FLOOD PLAIN INFORMATION

LEVEL I

KUSKOKWIM RIVER. NW

BETHEL, ALASKA

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PREPARED FOR
THE CITY OF BETHEL
BY
CORPS OF ENGINEERS, U. S. ARMY
ALASKA DISTRICT
DEC [redacted] 68

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FLOOD HAZARD
PRINTOUT DEFINITIONS

Column Heading
Name - Self-explanatory
Longitude - " "
Latitude - " "
Type of Hazard is shown as one or more of the following conditions:

LJ - Ice jamming is a possible flood cause
SO - Stream overflow is a possible flood cause
CO - Coastal flooding would result from waves or tidal action
E - Erosion problems are possible or present.
LD - Local drainage maybe most serious problem
GL - Glaciation flooding is possible
TL - Local tsunami " "
TT - Telesiesmic tsunami " "
NO - No flooding problems

Frequency of flooding is given six catagories as follows:

Very High (VHIGH) means that flooding can be expected on a five-year frequency or more often.
High (HIGH) flooding can be expected in the 5-20 year frequency rang
High Average (HIAVE) flooding can be expected in the 20-40 year frequency range
Average (AVER) covers the 40-60 year frequency range
Low Average (LOAVE) includes the frequency range of 60-100 years
Low (LOW) indicates that flooding would occur on the average of less than once in 100 years
NOTE: All of the above refers to the most critical area of each community. It is hoped that as information is furnished to the critical areas that the property exposed to flooding will gradually reduce.

% relates to the percent of the community that will be flooded by the frequency indicated. Floods of lesser frequency will inundate greater percentages of the community. The percents shown are in increments of 10 only.
Qlty Info relates to the quality of the information provided. Ten possible ratings are provided from excellent (EXCL) down to very low (VLOW). EXCL means the best of information is available (such as a completed FPI report) while VLOW indicates almost no reliable information is available.
Maps this column receives a yes if maps to a scale of 1"=2000' or larger are availabe.
Flood Warn. Flood warning receives a yes if the weather bureau considers the existing system adequate. Many areas are being improved at this time.
Tsun. Warn. The tsunami warning column receives a yes if warning is available and needed. A DNA means that the area is not threatened by tsunami.
Comm. This column refers to tsunami warning. If communications are available on a 24-hour basis, the column received a yes. However, a no is shown if communications are not reliable.
Pop (population) self explanatory where known.
Studies refers to Flood Studies and their status as follows:

CSR - Corps survey report
CFPI - Corps flood plain information report
SCS SCS watershed survey
GS GS flood hazard report.
BR Reclamation project survey containing flood hazard info

S	State survey
L	Locally accomplished survey including flood hazard reports developed with Federal financial assistance
a	Study complete
b	Study active
c	Corps study authorized or SCS study application received, neither funded
d	No current study authorized or application received

Protection refers to flood protective works and their status as follows:

CE	Corps of Engineers project
SCS	Soil Conservation Service project
BR	Bureau of Reclamation project
S	State constructed project (providing significant degree of protection)
L	Locally constructed project (providing significant degree of protection)
COP	Cooperative project (any combination of above)
a	Project constructed (either local protection, reservoir, or combination; degree of protection undefined)
b	Project authorized, under construction (includes advance engineering and design)
c	Project authorized, not funded for construction or for advance engineering and design
d	Favorable project survey awaiting Congressional authorization
e	Project found economically or engineering unfeasible; date (year)

FP Regs. Refers to regulation as follows:

1	Flood Plain regulation adopted
2	Status of flood plain regulation unknown

FLOOD HAZARD INFORMATION - ALASKA DISTRICT -

ALL AREAS WITH STREAM OVERFLOW HAZARD--BY FREQUENCY,PERCENT FLOODED,QUALI

NAME	LONG	LAT	TYPE OF HAZARD	FLOOD FREQ	%	QLT INF
BETHEL	161 45	60 48	IJ,SO, , E, , , , ,	VHIGH	30	EXC
NAPAKIAK	161 57	60 42	IJ,SO, , E, , , , ,	VHIGH	80	GOO
NAPASKIAK	161 54	60 42	IJ,SO, , E, , , , ,	VHIGH	80	GOO
EMMONAK	164 31	62 46	IJ,SO, , , , , , ,	VHIGH	100	GOO
KOYUKUK	157 42	64 51	IJ,SO, , , , , , ,	VHIGH	100	GOO
LOWER KALSKAG	160 21	61 31	IJ,SO, , , , , , ,	VHIGH	100	GOO
MINTO	149 11	64 52	IJ,SO, , , , , , ,	VHIGH	100	GOO
ALAKANUK	164 37	62 41	IJ,SO, , E, , , , ,	VHIGH	100	HFA
SHELDON POINT	164 52	62 32	IJ,SO, , , , , , ,	VHIGH	100	HFA
HYDER	130 01	55 55	,SO, , , , ,TL, ,	VHIGH	UNK	VGO
KENAI	151 16	60 33	IJ,SO, , E, ,GL, ,TT,	HIGH	10	EXC
SOLDOTNA	151 03	60 29	IJ,SO, , , , , , ,	HIGH	10	EXC
ANCHORAGE	149 54	61 13	IJ,SO,CO, , ,GL, ,TT,	HIGH	10	VGO
SEWARD	149 27	60 07	,SO,CO, , , ,TL,TT,	HIGH	10	HFA
FAIRBANKS	147 43	64 51	IJ,SO, , E, , , , ,	HIGH	30	EXC
NULATO	158 04	64 45	IJ,SO, , , , , , ,	HIGH	30	GOO
PILOT STATION	162 54	61 55	IJ,SO, , , , , , ,	HIGH	30	HFA
ANIAK	159 40	61 45	IJ,SO, , , , , , ,	HIGH	40	HFA
ANVIK	160 12	62 38	IJ,SO, , , , , , ,	HIGH	50	HFA
RAMPART	150 10	65 30	IJ,SO, , , , , , ,	HIGH	50	AVE
GIRDWOOD	149 10	60 57	,SO, , , ,GL, , ,	HIGH	60	VGO
NENANA	149 06	64 34	IJ,SO, , E, , , , ,	HIGH	80	GOO
AKIACHAK	161 26	60 55	IJ,SO, , E, , , , ,	HIGH	80	HFA
GALENA	156 55	64 45	IJ,SO, , , , , , ,	HIGH	80	HFA
KWETHLUK	161 27	60 50	IJ,SO, , , , , , ,	HIGH	80	HFA
MCGRATH	155 35	62 58	IJ,SO, , , , , , ,	HIGH	80	FAI
RED DEVIL	157 18	61 46	IJ,SO, , , , , , ,	HIGH	80	FAI
KWIGILLINGOK	163 08	59 51	,SO,CO, , , , , ,	HIGH	100	HFA
SLEETMUTE	157 10	61 42	IJ,SO, , , , , , ,	HIGH	100	HFA
NAGOSAKCHOWIK	164 57	62 31	,SO,CO, , , , , ,	HIGH	100	VPO
COPPER CENTER	145 20	61 55	IJ,SO, , , ,GL, , ,	HIGH	UNK	HFA
UGASHIK	157 24	57 31	,SO, , , , , , ,	HIGH	UNK	POO
PLATINUM	161 49	59 00	,SO, , , , , , ,	HIGH	UNK	VPO
ALLAKAKET	152 40	66 34	,SO, , , , , , ,	HIGH	UNK	VLO
SPENARD	149 55	61 11	IJ,SO, , ,LD,GL, , ,	HIAVE	10	VGO
FORT YUKON	145 18	66 34	IJ,SO, , , , , , ,	HIAVE	20	HFA
CROOKED CREEK	158 06	61 52	IJ,SO, , , , , , ,	HIAVE	20	FAI
MANLEY HOT SPRINGS	150 40	65 00	IJ,SO, , , , , , ,	HIAVE	20	FAI
KALSKAG	160 18	61 32	IJ,SO, , , , , , ,	HIAVE	30	HFA
AKIAK	161 12	60 55	IJ,SO, , , , , , ,	HIAVE	40	HFA
TOLUKSAK	160 57	61 04	IJ,SO, , , , , , ,	HIAVE	100	HFA
STONY RIVER	156 36	61 46	IJ,SO, , , , , , ,	HIAVE	100	FAI
EEK	162 01	60 12	,SO, , , , , , ,	HIAVE	100	POO
SKAGWAY	135 19	59 27	,SO,CO, , , ,TL, ,	HIAVE	UNK	FAI
EKWOK	157 28	59 21	,SO, , , , , , ,	HIAVE	UNK	POO
CHALKYITSIK	143 43	66 39	,SO, , , , , , ,	HIAVE	UNK	VPO

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ODED.QUALITY.

OD O	%	QLTY INFO	MAP	FLOOD WARN	TSUN WARN	COMM	POP	STUDIES		PROTECTION		FP REGS
GH	30	EXCL	YES	NO	DNA		1750	CSRB	FPIB			2
GH	80	GOOD	NO	NO	DNA		279		D			2
GH	80	GOOD	NO	NO	DNA		188		D			2
GH	100	GOOD	YES	NO	DNA		414	CSR			L	2
GH	100	GOOD	NO	NO	DNA		125		D			2
GH	100	GOOD	YES	NO	DNA		169		D			2
GH	100	GOOD	NO	NO	DNA		202		D			2
GH	100	HEAR	YES	NO	DNA		447		D	L		2
GH	100	HEAR	NO	NO	DNA		117		D			2
GH	UNK	VGOD	NO	NO	YES	NO	32	CSR	FPI	CE	CE	2
GH	10	EXCL	YES	NO	YES	YES		FPIA		CEE		3
GH	10	EXCL	YES	NO	DNA			FPIA				2
GH	10	VGOD	YES	NO	YES	YES	138000	FPIA	FPIC			3
GH	10	HEAR	NO	NO	YES	YES		CSRA	FPIC	CEE		2
GH	30	EXCL	YES	YES	DNA		19648	CSRA	FPIA	CEA	CED	3
GH	30	GOOD	YES	NO	DNA		307		D			2
GH	30	HEAR	NO	NO	DNA		273		D			2
GH	40	HEAR	NO	NO	DNA		240	CSR	A	S P	L	2
GH	50	HEAR	NO	NO	DNA		125		D			2
GH	50	AVER	NO	NO	DNA		47		D			2
GH	60	VGOD	NO	NO	DNA			FPIC		S A		2
GH	80	GOOD	YES	NO	DNA		470	CSRB		L A		2
GH	80	HEAR	YES	NO	DNA		311		D			2
GH	80	HEAR	YES	NO	DNA		298	CSRA	CSRA	CEA	CEE	2
GH	80	HEAR	YES	NO	DNA		402		D			2
GH	80	FAIR	NO	NO	DNA		200	CSRA	CSRA		E	2
GH	80	FAIR	NO	NO	DNA		25		D			2
GH	100	HEAR	NO	NO	DNA		337		D			2
GH	100	HEAR	NO	NO	DNA		127		D			2
GH	100	VPOR	NO	NO	DNA				D			2
GH	UNK	HEAR	NO	NO	DNA		150	CSRB		CEB	L	2
GH	UNK	POOR	NO	NO	DNA				D			2
GH	UNK	VPOR	NO	NO	DNA		80		D			2
GH	UNK	VLOW	NO	NO	DNA		158		D			2
AVE	10	VGOD	YES	NO	DNA		9700	FPIA				3
AVE	20	HEAR	NO	NO	DNA		650	CSRA	CSRB	CED	CEA	2
AVE	20	FAIR	NO	NO	DNA		79		D		NO	2
AVE	20	FAIR	NO	NO	DNA		42		D			2
AVE	30	HEAR	YES	NO	DNA		167		D			2
AVE	40	HEAR	NO	NO	DNA		179		D			2
AVE	100	HEAR	NO	NO	DNA		176		D			2
AVE	100	FAIR	YES	NO	DNA		2 145		D			2
AVE	100	POOR	NO	NO	DNA		197		D			2
AVE	UNK	FAIR	NO	NO	YES	YES	650	CSRA	CSRA	CEE		2
AVE	UNK	POOR	YES	NO	DNA		100		D			2
AVE	UNK	VPOR	YES	NO	DNA		96		D		NO	2

FLOOD HAZARD INFORMATION - ALASKA DISTRICT -

ALL AREAS WITH STREAM OVERFLOW HAZARD--BY FREQUENCY, PERCENT FLOODED, QUALIT

NAME	LONG	LAT	TYPE OF HAZARD	FLOOD FREQ	%	QLTY INFO
CHEVAK	165 35	61 32	IJ,SO, , , , , , ,	HIAVE	UNK	VPOR
BEAVER	147 23	66 21	IJ,SO, , , , , , ,	HIAVE	UNK	LOW
BIRCH CREEK	145 48	66 15	IJ,SO, , , , , , ,	HIAVE	UNK	LOW
BLACK	165 20	62 20	IJ,SO, , , , , , ,	HIAVE	UNK	LOW
BUCKLAND	161 08	65 59	,SO, , , , , , ,	HIAVE	UNK	LOW
CANYON VILLAGE	143 10	66 50	,SO, , , , , , ,	HIAVE	UNK	LOW
JUNEAU	134 25	58 18	,SO,CO, , , ,TL, ,	AVER	10	GOOD
KETCHIKAN	131 39	55 21	,SO,CO, , , ,TL,TT,	AVER	10	HEAR
MARSHALL	162 06	61 53	IJ,SO, , , , , , ,	AVER	20	FAIR
MOUNTAIN VILLAGE	163 44	62 05	IJ,SO, , , , , , ,	AVER	20	AVER
EAGLE	141 10	64 48	IJ,SO, , , , , , ,	AVER	20	POOR
GEORGETOWN	157 43	61 54	IJ,SO, , , , , , ,	AVER	20	POOR
TALKEETNA	150 06	62 19	IJ,SO, , , , , , ,	AVER	UNK	AVER
LEVELOCK	156 51	59 07	,SO, , , , , , ,	AVER	UNK	POOR
RUSSIAN MISSION	161 19	61 48	IJ,SO, , , , , , ,	AVER	UNK	POOR
STEVENS	149 05	66 02	IJ,SO, , , , , , ,	AVER	UNK	POOR
KOYUK	161 10	64 55	,SO,CO, , , , , ,	AVER	UNK	VPOR
NOME	165 27	64 31	IJ,SO,CO, , , , , ,	AVER	UNK	VPOR
NEW STUYAHOK	157 20	59 29	,SO, , , , , , ,	AVER	UNK	LOW
NIGHTMUTE	164 44	60 28	,SO, , , , , , ,	AVER	UNK	LOW
ALEKNAGIK	158 35	59 15	IJ,SO, , , , , , ,	AVER	UNK	VLOW
HOLY CROSS	159 47	62 11	IJ,SO, , , , , , ,	LOAVE	10	POOR
PETERSBURG	132 58	56 48	,SO,CO, , , , ,TT,	LOAVE	10	POOR
BIG DELTA	145 51	64 09	,SO, , E, , , , ,	LOAVE	100	GOOD
NORTH POLE	147 21	64 45	,SO, , , , , , ,	LOAVE	100	AVER
HOOPER BAY	166 08	61 29	,SO, , ,LD, , , ,	LOAVE	100	VPOR
DELTA JUNCTION	145 44	64 00	,SO, , E, , , , ,	LOAVE	UNK	AVER
WILLOW	150 02	61 45	,SO, , , , , , ,	LOAVE	UNK	AVER
SOUTH NAKNEK	157 01	58 43	,SO,CO, E, , , , ,	LOAVE	UNK	POOR
MOOSE PASS	149 22	60 29	,SO, , ,LD, , , ,	LOAVE	UNK	VPOR
NABESNA	143 00	62 22	,SO, , ,LD, , , ,	LOAVE	UNK	VPOR
NOATAK	162 58	67 37	IJ,SO, , , , , , ,	LOAVE	UNK	VPOR
TANANA	152 05	65 10	,SO, , , , , , ,	LOAVE	UNK	VPOR
KONGIGANAK	163 00	60 00	,SO, , , , , , ,	LOAVE	UNK	LOW
MOOSE CREEK	147 08	62 42	,SO, , ,LD, , , ,	LOAVE	UNK	LOW
NEW KOYUKUK	157 42	64 52	,SO, , , , , , ,	LOAVE	UNK	LOW
PORTAGE CREEK	157 42	59 06	,SO, , , , , , ,	LOAVE	UNK	LOW
SAINT MARYS	163 10	62 03	IJ,SO, , , , , , ,	LOW	10	AVER
ANATUVUK PASS	151 45	68 08	,SO, , ,LD, , , ,	LOW	10	VPOR
GRAYLING	160 03	62 57	,SO, , , , , , ,	LOW	20	HEAR
KALTAG	158 45	64 20	IJ,SO, , , , , , ,	LOW	50	GOOD
PALMER	149 08	61 35	,SO, , ,LD, , , ,	LOW	UNK	AVER
VALDEZ	146 16	61 07	,SO,CO, , , ,TL, ,	LOW	UNK	AVER
BUTTE	149 00	61 00	,SO, , , ,GL, , ,	LOW	UNK	POOR
RUBY	155 30	64 45	,SO, , , , , , ,	LOW	UNK	POOR
SUTTON	148 54	61 42	,SO, , E, , , , ,	LOW	UNK	VPOR

ED,QUALITY.

*	QLTY INFO	MAP	FLOOD WARN	TSUN WARN	COMM	POP	STUDIES	PROTECTION		FP REGS
UNK	VPOR	YES	NO	DNA		412	D		NO	2
UNK	LOW	NO	NO	DNA		106	D			2
UNK	LOW	YES	NO	DNA		33	D			2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	YES	NO	DNA		96	D			2
UNK	LOW	NO	NO	DNA		41	D		NO	2
10	GOOD	NO	NO	YES	YES	8500	CSRA FPIB	CEA		3
10	HEAR	NO	NO	YES	YES	8200	CSRA FPIC	CEE		2
20	FAIR	YES	NO	DNA		142	D			2
20	AVER	NO	NO	DNA		412	D			2
20	POOR	YES	NO	DNA		89	D			2
20	POOR	NO	NO	DNA		32	D			2
UNK	AVER	NO	NO	DNA			FPIC			2
UNK	POOR	YES	NO	DNA		90	D			2
UNK	POOR	NO	NO	DNA		150	D			2
UNK	POOR	YES	NO	DNA		221	D			2
UNK	VPOR	YES	NO	DNA		174	D			2
UNK	VPOR	YES	YES	DNA		2450	D	CEA		2
UNK	LOW	YES	NO	DNA		188	D			2
UNK	LOW	NO	NO	DNA		110	D			2
UNK	VLOW	YES	NO	DNA		184	D			2
10	POOR	NO	NO	DNA		260	D			2
10	POOR	NO	NO	YES	YES	1800	D			2
100	GOOD	NO	NO	DNA			D	COPA		2
100	AVER	NO	NO	DNA			D			2
100	VPOR	NO	NO	DNA		554	D			1
UNK	AVER	NO	NO	DNA		1027	D		COPA	2
UNK	AVER	NO	NO	DNA			D			2
UNK	POOR	YES	NO	DNA		166	D			2
UNK	VPOR	NO	NO	DNA			D			2
UNK	VPOR	NO	NO	DNA			D			2
UNK	VPOR	YES	NO	DNA		200	D			2
UNK	VPOR	NO	NO	DNA		400	D			2
UNK	LOW	NO	NO	DNA		44	D			2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	YES	NO	DNA			D			2
UNK	LOW	NO	NO	DNA		66	D			2
10	AVER	NO	NO	DNA		330	D			2
10	VPOR	NO	NO	DNA		117	D			2
20	HEAR	NO	NO	DNA		155	D			2
50	GOOD	YES	NO	DNA		226	D			2
UNK	AVER	NO	NO	DNA			CSRA	CEE		2
UNK	AVER	NO	NO	YES	YES	650	D	CEA		2
UNK	POOR	NO	NO	DNA			D			2
UNK	POOR	NO	NO	DNA		168	D			2
UNK	VPOR	NO	NO	DNA			D			2

FLOOD HAZARD INFORMATION - ALASKA DISTRICT -

ALL AREAS WITH STREAM OVERFLOW HAZARD--BY FREQUENCY, PERCENT FLOODED, QUALIT

NAME	LONG	LAT	TYPE OF HAZARD	FLOOD FREQ	%	QLTY INFO
BIRCHWOOD	149 29	61 25	,SO, , , ,GL, , ,	LOW	UNK	LOW
BORNITE	157 09	66 52	,SO, , , , , , ,	LOW	UNK	LOW
HOUSTON	149 50	61 38	,SO, , , ,GL, , ,	LOW	UNK	LOW
AUKE BAY	134 39	58 23	,SO,CO, , , ,TL, ,	UNK	UNK	FAIR
ANCHOR POINT	151 50	59 47	IJ,SO, , , ,GL, ,TT,	UNK	UNK	POOR
AURORA	147 46	64 51	IJ,SO, , , , , , ,	UNK	UNK	POOR
DILLINGHAM	158 28	59 01	,SO,CO, , , , , ,	UNK	UNK	POOR
AMBLER	157 52	67 05	,SO, , , , , , ,	UNK	UNK	LOW
ARCTIC VILLAGE	145 32	68 10	,SO, , , , , , ,	UNK	UNK	LOW
BETTLES	151 41	66 55	,SO, , , , , , ,	UNK	UNK	LOW
CANDLE	161 57	65 55	,SO, , , , , , ,	UNK	UNK	LOW
CHICKEN	141 56	64 04	,SO, , , , , , ,	UNK	UNK	LOW
CHIGNIK	158 24	56 18	,SO,CO, , , ,TL,TT,	UNK	UNK	LOW
CHIGNIK LAKE	158 47	56 15	,SO, , , , , , ,	UNK	UNK	LOW
CIRCLE	144 03	65 49	,SO, , , , , , ,	UNK	UNK	LOW
COHOE	151 18	60 22	,SO, , , , , , ,	UNK	UNK	LOW
DYEA	135 22	59 30	,SO, , , , , , ,	UNK	UNK	LOW
EYAK	145 36	60 33	,SO,CO, , , ,TL, ,	UNK	UNK	LOW
HUSLIA	156 25	65 42	IJ,SO, , , , , , ,	UNK	UNK	LOW
KAKE	133 57	56 59	,SO,CO, , , ,TL, ,	UNK	UNK	LOW
KASIGLOOK	162 32	60 52	,SO, , , , , , ,	UNK	UNK	LOW
KASILOF	151 17	60 23	,SO,CO, , , , ,TT,	UNK	UNK	LOW
KIANA	160 28	66 58	,SO, , , , , , ,	UNK	UNK	LOW
KING SALMON	156 40	58 42	,SO, , ,LO, , , ,	UNK	UNK	LOW
KOBUK	156 52	66 55	,SO, , , , , , ,	UNK	UNK	LOW
KOLIGANEK	157 26	59 48	,SO, , , , , , ,	UNK	UNK	LOW
KOTLIK	163 33	63 02	,SO, , , , , , ,	UNK	UNK	LOW
MANOKOTAK	159 03	58 59	,SO, , , , , , ,	UNK	UNK	LOW
MATANUSKA	149 13	61 32	,SO, , E, , , , ,	UNK	UNK	LOW
NAKNEK	157 02	58 44	,SO,CO, , , , , ,	UNK	UNK	LOW
NEWHALEN	154 54	59 43	,SO, , , , , , ,	UNK	UNK	LOW
NEW KNOCKHOCK	162 00	62 00	,SO, , , , , , ,	UNK	UNK	LOW
NEWTOK	164 38	60 56	,SO, , , , , , ,	UNK	UNK	LOW
NIKOLAI	154 09	59 29	,SO, , , , , , ,	UNK	UNK	LOW
NINILCHIK	151 40	60 03	,SO,CO, , , ,TL, ,	UNK	UNK	LOW
NONDALTON	154 51	59 58	,SO, , , , , , ,	UNK	UNK	LOW
NUNAPITCHUK	162 29	60 53	IJ,SO, , E, , , , ,	UNK	UNK	LOW
OPHIR	156 31	63 10	,SO, , , , , , ,	UNK	UNK	LOW
PORTAGE	148 58	60 50	,SO,CO, , , ,TL,TT,	UNK	UNK	LOW
SHAGELUK	159 34	62 41	IJ,SO, , , , , , ,	UNK	UNK	LOW
SHUNGNAK	157 09	66 54	IJ,SO, , , , , , ,	UNK	UNK	LOW
SUNTRANA	148 50	63 51	,SO, , , , , , ,	UNK	UNK	LOW
TANACROSS	143 22	63 24	,SO, , , , , , ,	UNK	UNK	LOW
TUNTATULIAK	162 38	60 22	,SO, , , , , , ,	UNK	UNK	LOW
VENETIE	146 25	67 00	IJ,SO, , , , , , ,	UNK	UNK	LOW
WHITE MOUNTAIN	163 24	64 41	,SO, , , , , , ,	UNK	UNK	LOW

ED.QUALITY.

%	QLTY INFO	MAP	FLOOD WARN	TSUN WARN	COMM	POP	STUDIES	PROTECTION		FP REGS
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	NO	NO	DNA			CSRA		F	2
UNK	FAIR	NO	NO	YES	YES		D			2
UNK	POOR	NO	NO	YES	NO		FPIC CSRA		F	2
UNK	POOR	NO	NO	DNA			D			2
UNK	POOR	NO	NO	DNA		1200	CSRB	NO		2
UNK	LOW	YES	NO	DNA		134	D			2
UNK	LOW	NO	NO	DNA		82	D			2
UNK	LOW	NO	NO	DNA		77	D			2
UNK	LOW	NO	NO	DNA		25	D	NO		2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	NO	NO	YES	NO	118	D	NO		2
UNK	LOW	NO	NO	DNA		140	D	NO		2
UNK	LOW	NO	NO	DNA		86	D	NO		2
UNK	LOW	NO	NO	DNA			D	NO		2
UNK	LOW	NO	NO	YES	NO		CSRA		E	2
UNK	LOW	NO	NO	YES	NO		D			2
UNK	LOW	NO	NO	DNA		180	D			2
UNK	LOW	NO	NO	YES	NO	500	D			2
UNK	LOW	NO	NO	DNA		230	D			2
UNK	LOW	NO	NO	YES	NO		FPIC			2
UNK	LOW	NO	NO	DNA		263	D			2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	NO	NO	DNA		64	D			2
UNK	LOW	NO	NO	DNA		130	D			2
UNK	LOW	YES	NO	DNA		245	D			2
UNK	LOW	YES	NO	DNA		193	D			2
UNK	LOW	NO	NO	DNA			CSRB			2
UNK	LOW	NO	NO	DNA		327	D			2
UNK	LOW	NO	NO	DNA		114	D			2
UNK	LOW	NO	NO	DNA			D			2
UNK	LOW	NO	NO	DNA		131	D			2
UNK	LOW	NO	NO	YES	NO	115	D			2
UNK	LOW	NO	NO	YES	YES		FPIC			2
UNK	LOW	YES	NO	DNA		245	D			2
UNK	LOW	NO	NO	DNA		391	CSRA	CEE		2
UNK	LOW	NO	NO	DNA			D	CEE		2
UNK	LOW	NO	NO	YES	NO		D			2
UNK	LOW	NO	NO	DNA		165	D			2
UNK	LOW	YES	NO	DNA		167	D			2
UNK	LOW	NO	NO	DNA			CSRA			2
UNK	LOW	NO	NO	DNA		112	D			2
UNK	LOW	NO	NO	DNA		183	D			2
UNK	LOW	NO	NO	DNA		135	D			2
UNK	LOW	NO	NO	DNA		119	D			2

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
P. O. BOX 7002
ANCHORAGE, ALASKA 99501

IN REPLY REFER TO

NPAEN-A-FP

15 January 1969

Mr. August Reetz, Commissioner
Department of Fish and Game
Subport Building
Juneau, Alaska 99801

Dear Mr. Reetz:

We have recently put our flood hazard information on automatic data processing cards, both for ease in updating and to have the ability to provide special lists without extensive typing.

A sample printout is inclosed for your information. This printout lists all communities that have a potential for stream overflow flooding and is sublisted to reflect frequency, percent of community that is endangered and quality of information.

If you have a need for a special listing of any order (about 260 locations total), please provide your criteria, and we will furnish a copy. Our Anchorage telephone number is 752-3176.

Sincerely yours,

for WARREN GEORGE
Chief, Engineering Division

1 Incl
As stated

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INTRODUCTION

This report relates to the flood situation along the Kuskokwim River in the vicinity of Bethel, Alaska. It was prepared at the request of the City of Bethel through the State of Alaska, Department of Natural Resources, to aid in the solution of local flood problems and to suggest the best utilization of land subject to overflow. This report is based upon information concerning rainfall, snowfall, ice jams, runoff, historical and current flood heights and other technical data bearing upon the occurrence and size of potential floods in the Bethel area.

This report covers several significant aspects of the potential flood problems. It first brings together a record of the largest known floods of the past in the Bethel area. Secondly, it deals with the probability of future floods, such as Intermediate Regional and Standard Project Floods. Intermediate Regional Floods have an average frequency of once in 100 years as determined from an analysis of known floods on the Kuskokwim River. Standard Project Floods are the largest floods that may reasonably be expected to occur. However, they should be considered in the planning for use of the flood plains.

In view of the need to control the use of the flood plains of Bethel and to guide future development in the area, this study develops the size and frequency of both the Intermediate Regional and Standard Project Floods.

The report contains maps and cross-sections, which indicate the extent of flooding which has been experienced and that which might occur in the future in the vicinity of Bethel. The graphic map presentation should prove helpful in planning the best use of the flood plain. It is possible, using the report, to determine the depth of probable flooding in any location, either by recurrence of the largest known floods or by occurrence of the Intermediate Regional or Standard Project Floods. With this information, floor levels for buildings may be planned high to avoid flood damage. Construction below predicted flood elevations is done with full recognition of the risks and of flooding hazards involved.

This report does not include plans for the solution of flood problems. Rather, it is intended to provide the basis for future study and planning on the part of the City of Bethel in arriving at solutions to minimize vulnerability to flood damage. This might involve local planning to control the use of the flood plain through zoning and subdivision regulations, the construction of flood protection works, or a combination thereof.

The Alaska District, Corps of Engineers will, upon request, provide technical assistance to federal, state, and local agencies in the interpretation and use of the information contained herein and will provide other available related data.

SUMMARY OF FLOOD SITUATION

The City of Bethel, with an estimated population of 2,000, is the most heavily populated area in the southwestern region (see Plate 1). Within this region, there are 66 other villages, consisting of approximately 15,000 persons, who are either Eskimos or Athabascan Indians. Bethel is situated on the right bank of the Kuskokwim River and is surrounded by flood plains. This report covers the immediate area of the City of Bethel along that short stretch of the Kuskokwim River.

The principal residential development is situated on ground that is subject to flooding. There are areas, such as Brown's Slough, that are more subject to flooding and contain a heavier density of residential structures than the higher ground still subject to flooding, where commercial establishments are located. Ninety per cent of the residential and commercial areas have been inundated by floods in the past, and a substantially greater area is within reach of the potentially greater floods of the future.

The U. S. Geological Survey maintains a stream gage on the Kuskokwim River approximately 150 miles upstream near Crooked Creek, which has been in operation since 1951. Residents were interviewed and historical documents searched for information concerning past floods. From these investigations and from theoretical studies of possible floods on the Kuskokwim River, the local flood situation, both past and future, has been developed.

The following paragraphs summarize the significant findings, which are discussed in more detail in succeeding sections of this report.

* * *

THE GREATEST FLOOD known to have occurred at Bethel in the Kuskokwim River Basin occurred in the spring of 1941. This flood was the result of an ice jam downstream from Bethel. There have been other high floods without ice jams, the latest of which was in June 1964.

* * *

OTHER FLOODS at Bethel, caused by ponding of the Kuskokwim River upstream from ice jams, occurred in the spring breakups of 1963, 1964 and 1967.

* * *

INTERMEDIATE REGIONAL FLOODS have an average frequency of occurrence in the order of once in 100 years. They are determined from an analysis of this stream and other streams in the same general area. The analysis indicates that the Intermediate Regional Flood for the Kuskokwim River would have a water surface elevation of 32.0 feet at Bethel when affected by maximum expected ice jam and tide effect. The same discharge of water (690,000 cfs)

under ice-free conditions would result in a water surface elevation of 29.7 feet.

* * *

STANDARD PROJECT FLOOD determinations indicate that flooding under ice jam conditions would occur at Bethel to a depth of 0.5 feet higher than the Intermediate Regional Flood. An equal discharge of water (1,385,000 cfs) under ice-free conditions on the Kuskokwim River would have a water surface elevation of 30.5.

* * *

MAIN FLOOD SEASON for the Kuskokwim River is in the spring. Most of the floods have resulted from ice jams which are frequent and are caused by the heavy spring runoff. The Kuskokwim River is fed by numerous glaciers at its headwaters in the Alaska Range. High temperatures in these areas increase glacial melt, thus a relatively small amount of rain on the glacial ice can cause as much stream flow as a much larger amount of precipitation in a nonglacial area of the basin. Large floods caused by intense rainfall can occur anytime during the summer or early fall.

* * *

VELOCITIES OF WATER during major floods range up to 10 feet per second (about 7 miles per hour) in the channel of the Kuskokwim River. Velocities on the flood plain vary widely, depending on location, but are generally less than 2 feet per second. During floods caused by ice jams, current directions and velocities can change rapidly as a result of changes in conditions; thus main channel velocities could be attained in overbank areas. Velocities of 3 feet per second or greater, combined with depths of 3 feet or greater, are generally considered hazardous.

* * *

DURATION OF FLOODS caused by ice jams can be long. The pool impounded by the ice dam lasts either until the ice melts; hydraulic pressures or attrition from shifting ice breech the dam; or until sufficient water occurs downstream to float the ice. During a Standard Project Flood, the stream would rise rapidly to an elevation of 27 feet, at which stage the river would go overbank. The flood plain is several miles wide at Bethel, and a large increase in flow is required for a small rise in the river stage. Consequently, any rise above 27 feet would normally be at a much slower rate.

* * *

HAZARDOUS CONDITIONS would occur during large floods as a result of the rapidly rising stream, high velocities and

deep flows. An additional hazard during an ice jam flood is presented by drifting ice floes, which can destroy buildings, erode banks and change the location of the channel. These floating cakes of ice can also pile up overbank in an unpredictable manner, causing rapid shifts in direction of water flow and velocities.

* * *

FLOOD DAMAGE PREVENTION MEASURES. There are no existing or authorized flood control or related measures in the study area or upstream in the watershed; nor, are there any flood plain regulations in the City of Bethel.

* * *

FUTURE FLOOD HEIGHTS that would be reached if the Intermediate Regional and Standard Project Floods occurred in the vicinity of Bethel are shown in Table 1. The table gives the comparison of these flood crests and also shows the comparison with the highest flood of record.

* * *

TABLE 1

RELATIVE FLOOD HEIGHTS

Flood	Location	Mile Above Mouth	Estimated Peak Discharge	Water Surface Elevation
			cfs	feet
Spring 1941	Bethel	65	(1)	30.96
Spring 1963	Bethel	65	(1)	30.17
Intermediate Regional			690,000	32.00 (2)
Standard Project			1,385,000	32.50 (2)

(1) Backwater from ice jam.

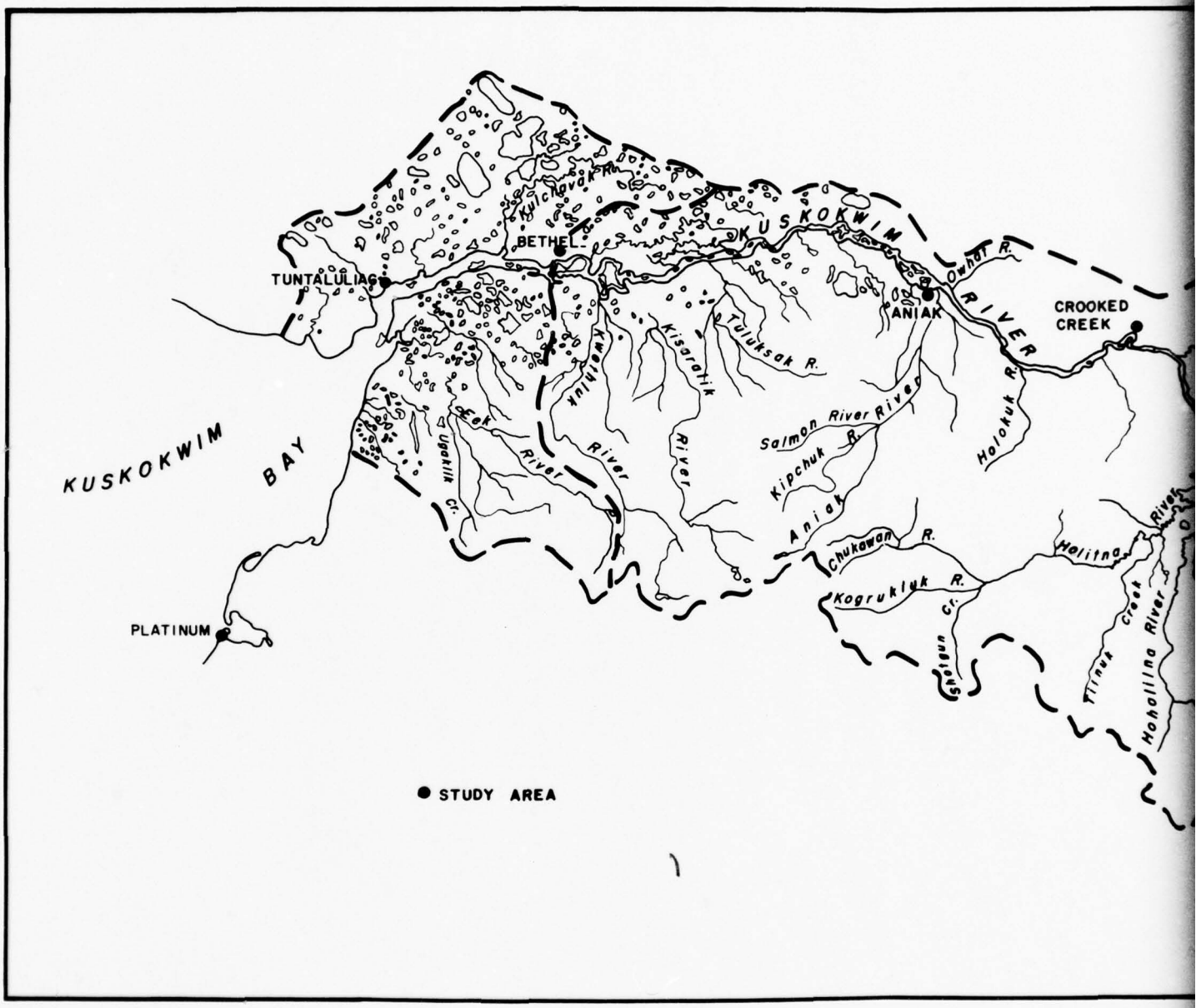
(2) This stage is caused by ice jam. Stage under ice-free conditions would be about 2 feet lower.

GENERAL CONDITIONS AND PAST FLOODS:

This section of the report includes a general description of the study area and a history of floods on the Kuskokwim River in the vicinity of Bethel, together with a discussion of the prevailing flood situation. It covers in detail obstructions to flood flows in the study area.

The portion of the Bethel study extends along the Kuskokwim River from the confluence of Brown's Slough downstream approximately one mile to the high bank south of the Alaska Native Hospital and along Brown's Slough to the north of the City of Bethel.

Although there are few newspaper accounts or other records of flooding in the flood plain, persons interviewed recall several seasons when the lower areas were flooded during the spring breakup as a result of ice jams in the river. The flood history for the Kuskokwim River in the vicinity of Bethel has been developed from the meager records of past floods. The possible area of inundation, used for this report, was developed from the earlier data, plus reports of flood observers in the area during spring breakup and from field investigations and office computations.


KUSKOKWIM BAY
PLATINUM
TUNTALULIAG
BETHEL
Kwethluk
KUSKOKWIM RIVER
Owhat R.
ANIAK
CROOKED CREEK
Kisaratik River
Tuluksak R.
Holokuk R.
Salmon River
Kipchuk R.
Aniak
Chukowan R.
Kogrukluk R.
Holitna River
Holitna
Stony Creek
Hoholitna River
Ugaviik Ck.
Eek River
● STUDY AREA

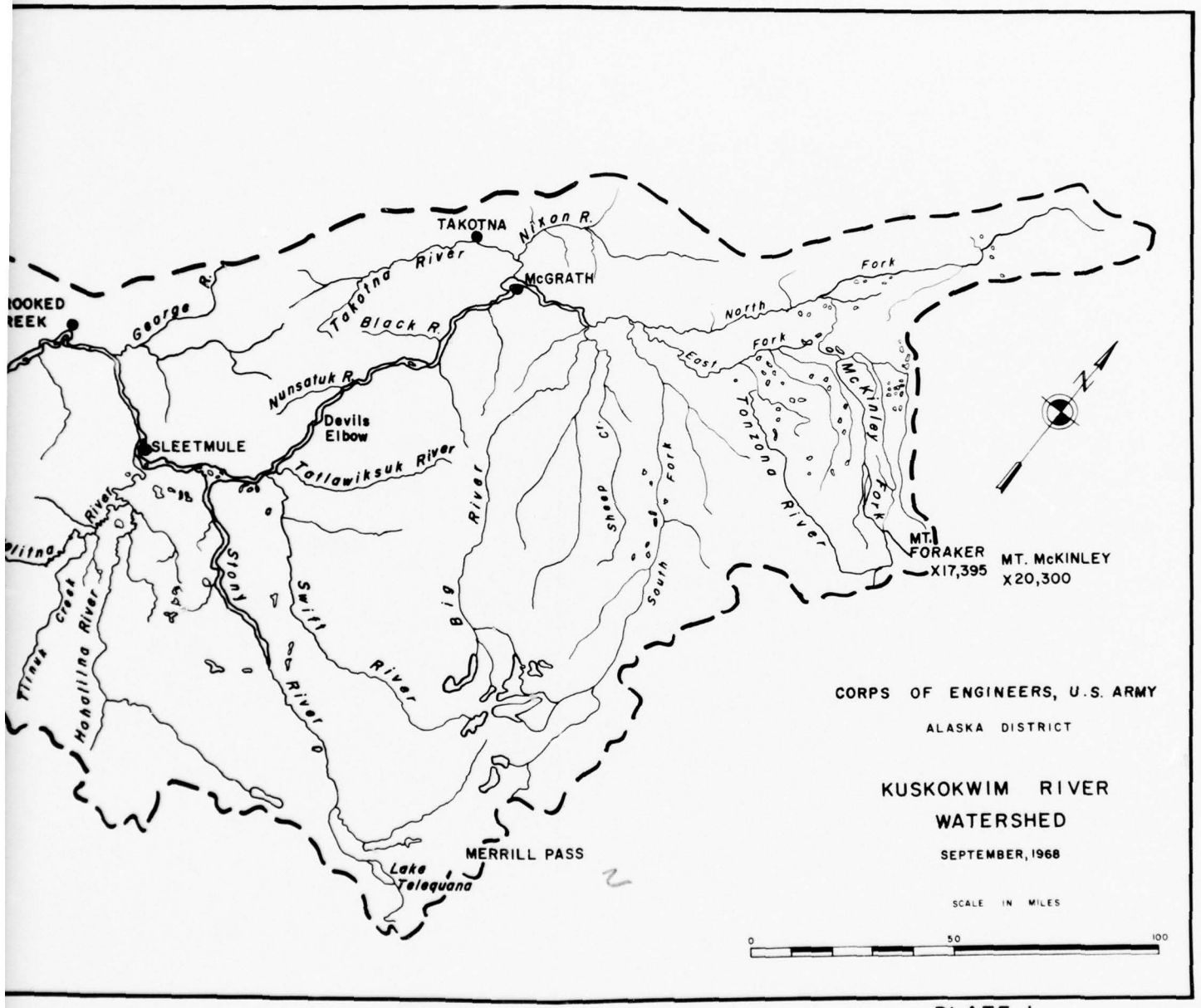

TAKOTNA
Nixon R.
Takotna River
McGRATH
George R.
Black R.
Nunsatuk R.
Devils Elbow
SLEETMULE
Tatlawiksuk River
Big River
Sheep Cr.
South Fork
Swift River
Stony River
Hoholitna River
Tlikakila Creek
Lake Telequana
MERRILL PASS
North Fork
East Fork
McKinley Fork
Tonzona River
MT. FORAKER X17,395
MT. McKINLEY X20,300
N
CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT
KUSKOKWIM RIVER WATERSHED
SEPTEMBER, 1968
SCALE IN MILES
0
50
100

PLATE I

BETHEL AREA

GENERAL

Settlement:

Bethel was originally the site of an Eskimo village and a trading post of the Alaska Commercial Company and was known by the name of Mumtrekhlogamute. The population was 41 in 1880; 110 in 1910; 221 in 1920; 278 in 1930; 376 in 1940; 651 in 1950; 1,258 in 1960 and is about 2,000 at present. In 1884 missionaries from the Moravian Church were sent to Mumtrekhlogamute to establish a mission, which they did in 1885, and they called it "Bethel," derived from a biblical passage, meaning "House of God."

Bethel lies on the right bank of the Kuskokwim River approximately 390 air miles west of Anchorage, 500 air miles southwest of Fairbanks and about 65 river miles up the Kuskokwim River from the Bering Sea. It is the hub of Southwestern Alaska as it has an airport suitable for jet aircraft and is a port of call for oceangoing vessels on the Kuskokwim River. It is the center of trade, transportation, distribution, communication, administration and education. Within the vast region of Bethel, there are 66 villages consisting of approximately 15,000 persons, 95% of whom are either Eskimos or Athabascan Indians. The climate in this region is under the continental influence but is also affected by the influence of the Bering Sea. As a result, the Bethel area has warmer summers and colder winters than most

coastal communities in this region. The temperatures average below freezing seven months of the year.

The town's location on an outside curve of the Kuskokwim River has created special problems. The erosion of the riverbank, most of which has taken place in the last 50 years, has forced the frequent moving of structures and the loss of streets. In moving away from the high riverbank, many have located on the lower ground along Brown's Slough, which borders the town on the north and east. This has created a flooding problem, particularly in spring when the ice begins to melt in the Kuskokwim River, and the water rises in the Slough. There is very little high ground available between the flooding Brown's Slough and the eroding banks of the Kuskokwim River. Should the erosion continue at its present rate, the entire town will have to move to a new location.

The Federal Government is the principal employer in the Bethel area. The U. S. Public Health Service hospital employs approximately 100 people. In addition, there are offices of the Bureau of Indian Affairs, U. S. Weather Bureau, Bureau of Sports Fisheries, Air Force Communications System, Alaska National Guard, State Public Health, and Public Welfare. Fishing, hunting, and trapping offer subsistence to many. Technological changes have taken place, as stated in a report by the Bethel Community Action Program Committee, in that instead of skin boats with paddles, they have skiffs with outboard motors; instead of handcarried mail, they have radio, telegraph and airborne

postal services; instead of seal-oil lamps, they have electricity; instead of driftwood fire pits, they use fuel oil stoves. The list could go on; however, all these changes call for a change from a subsistence economy to a wage economy. A combined Federal-State program, which began in 1968, is intended to provide new housing, new jobs, investment activities, and a higher standard of living.

The Stream and Its Valley:

The Kuskokwim River heads in the glaciers of Mt. Foraker, 17,400 elevation, located in Mt. McKinley National Park, a part of the Alaska Range. From this rugged terrain, the river flows southwestward at a gradually diminishing gradient, emerging from the foothills at Aniak. From Aniak, the river passes through a region of mature topography and low relief characterized by many meanders, oxbow lakes and sloughs. Discharge is into Kuskokwim Bay an arm of the Bering Sea. The entire drainage basin of 50,000 square miles is underlain by permafrost.

The primary cause of flooding in the Kuskokwim Basin is from ice jams which restrict the flow and impound the water upstream. The severity of spring floods is determined by a combination of factors, including thickness of ice, amount of snow pack, air temperatures, amount of sunshine and precipitation. The sequence of events also affects the flooding potential. For example, spring floods may occur as a result of an above-normal snowfall during the winter, followed by an unusually cold spring, and

finally, a rapid snow melt. Summer floods can result from an extreme amount of rainfall in a short period of time. High temperatures in the glacial areas or warm rain on snow and ice fields will contribute heavily to flood hazard during summer months.

Bethel is located on the right bank of the Kuskokwim River, 65 miles upstream from the mouth. The drainage area upstream from Bethel is 42,800 square miles.

Most known floods at Bethel have been caused by jams downstream from the town. According to local residents, more damage is attributed to floating ice cakes during these floods than to the flood water themselves. Most of the town will be flooded by the Intermediate Regional Flood.

Tides have an effect on flooding. A high tide with a wind set over the delta area would substantially increase the stage of flooding at Bethel during periods of high runoff.

A potential power dam site on the Kuskokwim River at Crooked Creek at River Mile 270, if developed, could be used for flood control and would alleviate some of the spring flooding at Bethel.

TABLE 2

DRAINAGE AREAS IN WATERSHED OF KUSKOKWIM RIVER BASIN

Stream	Location	Mile Above Mouth	Drainage Area Sq. Mi.
Kuskokwim River	Mouth	0	50,000
	Bethel	65	42,800

* * *

Flood Damage Prevention Measures:

There have been no flood damage prevention works constructed. However, emergency measures have been taken during times of spring breakup with no thought of possible future floods of the Intermediate Regional or Standard Project magnitude.

Flood Warning or Forecasting Services:

River forecasts and flood warnings are issued by the U. S. Weather Bureau during spring breakup and at other times when flooding is expected. General weather forecasts of temperatures, precipitation, and cloud cover are not generally available to the local residents, although they are broadcast several times daily over radio stations in Anchorage and Fairbanks. However, a first-order Weather Bureau office is located at Bethel, and weather information may be obtained by contacting them.

Developments in the Flood Plain:

Plate 3 is an index map of four sheets that show the potential flood area of Bethel. Plates 4 through 7 show the flood plain of Bethel for the reach covered by this report. There are no subdivisions, as such, within the range of overflow from the Kuskokwim River. However, there are concentrations of people along Brown's Slough and along the right bank of the Kuskokwim River. As previously stated, 90% of this area is subject to flooding and flood damage, as well as health hazards caused by sewage disposal. There is high ground west of the main settlement near the Alaska Native Hospital. This area is being developed by the Alaska State Housing Authority in cooperation with several other federal and state agencies for relocating the natives living along Brown's Slough and other areas subject to inundation. This program began in 1968 through the efforts of the Federal Field Committee, and the first occupants will be ready to move in to their new homes in late 1968. This new housing area will have its own water supply and sewage disposal facilities. It will, therefore, become the haven for others within the Bethel area who do not, or cannot, move from their present flood area to the new location on high ground.

Bridges and Culverts Along Brown's Slough at Bethel:

Tables 3 and 4 give the description, location, streambed location, road elevation, and the flood crest of the Intermediate Regional and Standard Project Floods

along Brown's Slough. Brown's Slough is actually a misnomer, as it is an estuarine creek and is used by local residents for transportation to their homes and for a small boat anchorage.

Obstructions to Flood Flow:

The major obstructions to flood flow of the Kuskokwim River are the islands in river channel and the sharp meanders common in the area. During spring breakup the major obstructions to the large ice flows are constrictions in the channels which will not allow the large ice "pans" to pass. On Brown's Slough, the major obstructions to flood flow would be the culvert and the bridge.

Ice Jams:

Ice jams occur on the Kuskokwim River during spring breakup. In general, as temperatures rise, increased snow melt raises the river gage height, and the ice separates from the shores and floats. Constrictions of channel and channel obstructions, such as islands, river bends and shallows, prevent the large pieces of ice, formed in the wide river pods and known as "pans," from passing. Thus, if the river stage increases so as to float a pan of ice 2,000 feet wide and a mile long, the pan will start to move downstream with the current. If a channel constriction, say 1,000 feet wide, is encountered, the pan will breakup into small pieces. If the winter has been severe and the ice is thick and strong, the large pan will

lodge in the narrow portion of the river and more floating ice will pile on top of this large piece. If the large pan does not break into small pieces, an ice jam is formed by float ice piling on top of the pan. The ice jam can form an extensive dam or restriction, and as water is impounded, it will flow overbank. The foregoing is the most common method by which ice jams are formed, although any combination of small ice pieces can start a jam. A section of river still frozen from bank to bank may also form an obstruction to ice flow when the upstream ice begins to move.

The largest known floods at Bethel have been caused by ice jams. Most have been the result of the constriction created by sediments deposited in the Kuskokwim River by the Johnson River flowing in from the west about 20 miles downstream from Bethel. Major ice jams, causing flooding at Bethel, occurred in 1941, 1963 1964 and 1967.

* * *

TABLE 3

BRIDGE ACROSS BROWN'S SLOUGH

Mile Above Mouth	I. D.	Stream Bed Elev.	Road Surface Elev.	Intermediate Regional Flood Crest Elev.	Standard Project Flood Crest Elev.	Underclearance Relation to Intermediate Regional Flood Elev.	Below
		feet	feet	feet	feet	feet	feet
3.0	Tacan Site	17.6	28.0	32.0	32.5	26.5	5.5

* * *

TABLE 4

CULVERT ACROSS BROWN'S SLOUGH

Mouth	I. D.	Stream Bed Elev. feet	Road Surface Elev. feet	Intermediate Regional Flood Crest Elev. feet	Standard Project Flood Crest Elev. feet	Number Size Kind of Culvert
0.2	Bridge Ave.	12.7	29.7	32.0	32.5	1-14'x16' CMP

* * *

Figure 1
17

AERIAL VIEW OF THE CITY OF BETHEL AS THE FLOOD WAS RECEDING IN 1964. KUSKOKWIM RIVER IN BACKGROUND, RUNNING FROM LEFT TO RIGHT. MOM'S KITCHEN, FORMERLY THE BETHEL CAFE, SHOWN IN FIGURES 5 AND 6, IS CIRCLED NEAR CENTER OF PHOTO. LOOKING SOUTHWESTERLY.

Figure 2
18

ANOTHER AERIAL VIEW OF THE CITY OF BETHEL DURING THE 1964 SPRING FLOOD. THE AIRFIELD IN CENTER RIGHT OF PHOTO HAS BEEN ABANDONED AND IS BEING USED FOR A STAGING AREA FOR THE CONSTRUCTION OF NATIVE HOMES. V.F.W. BUILDING, SHOWN IN FIGURES 4 AND 7, IS CIRCLED, CENTER RIGHT. LOOKING WEST.

DURING THE PEAK OF THE 1964 FLOOD. KUSKOKWIM RIVER TO THE LEFT.
BROWN'S SLOUGH FROM LEFT TO RIGHT IN CENTER OF PHOTO. LOOKING WEST.

Figure 3
19

FLOOD SITUATION

Flood Records

Records of stream flows on the Kuskokwim River have been maintained at Crooked Creek since June 1951 by the U. S. Geological Survey. Another gage was installed at McGrath in July 1963. Miscellaneous measurements of the Kuskokwim River are available from the U. S. Geological Survey.

These records have been supplemented by interviews with local residents, recovered high water marks from previous floods, tide data from U. S. Coast & Geodetic Survey, and records of ice jams by the U. S. Army Corps of Engineers. Using the foregoing records and correlating weather records with flows, it has been possible to develop a knowledge of flooding at Bethel.

Flood Stages and Discharges

Plate 2 depicts crest stages and discharges for high water and floods exceeding the streambed capacity (a stage of 27 feet at Bethel). Stages above bankfull were obtained from high water marks; others were obtained by correlations with gaging stations.

Flood Occurrences

Table 5 shows known crest elevations and year of occurrence of known floods on the Kuskokwim River at

Bethel, which have exceeded stream capacity, since 1941. The table also shows cause of the flooding.

Duration and Rate of Rise

Although there has been serious flooding at Bethel in the past, lack of adequate data, concerning actual rates of rise and fall, preclude presentation of an actual flood hydrograph. However, studies indicate the Kuskokwim River at Bethel is a slow rising stream, and it tends to remain high for several days. Also, under ice jam conditions, water will generally rise at a faster rate than under free-flowing conditions.

Velocities

The normal high flow velocities in the Kuskokwim River range from 3 to 5 feet per second. However, during flood periods, the velocities will increase drastically. Such higher velocities would result in extensive erosion and displacement of buildings. During floods involving ice, the problem is much more severe because of the damage by huge blocks of ice traveling at high velocities.

Flooded Areas and Cross-Sections

Plates 4 through 7 show the areas along the right bank of the Kuskokwim River and both banks of Brown's Slough at Bethel that would be inundated by the Intermediate Regional and Standard Project Floods. The actual limits of these overflow areas on the ground may vary somewhat

from those shown on the maps since their scale is such that precise plotting of flooded areas is not possible.

Plates 8 and 9 show cross-sections obtained during surveys made in 1968 with water surface elevations of Standard Project and Intermediate Regional Floods.

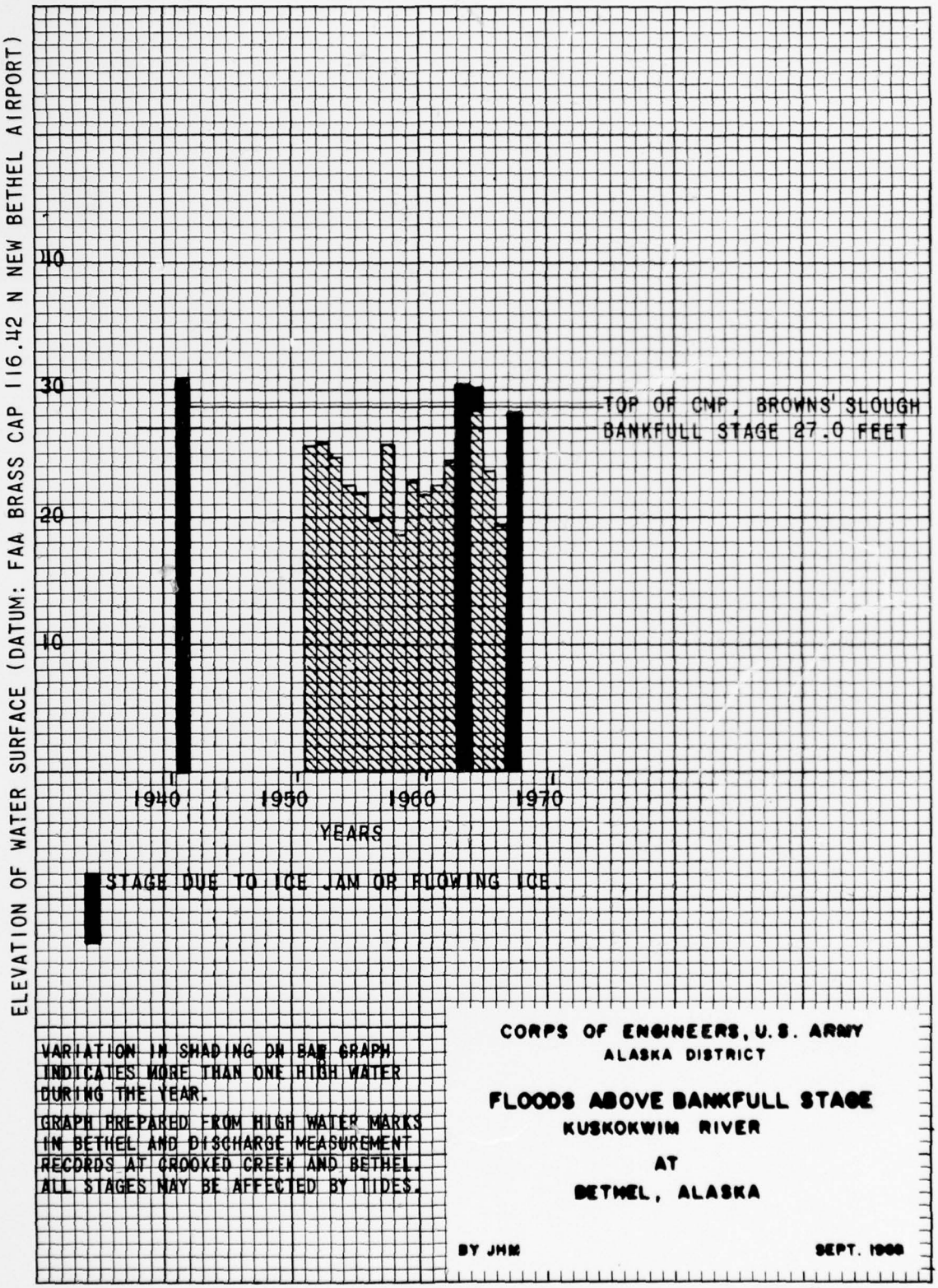

ELEVATION OF WATER SURFACE (DATUM: FAA BRASS CAP 116.42 N NEW BETHEL AIRPORT)
40
30
20
10
1940
1950
1960
1970
YEARS
TOP OF CMP, BROWNS' SLOUGH
BANKFULL STAGE 27.0 FEET
STAGE DUE TO ICE JAM OR FLOWING ICE.
VARIATION IN SHADING ON BAR GRAPH INDICATES MORE THAN ONE HIGH WATER DURING THE YEAR.
GRAPH PREPARED FROM HIGH WATER MARKS IN BETHEL AND DISCHARGE MEASUREMENT RECORDS AT CROOKED CREEK AND BETHEL. ALL STAGES MAY BE AFFECTED BY TIDES.
CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT
FLOODS ABOVE BANKFULL STAGE
KUSKOKWIM RIVER
AT
BETHEL, ALASKA
BY JHM
SEPT. 1968

PLATE 2

TABLE 5

HIGHEST KNOWN STAGES AND DISCHARGES IN ORDER OF MAGNITUDE

Kuskokwim River at Bethel, Alaska
Drainage Area 42,800 Square Miles
Elevation of Water Surface Based on FAA Station B.M.
Elevation 116.42 at New Bethel Airport

Order No.	Date of Crest	Elevation of Water Surface feet	Estimated Peak Discharge cfs
1	Spring 41	(1) 30.96	-
2	Spring 63	(1) 30.17	-
3	5 Jun 64	(1) 30.02	-
4	9 Jun 64	28.84	579,200
5	13 May 67	(1) 28.17	-
6	1 Sep 63	27.00	446,200
7	11 May 57	25.94	384,200
8	5 Jun 52	25.94	384,200
9	5 Sep 51	25.69	373,800
10	4 Sep 53	24.80	330,400
11	27 May 62	24.40	310,300
12	3 Oct 65	23.58	279,200
13	23 Aug 67	23.32	269,900
14	5 Oct 65	22.93	254,100
15	31 Aug 59	22.75	251,200
16	19 Sep 61	22.63	246,700
17	25 Sep 54	22.62	246,700
18	3 Sep 55	21.99	227,500
19	31 May 60	21.91	223,100
20	22 Aug 56	19.98	174,300
21	16 Jun 66	19.89	171,400

(1) Affected by ice jam, floating ice and/or tide.

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on the Kuskokwim River near Bethel and some of the hazards of great floods. Floods the size of the Standard Project Flood represent the reasonable upper limits of expected flooding. Those the size of the Intermediate Regional Flood represent floods that may reasonable be expected to occur more frequently, although they will not be as high as the Standard Project Flood. While they have not occurred as far as is known, there is no reason to suspect that they could not occur sometime in the future. In determining the floods that would result from this type of storm, consideration was given to topography, watershed cover, and the physical characteristics of the stream.

Determination of Intermediate Regional Floods

The Intermediate Regional Flood is defined as a flood at any given location having an average frequency of occurrence in the order of once in 100 years, although the flood may occur in any year. Frequency estimates are generally based on statistical analyses of stream flow records available for the watershed under study. However, limitations in such records usually require analyses of rainfall and runoff characteristics in the "general region" of the area under study. The Intermediate Regional Flood represents a major flood, although it is much less severe than the Standard Project Flood.

Streamflow records of the U. S. Geological Survey at stations on the upper Kuskokwim River and miscellaneous measurements on the lower portion of the Kuskokwim River were used in deriving at the Intermediate Regional Flood at Bethel. The precipitation amounts with their specified frequencies were used along with streamflow records. The precipitation amounts and temperature data are published by the U. S. Weather Bureau. The results of statistical analysis and electronic computer correlations indicate that the Intermediate Regional Flood peak discharge for the Kuskokwim River at Bethel is 690,000 cubic feet per second, resulting in a water surface elevation of 29.7 feet, without the effects of ice.

Further analysis, using the tidal information available from U. S. Coast and Geodetic Survey and wind data together with ice jam information obtained by the U. S.

Army Corps of Engineers, indicates that under the most adverse, reasonably expectable, combination of tide, ice jam, offshore wind, and discharge would result in a water surface elevation of 32.0 feet at Bethel.

Determination of Standard Project Floods

Only in rare instances has a specific stream experienced the largest flood that is likely to occur. Severe as the maximum known flood may have been on any given stream, it is commonly accepted that sooner or later a larger flood can and probably will occur. A Standard Project Flood is defined as the largest flood that can be experienced from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved.

The Standard Project Flood for the Kuskokwim River at Bethel is estimated to have a peak discharge of 1,385,000 cubic feet per second.

Frequency

No frequency is assigned to the Standard Project Flood. The occurrence of such a flood would be a rare event; however, it could occur in any year.

Possible Larger Floods

Floods larger than the Standard Project Flood are possible. However, the combination of factors that would be necessary to produce such floods would seldom occur.

The consideration of floods of this magnitude is of greater importance in some problems than in others, but should not be overlooked in the study of any problem.

HAZARDS OF GREAT FLOODS

The amount and extent of damage caused by any flood depend in general upon how much area is flooded, the height of flooding, the velocities of flow, the rate of rise, and the duration of flooding.

Areas Flooded and Heights of Flooding

The areas of Bethel subject to flooding by the Standard Project and Intermediate Regional Floods are shown on Plates 4 through 7.

Flood conditions of both the Standard Project and Intermediate Regional Floods would be affected by ice. The condition of a very negligible slope would exist at the crest stage, and, therefore, no crest or high water profile was prepared.

The depth of flow can be obtained by subtracting the elevation at the point desired from the flood elevation.

The overflow areas shown on Plates 4 through 7 have been determined with an accuracy consistent with the purpose of this study and accuracy of the basic data.

The Standard Project Flood elevation at Bethel is 3.7 feet higher than any recorded flood.

The Intermediate Regional Flood elevation for Bethel is 3.2 feet higher than any recorded flood.

Figures 4, 5, 6 and 7 show the heights that would be reached by the Kuskokwim River during the Standard Project and Intermediate Regional Floods on facilities presently existing within the flood plain in the vicinity of Bethel.

Velocities, Rates of Rise, and Duration

Water velocities during a flood depend largely upon the size and shape of the cross-sections, the condition of the stream, and the bed slope.

The maximum velocities that would occur in the main channel and overbank areas at Bethel would range up to 7 feet per second during Intermediate Regional Floods.

The maximum velocities that would occur in the main channel and overbank areas at Bethel would range up to 10 feet per second during Standard Project Floods.

Plate 9 shows one cross-section that is typical of the total of three sections obtained for Brown's Slough at Bethel in the flood plain area investigated. Plate 8 shows one cross-section that is typical for the Kuskokwim River in the reach investigated. The elevations and extent of overflow of the Intermediate Regional and Standard Project Floods are indicated on these sections under conditions of free-flow and ice jam conditions.

* * *

TABLE 6

INTERMEDIATE REGIONAL FLOOD
PEAK DISCHARGE

Stream	Location	River Mile	Discharge cfs
Kuskokwim River	Bethel	65	690,000

* * *

TABLE 7

STANDARD PROJECT FLOOD

PEAK DISCHARGE

Stream	Location	River Mile	Discharge cfs
Kuskokwim River	Bethel	65	1,385,000

* * *

TABLE 8

INTERMEDIATE REGIONAL FLOODS

MAXIMUM VELOCITIES

Stream	Location	Maximum Velocities	
		Channel ft per sec	Overbank ft per sec
Kuskokwim	Bethel	7.0	1.5

* * *

TABLE 9

STANDARD PROJECT FLOODS

MAXIMUM VELOCITIES

Stream	Location	Maximum Velocities	
		Channel ft per sec	Overbank ft per sec
Kuskokwim	Bethel	10.0	1.5

* * *

TABLE 10

INTERMEDIATE REGIONAL FLOOD
RATES OF RISE AND DURATION

Stream	Location	Ht. of Rise feet	Time of Rise hrs	Max. Rate of Rise ft per hr	Duration Above Bankfull hr
Kuskokwim River	Bethel	5	12	1	120

* * *

TABLE 11

STANDARD PROJECT FLOOD
RATES OF RISE AND DURATION

Stream	Location	Ht. of Rise feet	Time of Rise hrs	Max. Rate of Rise ft per hr	Duration Above Bankfull hr
Kuskokwim River	Bethel	6	12	1.5	180

* * *

Figure 4
32

VETERANS OF FOREIGN WARS BUILDING, SHOWING THE HEIGHTS OF FLOODS IN THE YEARS 1963 AND 1967, ALSO SHOWING THE HEIGHTS OF THE STANDARD PROJECT AND INTERMEDIATE REGIONAL FLOODS.

Figure 5
33

A STREET SCENE DURING THE 1964 FLOOD. BETHEL CAFE IS NOW KNOWN AS MOM'S KITCHEN AND JOE'S POOL PARLOR. THEATER BUILDING IN BACKGROUND.

THE STANDARD PROJECT AND INTERMEDIATE REGIONAL FLOOD HEIGHTS IN RELATION TO THE 1967 FLOOD.

Figure 6

ANOTHER SHOT OF THE V.F.W. BUILDING SHOWING HEIGHTS OF FLOODS TO DATE AND POTENTIAL FLOODS.

Figure 7

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or low lands adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Head Loss. The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Left Bank. The bank on the left side of a river, stream, or watercourse, looking downstream.

Low Steel (or Underclearance). See "underclearance."

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological

and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40% or 60% of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as "low steel" in some regions.

CFS. Cubic Foot per Second is the rate of discharge of a stream whose channel is one square foot in cross-sectional area and whose average velocity is one foot per second.

CM. Corrugated Metal.

CMP. Corrugated Metal Pipe.

RCP. Reinforced Concrete Pipe.

AUTHORITY, ACKNOWLEDGEMENTS, AND INTERPRETATIONS

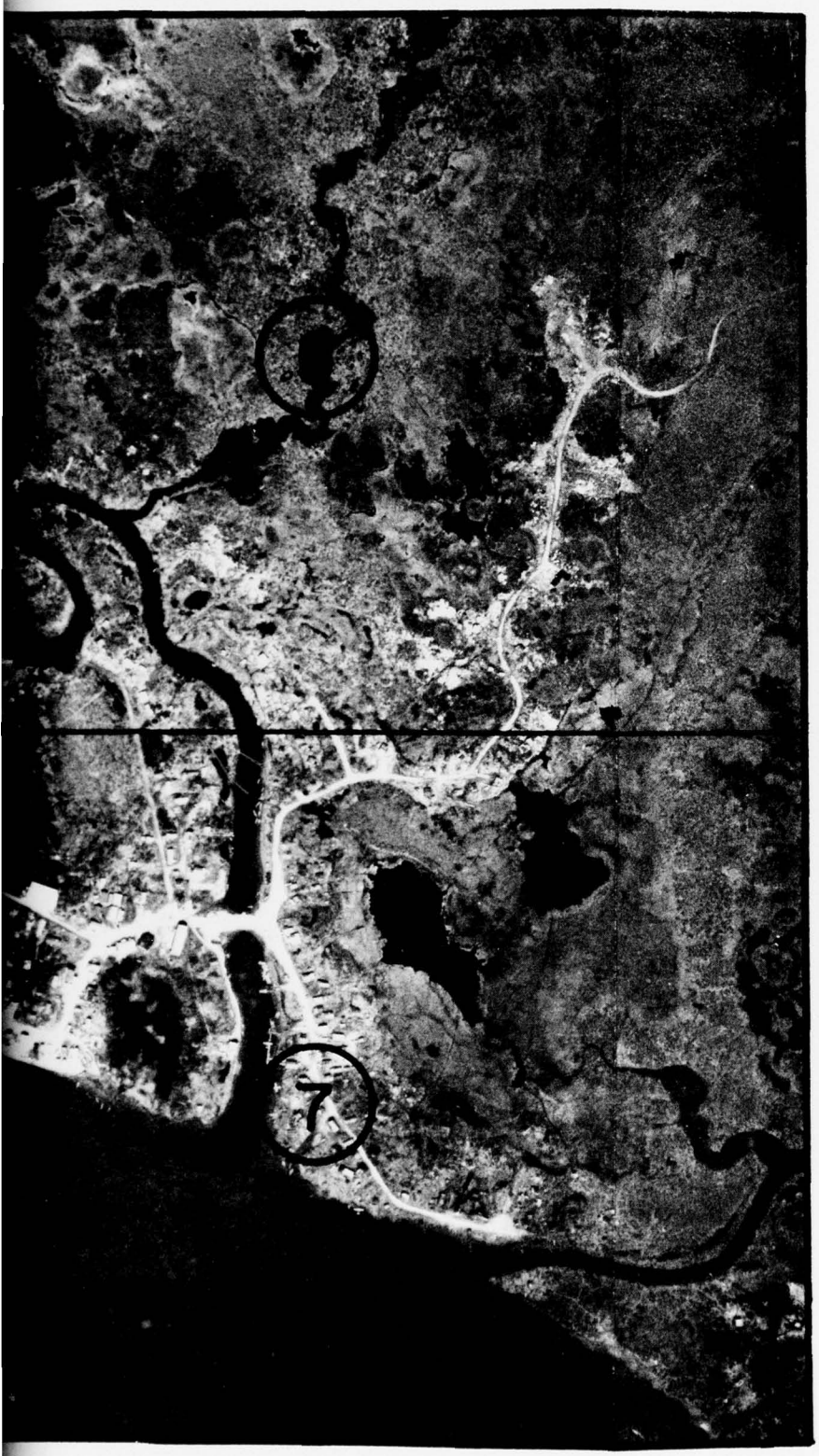
This report has been prepared under the authority of Section 206 of the 1960 Flood Control Act (Public Law 86-645), as amended by Section 206 of the 1966 Flood Control Act (Public Law 89-789).

* * *

The assistance and cooperation of the U. S. Weather Bureau, U. S. Geological Survey, Department of Natural Resources, State of Alaska, and the City of Bethel who aided in the preparation of the report are gratefully acknowledged.

* * *

This report presents the local flood situation for the City of Bethel and vicinity. The Alaska District of the Corps of Engineers will, upon request, provide interpretation and limited technical assistance to Federal, State, and local agencies and will provide other available flood data related thereto.



LEGEND

(4) PLATE NUMBER

200' 0 200' 600' 1000'

SCALE IN FEET

KUSKOKWIM RIVER, BETHEL, ALASKA

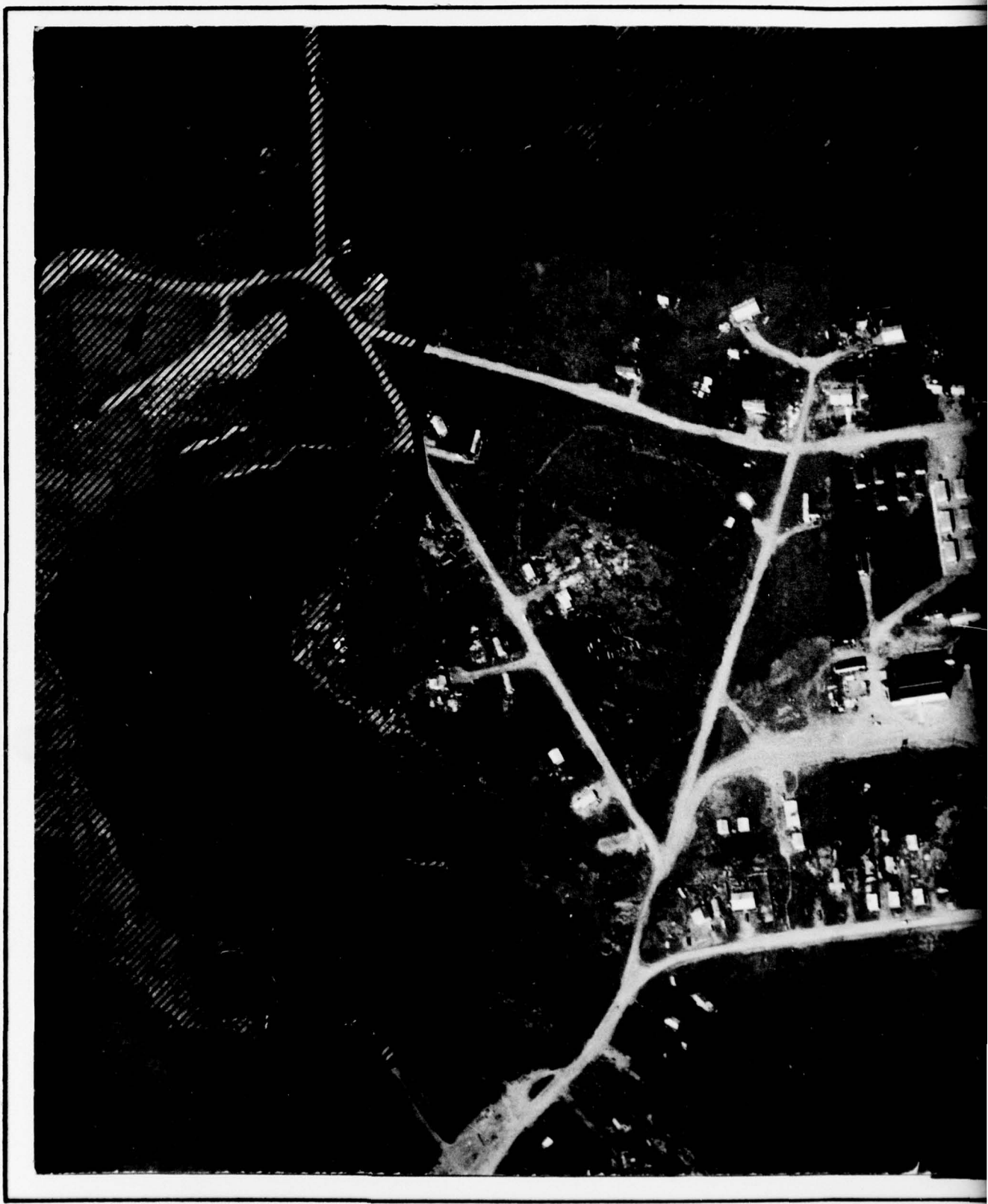
INDEX MAP

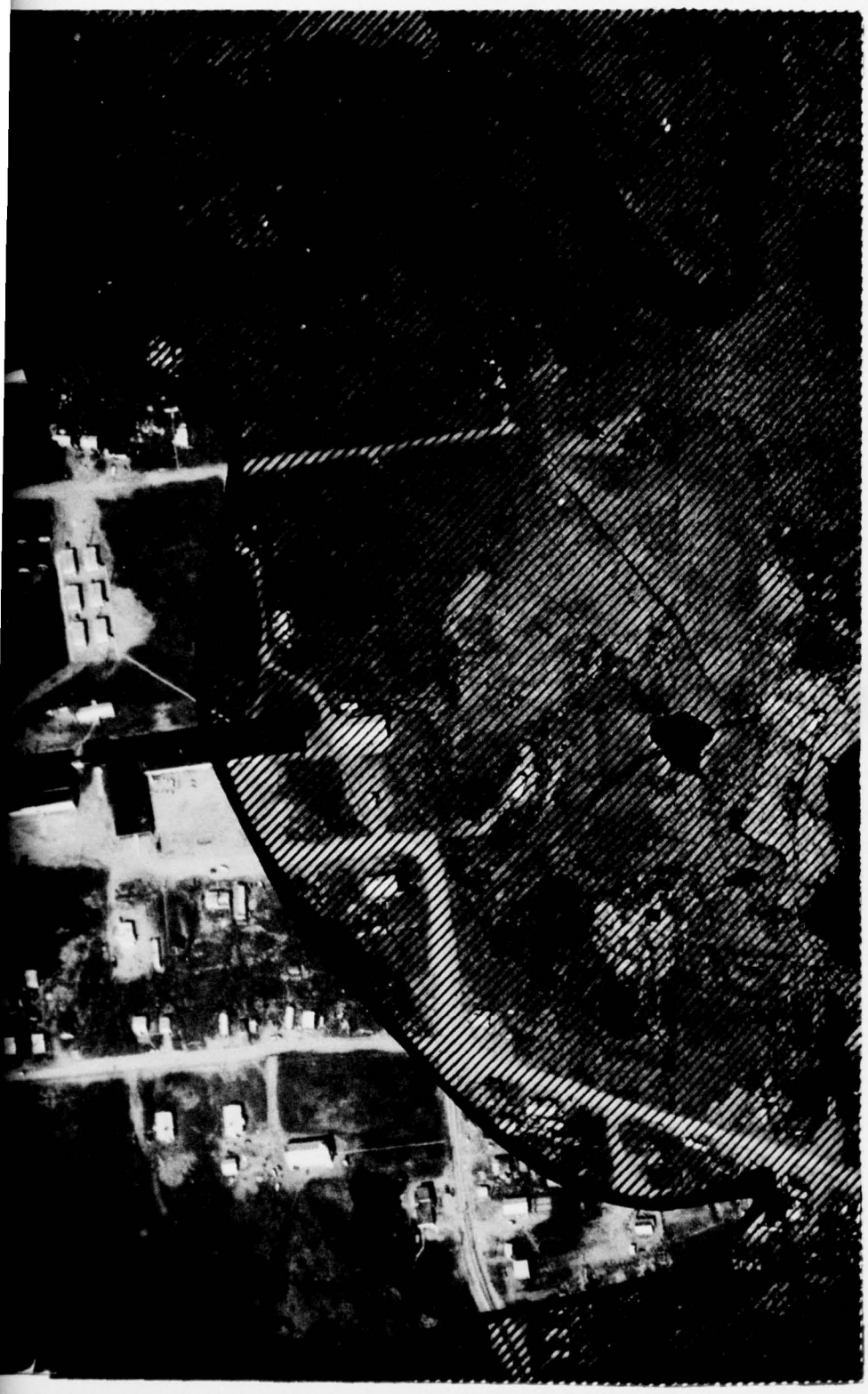
FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA

CORPS OF ENGINEERS

PLATE 3 NOV. 1968





LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

200' 0 200' 400'

SCALE IN FEET

KUSKOKWIM RIVER, BETHEL, ALASKA

FLOOD PLAIN INFORMATION STUDY

U.S. ARMY ENGINEER DISTRICT, ALASKA

CORPS OF ENGINEERS

PLATE 4

NOV. 1968

BEST AVAILABLE COPY

LEGEND

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

200' 0 200' 400'

SCALE IN FEET

KUSKOKWIM RIVER, BETHEL, ALASKA

FLOOD PLAIN INFORMATION STUDY

U. S. ARMY ENGINEER DISTRICT, ALASKA

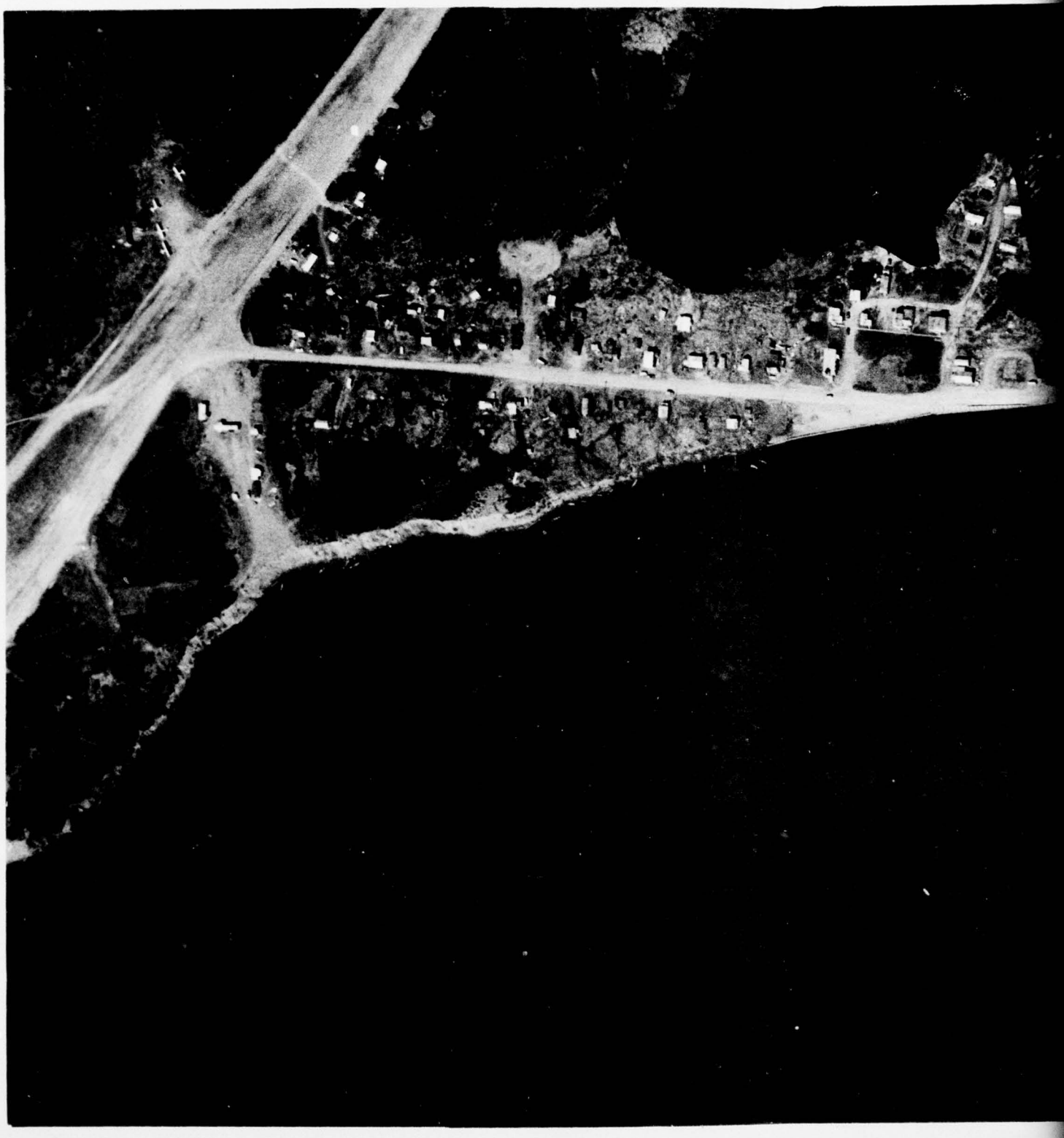
CORPS OF ENGINEERS

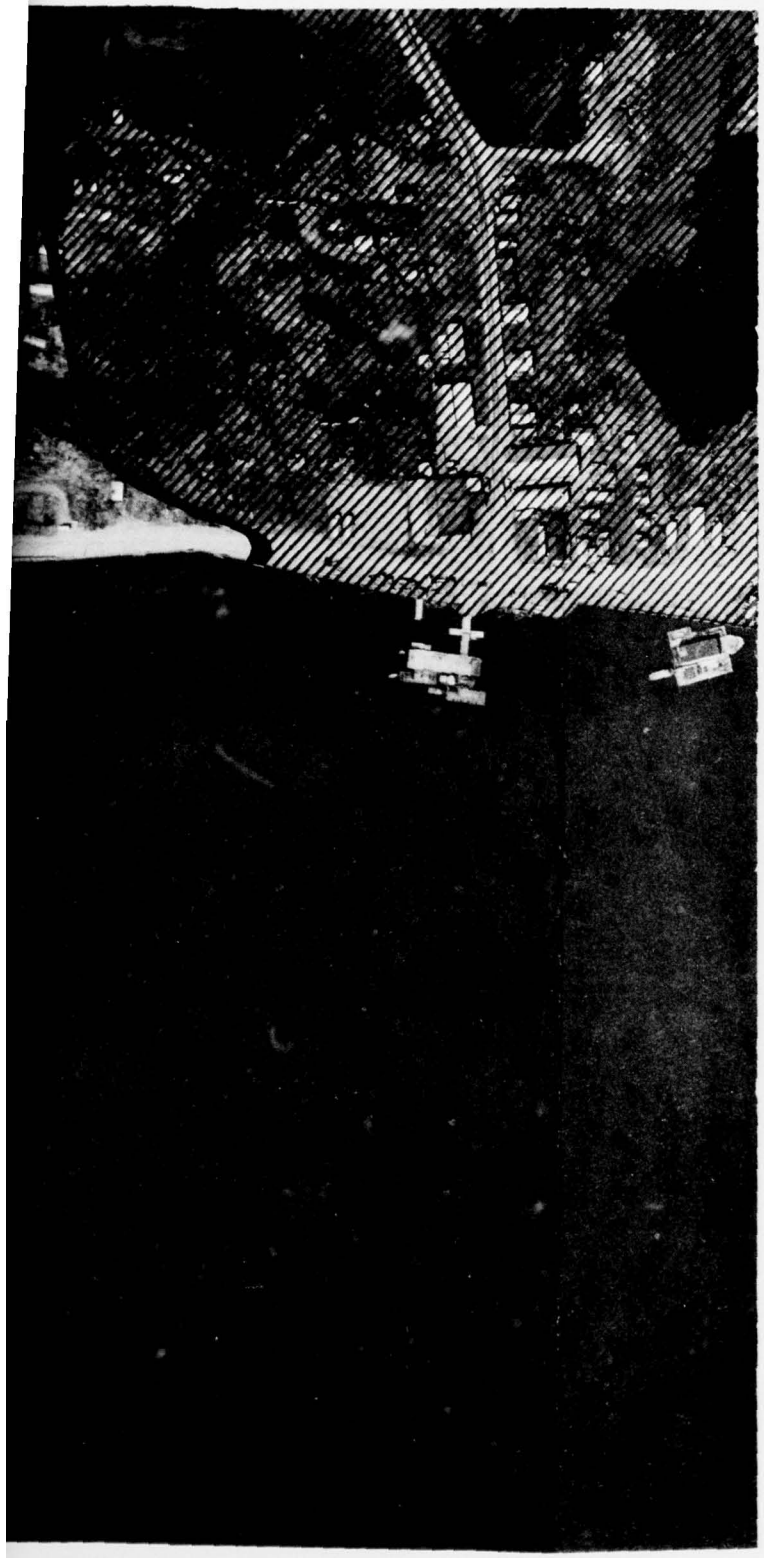
PLATE 5

NOV. 1968

1

2





LEGEND

INTERMEDIATE REGIONAL FLOOD

STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

200' 0 200' 400'

SCALE IN FEET

KUSKOKWIM RIVER, BETHEL, ALASKA

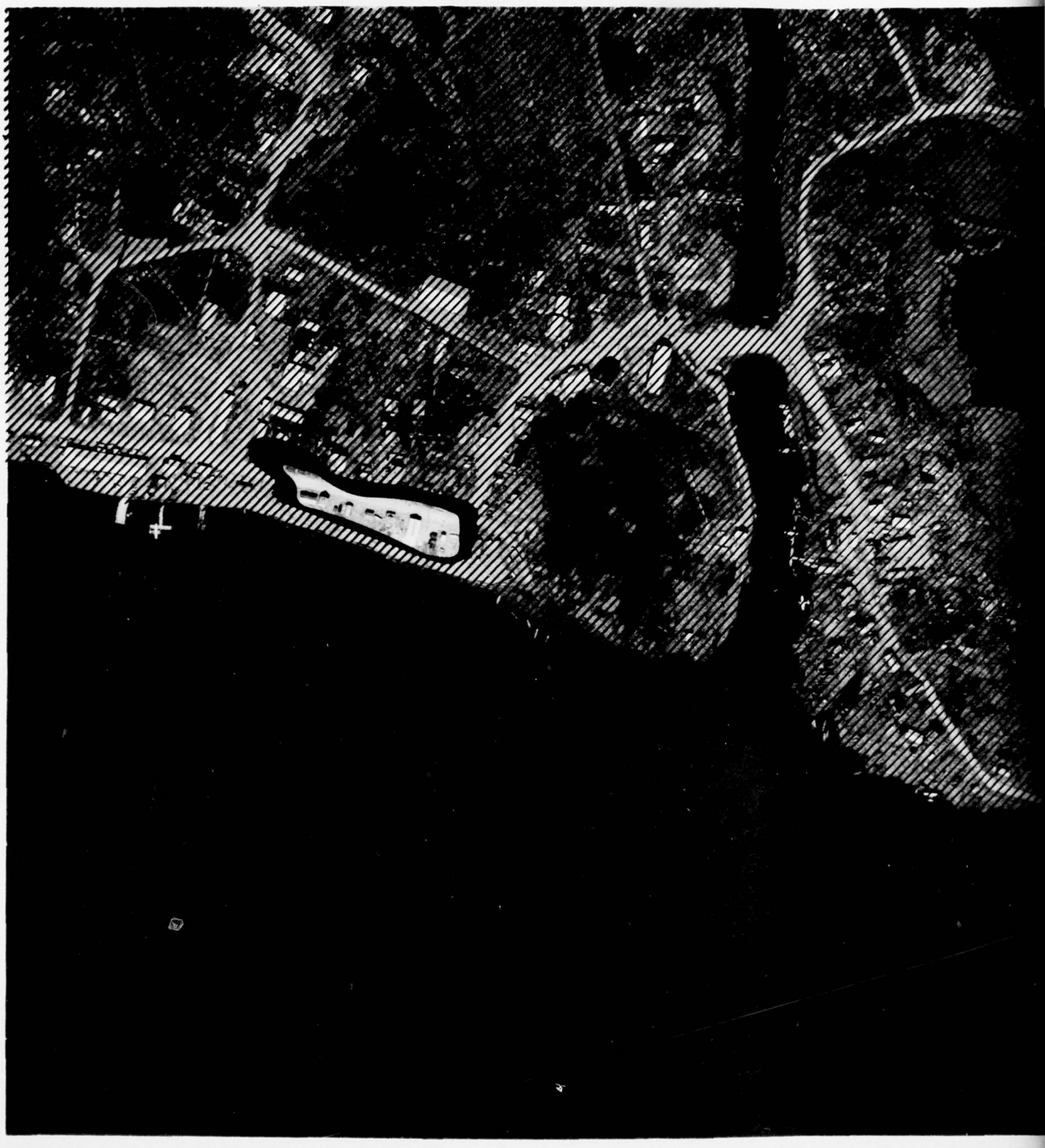
FLOOD PLAIN INFORMATION STUDY

U. S. ARMY ENGINEER DISTRICT, ALASKA

CORPS OF ENGINEERS

PLATE 6

NOV. 1968



LEGEND

INTERMEDIATE REGIONAL FLOOD — STANDARD PROJECT FLOOD

LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT.

200' 0 200' 400'

SCALE IN FEET

KUSKOKWIM RIVER, BETHEL, ALASKA

FLOOD PLAIN INFORMATION STUDY

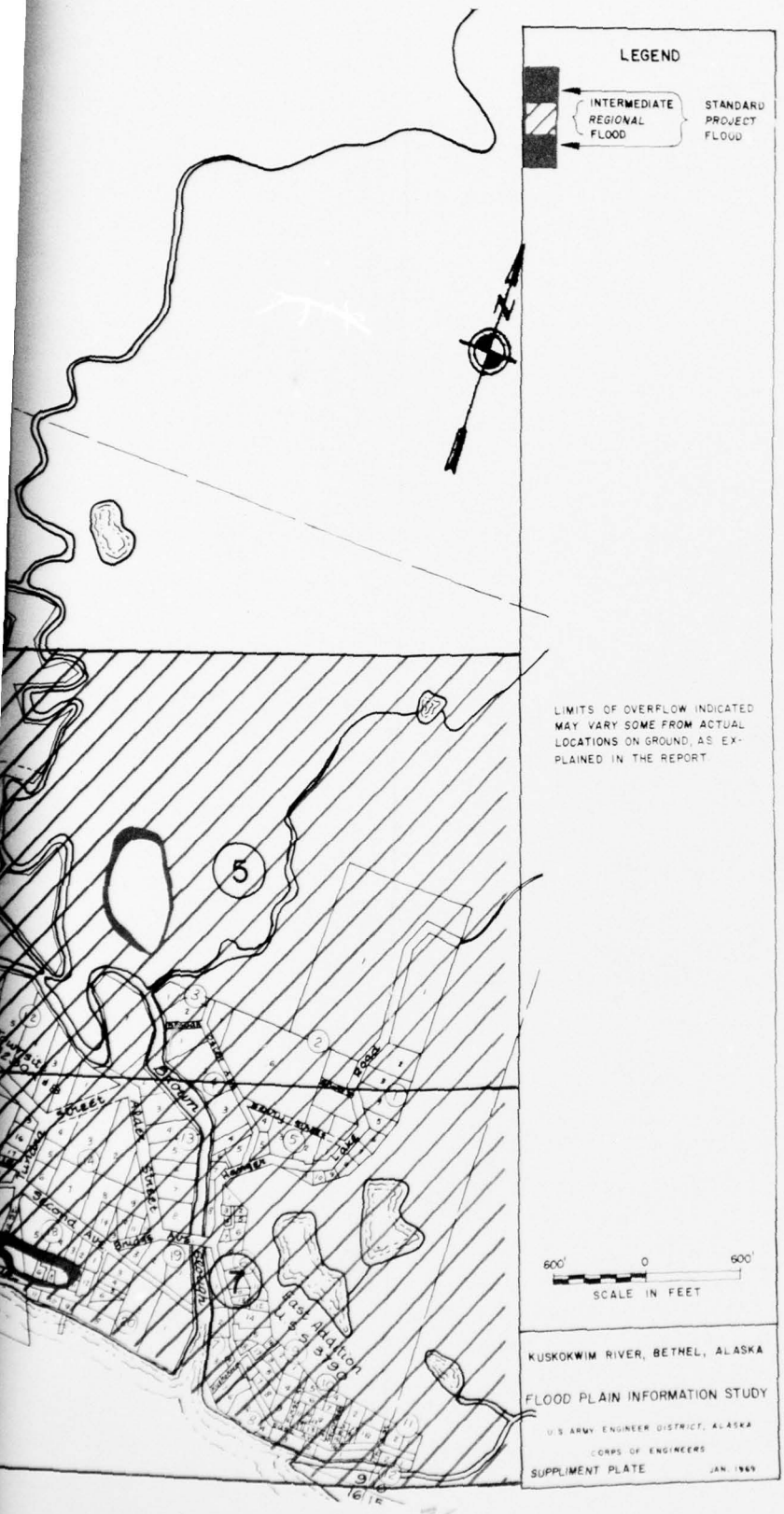
U. S. ARMY ENGINEER DISTRICT, ALASKA

CORPS OF ENGINEERS

PLATE 7

NOV. 1968

Seventh Avenue
Sixth Avenue
Fifth Avenue
Fourth Avenue
Third Avenue
Second Avenue
First Avenue
Addition
4
Northwest
U.S.S.
Duck Lake
Route 61 State Highway
U.S.S. 4000
6


LEGEND
INTERMEDIATE REGIONAL FLOOD
STANDARD PROJECT FLOOD
LIMITS OF OVERFLOW INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND, AS EXPLAINED IN THE REPORT
600' 0 600'
SCALE IN FEET
KUSKOKWIM RIVER, BETHEL, ALASKA
FLOOD PLAIN INFORMATION STUDY
U.S. ARMY ENGINEER DISTRICT, ALASKA
CORPS OF ENGINEERS
SUPPLIMENT PLATE
JAN. 1969
5
7
Second Ave
Front Street
Main Street
Lake Street
Cemetery
Road
Runway
Taxiway
Apron
Bethel
Airport
Beacon
Lights
Station
Wind Cone
Tower
Hangar
Building
Area
Boundary
Fence
Gate
Entrance
Exit
Parking
Lot
Ramp
Tie Down
Fuel
Storage
Tank
Pump
House
Office
Terminal
Waiting
Room
Restroom
Men
Women
Utility
Room
Mechanical
Room
Electrical
Room
Storage
Room
Janitor
Closet
Custodian
Equipment
Room
Maintenance
Shop
Garage
Vehicle
Parking
Area
Loading
Dock
Unloading
Dock
Receiving
Area
Shipping
Area
Warehouse
Supply
Room
Tool
Room
Parts
Room
Inventory
Control
Office
Manager
Office
Secretary
Reception
Area
Conference
Room
Meeting
Room
Training
Room
Classroom
Lecture
Hall
Auditorium
Gymnasium
Locker
Room
Shower
Room
Sauna
Swimming
Pool
Diving
Board
Lifeguard
Chair
Tennis
Court
Basketball
Court
Volleyball
Court
Baseball
Diamond
Soccer
Field
Football
Field
Track
Field
Jumping
Pit
Pole
Vault
Shot
Put
Discus
Throw
Javelin
Throw
Hammer
Throw
Long
Jump
High
Jump
Relay
Race
Marathon
Race
Walking
Race
Cross
Country
Course
Obstacle
Course
Rope
Climb
Horizontal
Bar
Parallel
Bars
Rings
Trapeze
Vaulting
Horse
Pommel
Horse
Floor
Exercise
Mat
Balance
Beam
Uneven
Bars
Rope
Ladder
Cargo
Net
Climbing
Wall
Rock
Wall
Ice
Wall
Ice
Pick
Ice
Axe
Crampons
Snowshoes
Skis
Ski
Poles
Ski
Boots
Ski
Bindings
Ski
Wax
Ski
Tuning
Kit
Ski
Repair
Kit
Ski
Storage
Rack
Ski
Lift
Ski
Tow
Ski
Jump
Ski
Slope
Ski
Trail
Ski
Patrol
Ski
Patrol
Hut
Ski
Patrol
Toboggan
Ski
Patrol
Sled
Ski
Patrol
Dog
Team
Ski
Patrol
Snowmobile
Ski
Patrol
Helicopter
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Patrol
Airplane
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Patrol
Boat
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Canoe
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Kayak
Ski
Patrol
Raft
Ski
Patrol
Rescue
Equipment
Ski
Patrol
First
Aid
Kit
Ski
Patrol
Oxygen
Tank
Ski
Patrol
Stretcher
Ski
Patrol
Blanket
Ski
Patrol
Splint
Ski
Patrol
Bandage
Ski
Patrol
Medicine
Ski
Patrol
Radio
Ski
Patrol
Telephone
Ski
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Gun
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Matches
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Fuel
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Cooking
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Patrol
Frying
Pan
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Patrol
Spatula
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Ladle
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Patrol
Knife
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Fork
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Patrol
Spoon
Ski
Patrol
Plate
Ski
Patrol
Cup
Ski
Patrol
Bowl
Ski
Patrol
Napkin
Ski
Patrol
Tablecloth
Ski
Patrol
Salt
Ski
Patrol
Pepper
Ski
Patrol
Sugar
Ski
Patrol
Coffee
Ski
Patrol
Tea
Ski
Patrol
Milk
Ski
Patrol
Cream
Ski
Patrol
Butter
Ski
Patrol
Bread
Ski
Patrol
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Jelly
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Butter
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Cheese
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Meat
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Vegetables
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Fruit
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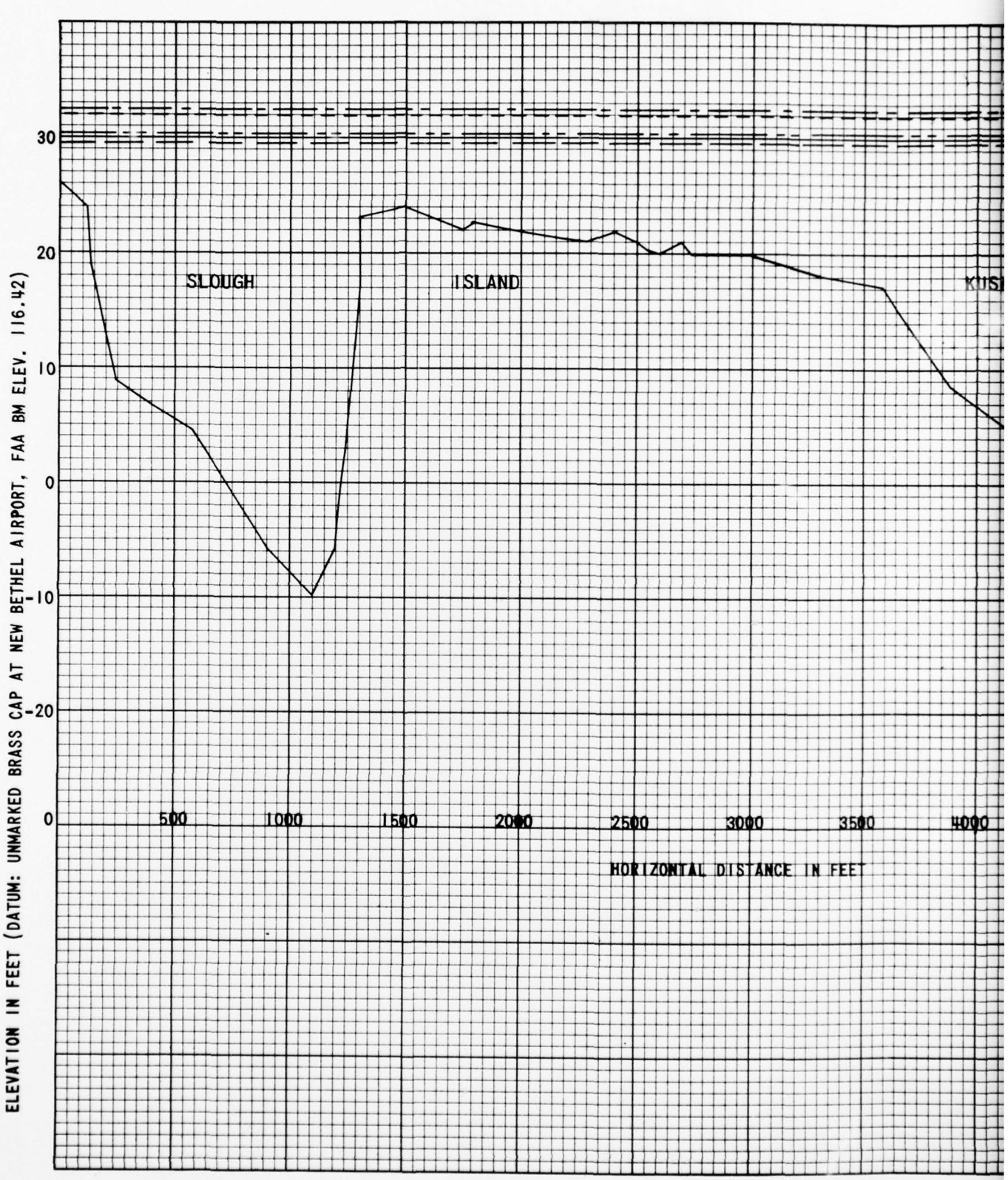
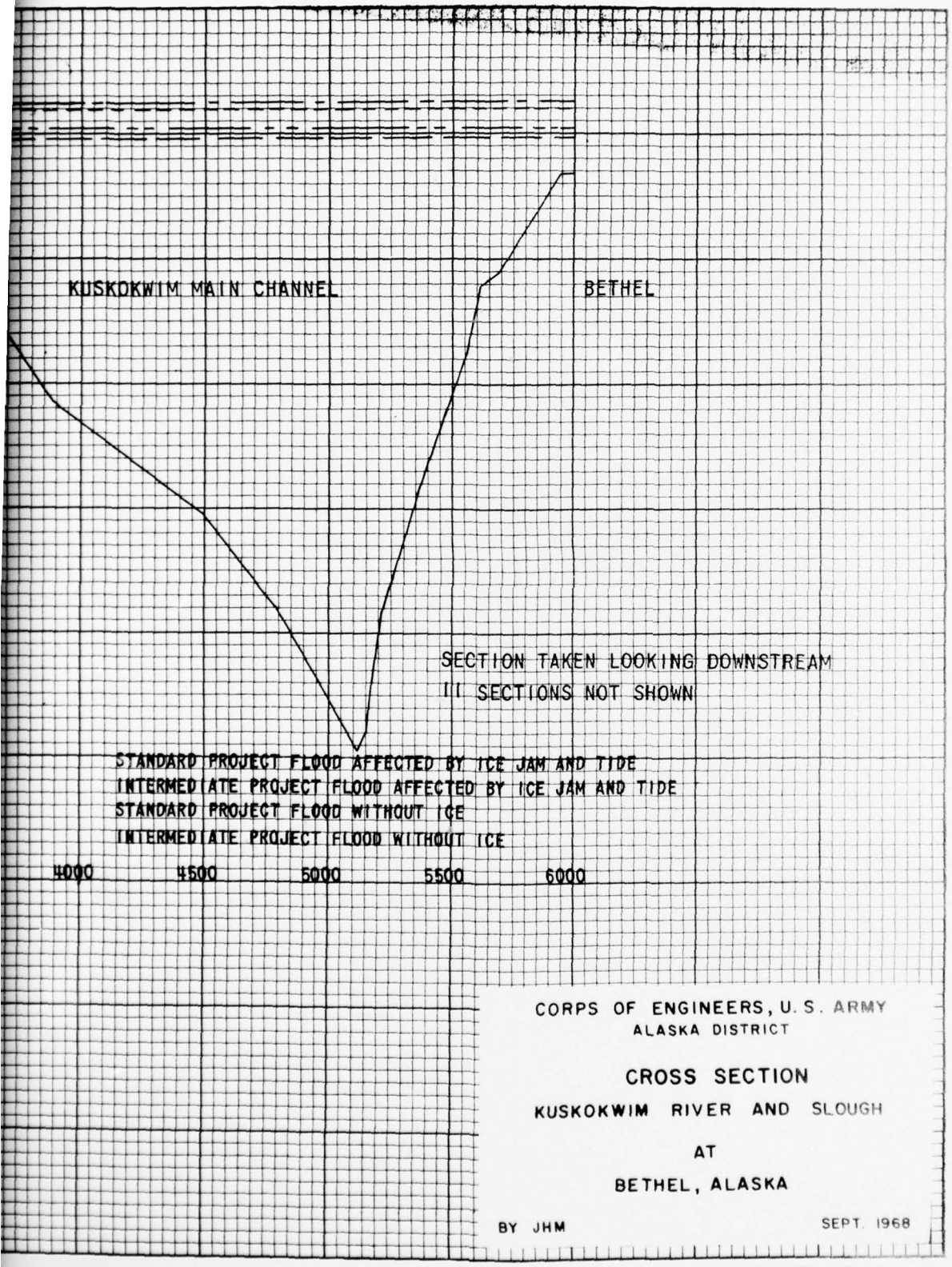
Patrol
Dessert
Ski
Patrol
Beverage
Ski
Patrol
Water
Ski
Patrol
Ice
Ski
Patrol
Snow
Ski
Patrol
Shelter
Ski
Patrol
Tent
Ski
Patrol
Sleeping
Bag
Ski
Patrol
Mattress
Ski
Patrol
Pillow
Ski
Patrol
Blanket
Ski
Patrol
Clothing
Ski
Patrol
Boots
Ski
Patrol
Gloves
Ski
Patrol
Mittens
Ski
Patrol
Hat
Ski
Patrol
Scarf
Ski
Patrol
Goggles
Ski
Patrol
Sunglasses
Ski
Patrol
Sunscreen
Ski
Patrol
Lip
Balm
Ski
Patrol
Insect
Repellent
Ski
Patrol
Bug
Net
Ski
Patrol
Fishing
Rod
Ski
Patrol
Fishing
Reel
Ski
Patrol
Fishing
Line
Ski
Patrol
Fishing
Lure
Ski
Patrol
Fishing
Hook
Ski
Patrol
Fishing
Net
Ski
Patrol
Fishing
Boat
Ski
Patrol
Fishing
Canoe
Ski
Patrol
Fishing
Kayak
Ski
Patrol
Fishing
Raft
Ski
Patrol
Fishing
Equipment
Ski
Patrol
Fishing
Tackle
Box
Ski
Patrol
Fishing
Vest
Ski
Patrol
Fishing
Waders
Ski
Patrol
Fishing
Boots
Ski
Patrol
Fishing
Gloves
Ski
Patrol
Fishing
Hat
Ski
Patrol
Fishing
Scarf
Ski
Patrol
Fishing
Goggles
Ski
Patrol
Fishing
Sunglasses
Ski
Patrol
Fishing
Sunscreen
Ski
Patrol
Fishing
Lip
Balm
Ski
Patrol
Fishing
Insect
Repellent
Ski
Patrol
Fishing


ELEVATION IN FEET (DATUM: UNMARKED BRASS CAP AT NEW BETHEL AIRPORT, FAA BM ELEV. 116.42)
30
20
10
0
-10
-20
SLOUGH
ISLAND
KIS
0
500
1000
1500
2000
2500
3000
3500
4000
HORIZONTAL DISTANCE IN FEET



CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT

CROSS SECTION

KUSKOKWIM RIVER AND SLOUGH

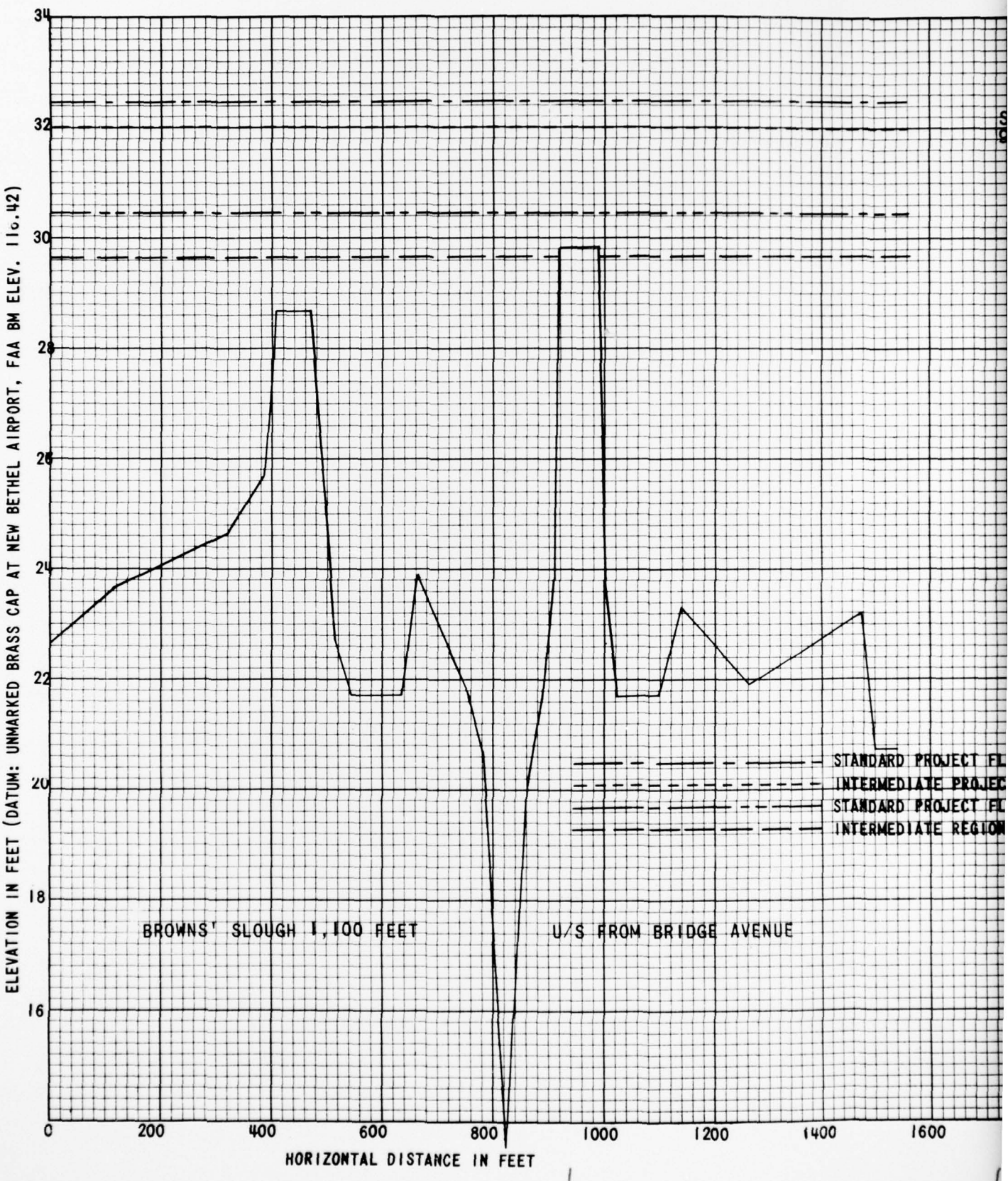
AT

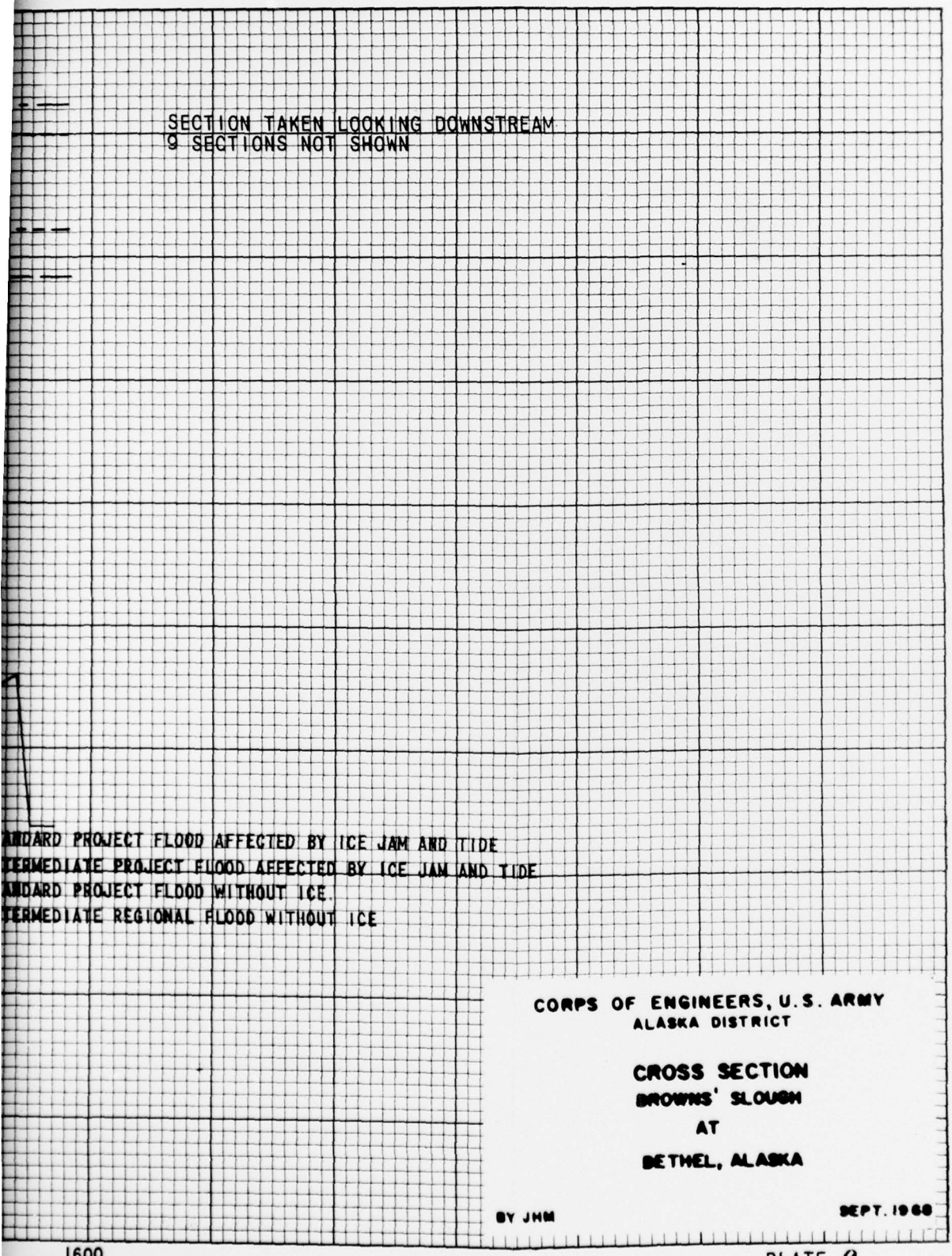
BETHEL, ALASKA

BY JHM

SEPT. 1968

PLATE 8


ELEVATION IN FEET (DATUM: UNMARKED BRASS CAP AT NEW BETHEL AIRPORT, FAA BM ELEV. 110.42)
34
32
30
28
26
24
22
20
18
16
0
200
400
600
800
1000
1200
1400
1600
HORIZONTAL DISTANCE IN FEET
BROWNS' SLOUGH 1,100 FEET
U/S FROM BRIDGE AVENUE
STANDARD PROJECT FL
INTERMEDIATE PROJEC
STANDARD PROJECT FL
INTERMEDIATE REGION



CORPS OF ENGINEERS, U.S. ARMY
ALASKA DISTRICT

CROSS SECTION
BROWNS' SLOUGH
AT
BETHEL, ALASKA

BY JHM

SEPT. 1968

1600

PLATE 9