

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

VOLUME II

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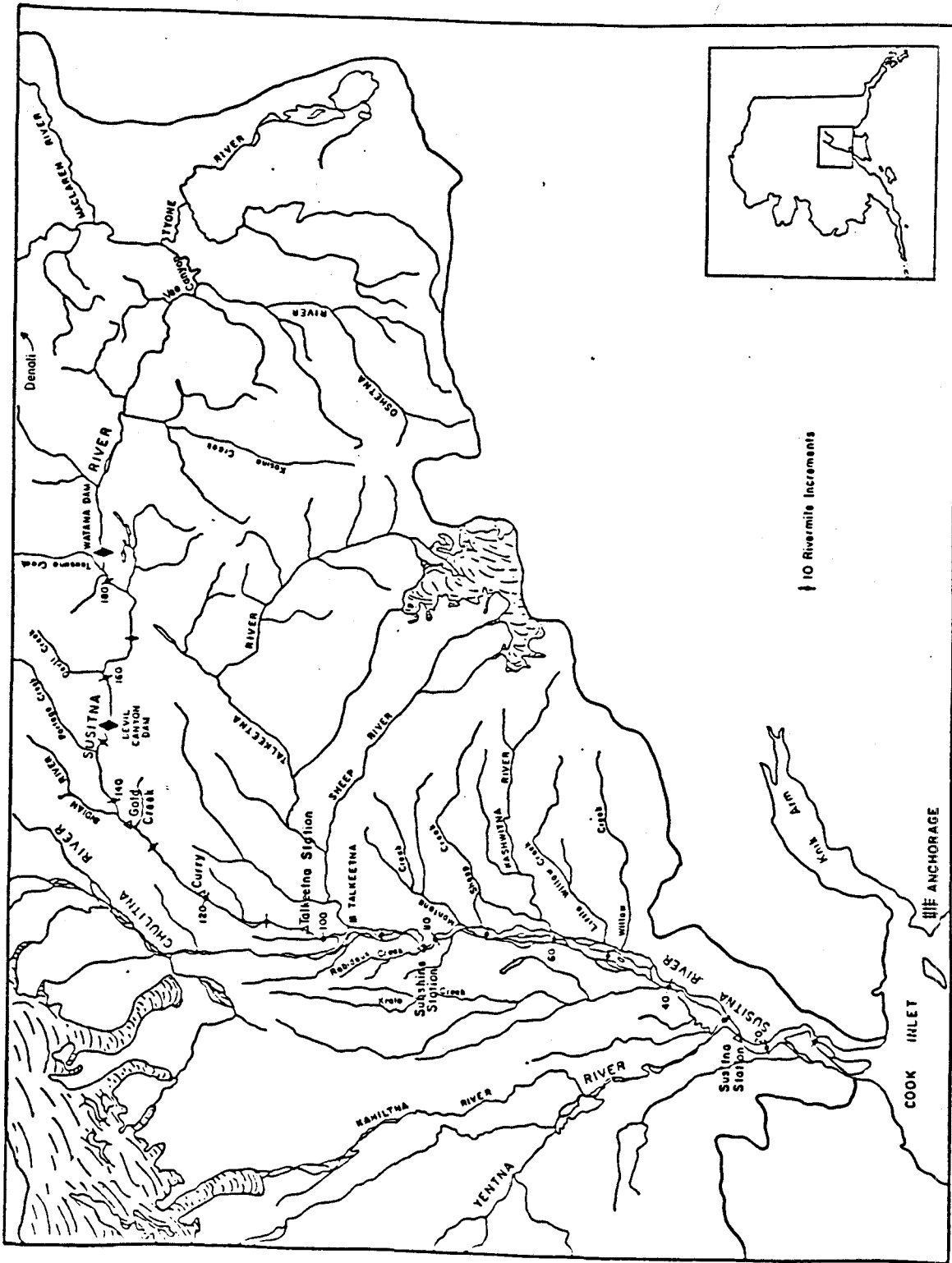


Figure 1. Map of the Susitna basin study region.

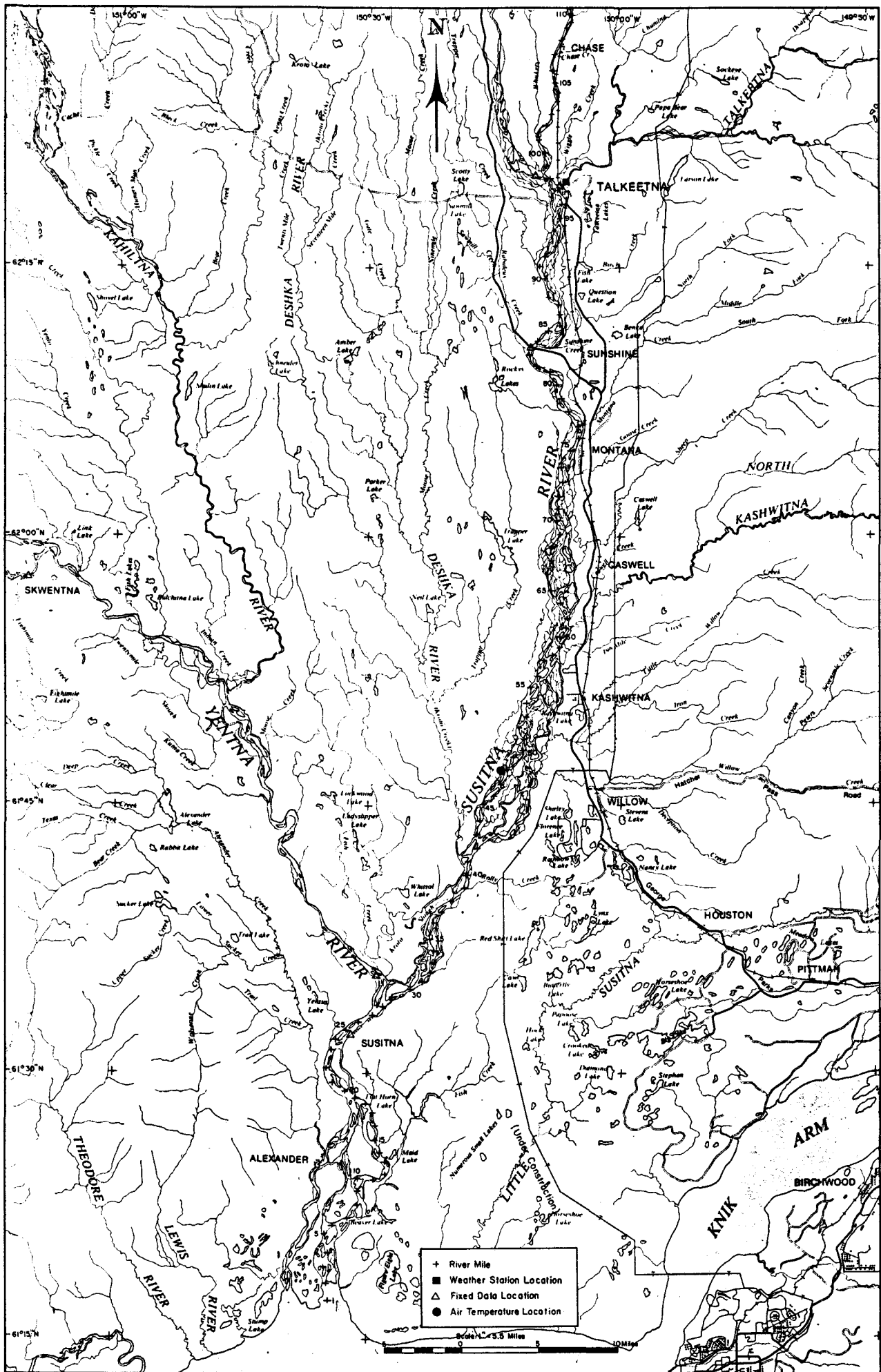


Figure 2. Lower River

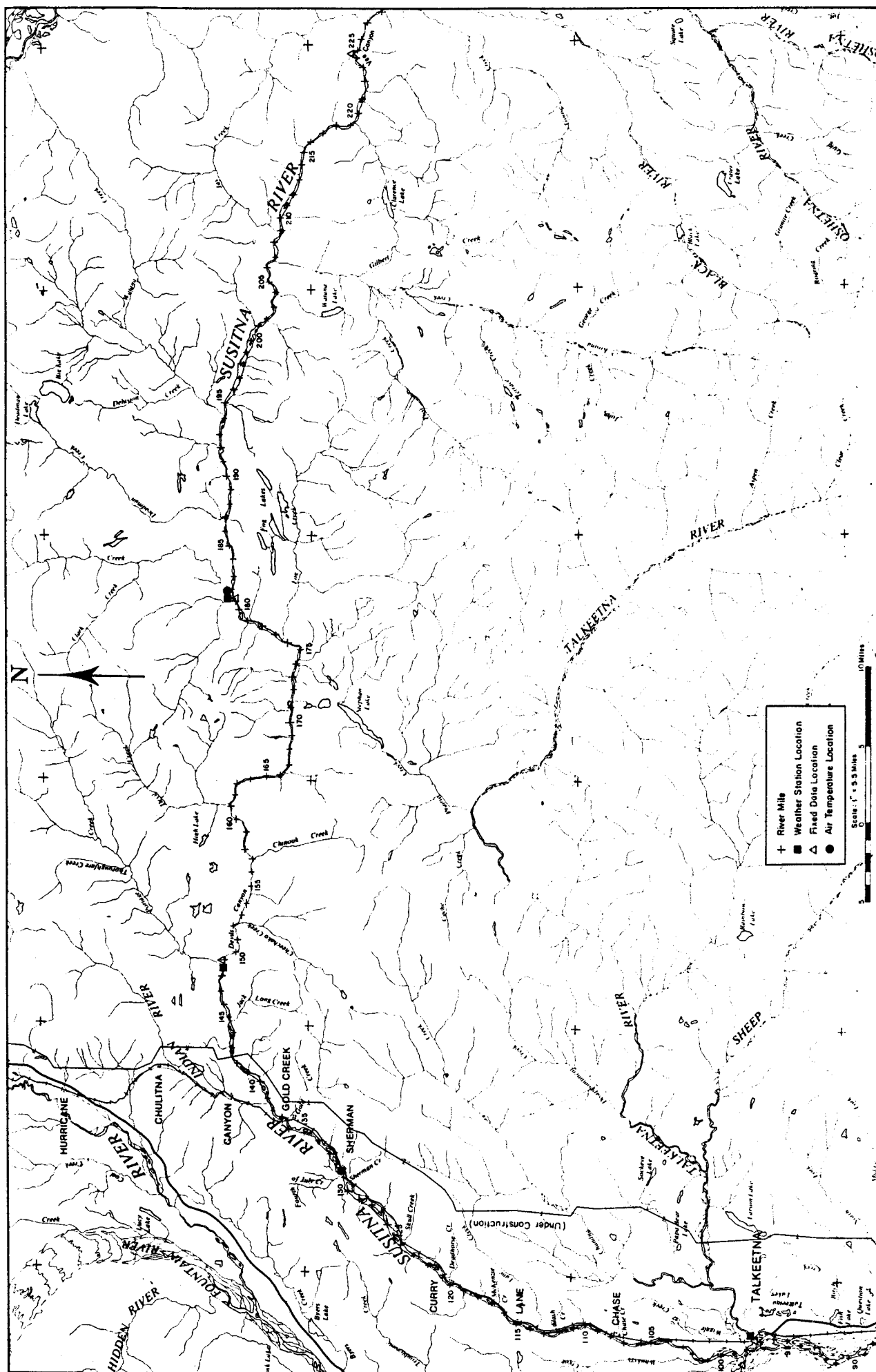


Figure 3. Middle River

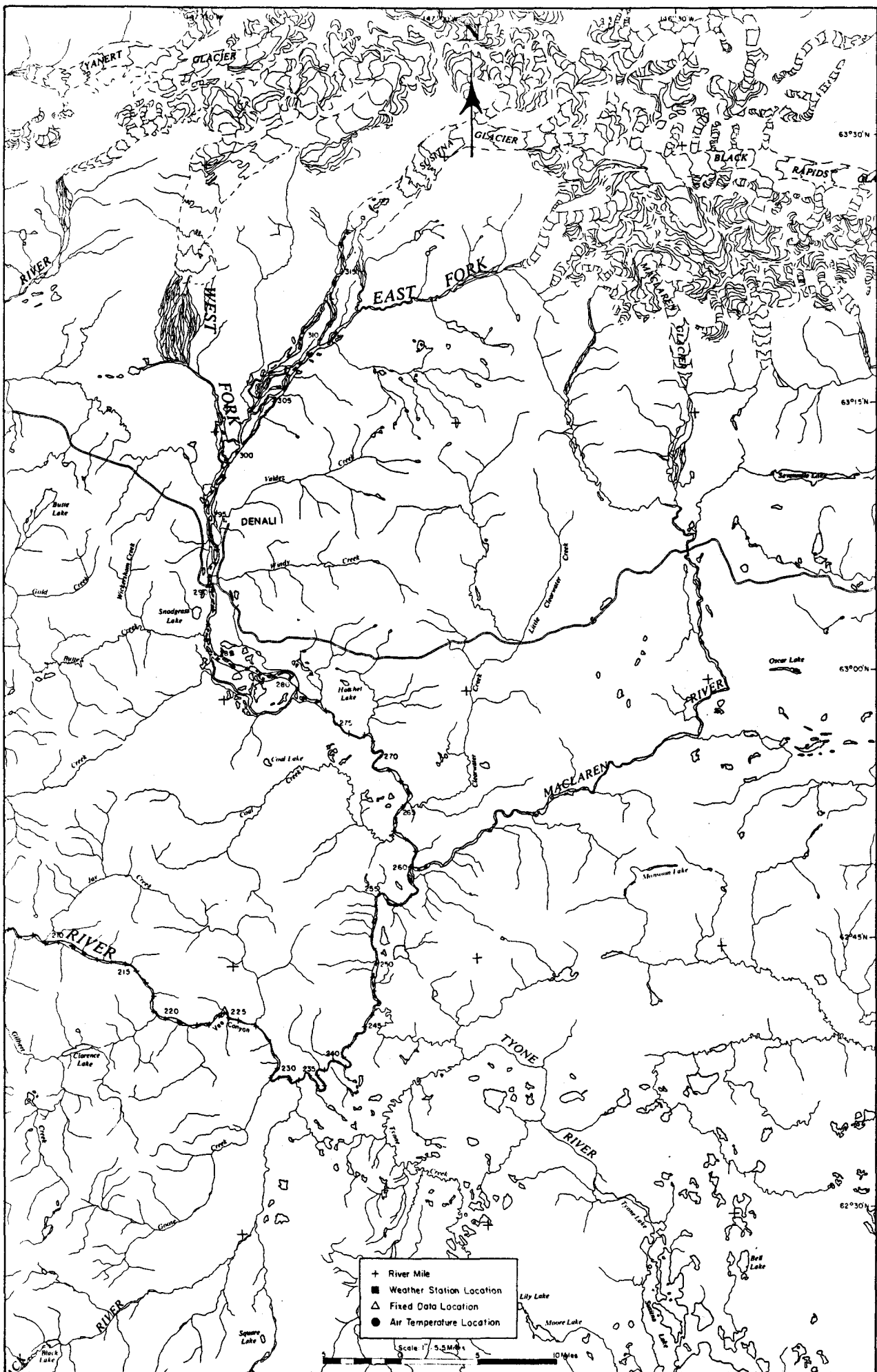
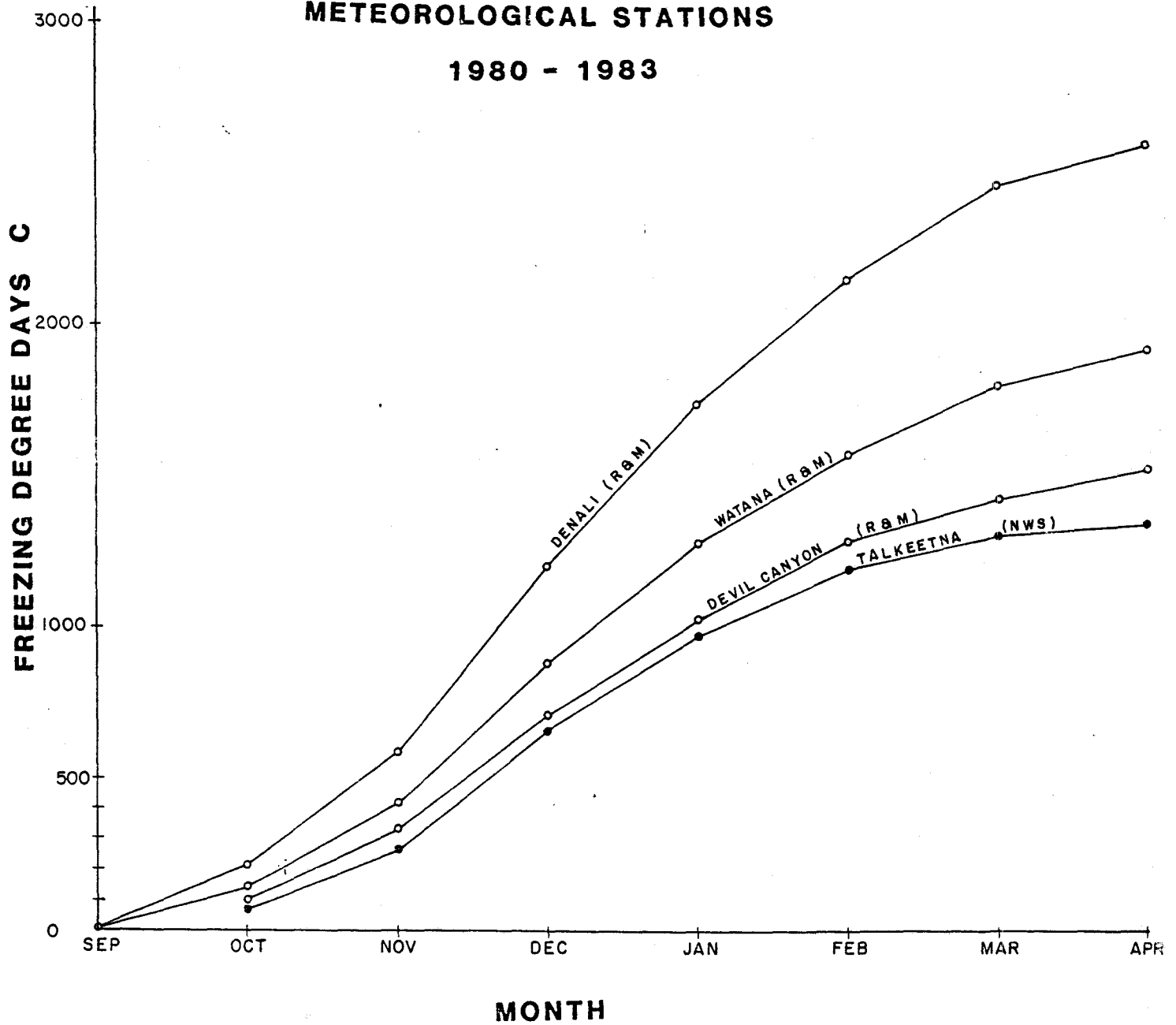


Figure 4. Upper River

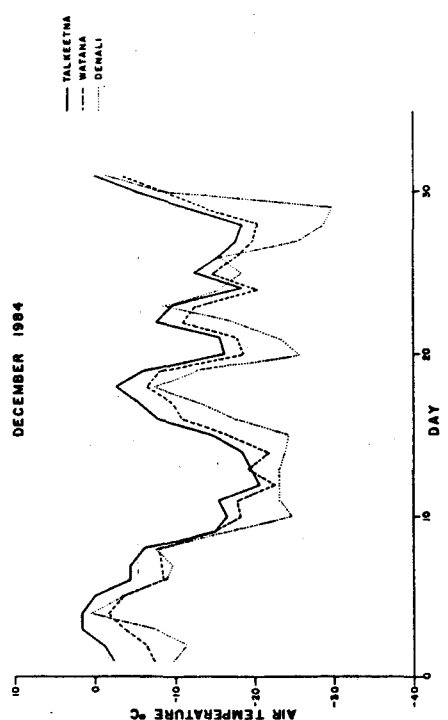
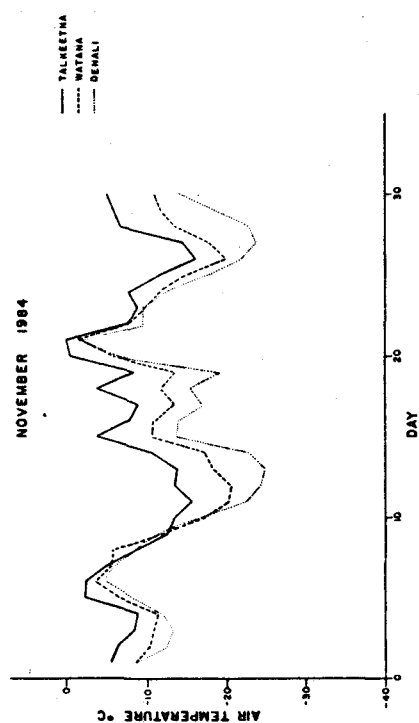
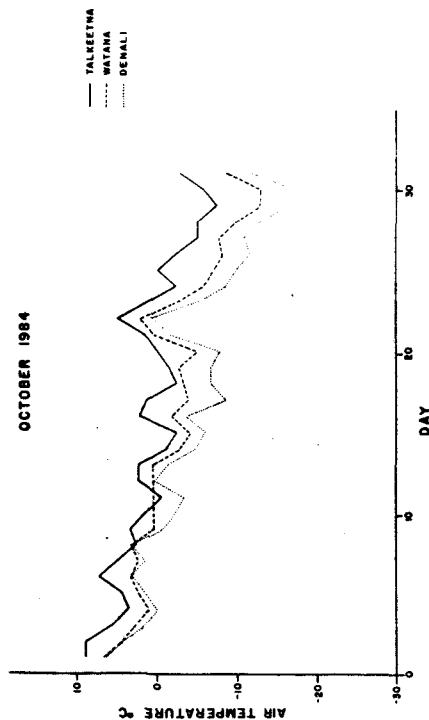
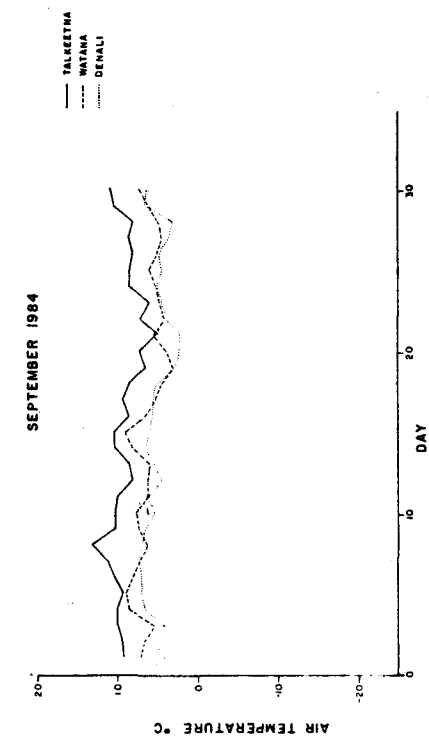
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**AVERAGE HISTORICAL
ACCUMULATED FREEZING DEGREE DAYS
FOR SUSITNA RIVER BASIN
METEOROLOGICAL STATIONS
1980 - 1983**



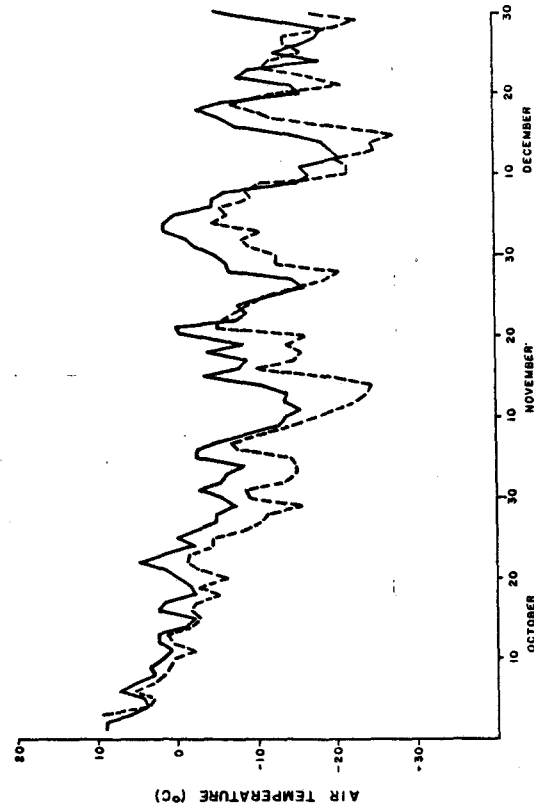
FIGURE

UPPER SUSITNA RIVER BASIN AIR TEMPERATURE VARIATION



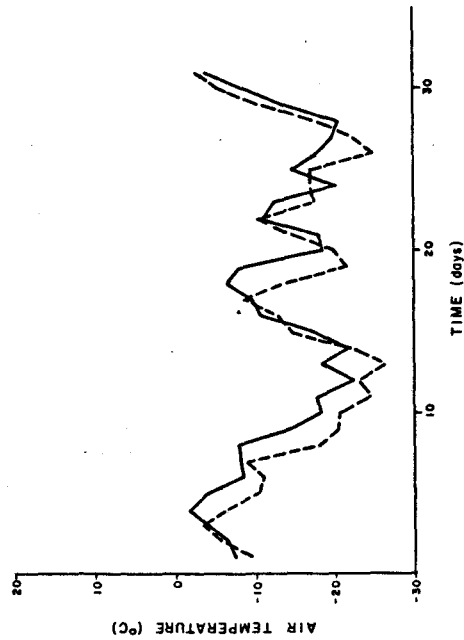
LOWER SUSITNA RIVER
MEAN DAILY AIR TEMPERATURES
OCTOBER-DECEMBER
1984

--- DELTA ISLANDS
--- TALKEETNA

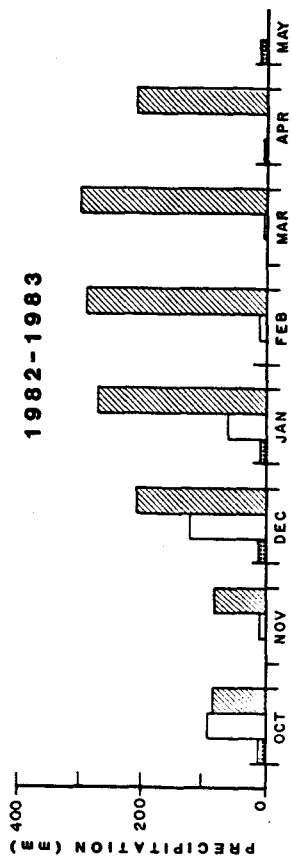


MIDDLE SUSITNA RIVER
MEAN DAILY AIR TEMPERATURE RECORD
DECEMBER 1984

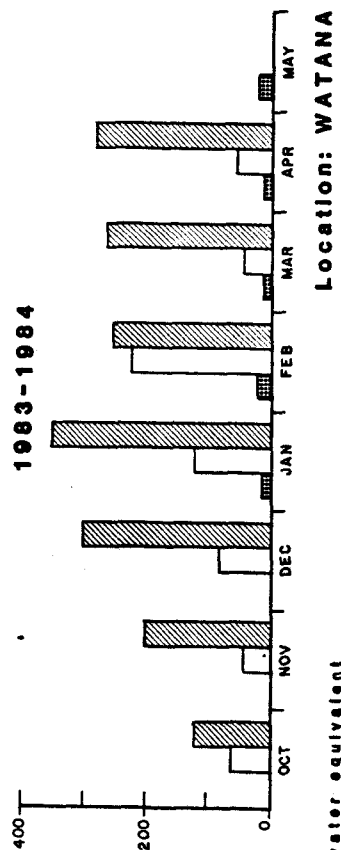
--- WATANA WEATHER STATION SITE
--- WATANA STREAMGAGE SITE



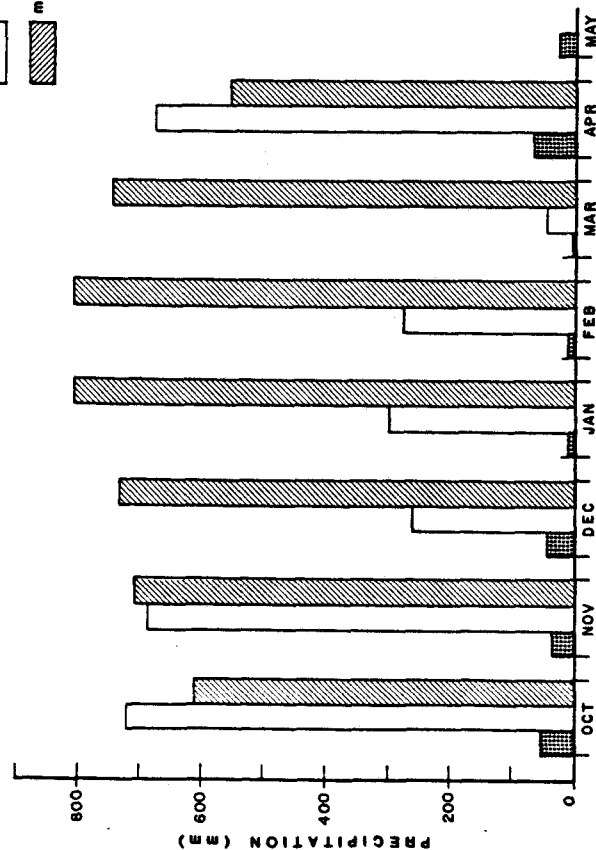
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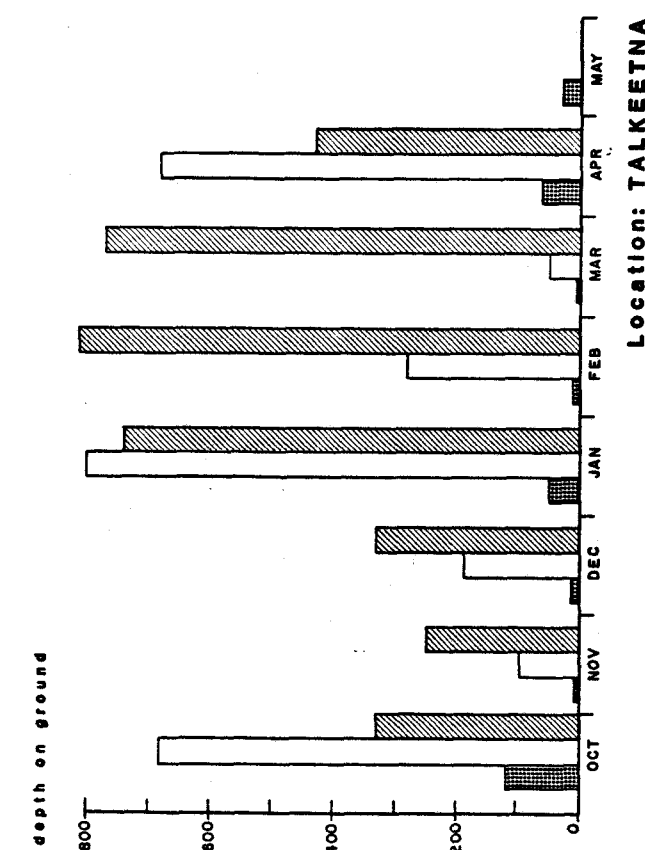
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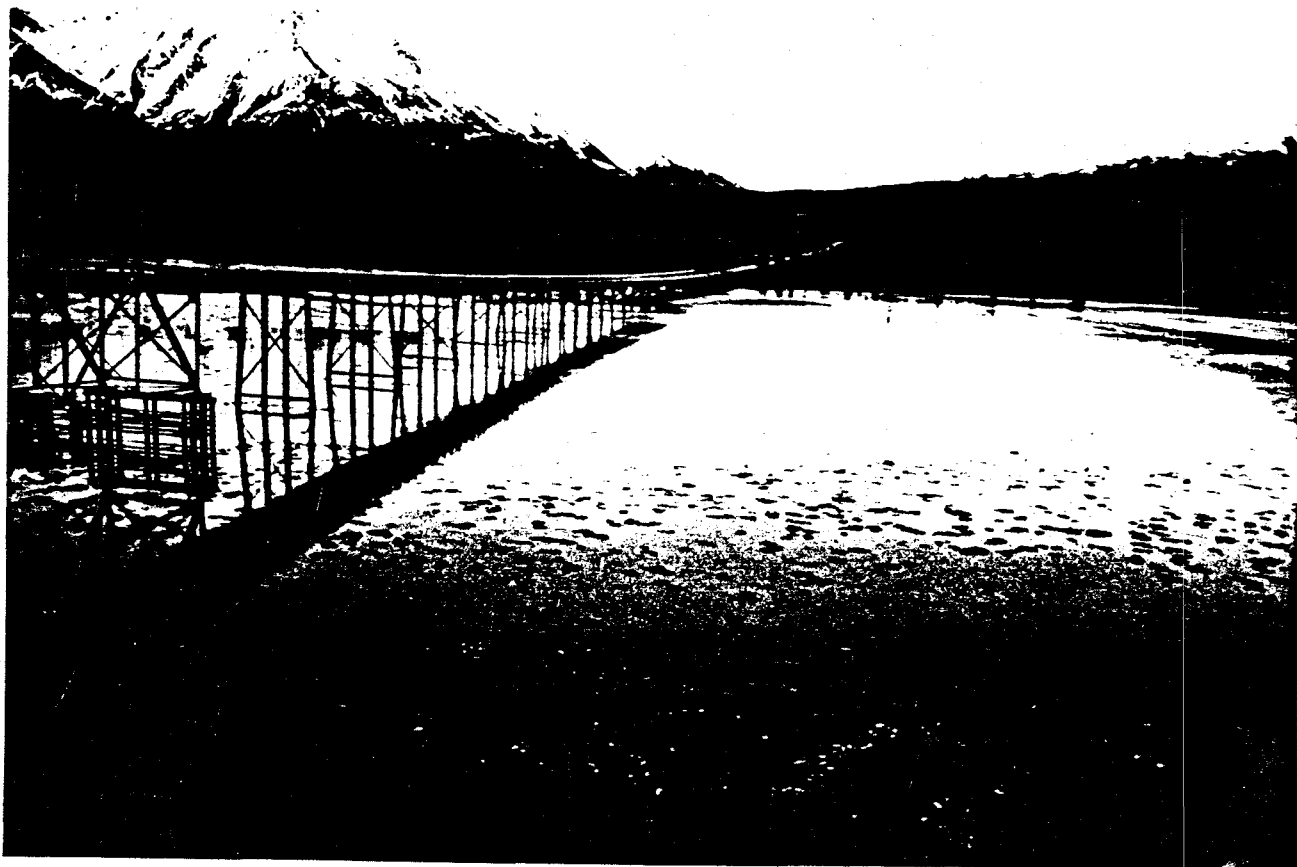
Location: WATANA



Location: TALKEETNA



Location: TALKEETNA



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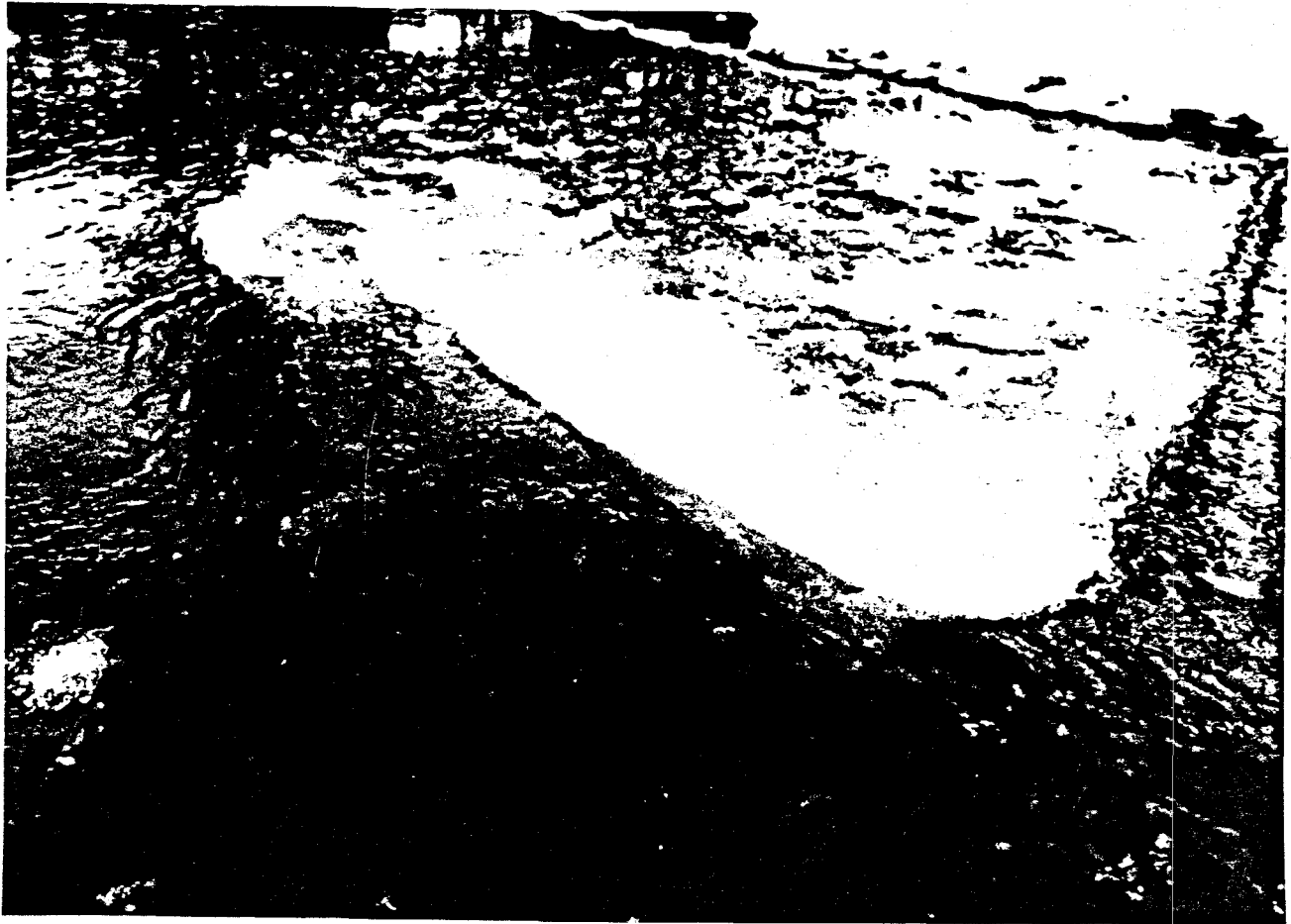
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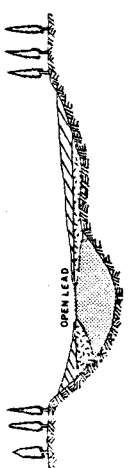
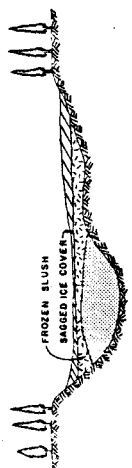
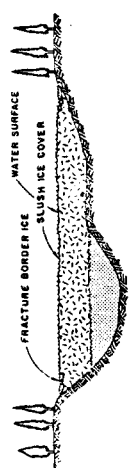
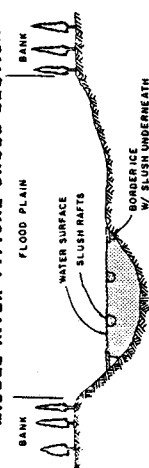




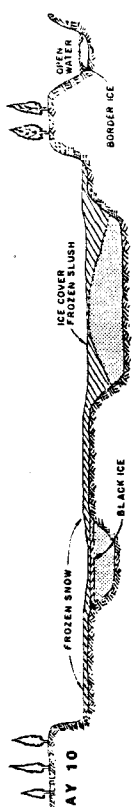
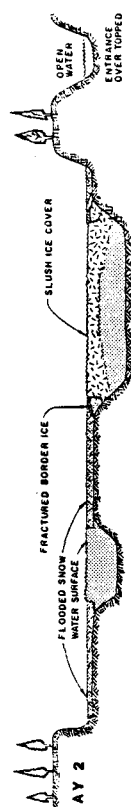
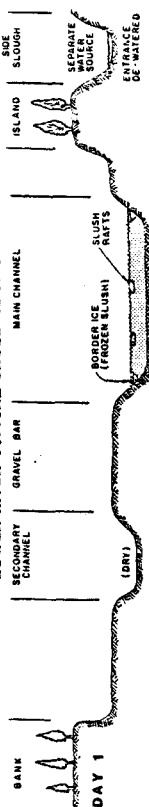




MIDDLE RIVER TYPICAL CROSS SECTION

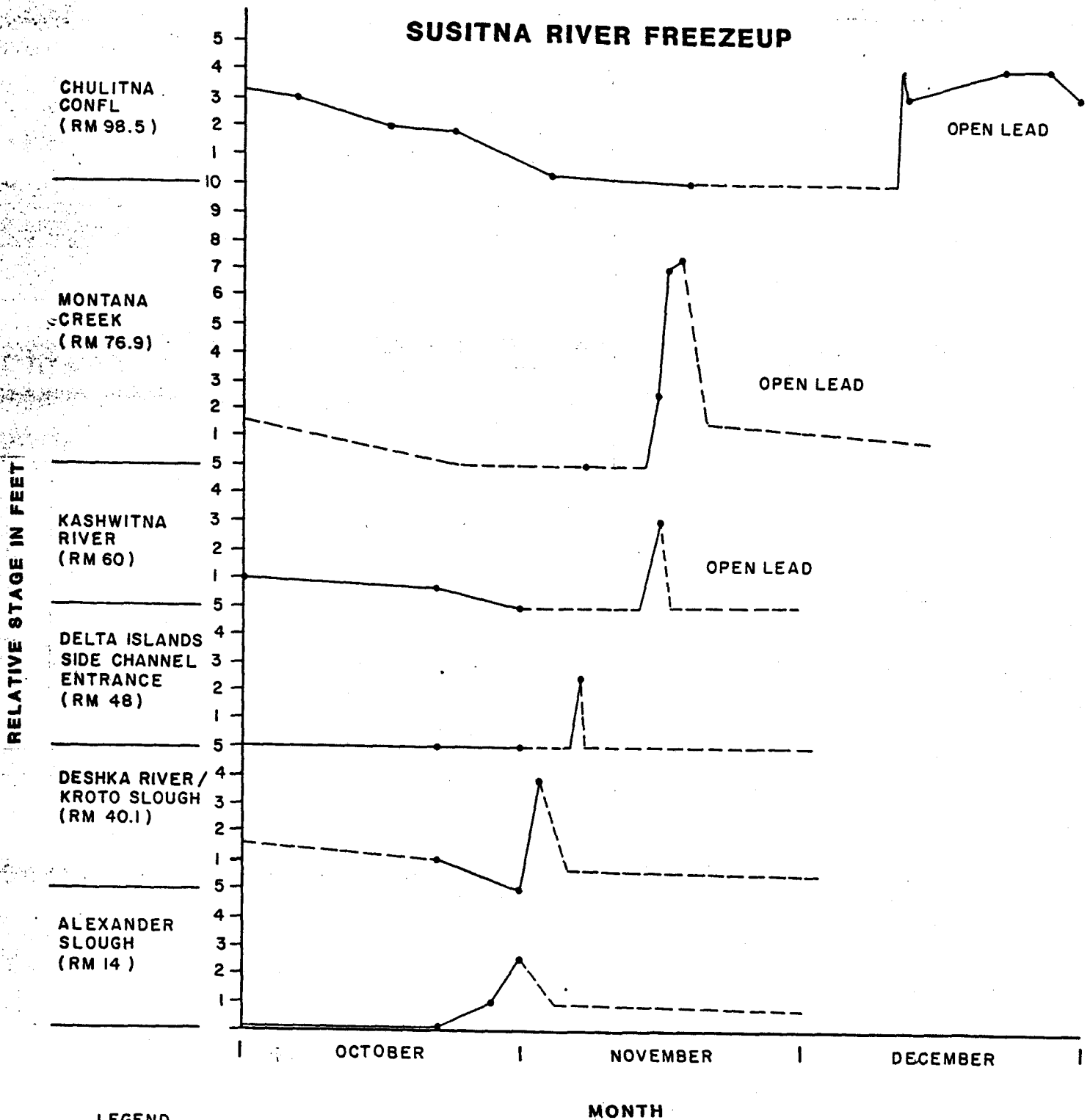


LOWER RIVER TYPICAL CROSS SECTION



RELATIVE STAGE LEVELS AT SELECTED SITES DURING 1983

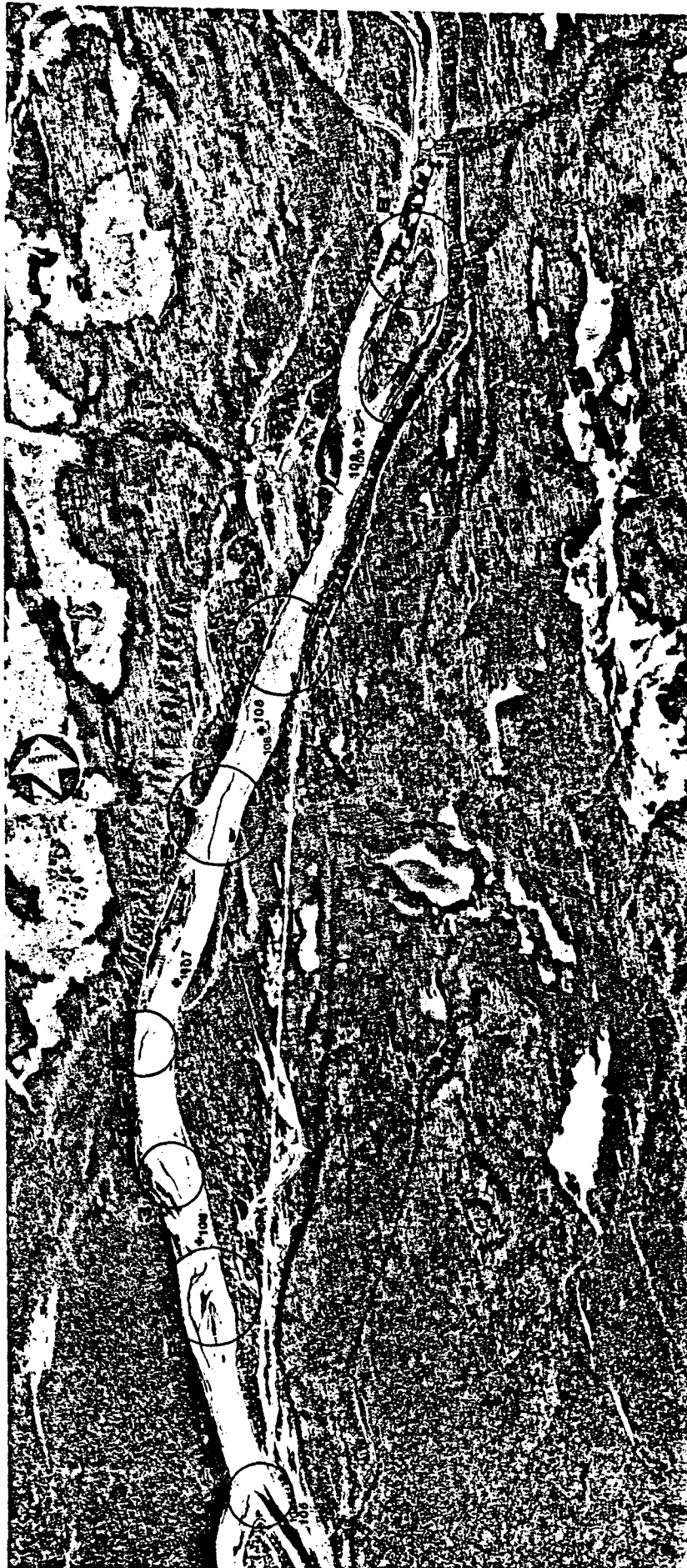
SUSITNA RIVER FREEZEUP

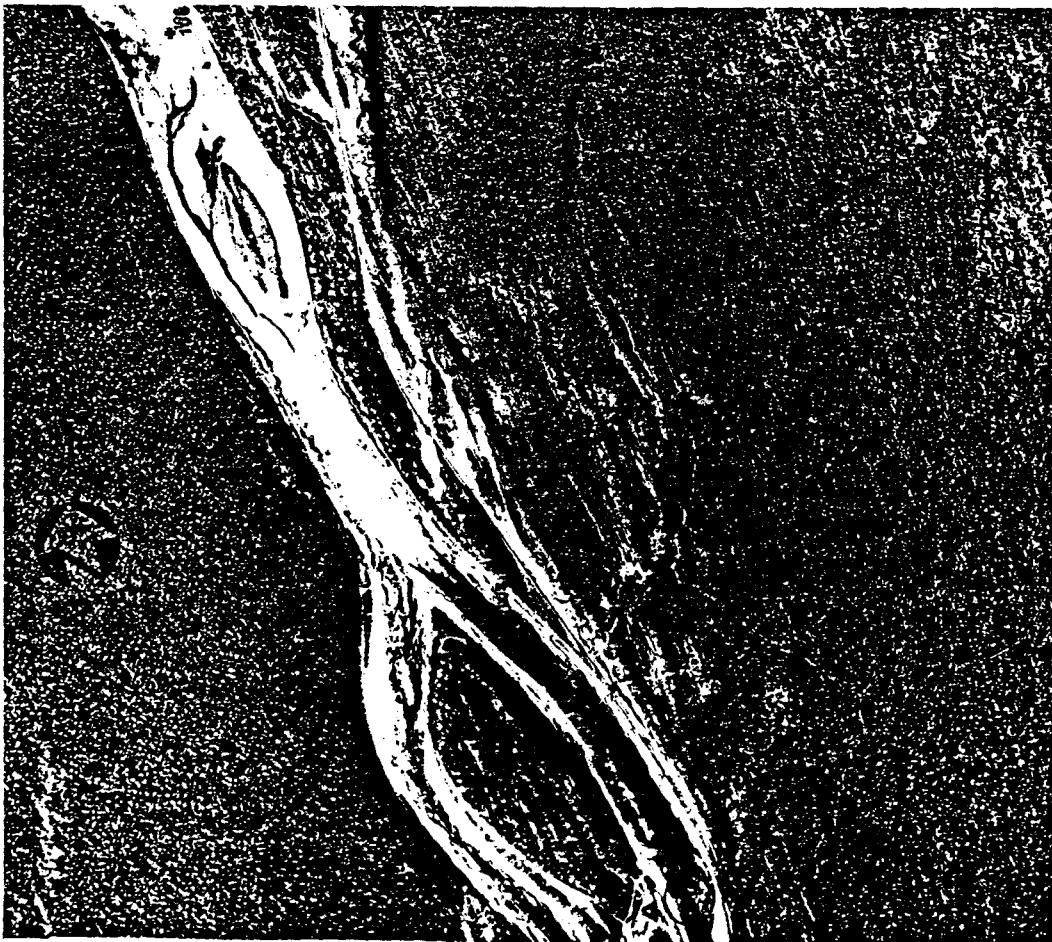


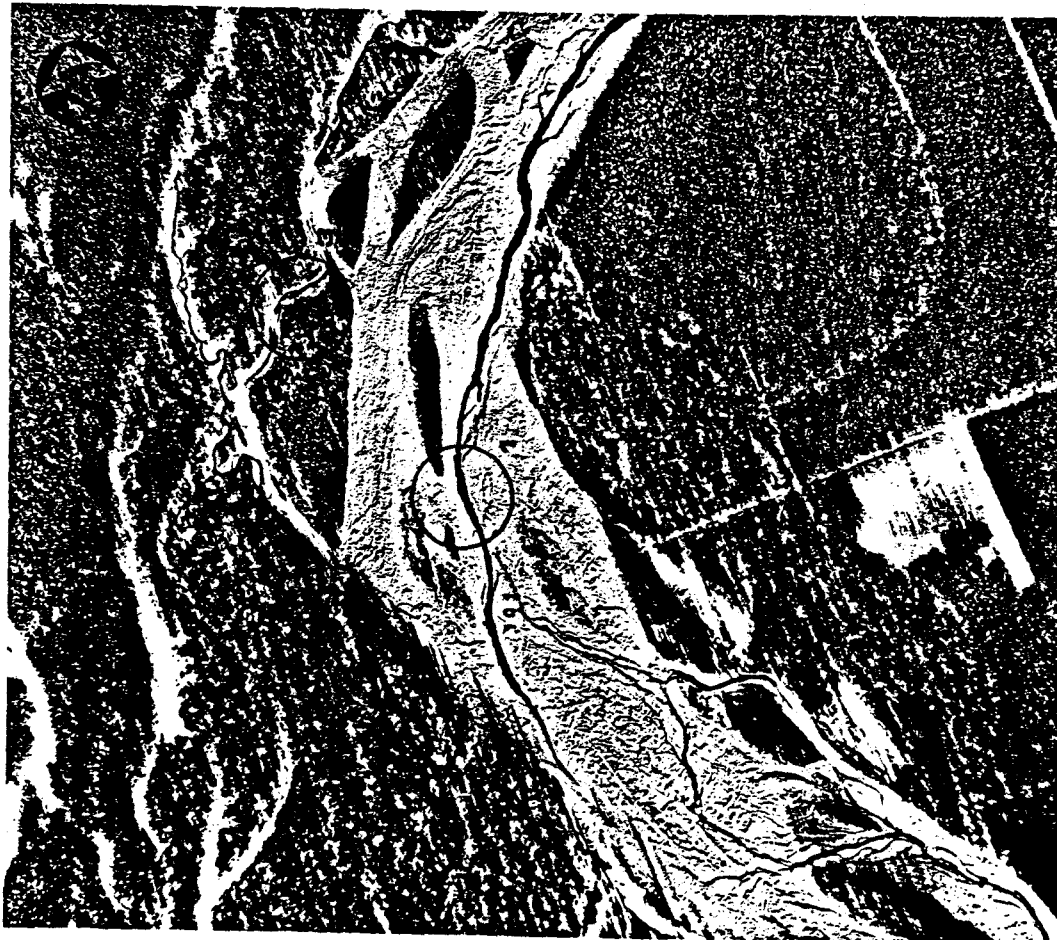
LEGEND

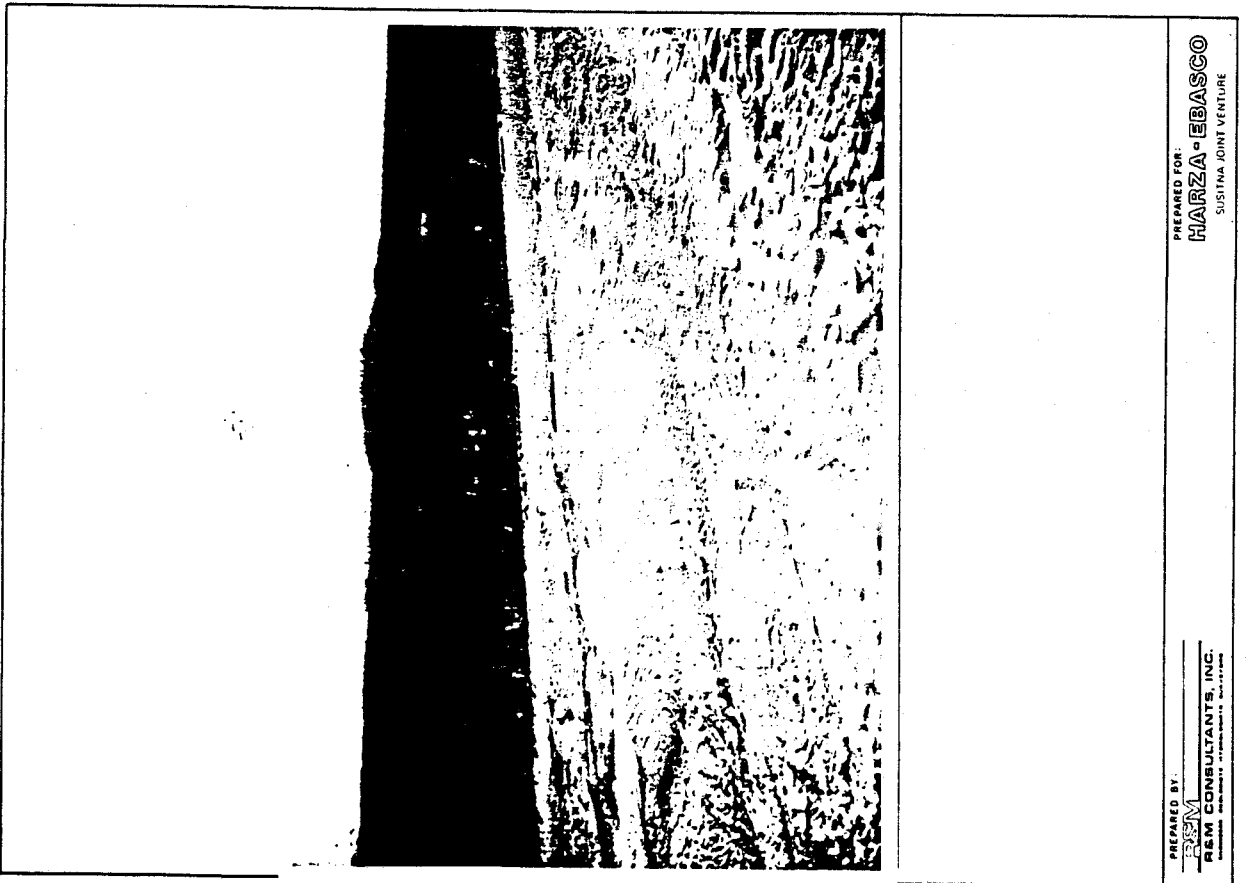
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- SURVEYED DATA POINTS















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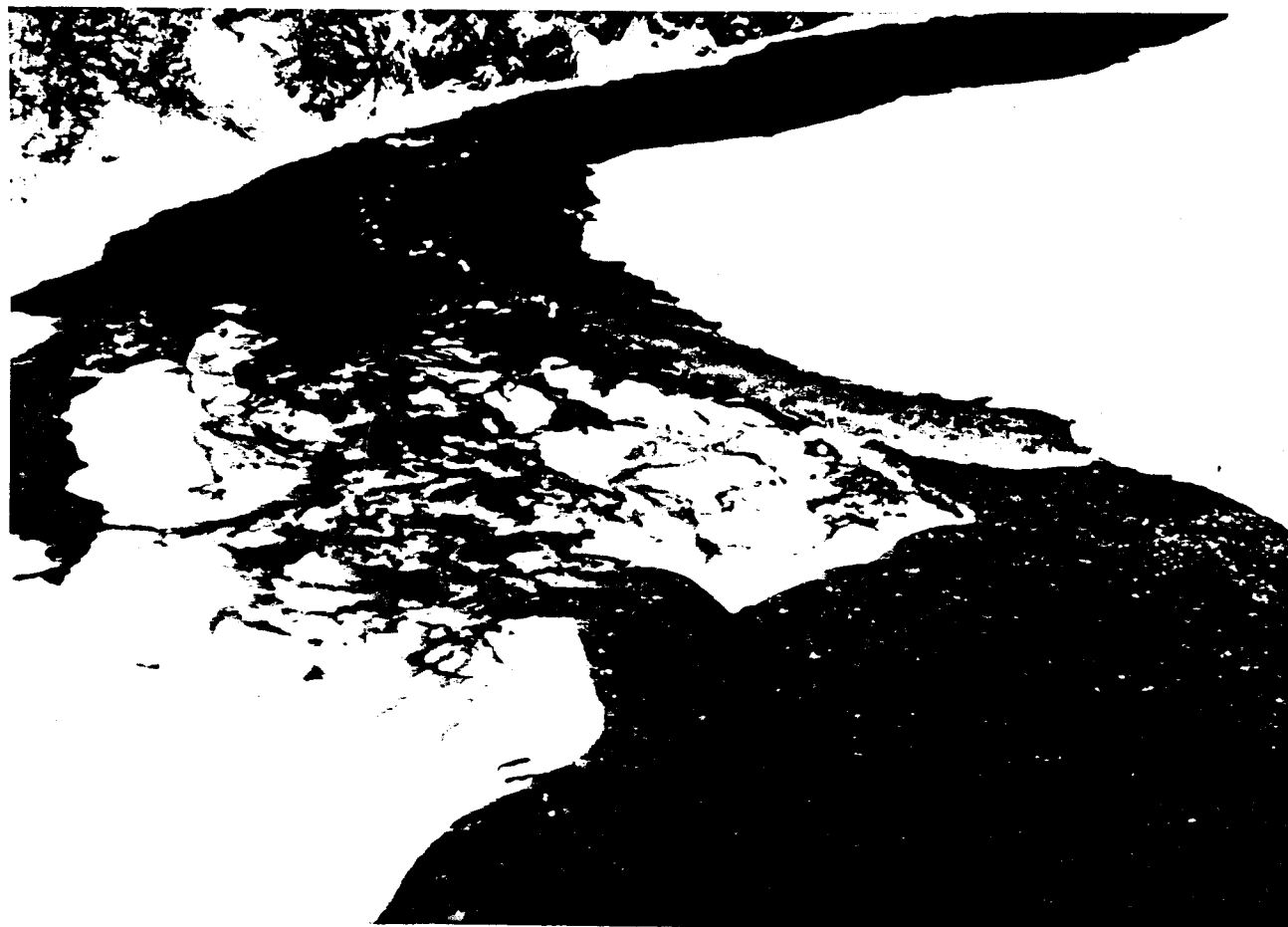
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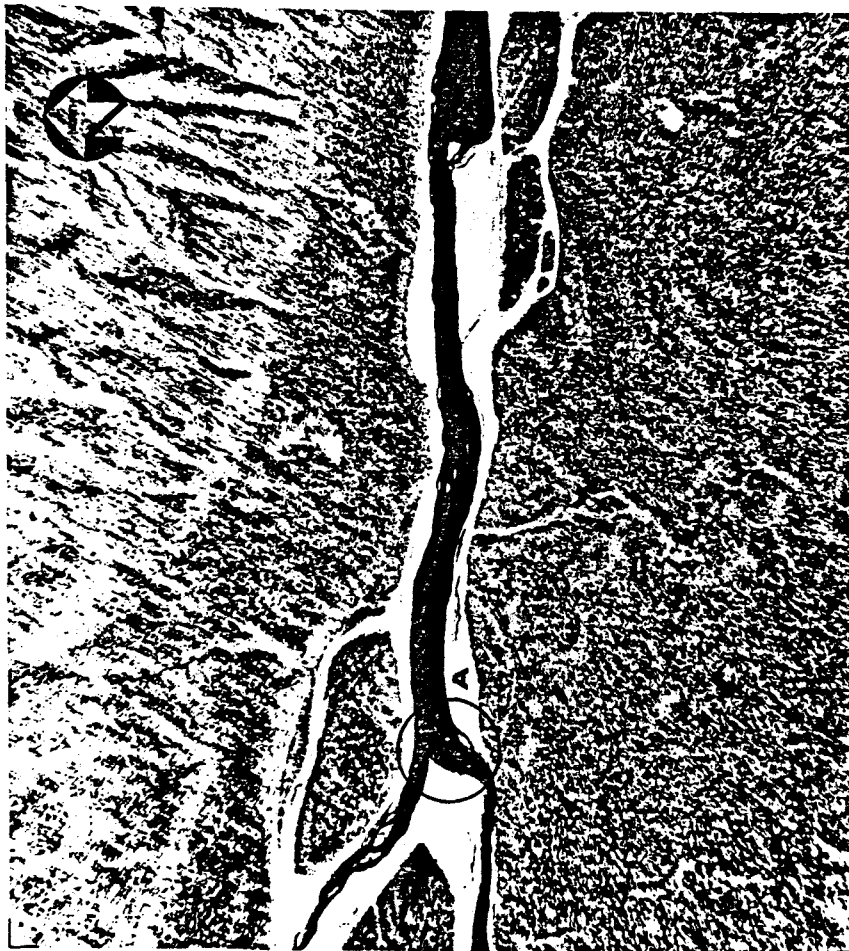
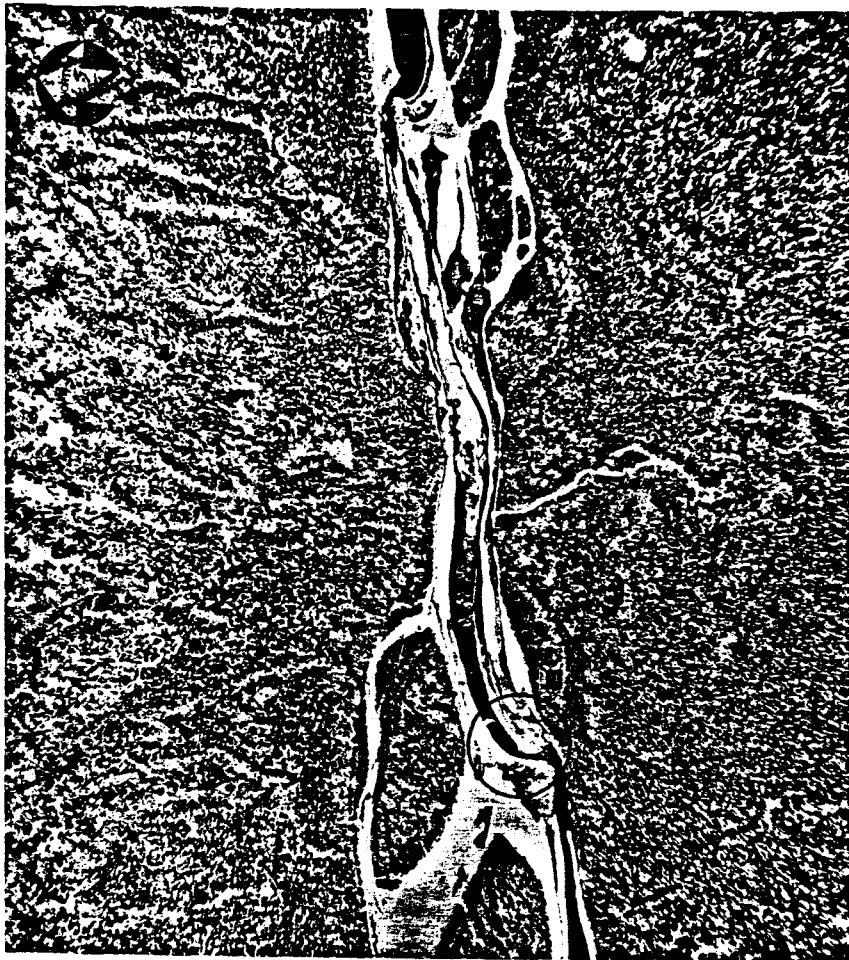
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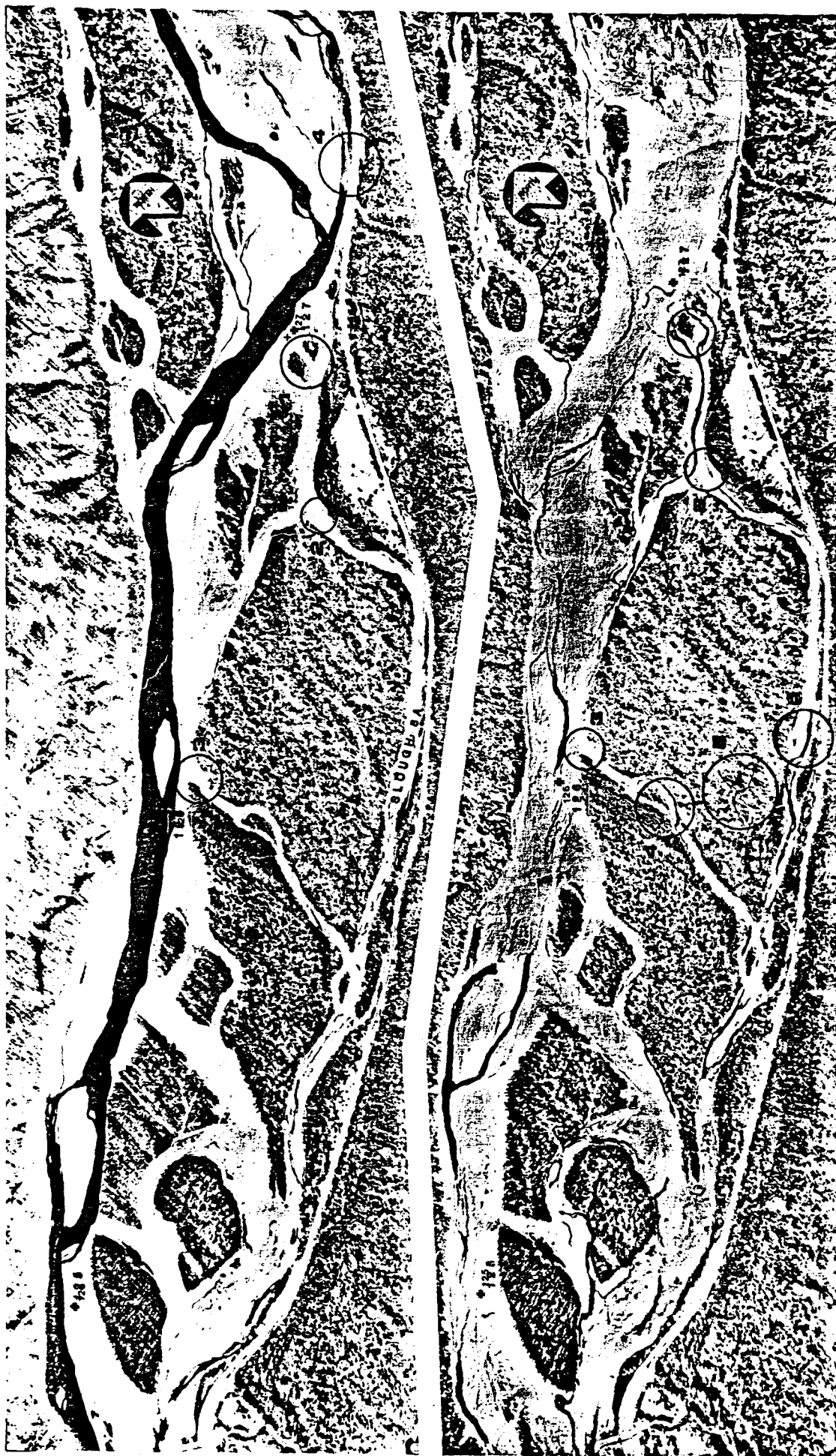
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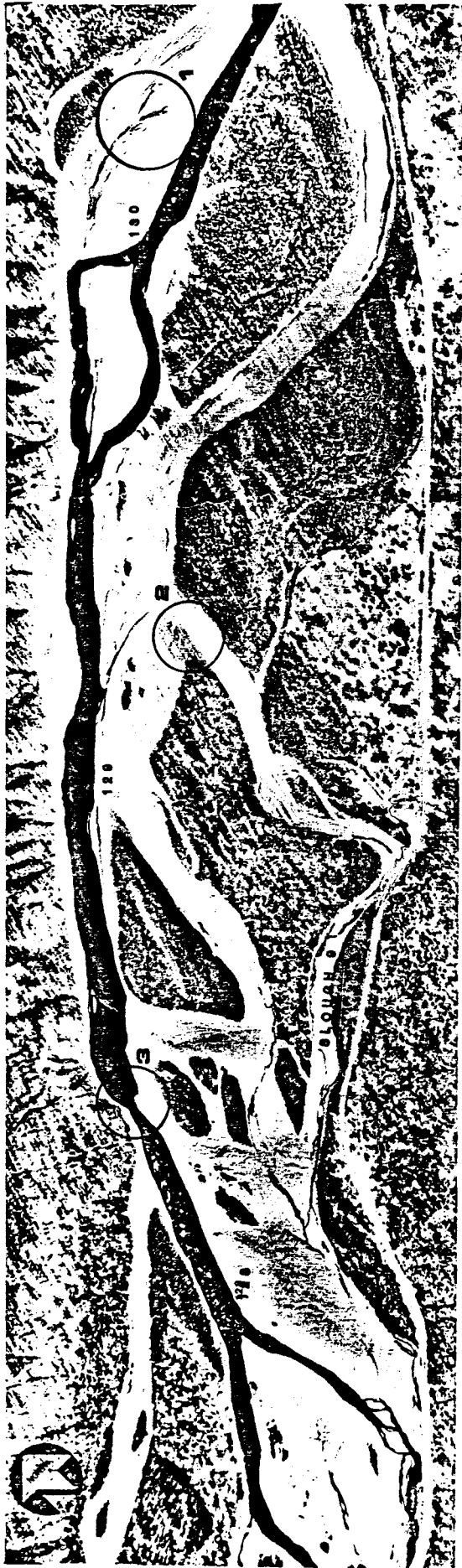
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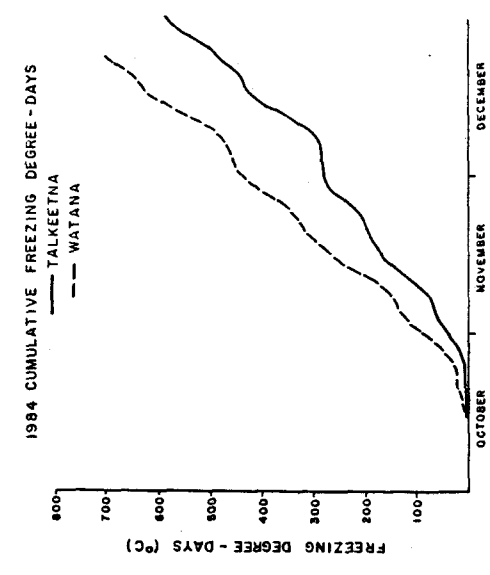
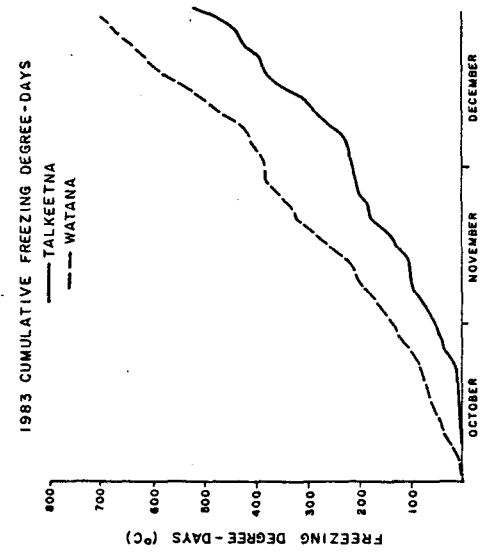
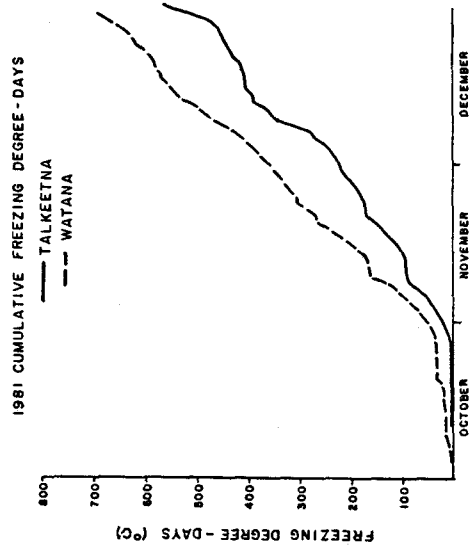
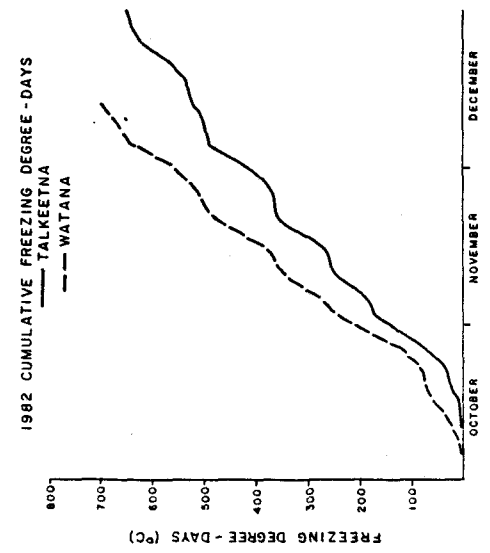
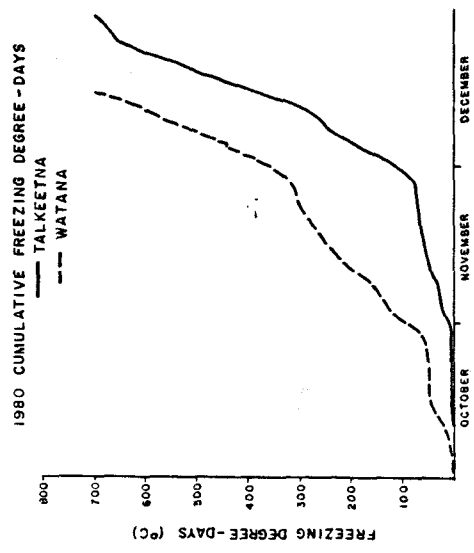
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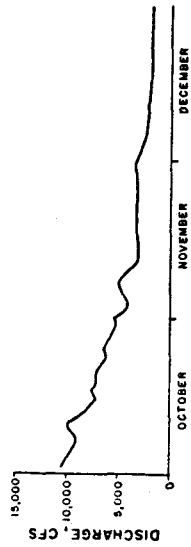




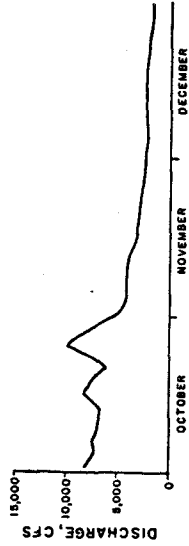




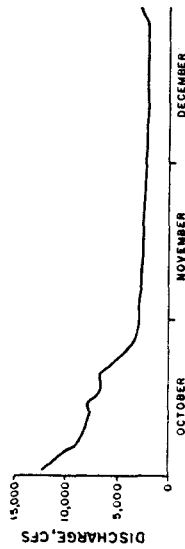
1980 USGS STREAMFLOW RECORD
GOLD CREEK



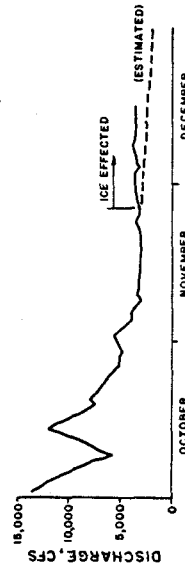
1981 USGS STREAMFLOW RECORD
GOLD CREEK



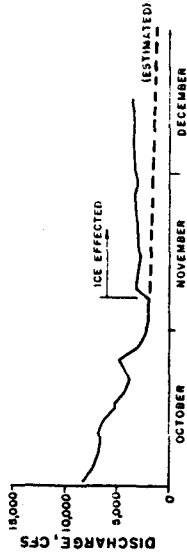
1982 USGS STREAMFLOW RECORD
GOLD CREEK



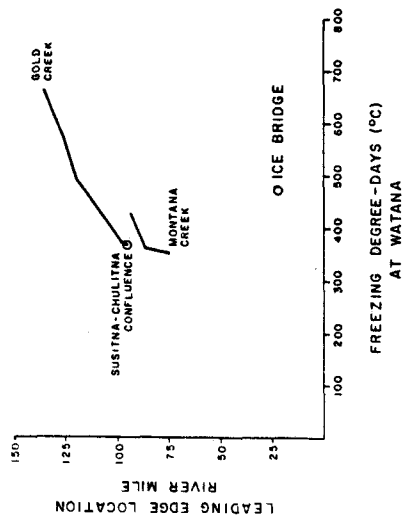
1983 RBM CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)



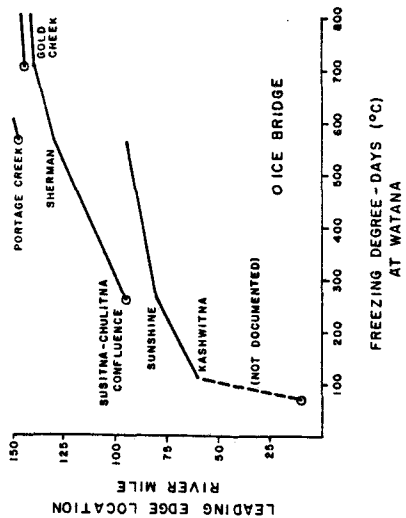
1984 RBM CONSULTANTS STREAMFLOW RECORD
GOLD CREEK
(BASED ON WIRE WEIGHT READINGS)



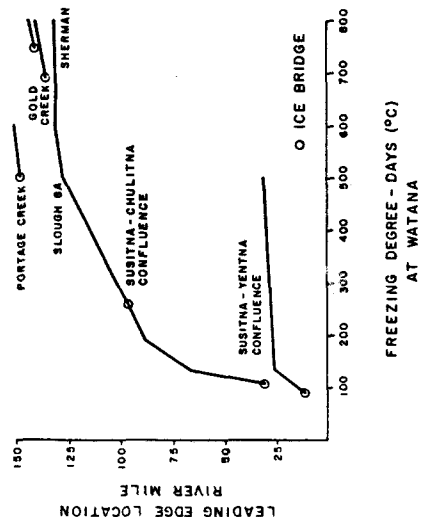
1980 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



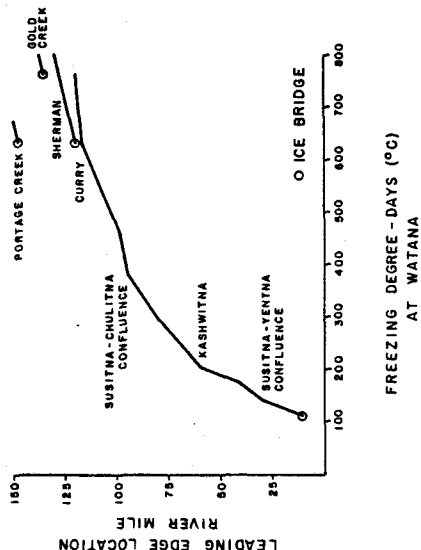
1981 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



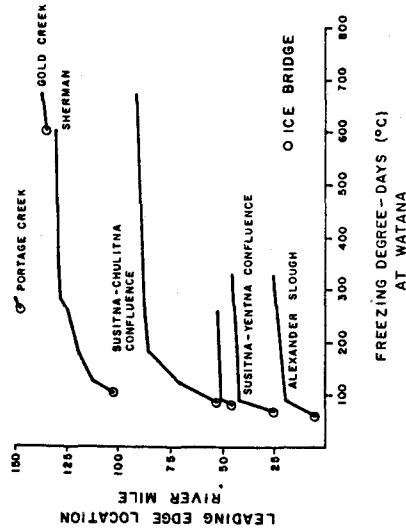
1982 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



1983 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS



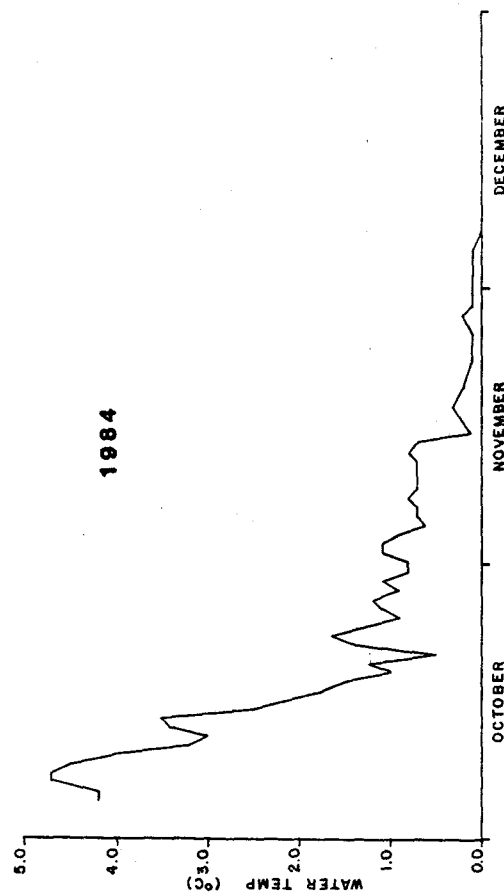
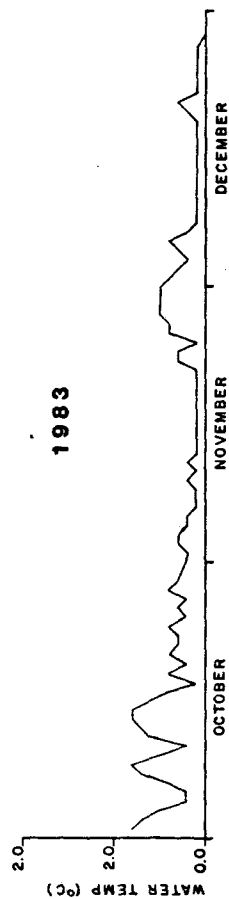
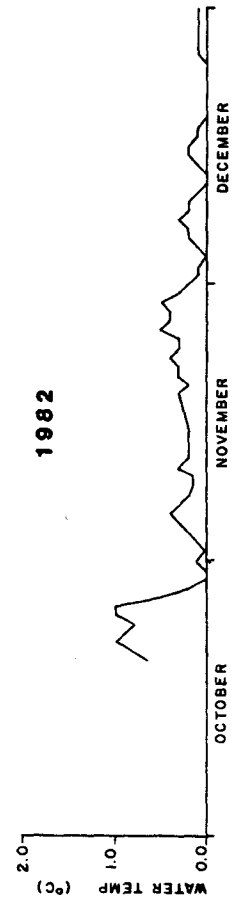
1984 LEADING EDGE PROGRESSION
vs. FREEZING DEGREE-DAYS

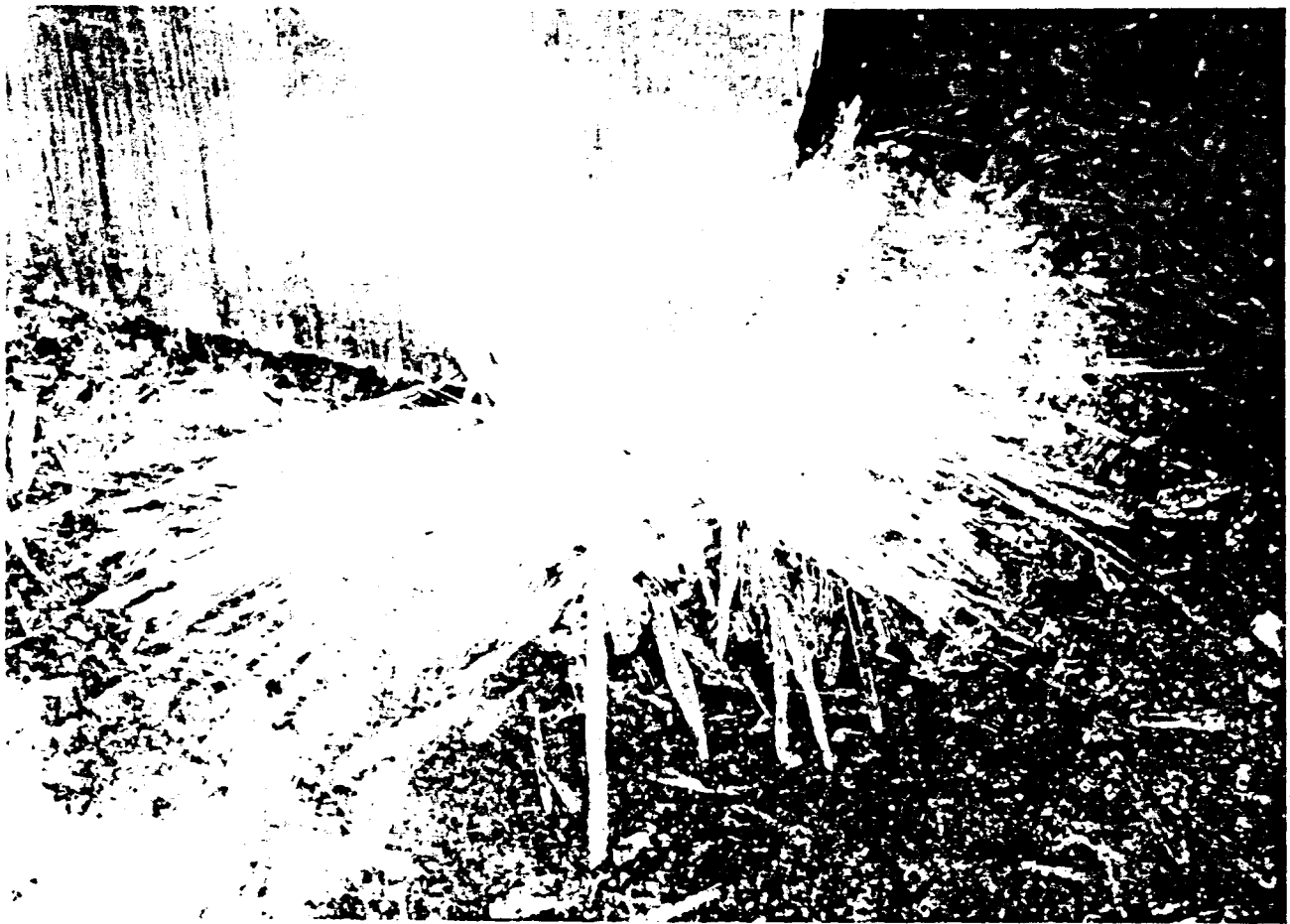


LOCATION RIVER MILE

ALEXANDER SLOUGH	RM 19
YENTNA RIVER CONFLUENCE	RM 28
KASHWITNA RIVER	RM 60
MONTANA CREEK	RM 76
SUNSHINE	RM 84
CHULITNA RIVER CONFLUENCE	RM 98.5
SLOUGH 8A	RM 126
SHERMAN	RM 130
GOLD CREEK	RM 136.6
PORTAGE CREEK	RM 149

WATER TEMPERATURES AT GOLD CREEK





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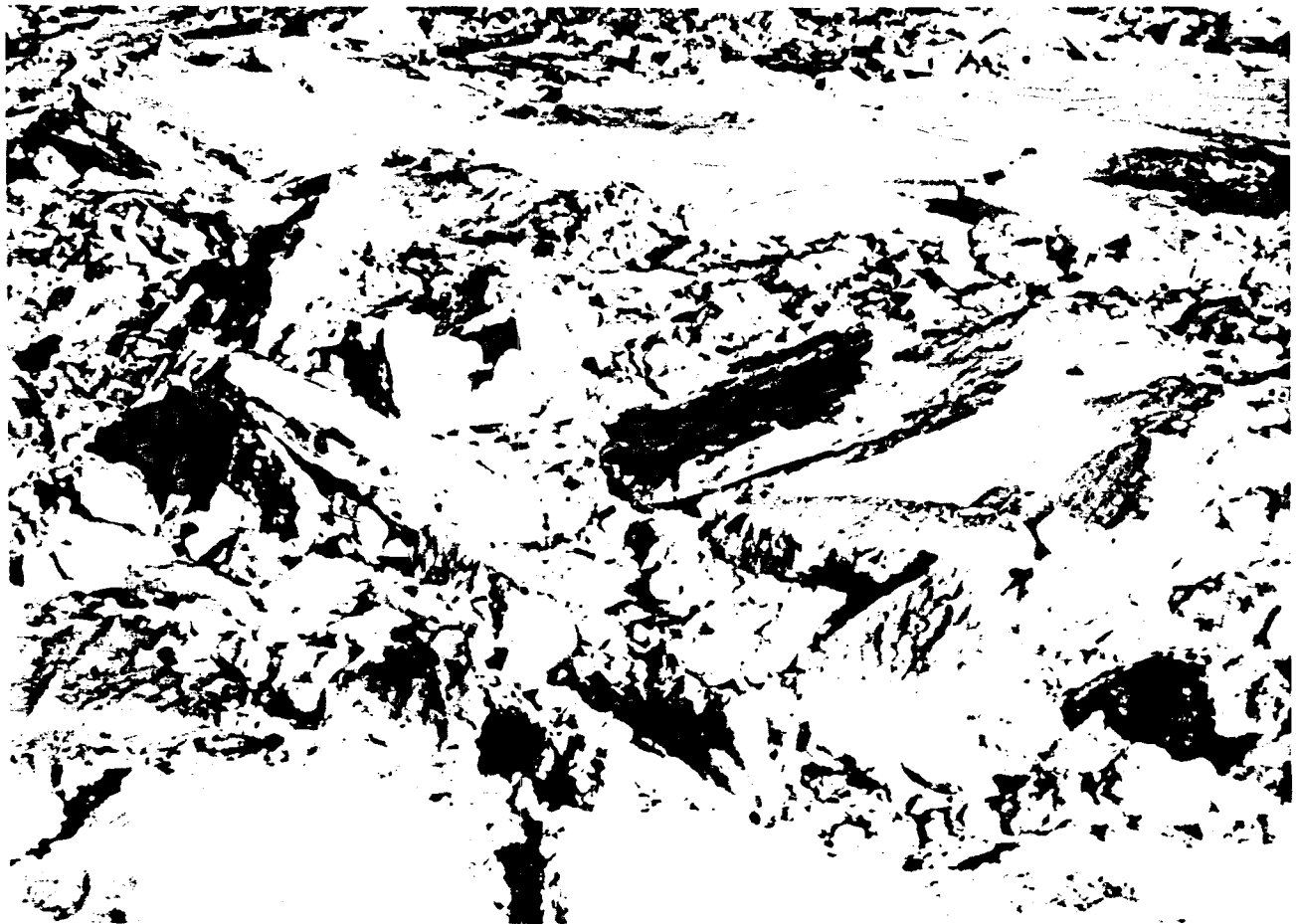
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HARZA-EBASCO

SUSITNA JOINT VENTURE



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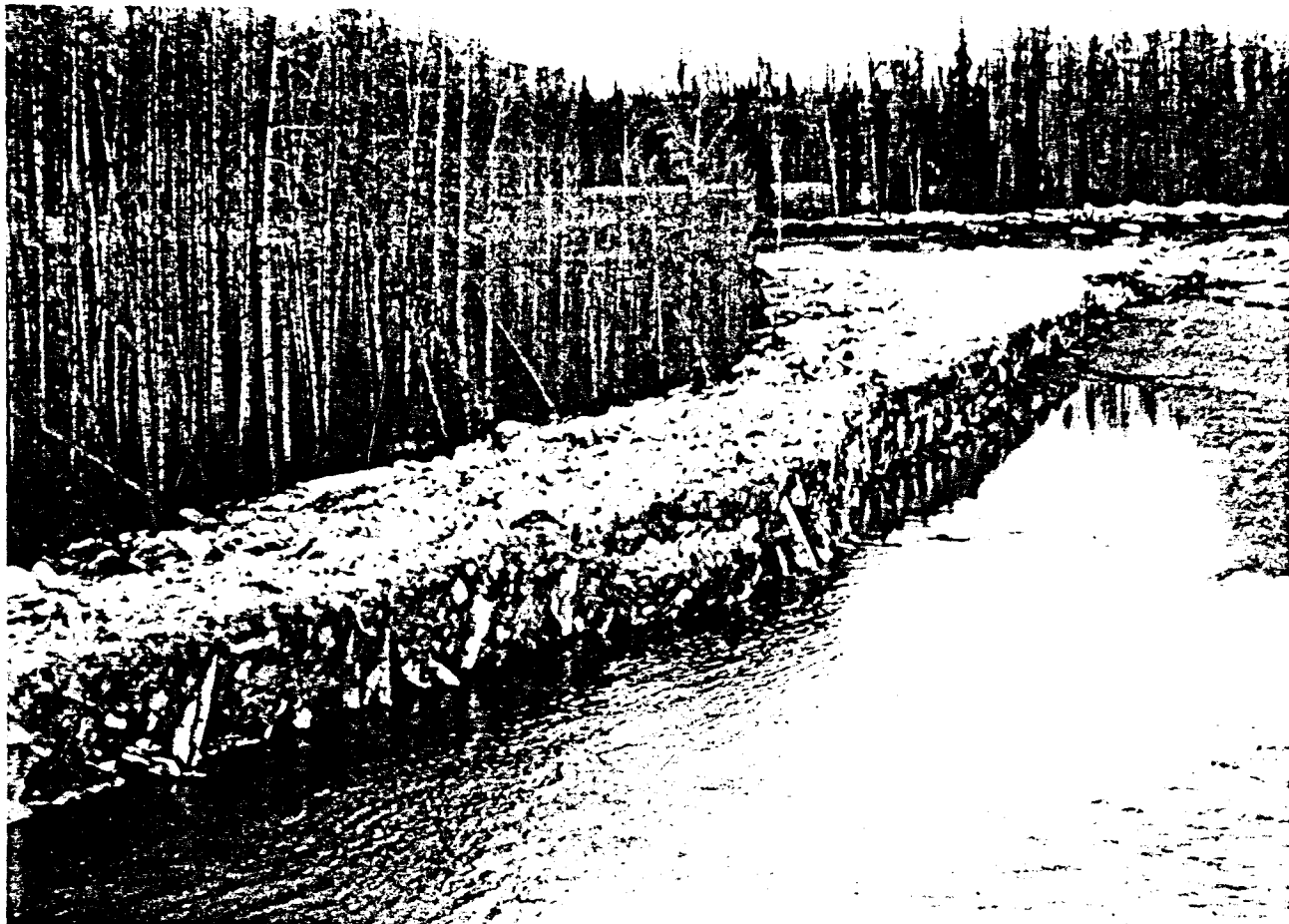
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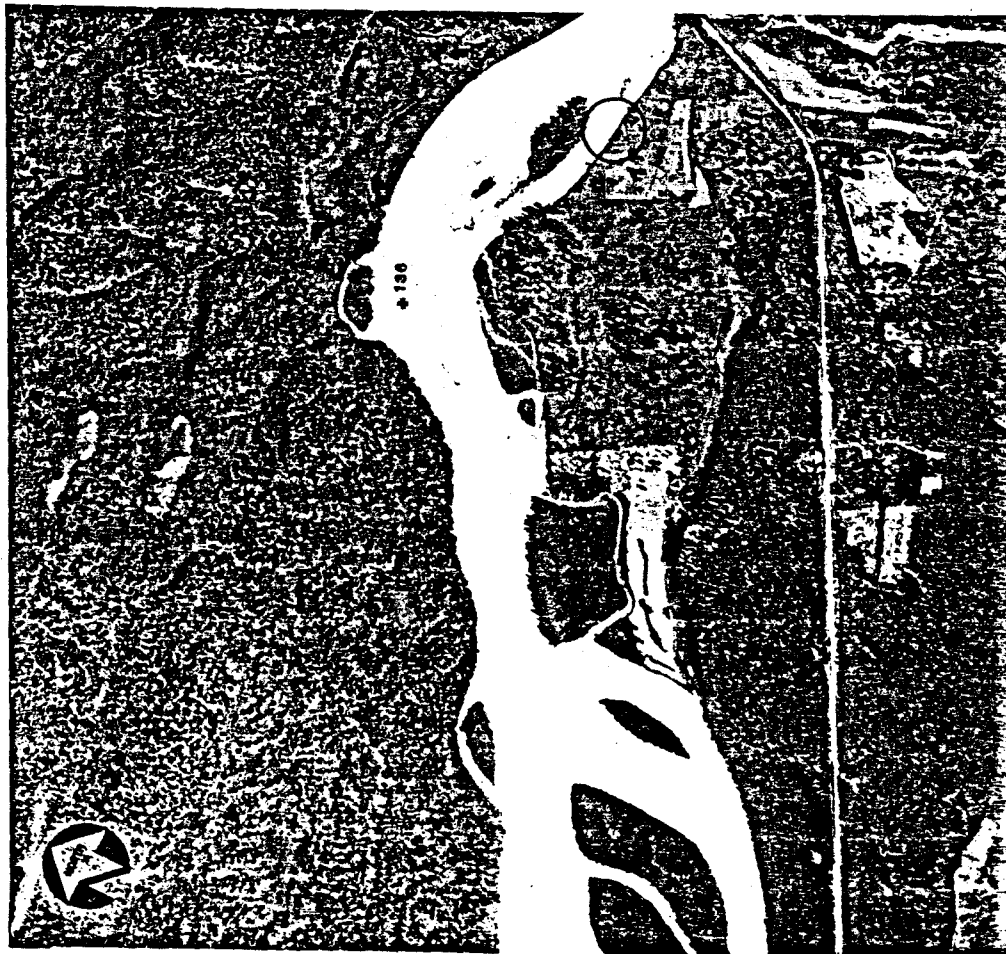
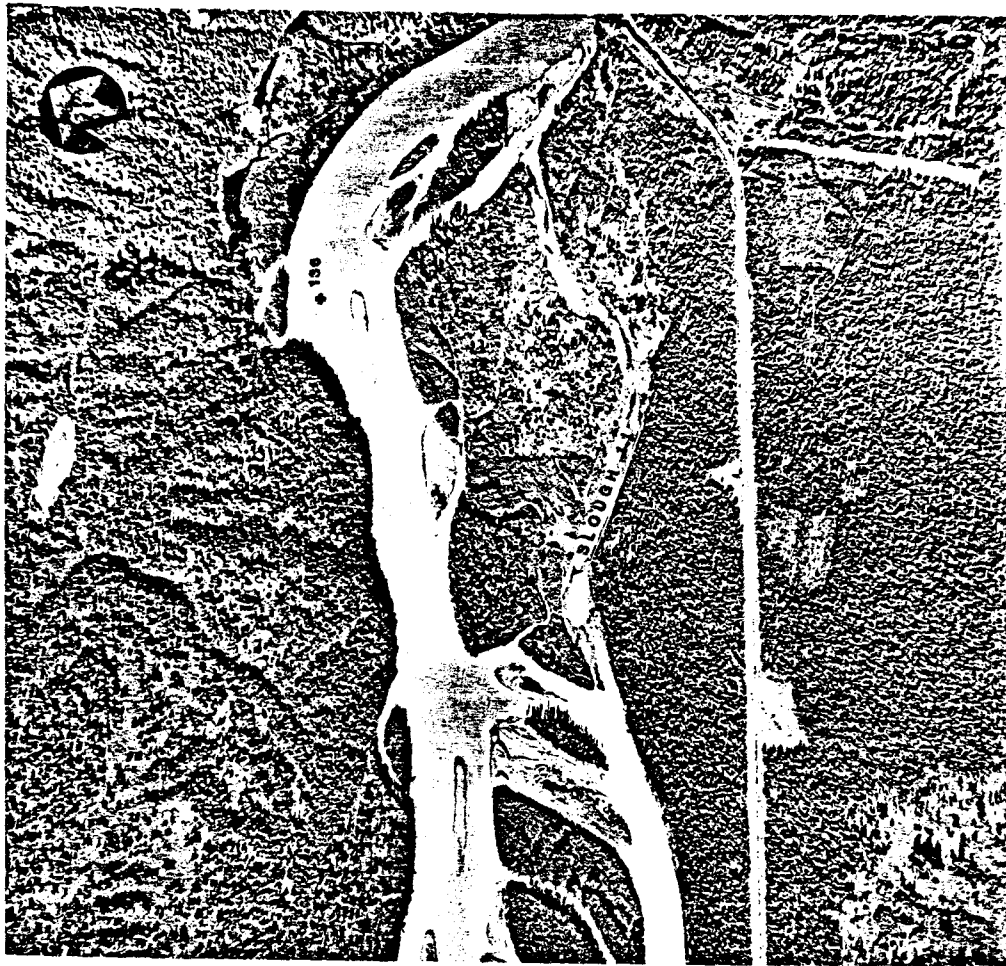
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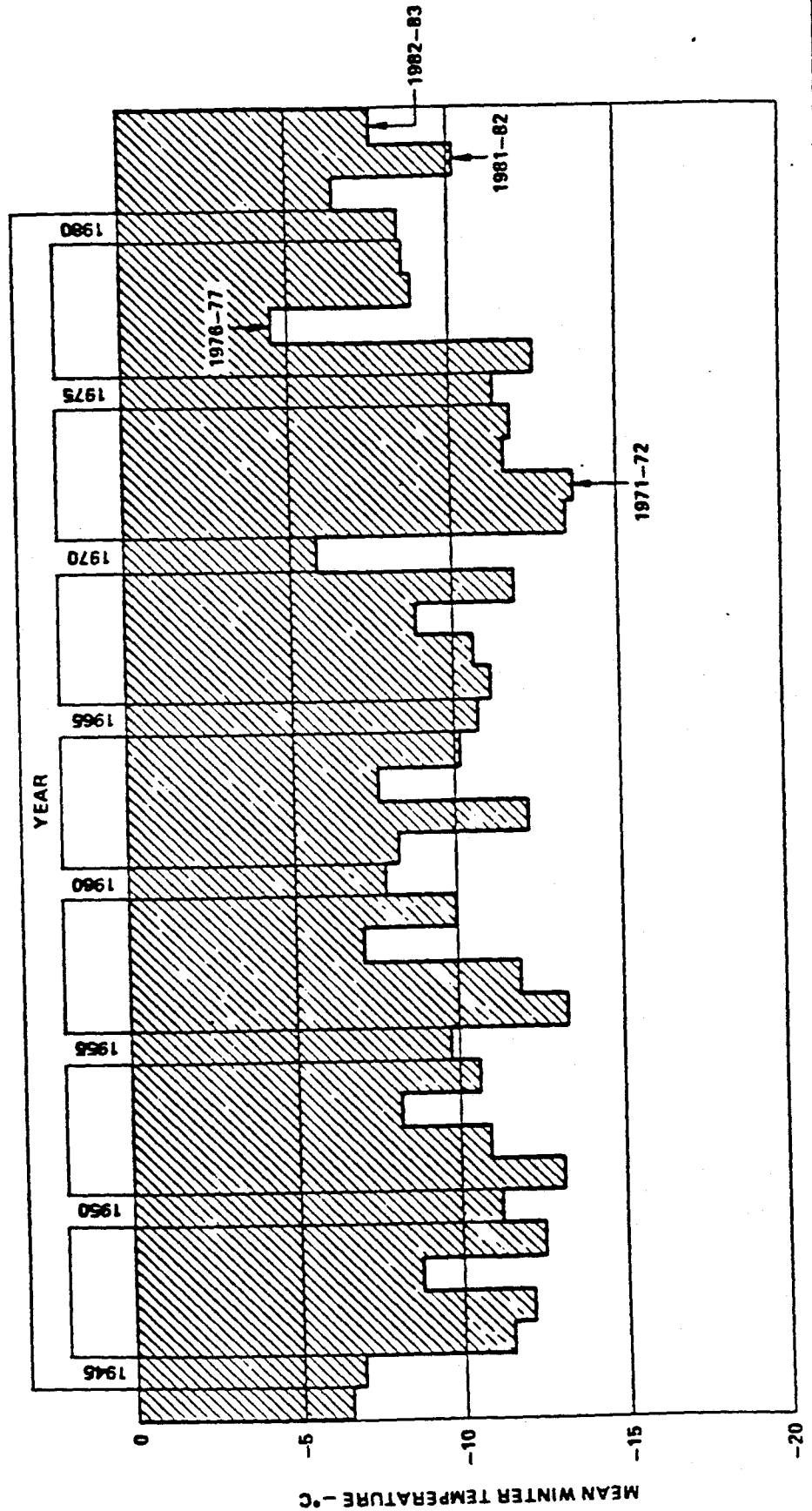
PREPARED FOR:

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SUSITNA JOINT VENTURE



SUSITNA PROJECT
TALKEETNA AIR TEMPERATURES
NOVEMBER - MARCH
1944 - 1983



FIGURE

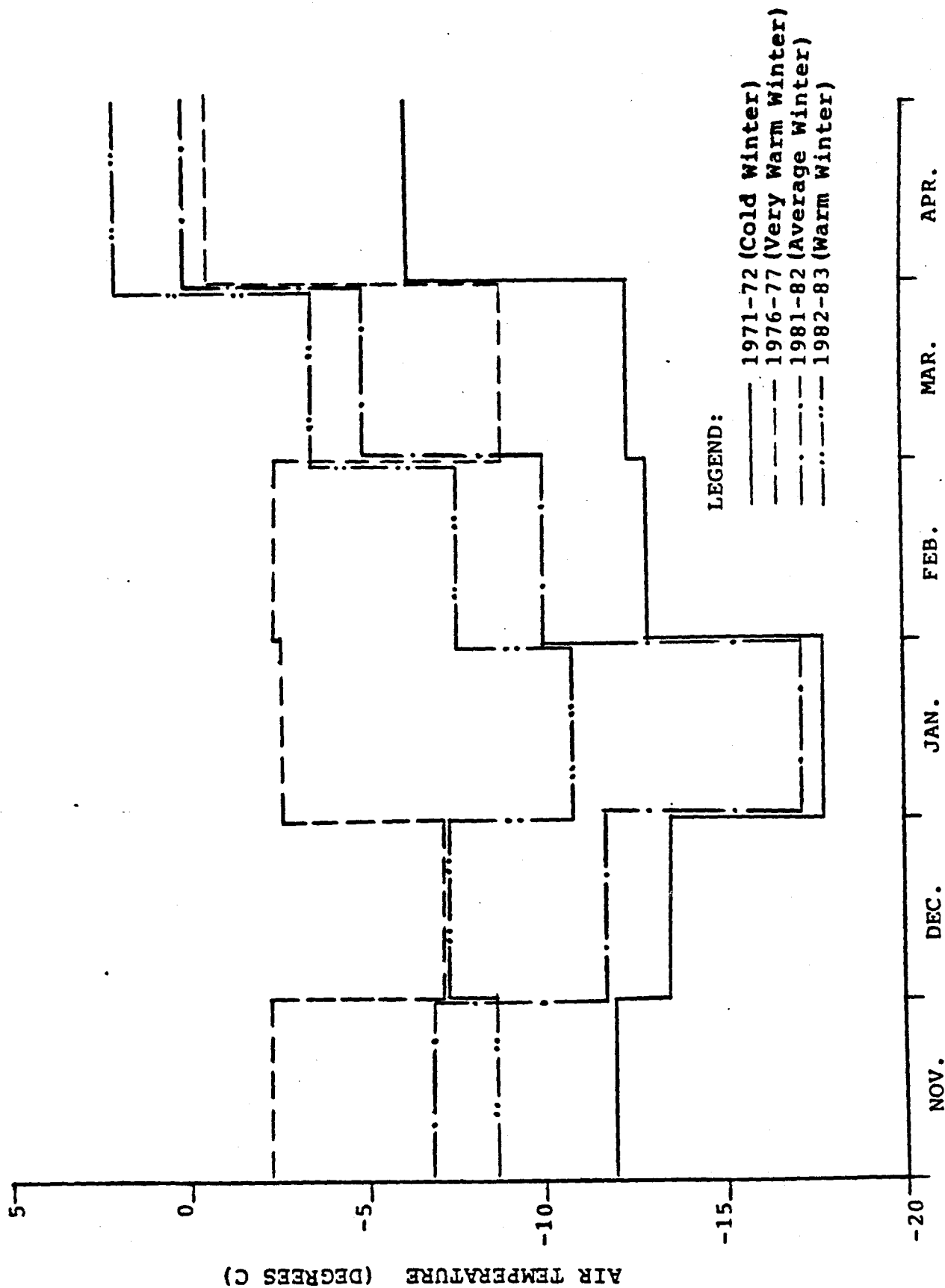
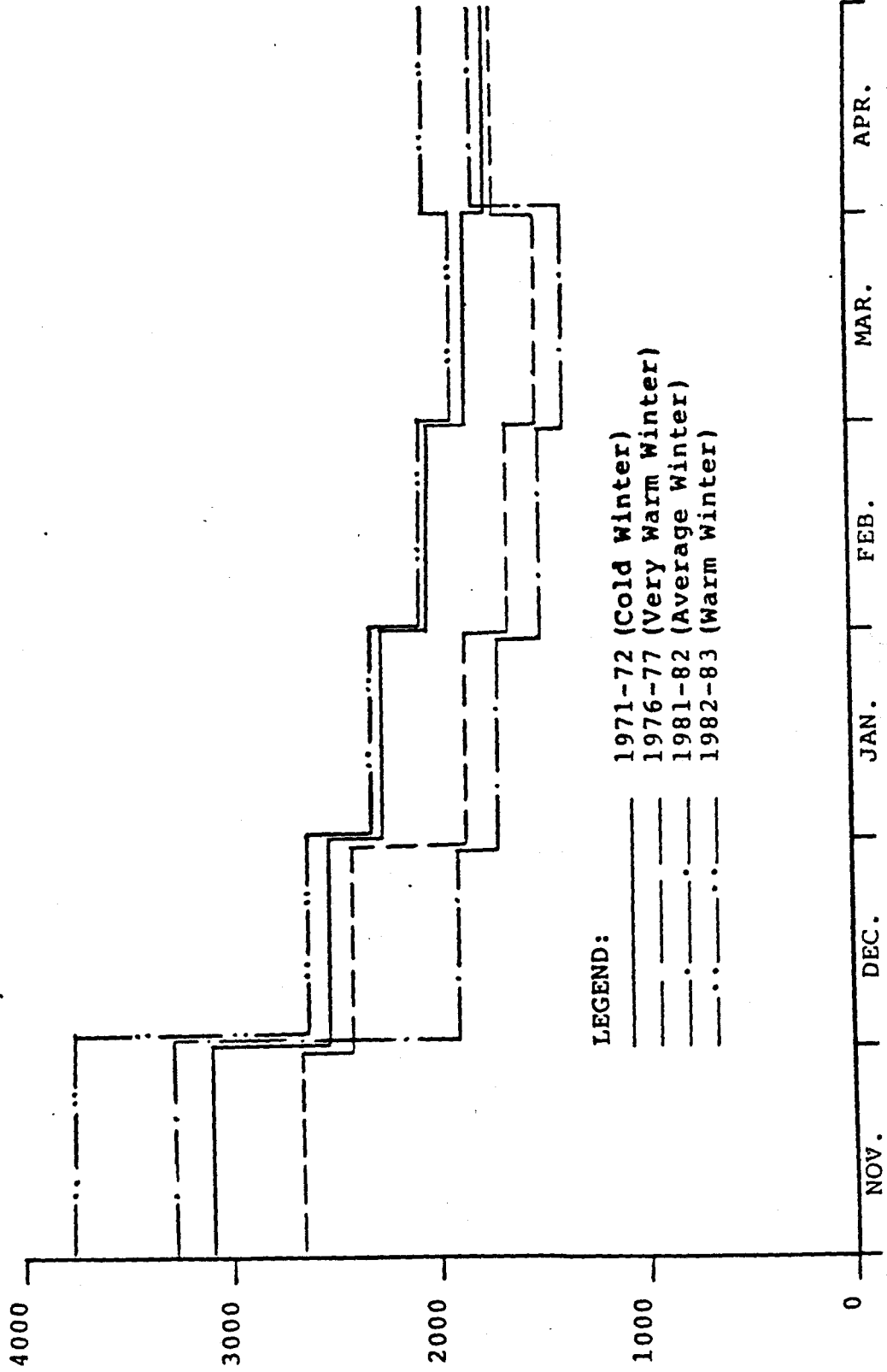
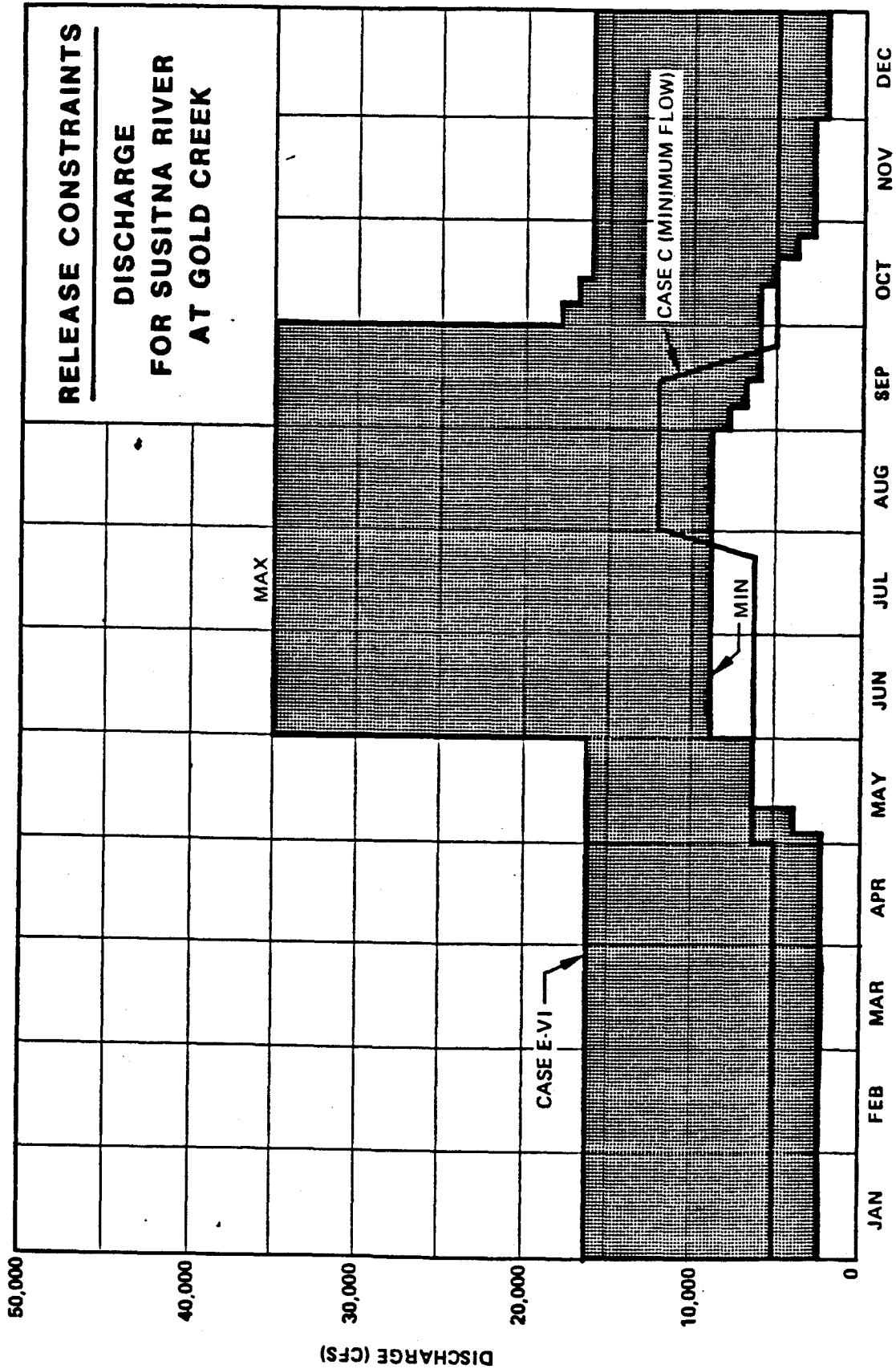
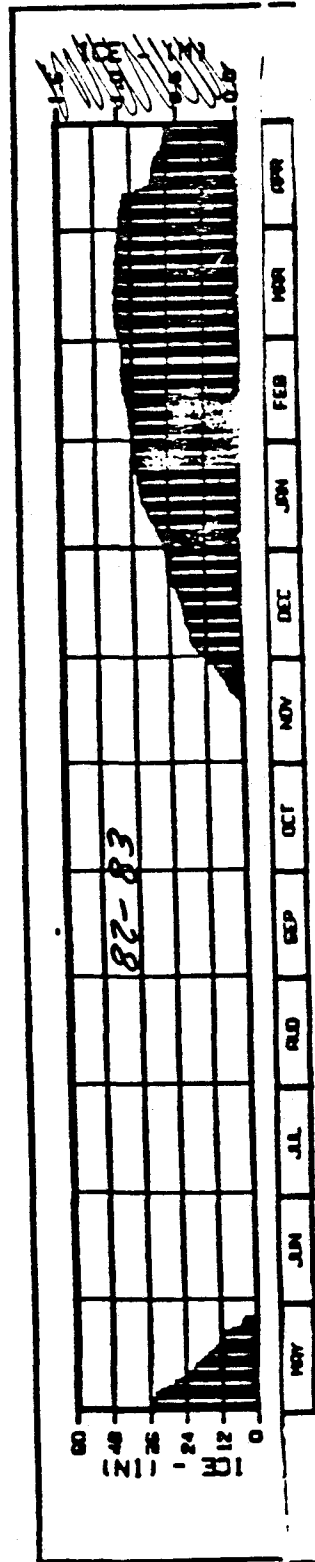
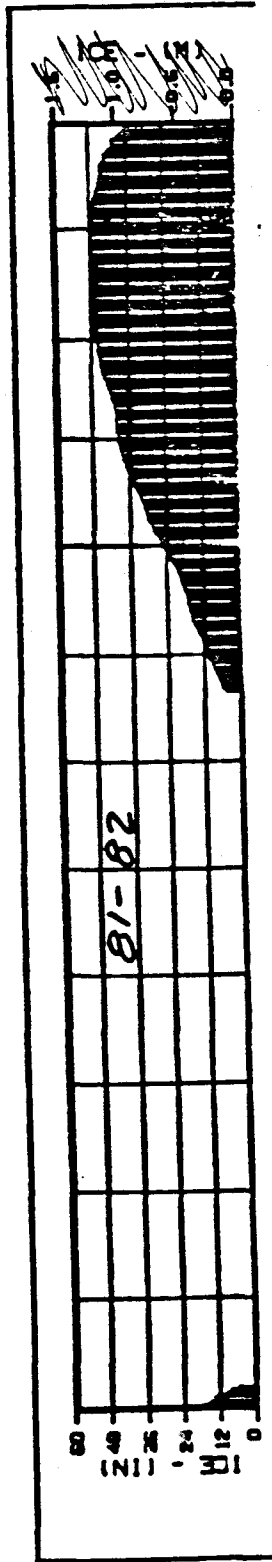
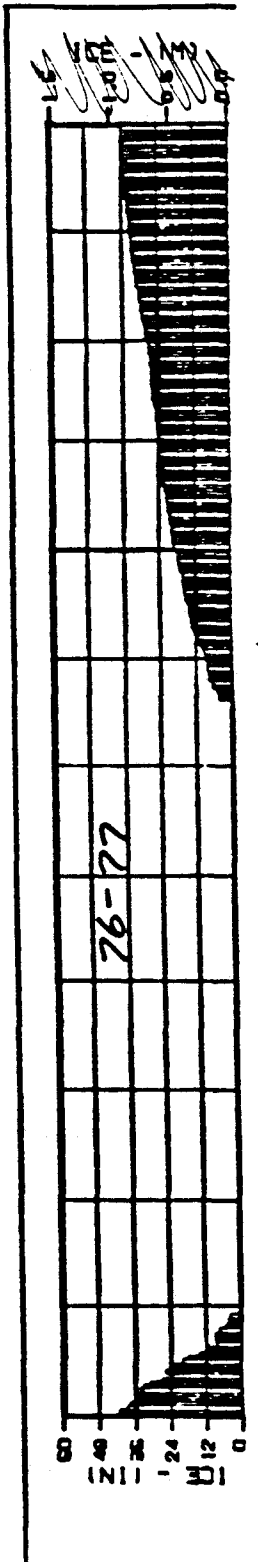
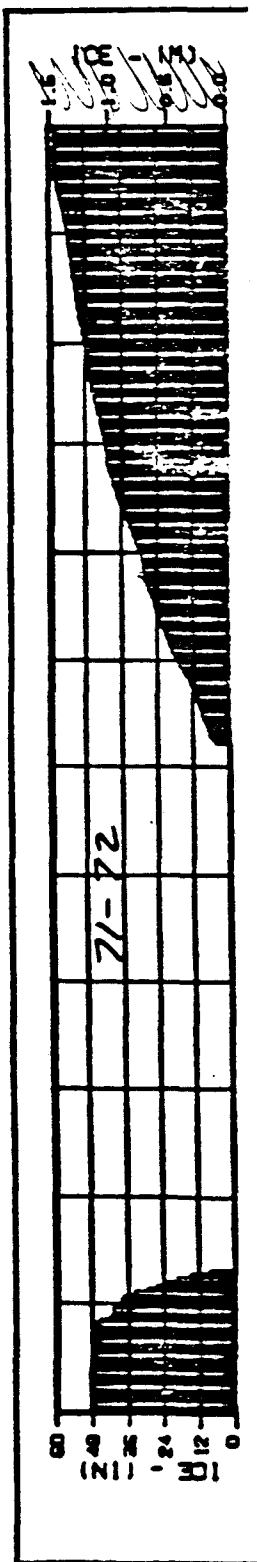


FIGURE 3 - AVERAGE MONTHLY AIR TEMPERATURES AT TALKEETNA



SUSITNA RIVER NATURAL STREAMFLOWS AT GOLD CREEK - AVERAGE MONTHLY VALUES





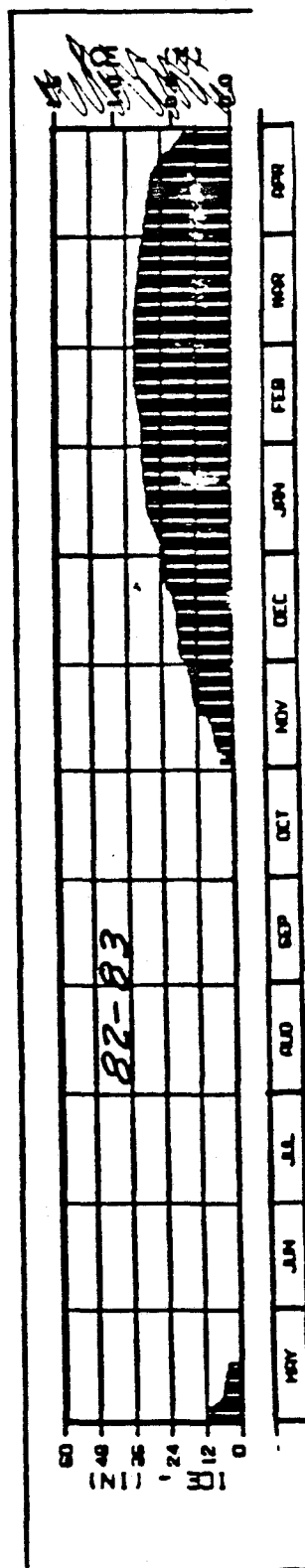
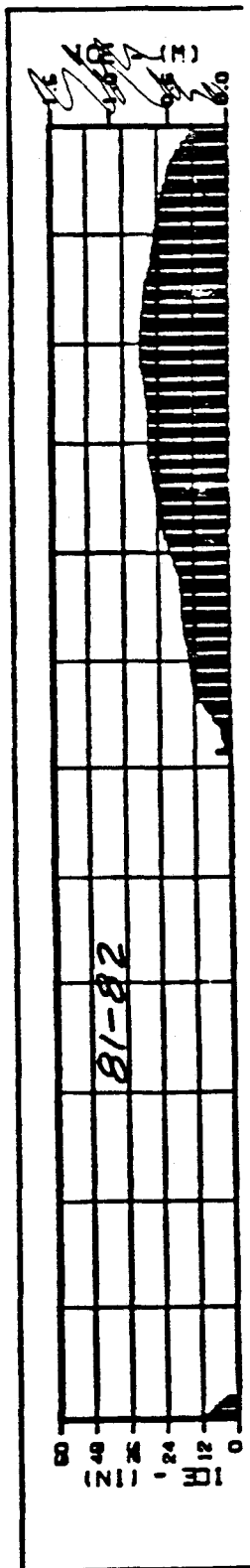
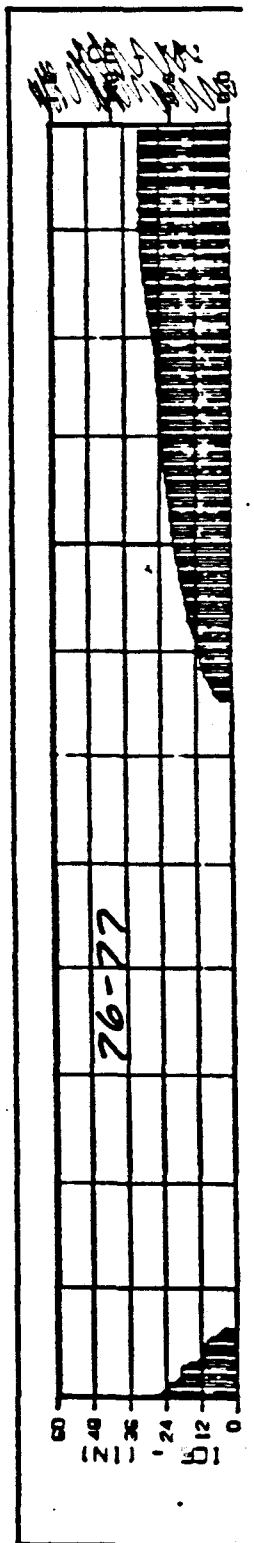
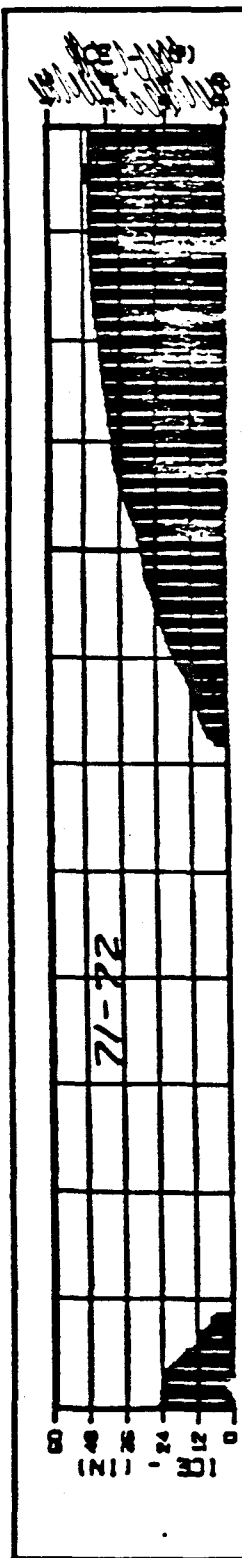
HARDA-EBERCO JOINT VENTURE		
PREPARED BY: H.A. HARRIS	DATE: 10 JAN 84	BY: H.A. HARRIS

NATANA RESERVOIR

ICE GROWTH

1996-CASE C

ALASKA POWER AUTHORITY	
DESIGN PROJECT	DESIGN NUMBER



HERZOG-EBASCO JOINT VENTURE

DATE: 04/08/00	0 45 00	1000-142 00-00
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DEVIL CANYON RESERVOIR

ICE GROWTH

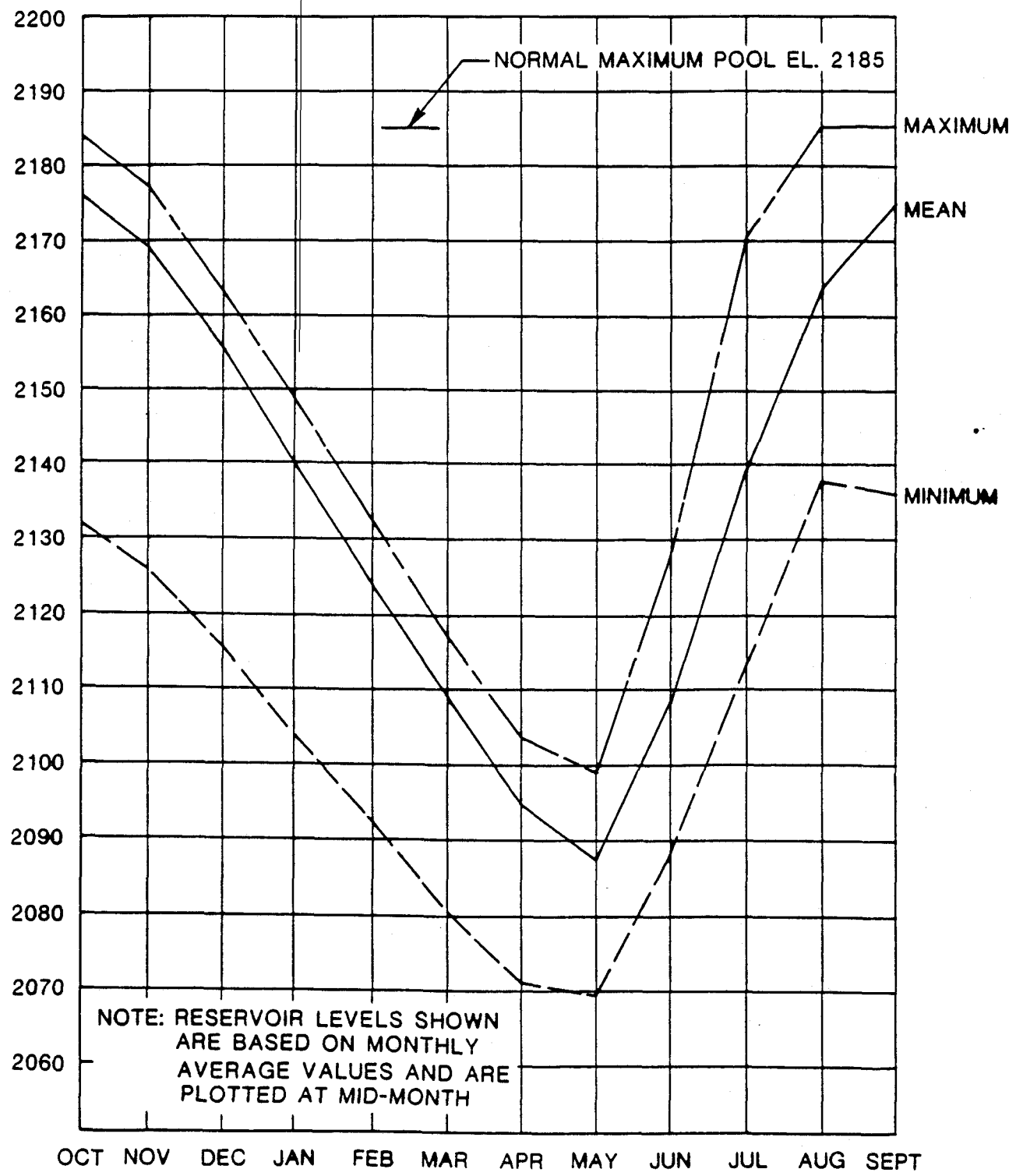
2002-CASE C

ALASKA POWER AUTHORITY

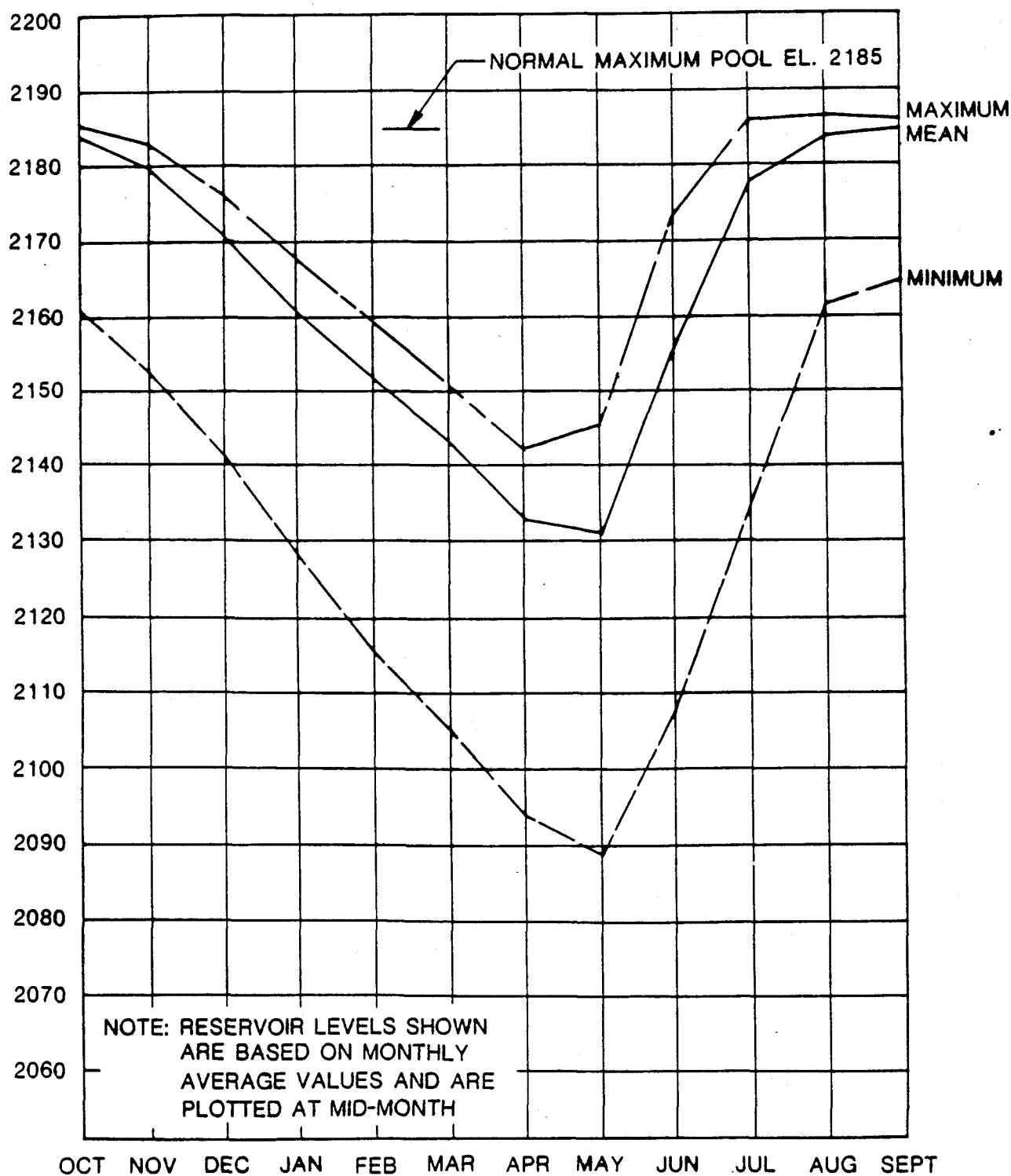
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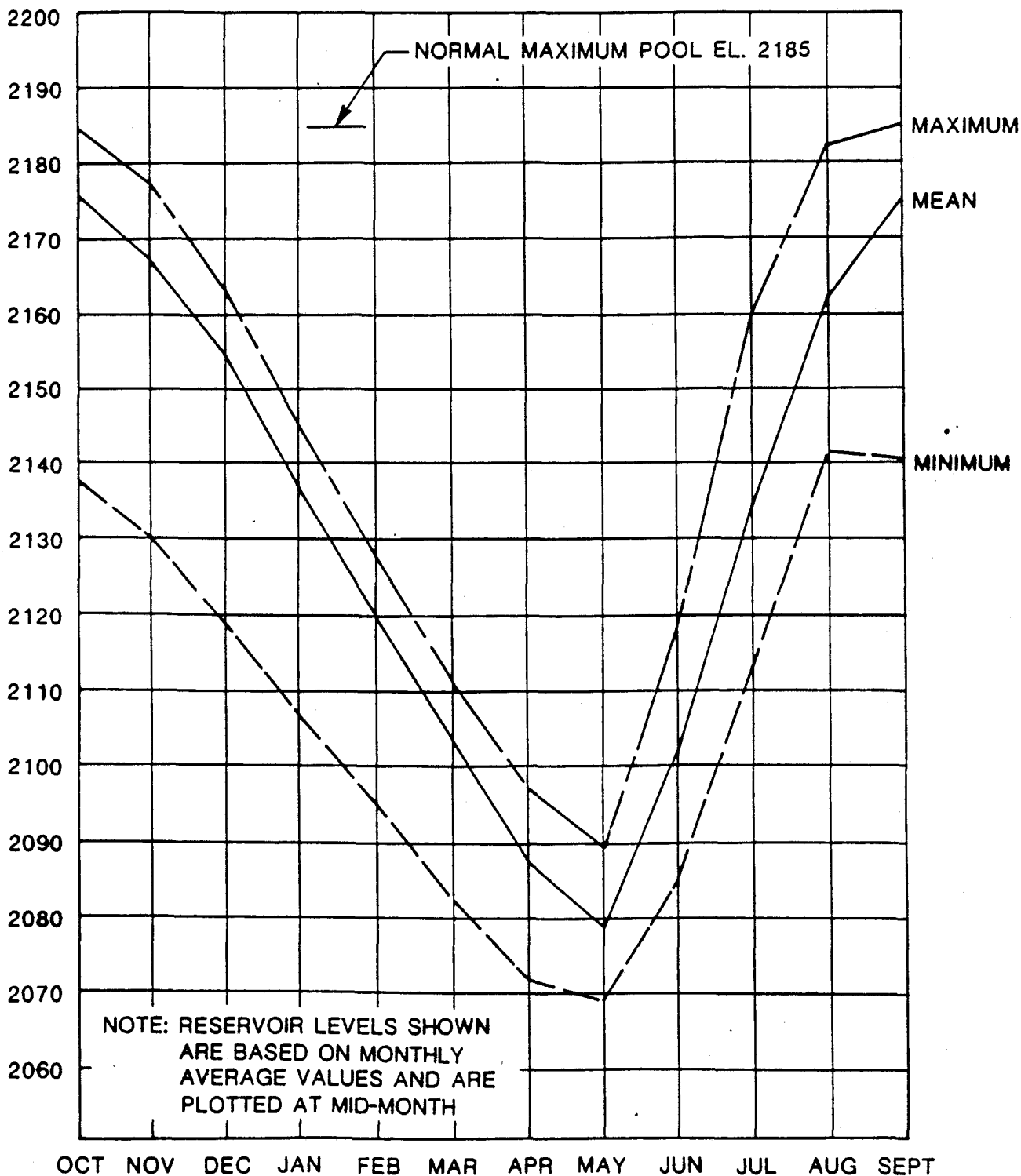
WATANA RESERVOIR WATER LEVELS WATANA ONLY OPERATING 2001 SIMULATION CASE E-VI



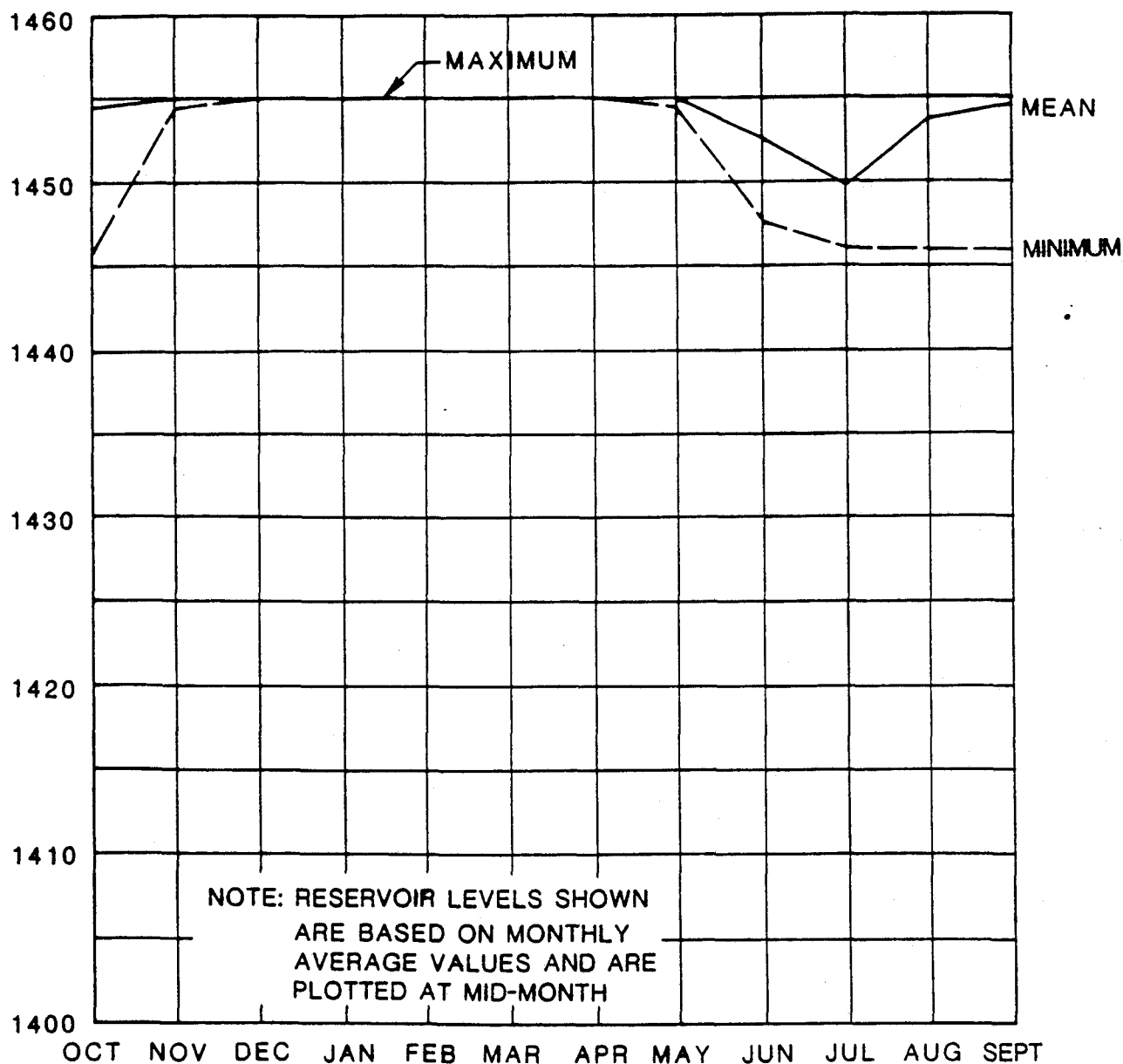
WATANA RESERVOIR WATER LEVELS WATANA AND DEVIL CANYON OPERATING 2002 SIMULATION CASE E-VI



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



DEVIL CANYON WATER LEVELS 2002 SIMULATION CASE E-VI



DEVIL CANYON WATER LEVELS 2020 SIMULATION CASE E-VI

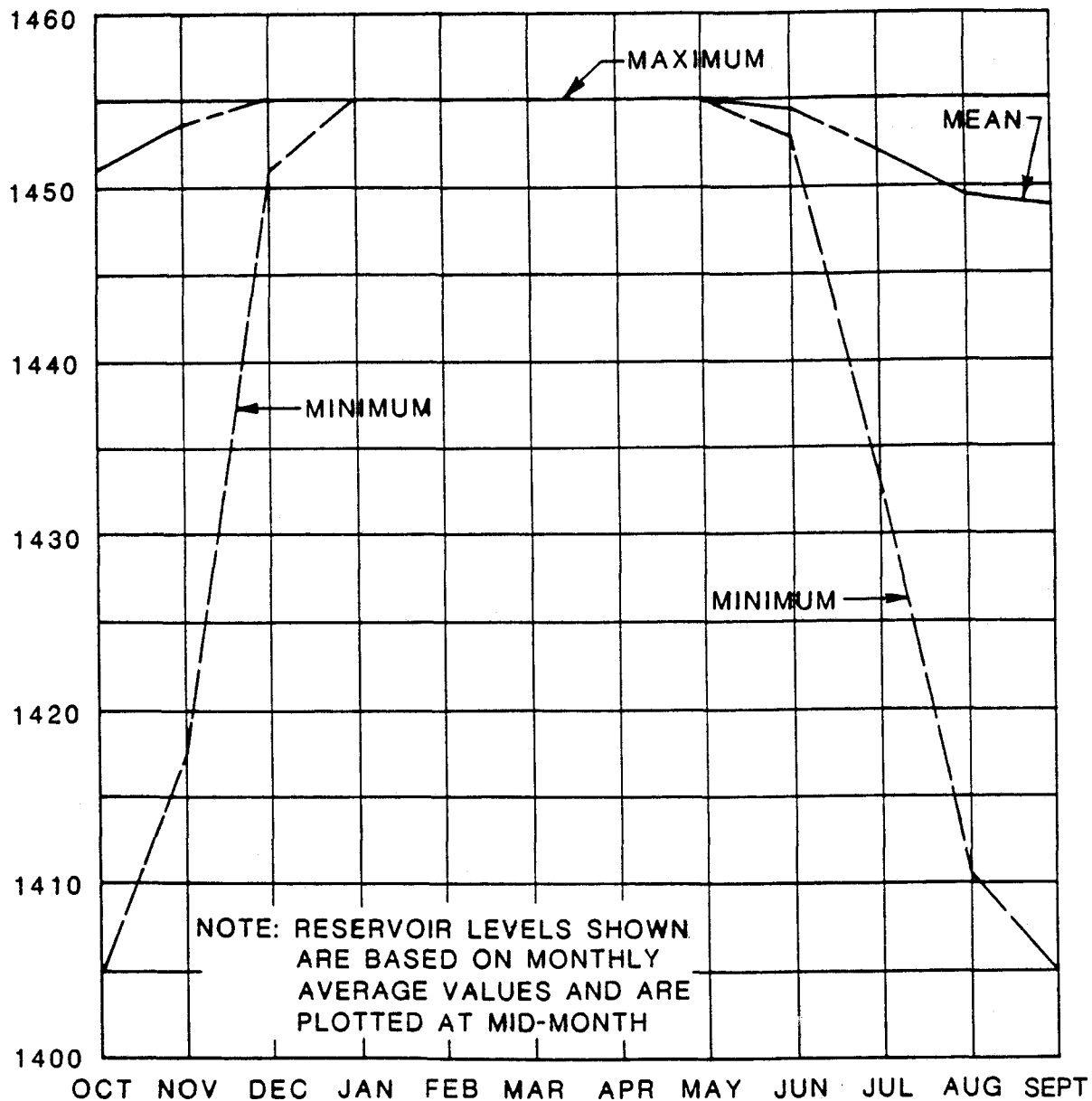


Photo 1.

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

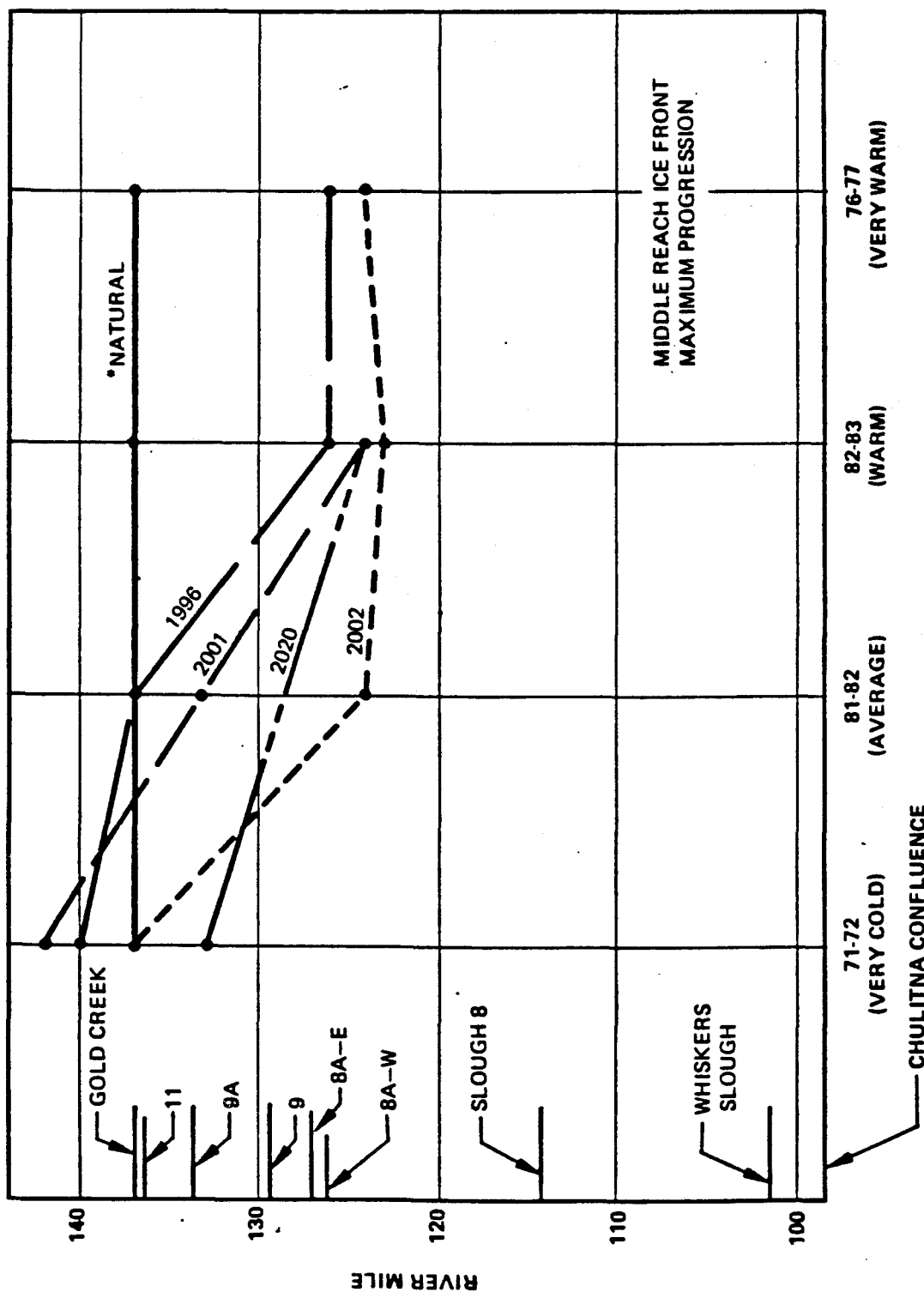


**US Army Corps
of Engineers**

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.

EXHIBIT 8.
13

MIDDLE REACH
ICE COVER DURATION

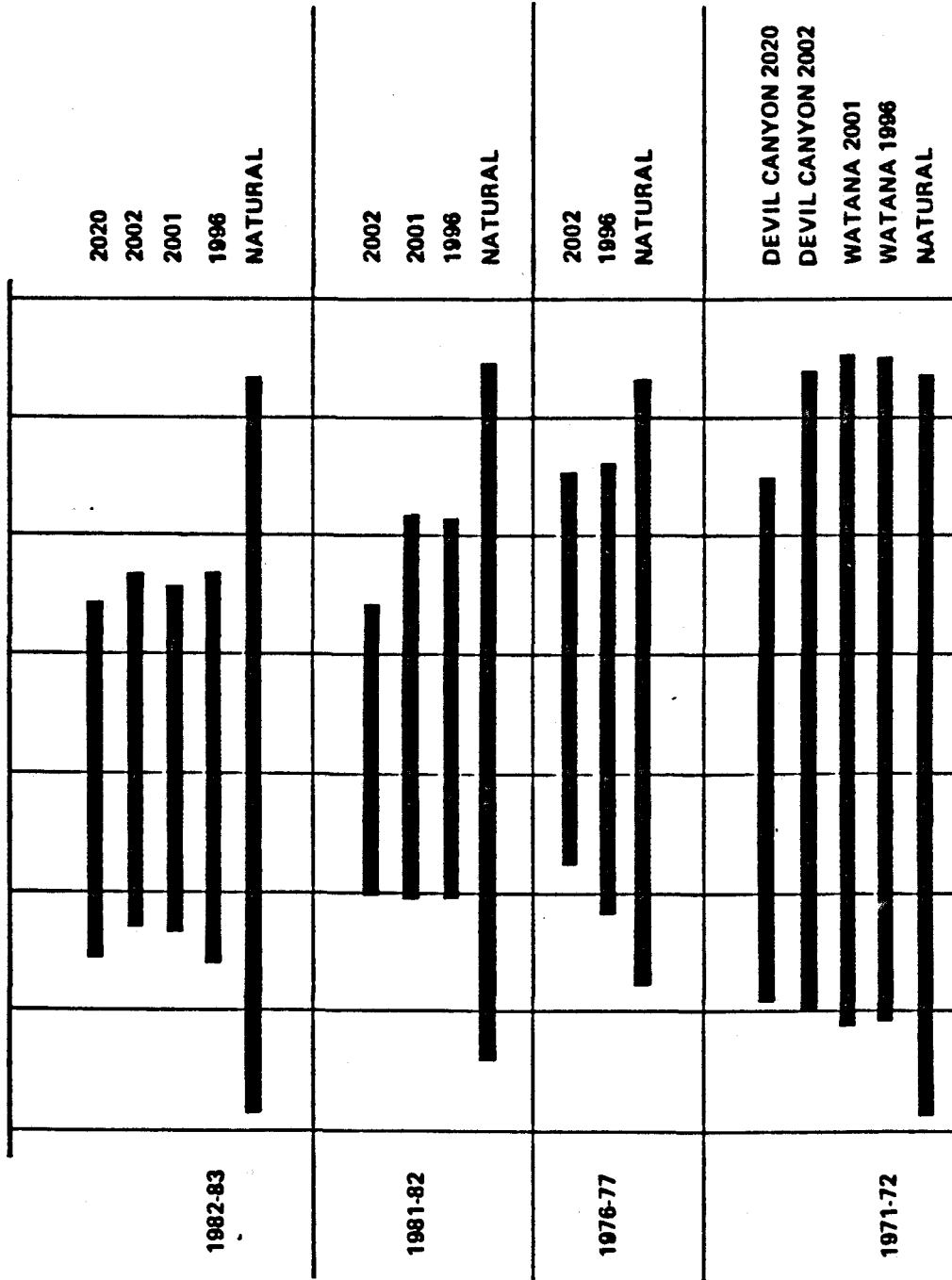


TABLE IV
SUSITNA HYDROELECTRIC PROJECT
MAXIMUM SIMULATED WINTER RIVER STAGES

Slough or Side Channel	River Mile	Threshold Elevation	NATURAL CONDITIONS	WATANA ONLY				WATANA AND DEVIL CANYON				WATANA FILLING	
				1971-72	1976-77	1981-82	1982-83	1998 DEMAND	2001 DEMAND	2002 DEMAND	2020 DEMAND	YR. 1	YR. 2
Whiskers	101.5	387 ✓	✓	388	386	388	387	372	370	368	370	387	387
Gash Creek	112.0	Unknown	✓	458	455	455	458	459	457	458	457	455	455
6A	112.3	(Upland)	✓	459	457	457	459	462	463	460	458	457	457
8	114.1	478 ✓	✓	474	472	472	474	478	478	475	475	473	473
MS II	115.5	482	✓	484	480	484	484	488	488	485	487	481	483
MS II	115.9	487	✓	485	482	488	488	491	491	489	490	485	486
Curry	120.0	Unknown	✓	522	520	523	520	525	521	520	520	520	521
Moose	123.5	Unknown	✓	552	548	548	548	552	550	547	545	546	548
8A West	126.1	573 ✓	✓	572	569	571	570	574	572	568	568	568	570
8A East	127.1	582 ✓	✓	584	581	583	582	585	581	581	581	580	582
9	129.3	604 ✓	✓	605	603	606	605	607	603	601	602	602	603
9 u/s	130.6	Unknown	✓	622	616	620	621	624	617	616	616	616	618
4th July	131.8	Unknown	✓	632	628	629	630	635	628	627	627	625	628
9A	133.7	651 ✓	✓	655	649	651	651	657	650	650	650	650	650
10 u/s	134.3	657	✓	662	654	657	658	663	656	655	655	658	655
11 d/s	135.3	Unknown	✓	673	667	670	672	675	667	667	667	670	668
11	136.5	687 ✓	✓	684	681	683	684	688	684	682	682	682	682
17	139.3	Unknown	✓	-	-	-	-	717	715	715	715	712	713
20	140.5	730	✓	-	-	-	-	729	729	728	728	727	729
21 (A6)	141.8	747	✓	-	-	-	-	746	746	746	746	745	745
21	142.2	755	✓	-	-	-	-	753	753	752	752	751	750
22	144.8	788	✓	-	-	-	-	787	787	785	785	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. 1971-72W 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.
5. All river stages in feet.
6. Winter air temperatures:
1971-72 cold
1976-77 very warm
1981-82 average
1982-83 warm

Upstream Boundary of Natural Simulations

Upstream Extent of Ice Cover Progression

EXHIBIT A
14

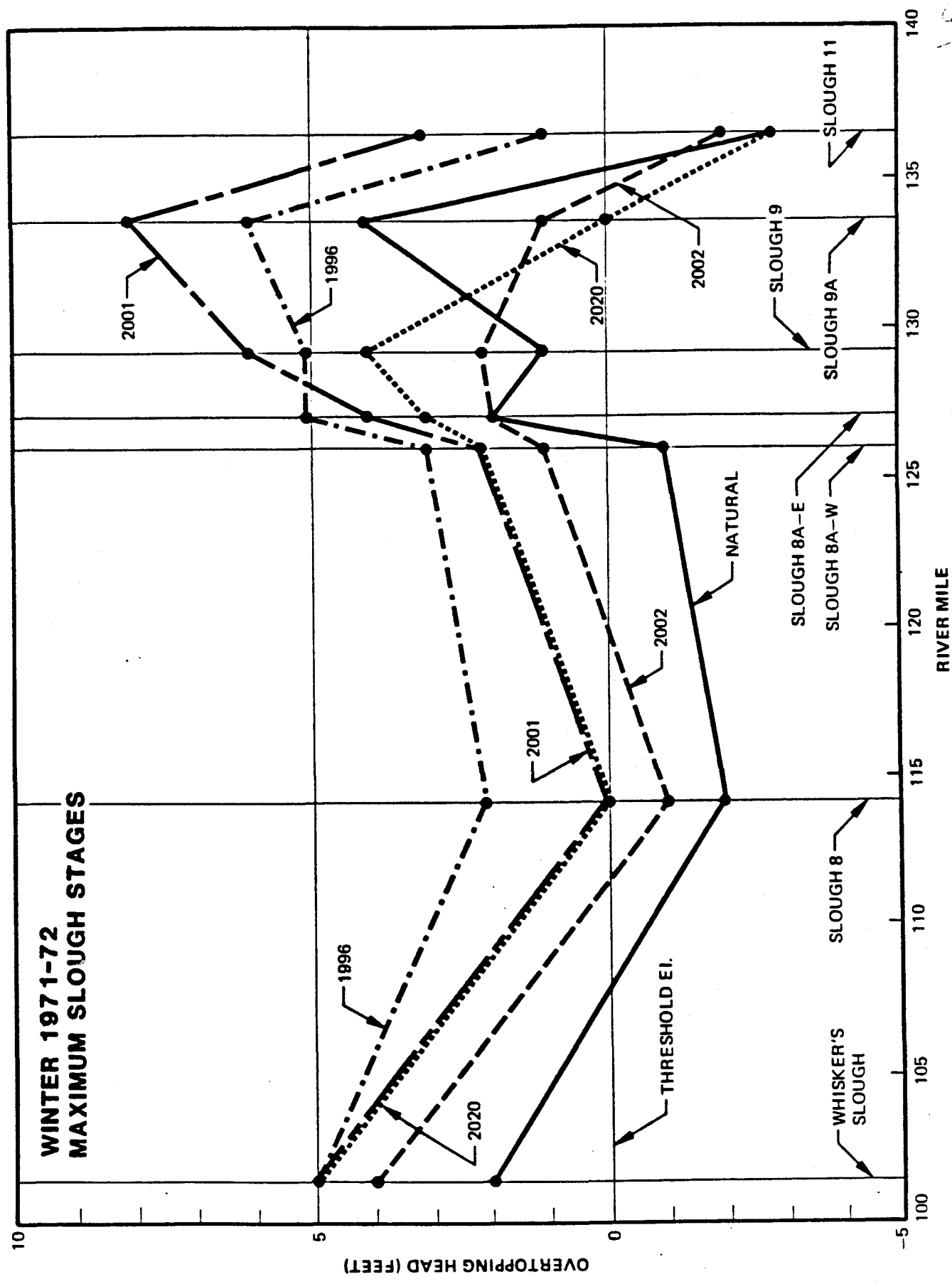
TABLE VIII

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

	NATURAL CONDITIONS	WATANA ONLY				WATANA AND DEVIL CANYON				WATANA FILLING												
		✓	1971-72	1976-77	1981-82	1982-83	1971-72	2001 DEMAND	2002 DEMAND	2020 DEMAND	YR. 1	YR. 2										
Slough or Side Channel																						
Whitlers	101.5	5	2	4	3	5	1	3	2	3	5	2	4	1	1	1						
Gash Creek	112.0	5	4	4	4	5	3	5	5	6	5	7	5	2	2	3	4	1	1			
6A	112.3	6	5	4	5	5	3	5	4	6	5	7	5	3	3	4	4	1	1	5	5	
8	114.1	5	2	4	4	5	3	4	3	4	5	5	4	2	3	3	4	1	1	3	3	
MSII	115.5	5	2	5	5	6	2	5	5	4	5	6	4	4	3	4	4	2	2	3	5	
MSII	115.8	5	3	7	6	7	4	7	6	6	5	8	4	6	4	6	5	3	5	5	8	
Curry	120.0	6	5	7	4	7	5	8	5	3	5	1	4	1	1	1	4	2	4	4	6	
Moose	123.5	10	4	7	5	9	5	8	2	4	6	2	7	1	1	1	7	2	5	5	6	
8A West	126.1	5	2	3	3	5	2	3	1	1	5	5	3	3	3	3	3	1	1	2	2	
8A East	127.1	5	2	3	3	4	2	2	2	2	4	4	3	3	3	3	3	1	1	2	2	
9	129.3	6	4	7	6	5	3	3	3	3	6	6	3	3	3	3	3	2	2	4	4	
9 u/s	130.6	8	3	6	7	5	2	2	2	2	6	6	3	3	3	3	2	2	3	3	6	
4th July	131.8	7	1	3	5	5	2	2	2	2	7	7	3	3	3	3	2	2	1	1	3	
9A	133.7	7	1	3	3	6	2	2	2	2	8	8	3	3	3	3	3	3	3	2	2	
10 u/s	134.3	11	1	3	4	7	2	2	2	2	9	9	4	4	4	4	4	6	6	2	2	
11 d/s	135.3	6	1	3	5	6	2	2	2	2	8	8	3	3	3	3	3	3	3	3	3	
11	136.5	5	1	3	4	3	2	2	2	2	5	5	1	1	1	1	1	1	1	1	1	
17	139.3	Upstream Boundary of Natural Simulations		2	2	13	13	12	12	12	1	1	1	1	1	1	1	1	1	1	1	
20	140.5			2	2	12	12	12	12	12	12	1	1	1	1	1	1	1	1	1	1	1
21 (A6)	141.8			2	2	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	1	1
21	142.2			2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
22	144.8																					

NOTES:

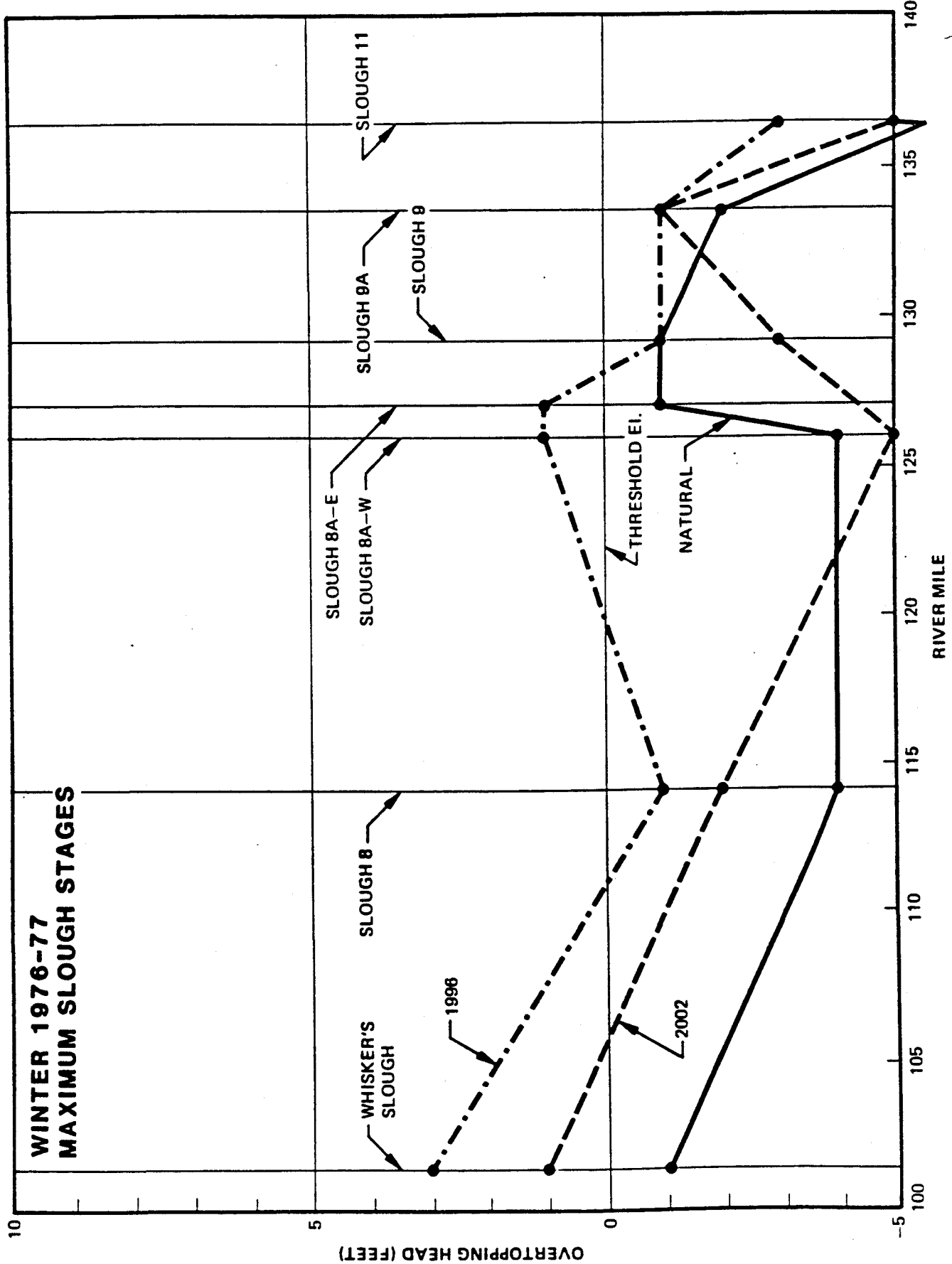
- "Case C" operating guide is assumed for with-project simulations.
- 1971-72^w simulation assumes warm, 4°C reservoir releases.
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- Upstream extent of simulated ice cover progression for Watana filling occurs upstream of River Mile 144.8.
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1981-82 average
1982-83 warm



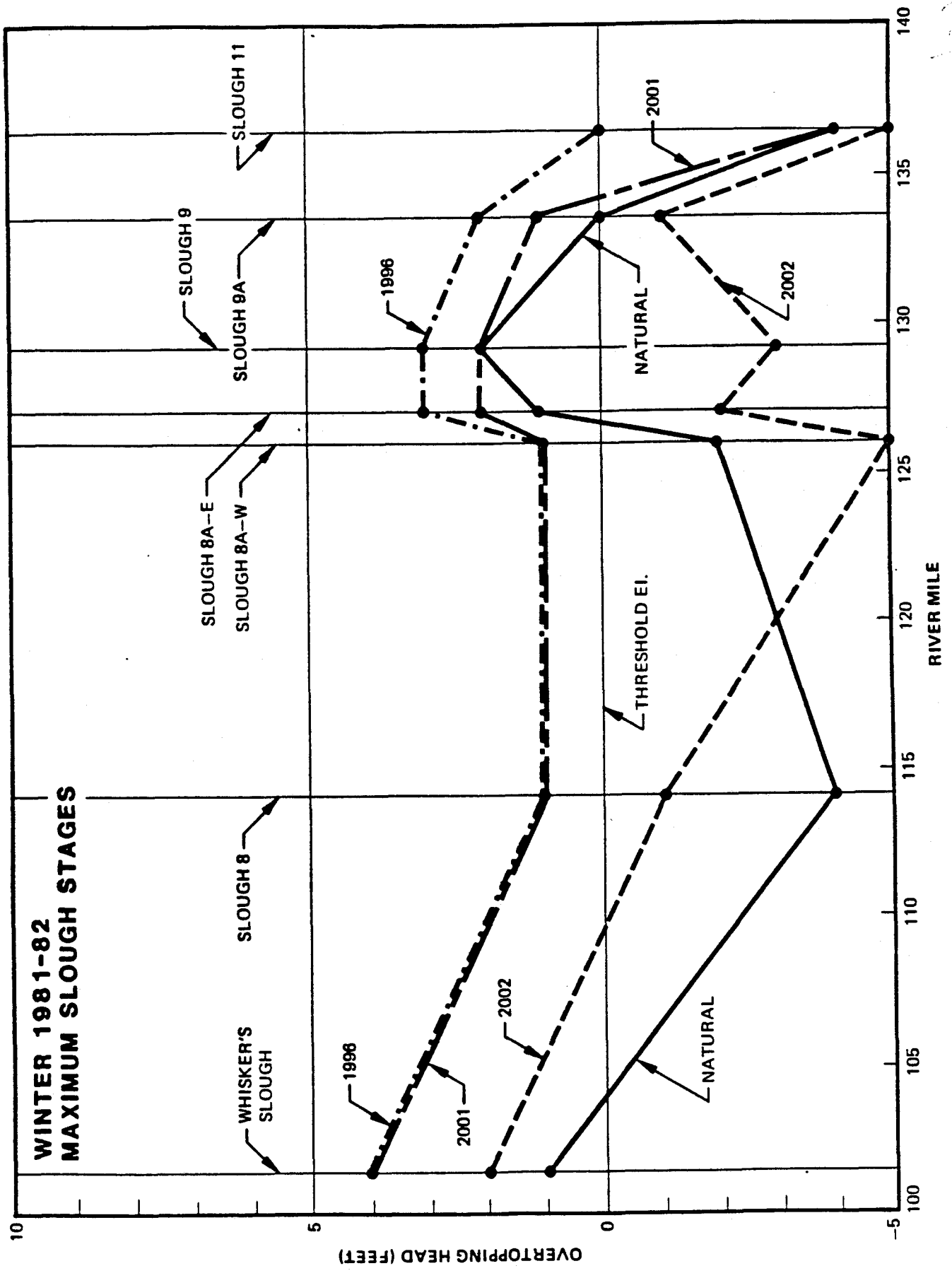
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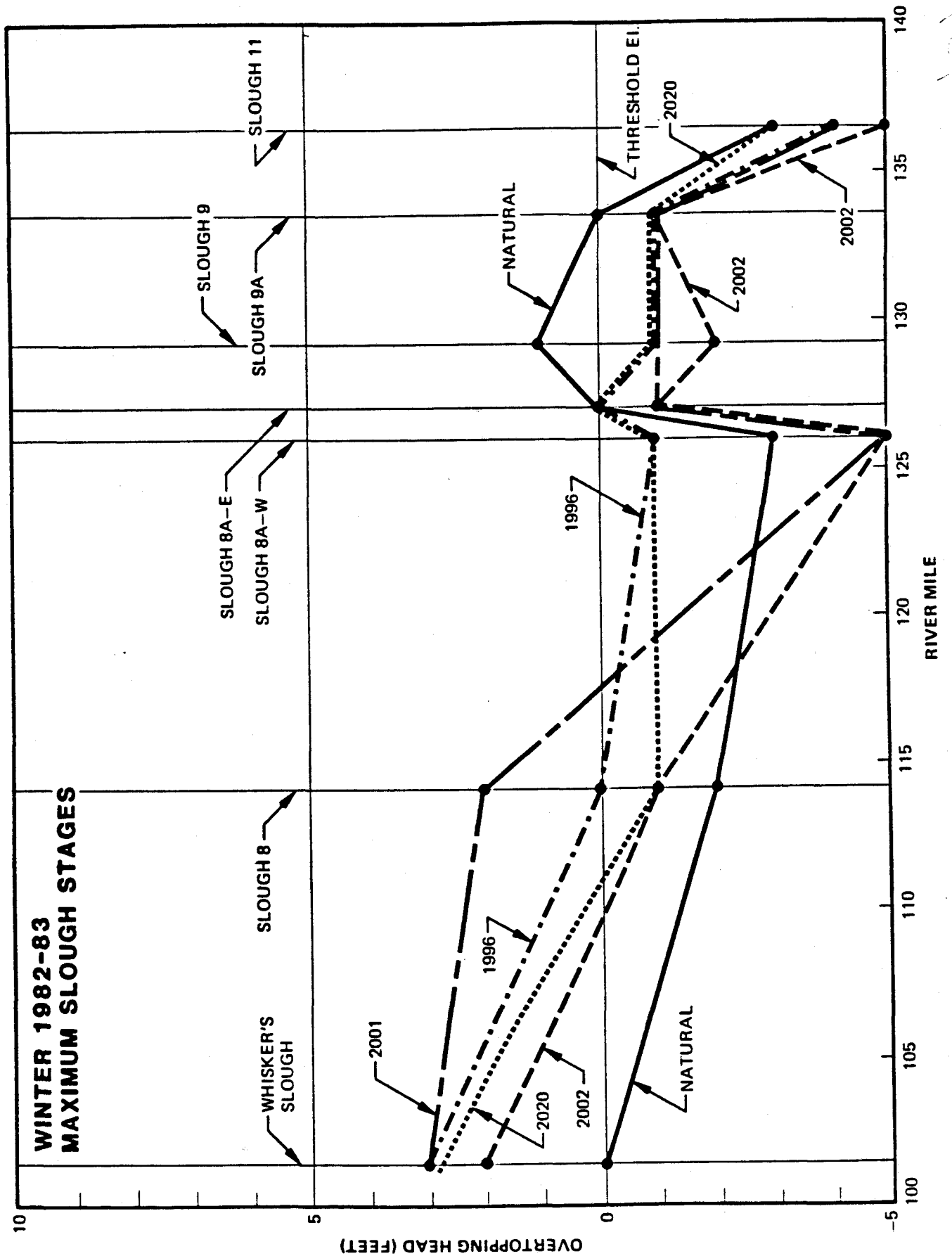
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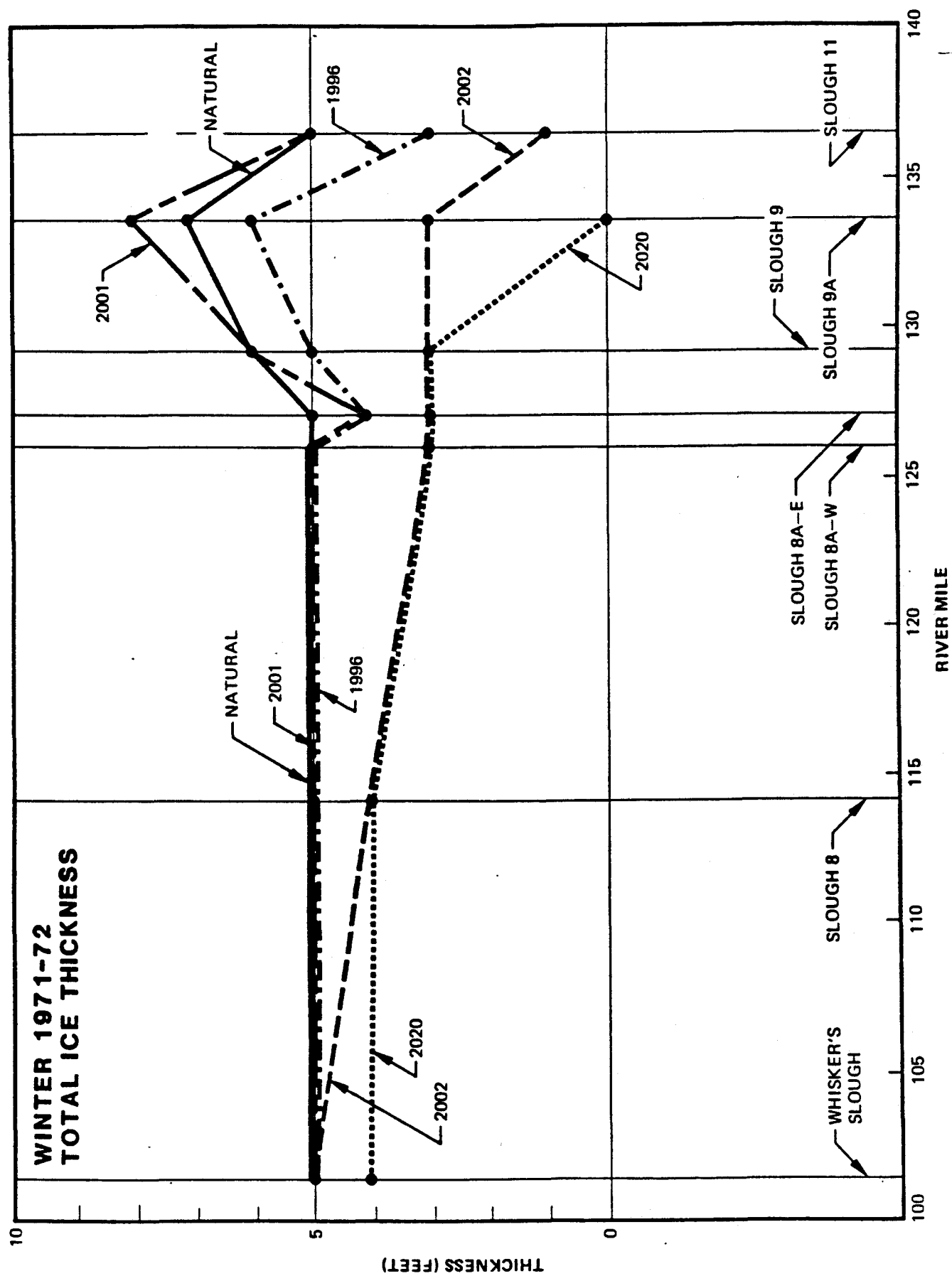


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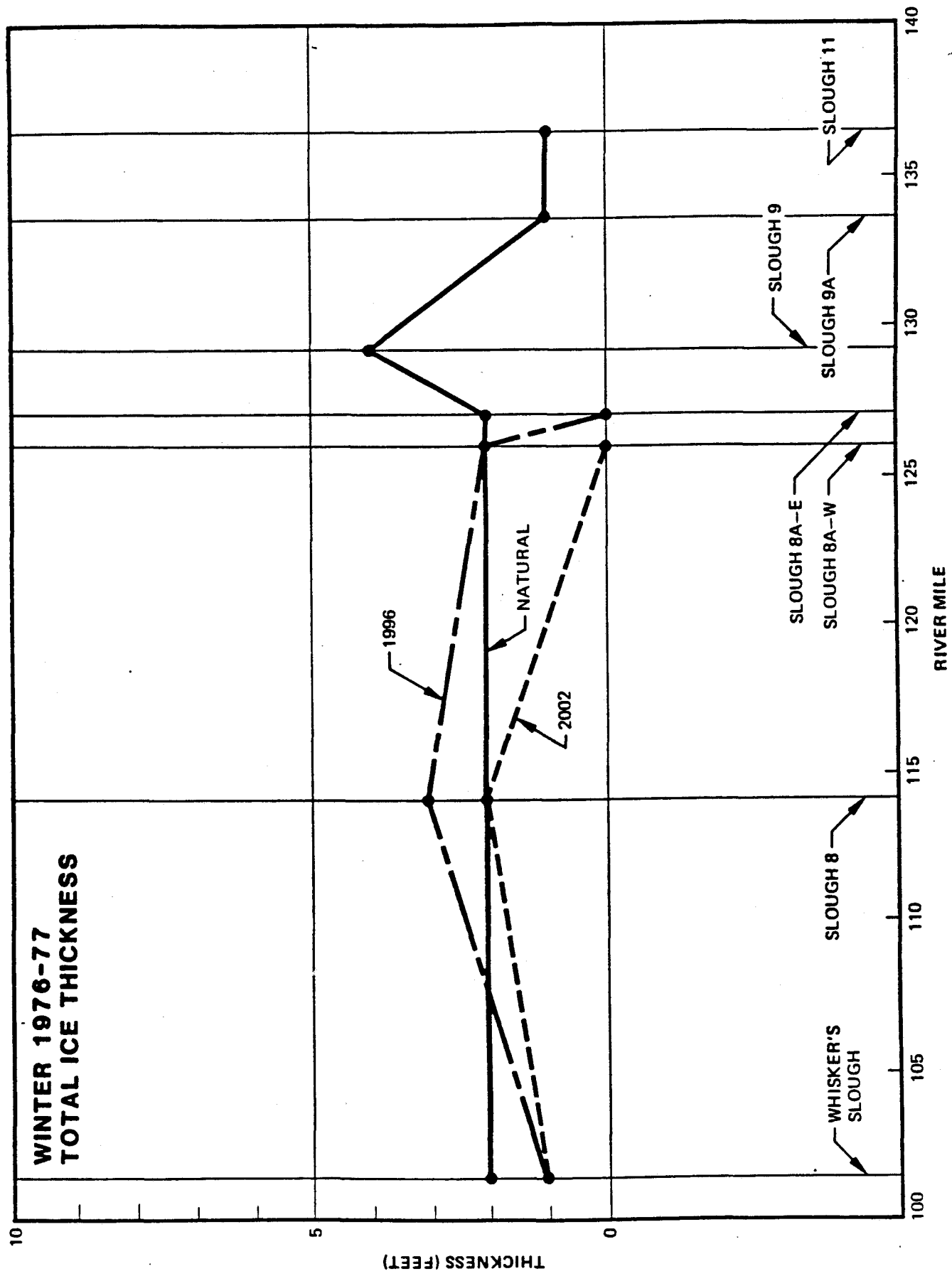


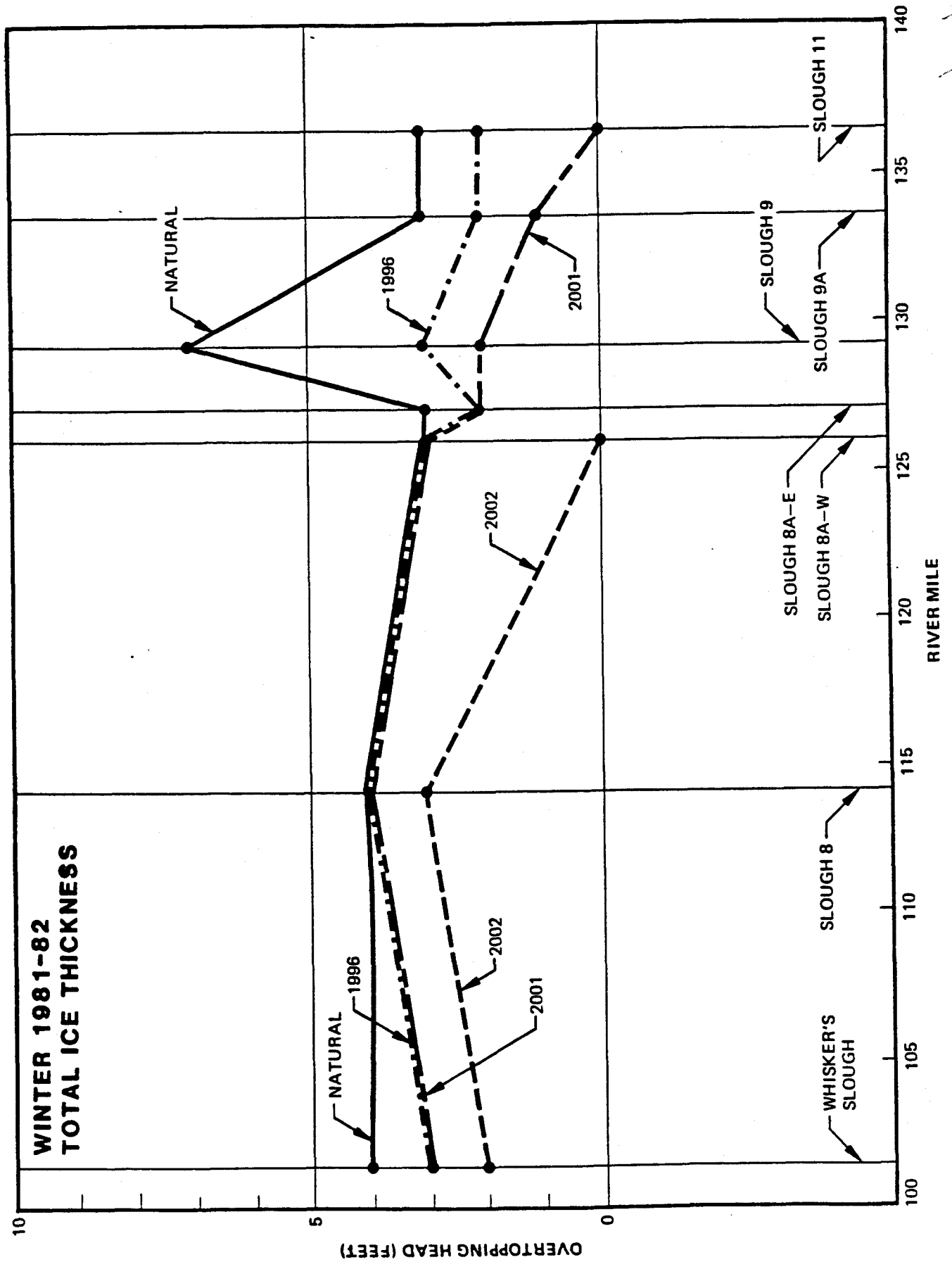
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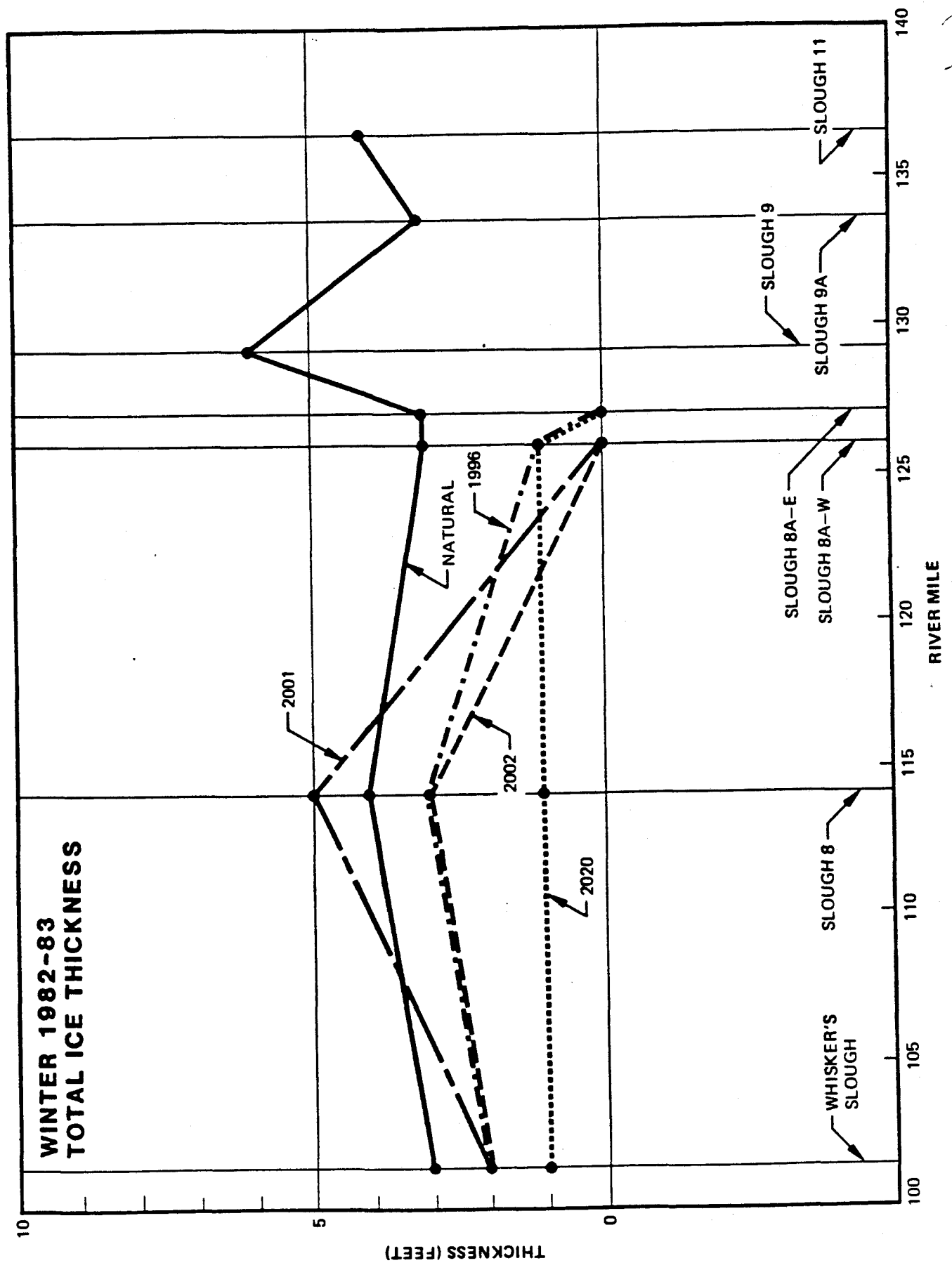


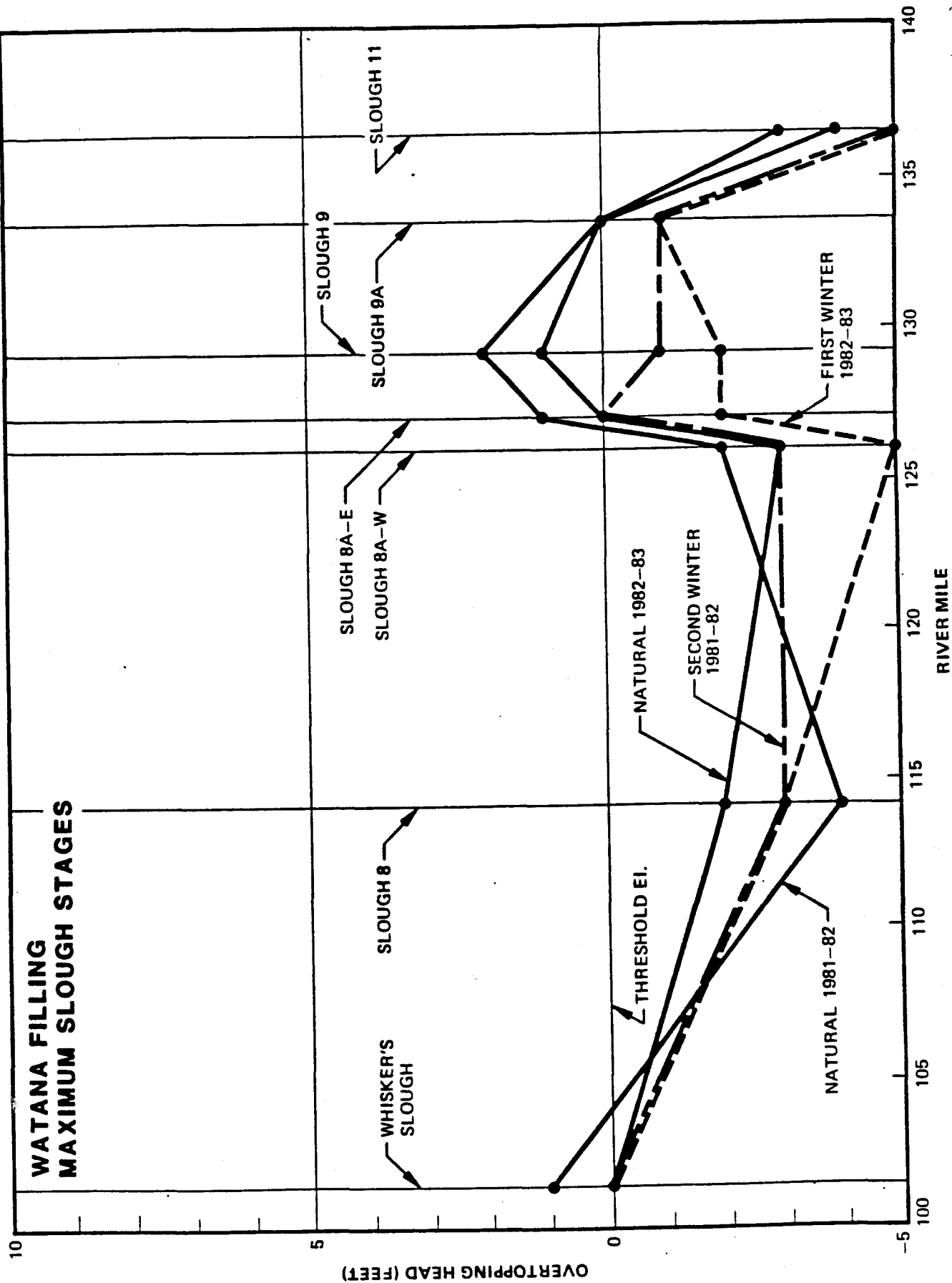
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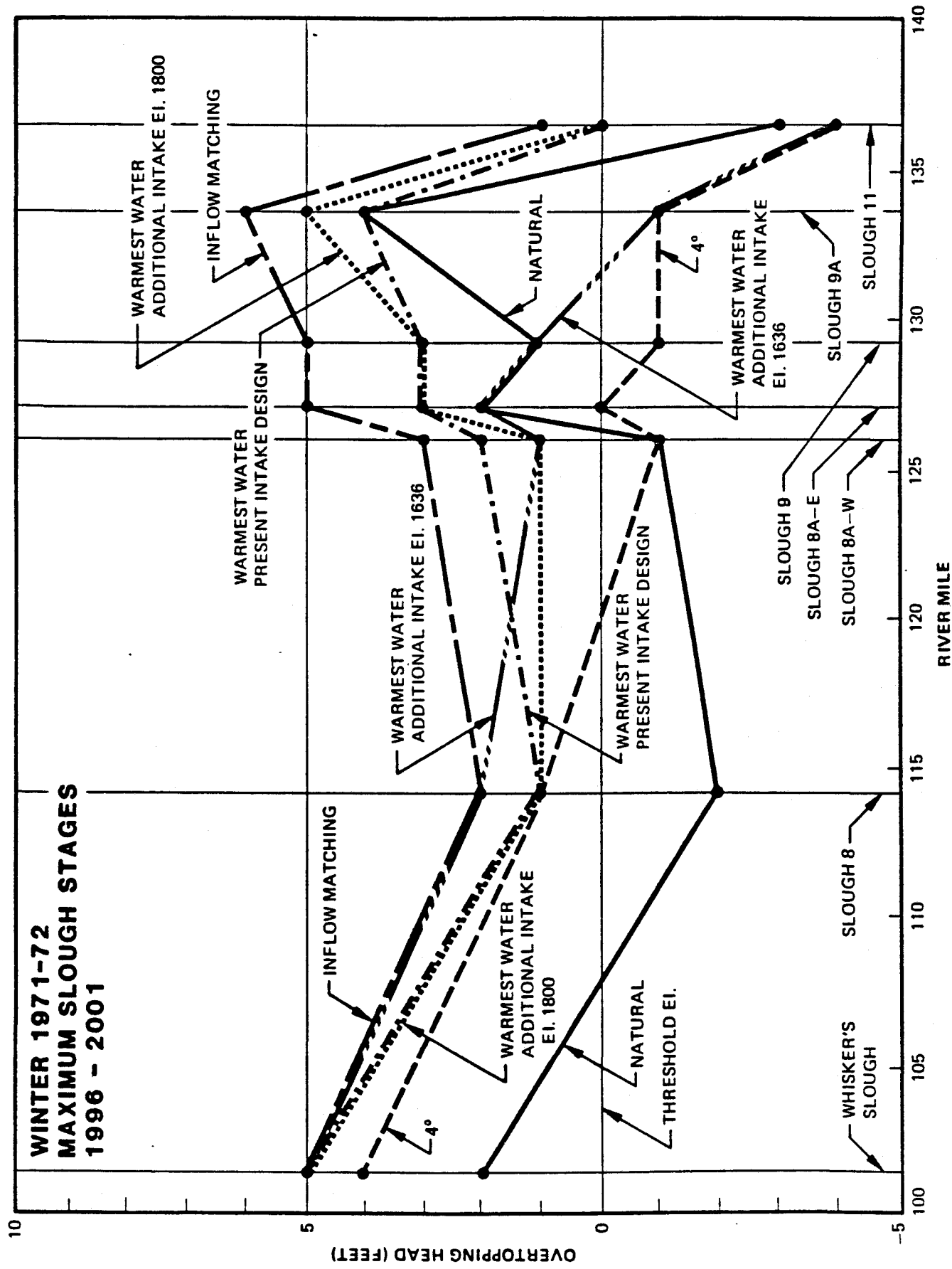
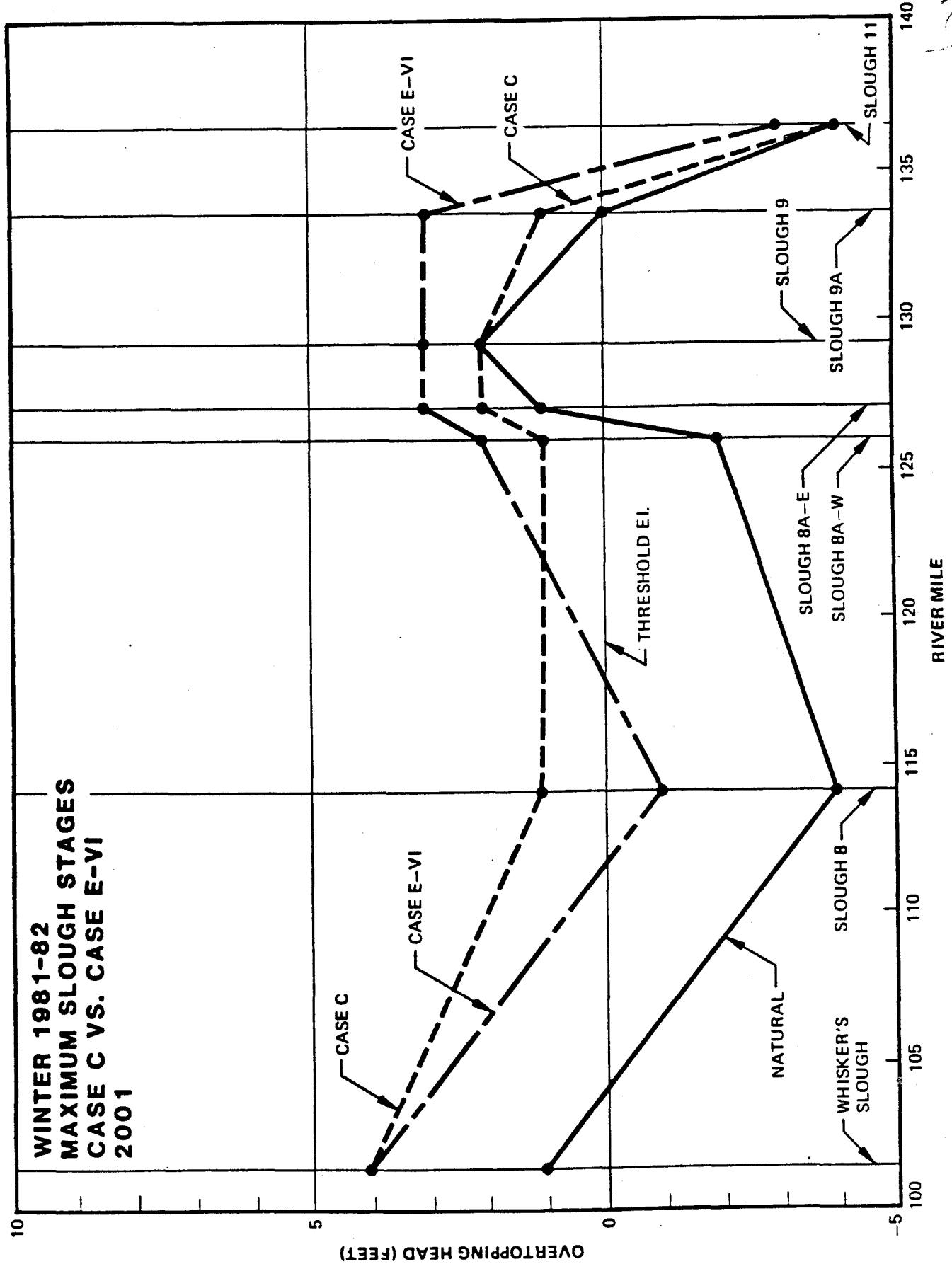
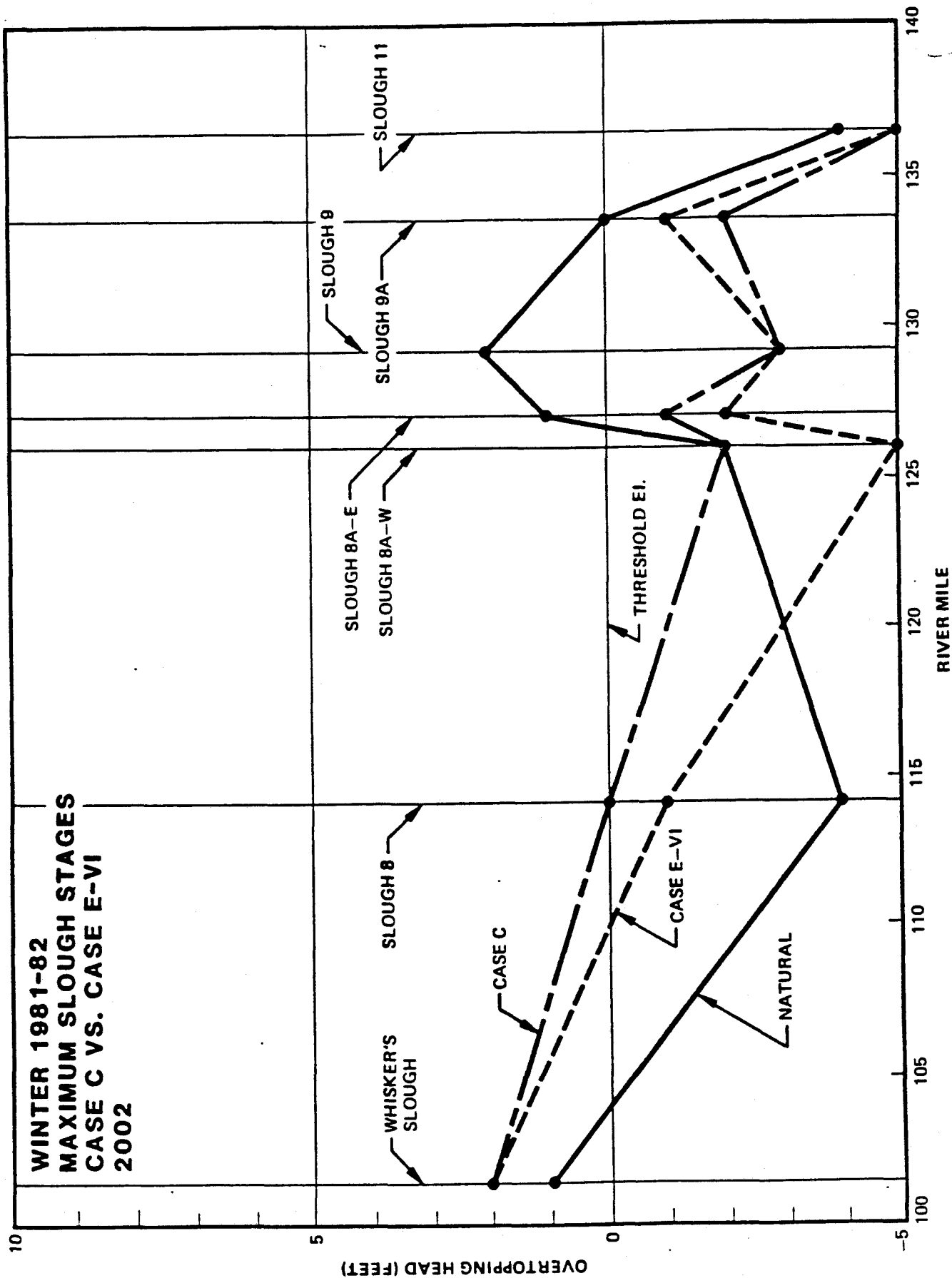
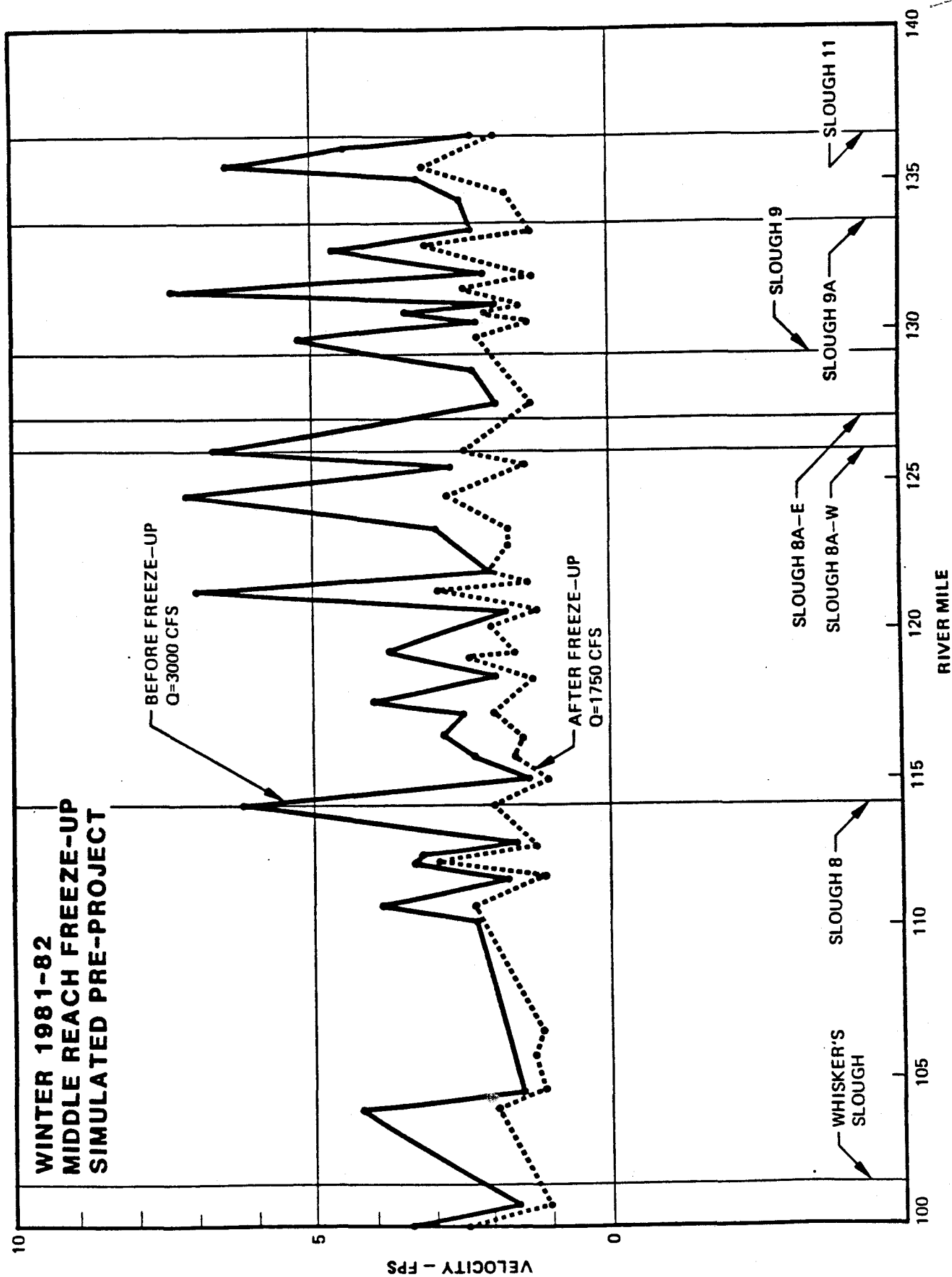


EXHIBIT 25
78

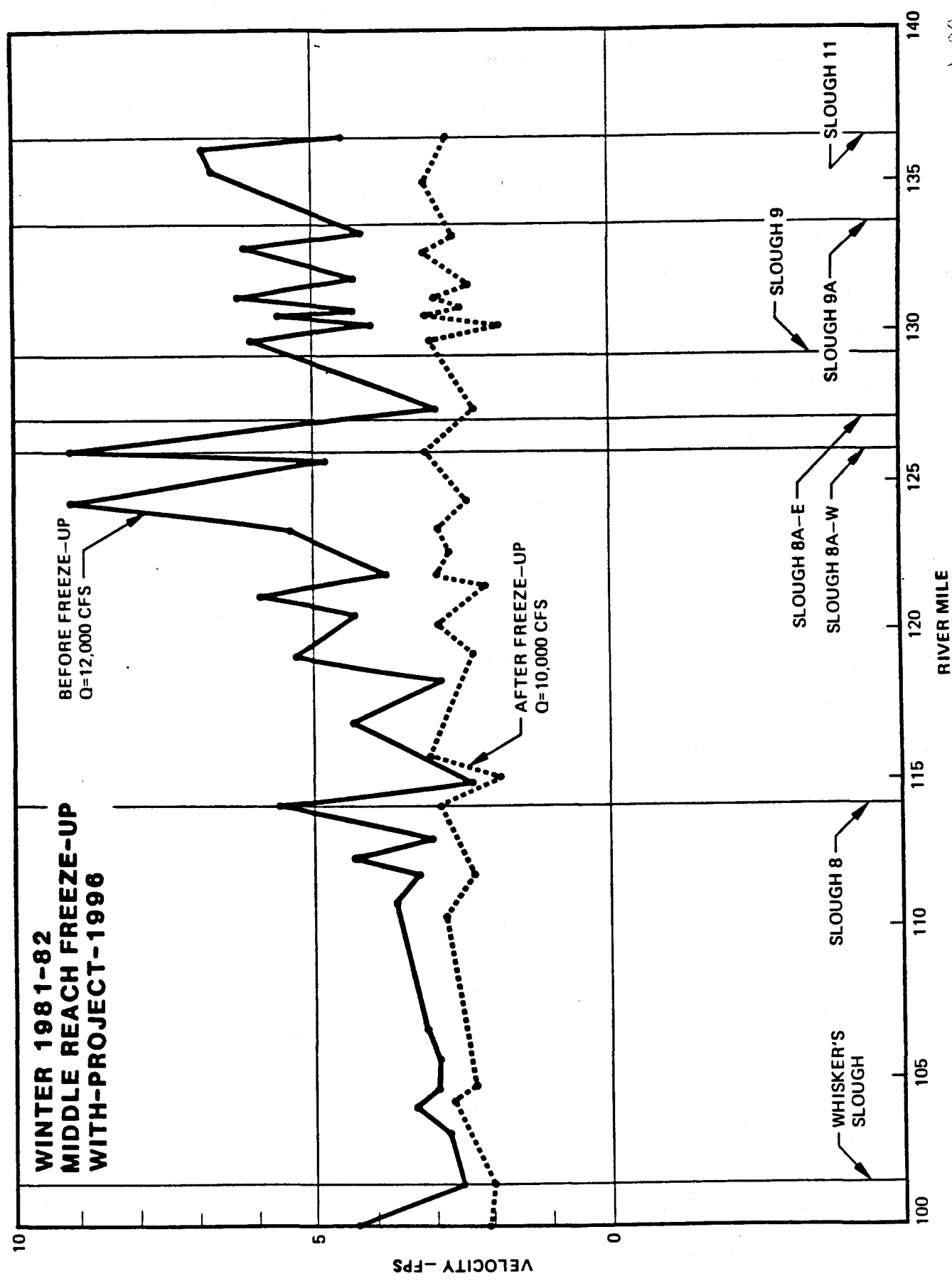
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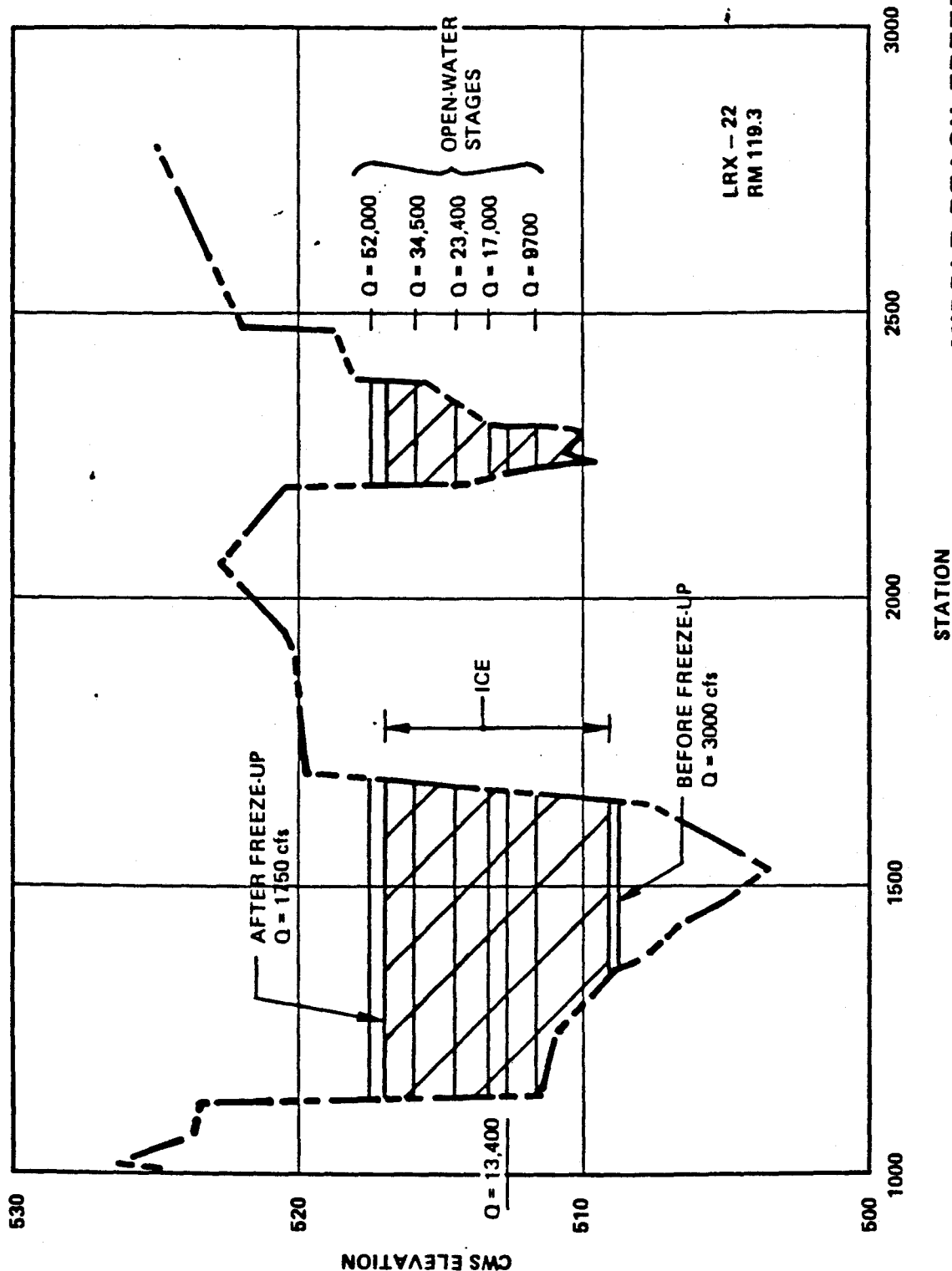




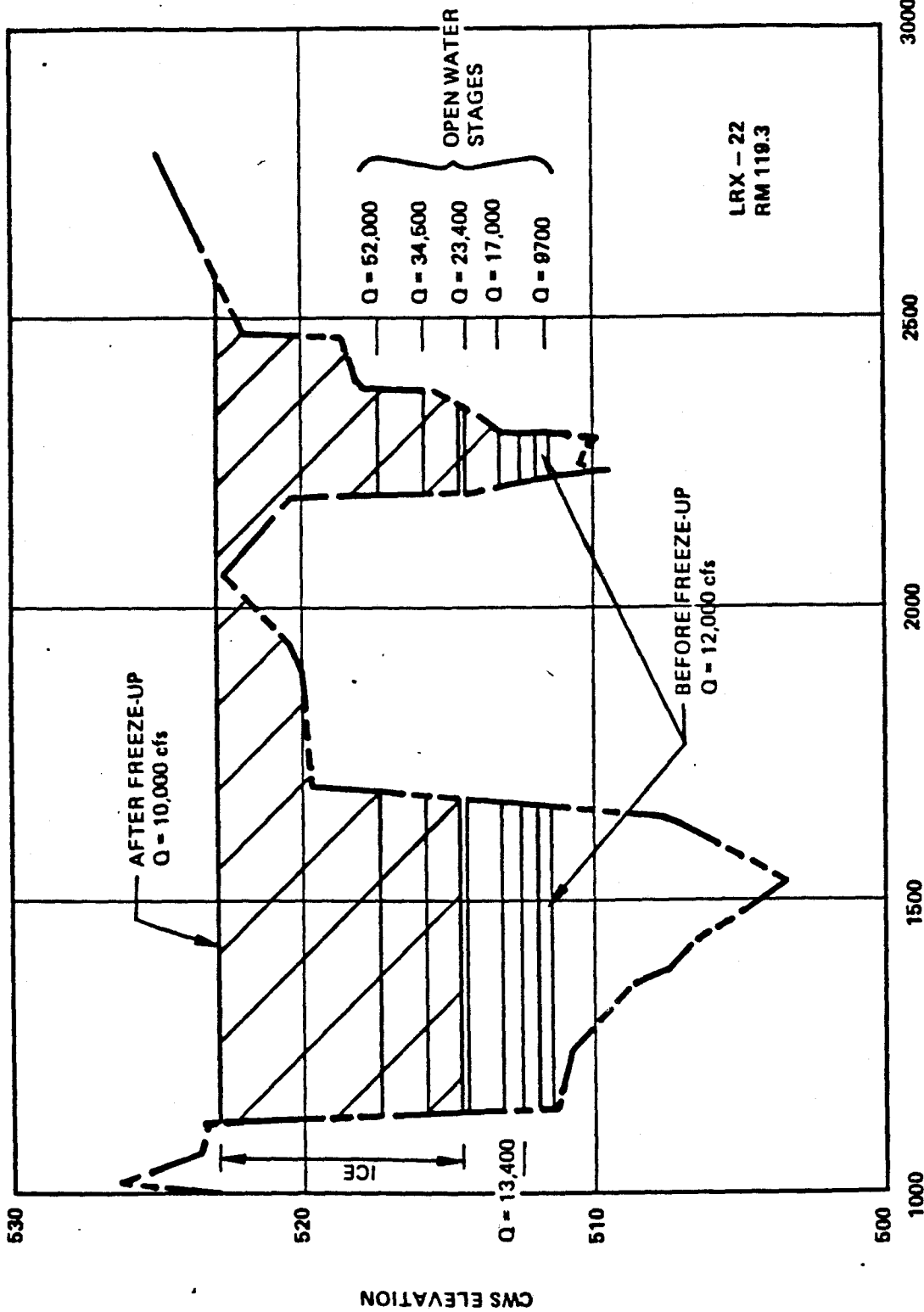
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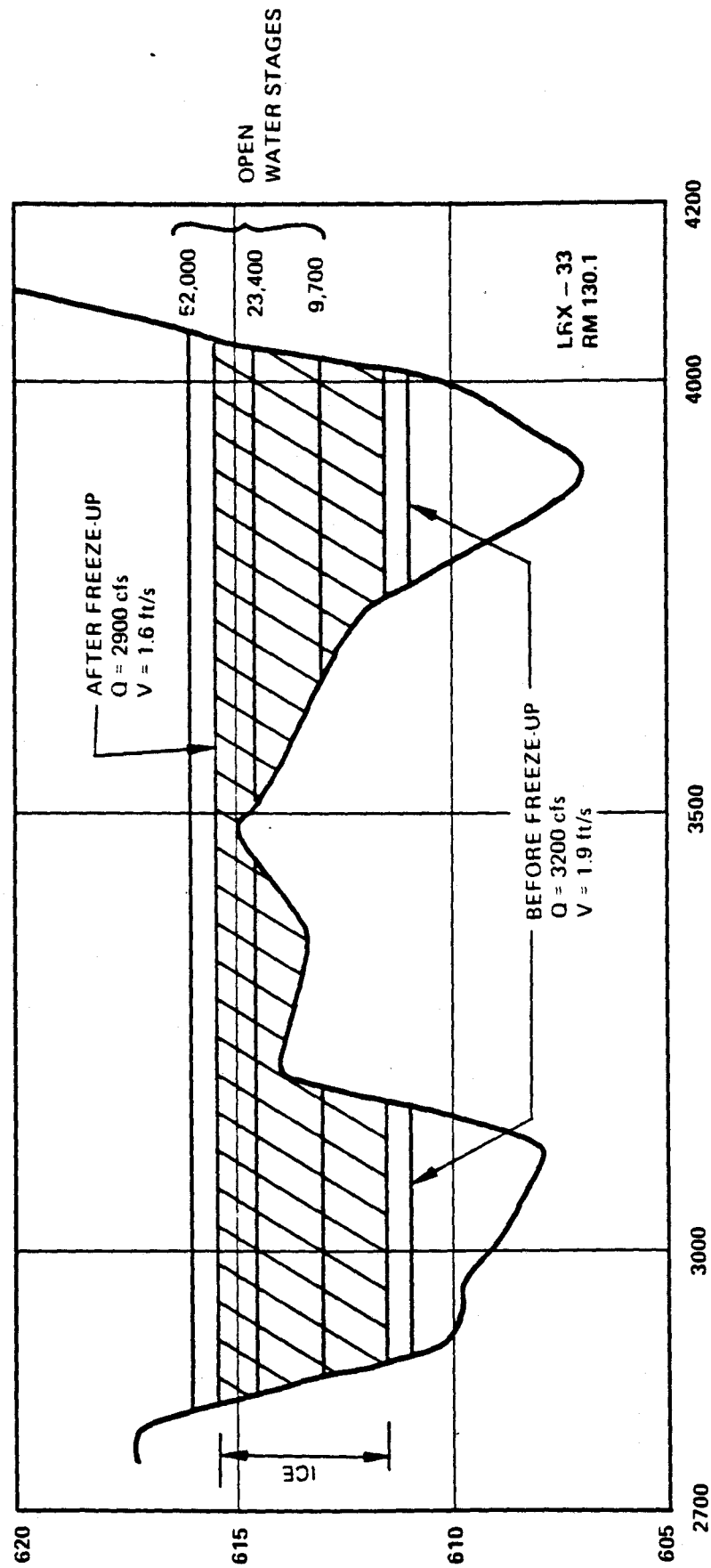


MIDDLE REACH FREEZE-UP
SIMULATED PRE-PROJECT
WINTER 1981-82



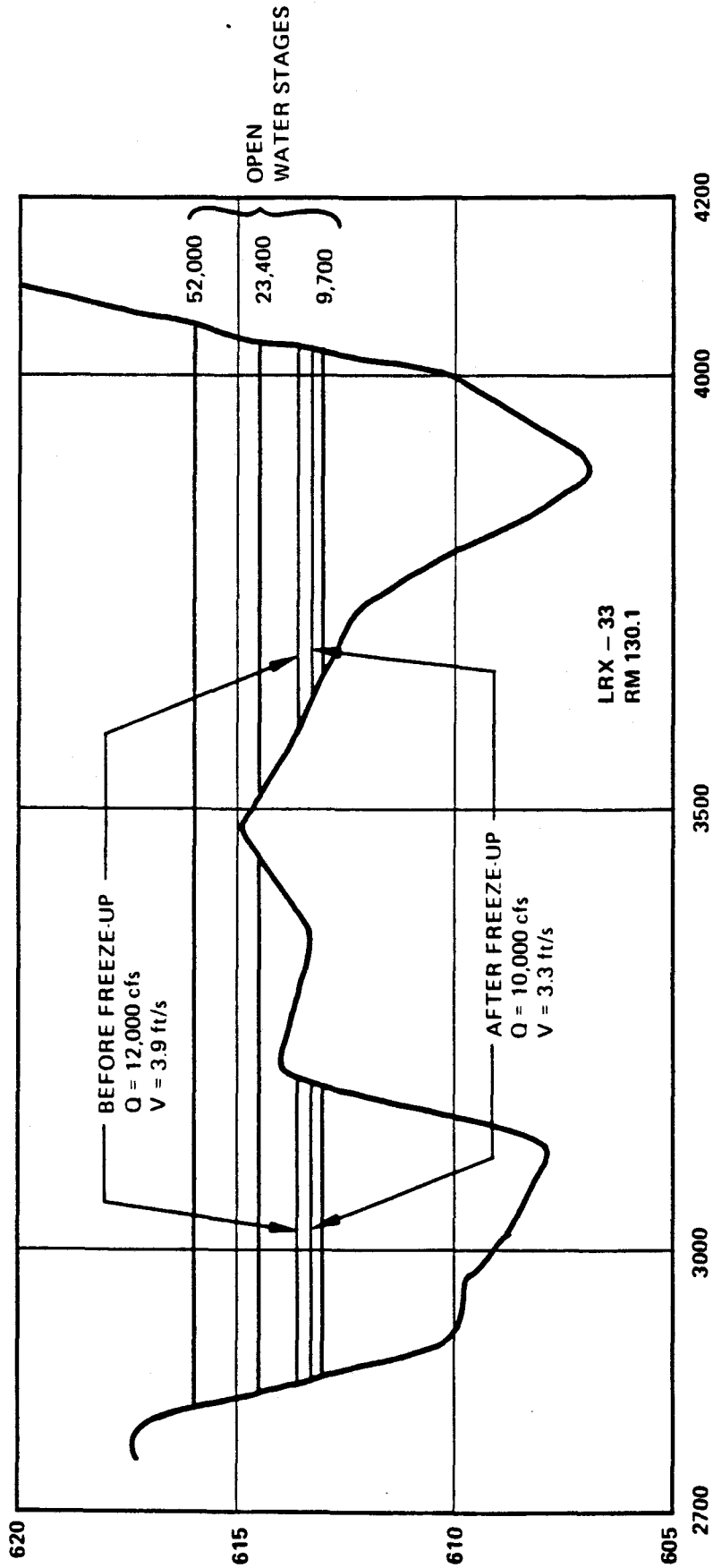
MIDDLE REACH FREEZE-UP
WITH PROJECT - 1996
WINTER 1981-82



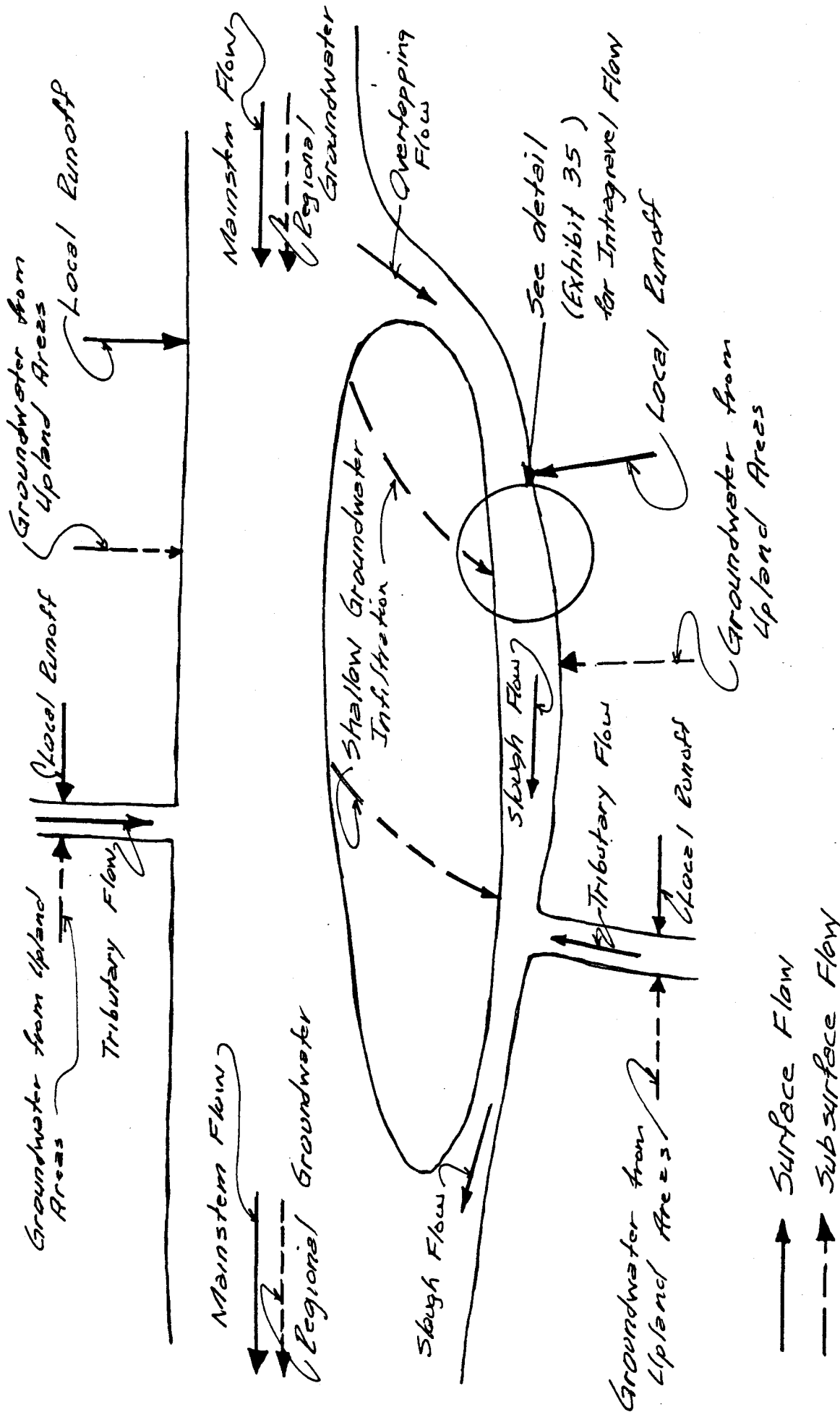


**MIDDLE REACH FREEZE-UP
SIMULATED PRE-PROJECT
WINTER 1982-83**

86

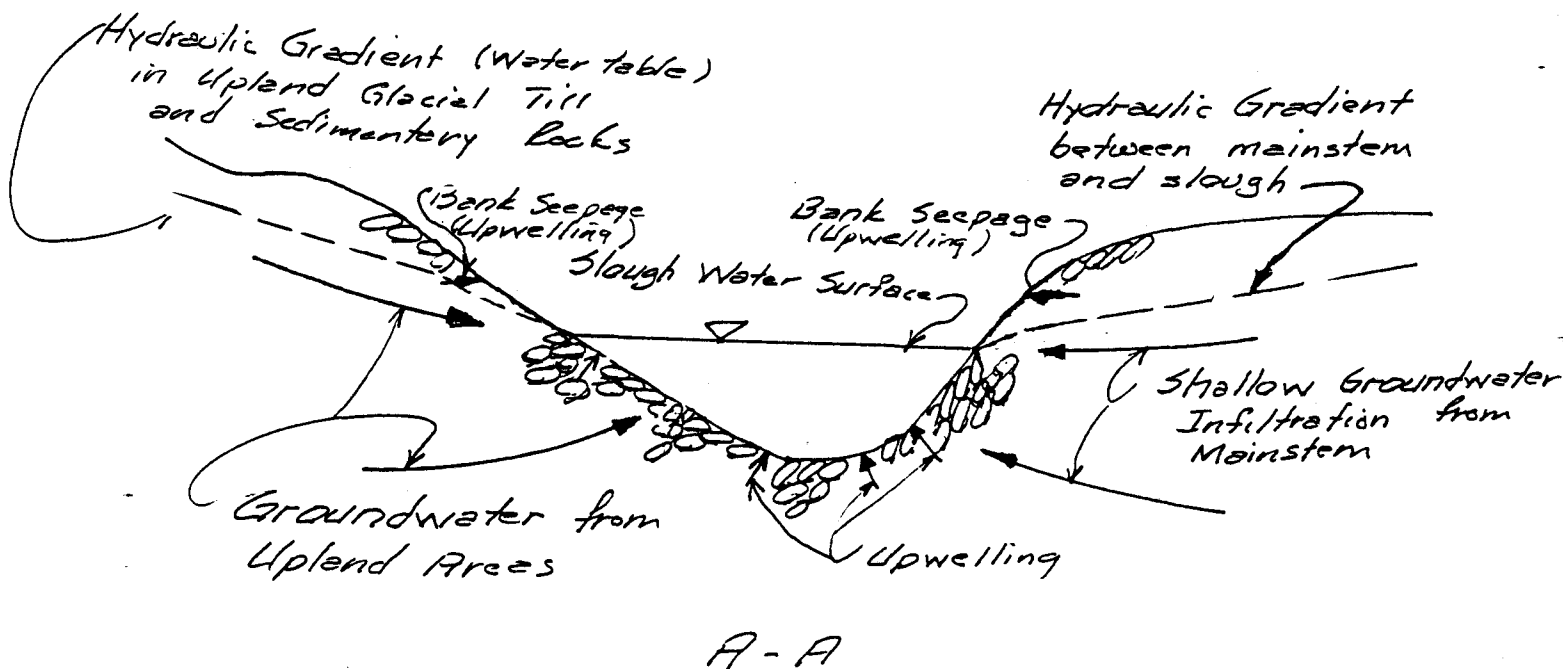
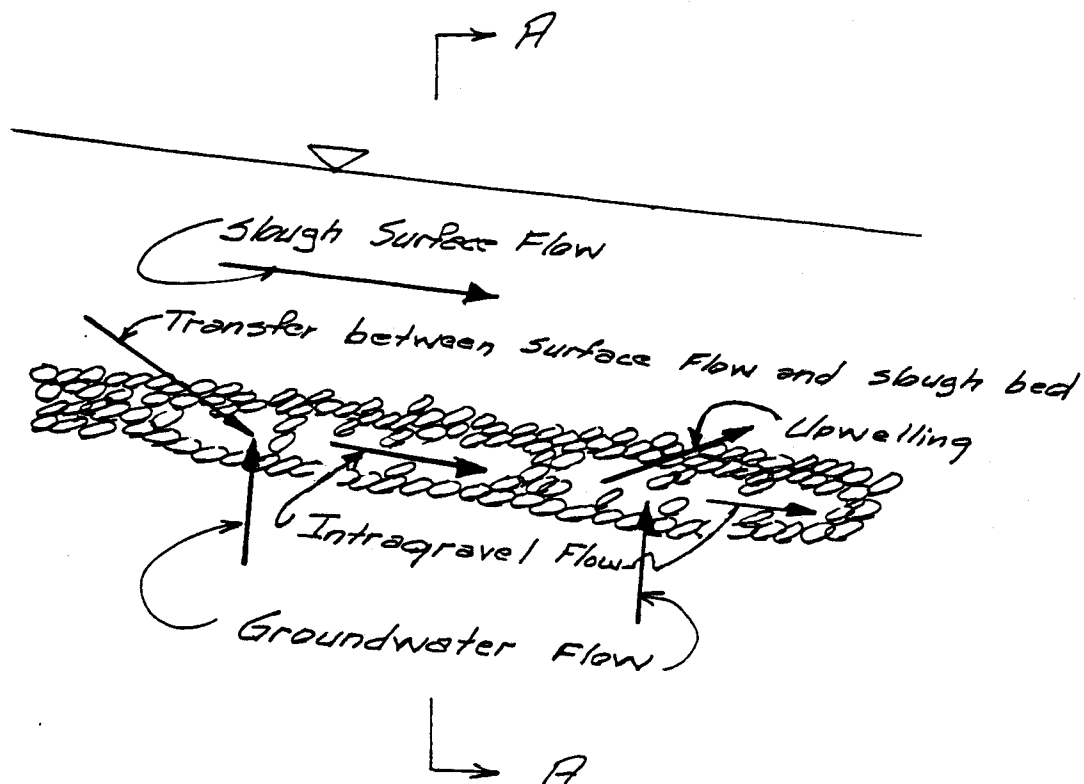


**MIDDLE REACH FREEZE-UP
WITH-PROJECT 1996
WINTER 1982-83**



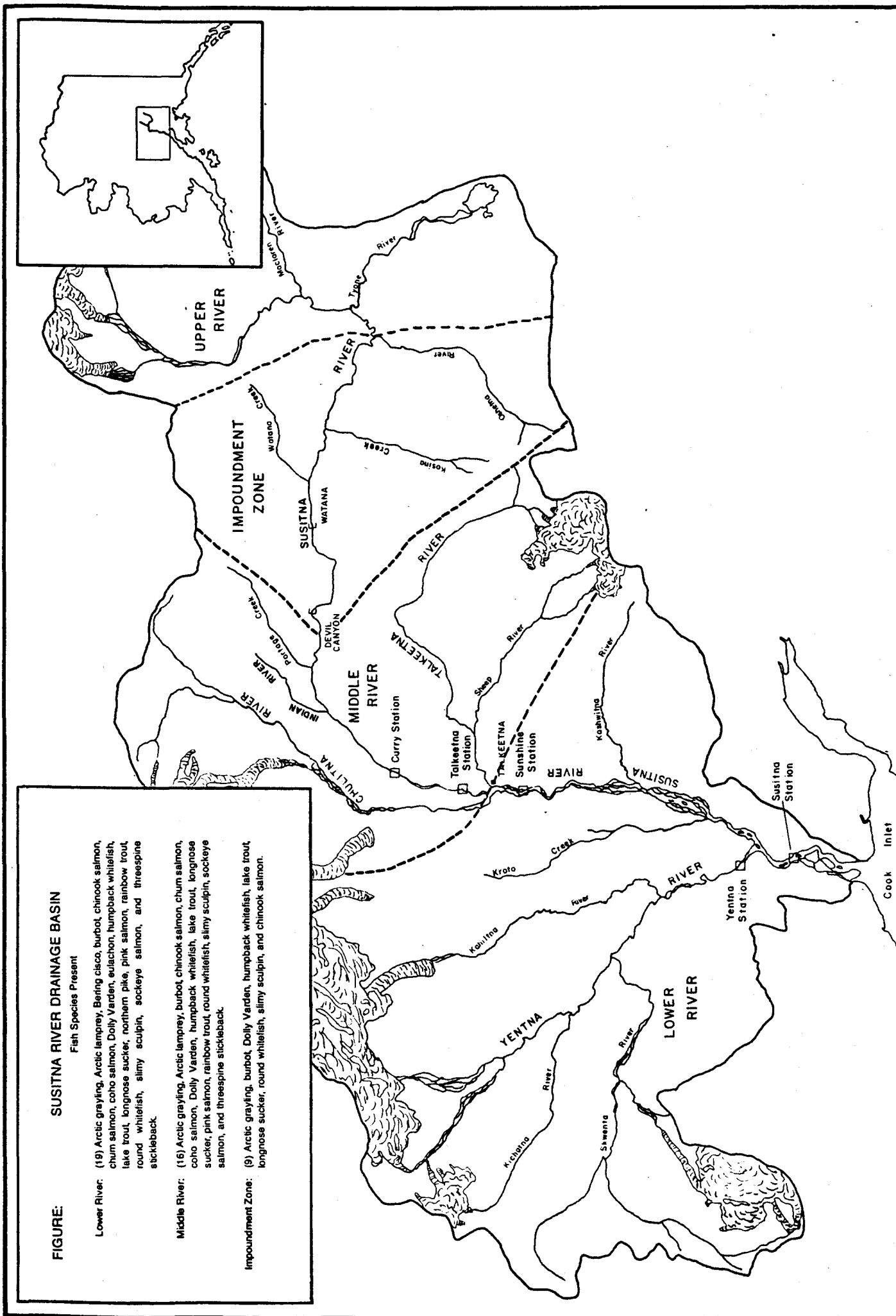
PLAN VIEW SHOWING FLOW COMPONENTS
TYPICAL SLOUGH

88



Detail Of Intragravel Flow
From Exhibit 34

Figure 2. Susitna River drainage Basin fish species life study zone



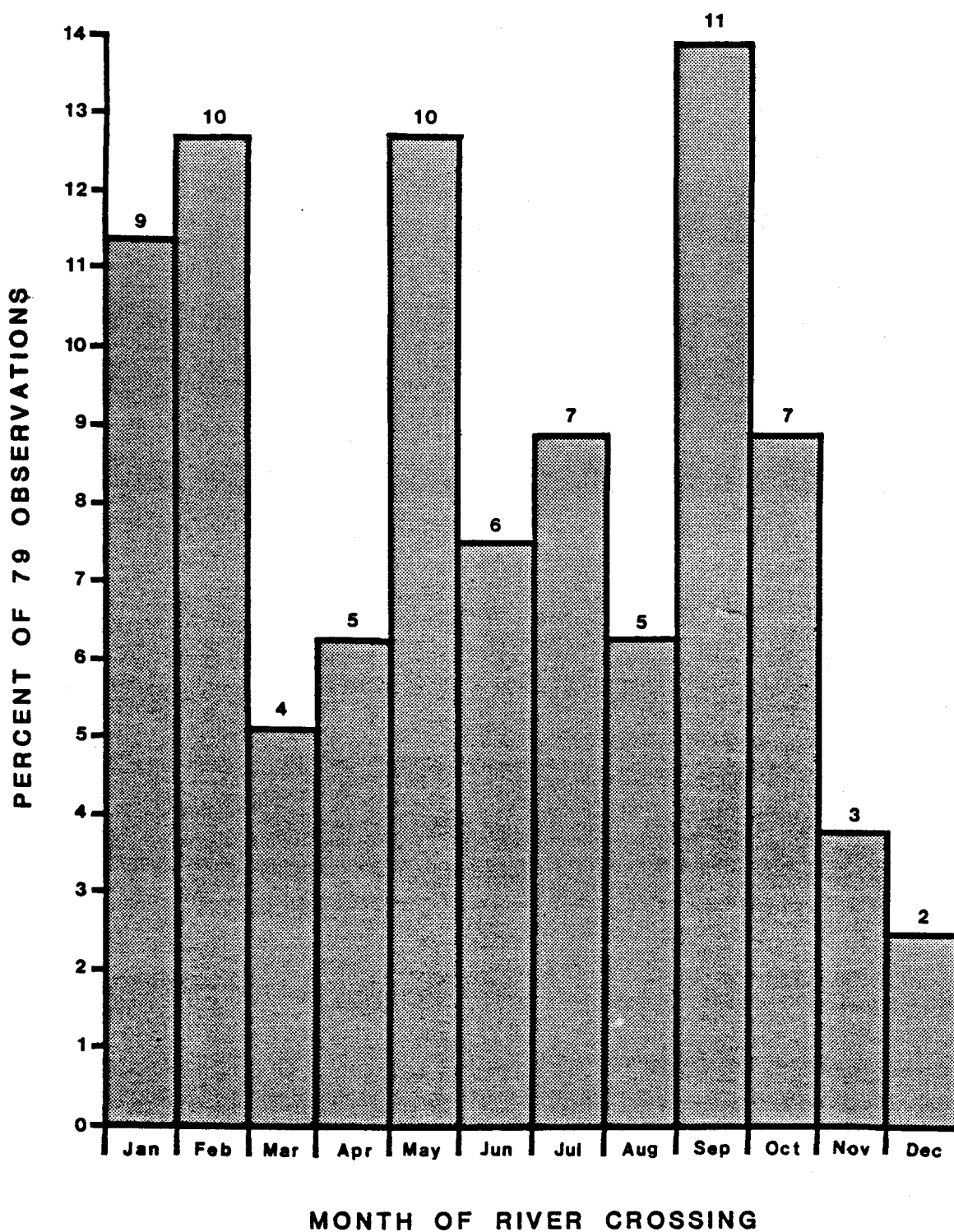


Figure 90. Timing of 79 crossings by moose of the middle Susitna River above Devil Canyon from April 1980 through December 1982 (Source: modified from data in Ballard et al. 1983a).

Figure 91. Population estimates for main Nelchima caribou herd (Sources: Plicher 1984, 1986; Lieb et al. 1985).

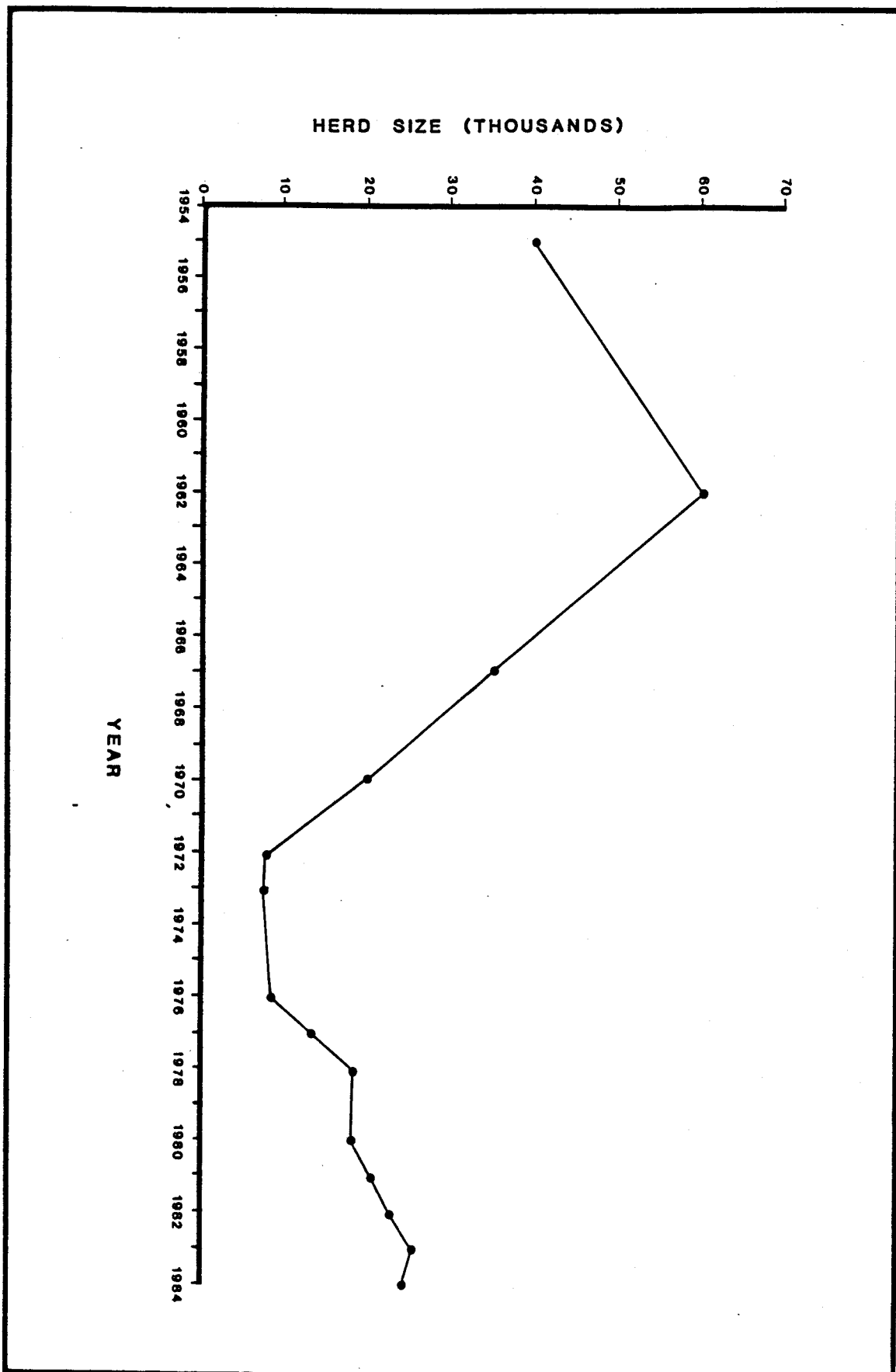
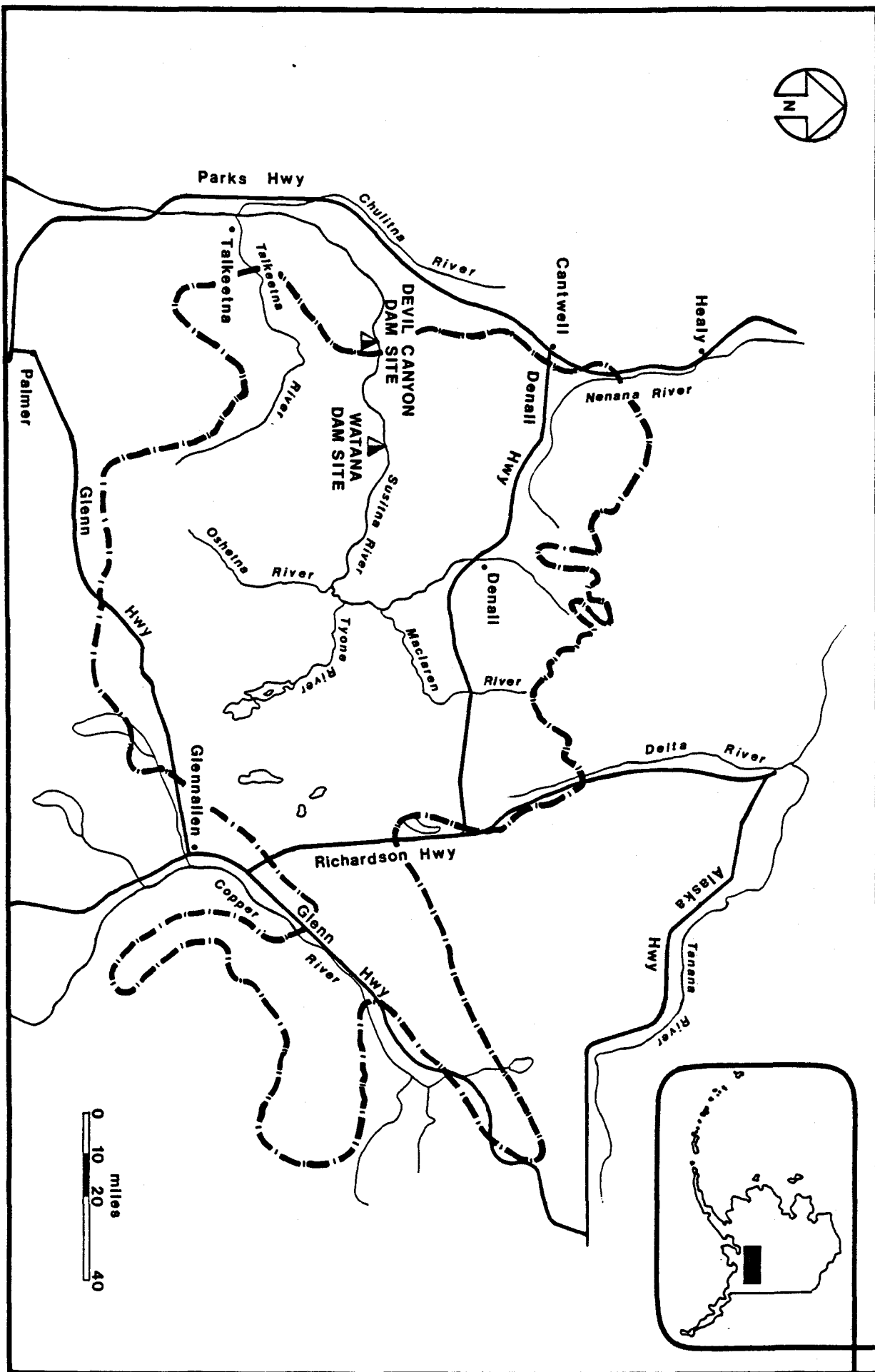


Figure 92. Historical range of the Nelchina caribou herd (Source: Hemming 1971).



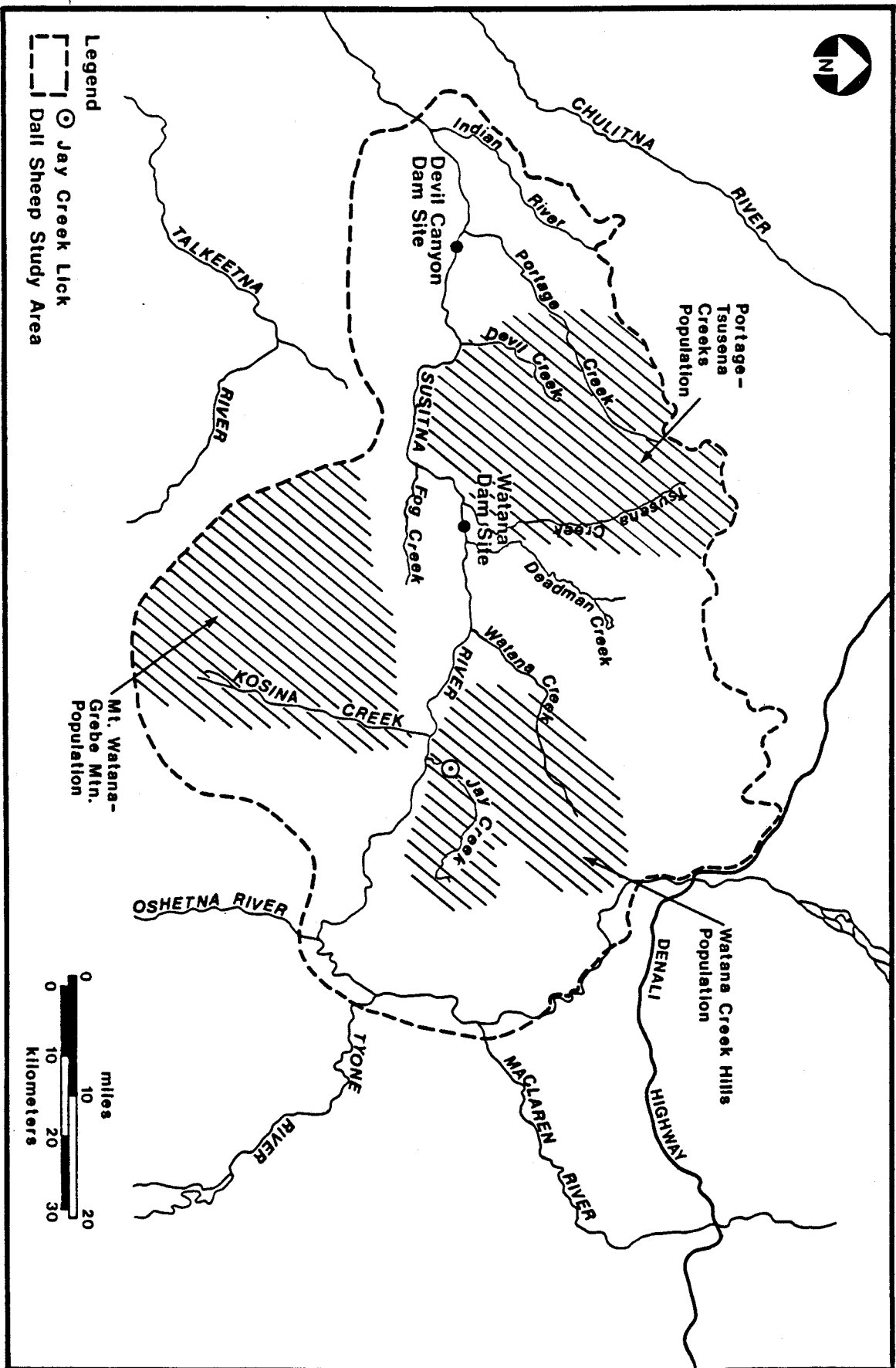


Figure 93. Dall sheep study area and local populations (Source: Tankersley 1984).

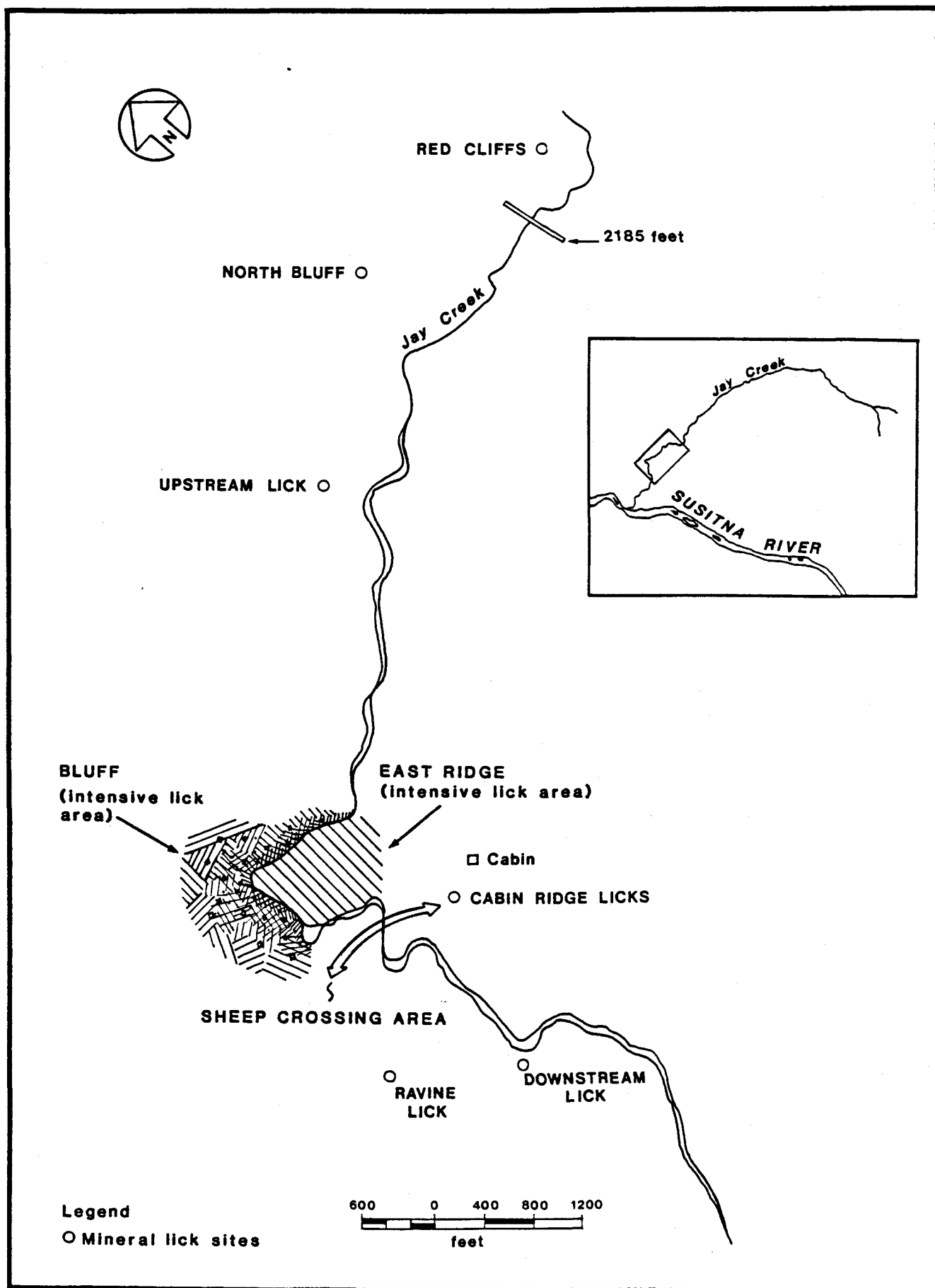


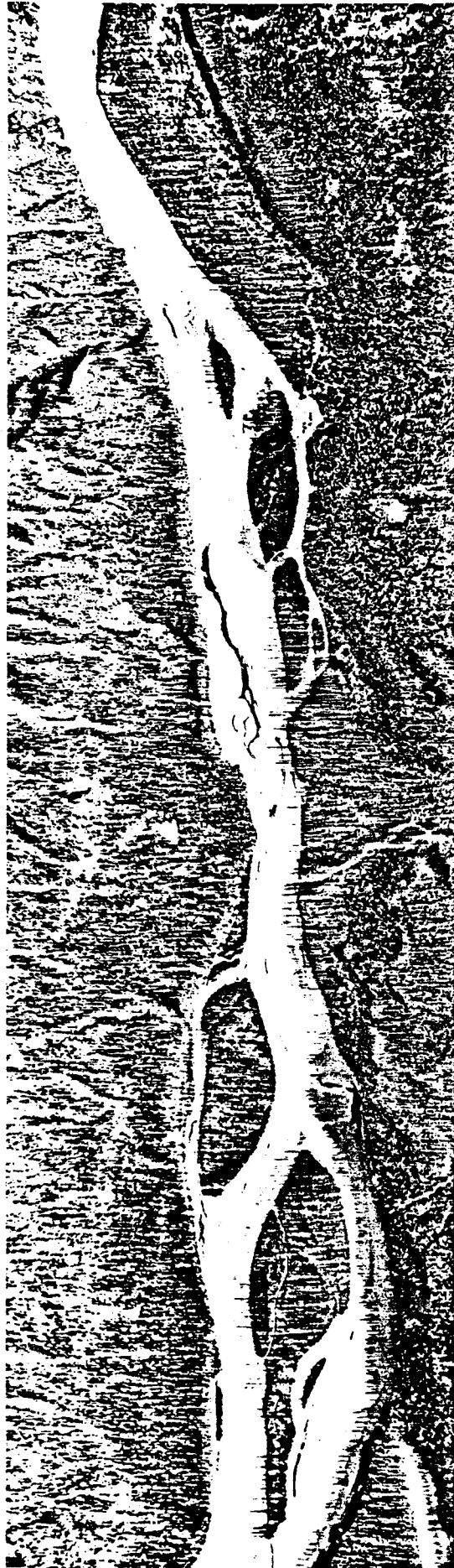
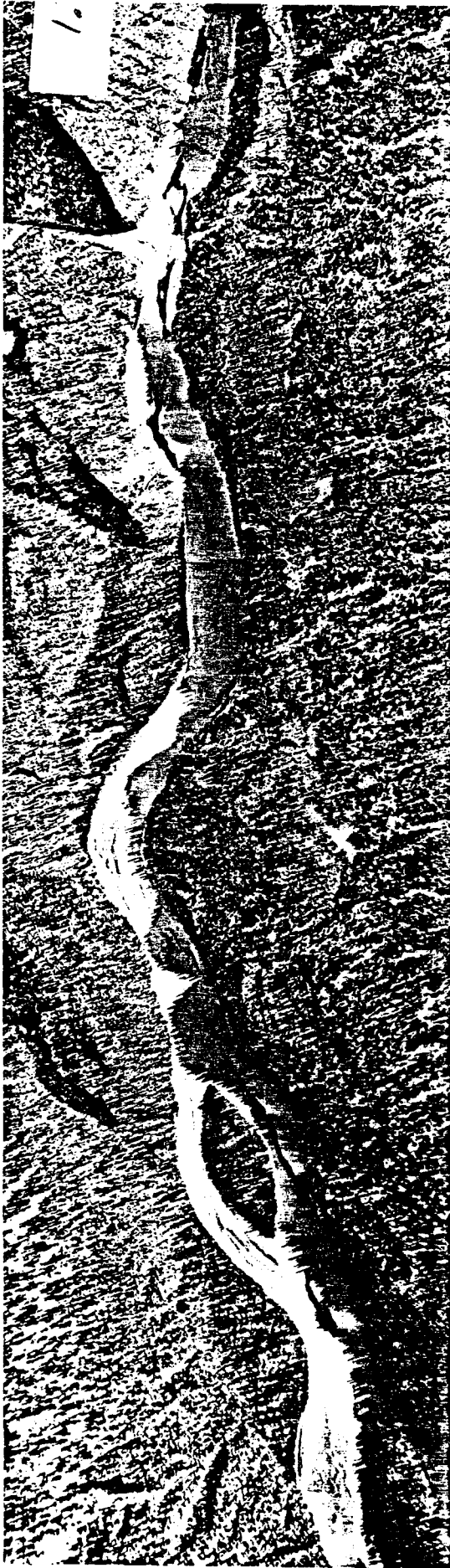
Figure 94. The Jay Creek mineral lick complex (Source: Tankersley 1984).

APPENDIX A

LOWER SUSITNA RIVER

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

APPENDIX B
MIDDLE SUSITNA RIVER



MIDDLE SUSITNA RIVER

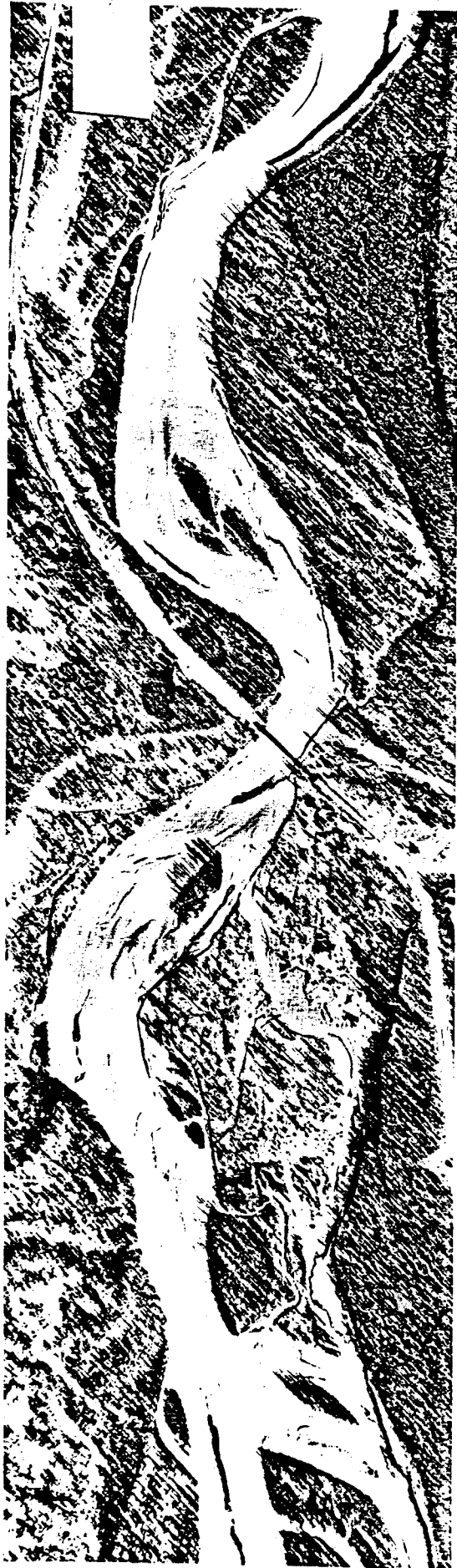
Top: River Mile 147 to 149

Bottom: River Mile 144 to 146

March 2, 1983 Scale: 1"=1000'



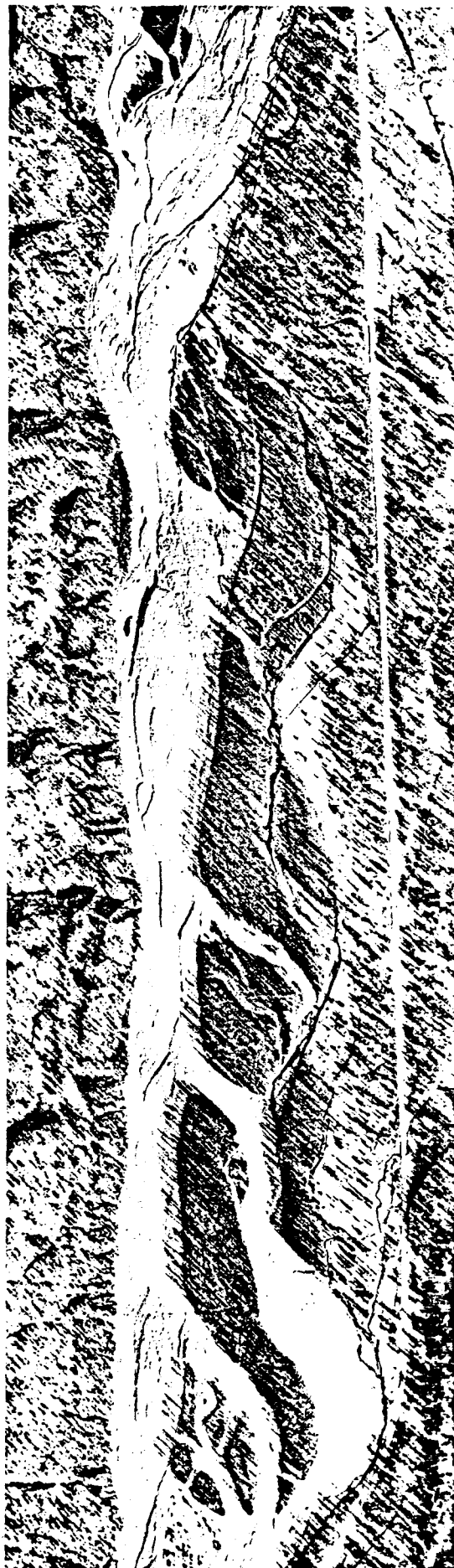
MIDDLE SUSITNA RIVER
Top: River Mile 142 to 144
Bottom: River Mile 139 to 141
March 2, 1983 Scale: 1"=1000'



MIDDLE SUSITNA RIVER
Top: River Mile 136 to 138
Bottom: River Mile 133 to 136
March 2, 1983 Scale: 1"=1000'



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'

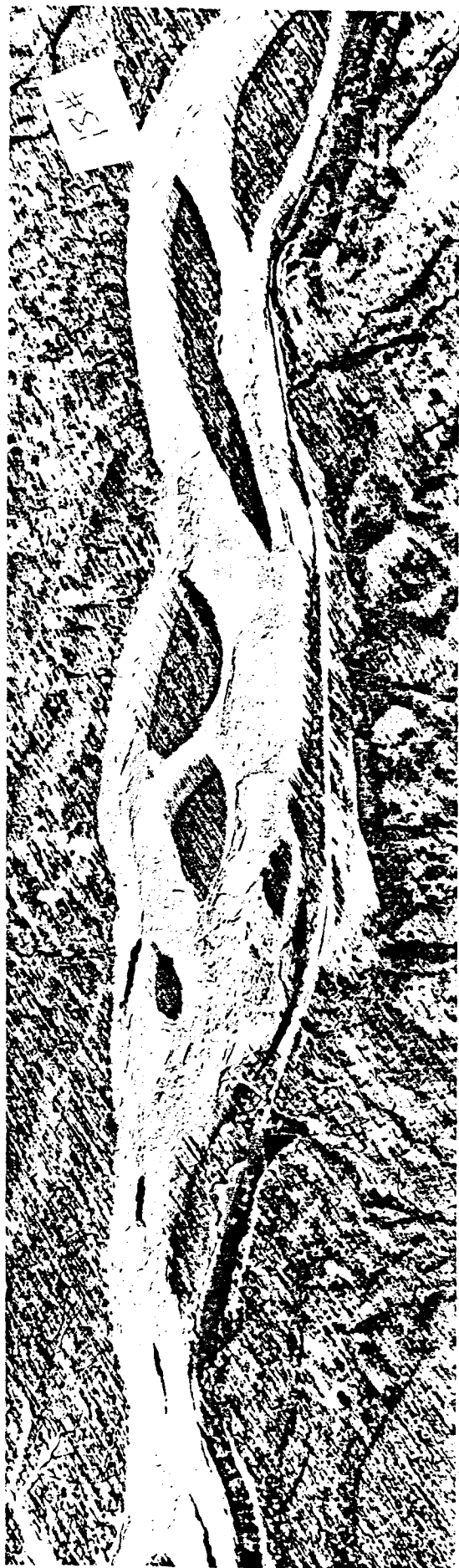


MIDDLE SUSITNA RIVER

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'