

SUSITNA HYDROELECTRIC PROJECT

HYPOTHETICAL DAM-BREAK ANALYSES

TASK 3 - HYDROLOGY

MARCH 1982

Prepared by:



ALASKA POWER AUTHORITY

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TASK 3.05 - FLOOD STUDIES

SUBTASK 3.05(iv)
HYPOTHETICAL DAM BREAK ANALYSES - CLOSEOUT REPORT

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1 - INTRODUCTION

The proposed Susitna Hydroelectric Project will ultimately involve construction of major dams at the Watana and Devil Canyon sites. The earthfill dam at Watana will be 885 feet high and the arch dam at Devil Canyon 645 feet high. The likelihood of failure of these structures is extremely small. Nevertheless, some consideration must be given to the consequences of failure, however remote.

1.1 - Basis for Study

The scope of this subtask was defined in the Revised Scope dated . The objective of the Subtask 3.05 (iv) study is to undertake a preliminary assessment of the downstream effects of hypothetical dam failure on the Susitna River.

The scope of work involves essentially a desk study using available data and computer modeling capability. The study has been directed toward assessing the relative magnitude of dam break flood waves at various locations along the Susitna River. Although topographical data available downstream of Devil Canyon is somewhat limited, approximate estimates of dam break flood wave crest elevations are possible. Extreme conditions have been postulated for all dam failures. Thus, the analyses results are of a conservative nature. This report presents the results and conclusions of this study.

1.2 - Report Contents

Section 2 of this report is a summary of the work undertaken and its conclusions. Section 3 is an outline of the scope of work. Hypothetical dam failures which are analyzed are described in Section 4. Section 5 summarizes the technical methodology employed. The dam break wave analyses are reported in Section 6. Conclusions are presented in Section 7.

2 - SUMMARY

The objectives of this study are to analyze extreme cases of floodwaves produced by hypothetical failures of the proposed dams of the Susitna Hydroelectric Project. Scenarios of the most extreme cases of hypothetical dam failures are postulated and the resulting floodwaves routed downstream to the confluence of Trapper Creek with the Susitna River approximately 5 miles downstream from Talkeetna.

Earth/rock fill dams and concrete dams are extremely safe structures when designed properly and are capable of withstanding extremely rare natural events. Four hypothetical dam failure scenarios which create extreme conditions in the river reach have been postulated. The scenarios are based on a combination of unlikely events that have an extremely remote probability of occurrence. Hypothetical dam failure scenarios are developed for the Watana dam, the Devil Canyon dam, a domino-type failure of the two dams. A hypothetical failure of the coffer dam at Watana is also analysed.

The technical methodology adopted employs the-state-of-the-art-analysis of the problem. The dam break flood forecasting model, "DAMBRK," developed by the National Weather Service was selected to model the hypothetical dam failures and to route the resulting floodwaves downstream. Postulated geometry of the breach and duration of catastrophic failure time yield a hydraulically instantaneous failure of the dams resulting in the most extreme flood waves being generated. United States Geological Survey (USGS) quadrangle maps with contour intervals of 50 feet and 100 feet have been used in defining the river cross sections below Devil Canyon dam site.

Flood hydrographs of the hypothetical failures have been dynamically routed down the Susitna River. Peak flood levels, peak discharges, and time interval to peak were determined at various points of interest along the river.

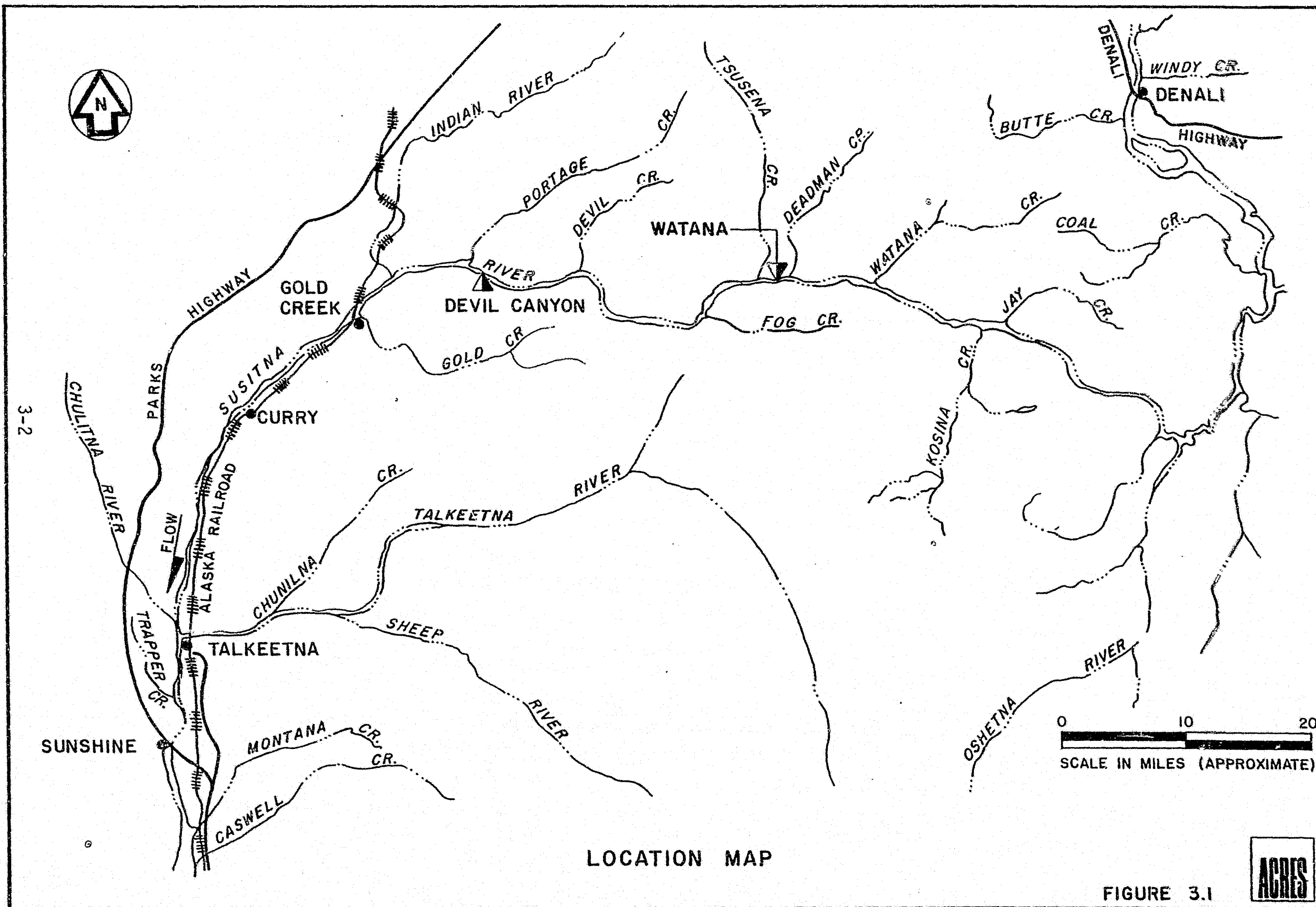
The hypothetical dam failures at Watana and Devil Canyon produce extremely large steep fronted flood waves which travel rapidly down the Susitna River. The hypothetical domino-type failure of the dam at Watana and Devil Canyon produces the highest flood wave at Talkeetna with a height 54 feet above the Probable Maximum Flood (PMF) level and would crest approximately 5 hours after initiation of failure at Watana. The hypothetical cofferdam failure at Watana produces water levels which are considerably lower than those produced by the PMF but approximately 4 feet higher than the 50-year flood level at Talkeetna.

3 - SCOPE OF WORK

The objectives of this study are to analyze extreme cases of flood waves produced by hypothetical failures of the proposed dams of the Susitna Hydroelectric Project. The analyses are carried out over the reach of the Susitna River from the most upstream point in the reservoir of the dam being considered to the confluence of Trapper Creek, approximately 5 miles downstream from Talkeetna (see Figure 3.1).

To satisfy the study objectives, the work was organized and carried out in the following manner:

- Scenarios of worst case hypothetical dam failures were postulated for the Watana dam, the Devil Canyon dam, the Watana upstream cofferdam, and a domino type failure of both the Watana and Devil Canyon dams.
- A dam break computer program was selected to assist in analyses.
- Final dam breach dimensions and time of breach formation were estimated for each scenario.
- Downstream valley topographical and vegetative information were assembled and the geometric models were prepared.
- Dam break hydrographs were developed and routed downstream. Peak flood elevations, time to peak, and peak discharges were determined at various downstream locations for each of the postulated failures.
- The study was completed with analyses of the routed hydrographs and a comparison of flood wave crest levels in the river reach under dam break and probable maximum flood conditions together with the 50 year flood conditions.



4. - HYPOTHETICAL DAM FAILURE SCENARIOS

Earth/rockfill dams are extremely safe structures capable of safely withstanding severe seismic shaking. The structure is normally designed to slump during a severe earthquake without being overtopped. As with all major water retaining structures, the safety of the development is also dependent on the performance of properly designed spillway facilities to safely discharge severe floods. Should spillway facilities not perform satisfactorily during a major seismic event (they are normally very conservatively designed to do so), there is a risk of overtopping of the earth/rockfill dam which could lead to a breach and subsequent failure.

Concrete dams are also extremely safe structures capable of safely withstanding severe seismic shaking and flood conditions. However, there is a very remote possibility of a flood of unforeseen magnitude occurring simultaneously with severe seismic shaking which together with spillway malfunction might lead to overtopping of the dam and under extremely adverse conditions, breaching of the structure.

Four hypothetical dam failure scenarios which create extreme conditions in the river reach have been postulated. The probability of any of these scenarios actually occurring is considered to be extremely small, but still not equal to zero. The hypothetical dam failure scenarios are described below.

4.1 - Hypothetical Watana Dam Failure

The remote possibility of a failure at Watana would have to be based on a combination of unlikely events. For study purposes these events are assumed as follows: Prior to the construction of the Devil Canyon dam, a major earthquake and a Probable Maximum Flood (PMF) simultaneously occur at Watana. All normal outflow facilities are inoperable and only the emergency spillway is left to discharge flows from the reservoir. Seismic activity causes the Watana dam to slump to a crest elevation of 2205. The rockfill dam catastrophic failure is initiated when the reservoir level is three above over the crest level (El. 2208).

4.2 - Hypothetical Devil Canyon Dam Failure

Similarly, at Devil Canyon the following combination of unlikely events is assumed: The Devil Canyon arch dam fails during a PMF routed through the Watana reservoir. All of the Devil Canyon dam normal outflow facilities are inoperable and only the emergency spillway discharges flows downstream. The Devil Canyon arch dam failure is initiated when the Devil Canyon reservoir reaches the maximum level or when thirty feet of water is flowing over the arch dam, whichever occurs first. Failure of the saddle dam is not considered since this case would produce lower discharges and water levels below the dam compared to the failure of the arch dam.

4.3 - Hypothetical Domino Type Failures

In this case, the following combination of unlikely events is assumed: This scenario is a combination of the Watana and Devil Canyon failure scenarios. The Watana dam failure triggers a failure of the Devil Canyon arch dam. The Watana dam failure is the same as that postulated in Section 4.1 followed by Devil Canyon arch dam failure as postulated in Section 4.2. The Devil Canyon reservoir level at which catastrophic failure begins is that level which is determined during the analysis of the hypothetical Devil Canyon dam failure.

4.4 - Hypothetical Watana Cofferdam Failure

In this case, the following scenario is assumed: The upstream Watana cofferdam fails during a fifty year flood. The diversion tunnels are sufficiently obstructed to raise the pool level three feet over the dam crest. The cofferdam crest elevation is 1545 and catastrophic failure is initiated at a pool level of 1548.

5 - TECHNICAL METHODOLOGY

The technical methodology employed yields the most accurate results reasonably achievable given the constraints of the problem. This methodology employs state-of-the-art analysis of the problem and is described in the following sections.

5.1 - Dam Break Computer Program Selection

The National Weather Service (NWS) dam break flood forecasting model, "DAMBRK," by Dr. Danny Fread (2) was selected to model the hypothetical dam failures. McMahon (4), United States Geological Survey (5), and others have judged this model to be the best dam break model currently available. The NWS DAMBRK model includes an extremely versatile dynamic flood routing program which solves the Saint Venant equations by implicit finite difference techniques.

The dam break hydrograph is developed internally by the Fread method. The hydrograph is dependent on the final breach shape and the time over which the breach develops. Specific breach input parameters are bottom width, bottom elevation, side slopes, and time of failure (see Figure 5.1).

The program requires minimal river cross section data. Of major importance is river slope, roughness, and valley geometry. DAMBRK interpolates cross sections at intervals as needed and specified by the user. This capability is nearly essential for numerical stability requires that the distance between cross sections be approximately equal to the product of the wave speed and the time step used in the analysis.

To determine the hypothetical failure pool level of the Devil Canyon arch dam discussed in Section 4.2, the Modified Puls method, a storage routing technique based on the continuity principle, was employed to rout the PMF through the Watana and the Devil Canyon reservoirs. This method was also used to determine the point on the PMF hydrograph at which the hypothetical Watana dam failure commences. The Modified Puls routing was accomplished with an Acres' in-house computer program.

5.2 - Breach Dimensions and Time of Failure

The final breach geometry is specified in DAMBRK by bottom width, bottom elevation, and side slopes which must be equal on both sides. The natural channel width and elevation at the sites have been used as breach dimensions. Breach side slopes are assumed to be one horizontal to one vertical for an earth/rockfill dam and the average valley slope for the arch dam.

Development of the breach commences when the pool level is equal to or greater than the assumed failure elevation. Breach progression is directly related to the ratio of the time passed since start of failure to the total duration of failure, or "time of failure". The time of failure pertains to only the catastrophic event and not to the relatively lower antecedent discharges. Dam break hydrographs can be very sensitive to the time of failure. Unfortunately, there is no method available to accurately determine time of failures. Time of failures may be either crudely estimated based on erosion characteristics of the

dam and/or determined as that time which would produce a hydraulically instantaneous failure. The unreliability of time of failure prediction necessitated a sensitivity analysis. Watana dam time of failures of 2.5 hours and 3.0 hours were analyzed. These times are based on a conservative estimate of time required to erode approximately 49 million cubic yards of material. Devil Canyon time of failures of 0.4 hours and 0.5 hours were analyzed. A Watana cofferdam time of failure of 0.5 hours was assumed. The domino failure scenario is based on a Watana time of failure of 2.5 hours and a Devil Canyon time of failure of 0.5 hours.

5.3 - Geometric Model

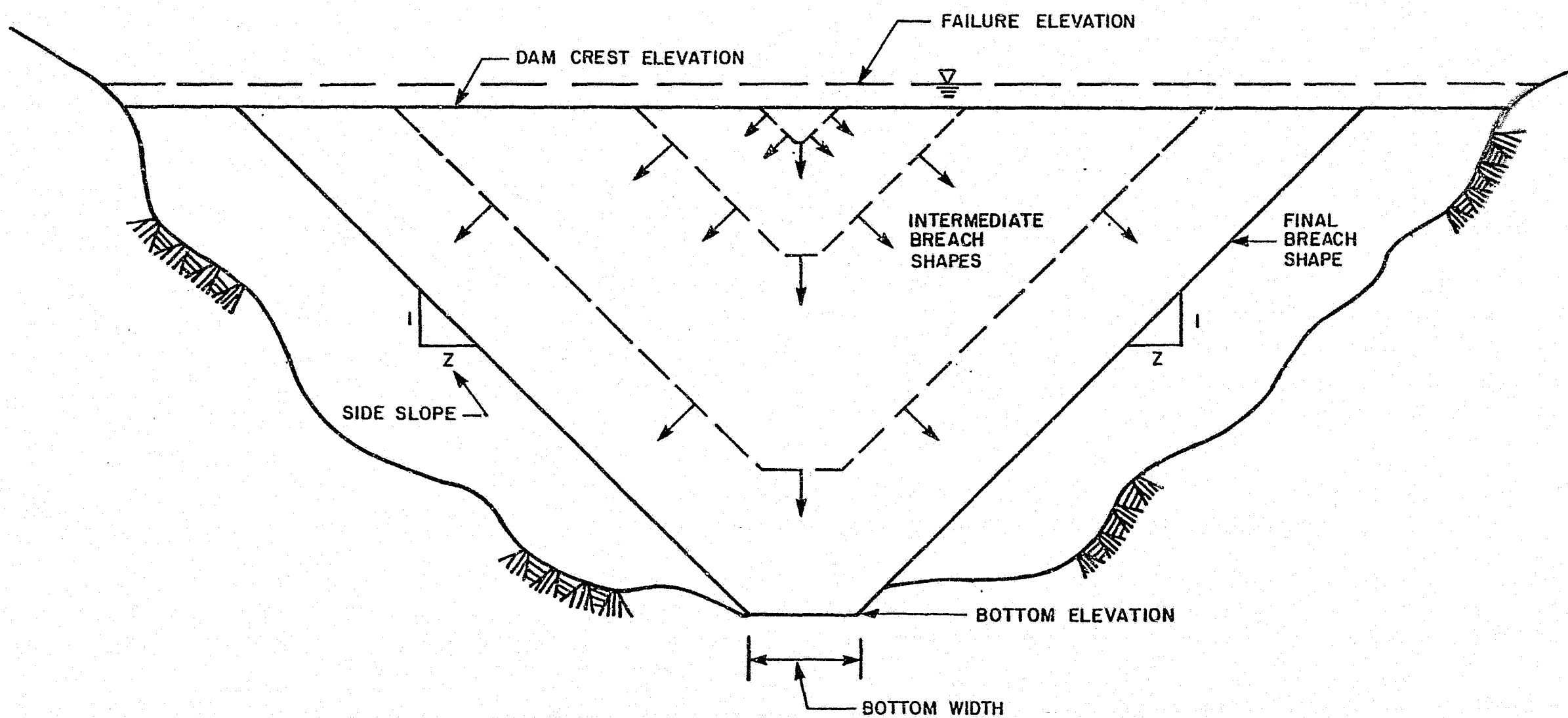
A simplified geometric model representative of the river valley is input into DAMBRK. Cross sections are required only at significant changes in river slope or valley cross section. Eight elevations and corresponding valley widths are input to define each river cross section. Additional sections are created in the model by interpolation. Surface roughness is expressed as the Manning coefficient "n" and input for each reach defined by the original sections.

The majority of cross section information was taken from United States Geological Survey quadrangle maps with a horizontal scale of 1:63360 and 100 foot contour intervals upstream of the Town of Chase and 50 foot intervals downstream of Chase. More detailed river valley topographical information is available only in the vicinity of Devil Canyon and Watana.

To define the downstream cross section geometry it is desirable to have more detailed information than currently available. This is especially true in the vicinity of Talkeetna where the river valley width is in the range of two to three miles and only 50 foot contour intervals are available. Nevertheless, the available topographical information is sufficient to analyze flood waves with reasonable accuracy.

The Manning coefficients were predicted for the reaches of the Susitna River. Manning's coefficient calculations for the over bank area are based on bottom friction and drag from partially submerged obstructions (6). Composite "n" values were determined using the assumption of equal velocity across the section (1). Preliminary DAMBRK runs showed that in a few reaches the flow regime changed with time from subcritical to supercritical and back to subcritical as the dam break flood wave passed through a reach. At numerous sections, the Froude number became so large that mathematical nonconvergence occurred in the computer run or the computed flow area at a cross section became zero. To eliminate modeling problems due to supercritical flow in a subcritical run, it is common practice to either alter the cross section geometry or increase the "n" value (3). Thus, in a number of reaches, the "n" values were increased to values above the predicted "n" value. The artificially high "n" values tend to reduce the speed of the wave and increase the depth of flow in the reach. The DAMBRK output has been adjusted slightly in an attempt to smooth errors created by computer modeling limitations.

5-3



BREACH DEFINITION SKETCH

FIGURE 5.1



6 - ANALYSES OF DAM BREAK FLOOD WAVES

Dam break hydrographs have been dynamically routed down the Susitna River to the confluence of Trapper Creek which is approximately 5 miles downstream from Talkeetna. Peak flood levels, peak discharges, and time to peak were determined along the river. The following sections summarize the study results and discuss sensitivity of the analysis to time of failure assumed.

Peak dam break flood levels are compared to the PMF and 50 year flood levels at selected cross sections and shown graphically in Figures 6.1, 6.2 and 6.3.

6.1 - Watana Failure Analyses

The hypothetical Watana dam break was analyzed for failure times of 3.0 hours and 2.5 hours. The Watana dam break hydrograph superposed on the PMF hydrograph is shown in Figure 6.4. The Watana dam break hydrograph at Watana and Talkeetna is shown in Figure 6.5. Maximum stage, flow rate, velocity, and time to peak stage are given in Table 6.1 at six locations along the Susitna River.

6.2 - Devil Canyon Failure Analyses

The hypothetical Devil Canyon dam break was analyzed for failure times of 0.5 hours and 0.4 hours. The Devil Canyon dam break hydrograph at Devil Canyon and Talkeetna is shown in Figure 6.6. Maximum stage, flow rates, velocities, and times to peak stage are given in Table 6.2.

6.3 - Domino Failure Analyses

The hypothetical domino type failure analysis is based on failure times of 2.5 hours and 0.5 hours at Watana and Devil Canyon, respectively. The dam break hydrograph at the Devil Canyon dam and Talkeetna is shown in Figure 6.7. Maximum stage, flow rates, velocities, and times to peak stage are given in Table 6.3.

6.4 - Watana Cofferdam Failure Analysis

The hypothetical Watana cofferdam failure analysis is based on a failure time of 0.5 hours. The Watana cofferdam hydrograph at Watana and Talkeetna is shown in Figure 6.8. Maximum stage, flow rates, velocities, and times to peak stage are given in Table 6.4.

6.5 - Sensitivity Analysis Discussion

The sensitivity analysis conducted revealed that the failure times chosen give results not significantly different from those for hydraulically instantaneous failure times. Both the Devil Canyon and Watana peak discharges increased only slightly with reduced failure times. Differences in downstream effects are not discernible over the range of failure times tested. However, since much longer failure times would be outside of the hydraulically instantaneous failure range, they should significantly reduce the downstream affects of dam failure.

TABLE 6.1: WATANA DAM BREAK ANALYSES SUMMARY TABLE

Location	Maximum Stage (ft)		Maximum Flow (cfs)		Maximum Velocity (fps)		Time to Peak Stage (hr)		PMF Stage (ft)
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	
Watana	N.A.	N.A.	42,624,000	40,464,000	76	73	N.A.	N.A.	N.A.
Indian River	126	125	30,121,000	29,390,000	63	63	3.9	4.3	22
Gold Creek	179	177	29,980,000	29,239,000	40	39	4.2	4.6	31
Curry	205	203	27,939,000	27,439,000	62	62	4.5	4.9	53
Talkeetna	77	77	26,331,000	25,992,000	16	17	5.4	5.7	25
Trapper Creek	85	85	26,175,000	25,910,000	21	21	5.9	6.2	15

(1) 2.5 hour time of failure
(2) 3.0 hour time of failure

TABLE 6.2: DEVIL CANYON DAM BREAK ANALYSES SUMMARY TABLE

Location	Maximum Stage (ft)		Maximum Flow (cfs)		Maximum Velocity (fps)		Time to Peak Stage (hr)		PMF Stage (ft)
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	
Devil Canyon	N.A.	N.A.	11,453,000	10,963,000	60	59	N.A.	N.A.	N.A.
Indian River	73	73	9,054,000	9,116,000	43	43	0.8	0.9	22
Gold Creek	103	103	8,512,000	8,598,000	31	31	0.8	1.0	31
Curry	112	112	6,391,000	6,408,000	37	37	1.9	1.9	53
Talkeetna	42	42	5,271,000	5,274,000	9	9	3.3	3.3	25
Trapper Creek	56	56	4,608,000	4,609,000	8	8	4.1	4.2	15

(1) 0.4 hour time of failure
(2) 0.5 hour time of failure

N.A. - Not Applicable

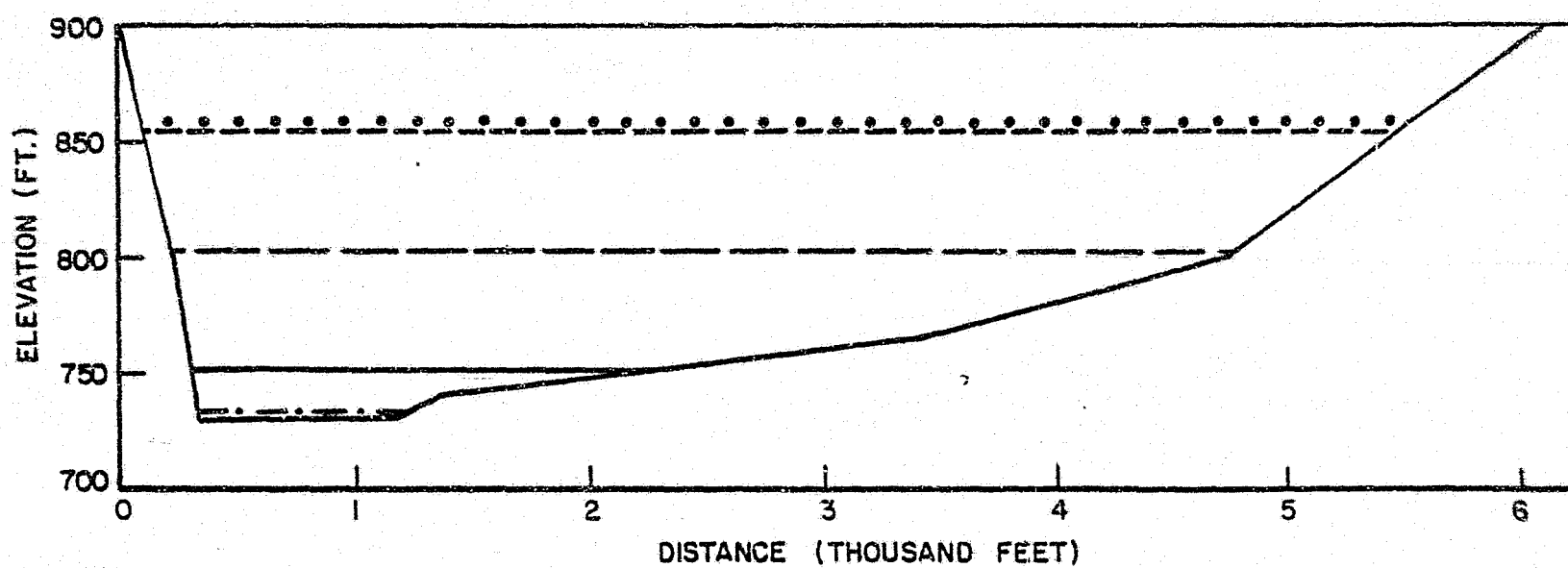
TABLE 6.3: DOMINO FAILURE ANALYSES SUMMARY TABLE

Location	Maximum Stage (ft)	Maximum Flow (cfs)	Maximum Velocity (fps)	Time to Peak Stage (hr)	PMF Stage (ft)
Watana	N.A.	42,587,000	75	N.A.	N.A.
Devil Canyon	579	31,112,000	90	3.6	N.A.
Indian River	128	31,036,000	64	3.8	22
Gold Creek	183	30,853,000	39	4.1	31
Curry	208	28,991,000	63	4.3	53
Talkeetna	79	27,553,000	17	5.2	25
Trapper Creek	86	27,457,000	21	5.7	15

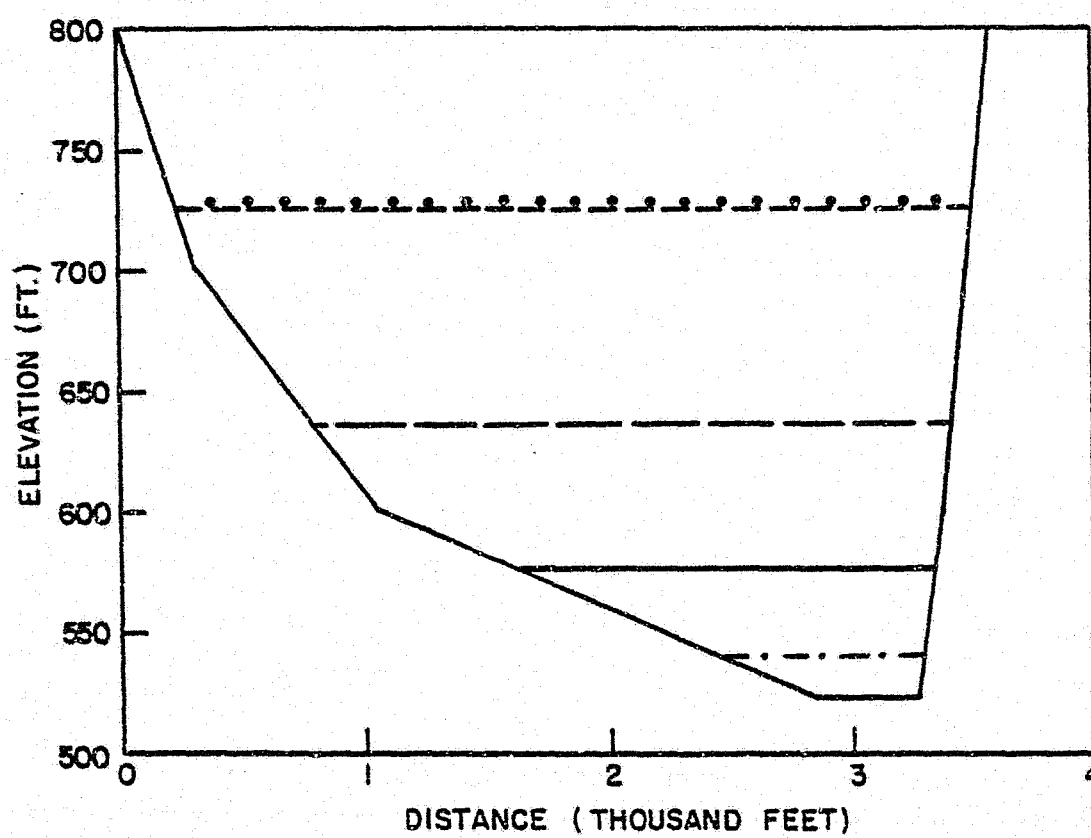
TABLE 6.4: WATANA COFFERDAM FAILURE ANALYSE SUMMARY TABLE

Location	Maximum State (ft)	Maximum Flow (cfs)	Maximum Velocity (fps)	Time to Peak Stage (hr)	50 Yr Flood Stage (ft)
Watana	N.A.	469,800	19	N.A.	N.A.
Indian River	18	321,400	15	5.0	3
Gold Creek	27	323,700	12	5.3	9
Curry	30	298,400	21	7.2	18
Talkeetna	11	290,000	6	10.1	7
Trapper Creek	11	354,900	6	10.8	5

N.A. - Not Applicable



INDIAN RIVER CROSS SECTION

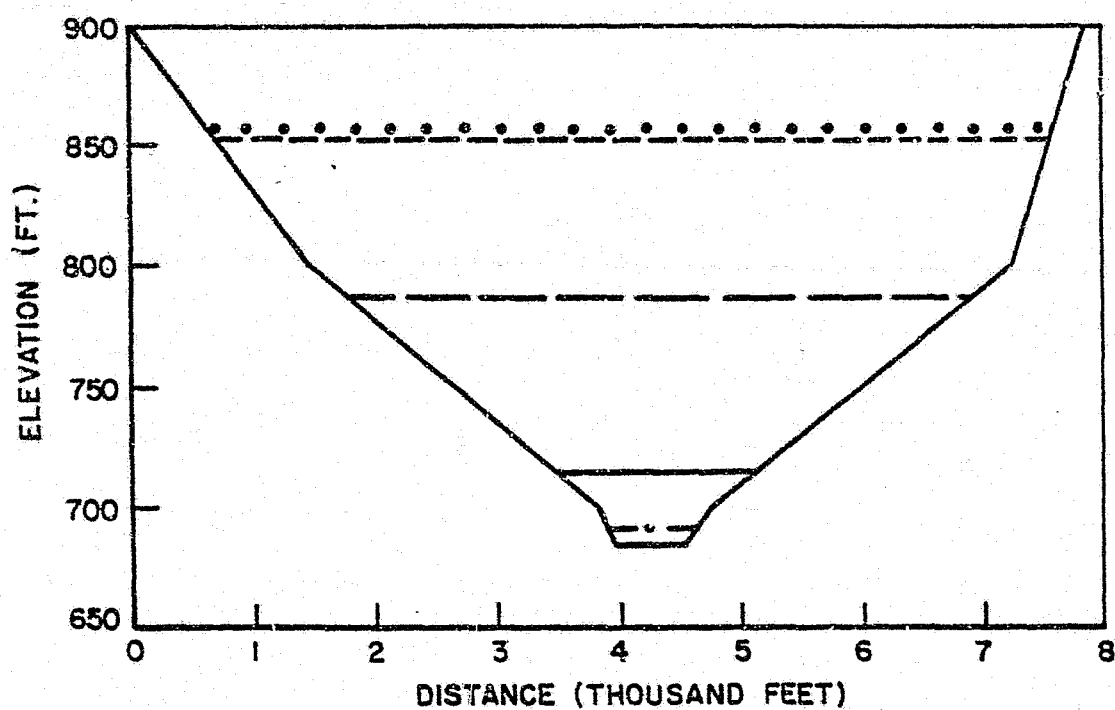


CURRY CROSS SECTION

LEGEND

- DOMINO FAILURE LEVEL
- WATANA FAILURE LEVEL -----
- DEVIL CANYON FAILURE LEVEL - - - - -
- NATURAL PMF LEVEL =====
- 50 YEAR FLOOD LEVEL - . - . - .

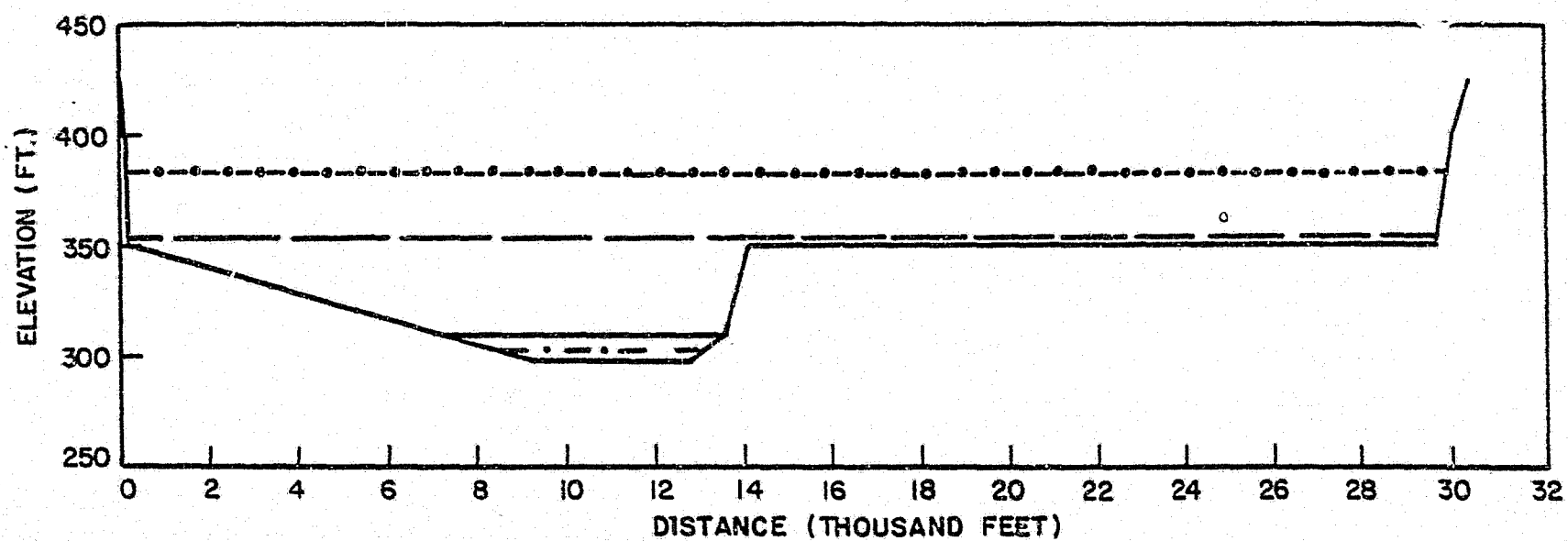




LEGEND

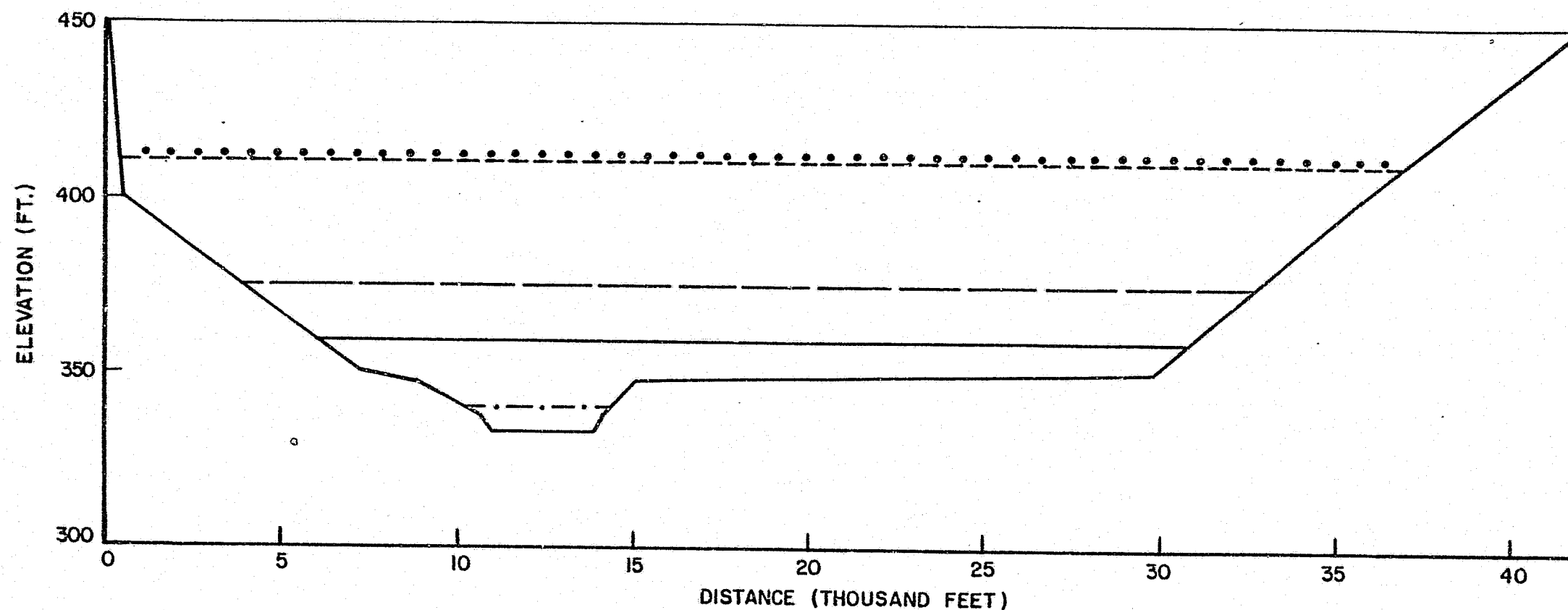
DOMINO FAILURE LEVEL	
WATANA FAILURE LEVEL	-----
DEVIL CANYON FAILURE LEVEL	————
NATURAL PMF LEVEL	————
50 YEAR FLOOD LEVEL	- . - . - .

GOLD CREEK CROSS SECTION



TRAPPER CREEK CROSS SECTION

9-9



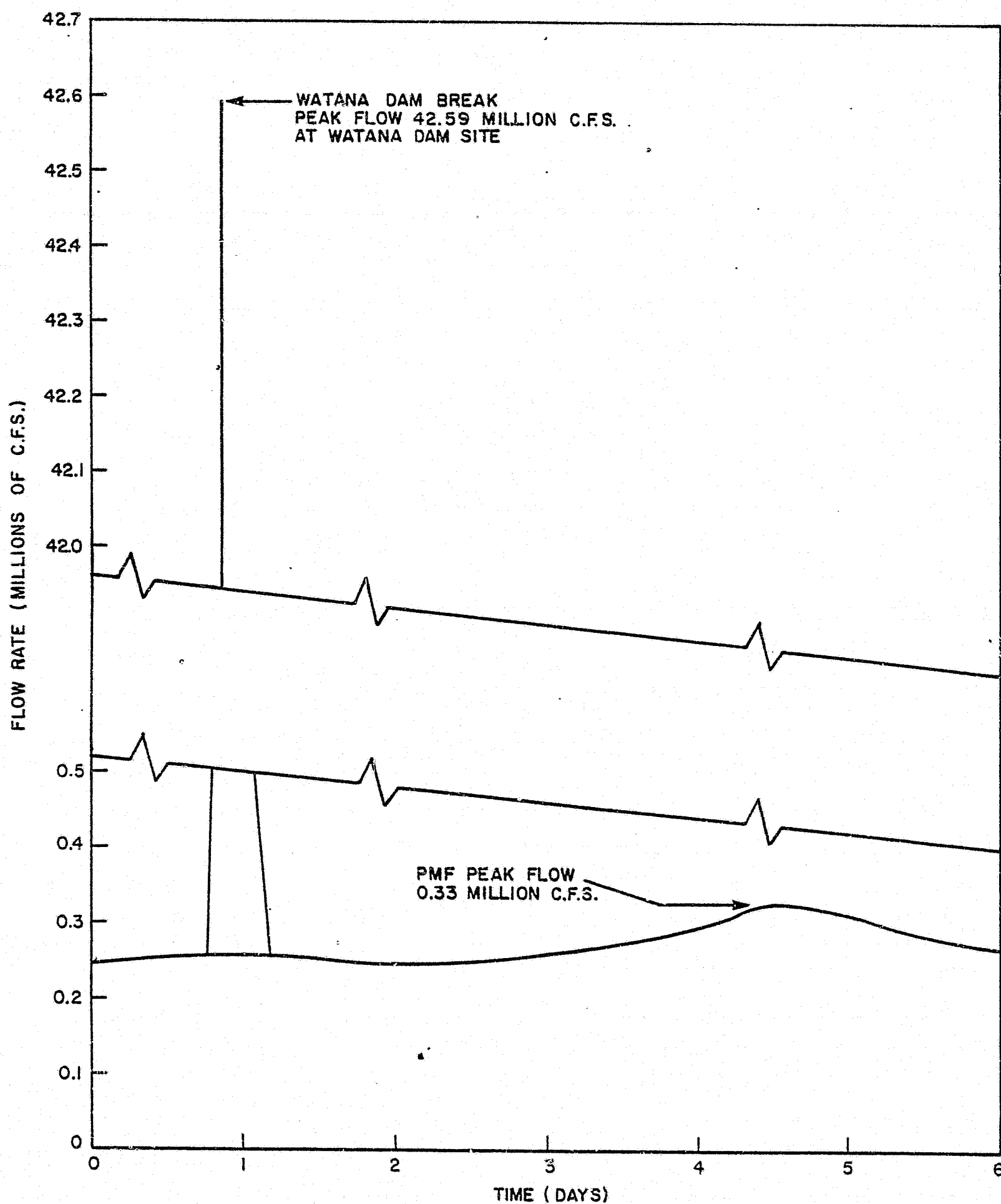
LEGEND

DOMINO FAILURE LEVEL	
WATANA FAILURE LEVEL	-----
DEVIL CANYON FAILURE LEVEL	- - - - -
NATURAL PMF LEVEL	—————
50 YEAR FLOOD LEVEL	- . - . - .

TALKEETNA CROSS SECTION

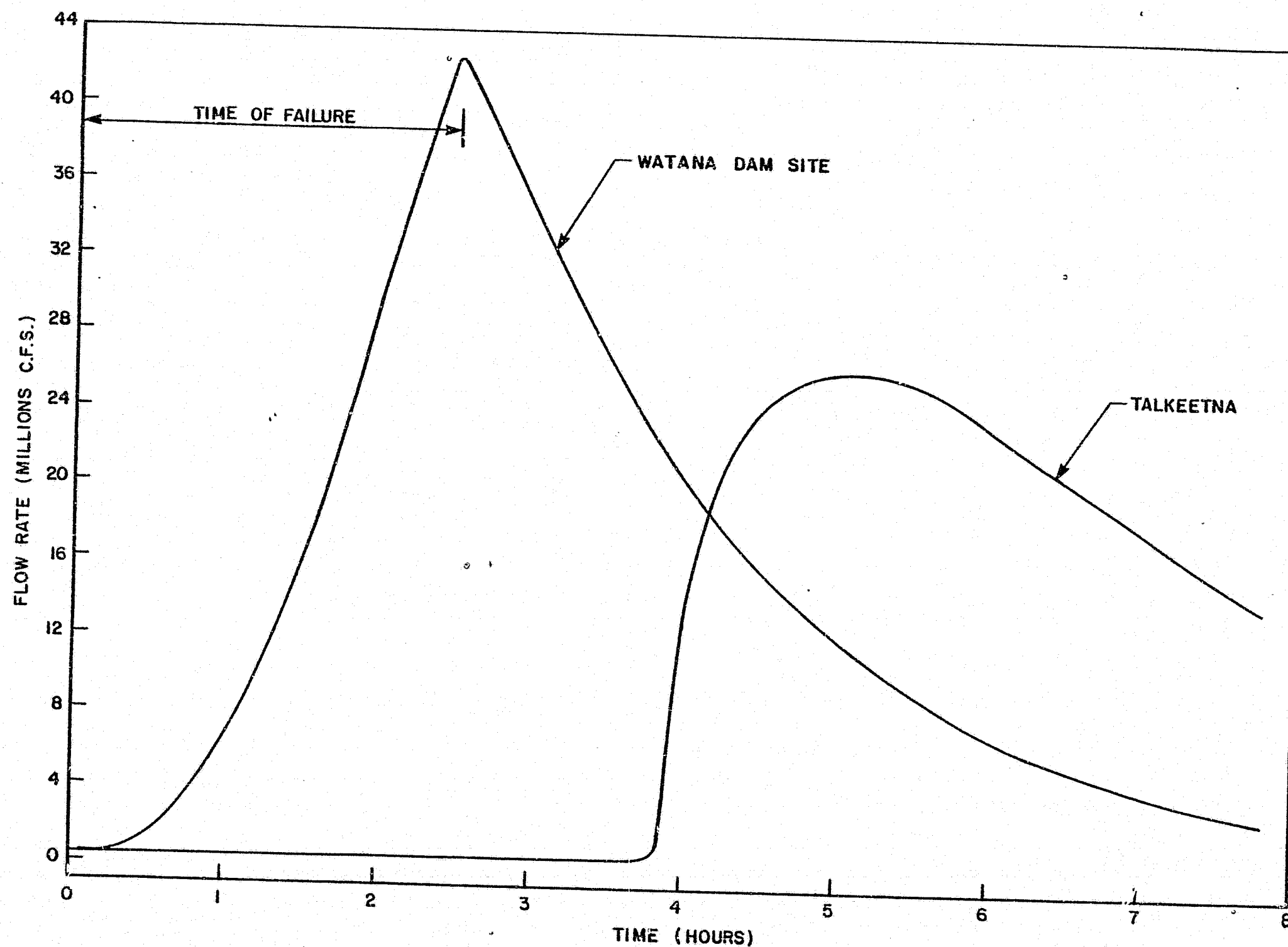
FIGURE 63





WATANA DAM BREAK HYDROGRAPH
SUPERPOSED ON THE PMF HYDROGRAPH

8-9

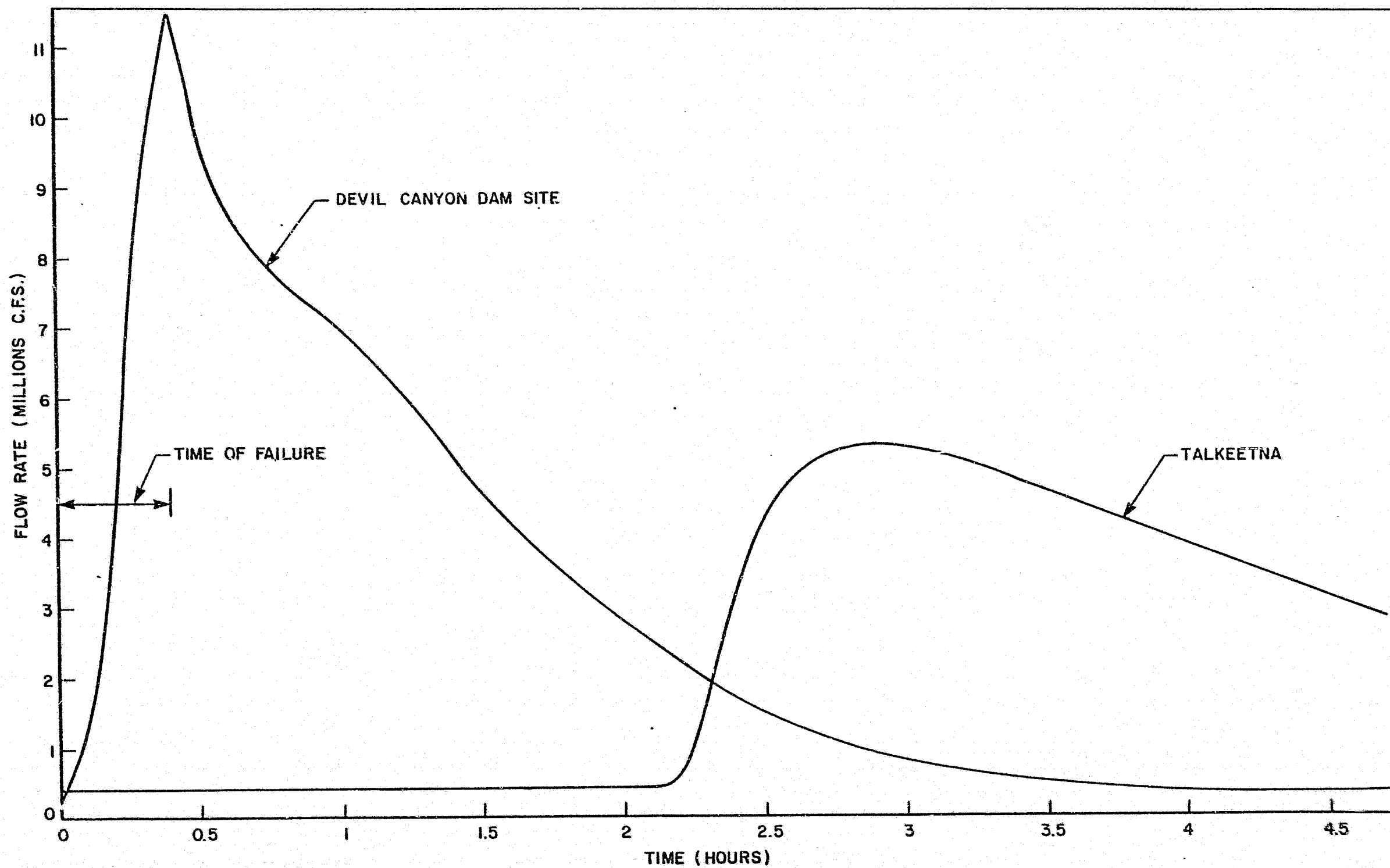


WATANA DAM BREAK HYDROGRAPH

FIGURE 6.5



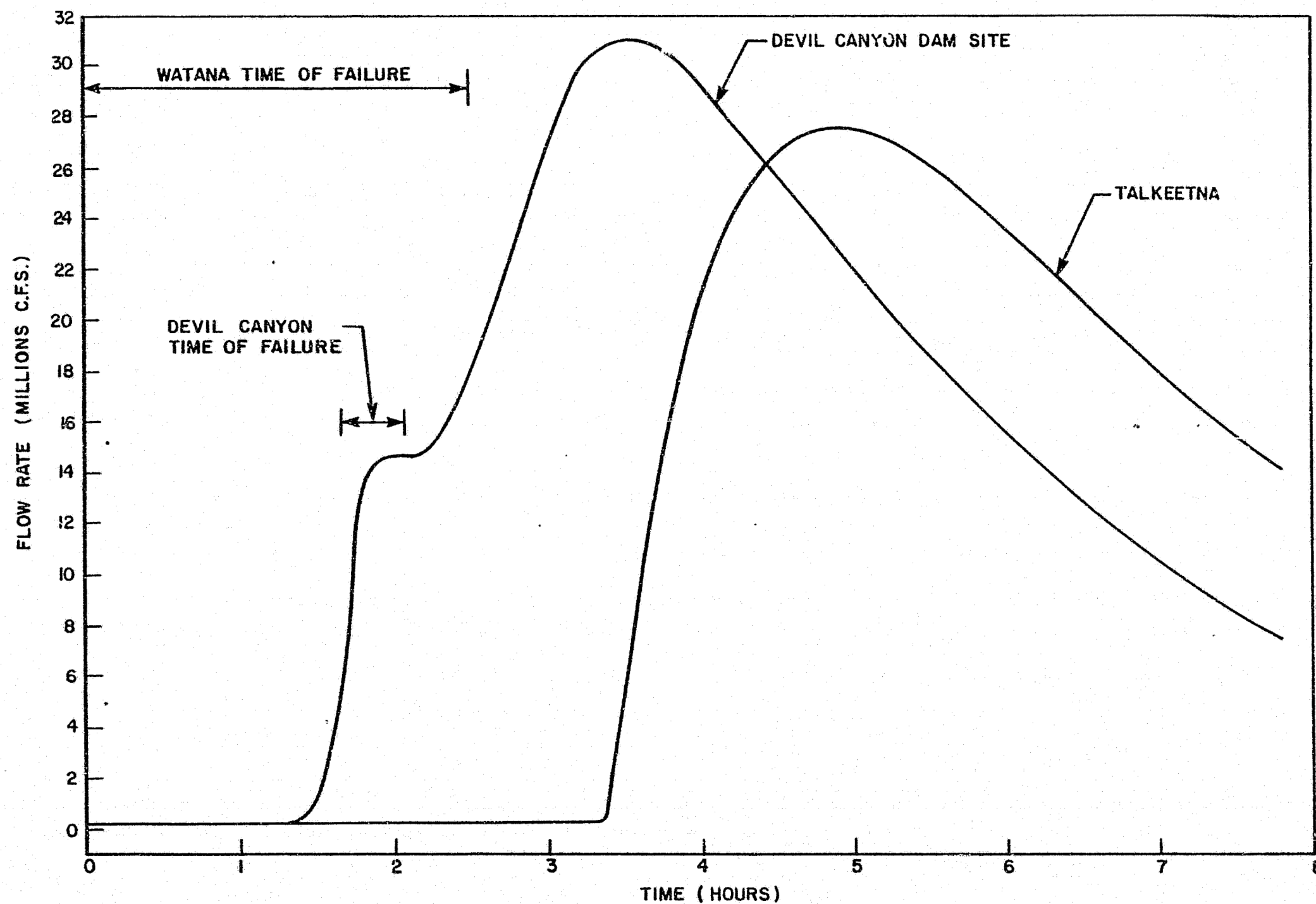
6-9



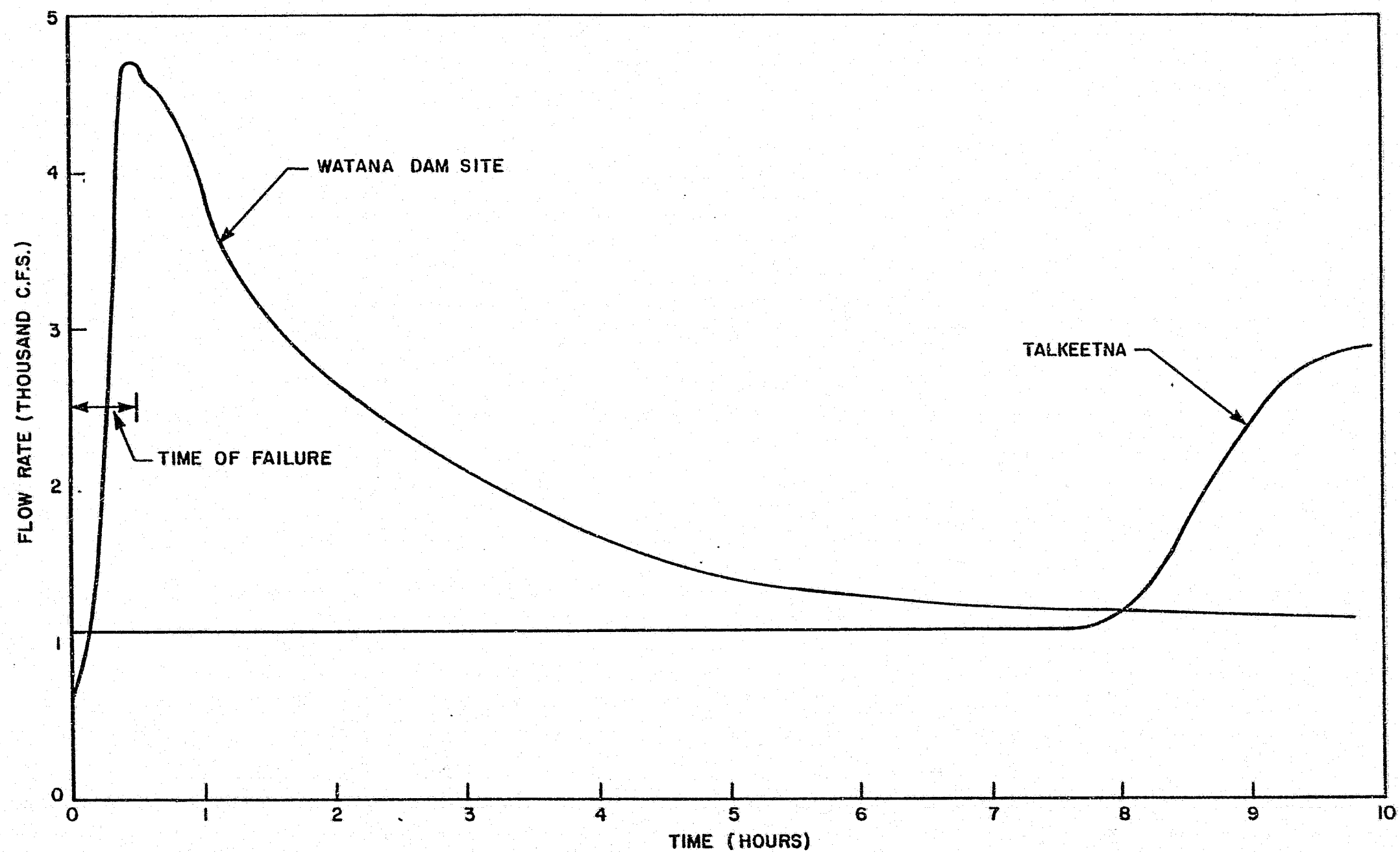
DEVIL CANYON DAM BREAK HYDROGRAPH

FIGURE 6.6





DOMINO DAM BREAK HYDROGRAPH



WATANA COFFERDAM DAM BREAK HYDROGRAPH

7 - CONCLUSIONS

7.1 - Conclusions

The conclusions of this study are:

- The hypothetical dam failure at Watana produces a peak flood level at Talkeetna 52 feet above the level which would be produced by the PMF.
- The hypothetical dam failure at Devil Canyon produces a peak flood level at Talkeetna 17 feet above the level which would be produced by the PMF.
- The hypothetical domino failure downstream effects are not significantly different from those of the Watana dam failing prior to the construction of the Devil Canyon dam.
- The hypothetical failure effects of Devil Canyon dam failing singly are less devastating than those of the failure of Watana singly.
- The Devil Canyon dam will fail if the Watana dam fails.
- Peak discharges and elevations produced by the hypothetical Watana cofferdam failure are less than those which would be produced by the PMF but approximately 4 feet higher than the 50 year flood at Talkeetna.
- A period of approximately 5 hours would elapse between initiation of a failure at Watana and the arrival of the flood peak at Talkeetna. Additional time might be available prior to the failure with appropriate flood and other event warning systems.

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APPENDIX A

EXCERPT FROM DAMBRK: THE NWS DAM-BREAK
FLOOD FORECASTING MODEL (2)

DAMBRK: THE NWS DAM-BREAK
FLOOD FORECASTING MODEL

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February 10, 1981

1. INTRODUCTION

Catastrophic flash flooding occurs when a dam is breached and the impounded water escapes through the breach into the downstream valley. Usually the response time available for warning is much shorter than for precipitation-runoff floods. Dam failures are often caused by overtopping of the dam due to inadequate spillway capacity during large inflows to the reservoir from heavy precipitation runoff. Dam failures may also be caused by seepage or piping through the dam or along internal conduits, slope embankment slides, earthquake damage and liquefaction of earthen dams from earthquakes, and landslide-generated waves within the reservoir. Middlebrooks (1952) describes earthen dam failures occurring within the U.S. prior to 1951. Johnson and Illes (1976) summarize 300 dam failures throughout the world.

The potential for catastrophic flooding due to dam failures has recently been brought to the Nation's attention by several dam failures such as the Buffalo Creek coal-waste dam, the Toccoa Dam, the Teton Dam, and the Laurel Run Dam. A report by the U.S. Army (1975) gives an inventory of the Nation's approximately 50,000 dams with heights greater than 25 ft. or storage volumes in excess of 50 acre-ft. The report also classifies some 20,000 of these as being "so located that failure of the dam could result in loss of human life and appreciable property damage...."

The National Weather Service (NWS) has the responsibility to advise the public of downstream flooding when there is a failure of a dam. Although this type of flood has many similarities to floods produced by precipitation runoff, the dam-break flood has some very important differences which make it difficult to analyze with the common techniques which have worked so well for the precipitation-runoff floods. To aid NWS flash flood hydrologists who are called upon to forecast the downstream flooding (flood inundation information and warning times) resulting from dam-failures, a numerical model (DAMBRK) has been recently developed. Herein is presented an outline of the model's theoretical basis, its predictive capabilities, and ways of utilizing the model for forecasting of dam-break floods. The DAMBRK model may also be used for a multitude of purposes by

planners, designers, and analysts who are concerned with possible future or historical flood inundation mapping due to dam-break floods and/or reservoir spillway floods, or any specified flood hydrograph.

2. MODEL DEVELOPMENT

The DAMBRK model attempts to represent the current state-of-the-art in understanding of dam failures and the utilization of hydrodynamic theory to predict the dam-break wave formation and downstream progression. The model has wide applicability; it can function with various levels of input data ranging from rough estimates to complete data specification; the required data is readily accessible; and it is economically feasible to use, i.e., it requires a minimal computation effort on large computing facilities.

The model consists of three functional parts, namely: (1) description of the dam failure mode, i.e., the temporal and geometrical description of the breach; (2) computation of the time history (hydrograph) of the outflow through the breach as affected by the breach description, reservoir inflow, reservoir storage characteristics, spillway outflows, and downstream tailwater elevations; and (3) routing of the outflow hydrograph through the downstream valley in order to determine the changes in the hydrograph due to valley storage, frictional resistance, downstream bridges or dams, and to determine the resulting water surface elevations (stages) and flood-wave travel times.

DAMBRK is an expanded version of a practical operational model first presented in 1977 by the author (Fread, 1977). That model was based on previous work by the author on modeling breached dams (Fread and Harbaugh, 1973) and routing of flood waves (Fread, 1974, 1976). There have been a number of other operational dam-break models that have appeared recently in the literature, e.g., Price, et al. (1977), Gundlach and Thomas (1977), Thomas (1977), Keefer and Simons (1977), Chen and Druffel (1977), Balloffet, et al. (1974), Balloffet (1977), Brown and Rogers (1977), Rajar (1978), Brevard and Theurer (1979). DAMBRK differs from each of these models in the treatment of the breach formation, the outflow hydrograph generation, and the downstream flood routing.

6. SUMMARY AND CONCLUSIONS

A dam-break flood forecasting model (DAMBRK) is described and applied to some actual dam-break flood waves. The model consists of a breach component which utilizes simple parameters to provide a temporal and geometrical description of the breach. A second component computes the reservoir outflow hydrograph resulting from the breach via a broad-crested weir-flow approximation, which includes effects of submergence from downstream tailwater depths and corrections for approach velocities. Also, the effects of storage depletion and upstream inflows on the computed outflow hydrograph are accounted for through storage routing within the reservoir. The third component

consists of a dynamic routing technique for determining the modifications to the dam-break flood wave as it advances through the downstream valley, including its travel time and resulting water surface elevations. The dynamic routing component is based on a weighted, four-point non-linear finite difference solution of the one-dimensional equations of unsteady flow which allows variable time and distance steps to be used in the solution procedure. Provisions are included for routing supercritical flows as well as subcritical flows, and incorporating the effects of downstream obstructions such as road-bridge embankments and/or other dams.

Model data requirements are flexible, allowing minimal data input when it is not available while permitting extensive data to be used when appropriate.

The model was tested on the Teton Dam failure and the Buffalo Creek coal-waste dam collapse. Computed outflow volumes through the breaches coincided with the observed values in magnitude and timing. Observed peak discharges along the downstream valleys were satisfactorily reproduced by the model even though the flood waves were severely attenuated as they advanced downstream. The computed peak flood elevations were within an average of 1.5 ft and 1.8 ft of the observed maximum elevations for Teton and Buffalo Creek, respectively. Both the Teton and Buffalo Creek simulations indicated an important lack of sensitivity of downstream discharge to errors in the forecast of the breach size and timing. Such errors produced significant differences in the peak discharge in the vicinity of the dams; however, the differences were rapidly reduced as the waves advanced downstream. Computational requirements of the model are quite feasible; CPU time (IBM 360/195) was 0.005 second per hr per mile of prototype dimensions for the Teton Dam simulation, and 0.095 second per hr per mile for the Buffalo Creek simulation. The more rapidly rising Buffalo Creek wave ($\tau = 0.008$ hr as compared to Teton where $\tau = 1.25$ hr) required smaller Δt and Δx computational steps; however, total computation times (Buffalo: 19 sec and Teton: 18 sec) were similar since the Buffalo Creek wave attenuated to insignificant values in a shorter distance downstream and in less time than the Teton flood wave.

Suggested ways for using the DAMBRK model in preparation of pre-computed flood information and in real-time forecasting were presented.

APPENDIX B
SAMPLE DAMBRK OUTPUT

TY COSOUT.OUT

PROGRAM DAMBRK---VERSION-A-09/10/80

1/23/83 RSJW

Wahona & Peil Canyon Failure
COSOUT.OUT

ANALYSIS OF THE DOWNSTREAM FLOOD HYDROGRAPH

Wahona $TF = 2.5$
D.C. $TF = 0.5$

PRODUCED BY THE DAM BREAK OF

MULTIPLE FAILURES

ON

SUSITNA RIVER

ANALYSIS BY

ACRES AMERICAN INC.,
LIBERTY BANK BLD., MAIN AT COURT ST.
BUFFALO, NEW YORK 14202

BASED ON PROCEDURE DEVELOPED BY

DANNY L. FREAD, PH.D., RESEARCH HYDROLOGIST
HYDROLOGIC RESEARCH LABORATORY
W23, OFFICE OF HYDROLOGY
NOAA, NATIONAL WEATHER SERVICE
SILVER SPRING, MARYLAND 20910

```

*****
*****
***          ***
*** SUMMARY OF INPUT DATA ***
***          ***
*****
*****

```

INPUT CONTROL PARAMETERS FOR MULTIPLE FAILURES

PARAMETER	VARIABLE	VALUE
*****	*****	*****
NUMBER OF DYNAMIC ROUTING REACHES	KKN	1
TYPE OF RESERVOIR ROUTING	KUI	1
MULTIPLE DAM INDICATOR	MULDAH	2
PRINTING INSTRUCTIONS FOR INPUT SUMMARY	KDHP	3
NO. OF RESERVOIR INFLOW HYDROGRAPH POINTS	ITEH	5
INTERVAL OF CROSS-SECTION INFO PRINTED OUT WHEN JNK=9 NPRT		0
FLOOD-PLAIN MODEL PARAMETER	KFLP	0
LANDSLIDE PARAMETER	KSL	0

IDAM= 5

IDAM= 12

DAM NUMBER 1

MULTIPLE FAILURES RESERVOIR AND BREACH PARAMETERS

PARAMETER	UNITS	VARIABLE	VALUE
ELEVATION OF WATER SURFACE	FT	YD	2208.01
SIDE SLOPE OF BREACH		Z	1.00
ELEVATION OF BOTTOM OF BREACH	FT	YBMIN	1460.00
WIDTH OF BASE OF BREACH	FT	BB	420.00
TIME TO MAXIMUM BREACH SIZE	HR	TFH	2.50
ELEVATION OF WATER WHEN BREACHED	FT	HF	2208.00
ELEVATION OF TOP OF DAM	FT	HD	2205.00
ELEVATION OF UNCONTROLLED SPILLWAY CREST	FT	HSP	0.00
ELEVATION OF CENTER OF GATE OPENINGS	FT	HGT	0.00
DISCHARGE COEF. FOR UNCONTROLLED SPILLWAY		CS	0.00
DISCHARGE COEF. FOR GATE FLOW		CG	0.00
DISCHARGE COEF. FOR UNCONTROLLED WEIR FLOW		CDD	6720.00
DISCHARGE THRU TURBINES	CFS	QT	326000.00

DAM NUMBER 2

MULTIPLE FAILURES RESERVOIR AND BREACH PARAMETERS

PARAMETER	UNITS	VARIABLE	VALUE
ELEVATION OF WATER SURFACE	FT	YD	1455.00
SIDE SLOPE OF BREACH		Z	1.34
ELEVATION OF BOTTOM OF BREACH	FT	YBMIN	907.00
WIDTH OF BASE OF BREACH	FT	BB	120.00
TIME TO MAXIMUM BREACH SIZE	HR	TFH	0.50

ELEVATION OF WATER WHEN BREACHED	FT	HF	1475.90
ELEVATION OF TOP OF DAM	FT	HD	1465.00
ELEVATION OF UNCONTROLLED SPILLWAY CREST	FT	HSP	1470.00
ELEVATION OF CENTER OF GATE OPENINGS	FT	HGT	0.00
DISCHARGE COEF. FOR UNCONTROLLED SPILLWAY		CS	2900.00
DISCHARGE COEF. FOR GATE FLOW		CG	0.00
DISCHARGE COEF. FOR UNCONTROLLED WEIR FLOW		CDO	4277.50
DISCHARGE THRU TURBINES	CFS	QT	160500.00

DHF (INTERVAL BETWEEN INPUT HYDROGRAPH ORDINATES) = 0.00 HRS.

TEH (TIME AT WHICH COMPUTATIONS TERMINATE) = 8.00 HRS.

INFLOW HYDROGRAPH TO MULTIPLE FAILURES

 252743. 255000. 257000. 257500. 258000.

TIME OF INFLOW HYDROGRAPH ORDINATES

0.00 2.00 4.00 6.00 15.00

CROSS-SECTIONAL PARAMETERS FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

PARAMETER	VARIABLE	VALUE
*****	*****	*****
NUMBER OF CROSS-SECTIONS	NS	24
MAXIMUM NUMBER OF TOP WIDTHS	NCS	8
NUMBER OF CROSS-SECTIONAL HYDROGRAPHS TO PLOT	NTT	5
TYPE OF OUTPUT OTHER THAN HYDROGRAPH PLOTS	JNK	4
CROSS-SECTIONAL SMOOTHING PARAMETER	KSA	0
DOWNSTREAM SUPERCRITICAL OR NOT	KSUPC	0
NO. OF LATERAL INFLOW HYDROGRAPHS	LQ	7

NUMBER OF CROSS-SECTION WHERE HYDROGRAPH DESIRED
(MAX NUMBER OF HYDROGRAPHS = 6)

6 12 16 18 23

CROSS-SECTIONAL VARIABLES FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

PARAMETER	UNITS	VARIABLE
*****	*****	*****
LOCATION OF CROSS-SECTION	MI	XS(I)
ELEVATION (MSL) OF FLOODING AT CROSS-SECTION	FT	FSTG(I)
ELEV CORRESPONDING TO EACH TOP WIDTH	FT	HS(K,I)
TOP WIDTH CORRESPONDING TO EACH ELEV (ACTIVE FLOW PORTION)	FT	BS(K,I)
TOP WIDTH CORRESPONDING TO EACH ELEV	FT	BSS(K,I)

SURFACE AREA CORRESPONDING TO EACH ELEV ACRES DSA(K,I)
 (ACTIVE FLOW PORTION)
 SURFACE AREA CORRESPONDING TO EACH ELEV ACRES SSA(K,I)
 (OFF-CHANNEL PORTION)

NUMBER OF CROSS-SECTION I
 NUMBER OF ELEVATION LEVEL K

CROSS-SECTION NUMBER 1

XS(I) = 0.000 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 2200.0 2230.0 2380.0 2585.0 2643.0 2765.0 2862.0 3060.0

BS ... 792.8 987.9 1963.5 3296.8 3674.0 4467.5 5098.4 6386.2

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

CROSS-SECTION NUMBER 2

XS(I) = 3.784 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 2160.0 2190.0 2340.0 2545.0 2603.0 2725.0 2822.0 3020.0

BS ... 792.8 987.9 1963.5 3296.8 3674.0 4467.5 5098.4 6386.2

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

CROSS-SECTION NUMBER 3

XS(I) = 35.000 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 1830.0 1860.0 2010.0 2215.0 2273.0 2395.0 2492.0 2690.0

BS ... 792.8 987.9 1963.5 3296.8 3674.0 4467.5 5098.4 6386.2

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

MOORE BUSINESS FORMS, INC. HQ 22

HS	...	1465.0	1495.0	1645.0	1850.0	1908.0	2030.0	2127.0	2325.0
BS	...	792.8	1114.0	2723.0	4921.0	5543.0	6852.0	7892.0	10015.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. HQ 22

H9 ...	1460.0	1490.0	1640.0	1845.0	1903.0	2025.0	2122.0	2320.0
B9 ...	250.0	350.0	825.0	1340.0	1830.0	2300.0	2920.0	4800.0
BSS ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. HQ 22

HS ...	5955.0	1500.0	1600.0	1700.0	1800.0	2000.0	2100.0	2200.0
RS ...	370.0	725.0	980.0	1550.0	1720.0	2560.0	3200.0	5680.0
RSS ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. HQ 22

HS	...	1450.0	1500.0	1550.0	1600.0	1700.0	1800.0	1900.0	2000.0
ES	...	260.0	1680.0	2130.0	2785.0	3700.0	4440.0	5325.0	6430.0
HSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 8

X5(I) = 78.200 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ...	1379.0	1400.0	1500.0	1600.0	1700.0	1800.0	1900.0	2000.0
BS ...	475.0	2120.0	3395.0	4175.0	5010.0	5800.0	6900.0	8175.0
BSS ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 9

XS(I) = 85.900 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS	785.0	1265.0	1300.0	1400.0	1500.0	1600.0	1700.0	1800.0	1900.0
BS	...	785.0	990.0	1115.0	1590.0	1960.0	2850.0	3375.0	4225.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 10

XS(I) = 91.500 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS	...	1122.0	1200.0	1300.0	1400.0	1500.0	1600.0	1700.0	1900.0
RS	...	325.0	520.0	890.0	1150.0	1590.0	2640.0	3275.0	4545.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 11

XS(I) = 97.700 FSLG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS	...	995.0	1100.0	1200.0	1300.0	1400.0	1500.0	1800.0	1900.0
RS	...	310.0	535.0	845.0	1125.0	1530.0	1900.0	4165.0	5210.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 12

XS(I) = 101.800 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 907.0 1100.0 1200.0 1300.0 1400.0 1500.0 1600.0 1700.0

BS ... 265.0 565.0 765.0 960.0 1400.0 2650.0 3240.0 4120.0

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

CROSS-SECTION NUMBER 13

XS(I) = 102.200 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 902.0 1100.0 1200.0 1300.0 1400.0 1500.0 1600.0 1700.0

BS ... 265.0 565.0 765.0 960.0 1400.0 2650.0 3240.0 4120.0

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

CROSS-SECTION NUMBER 14

XS(I) = 103.800 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 880.0 950.0 1000.0 1050.0 1100.0 1200.0 1300.0 1400.0

BS ... 370.0 530.0 630.0 1100.0 1570.0 1900.0 2210.0 2550.0

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

CROSS-SECTION NUMBER 15

XS(I) = 109.000 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS ... 800.0 825.0 850.0 875.0 900.0 1000.0 1100.0 1200.0

BS ... 1575.0 1865.0 2110.0 2600.0 3060.0 3540.0 4865.0 5385.0

BSS ... 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

MOORE BUSINESS FORMS, INC. NO 25

HS	...	730.0	745.0	800.0	850.0	900.0	950.0	1000.0	1100.0
BS	...	1695.0	3100.0	4550.0	5350.0	6125.0	6425.0	6750.0	7470.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. NO 25

HS	...	635.0	650.0	675.0	700.0	750.0	800.0	850.0	900.0
RS	...	2220.0	2770.0	3720.0	4650.0	4800.0	4950.0	5225.0	5500.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. NO 25

HS	...	523.0	540.0	550.0	575.0	600.0	650.0	700.0	750.0
BS	...	400.0	490.0	550.0	1465.0	2315.0	2735.0	3165.0	3380.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. NO 25

HS	...	480.0	490.0	500.0	525.0	550.0	600.0	650.0	700.0
BS	...	660.0	825.0	970.0	1340.0	1675.0	2365.0	2915.0	3455.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOORE BUSINESS FORMS, INC. OK 22
247

[illegible]

ALBERT EINSTEIN'S HOME, IN
1905

[illegible]

HS ...	365.0	372.0	380.0	390.0	400.0	415.0	430.0	450.0
BS ...	1010.0	1500.0	2100.0	4000.0	10000.0	15900.0	17200.0	19000.0
BSS ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Age Group	1970	1980	1990	2000	2010	2020
0-14	20	18	15	12	10	10
15-24	15	14	13	12	11	10
25-34	12	11	10	9	8	7
35-44	10	9	8	7	6	5
45-54	8	7	6	5	4	3
55-64	6	5	4	3	2	1
65-74	10	11	12	13	14	20
75+	2	3	4	5	6	7

HIS	...	333.0	338.0	345.0	355.0	365.0	375.0	385.0	400.0
SS	...	2950.0	3600.0	8000.0	13700.0	19600.0	24500.0	29500.0	33200.0
BSC	...	- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CROSS-SECTION NUMBER 24

XS(I) = 157.700 FSTG(I) = 0.00 XSL(I) = 0.0 XSR(I) = 0.0

HS	...	298.0	308.0	320.0	335.0	350.0	365.0	380.0	400.0
BS	...	3500.0	4000.0	8200.0	11000.0	17000.0	23000.0	29000.0	29750.0
BSS	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MANNING N ROUGHNESS COEFFICIENTS FOR THE GIVEN REACHES
(CM(K,I), K=1, NCS) WHERE I = REACH NUMBER

REACH 1 ... 0.045 0.045 0.045 0.045 0.045 0.045 0.045 0.045

REACH 2 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 3 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 4 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 5 ... 0.045 0.045 0.045 0.045 0.045 0.045 0.045 0.045

REACH 6 ... 0.095 0.095 0.095 0.095 0.095 0.095 0.095 0.095

REACH 7 ... 0.089 0.089 0.089 0.089 0.089 0.089 0.089 0.089

REACH 8 ... 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075

REACH 9 ... 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075

REACH 10 ... 0.075 0.075 0.075 0.075 0.075 0.075 0.075 0.075

REACH 11 ... 0.070 0.070 0.070 0.070 0.070 0.070 0.070 0.070

REACH 12 ... 0.095 0.095 0.095 0.095 0.095 0.095 0.095 0.095

REACH 13 ... 0.100 0.100 0.100 0.100 0.100 0.100 0.100 0.100

REACH 14 ... 0.085 0.085 0.085 0.085 0.085 0.085 0.085 0.085

REACH 15 ... 0.055 0.055 0.055 0.055 0.055 0.055 0.055 0.055

REACH 16 ... 0.040 0.040 0.040 0.040 0.040 0.040 0.040 0.040

REACH 17 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 18 ... 0.036 0.036 0.036 0.036 0.036 0.036 0.036 0.036

REACH 19 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 20 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 21 ... 0.035 0.035 0.035 0.035 0.035 0.035 0.035 0.035

REACH 22 ... 0.031 0.031 0.031 0.031 0.031 0.031 0.031 0.031

REACH 23 ... 0.060 0.060 0.060 0.060 0.060 0.060 0.060 0.060

CROSS-SECTIONAL VARIABLES FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

PARAMETER	UNITS	VARIABLE
MINIMUM COMPUTATIONAL DISTANCE USED BETWEEN CROSS-SECTIONS	MI	DXH(I)
CONTRACTION = EXPANSION COEFFICIENTS BETWEEN CROSS-SECTIONS		FKC(I)

REACH NUMBER	DXH(I)	FKC(I)
1	3.000	0.000
2	4.000	0.000
3	7.000	0.000
4	8.000	0.200
5	0.500	-0.700
6	0.500	-0.700
7	0.900	0.000
8	1.500	0.000
9	1.500	0.000
10	1.500	0.000
11	1.500	0.000
12	1.500	0.000
13	0.500	0.000
14	1.300	-0.500

15	0.780	0.000
16	0.350	0.000
17	0.520	0.000
18	0.880	0.000
19	0.870	0.000
20	1.350	0.000
21	0.420	-0.700
22	0.250	0.000
23	0.320	0.000

DOWNSTREAM FLOW PARAMETERS FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

PARAMETER	UNITS	VARIABLE	VALUE
*****	*****	*****	*****
MAX DISCHARGE AT DOWNSTREAM EXTREMITY	CFS	QMAXD	0.0
MAX LATERAL OUTFLOW PRODUCING LOSSES	CFS/FT	QLL	0.000
INITIAL SIZE OF TIME STEP	HR	DTIM	0.040
INITIAL WATER SURFACE ELEVATION DOWNSTREAM	FT	YDN	0.00
SLOPE OF CHANNEL DOWNSTREAM OF DAM	FT/MI	SOM	0.00
THETA WEIGHTING FACTOR		THETA	0.00
CONVERGENCE CRITERION FOR STAGE	FT	EPSY	0.100
TIME AT WHICH DAM STARTS TO FAIL	HR	TFI	0.00

LATERAL INFLOW REACH NUMBER

LOX(I)

7

10

14

16

18

20

23

(QL(L, 1), L=1, ILEN)

27000. 27000. 27000. 27000. 27000.

(QL(L, 2), L=1, ITEH)
27000. 27000. 27000. 27000. 27000.

(QL(L, 3), L=1, ITEH)
14000. 14000. 14000. 14000. 14000.

(QL(L, 4), L=1, ITEH)
14000. 14000. 14000. 14000. 14000.

(QL(L, 5), L=1, ITEH)
6000. 6000. 6000. 6000. 6000.

(QL(L, 6), L=1, ITEH)
6000. 6000. 6000. 6000. 6000.

(QL(L, 7), L=1, ITEH)
228000. 228000. 228000. 228000. 228000.

*** SUMMARY OF OUTPUT DATA ***

CROSS-SECTION NO.	MILE	BOTTOM ELEVATION FEET	REACHING NO.	REACH LENGTH MILES	SLOPE FT/MI	MESSAGE
1	0.00	2200.00	1	3.78	10.57	
2	3.78	2160.00	2	31.22	10.57	
3	35.00	1830.00	3	28.00	13.04	
4	63.00	1465.00	4	7.50	0.67	
5	70.50	1460.00	5	0.50	10.00	
6	71.00	1455.00	6	2.30	2.17	
7	73.30	1450.00	7	4.90	14.49	
8	78.20	1379.00	8	7.70	14.81	
9	85.90	1265.00	9	5.60	25.54	
10	91.50	1122.00	10	6.20	20.48	
11	97.70	995.00	11	4.10	21.46	
12	101.80	907.00	12	0.40	12.50	
13	102.20	902.00	13	1.60	13.75	
14	103.80	880.00	14	5.20	15.38	
15	109.00	800.00	15	3.90	17.95	
16	112.90	730.00	16	7.00	13.57	
17	119.90	635.00	17	10.90	10.28	
18	130.80	523.00	18	4.40	9.77	
19	135.20	480.00	19	6.10	8.56	
20	141.30	440.00	20	2.70	10.37	
21	144.00	412.00	21	4.60	10.22	
22	148.60	365.00	22	4.20	7.62	
23	152.80	333.00	23	4.90	7.14	
24	157.70	298.00				

NUMBER OF INTERMEDIATE STATIONS (N) = 146 (MAXIMUM ALLOWABLE = 200)

RE-NUMBERED VALUES FOR IDAM

IDAM(1) = 14

IDAM(2) = 38

1 252743.00

2 252743.00

3 252743.00

4 252743.00

5 252743.00
6 252743.00
7 252743.00
8 252743.00
9 252743.00
10 252743.00
11 252743.00
12 252743.00
13 252743.00
14 361093.06
15 361093.06
16 361093.06
17 361093.06
18 361093.06
19 361093.06
20 388093.06
21 388093.06
22 388093.06
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26 388093.06
27 388093.06
28 388093.06
29 388093.06
30 388093.06
31 388093.06
32 388093.06
33 415093.06
34 415093.06
35 415093.06
36 415093.06
37 415093.06
38 160500.00
39 160500.00
40 160500.00
41 160500.00
42 160500.00
43 174500.00
44 174500.00
45 174500.00
46 174500.00
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128 200500.00
129 200500.00
130 200500.00
131 200500.00
132 428500.00
133 428500.00
134 428500.00
135 428500.00
136 428500.00

ON THE BASIS OF THE RECORD

137 428500.00
 138 428500.00
 139 428500.00
 140 428500.00
 141 428500.00
 142 428500.00
 143 428500.00
 144 428500.00
 145 428500.00
 146 428500.00

L=146	X(L)=	157.700	YD(L)=	314.18	HO=	314.51	K= 0
L=145	X(L)=	157.373	YD(L)=	316.54	HO=	316.51	K= 2
L=144	X(L)=	157.047	YD(L)=	318.91	HO=	318.86	K= 2
L=143	X(L)=	156.720	YD(L)=	321.40	HO=	321.24	K= 2
L=142	X(L)=	156.393	YD(L)=	323.86	HO=	323.67	K= 3
L=141	X(L)=	156.067	YD(L)=	326.33	HO=	326.13	K= 3
L=140	X(L)=	155.740	YD(L)=	328.80	HO=	328.60	K= 3
L=139	X(L)=	155.413	YD(L)=	331.27	HO=	331.07	K= 3
L=138	X(L)=	155.087	YD(L)=	333.72	HO=	333.53	K= 3
L=137	X(L)=	154.760	YD(L)=	336.16	HO=	335.99	K= 3
L=136	X(L)=	154.433	YD(L)=	338.57	HO=	338.44	K= 2
L=135	X(L)=	154.107	YD(L)=	340.96	HO=	340.87	K= 2
L=134	X(L)=	153.780	YD(L)=	343.32	HO=	343.27	K= 2
L=133	X(L)=	153.453	YD(L)=	345.64	HO=	345.64	K= 2
L=132	X(L)=	153.127	YD(L)=	347.93	HO=	347.98	K= 2
L=131	X(L)=	152.800	YD(L)=	349.65	HO=	350.29	K= 3
L=130	X(L)=	152.538	YD(L)=	349.77	HO=	351.96	K= 4
L=129	X(L)=	152.275	YD(L)=	350.02	HO=	352.71	K= 4
L=128	X(L)=	152.013	YD(L)=	350.52	HO=	352.89	K= 4
L=127	X(L)=	151.750	YD(L)=	351.48	HO=	353.27	K= 4
L=126	X(L)=	151.488	YD(L)=	353.00	HO=	354.00	K= 3
L=125	X(L)=	151.225	YD(L)=	354.96	HO=	355.24	K= 3
L=124	X(L)=	150.963	YD(L)=	357.13	HO=	356.98	K= 3
L=123	X(L)=	150.700	YD(L)=	359.39	HO=	359.05	K= 3
L=122	X(L)=	150.438	YD(L)=	361.68	HO=	361.26	K= 3
L=121	X(L)=	150.175	YD(L)=	364.00	HO=	363.53	K= 3
L=120	X(L)=	149.913	YD(L)=	366.34	HO=	365.84	K= 3
L=119	X(L)=	149.650	YD(L)=	368.71	HO=	368.17	K= 3
L=118	X(L)=	149.388	YD(L)=	371.11	HO=	370.52	K= 3
L=117	X(L)=	149.125	YD(L)=	373.54	HO=	372.91	K= 3
L=116	X(L)=	148.863	YD(L)=	376.00	HO=	375.32	K= 3
L=115	X(L)=	148.600	YD(L)=	378.50	HO=	377.77	K= 3
L=114	X(L)=	148.140	YD(L)=	384.29	HO=	382.95	K= 3
L=113	X(L)=	147.680	YD(L)=	389.73	HO=	388.45	K= 4
L=112	X(L)=	147.220	YD(L)=	395.21	HO=	394.06	K= 4
L=111	X(L)=	146.760	YD(L)=	400.39	HO=	399.52	K= 3
L=110	X(L)=	146.300	YD(L)=	405.41	HO=	404.85	K= 3
L=109	X(L)=	145.840	YD(L)=	410.35	HO=	409.95	K= 3
L=108	X(L)=	145.380	YD(L)=	415.28	HO=	414.93	K= 3
L=107	X(L)=	144.920	YD(L)=	420.22	HO=	419.87	K= 3
L=106	X(L)=	144.460	YD(L)=	425.18	HO=	424.80	K= 3
L=105	X(L)=	144.000	YD(L)=	430.18	HO=	429.75	K= 3
L=104	X(L)=	142.650	YD(L)=	443.72	HO=	444.03	K= 3
L=103	X(L)=	141.300	YD(L)=	455.49	HO=	457.95	K= 3
L=102	X(L)=	140.429	YD(L)=	462.38	HO=	462.32	K= 2
L=101	X(L)=	139.557	YD(L)=	468.74	HO=	467.51	K= 3
L=100	X(L)=	138.686	YD(L)=	475.10	HO=	474.13	K= 3
L= 99	X(L)=	137.814	YD(L)=	481.50	HO=	480.50	K= 3
L= 98	X(L)=	136.943	YD(L)=	487.96	HO=	486.88	K= 3
L= 97	X(L)=	136.071	YD(L)=	494.49	HO=	493.30	K= 3
L= 96	X(L)=	135.200	YD(L)=	501.12	HO=	499.80	K= 3
L= 95	X(L)=	134.320	YD(L)=	508.98	HO=	509.26	K= 3
L= 94	X(L)=	133.440	YD(L)=	518.85	HO=	517.95	K= 3
L= 93	X(L)=	132.560	YD(L)=	528.71	HO=	526.81	K= 3
L= 92	X(L)=	131.680	YD(L)=	538.76	HO=	536.68	K= 3
L= 91	X(L)=	130.800	YD(L)=	549.10	HO=	546.64	K= 3

L= 90	X(L)=	130.255	YD(L)=	555.11	HO=	553.83	K= 3
L= 89	X(L)=	129.710	YD(L)=	559.09	HO=	560.51	K= 3
L= 88	X(L)=	129.165	YD(L)=	562.63	HO=	565.50	K= 4
L= 87	X(L)=	128.620	YD(L)=	566.19	HO=	569.26	K= 4
L= 86	X(L)=	128.075	YD(L)=	569.98	HO=	572.81	K= 4
L= 85	X(L)=	127.530	YD(L)=	574.06	HO=	576.48	K= 3
L= 84	X(L)=	126.985	YD(L)=	578.42	HO=	580.42	K= 4
L= 83	X(L)=	126.440	YD(L)=	583.03	HO=	584.64	K= 3
L= 82	X(L)=	125.895	YD(L)=	587.83	HO=	589.13	K= 3
L= 81	X(L)=	125.350	YD(L)=	592.74	HO=	593.83	K= 3
L= 80	X(L)=	124.805	YD(L)=	597.75	HO=	598.68	K= 3
L= 79	X(L)=	124.260	YD(L)=	602.82	HO=	603.65	K= 3
L= 78	X(L)=	123.715	YD(L)=	607.95	HO=	608.69	K= 3
L= 77	X(L)=	123.170	YD(L)=	613.13	HO=	613.79	K= 3
L= 76	X(L)=	122.625	YD(L)=	618.34	HO=	618.94	K= 3
L= 75	X(L)=	122.080	YD(L)=	623.59	HO=	624.14	K= 3
L= 74	X(L)=	121.535	YD(L)=	628.87	HO=	629.37	K= 3
L= 73	X(L)=	120.990	YD(L)=	634.17	HO=	634.63	K= 3
L= 72	X(L)=	120.445	YD(L)=	639.49	HO=	639.92	K= 3
L= 71	X(L)=	119.900	YD(L)=	644.83	HO=	645.23	K= 3
L= 70	X(L)=	119.355	YD(L)=	649.42	HO=	649.71	K= 3
L= 69	X(L)=	119.200	YD(L)=	654.24	HO=	654.25	K= 2
L= 68	X(L)=	118.850	YD(L)=	659.05	HO=	658.95	K= 2
L= 67	X(L)=	118.500	YD(L)=	663.87	HO=	663.77	K= 2
L= 66	X(L)=	118.150	YD(L)=	668.69	HO=	668.59	K= 2
L= 65	X(L)=	117.800	YD(L)=	673.51	HO=	673.41	K= 2
L= 64	X(L)=	117.450	YD(L)=	678.33	HO=	678.22	K= 2
L= 63	X(L)=	117.100	YD(L)=	683.15	HO=	683.04	K= 2
L= 62	X(L)=	116.750	YD(L)=	687.97	HO=	687.86	K= 2
L= 61	X(L)=	116.400	YD(L)=	692.80	HO=	692.69	K= 2
L= 60	X(L)=	116.050	YD(L)=	697.63	HO=	697.51	K= 2
L= 59	X(L)=	115.700	YD(L)=	702.45	HO=	702.34	K= 2
L= 58	X(L)=	115.350	YD(L)=	707.28	HO=	707.16	K= 2
L= 57	X(L)=	115.000	YD(L)=	712.11	HO=	711.99	K= 2
L= 56	X(L)=	114.650	YD(L)=	716.95	HO=	716.82	K= 2
L= 55	X(L)=	114.300	YD(L)=	721.78	HO=	721.65	K= 2
L= 54	X(L)=	113.950	YD(L)=	726.62	HO=	726.49	K= 2
L= 53	X(L)=	113.600	YD(L)=	731.45	HO=	731.32	K= 2
L= 52	X(L)=	113.250	YD(L)=	736.29	HO=	736.16	K= 2
L= 51	X(L)=	112.900	YD(L)=	741.13	HO=	741.00	K= 2
L= 50	X(L)=	112.120	YD(L)=	756.31	HO=	755.09	K= 3
L= 49	X(L)=	111.340	YD(L)=	769.99	HO=	769.72	K= 2
L= 48	X(L)=	110.560	YD(L)=	784.34	HO=	784.15	K= 2
L= 47	X(L)=	109.780	YD(L)=	798.42	HO=	798.16	K= 2
L= 46	X(L)=	109.000	YD(L)=	812.65	HO=	812.38	K= 2
L= 45	X(L)=	107.700	YD(L)=	841.30	HO=	832.54	K= 4
L= 44	X(L)=	106.400	YD(L)=	860.86	HO=	856.97	K= 3
L= 43	X(L)=	105.100	YD(L)=	887.07	HO=	881.08	K= 3
L= 42	X(L)=	103.800	YD(L)=	913.94	HO=	903.97	K= 3
L= 41	X(L)=	103.267	YD(L)=	928.34	HO=	917.84	K= 4
L= 40	X(L)=	102.733	YD(L)=	939.23	HO=	932.14	K= 4
L= 39	X(L)=	102.200	YD(L)=	949.73	HO=	944.79	K= 3
L= 38	X(L)=	101.800	YD(L)=	949.73	HO=	993.73	K= 0
L= 37	X(L)=	99.750	YD(L)=	999.41	HO=	993.73	K= 3
L= 36	X(L)=	97.700	YD(L)=	1060.12	HO=	1040.57	K= 4
L= 35	X(L)=	96.150	YD(L)=	1089.43	HO=	1083.52	K= 3
L= 34	X(L)=	94.600	YD(L)=	1120.69	HO=	1122.40	K= 3
L= 33	X(L)=	93.050	YD(L)=	1151.93	HO=	1152.68	K= 3
L= 32	X(L)=	91.500	YD(L)=	1182.66	HO=	1183.94	K= 3
L= 31	X(L)=	89.633	YD(L)=	1218.14	HO=	1230.84	K= 3
L= 30	X(L)=	87.767	YD(L)=	1256.77	HO=	1271.90	K= 3
L= 29	X(L)=	85.900	YD(L)=	1299.27	HO=	1308.96	K= 3
L= 28	X(L)=	84.360	YD(L)=	1326.48	HO=	1324.65	K= 3
L= 27	X(L)=	82.820	YD(L)=	1347.30	HO=	1347.08	K= 2
L= 26	X(L)=	81.280	YD(L)=	1368.46	HO=	1371.13	K= 2
L= 25	X(L)=	79.740	YD(L)=	1389.35	HO=	1392.12	K= 3

L=24	X(L)=	78.200	YD(L)=	1410.17	HO=	1413.11	K=3
L=23	X(L)=	77.220	YD(L)=	1427.97	HO=	1425.36	K=3
L=22	X(L)=	76.240	YD(L)=	1445.14	HO=	1440.37	K=3
L=21	X(L)=	75.260	YD(L)=	1462.49	HO=	1457.85	K=3
L=20	X(L)=	74.280	YD(L)=	1479.92	HO=	1475.11	K=4
L=19	X(L)=	73.300	YD(L)=	1496.80	HO=	1492.51	K=3
L=18	X(L)=	72.725	YD(L)=	1505.02	HO=	1496.71	K=4
L=17	X(L)=	72.150	YD(L)=	1510.59	HO=	1502.78	K=4
L=16	X(L)=	71.575	YD(L)=	1515.46	HO=	1509.68	K=3
L=15	X(L)=	71.000	YD(L)=	1520.30	HO=	1514.90	K=3
L=14	X(L)=	70.500	YD(L)=	1520.30	HO=	1525.30	K=0
L=13	X(L)=	63.000	YD(L)=	1529.09	HO=	1525.30	K=3
L=12	X(L)=	56.000	YD(L)=	1531.88	HO=	1618.45	K=7
L=11	X(L)=	49.000	YD(L)=	1659.46	HO=	1667.36	K=4
L=10	X(L)=	42.000	YD(L)=	1765.17	HO=	1732.55	K=7
L=9	X(L)=	35.000	YD(L)=	1844.03	HO=	1849.19	K=3
L=8	X(L)=	30.541	YD(L)=	1903.44	HO=	1897.37	K=4
L=7	X(L)=	26.081	YD(L)=	1942.04	HO=	1944.45	K=3
L=6	X(L)=	21.622	YD(L)=	1995.04	HO=	1993.46	K=3
L=5	X(L)=	17.162	YD(L)=	2038.14	HO=	2039.25	K=3
L=4	X(L)=	12.703	YD(L)=	2088.06	HO=	2087.30	K=3
L=3	X(L)=	8.243	YD(L)=	2133.28	HO=	2133.81	K=3
L=2	X(L)=	3.784	YD(L)=	2181.74	HO=	2181.38	K=3
L=1	X(L)=	0.000	YD(L)=	2226.18	HO=	2221.08	K=3
L=146	X(L)=	157.700	YD(L)=	314.18	HO=	316.51	K=0
L=145	X(L)=	157.373	YD(L)=	316.54	HO=	316.51	K=2
L=144	X(L)=	157.047	YD(L)=	318.95	HO=	318.86	K=2
L=143	X(L)=	156.720	YD(L)=	321.40	HO=	321.24	K=2
L=142	X(L)=	156.393	YD(L)=	323.86	HO=	323.67	K=3
L=141	X(L)=	156.067	YD(L)=	326.33	HO=	326.13	K=3
L=140	X(L)=	155.740	YD(L)=	328.80	HO=	328.60	K=3
L=139	X(L)=	155.413	YD(L)=	331.27	HO=	331.07	K=3
L=138	X(L)=	155.087	YD(L)=	333.72	HO=	333.53	K=3
L=137	X(L)=	154.760	YD(L)=	336.16	HO=	335.99	K=3
L=136	X(L)=	154.433	YD(L)=	338.57	HO=	338.44	K=2
L=135	X(L)=	154.107	YD(L)=	340.96	HO=	340.87	K=2
L=134	X(L)=	153.780	YD(L)=	343.32	HO=	343.27	K=2
L=133	X(L)=	153.453	YD(L)=	345.64	HO=	345.64	K=2
L=132	X(L)=	153.127	YD(L)=	347.93	HO=	347.98	K=2
L=131	X(L)=	152.800	YD(L)=	349.65	HO=	350.29	K=3
L=130	X(L)=	152.538	YD(L)=	349.77	HO=	351.96	K=4
L=129	X(L)=	152.275	YD(L)=	350.02	HO=	352.71	K=4
L=128	X(L)=	152.013	YD(L)=	350.52	HO=	352.89	K=4
L=127	X(L)=	151.750	YD(L)=	351.08	HO=	353.27	K=4
L=126	X(L)=	151.488	YD(L)=	353.00	HO=	354.00	K=3
L=125	X(L)=	151.225	YD(L)=	354.96	HO=	355.24	K=3
L=124	X(L)=	150.963	YD(L)=	357.13	HO=	356.98	K=3
L=123	X(L)=	150.700	YD(L)=	359.39	HO=	359.05	K=3
L=122	X(L)=	150.438	YD(L)=	361.68	HO=	361.26	K=3
L=121	X(L)=	150.175	YD(L)=	364.00	HO=	363.53	K=3
L=120	X(L)=	149.913	YD(L)=	366.34	HO=	365.84	K=3
L=119	X(L)=	149.650	YD(L)=	368.71	HO=	368.17	K=3
L=118	X(L)=	149.388	YD(L)=	371.11	HO=	370.52	K=3
L=117	X(L)=	149.125	YD(L)=	373.54	HO=	372.91	K=3
L=116	X(L)=	148.863	YD(L)=	376.00	HO=	375.32	K=3
L=115	X(L)=	148.600	YD(L)=	378.50	HO=	377.77	K=3
L=114	X(L)=	148.140	YD(L)=	384.29	HO=	382.95	K=3
L=113	X(L)=	147.680	YD(L)=	389.73	HO=	388.45	K=4
L=112	X(L)=	147.220	YD(L)=	395.21	HO=	394.06	K=4
L=111	X(L)=	146.760	YD(L)=	400.39	HO=	399.52	K=3
L=110	X(L)=	146.300	YD(L)=	405.41	HO=	404.85	K=3
L=109	X(L)=	145.840	YD(L)=	410.35	HO=	409.95	K=3
L=108	X(L)=	145.380	YD(L)=	415.28	HO=	414.93	K=3
L=107	X(L)=	144.920	YD(L)=	420.27	HO=	419.87	K=3
L=106	X(L)=	144.460	YD(L)=	425.18	HO=	424.80	K=3
L=105	X(L)=	144.000	YD(L)=	430.18	HO=	429.75	K=3

L=704	X(L)=	YD(L)=	HO=	K=3
L=103	X(L)=	YD(L)=	HO=	K=3
L=102	X(L)=	YD(L)=	HO=	K=2
L=101	X(L)=	YD(L)=	HO=	K=3
L=100	X(L)=	YD(L)=	HO=	K=3
L=99	X(L)=	YD(L)=	HO=	K=3
L=98	X(L)=	YD(L)=	HO=	K=3
L=97	X(L)=	YD(L)=	HO=	K=3
L=96	X(L)=	YD(L)=	HO=	K=3
L=95	X(L)=	YD(L)=	HO=	K=3
L=94	X(L)=	YD(L)=	HO=	K=3
L=93	X(L)=	YD(L)=	HO=	K=3
L=92	X(L)=	YD(L)=	HO=	K=3
L=91	X(L)=	YD(L)=	HO=	K=3
L=90	X(L)=	YD(L)=	HO=	K=3
L=89	X(L)=	YD(L)=	HO=	K=3
L=88	X(L)=	YD(L)=	HO=	K=4
L=87	X(L)=	YD(L)=	HO=	K=4
L=86	X(L)=	YD(L)=	HO=	K=4
L=85	X(L)=	YD(L)=	HO=	K=3
L=84	X(L)=	YD(L)=	HO=	K=4
L=83	X(L)=	YD(L)=	HO=	K=3
L=82	X(L)=	YD(L)=	HO=	K=3
L=81	X(L)=	YD(L)=	HO=	K=3
L=80	X(L)=	YD(L)=	HO=	K=3
L=79	X(L)=	YD(L)=	HO=	K=3
L=78	X(L)=	YD(L)=	HO=	K=3
L=77	X(L)=	YD(L)=	HO=	K=3
L=76	X(L)=	YD(L)=	HO=	K=3
L=75	X(L)=	YD(L)=	HO=	K=3
L=74	X(L)=	YD(L)=	HO=	K=3
L=73	X(L)=	YD(L)=	HO=	K=3
L=72	X(L)=	YD(L)=	HO=	K=3
L=71	X(L)=	YD(L)=	HO=	K=3
L=70	X(L)=	YD(L)=	HO=	K=3
L=69	X(L)=	YD(L)=	HO=	K=2
L=68	X(L)=	YD(L)=	HO=	K=2
L=67	X(L)=	YD(L)=	HO=	K=2
L=66	X(L)=	YD(L)=	HO=	K=2
L=65	X(L)=	YD(L)=	HO=	K=2
L=64	X(L)=	YD(L)=	HO=	K=2
L=63	X(L)=	YD(L)=	HO=	K=2
L=62	X(L)=	YD(L)=	HO=	K=2
L=61	X(L)=	YD(L)=	HO=	K=2
L=60	X(L)=	YD(L)=	HO=	K=2
L=59	X(L)=	YD(L)=	HO=	K=2
L=58	X(L)=	YD(L)=	HO=	K=2
L=57	X(L)=	YD(L)=	HO=	K=2
L=56	X(L)=	YD(L)=	HO=	K=2
L=55	X(L)=	YD(L)=	HO=	K=2
L=54	X(L)=	YD(L)=	HO=	K=2
L=53	X(L)=	YD(L)=	HO=	K=2
L=52	X(L)=	YD(L)=	HO=	K=2
L=51	X(L)=	YD(L)=	HO=	K=2
L=50	X(L)=	YD(L)=	HO=	K=3
L=49	X(L)=	YD(L)=	HO=	K=2
L=48	X(L)=	YD(L)=	HO=	K=2
L=47	X(L)=	YD(L)=	HO=	K=2
L=46	X(L)=	YD(L)=	HO=	K=2
L=45	X(L)=	YD(L)=	HO=	K=4
L=44	X(L)=	YD(L)=	HO=	K=3
L=43	X(L)=	YD(L)=	HO=	K=3
L=42	X(L)=	YD(L)=	HO=	K=3
L=41	X(L)=	YD(L)=	HO=	K=4
L=40	X(L)=	YD(L)=	HO=	K=1
L=39	X(L)=	YD(L)=	HO=	K=3

L=38	X(L)=	101.800	YD(L)=	1455.00	H0=	1499.00	K=0
L=37	X(L)=	99.750	YD(L)=	1454.98	H0=	1499.00	K=4
L=36	X(L)=	97.700	YD(L)=	1455.00	H0=	1520.99	K=4
L=35	X(L)=	96.150	YD(L)=	1455.01	H0=	1508.74	K=4
L=34	X(L)=	94.600	YD(L)=	1455.02	H0=	1502.63	K=4
L=33	X(L)=	93.050	YD(L)=	1455.04	H0=	1502.64	K=4
L=32	X(L)=	91.500	YD(L)=	1455.08	H0=	1502.66	K=4
L=31	X(L)=	89.633	YD(L)=	1455.12	H0=	1518.60	K=4
L=30	X(L)=	87.767	YD(L)=	1455.17	H0=	1526.60	K=4
L=29	X(L)=	85.900	YD(L)=	1455.25	H0=	1526.65	K=4
L=28	X(L)=	84.360	YD(L)=	1455.35	H0=	1501.84	K=4
L=27	X(L)=	82.820	YD(L)=	1455.45	H0=	1489.50	K=4
L=26	X(L)=	81.280	YD(L)=	1455.57	H0=	1489.60	K=4
L=25	X(L)=	79.740	YD(L)=	1455.74	H0=	1489.71	K=4
L=24	X(L)=	78.200	YD(L)=	1456.05	H0=	1489.86	K=4
L=23	X(L)=	77.220	YD(L)=	1456.67	H0=	1481.50	K=4
L=22	X(L)=	76.240	YD(L)=	1458.58	H0=	1477.66	K=4
L=21	X(L)=	75.260	YD(L)=	1465.02	H0=	1478.93	K=4
L=20	X(L)=	74.280	YD(L)=	1479.79	H0=	1483.10	K=3
L=19	X(L)=	73.300	YD(L)=	1496.79	H0=	1493.71	K=3
L=18	X(L)=	72.725	YD(L)=	1505.02	H0=	1496.64	K=4
L=17	X(L)=	72.150	YD(L)=	1510.59	H0=	1502.78	K=4
L=16	X(L)=	71.575	YD(L)=	1515.46	H0=	1509.68	K=3
L=15	X(L)=	71.000	YD(L)=	1520.30	H0=	1514.90	K=3
L=14	X(L)=	70.500	YD(L)=	2208.01	H0=	2213.01	K=0
L=13	X(L)=	63.000	YD(L)=	2208.01	H0=	2213.01	K=3
L=12	X(L)=	56.000	YD(L)=	2208.01	H0=	2301.76	K=4
L=11	X(L)=	49.000	YD(L)=	2208.01	H0=	2344.89	K=4
L=10	X(L)=	42.000	YD(L)=	2208.01	H0=	2344.89	K=4
L=9	X(L)=	35.000	YD(L)=	2208.01	H0=	2344.89	K=5
L=8	X(L)=	30.541	YD(L)=	2208.01	H0=	2300.78	K=4
L=7	X(L)=	26.081	YD(L)=	2208.01	H0=	2278.73	K=4
L=6	X(L)=	21.622	YD(L)=	2208.01	H0=	2278.73	K=4
L=5	X(L)=	17.162	YD(L)=	2208.02	H0=	2278.73	K=4
L=4	X(L)=	12.703	YD(L)=	2208.03	H0=	2278.73	K=5
L=3	X(L)=	8.243	YD(L)=	2208.08	H0=	2278.74	K=5
L=2	X(L)=	3.784	YD(L)=	2208.38	H0=	2278.77	K=5
L=1	X(L)=	0.000	YD(L)=	2218.54	H0=	2271.80	K=5

I	X(I)	YD(I)	YNORM(I)
1	0.00	2218.54	2226.18
2	3.78	2208.38	2181.73
3	8.24	2208.08	2133.28
4	12.70	2208.03	2088.06
5	17.16	2208.02	2038.14
6	21.62	2208.01	1995.04
7	26.08	2208.01	1942.04
8	30.54	2208.01	1903.44
9	35.00	2208.01	1844.03
10	42.00	2208.01	1765.17
11	49.00	2208.01	1659.46
12	56.00	2208.01	1531.88
13	63.00	2208.01	1529.09
14	70.50	2208.01	1520.30
15	71.00	1520.30	1520.30
16	71.58	1515.46	1515.46
17	72.15	1510.59	1510.59
18	72.73	1505.02	1505.02
19	73.30	1496.79	1496.80
20	74.28	1479.79	1479.92
21	75.26	1465.02	1462.49
22	76.24	1458.58	1445.14
23	77.22	1456.67	1427.97
24	78.20	1456.05	1410.17
25	79.74	1455.74	1389.35
26	81.28	1455.57	1368.46
27	82.82	1455.45	1347.38

28	84.36	1455.35	1326.48
29	85.90	1455.25	1299.27
30	87.77	1455.17	1256.77
31	89.63	1455.12	1218.14
32	91.50	1455.08	1182.66
33	93.05	1455.04	1151.93
34	94.60	1455.02	1120.69
35	96.15	1455.01	1089.43
36	97.70	1455.00	1060.12
37	99.75	1454.98	999.41
38	101.80	1455.00	949.73
39	102.20	949.73	949.73
40	102.73	939.23	939.23
41	103.27	928.34	928.34
42	103.80	913.94	913.94
43	105.10	887.07	887.07
44	106.40	860.86	860.86
45	107.70	841.30	841.30
46	109.00	812.65	812.65
47	109.78	798.42	798.42
48	110.56	784.34	784.34
49	111.34	769.99	769.99
50	112.12	756.31	756.31
51	112.90	741.13	741.13
52	113.25	736.29	736.29
53	113.60	731.45	731.45
54	113.95	726.62	726.62
55	114.30	721.78	721.78
56	114.65	716.95	716.95
57	115.00	712.11	712.11
58	115.35	707.28	707.28
59	115.70	702.45	702.45
60	116.05	697.63	697.63
61	116.40	692.80	692.80
62	116.75	687.97	687.97
63	117.10	683.15	683.15
64	117.45	678.33	678.33
65	117.80	673.51	673.51
66	118.15	668.69	668.69
67	118.50	663.87	663.87
68	118.85	659.05	659.05
69	119.20	654.24	654.24
70	119.55	649.42	649.42
71	119.90	644.83	644.83
72	120.44	639.49	639.49
73	120.99	634.17	634.17
74	121.53	628.87	628.87
75	122.08	623.59	623.59
76	122.62	618.34	618.34
77	123.17	613.13	613.13
78	123.71	607.95	607.95
79	124.26	602.82	602.82
80	124.80	597.75	597.75
81	125.35	592.74	592.74
82	125.89	587.83	587.83
83	126.44	583.03	583.03
84	126.98	578.42	578.42
85	127.53	574.06	574.06
86	128.07	569.98	569.98
87	128.62	566.19	566.19
88	129.16	562.63	562.63
89	129.71	559.09	559.09
90	130.25	555.11	555.11
91	130.80	549.10	549.10
92	131.68	538.76	538.76
93	132.56	528.71	528.71

	133.44	518.85	518.85
94	134.32	508.98	508.98
95	135.20	501.12	501.12
96	136.07	494.49	494.49
97	136.94	487.96	487.96
98	137.81	481.50	481.50
99	138.69	475.10	475.10
100	139.56	468.74	468.74
101	140.43	462.38	462.38
102	141.30	455.49	455.49
103	142.65	443.72	443.72
104	144.00	430.18	430.18
105	144.46	425.18	425.18
106	144.92	420.22	420.22
107	145.38	415.28	415.28
108	145.84	410.35	410.35
109	146.30	405.41	405.41
110	146.76	400.39	400.39
111	147.22	395.21	395.21
112	147.68	389.73	389.73
113	148.14	384.29	384.29
114	148.60	378.50	378.50
115	148.86	376.00	376.00
116	149.13	373.54	373.54
117	149.39	371.11	371.11
118	149.65	368.71	368.71
119	149.91	366.34	366.34
120	150.18	364.00	364.00
121	150.44	361.68	361.68
122	150.70	359.39	359.39
123	150.96	357.13	357.13
124	151.23	354.96	354.96
125	151.49	353.00	353.00
126	151.75	351.48	351.48
127	152.01	350.52	350.52
128	152.28	350.02	350.02
129	152.54	349.77	349.77
130	152.80	349.65	349.65
131	153.13	347.93	347.93
132	153.45	345.64	345.64
133	153.78	343.32	343.32
134	154.11	340.96	340.96
135	154.43	338.57	338.57
136	154.76	336.16	336.16
137	155.09	333.72	333.72
138	155.41	331.27	331.27
139	155.74	328.80	328.80
140	156.07	326.33	326.33
141	156.39	323.86	323.86
142	156.72	321.40	321.40
143	157.05	318.95	318.95
144	157.37	316.54	316.54
145	157.70	314.18	314.18
146			

TT = 0.0000 DTH = 0.0400 ITERR = 0
 QU(1) = 252743.0 YU(1) = 2218.5 QU(N) = 428500.0 YU(N) = 314.18 FRDH=0.68 IFR= 1 FRH=0.00 IFH= 13

TT = 0.0000 DTH = 0.0400 ITERR = 1
 QU(1) = 252743.0 YU(1) = 2218.5 QU(N) = 429697.0 YU(N) = 314.18 FRDH=0.68 IFR= 1 FRH=0.00 IFH= 13

TT = 0.0000 DTH = 0.0400 ITERR = 1
 QU(1) = 252743.0 YU(1) = 2218.5 QU(N) = 429601.2 YU(N) = 314.18 FRDH=0.68 IFR= 1 FRH=0.00 IFH= 13

TT = 0.0400 DTH = 0.0400 ITERR = 1

TT = 8.0000 DTH = 0.0400 ITERR = 2
 QU(1) = 257611.1 YU(1) = 2225.9 QU(N) = 15266066.0 YU(N) = 377.92 FROM=2.56 IFR= 11 FRM=0.10 IFH= 13

KTIME=203 ALLOWABLE KTIME= 698 TT= 8.0

PROFILE OF CRESTS AND TIMES FOR SUSITNA RIVER
 BELOW MULTIPLE FAILURES

RVR MILE FROM DAM *****	MAX ELEV (FT) *****	MAX FLOW (CFS) *****	TIME MAX ELEV(HR) *****	MAX VEL (FT/SEC) *****	MAX VEL (MI/HR) *****	FLOOD ELEV (FT) *****	TIME FLOOD ELEV (HR) *****
0.000	2228.27	257611	2.800	11.33	7.72	0.00	0.00
3.784	2208.40	317065	0.480	9.56	6.52	0.00	0.00
8.243	2208.09	621556	0.400	8.69	5.92	0.00	0.00
12.703	2208.03	1147668	0.600	9.99	6.81	0.00	0.00
17.162	2208.02	1910650	0.240	11.17	7.62	0.00	0.00
21.622	2208.02	2928112	0.200	12.53	8.54	0.00	0.00
26.081	2208.01	4234858	0.120	14.96	10.20	0.00	0.00
30.541	2208.02	5901427	0.280	17.47	11.91	0.00	0.00
35.000	2208.02	7958814	0.200	17.35	11.83	0.00	0.00
42.000	2208.03	12458996	0.120	18.88	12.87	0.00	0.00
49.000	2208.03	18725304	0.040	16.99	11.58	0.00	0.00
56.000	2208.02	26391248	0.000	15.35	10.16	0.00	0.00
63.000	2208.01	35471588	0.000	13.96	9.32	0.00	0.00
70.500	2208.01	42587424	0.000	62.18	42.40	0.00	0.00
1 71.000	1887.49	42587424	2.520	75.18	51.26	0.00	0.00
71.575	1862.08	42547012	2.640	62.87	42.86	0.00	0.00
72.150	1845.43	42417684	2.880	53.73	36.64	0.00	0.00
72.725	1834.87	42181500	2.960	46.34	31.59	0.00	0.00
2 73.300	1827.47	41820912	3.000	39.98	27.26	0.00	0.00
74.280	1819.31	41234012	3.040	37.01	25.23	0.00	0.00
75.260	1813.16	40452496	3.080	34.17	23.30	0.00	0.00
76.240	1808.46	39507136	3.080	30.46	20.77	0.00	0.00
77.220	1804.92	38556228	3.120	27.45	18.72	0.00	0.00
3 78.200	1802.18	37447756	3.120	24.53	16.72	0.00	0.00
79.740	1797.23	35882208	3.120	24.93	17.00	0.00	0.00
81.280	1791.10	34552812	3.160	25.66	17.50	0.00	0.00
82.820	1782.83	33866440	3.200	27.42	18.69	0.00	0.00
84.360	1770.60	33424858	3.200	31.75	21.64	0.00	0.00
4 85.900	1748.72	33102712	3.280	40.48	27.60	0.00	0.00
87.767	1727.13	32738712	3.320	40.28	27.46	0.00	0.00
89.633	1704.16	32370350	3.400	40.77	27.80	0.00	0.00
5 91.500	1678.24	31986412	3.440	41.73	28.45	0.00	0.00
93.050	1655.93	31726170	3.440	42.10	28.70	0.00	0.00
94.600	1633.45	31497282	3.480	42.38	28.89	0.00	0.00
96.150	1610.53	31329138	3.520	43.11	29.40	0.00	0.00
4 97.700	1587.09	31221118	3.520	44.03	30.02	0.00	0.00
99.750	1554.84	31140230	3.520	46.18	31.69	0.00	0.00
101.800	1486.38	31111910	3.520	60.02	40.92	0.00	0.00
102.200	1395.66	31111910	3.560	82.67	61.15	0.00	0.00

102.733	1366.23	31109922	3.520	75.68	51.60	0.00	0.00
103.267	1287.94	31106228	3.560	79.59	54.27	0.00	0.00
103.000	1252.43	31104928	3.560	69.45	47.35	0.00	0.00
105.100	1187.22	31107104	3.600	60.15	41.01	0.00	0.00
106.400	1130.05	31095154	3.600	54.05	36.85	0.00	0.00
107.700	1075.58	31082102	3.640	50.53	34.45	0.00	0.00
109.000	976.75	31084596	3.640	65.95	44.97	0.00	0.00
109.783	960.00	31082242	3.640	58.48	39.87	0.00	0.00
110.560	942.65	31074844	3.680	53.34	36.36	0.00	0.00

PROFILE OF CRESTS AND TIMES FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

RVR MILE FROM DAM	MAX ELEV (FT)	MAX FLOW (CFS)	TIME MAX ELEV(HR)	MAX VEL (FT/SEC)	MAX VEL (MI/HR)	FLOOD ELEV (FT)	TIME FLOOD ELEV (HR)
*****	*****	*****	*****	*****	*****	*****	*****
111.340	925.22	31071896	3.680	49.60	33.82	0.00	0.00
112.120	907.18	31060380	3.720	47.09	32.11	0.00	0.00
112.900	887.83	31036336	3.760	45.75	31.20	0.00	0.00
113.250	882.69	31039204	3.800	45.86	31.26	0.00	0.00
113.600	877.71	31025584	3.840	45.88	31.28	0.00	0.00
113.950	872.84	31008818	3.840	45.90	31.29	0.00	0.00
114.300	868.19	30987972	3.920	45.88	31.28	0.00	0.00
114.650	863.87	30961824	4.000	45.82	31.24	0.00	0.00
115.000	859.98	30934044	4.040	45.52	31.04	0.00	0.00
115.350	856.53	30898216	4.120	45.26	30.86	0.00	0.00
115.700	853.47	30853374	4.120	44.88	30.60	0.00	0.00
116.050	850.76	30799250	4.160	44.39	30.27	0.00	0.00
116.400	848.33	30736224	4.200	43.79	29.86	0.00	0.00
116.750	846.19	30665176	4.200	43.09	29.38	0.00	0.00
117.100	844.26	30593378	4.200	41.99	28.63	0.00	0.00
117.450	842.51	30517732	4.200	41.18	28.08	0.00	0.00
117.800	840.94	30437978	4.240	40.35	27.51	0.00	0.00
118.150	839.51	30355102	4.240	39.52	26.94	0.00	0.00
118.500	838.20	30278678	4.240	38.40	26.18	0.00	0.00
118.850	837.00	30201376	4.240	37.61	25.64	0.00	0.00
119.200	835.88	30123054	4.240	36.85	25.13	0.00	0.00
119.550	834.84	30051962	4.240	35.89	24.47	0.00	0.00
119.900	833.86	29982134	4.240	35.21	24.00	0.00	0.00
120.445	831.86	29876980	4.240	35.12	23.95	0.00	0.00
120.990	829.83	29780804	4.240	35.29	24.06	0.00	0.00
121.535	827.75	29690360	4.240	35.29	24.06	0.00	0.00
122.080	825.61	29606382	4.240	35.52	24.22	0.00	0.00
122.625	823.41	29530492	4.240	35.63	24.29	0.00	0.00
123.170	821.14	29458908	4.280	35.95	24.51	0.00	0.00
123.715	818.78	29396984	4.280	36.17	24.66	0.00	0.00
124.260	816.33	29337450	4.280	36.58	24.94	0.00	0.00
124.805	813.76	29287806	4.280	36.94	25.19	0.00	0.00
125.350	811.05	29239658	4.280	37.48	25.55	0.00	0.00
125.895	808.19	29200138	4.280	37.99	25.90	0.00	0.00
126.440	805.13	29162536	4.280	38.69	26.38	0.00	0.00
126.985	801.84	29130766	4.280	39.40	26.86	0.00	0.00
127.530	798.28	29102700	4.280	40.31	27.48	0.00	0.00
128.075	794.38	29076104	4.280	41.30	28.16	0.00	0.00
128.620	790.05	29056406	4.320	42.53	28.99	0.00	0.00

129.165	785.15	29036426	4.320	43.98	29.99	0.00	0.00
129.710	779.48	29019456	4.320	45.69	31.15	0.00	0.00
130.255	772.67	29005960	4.320	47.92	32.67	0.00	0.00
130.800	763.96	28991268	4.320	50.92	34.72	0.00	0.00
131.680	755.87	28976520	4.360	51.05	34.80	0.00	0.00
132.560	747.25	28958814	4.360	51.39	35.04	0.00	0.00
133.440	737.67	28943216	4.360	52.02	35.47	0.00	0.00
134.320	726.25	28934120	4.360	53.37	36.39	0.00	0.00
135.200	683.12	28918538	4.320	69.14	47.14	0.00	0.00

PROFILE OF CRESTS AND TIMES FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

RVR MILE FROM DAM	MAX ELEV (FT)	MAX FLOW (CFS)	TIME MAX ELEV (HR)	MAX VEL (FT/SEC)	MAX VEL (MI/HR)	FLOOD ELEV (FT)	TIME FLOOD ELEV (HR)
*****	*****	*****	*****	*****	*****	*****	*****
136.071	669.67	28926830	4.400	66.87	45.59	0.00	0.00
136.943	654.67	28919314	4.400	64.88	44.24	0.00	0.00
137.814	644.88	28910270	4.400	62.74	42.78	0.00	0.00
138.686	633.24	28906220	4.440	60.97	41.57	0.00	0.00
139.557	623.08	28892542	4.520	59.01	40.23	0.00	0.00
140.429	615.84	28883044	4.560	55.99	38.17	0.00	0.00
141.300	610.74	28831564	4.560	52.52	35.61	0.00	0.00
142.650	608.88	28801742	4.520	44.87	30.59	0.00	0.00
144.000	524.68	28794788	4.480	78.99	53.86	0.00	0.00
144.460	516.52	28796170	4.520	63.18	43.07	0.00	0.00
144.920	507.73	28796878	4.520	54.09	36.88	0.00	0.00
145.380	499.24	28796654	4.520	48.03	32.75	0.00	0.00
145.840	491.16	28795200	4.520	43.65	29.76	0.00	0.00
146.300	483.44	28793432	4.560	40.33	27.50	0.00	0.00
146.760	475.98	28793992	4.560	37.76	25.75	0.00	0.00
147.220	468.65	28793024	4.560	35.78	24.39	0.00	0.00
147.680	461.27	28790268	4.600	34.34	23.41	0.00	0.00
148.140	453.49	28788042	4.600	33.57	22.89	0.00	0.00
148.600	444.43	28786938	4.600	34.12	23.26	0.00	0.00
148.863	441.21	28784756	4.640	33.16	22.61	0.00	0.00
149.125	438.11	28779588	4.760	32.25	21.99	0.00	0.00
149.388	435.71	28765746	5.000	31.28	21.33	0.00	0.00
149.650	434.07	28733768	5.120	30.10	20.52	0.00	0.00
149.913	432.89	28675680	5.120	28.59	19.49	0.00	0.00
150.175	432.04	28593888	5.160	26.59	18.13	0.00	0.00
150.438	431.42	28492502	5.160	24.71	16.85	0.00	0.00
150.700	430.96	28377526	5.160	22.63	15.43	0.00	0.00
150.963	430.61	28259338	5.160	20.88	14.24	0.00	0.00
151.225	430.35	28142144	5.160	19.09	13.02	0.00	0.00
151.488	430.15	28027826	5.160	17.49	11.97	0.00	0.00
151.750	430.00	27917800	5.160	16.05	10.94	0.00	0.00
152.013	429.88	27812836	5.160	14.76	10.06	0.00	0.00
152.275	429.79	27717316	5.160	13.67	9.32	0.00	0.00
152.538	429.72	27630332	5.160	12.62	8.60	0.00	0.00
152.800	429.66	27553452	5.160	11.68	7.96	0.00	0.00
153.127	427.85	27699442	5.160	11.98	8.17	0.00	0.00
153.453	426.03	27632398	5.160	12.19	8.31	0.00	0.00
153.780	424.14	27578476	5.200	12.12	8.47	0.00	0.00
154.107	422.19	27535442	5.200	12.66	8.63	0.00	0.00

154.433	420.15	27501054	5.200	12.92	8.01	0.00	0.00
154.760	418.01	27474650	5.200	13.21	9.01	0.00	0.00
155.087	415.76	27457812	5.200	13.52	9.22	0.00	0.00
155.413	413.38	27444142	5.200	13.87	9.46	0.00	0.00
155.740	410.83	27438440	5.240	14.27	9.73	0.00	0.00
156.067	408.06	27435156	5.240	14.72	10.04	0.00	0.00
156.393	405.02	27439010	5.200	15.27	10.41	0.00	0.00
156.720	401.58	27444002	5.200	15.95	10.87	0.00	0.00
157.047	397.53	27456694	5.200	16.87	11.50	0.00	0.00

PROFILE OF CRESTS AND TIMES FOR SUSITHA RIVER
BELOW MULTIPLE FAILURES

RVR MILE FROM DAM *****	MAX ELEV (FT) *****	MAX FLOW (CFS) *****	TIME MAX ELEV(HR) *****	MAX VEL (FT/SEC) *****	MAX VEL (MI/HR) *****	FLOOD ELEV (FT) *****	TIME FLOOD ELEV (HR) *****
157.373	392.45	27475192	5.120	18.25	12.45	0.00	0.00
157.700	385.06	27507370	4.960	21.11	14.39	0.00	0.00

DISCHARGE HYDROGRAPH FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES

... STATION NUMBER 15 (1977/78)
AT MILE 71.00

GAGE ZERO = 1455.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1987.49
FLOOD STAGE NOT AVAILABLE

MAX STAGE = 432.49 AT TIME = 2.52 HOURS
MAX FLOW = 42587424 AT TIME = 2.52 HOURS

HR	STAGE	FLOW	0	8517484	17034968	25552452	34069936	42587420
0.0	65.3	361093	*	I	I	I	I	I
0.2	70.3	479953	I*	I	I	I	I	I
0.4	91.2	1014876	I*	I	I	I	I	I
0.6	124.3	2129368	I *	I	I	I	I	I
0.8	161.5	3849966	I	*	I	I	I	I
1.0	200.9	6297127	I	*	I	I	I	I
1.2	238.9	9499439	I	I*	I	I	I	I
1.4	273.5	13504259	I	I	*	I	I	I
1.6	306.5	18198556	I	I	I*	I	I	I
1.8	337.9	23442124	I	I	I	*	I	I
2.0	368.0	29068926	I	I	I	I	*	I
2.2	396.2	34866756	I	I	I	I	I*	I
2.4	421.9	40518904	I	I	I	I	I	*I
2.6	431.5	41523176	I	I	I	I	I	*I
2.8	427.0	38338640	I	I	I	I	I*	I
3.0	420.7	34890164	I	I	I	I	*	I
3.2	411.8	31496268	I	I	I	I	*	I
3.4	400.9	28290108	I	I	I	I	*	I
3.6	388.5	25361062	I	I	I	I	I	I
3.8	375.4	22753804	I	I	I	I	I	I
4.0	361.9	20458612	I	I	I	I	I	I
4.2	348.2	18448220	I	I	I	I	I	I
4.4	334.6	16669837	I	I	I	I	I	I
4.6	321.3	15074528	I	I	I	I	I	I
4.8	308.1	13624444	I	I	I	I	I	I
5.0	295.1	12305652	I	I	I	I	I	I
5.2	282.3	11107820	I	I	I	I	I	I
5.4	269.8	10021558	I	I	I	I	I	I
5.6	257.7	9041072	I	I	I	I	I	I
5.8	246.0	8153188	I	I	I	I	I	I
6.0	234.8	7356992	I	I	I	I	I	I
6.2	223.6	6625690	I	I	I	I	I	I
6.4	212.8	5958229	I	I	I	I	I	I
6.6	203.5	5437003	I	I	I	I	I	I
6.8	194.9	4974215	I	I	I	I	I	I
7.0	186.3	4509882	I	I	I	I	I	I
7.2	177.7	4061652	I	I	I	I	I	I
7.4	169.4	3653440	I	I	I	I	I	I
7.6	161.6	3293037	I	I	I	I	I	I

$V \approx 4.369 \times 10^3 \text{ ft}^3$
highway

$V \approx 4.517 \times 10^3 \text{ ft}^3$
water

2.8 154.3 2948915 I 4

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DISCHARGE HYDROGRAPH FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES... STATION NUMBER 38 DEVIL CANYON
AT MILE 101.80GAGE ZERO = 907.00 MAX ELEVATION REACHED BY FLOOD WAVE = 1486.38
FLOOD STAGE NOT AVAILABLEMAX STAGE = 579.38 AT TIME = 3.52 HOURS
MAX FLOW = 31111912 AT TIME = 3.52 HOURS

HR STAGE FLOW 0 6222382 12444764 18667146 24889528 31111910

0.0	548.0	160500	*	I	I	I	I	I
0.2	553.0	160500	*	I	I	I	I	I
0.4	554.9	160500	*	I	I	I	I	I
0.6	556.6	160500	*	I	I	I	I	I
0.8	558.1	160567	*	I	I	I	I	I
1.0	559.4	167277	*	I	I	I	I	I
1.2	560.7	179916	*	I	I	I	I	I
1.4	567.9	325063	I	I	I	I	I	I
1.6	571.0	3607777	I	*	I	I	I	I
1.8	504.1	13280243	I	I	I*	I	I	I
2.0	440.8	14664711	I	I	I	*	I	I
2.2	440.6	14701547	I	I	I	*	I	I
2.4	457.8	16307810	I	I	I	*	I	I
2.6	486.7	19167628	I	I	I	1*	I	I
2.8	522.1	23000854	I	I	I	I	*	I
3.0	553.8	26976634	I	I	I	I	I	*
3.2	571.2	29438658	I	I	I	I	I	*
3.4	578.3	30913356	I	I	I	I	I	*
3.6	579.1	31058122	I	I	I	I	I	*
3.8	576.0	30433892	I	I	I	I	I	*
4.0	570.0	29337148	I	I	I	I	I	*
4.2	561.7	27978732	I	I	I	I	I	*
4.4	551.6	26490338	I	I	I	I	I	*
4.6	540.3	24958996	I	I	I	I	I	*
4.8	528.2	23452606	I	I	I	I	I	*
5.0	515.5	22018078	I	I	I	I	I	*
5.2	502.6	20672402	I	I	I	I	I	*
5.4	489.7	19329332	I	I	I	I	I	*
5.6	476.8	18009714	I	I	I	I	I	*
5.8	464.2	16791272	I	I	I	I	I	*
6.0	451.8	15658334	I	I	I	I	I	*
6.2	439.6	14561401	I	I	I	I	I	*
6.4	427.0	13491602	I	I	I	I	I	*
6.6	413.5	12424975	I	I	I	I	I	*
6.8	399.7	11423867	I	I	I	I	I	*
7.0	384.0	10488484	I	I	I	I	I	*
7.2	373.0	9620321	I	I	I	I	I	*
7.4	360.4	8831875	I	I	I	I	I	*
7.6	347.9	8099503	I	I	I	I	I	*

D.C.
Inlet
@ 568.9

7.8 335.6 7423592 1

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DISCHARGE HYDROGRAPH FOR SUSITNA RIVER
BELOW MULTIPLE FAILURES... STATION NUMBER 51
AT MILE 112.90

INDIAN CREEK

GAGE ZERO = 730.00 MAX ELEVATION REACHED BY FLOOD WAVE = 887.83
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 157.83 AT TIME = 3.76 HOURS
MAX FLOW = 31036338 AT TIME = 3.72 HOURS

HR	STAGE	FLOW	0	6207267	12414534	18621901	24829068	31036335
0.0	11.1	174500	*	I	I	I	I	I
0.2	11.1	174501	*	I	I	I	I	I
0.4	11.2	175231	*	I	I	I	I	I
0.6	11.2	175589	*	I	I	I	I	I
0.8	11.2	175686	*	I	I	I	I	I
1.0	11.2	175706	*	I	I	I	I	I
1.2	11.2	175707	*	I	I	I	I	I
1.4	11.2	175728	*	I	I	I	I	I
1.6	11.2	175595	*	I	I	I	I	I
1.8	11.1	175501	*	I	I	I	I	I
2.0	58.4	7558429	I	I *	I	I	I	I
2.2	103.7	14112761	I	I	I *	I	I	I
2.4	108.6	14704284	I	I	I *	I	I	I
2.6	114.2	16309481	I	I	I *	I	I	I
2.8	123.2	19299470	I	I	I	I *	I	I
3.0	134.8	23357660	I	I	I	I	I *	I
3.2	145.6	27204840	I	I	I	I	I *	I
3.4	153.1	29777102	I	I	I	I	I	I *
3.6	156.9	30909888	I	I	I	I	I	I *
3.8	157.8	30944184	I	I	I	I	I	I *
4.0	156.8	30258800	I	I	I	I	I	I *
4.2	154.7	29143764	I	I	I	I	I	I *
4.4	151.9	27799204	I	I	I	I	I	I *
4.6	148.4	26352440	I	I	I	I	I *	I
4.8	144.5	24861506	I	I	I	I	I *	I
5.0	140.2	23362042	I	I	I	I	I *	I
5.2	136.0	21962082	I	I	I	I	I *	I
5.4	131.8	20650026	I	I	I	I	I *	I
5.6	127.5	19331254	I	I	I	I	I *	I
5.8	123.1	18054620	I	I	I	I	I *	I
6.0	119.0	16866352	I	I	I	I	I *	I
6.2	115.0	15757381	I	I	I	I	I *	I
6.4	111.1	14695907	I	I	I	I	I *	I
6.6	107.2	13655168	I	I	I	I	I *	I
6.8	103.3	12627906	I	I	I	I	I *	I
7.0	99.3	11651947	I	I	I	I	I *	I
7.2	95.5	10742678	I	I	I	I	I *	I
7.4	91.8	9892704	I	I	I	I	I *	I
7.6	88.3	9113359	I	I	I	I	I *	I

7.8 85.0 8392901 1

DISCHARGE HYDROGRAPH FOR SUSITNA RIVER ... STATION NUMBER 91 CURRY
BELOW MULTIPLE FAILURES AT MILE 130.80

GAGE ZERO = 523.00 MAX ELEVATION REACHED BY FLOOD WAVE = 763.96
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 240.96 AT TIME 4.32 HOURS
MAX FLOW = 28991270 AT TIME = 4.24 HOURS

HR	STAGE	FLOW	0	5798254	11596508	17394742	23193016	28991270
0.0	26.1	188500	*	I	I	I	I	I
0.2	26.1	188500	*	I	I	I	I	I
0.4	26.1	188500	*	I	I	I	I	I
0.6	26.1	188500	*	I	I	I	I	I
0.8	26.1	188500	*	I	I	I	I	I
1.0	26.1	188500	*	I	I	I	I	I
1.2	26.1	188500	*	I	I	I	I	I
1.4	26.1	188500	*	I	I	I	I	I
1.6	26.1	188500	*	I	I	I	I	I
1.8	26.1	188500	*	I	I	I	I	I
2.0	26.1	188485	*	I	I	I	I	I
2.2	26.1	188949	*	I	I	I	I	I
2.4	26.2	189275	*	I	I	I	I	I
2.6	88.4	4348701	I	* I	I	I	I	I
2.8	140.1	10439139	I	I	* I	I	I	I
3.0	163.4	13660586	I	I	I	*	I	I
3.2	184.3	17227870	I	I	I	*	I	I
3.4	203.7	21317502	I	I	I	I	* I	I
3.6	219.7	24800390	I	I	I	I	I	* I
3.8	230.8	27177342	I	I	I	I	I	* I
4.0	237.4	28489240	I	I	I	I	I	* I
4.2	240.4	28973620	I	I	I	I	I	* I
4.4	240.9	28849276	I	I	I	I	I	* I
4.6	239.5	28291464	I	I	I	I	I	* I
4.8	236.7	27438192	I	I	I	I	I	* I
5.0	233.0	26384570	I	I	I	I	I	* I
5.2	228.6	25197396	I	I	I	I	I	* I
5.4	223.7	23968042	I	I	I	I	I*	I
5.6	218.7	22740702	I	I	I	I	* I	I
5.8	213.5	21511230	I	I	I	I	* I	I
6.0	208.1	20276976	I	I	I	I	* I	I
6.2	202.7	19081808	I	I	I	I	* I	I
6.4	197.3	17938606	I	I	I	I*	I	I
6.6	191.9	16846116	I	I	I	* I	I	I
6.8	186.6	15788913	I	I	I	* I	I	I
7.0	181.2	14763081	I	I	I	I	I	I
7.2	175.9	13769617	I	I	I	I	I	I
7.4	170.5	12826947	I	I	I	I	I	I

7.6 165.1 11933397
7.8 159.7 11088517

DISCHARGE HYDROGRAPH FOR SUSITNA RIVER ... STATION NUMBER 131
BELOW MULTIPLE FAILURES AT MILE 152.80

Talked to

GAGE ZERO = 333.00 MAX ELEVATION REACHED BY FLOOD WAVE = 429.66
FLOOD STAGE NOT AVAILABLE
MAX STAGE = 96.66 AT TIME = 5.16 HOURS
MAX FLOW = 27553454 AT TIME = 4.92 HOURS

HR	STAGE	FLOW	0	5510690	11021380	16532070	22042760	27553450
0.0	16.6	200500	*	I	I	I	I	I
0.2	16.6	200500	*	I	I	I	I	I
0.4	16.7	201047	*	I	I	I	I	I
0.6	16.7	201657	*	I	I	I	I	I
0.8	16.7	202016	*	I	I	I	I	I
1.0	16.7	202322	*	I	I	I	I	I
1.2	16.7	202338	*	I	I	I	I	I
1.4	16.7	202407	*	I	I	I	I	I
1.6	16.7	202450	*	I	I	I	I	I
1.8	16.7	202479	*	I	I	I	I	I
2.0	16.7	202497	*	I	I	I	I	I
2.2	16.7	202508	*	I	I	I	I	I
2.4	16.7	202517	*	I	I	I	I	I
2.6	16.7	202521	*	I	I	I	I	I
2.8	16.7	202524	*	I	I	I	I	I
3.0	16.7	202526	*	I	I	I	I	I
3.2	16.7	202528	*	I	I	I	I	I
3.4	17.1	259199	*	I	I	I	I	I
3.6	18.3	8905987	I	I	*	I	I	I
3.8	66.2	16016373	I	I	I	*I	I	I
4.0	76.9	20701018	I	I	I	I	*I	I
4.2	84.4	23844176	I	I	I	I	I	*
4.4	89.6	25797432	I	I	I	I	I	*
4.6	93.2	26919654	I	I	I	I	I	*
4.8	95.4	27466200	I	I	I	I	I	*
5.0	96.5	27526438	I	I	I	I	I	*
5.2	96.6	27195462	I	I	I	I	I	*
5.4	96.2	26552622	I	I	I	I	I	*
5.6	95.3	25684132	I	I	I	I	I	*
5.8	94.0	24685478	I	I	I	I	I	*
6.0	92.6	23616612	I	I	I	I	I	*
6.2	91.0	22503688	I	I	I	I	I	*
6.4	89.4	21368664	I	I	I	I	I	*
6.6	87.6	20243614	I	I	I	I	I	*
6.8	85.9	19145956	I	I	I	I	I	*
7.0	84.1	18083444	I	I	I	I	I	*
7.2	82.4	17053882	I	I	I	I	I	*
7.4	80.6	16055884	I	I	I	I	I	*
7.6	78.9	15090451	I	I	I	I	I	*