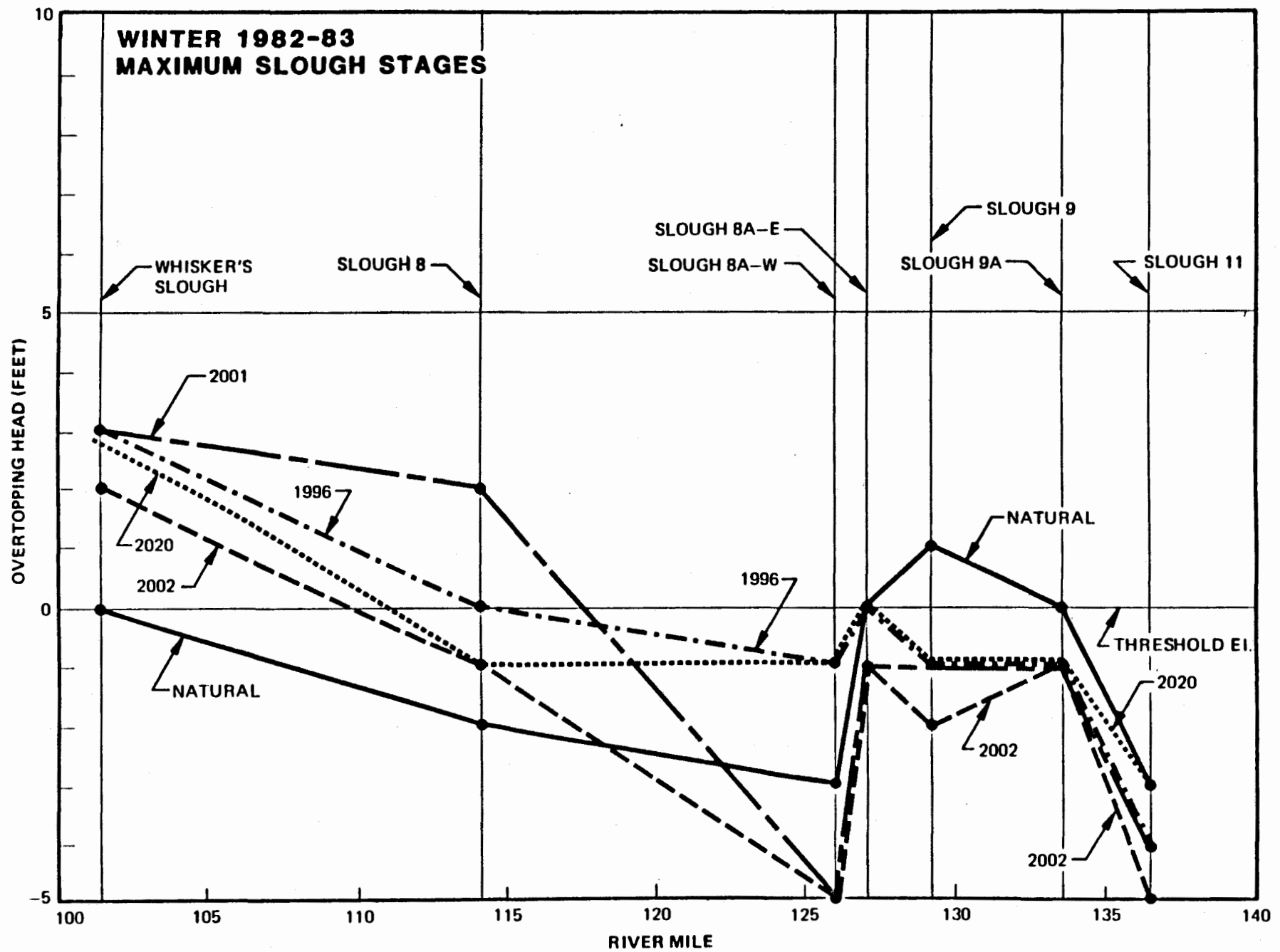
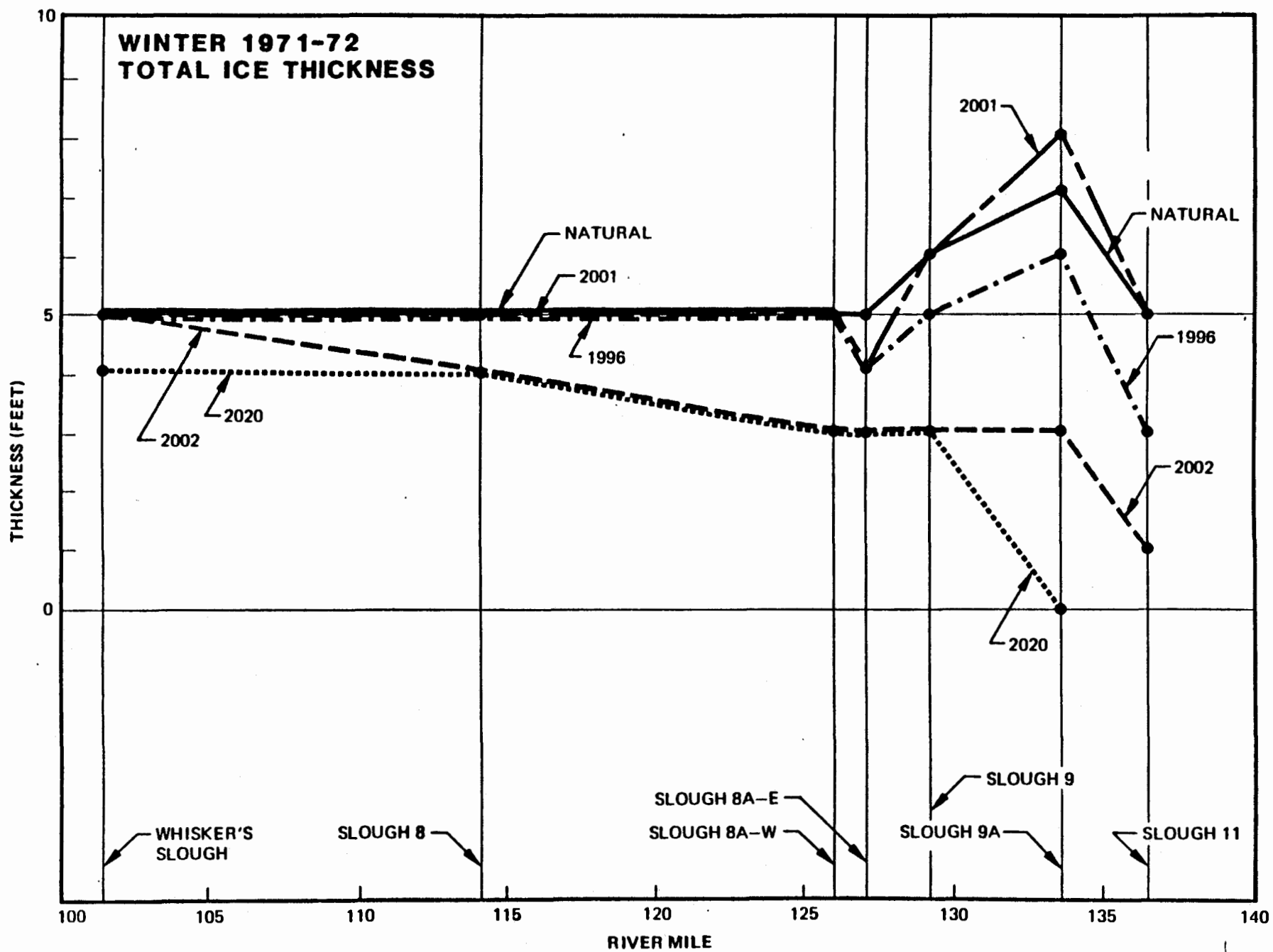


EXHIBIT 74
b7c

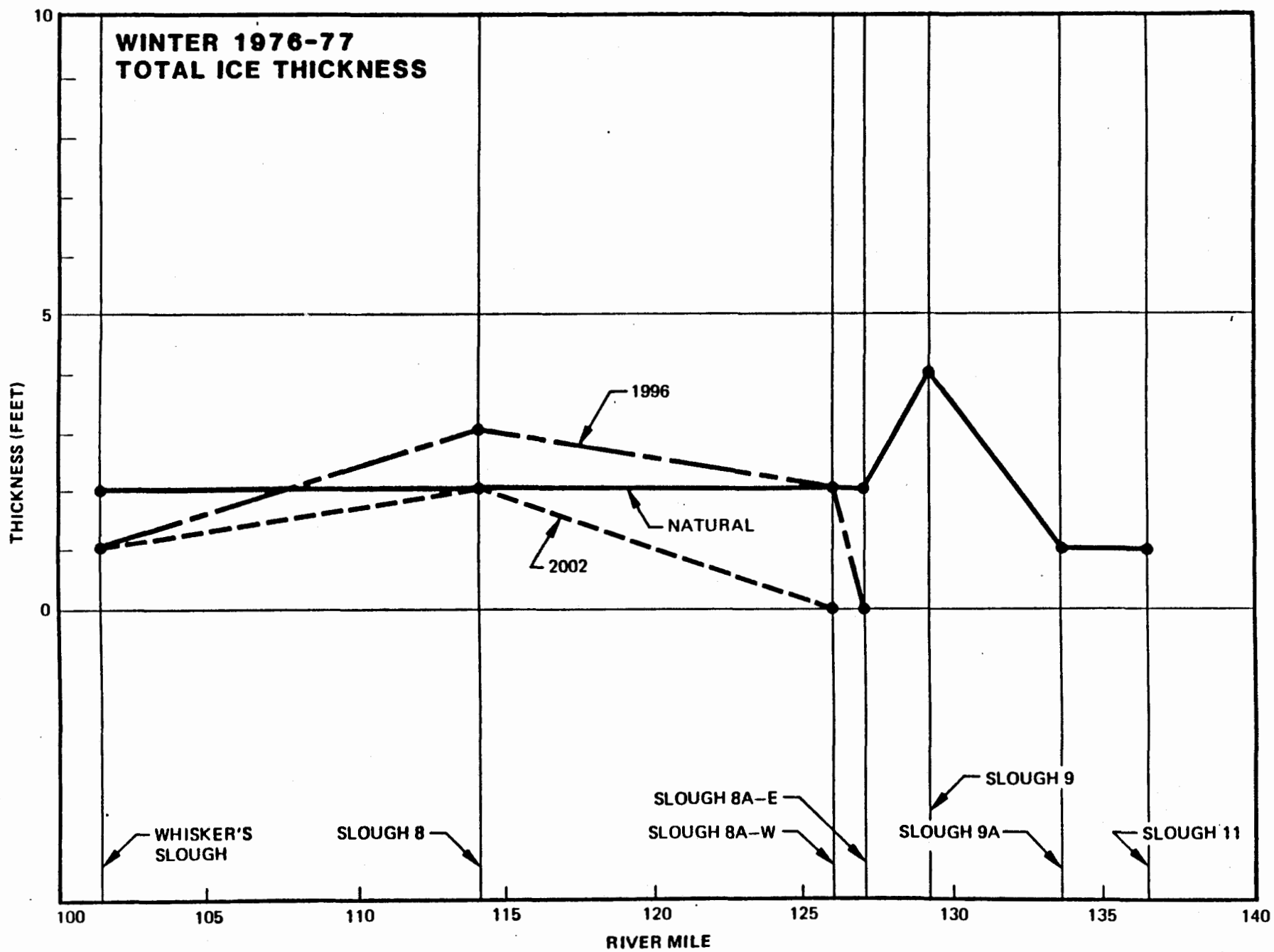
121



75

CANADIAN
20

122



1191012

12.64

123

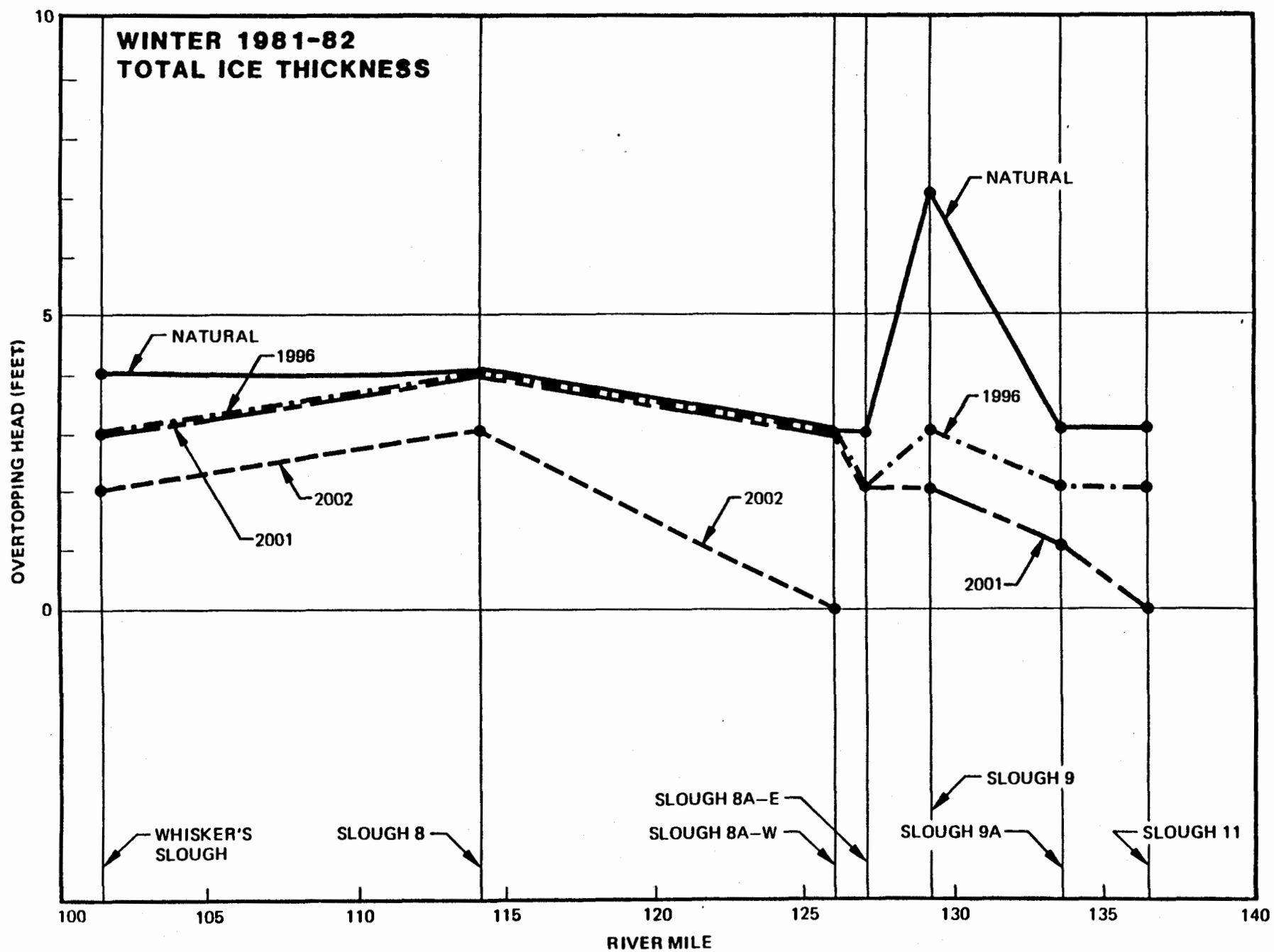
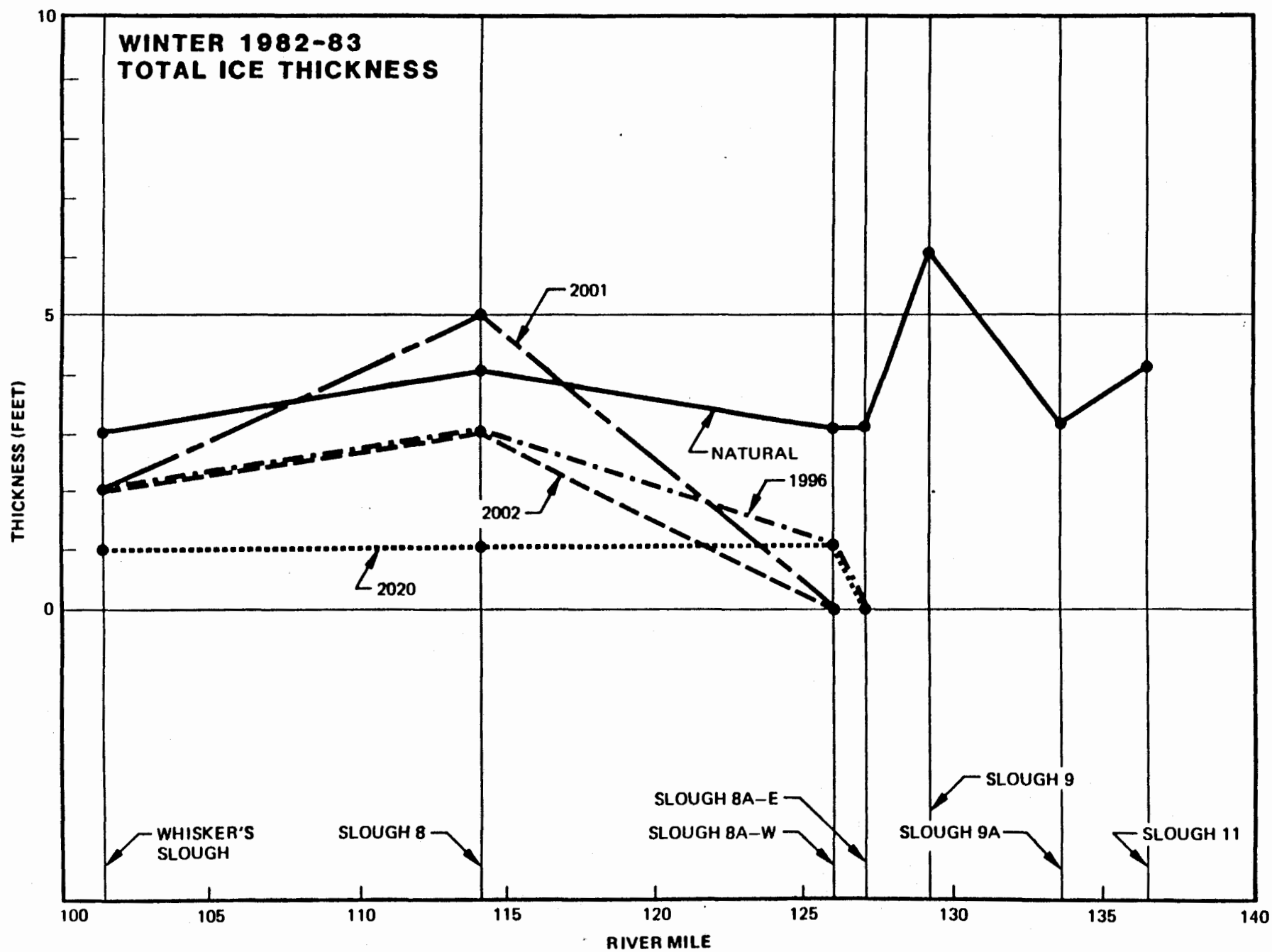


EXHIBIT 11
T.T.
22

124



125

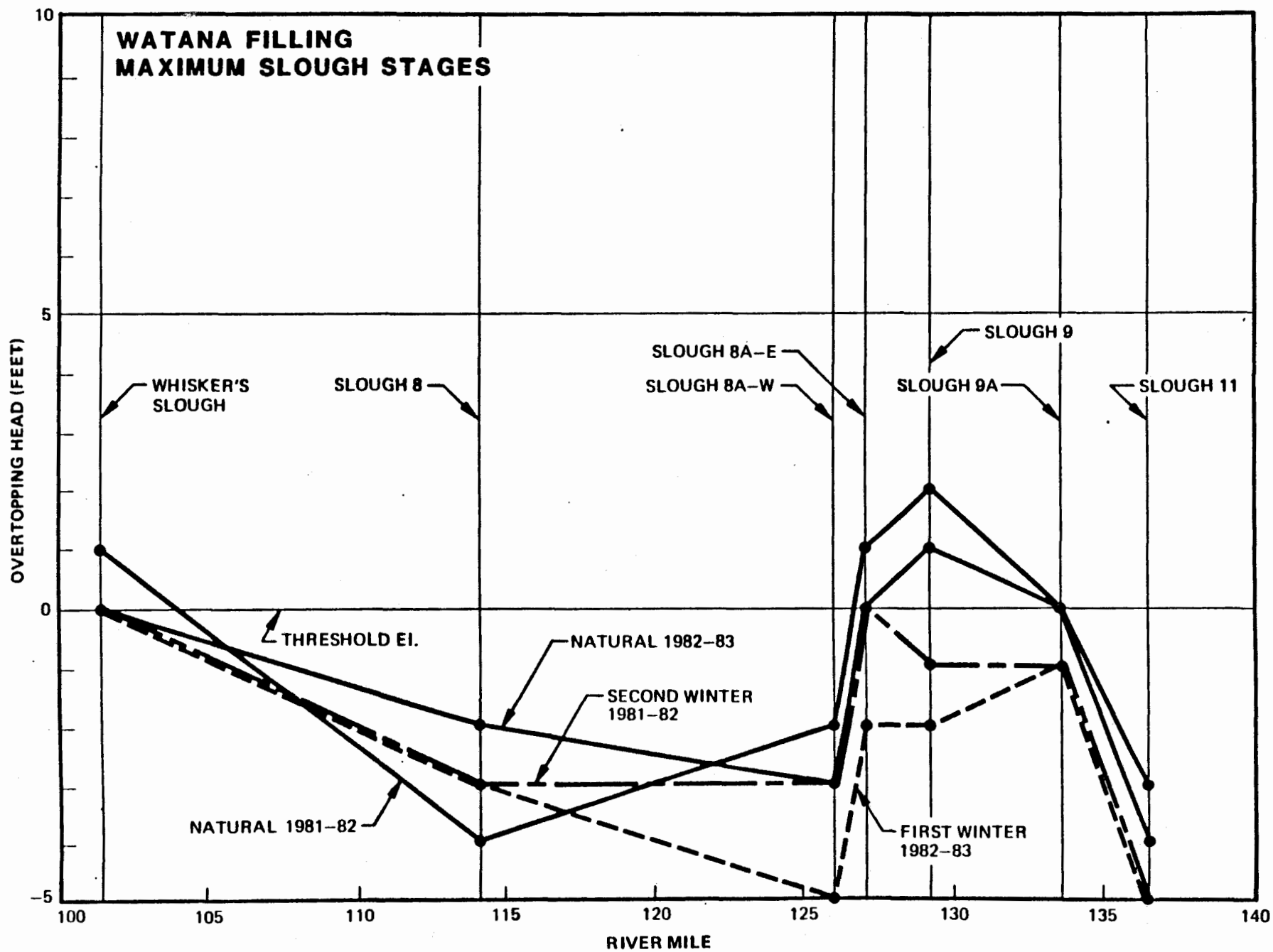
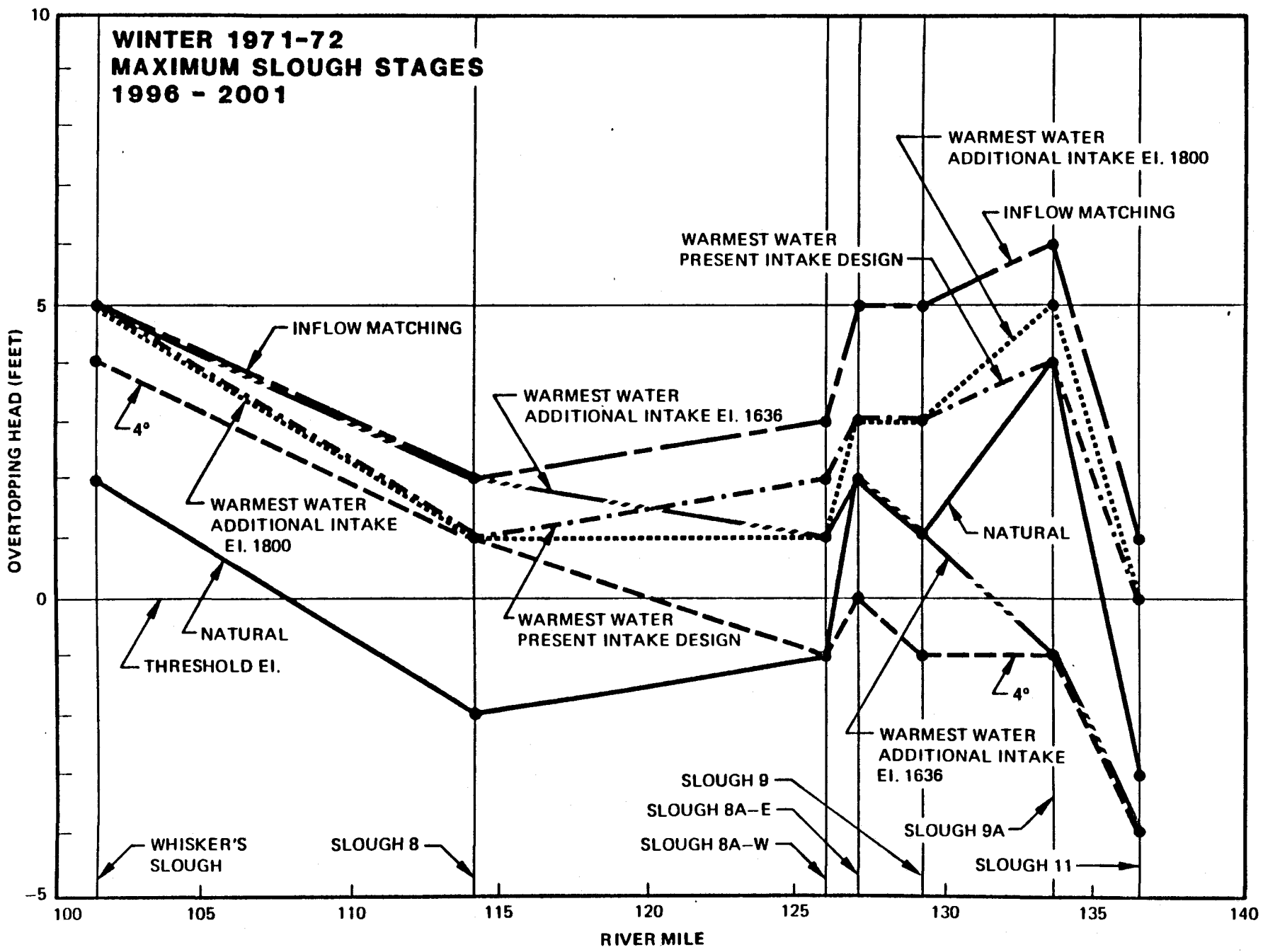


EXHIBIT 11
42
44

126



CANAL
25
186

127

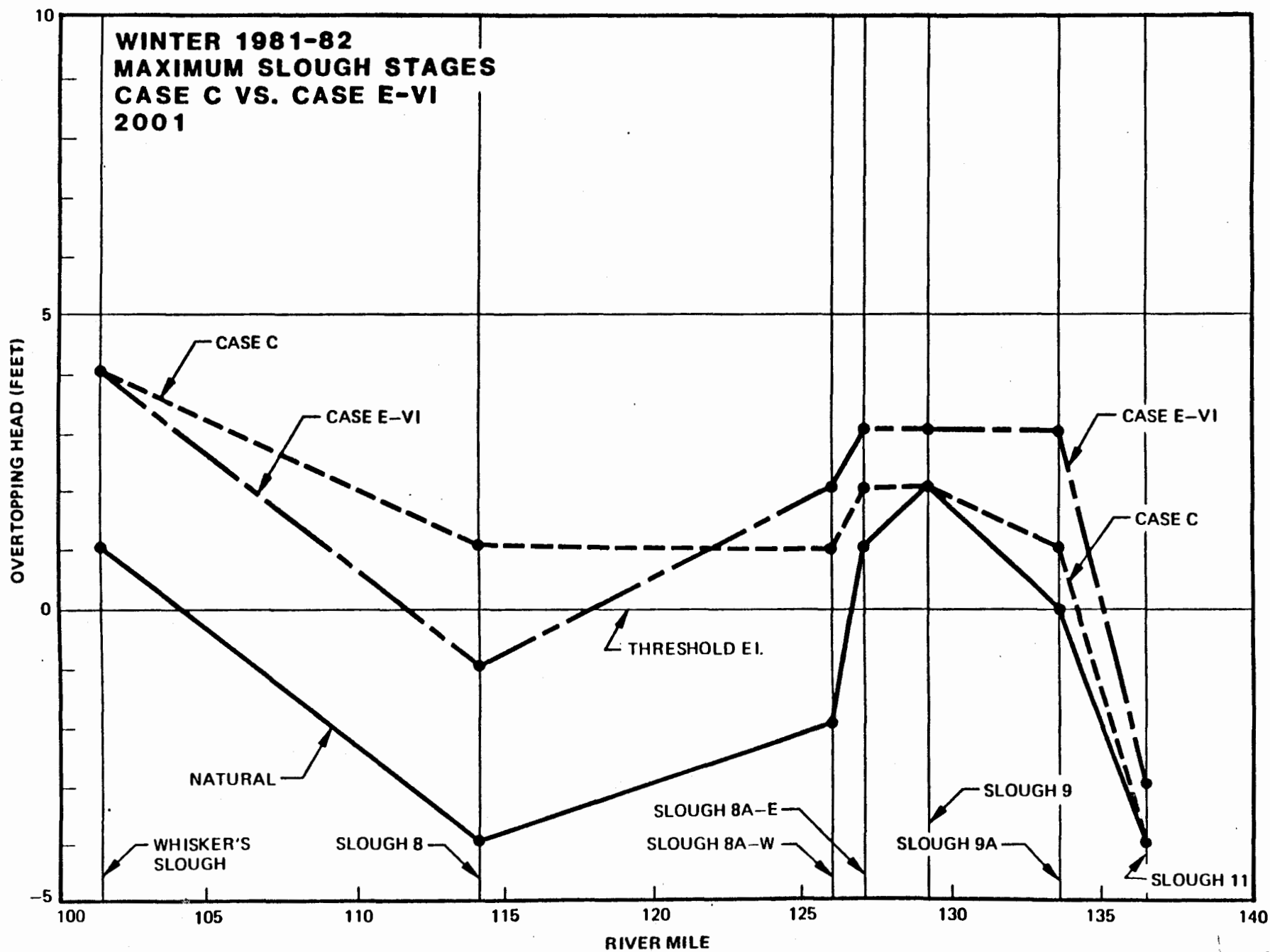
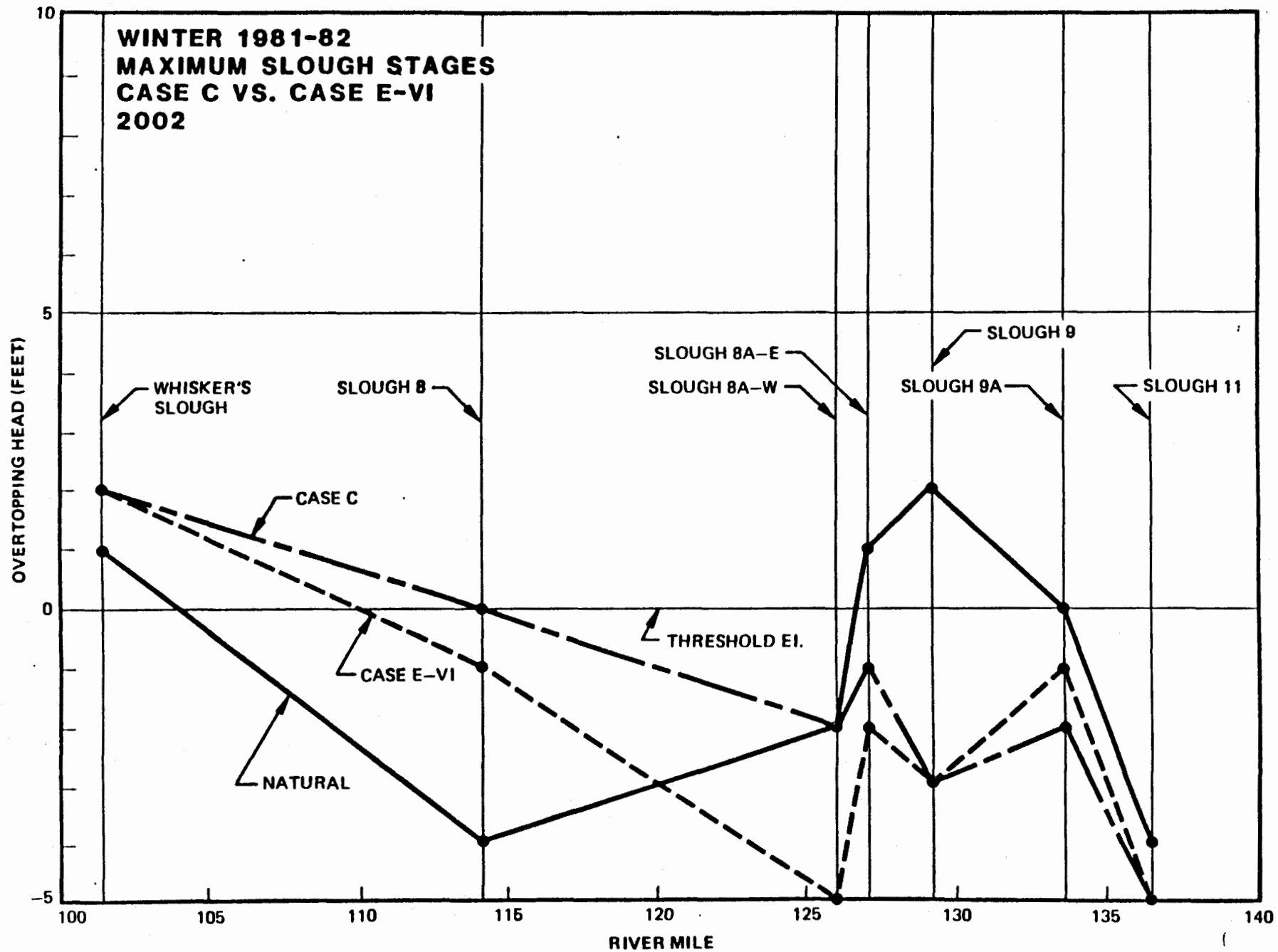


EXHIBIT 26

79

128



CAN/10/11 27

129

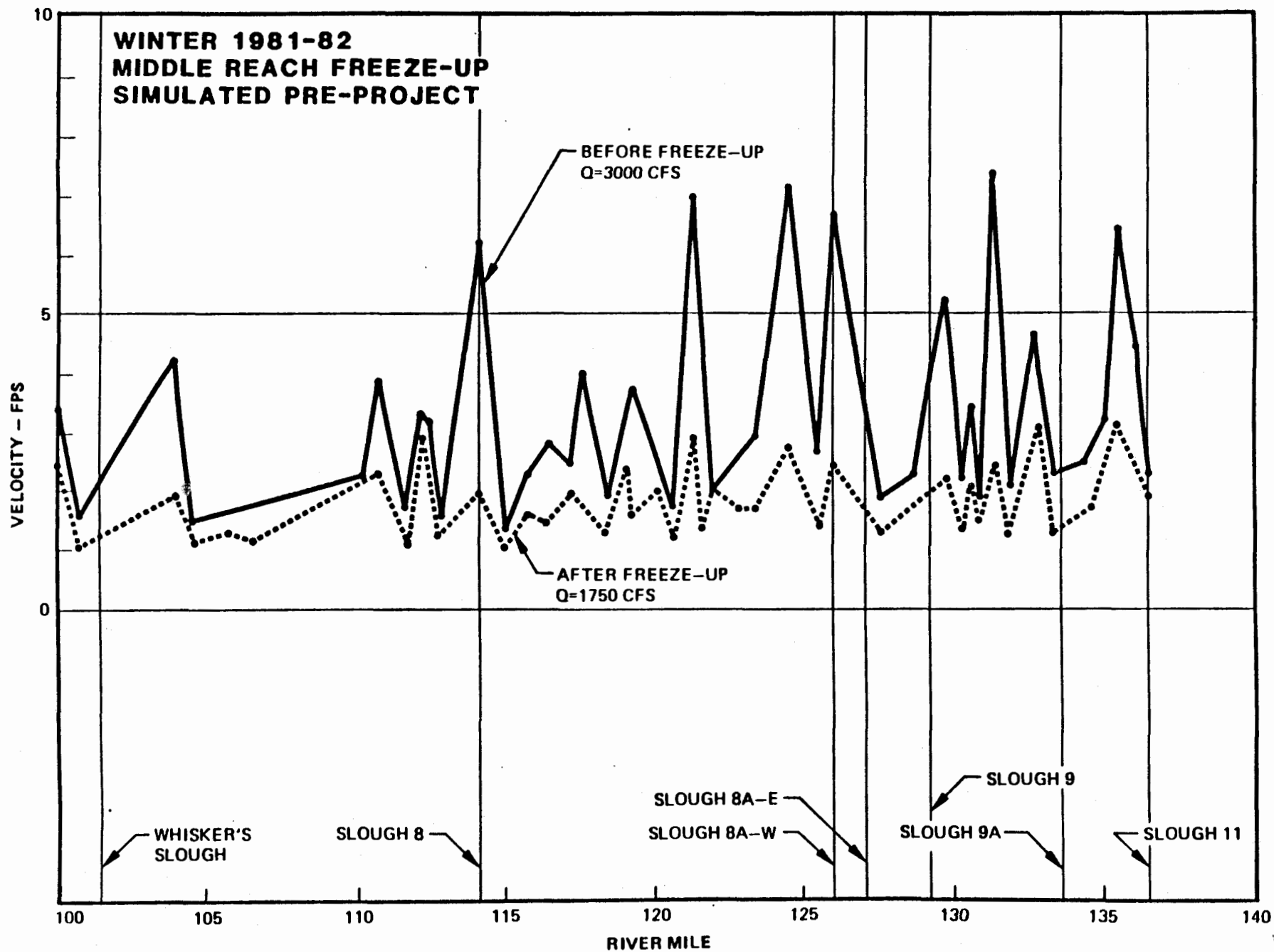


EXHIBIT 11
82
18

130

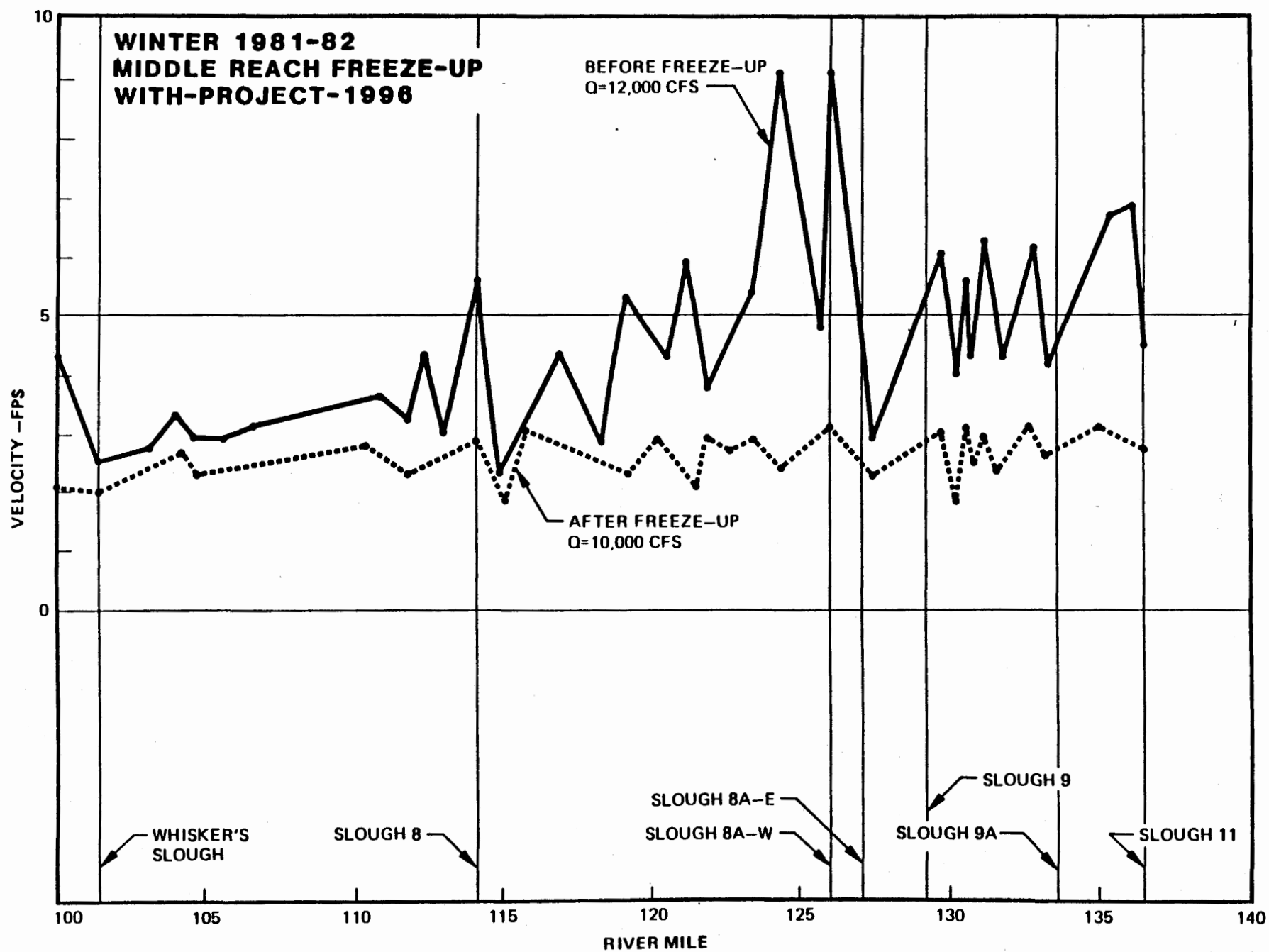
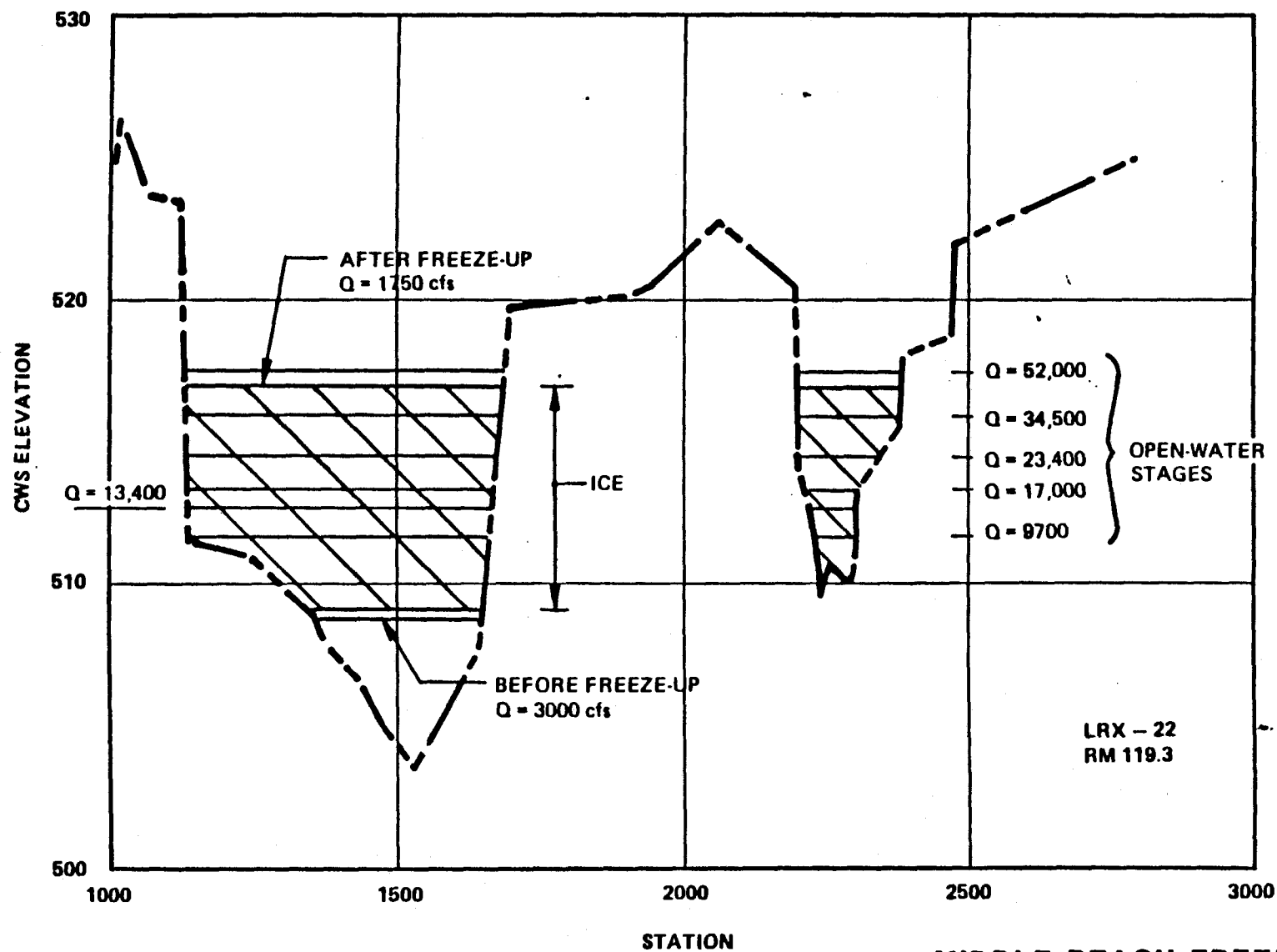
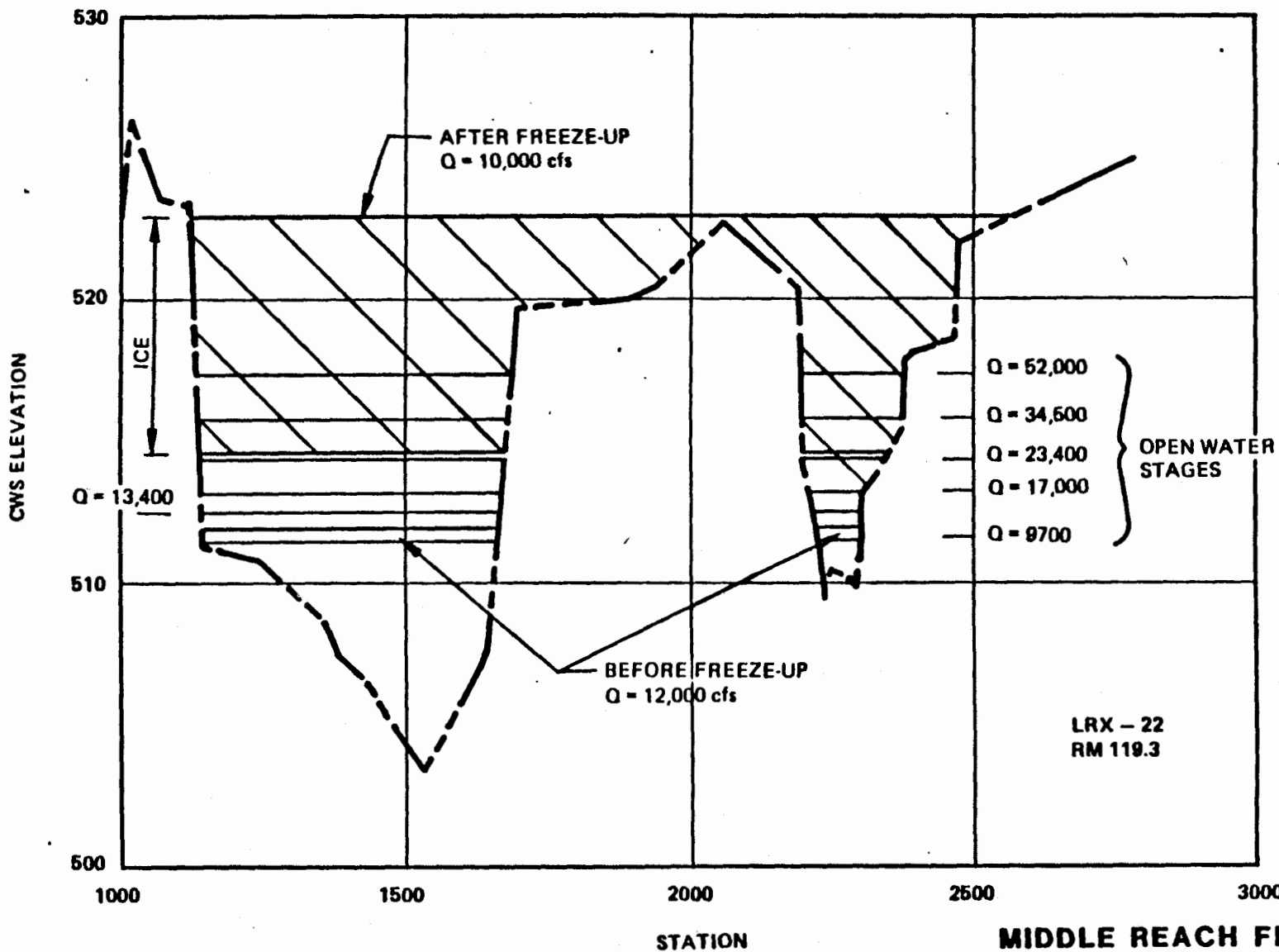


EXHIBIT
24.
29



**MIDDLE REACH FREEZE-UP
SIMULATED PRE-PROJECT
WINTER 1981-82**

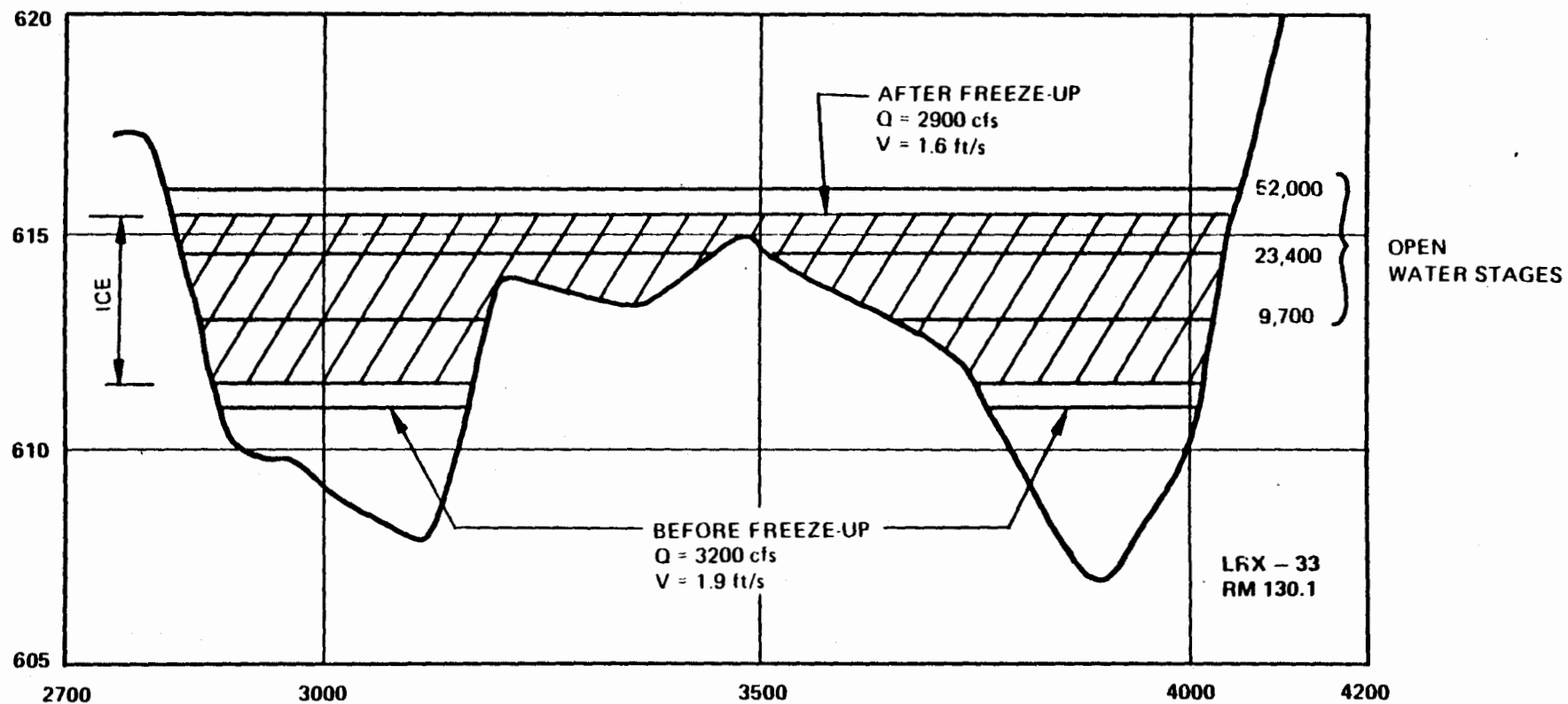
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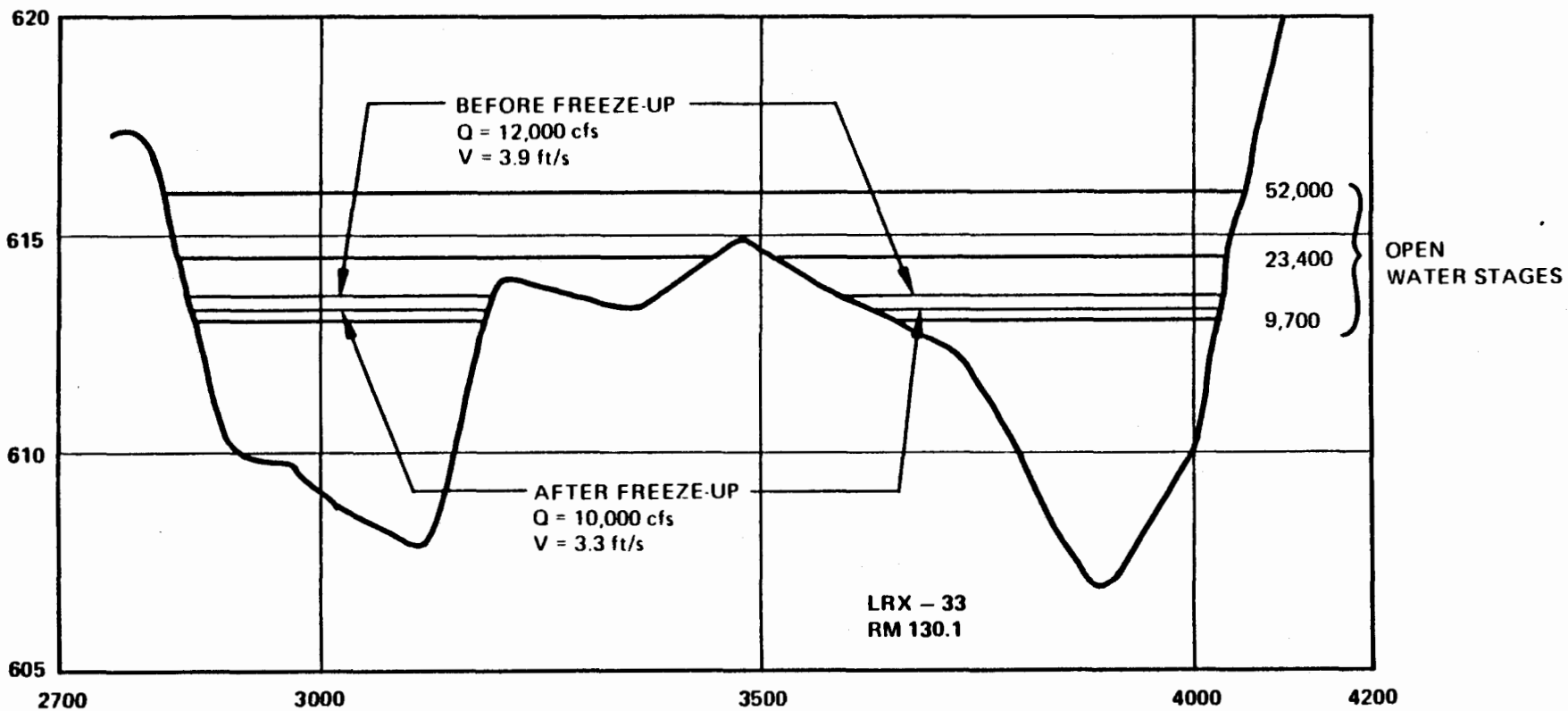
**MIDDLE REACH FREEZE-UP
WITH PROJECT - 1996
WINTER 1981-82**

EXHIBIT 17

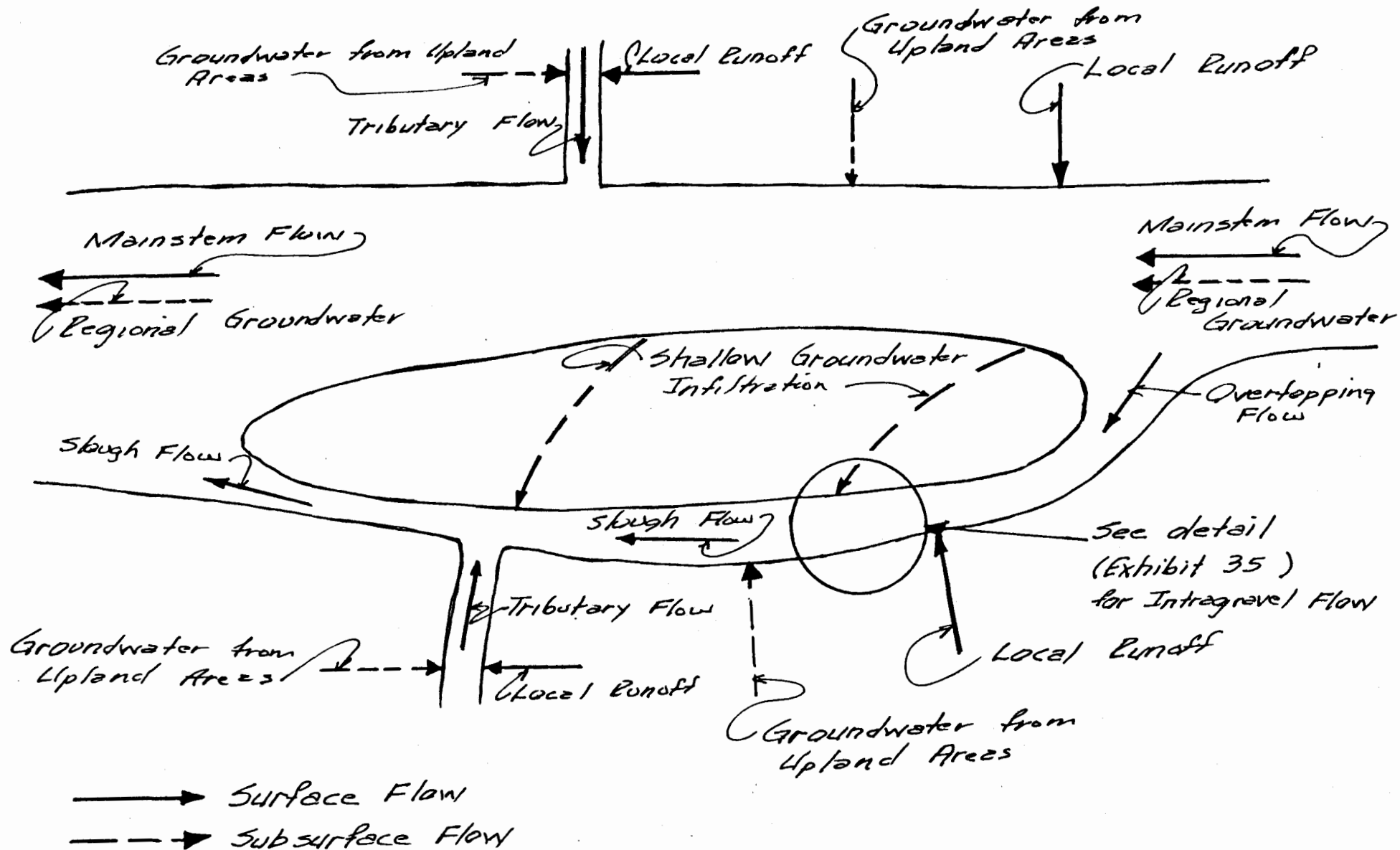
26.
31



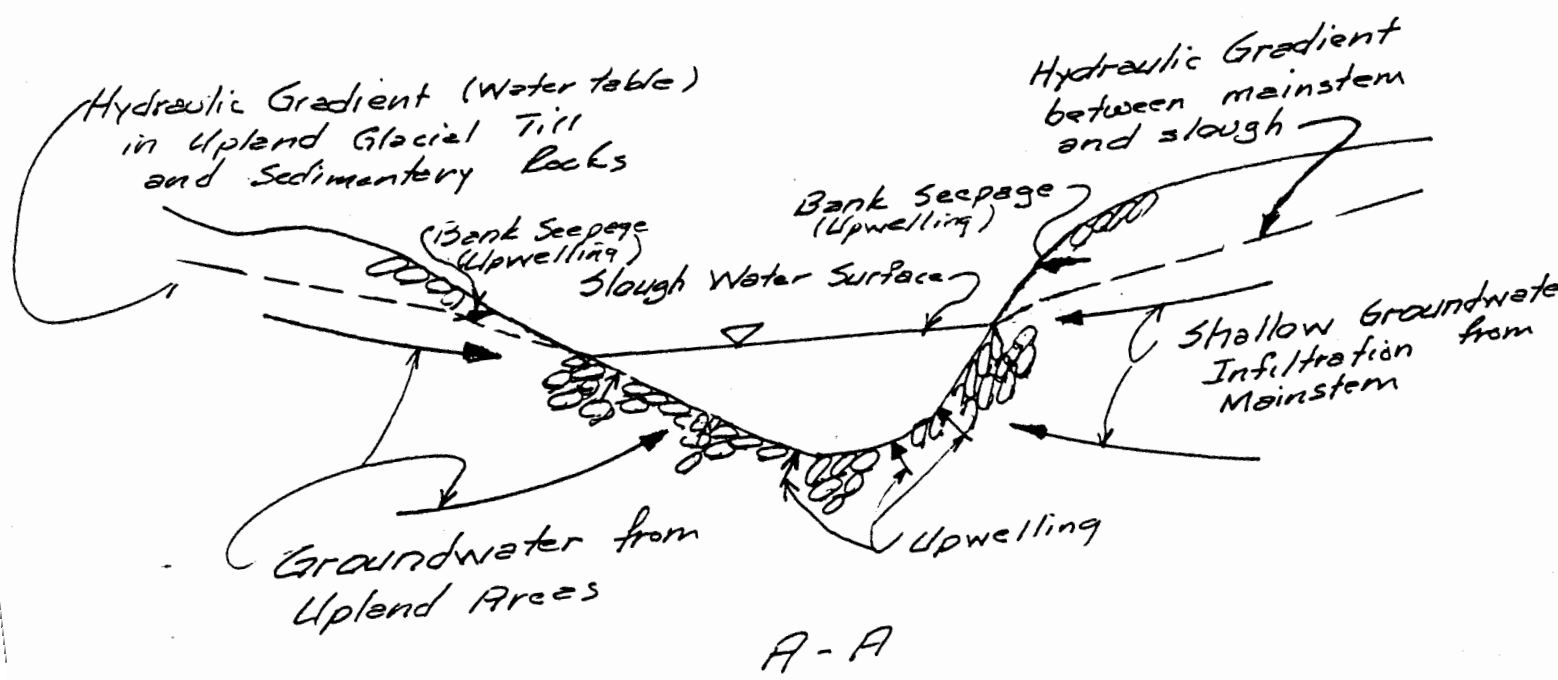
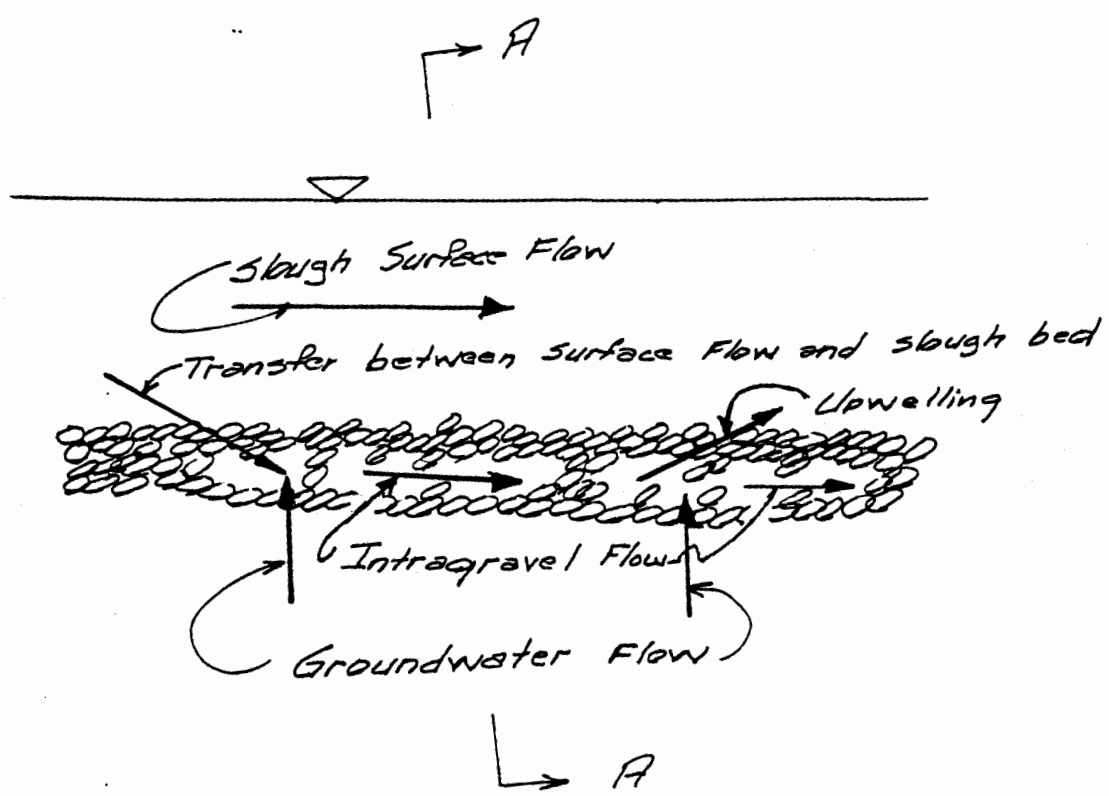
MIDDLE REACH FREEZE-UP
SIMULATED PRE-PROJECT
WINTER 1982-83



**MIDDLE REACH FREEZE-UP
WITH-PROJECT 1996
WINTER 1982-83**



PLAN VIEW SHOWING FLOW COMPONENTS
TYPICAL SLOUGH



Detail of Intragravel Flow
From Exhibit 34

Figure 2 Susitna River drainage Basin fish Species by study zone

FIGURE:

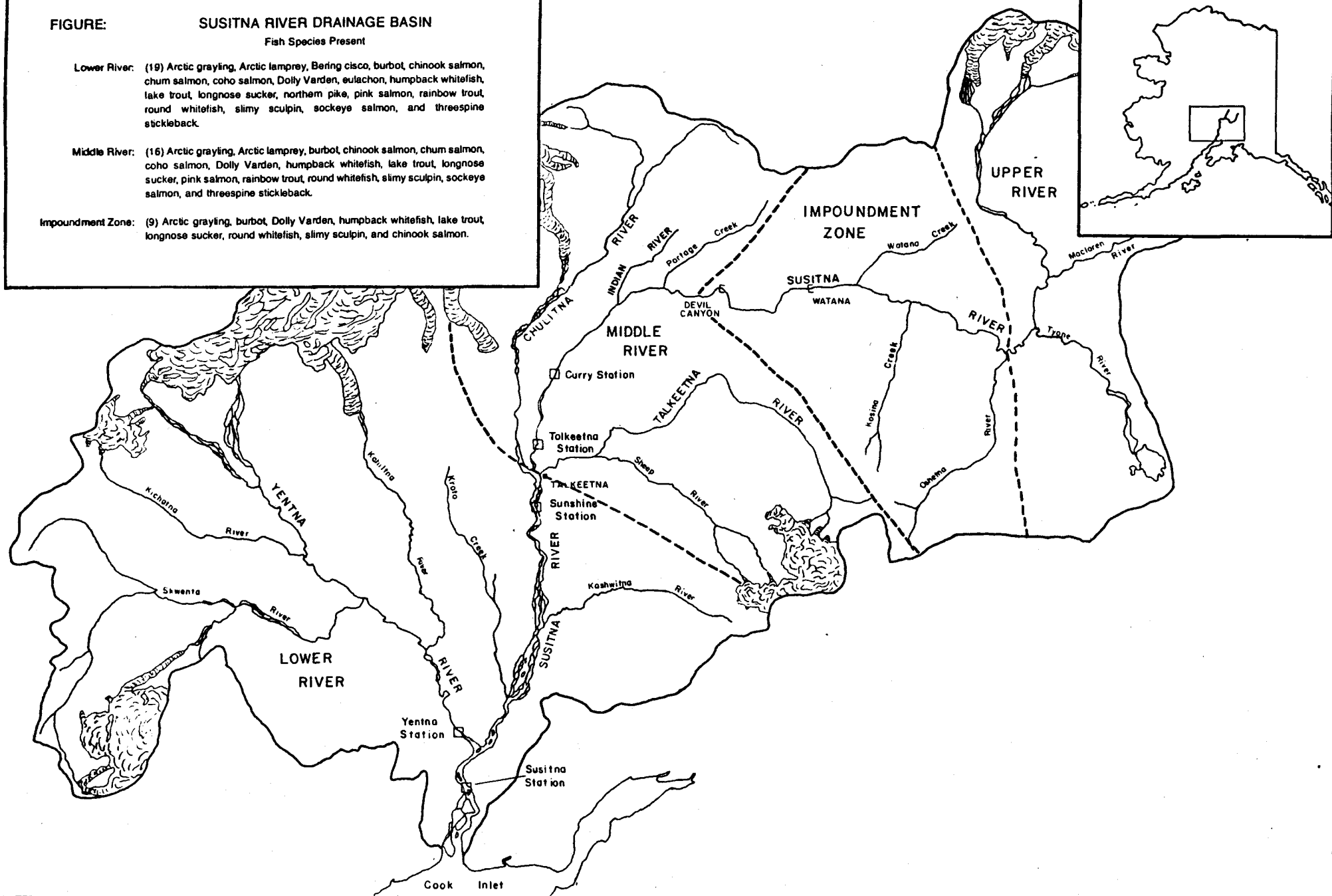
SUSITNA RIVER DRAINAGE BASIN

Fish Species Present

Lower River: (19) Arctic grayling, Arctic lamprey, Bering cisco, burbot, chinook salmon, chum salmon, coho salmon, Dolly Varden, eulachon, humpback whitefish, lake trout, longnose sucker, northern pike, pink salmon, rainbow trout, round whitefish, slimy sculpin, sockeye salmon, and threespine stickleback.

Middle River: (16) Arctic grayling, Arctic lamprey, burbot, chinook salmon, chum salmon, coho salmon, Dolly Varden, humpback whitefish, lake trout, longnose sucker, pink salmon, rainbow trout, round whitefish, slimy sculpin, sockeye salmon, and threespine stickleback.

Impoundment Zone: (9) Arctic grayling, burbot, Dolly Varden, humpback whitefish, lake trout, longnose sucker, round whitefish, slimy sculpin, and chinook salmon.



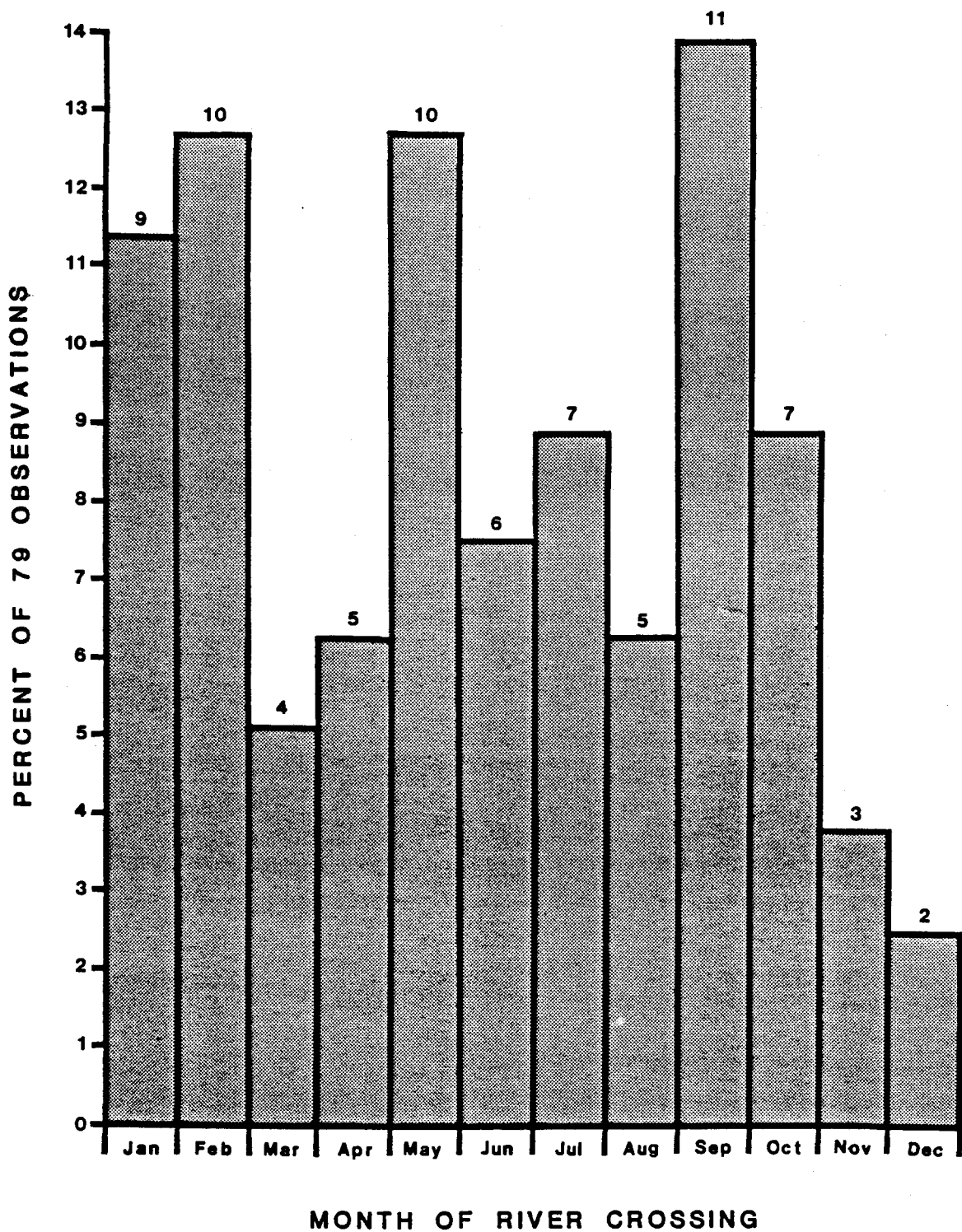


Figure 90. Timing of 79 crossings by moose of the middle Susitna River above Devil Canyon from April 1980 through December 1982 (Source: modified from data in Ballard et al. 1983a).

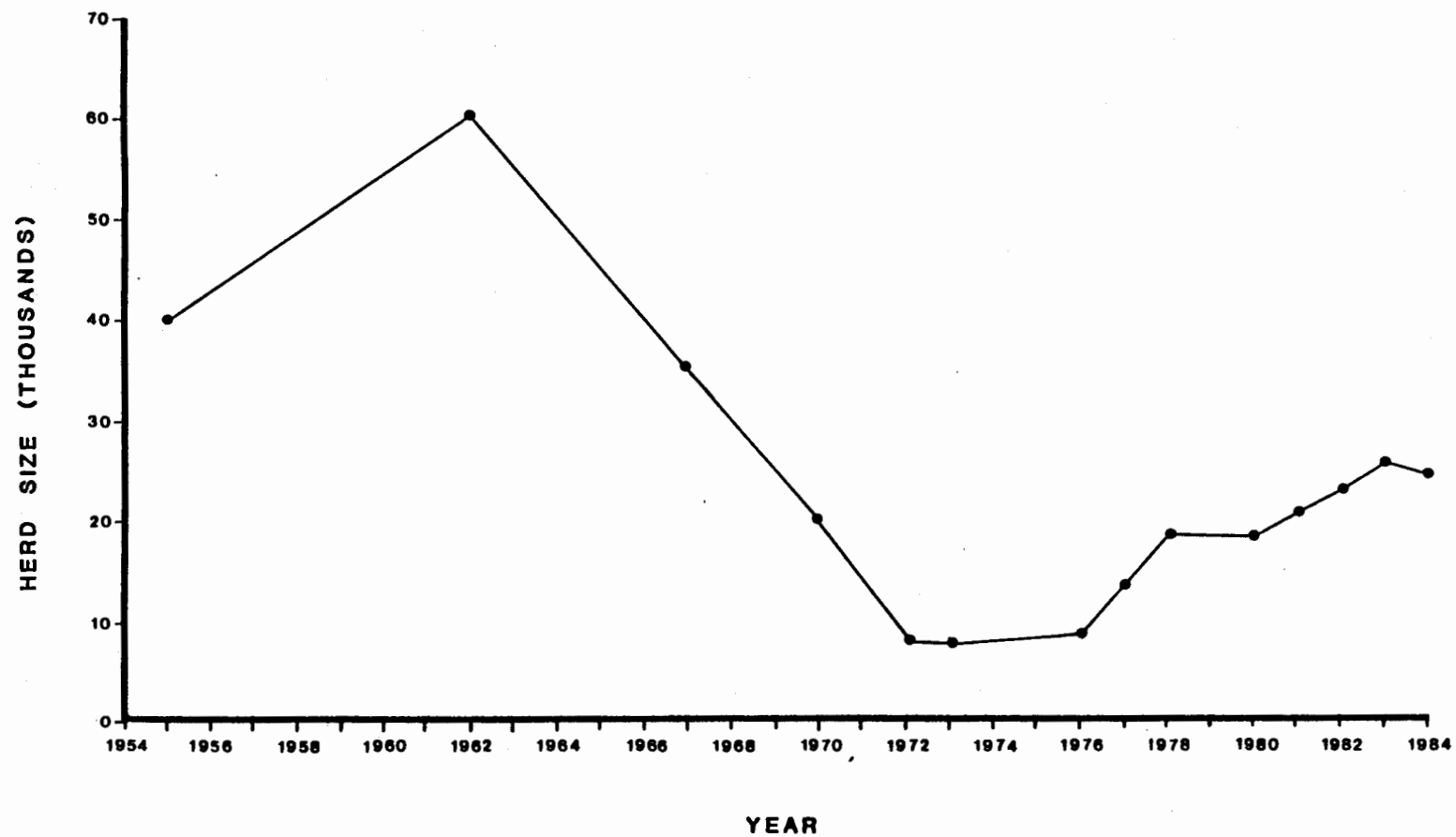


Figure 91. Population estimates for main Nelchina caribou herd (Sources: Pitcher 1984, 1985; Lieb et al. 1985).

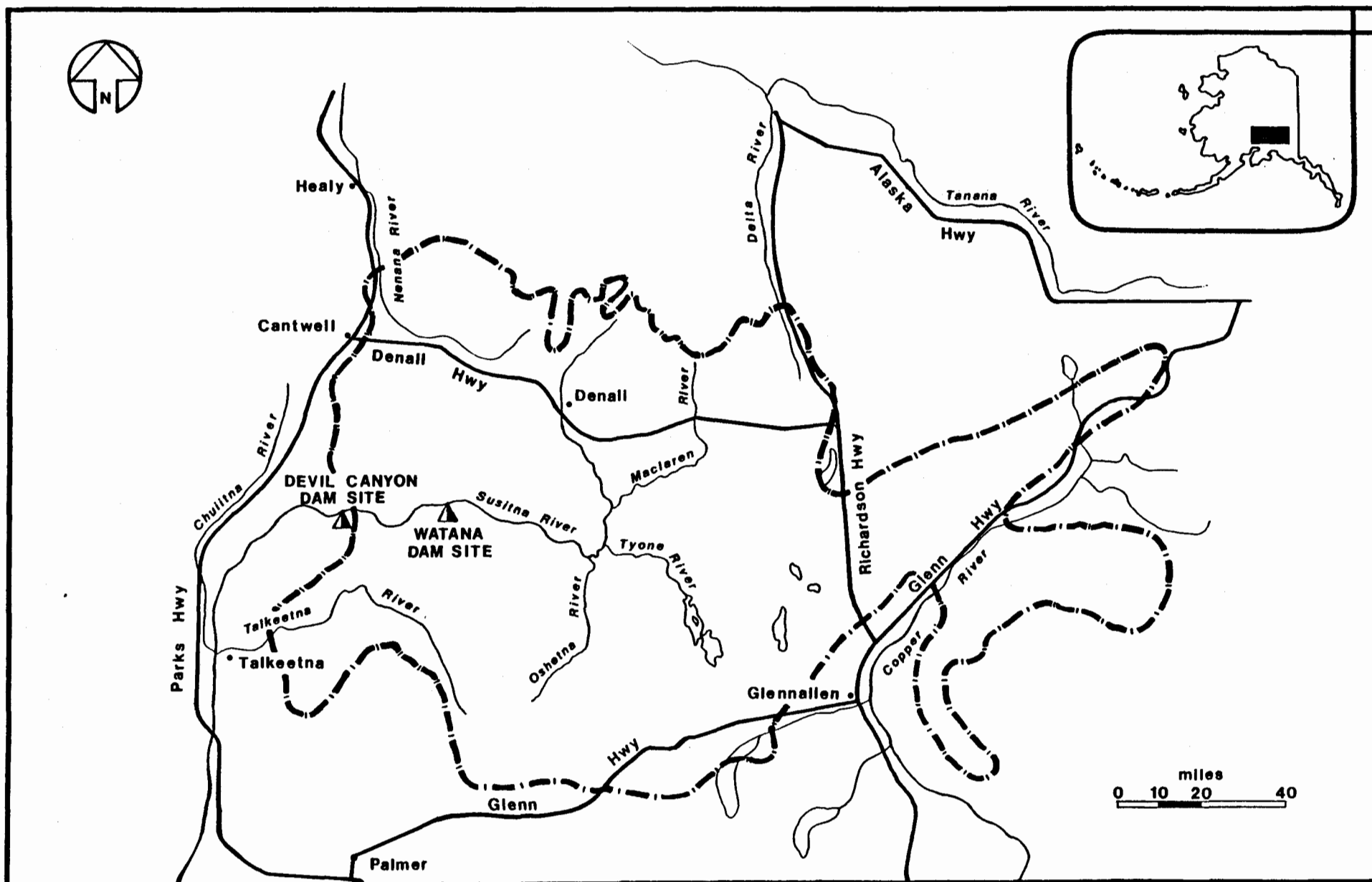


Figure 92. Historical range of the Nelchina caribou herd (Source: Hemming 1971).

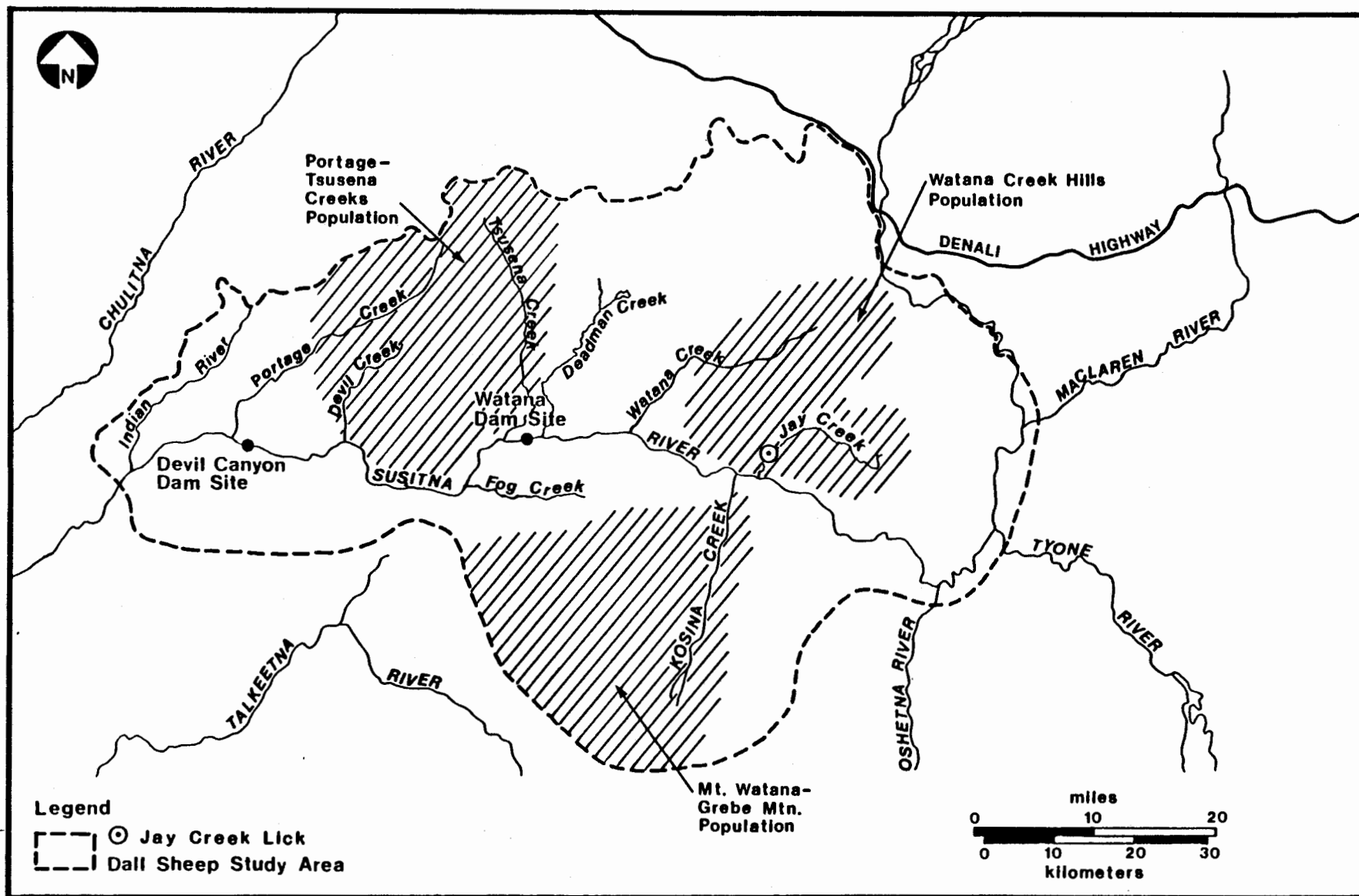


Figure 93. Dall sheep study area and local populations (Source: Tankersley 1984).

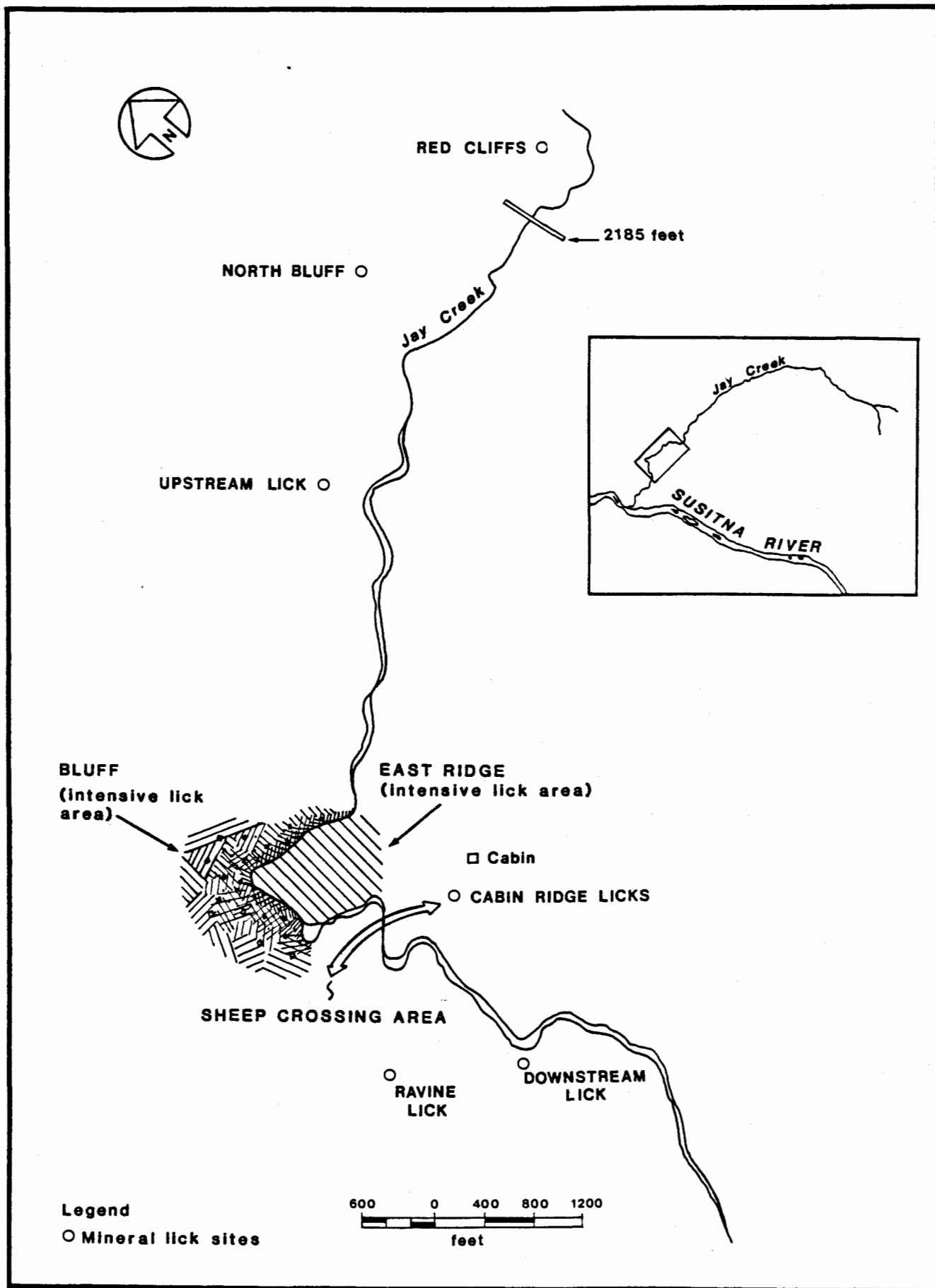
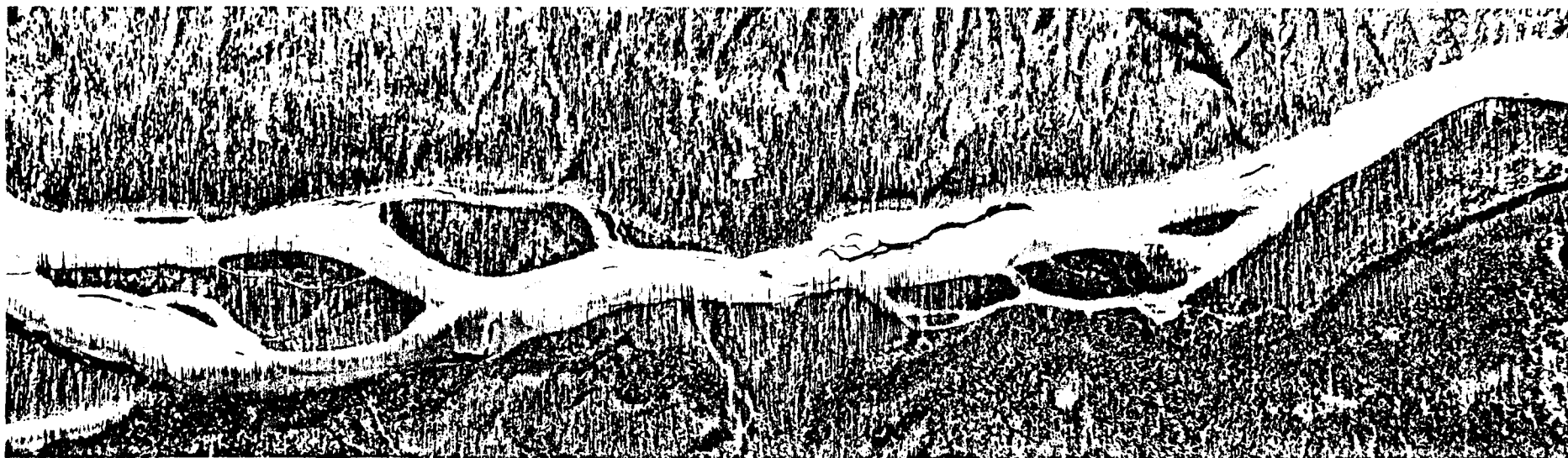


Figure 94. The Jay Creek mineral lick complex (Source: Tankersley 1984).

APPENDIX A
LOWER SUSITNA RIVER

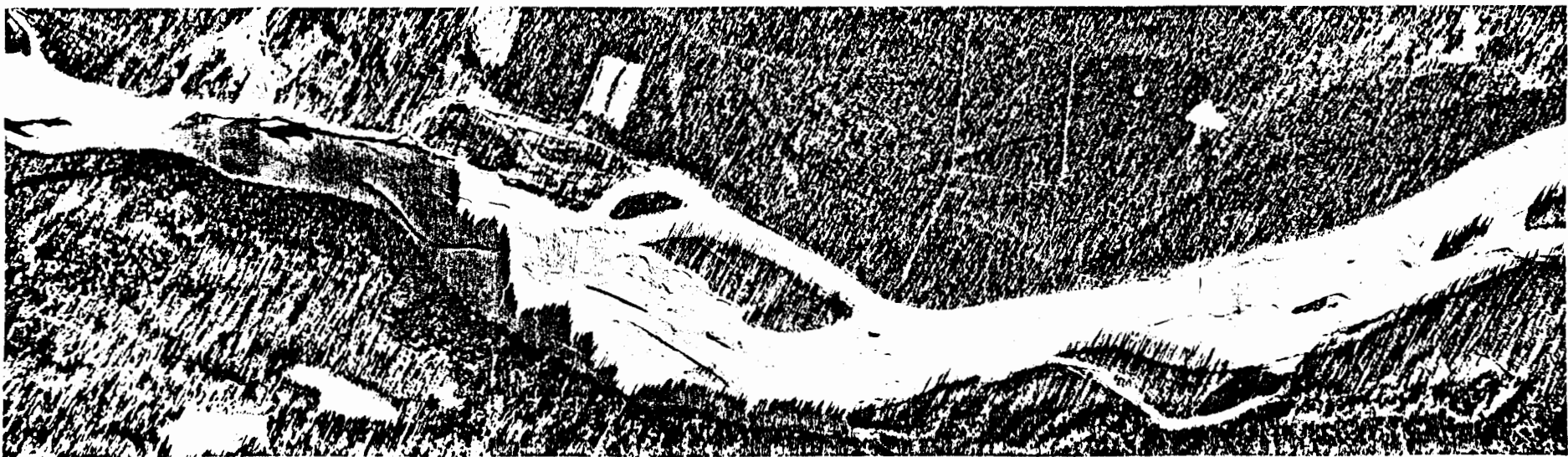
PHOTOGRAPHY NOT AVAILABLE FOR DRAFT REPORT -
WILL BE IN FINAL DRAFT

APPENDIX B
MIDDLE SUSITNA RIVER



MIDDLE SUSITNA RIVER

Top: River Mile 147 to 149
Bottom: River Mile 144 to 146
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 142 to 144
Bottom: River Mile 139 to 141
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER

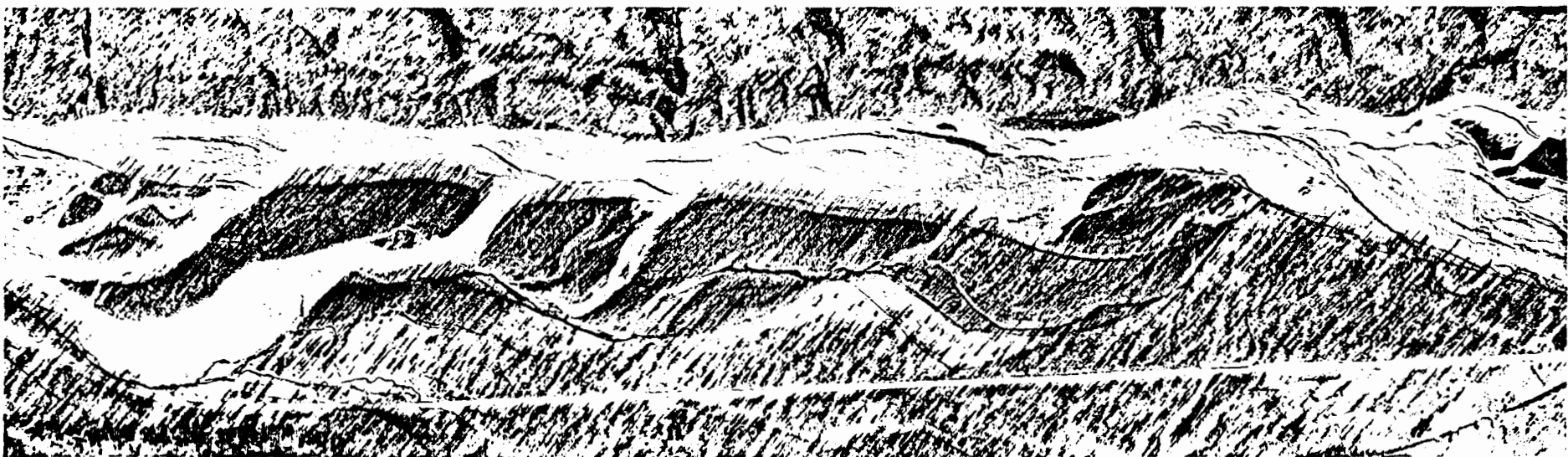
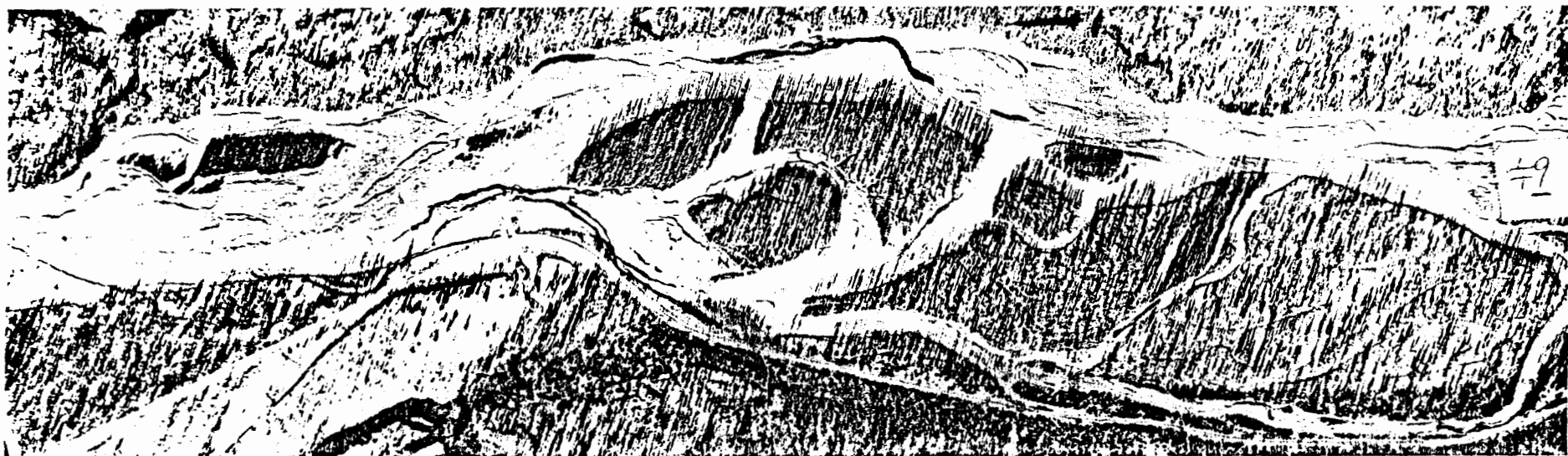
Top: River Mile 136 to 138

Bottom: River Mile 133 to 136

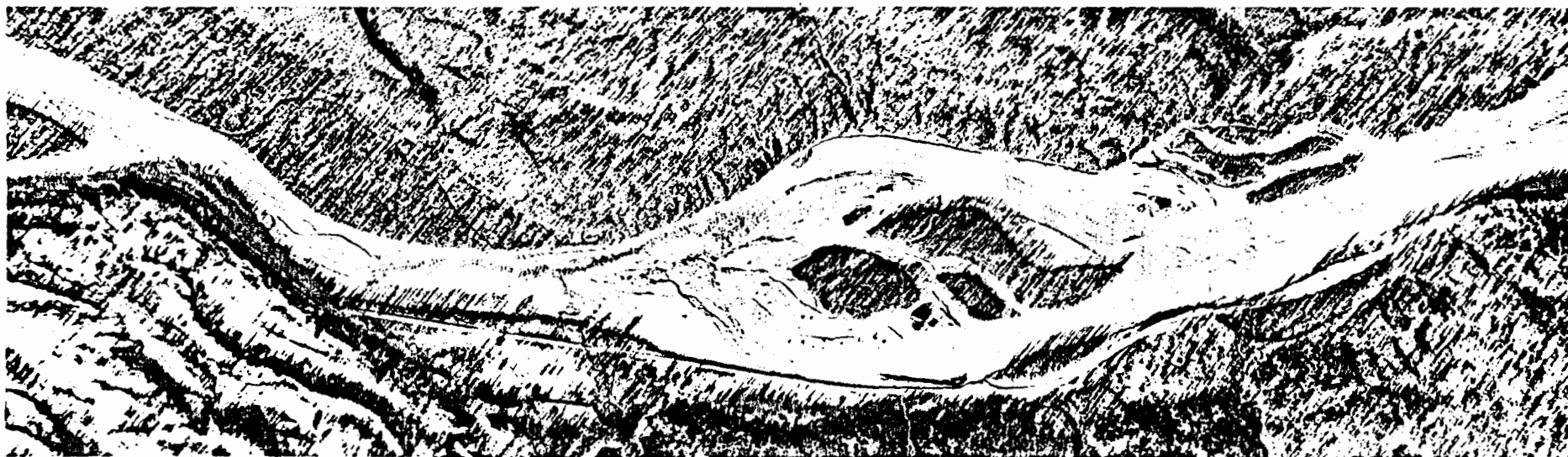
March 2, 1983 Scale: 1"=1000'



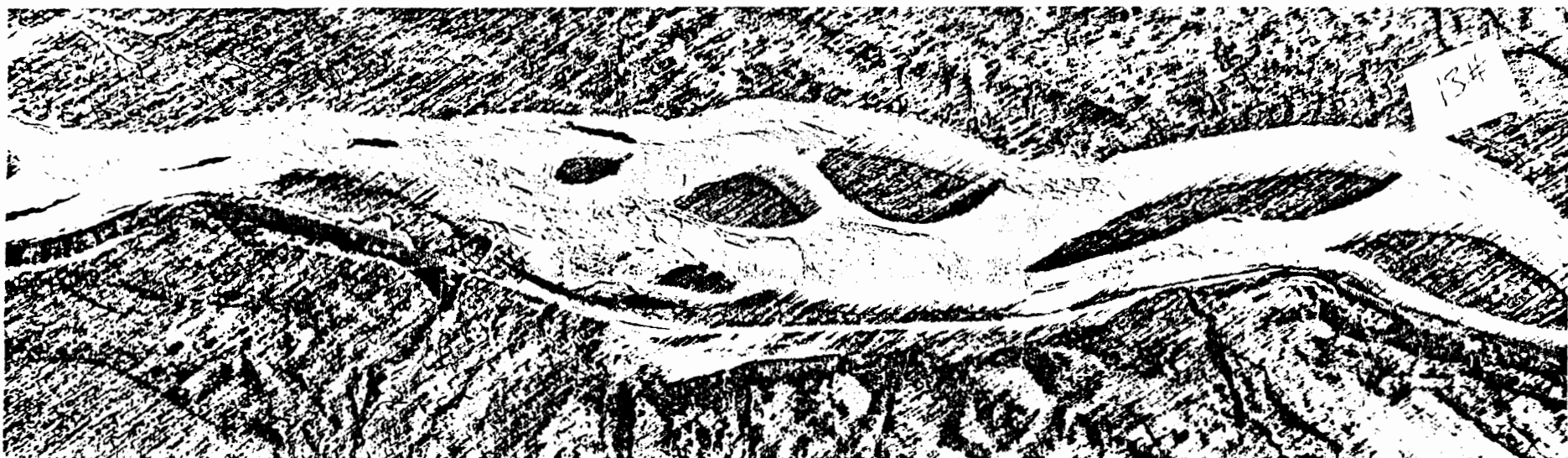
M MIDDLE SUSITNA RIVER
Top: River Mile 130 to 132
Bottom: River Mile 127 to 129
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 124 to 126
Bottom: River Mile 122 to 124
March 2, 1983 Scale: 1"=1000'



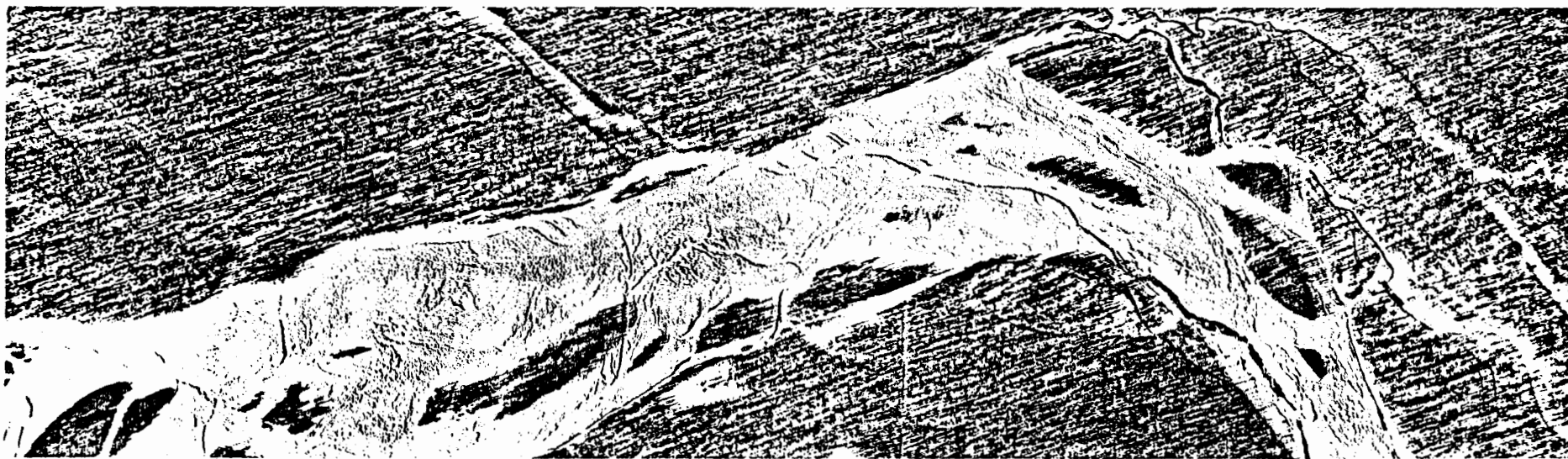
MIDDLE SUSITNA RIVER
Top: River Mile 119 to 121
Bottom: River Mile 116 to 118
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 113 to 115
Bottom: River Mile 110 to 112
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 108 to 110
Bottom: River Mile 105 to 107
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 102 to 104
Bottom: River Mile 101 to 102
March 2, 1983 Scale: 1"=1000'