SUSITNA HYDROELECTRIC PROJECT

TASK 7 — ENVIRONMENTAL

SUBTASK 7.04
WATER RESOURCES ANALYSIS
A PRELIMINARY ANALYSIS OF POTENTIAL
NAVIGATIONAL PROBLEMS DOWNSTREAM OF THE
PROPOSED HYDROELECTRIC DAMS
ON THE SUSITNA RIVER

MARCH 1982

Prepared for:

ACRES

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT
TASK 7 - ENVIRONMENTAL
SUBTASK 7.04 WATER RESOURCES ANALYSIS

A PRELIMINARY ANALYSIS OF POTENTIAL NAVIGATIONAL PROBLEMS DOWNSTREAM OF THE PROPOSED HYDROELECTRIC DAMS ON THE SUSITNA RIVER

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SUMMARY

A review of aerial photographs, river cross-sectional data, and simulated water surface profiles indicates that the proposed Susitna hydroelectric project is not likely to cause navigational problems in most areas above Talkeetna under Case D postproject flows (minimal impact on fisheries). Case A streamflows (maximum power production) are likely to cause periodic navigational problems during the months of August and September.

The major area of concern is a broad shallow reach one to three miles below Sherman, where the main channel of the Susitna River crosses the floodplain. The simulated flow is 6,500 cubic feet per second (cfs) and the depth is estimated at about 2.5 feet for this cross section -- indicating that the channel is navigable. Navigational problems may be encountered in about one year out of three in August and in about one year out of two in September in this reach under Case A postproject flows and in about one year out of 10 in June under Case D. Visual examination of aerial photographs from nearby areas without cross-sectional data indicates that these unsurveyed areas also may be non-navigable. Additional study in the Sherman reach is warranted during Phase II engineering and environmental studies, as these conditions are based on limited data.

Cross-sectional data were gathered on the main channel of the Susitna River below Talkeetna, on sloughs and side channels used for river access near Kashwitna Landing and Willow Creek, and at the upper access channel to Alexander Slough. While stage-discharge data at these sites

are very limited, initial analysis indicates that operation of the dams would have no significant negative impacts on navigation in the main channel below Talkeetna or on access at Kashwitna Landing. At access channels near Willow Creek, it appears that there would be minor negative impacts in May for Case D. Case A streamflows are higher than Case D during May, thus navigation during this month is less likely to be adversely affected near Willow. Between the months of June through September, access channels to Willow Creek should be navigable.

Data are insufficient to completely define the flow required at Susitna Station in order to keep upstream access to Alexander Slough open, but the decrease in stage is less than one foot for both Case A and Case D postproject flows.

INTRODUCTION

Will the operation of the proposed Watana and Devil Canyon hydroelectric dams on the Susitna River restrict the movement of vessels during the ice-free months downstream of these dams? It is the intent herein to provide a preliminary determination of whether navigation would or would not be adversely affected downstream of the Devil Canyon dam site, and, if so, to define in which river segments and during which period of the year navigational problems are most likely to occur. Specific reference will also be made regarding the possibility of postproject streamflows improving navigation during those years or portions of the year in which low streamflows occur naturally. It if is concluded that navigation would be adversely impacted, a more detailed study could be conducted in 1982 with the intention of defining, in detail, the extent to which this would occur.

For the purpose of this study, navigation is defined as past and present use of the river system for transportation by boats and float planes between May 1 and October 31. Future navigational craft are considered to require a depth similar to that required by the present craft. It has also been assumed that postproject channel morphology would remain much as it is now. The scientific basis for this assumption is found in concluding statements of the river morphology report (R&M Consultants, Inc. 1982). The effect of these dams on navigation over ice and snow is not discussed in this document, nor are potential impacts on navigation in Cook Inlet.

Some consider 1.5 feet to be an adequate depth for navigation (R. Krogseng, pers. comm.). However, much of the cross-sectional data used in preparing this report was obtained for purposes other than evaluating project effects on navigation. Hence they may not have been located in the most critical stream reach for determining navigation. In addition, the accuracy of the predicted water surface profiles currently available for the river segment between Devil Canyon and Talkeetna is, at best, approximately one foot (S. Bredthauer, pers. comm.). Because of these considerations, it has been recommended that it would be more appropriate to use a 2.5-foot depth criteria than a 1.5-foot depth criteria in this preliminary assessment of potential navigational problems (W. Trihey, pers. comm.). Both the 1.5-foot and the more conservative 2.5-foot depth criteria are used in this report. Potential navigational problems upstream and downstream of Talkeetna are discussed separately.

DISCUSSION

Site Selection, Data Collection and Data Analysis - Upstream of Talkeetna

During the fall of 1980, R&M Consultants, Inc. (R&M) surveyed 66 cross sections for the 50-mile river segment between the confluence of the Susitna and Chulitna Rivers and Devil Canyon. The U.S. Army Corps of Engineers Hydrologic Engineering Center's HEC-2 computer program ("Water Surface Profiles") was used by R&M to forecast water surface profiles for the Susitna River above Talkeetna. Water surface elevations were predicted for six different flow rates at each of the 66 cross sections.

This information, along with a description of its development, is presented in the Susitna River Hydroelectric Feasibility Report, Appendix B.7, Hydraulic and Ice Studies. Figure 1 presents a cross-sectional profile and simulated water surface elevations for cross section 32. This is located at River Mile 129.7, about 1.1 river miles below Sherman. Water surface profiles for calibrating the hydraulic model were collected from six crest gage stations in the 50-mile reach of the river. Due to their limited number, and the distance between the crest gages, possible inaccuracies in the HEC-2 analysis are worth noting. A comparison of stage-discharge data used by R&M in this analysis and that collected by the Alaska Department of Fish and Game (ADF&G) indicates that some errors may exist in the HEC-2 analysis. Mr. Steve Bredthauer of R&M believes the HEC-2 analysis predicts the water

surface elevations to within ±1 foot. This should be considered when deciding whether the 1.5-foot or the 2.5-foot depth criteria is most appropriate.

Table 1 gives the information used to plot the stage-discharge rating curve for cross section 32. This curve is shown in Figure 2. From this curve, the discharge required to maintain a certain water depth can be determined. For cross section 32, the discharge required to maintain a 2.5-foot depth is 6,500 cfs (Figure 2).

Table 1

Cross Section 32
Stage-Discharge Data

Thalweg Elevation = 602.0 feet

Water Surface Elevation (feet)	Depth of Flow (feet)	Discharge (cfs)
605.2	3.2	9,700
606.0	4.0	13,400
606.7	4.7	17,000
607.8	5.8	23,400
608.9	6.9	34,500
610.8	8.8	52,000

Figure 3.5 was developed by R&M. This shows monthly preproject and postproject flow duration curves for the Susitna River at Gold Creek.

This information, along with a description of its development and reliability, is given in the Susitna River Hydroelectric Feasibility Report, Appendix B.9, River Morphology.

Several operational schedules for water releases past the Devil Canyon dam have been proposed; two are considered in this analysis. Post-project Case A is a water release recommended for maximum power production. Postproject Case D is a water release recommended for minimal impact on fisheries. Comparing the discharge required to maintain a 1.5-foot or 2.5-foot depth to the flow duration curves in Figure 3.5 allows an estimate to be made, for each month of interest, as to the percentage of time existing navigational patterns might be adversely impacted by the two proposed postproject development scenarios. This information is shown in Table 2 using the 2.5-foot depth criteria for cross section 32.

This same analysis was done for each of the 66 cross sections available for the Devil Canyon to Talkeetna reach. With the exception of cross section 32, this analysis indicates that all locations are navigable both before and after the project, using the 2.5-foot depth criteria.

This analysis also indicates that cross section 32 is navigable both before and after the project using the 1.5-foot depth criteria. However, when using the 2.5-foot depth criteria, negative postproject impacts on navigation occur at cross section 32 during June, July, August and September (Table 2). A minimum flow of 6,500 cfs is required

to eliminate these negative impacts. Cross section 32 is located at River Mile 129.7, about 1.1 river miles below Sherman.

Table 2

Cross Section 32

Percent of time the discharge, required to maintain a 2.5-foot depth of flow, is equaled or exceeded.

Discharge to maintain 2.5-foot depth of flow (6,500 cfs)		Discharge to maintain 2.5-foot depth of flow (6,500 cfs)	
May		August	
Preproject	90	Preproject	100
Postproject Case A	100	Postproject Case A	70
Postproject Case D	90	Postproject Case D	100
June		September	
Preproject	100	Preproject	97
Postproject Case A	100	Postproject Case A	44
Postproject Case D	90	Postproject Case D	97
July		October	
Preproject	100	Preproject	26
Postproject Case A	97	Postproject Case A	100
Postproject Case D	100	Postproject Case D	65

Summary and Conclusions - Upstream of Talkeetna

With the exception of a section of the river below Sherman, this analysis indicates the operation of the dams would not change mainstem navigability of the Susitna River between the confluence of the Susitna and Chulitna Rivers and Devil Canyon. Assuming the 1.5-foot depth

criteria is adequate, navigability of the river near Sherman would not be altered. Using the 2.5-foot depth criteria, navigation near Sherman would be hindered about ten percent of the time, or about one year out of 10 during June under Case D postproject flows (minimal fisheries impact). Table 2 also indicates that navigation would be hindered about 30 percent of the time, or about one year out of three in August, and about 53 percent of the time, or about one year out of two in September, under Case A postproject flows (maximum power generation).

On February 25, 1982, Mr. Steve Mahay, who operates the Talkeetna River Boat Service, was contacted by telephone. He has operated boats on the Susitna River for a number of years. Although Mr. Mahay has never found the reach about one mile downstream of Sherman to be non-navigable under natural flows, he confirmed that, between Talkeetna and Devil Canyon, it is probably the most subject to navigational difficulties due to decreased flow.

A review of aerial photographs indicates that these navigational problems may occur not only at this one location, but in a reach of the river about one to three miles below Sherman. Because of the limited data available at this time, this cannot be confirmed or denied. Hence, additional study in this reach is warranted during Phase II.

Site Selection - Downstream of Talkeetna

To determine if navigational use would be adversely affected by the operation of the proposed dams, aerial photographs and topographic maps

of the river were reviewed. Also, discussions were held with persons familiar with navigation in the areas of interest. This resulted in the following areas being designated as those receiving a significant amount of navigational use that could be adversely affected by reduced discharges in the Susitna River downstream of the proposed dams.

1. A braided area on the east side of the Susitna River, about six river miles downstream from Talkeetna. This is at about River Mile 91.

2. A braided area on the east side of the Susitna River, adjacent to and extending about one mile downstream of Kashwitna. This is at about River Mile 60 to 61.

3. The Susitna River near its confluence with Willow Creek. This is at about River Mile 48 to 49.

4. On Alexander Slough (also known as the west channel), just as it divides off the mainstem of the Susitna River (also known as the east channel downstream of this point). This is near River Mile 19.

Data Collection - Downstream of Talkeetna

Seven staff gages were placed at the sites of interest, two on the Susitna River near Talkeetna, two near Kashwitna Landing, two near Willow Creek, and one on Alexander Slough. Since one gage was placed on

a side channel near Talkeetna that receives little traffic, it is not considered further in this report. The staff gages were installed September 22-25, 1981. When each staff gage was installed, a survey was made to define the cross section of the stream channel at the gage site and to establish the relative distance between the stream bed and the staff gage readings. The water surface elevation relative to the staff gage was noted when the gage was installed. Several other readings were made during September and October. These cross sections and water surface elevations are shown in Figures 4 through 9.

Data Analysis - Downstream of Talkeetna

This study will compare the depth of flow at the staff gage sites near Talkeetna, Kashwitna Landing, and Willow Creek to the mean daily flow rate in the Susitna River at Sunshine. Unfortunately, the U.S. Geological Survey (USGS) gage recording the Susitna River flow rate at Sunshine became inoperable on September 15, 1981. Therefore, the flow rates at this location had to be estimated. This was done by Mr. Jack McKechnie of USGS on February 1, 1982. USGS has gaging stations on the Susitna River at Susitna Station, Yentna River near its confluence with the Susitna River, Willow Creek near Willow, and Deshka River near Willow. The Susitna River discharge at Sunshine was taken to equal the Susitna River discharge at Susitna Station minus the discharge from the three gaged tributaries mentioned above, minus a minor amount from ungaged tributaries. Mr. McKechnie believes the Susitna River discharge at Sunshine estimated in this fashion has an accuracy of about eight percent. It is these flow rates, estimated by Mr. McKechnie, that were

compared to the depths of flow at the staff gage sites. This information is shown in Table 3.

This study will also compare the depth of flow at the staff gage site located on Alexander Slough to the mean daily flow rate in the Susitna River at Susitna Station, as recorded by the USGS gage 15294350. This information is shown in Table 3.

Preliminary rating curves at each of these staff gage sites are shown in Figures 10 through 14. Since there was only one observation of the staff gage on Alexander Slough, no discharge rating curve at this location could be made. From Figures 10 through 14, the discharge required in the Susitna River at Sunshine to maintain a water depth of 1.5-feet or 2.5-feet at the cross sections under study can be determined. These discharges are given in Tables 4 and 5.

Figure 3.7 was prepared by R&M. This shows monthly preproject and postproject flow duration curves for the Susitna River at Sunshine. Comparing the discharges given in Tables 4 and 5 to the curves in Figure 3.7 allows an estimate to be made, for each month of interest, as to the percentage of time preproject navigation would be adversely impacted by two proposed postproject conditions at the locations of interest. As mentioned earlier, postproject Case A is a water release recommended for maximum power production and postproject Case D is a water release recommended for minimal impact on fisheries. The results are shown in Tables 4 and 5. Table 4 deals with the case when a 1.5-foot depth is considered adequate for navigation. Table 5 deals with the case when a 2.5-foot depth is considered adequate.

Table 3

Stage-Discharge Data, Downstream of Talkeetna

	Near Talkeetna	Kashwitna Landing Upstream	Kashwitna Landing Downstream	Near Willow Creek	Near Willow Creek Middle Channel	Alexander Slough
	LRX-TKA1	LRX-KTA2	LRX-KTA3	LRX-WLD1	LRX-WLD3	LRX-ALEX
Thalweg Elevation (feet)	325.93	141.94	138.44	80.30	81.18	23.91
Date						9-25-81
Water Surface Elevation (feet)						27.80
Depth of Flow (feet)						3.89
Discharge at Susitna Station (cfs)						47,300
Date	9-22-81	9-23-81	9-23-81	9-23-81	9-23-81	
Water Surface Elevation (feet)	342.02	146.85	143.54	84.59	86.97	
Depth of Flow (feet)	16.09	4.91	5.10	4.29	5.79	
Discharge at Sunshine (cfs)	27,000	26,000	26,000	26,000	26,000	
Date	10-17-81	10-9-81	10-9-81	10-9-81	10-9-81	
Water Surface Elevation (feet)	340.92	145.87	143.89	82.92	84.97	
Depth of Flow (feet)	14.99	3.93	5.45	2.62	3.79	
Discharge at Sunshine (cfs)	20,000	17,000	17,000	17,000	17,000	
Date		10-16-81	10-15-81			
Water Surface Elevation (feet)		146.32	142.45			
Depth of Flow (feet)		4.38	4.01			
Discharge at Sunshine (cfs)		20,000	25,000			
Date			10-16-81			
Water Surface Elevation (feet)			142.53			
Depth of Flow (feet)			4.09			
Discharge at Sunshine (cfs)			20,000			

Table 4

Downstream of Talkeetna

Percent of time Susitna River discharge at Sunshine, required to maintain a 1.5-foot depth of flow, is equaled or exceeded.

	Near Talkeetna LRX-TKA1	Kashwitna Landing Upstream LRX-KTA2	Kashwitna Landing Downstream LRX-KTA3	Near Willow Creek LRX-WLD1	Near Willow Creek Middle Channel LRX-WLD3
Discharge for 1.5-foot depths (cfs)	100	2,750	3,550	10,400	6,500
May					
Preproject	100	100	100	93	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	99	100
June					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
July					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
August					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
September					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
October					
Preproject	100	100	100	91	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100

Table 5

Downstream of Talkeetna

Percent of time Susitna River discharge at Sunshine, required to maintain a 2.5-foot depth of flow, is equaled or exceeded.

	Near Talkeetna LRX-TKA1	Kashwitna Landing Upstream LRX-KTA2	Kashwitna Landing Downstream LRX-KTA3	Near Willow Creek LRX-WLD1	Near Willow Creek Middle Channel LRX-WLD3
Discharge for 2.5-foot depths (cfs)	100	7,200	8,100	16,200	11,000
May					
Preproject	100	100	99	88	92
Postproject Case A	100	100	100	90	100
Postproject Case D	100	100	100	82	98
June					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
July					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
August					
Preproject	100	100	100	100	100
Postproject Case A	100	100	100	100	100
Postproject Case D	100	100	100	100	100
September					
Preproject	100	100	100	98	100
Postproject Case A	100	100	100	96	100
Postproject Case D	100	100	100	98	100
October					
Preproject	100	100	99	18	87
Postproject Case A	100	100	100	38	100
Postproject Case D	100	100	100	28	100

Summary and Conclusions - Downstream of Talkeetna

Although the stage-discharge data at the sites studied are limited, this analysis indicates that operation of the dams will have no negative impacts on navigation in the main channel below Talkeetna or on two access sites near Kashwitna Landing. Using the 1.5-foot depth criteria for navigation, no negative impacts would occur near Willow Creek. Figure 18 indicates that, using the 2.5-foot depth criteria, there would be minor negative impacts here in May with postproject flow Case D. These are predicted to occur roughly six percent of the time, or about two years out of the 30 years of simulated record. Eliminating these negative impacts would require a flow in the Susitna River at Sunshine of 16,200 cfs. During the months of June through September, this access channel to Willow Creek should be navigable, with no significant negative impacts from the dams. Data are insufficient to completely define the flow required at Susitna Station in order to keep the upstream access to Alexander Slough open. It is anticipated, however, that the decrease in stage at this location would be less than one foot for both postproject flows.

According to R&M, the Susitna River, upstream of its confluence with the Chulitna River, contributes an average of 43 percent to the Susitna River flow at Talkeetna, and only 19 percent to the flow at Susitna Station. This may help explain why the operation of the dam has such a minor effect on navigation downstream of Talkeetna.

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION Number 32

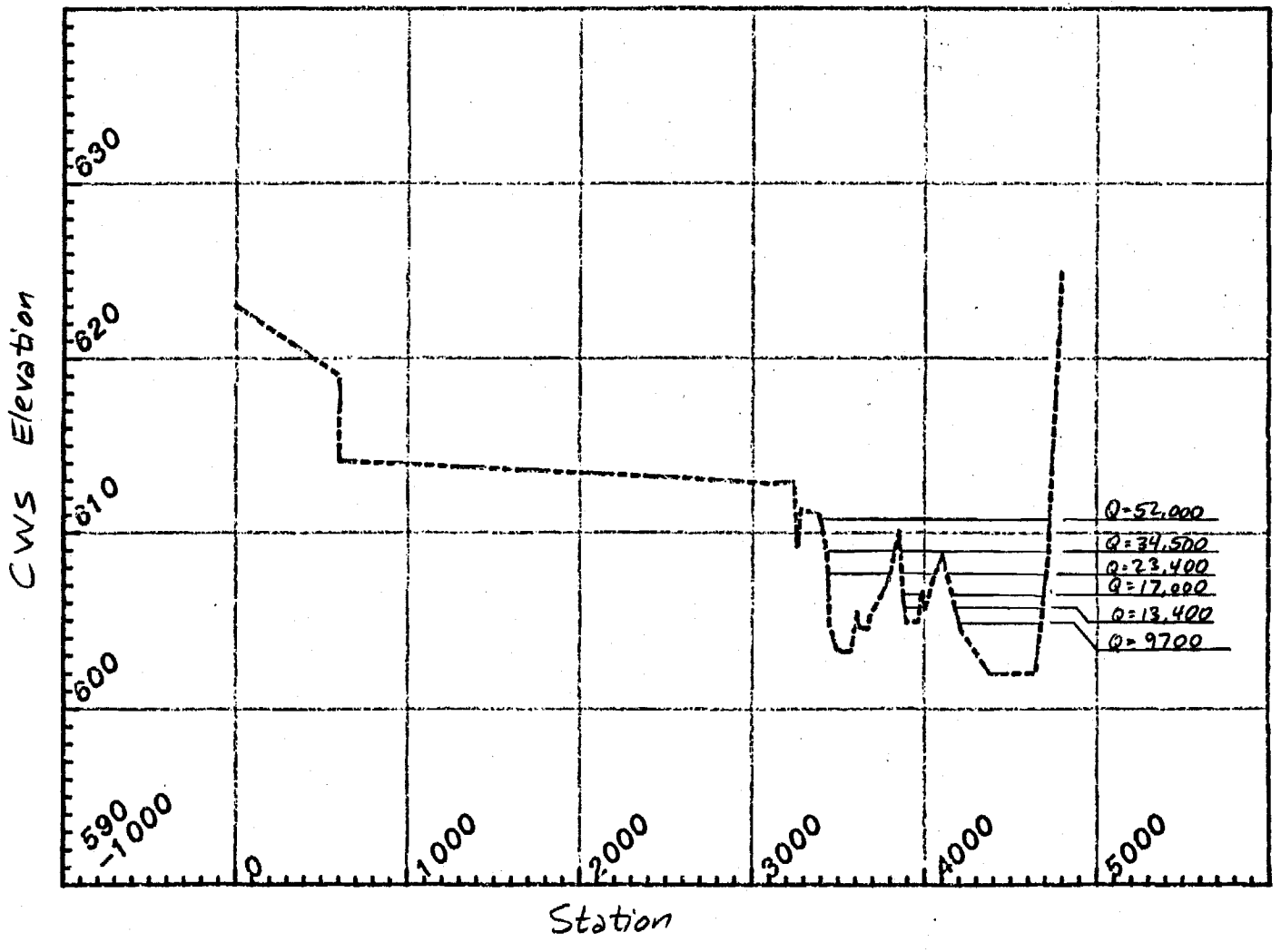

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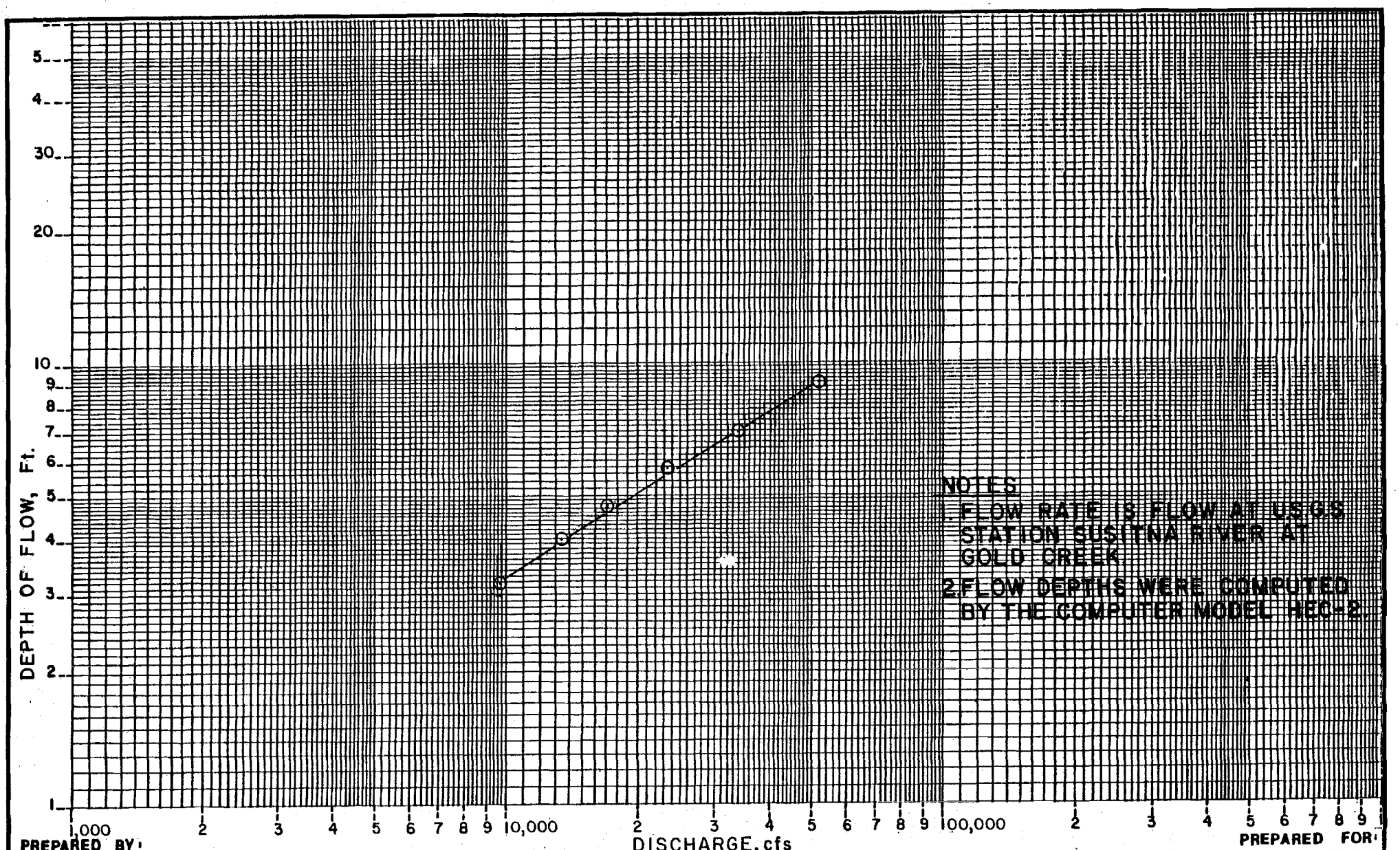
FIGURE 1



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STAGE - DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX-32
(NEAR SHERMAN)
(AFTER ORIGINAL CURVE BY ADNR)

FIGURE 2

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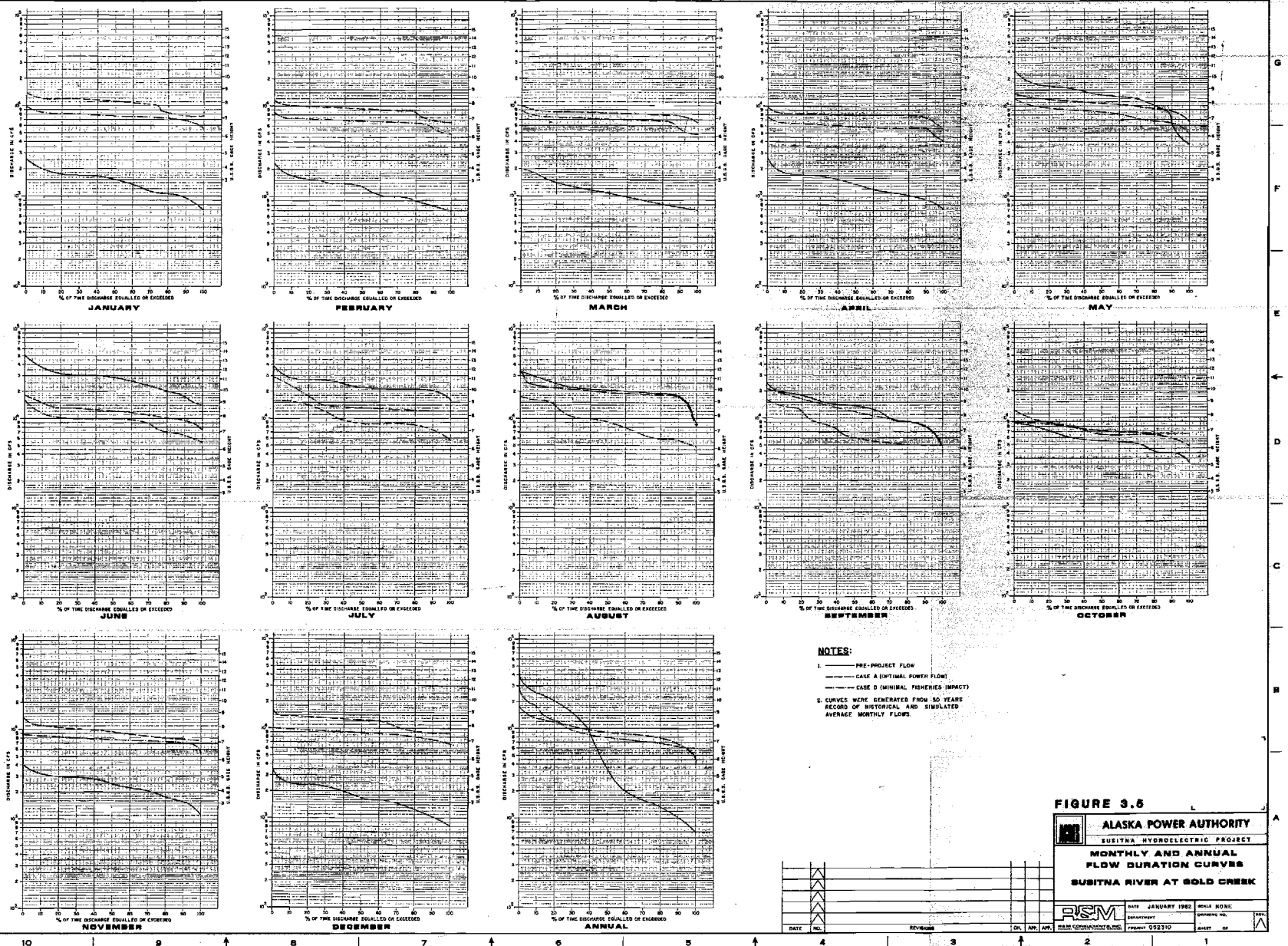

NOTES:

1. ——— PRE-PROJECT FLOW
   — — — CASE A (OPTIMAL POWER FLOW)
   — · — · — CASE D (MINIMAL FISHERIES IMPACT)
2. CURVES WERE GENERATED FROM 50 YEARS RECORD OF HISTORICAL AND SIMULATED AVERAGE MONTHLY FLOWS.

FIGURE 3.5

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MONTHLY AND ANNUAL FLOW DURATION CURVES

SUSITNA RIVER AT GOLD CREEK

DATE	JANUARY 1982	SCALE	NONE
DEPARTMENT		DRAWING NO.	
PROJECT	852310	SHEET	OF

REVISIONS

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **TKA-1**

Note: Elevations Are Based On Arbitrary Datums

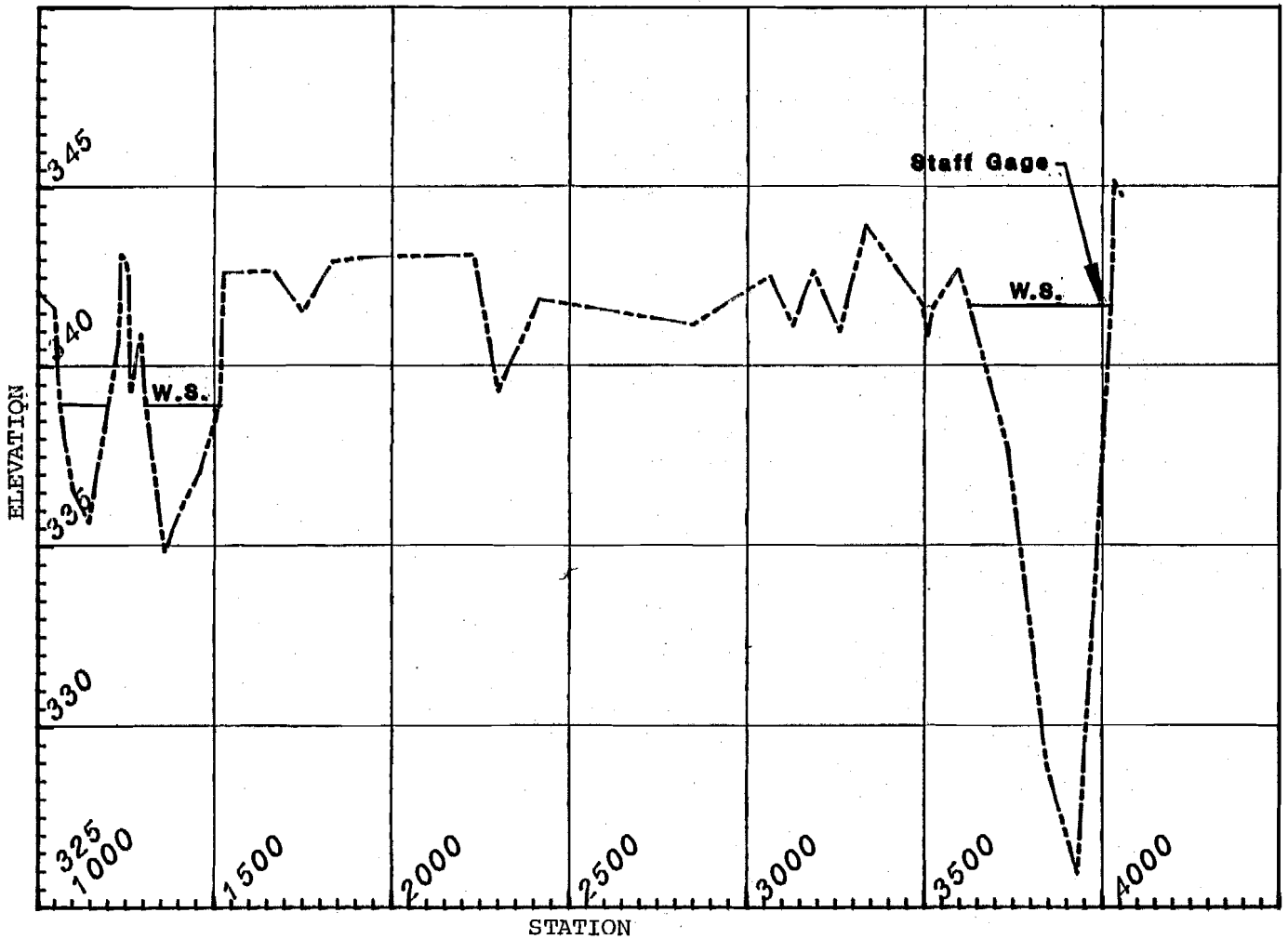

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FIGURE 4

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **KTA-2**

Note: Elevations Are Based On Arbitrary Datums

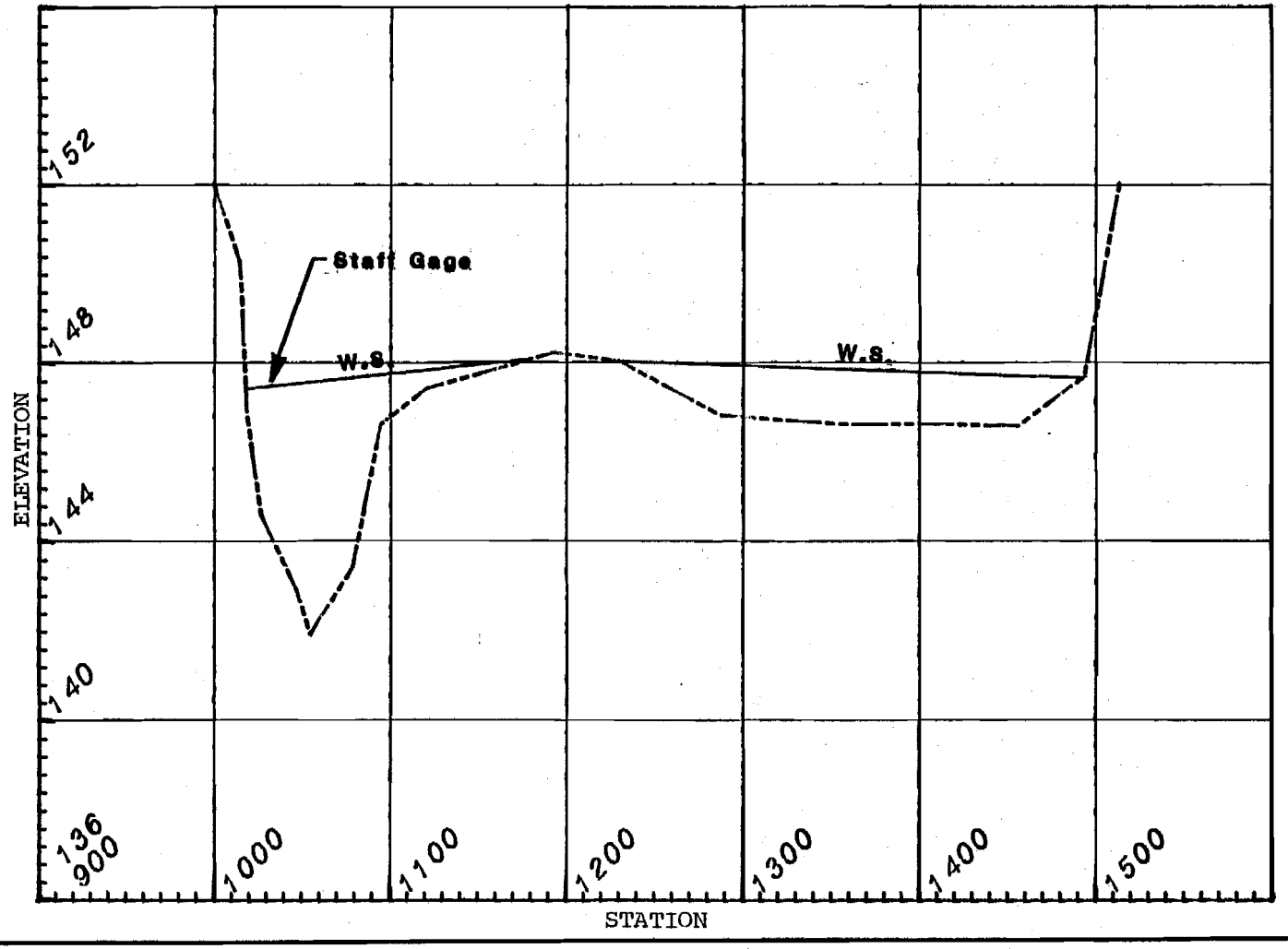

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FIGURE 5

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **KTA-3**

Note: Elevations Are Based On Arbitrary Datums

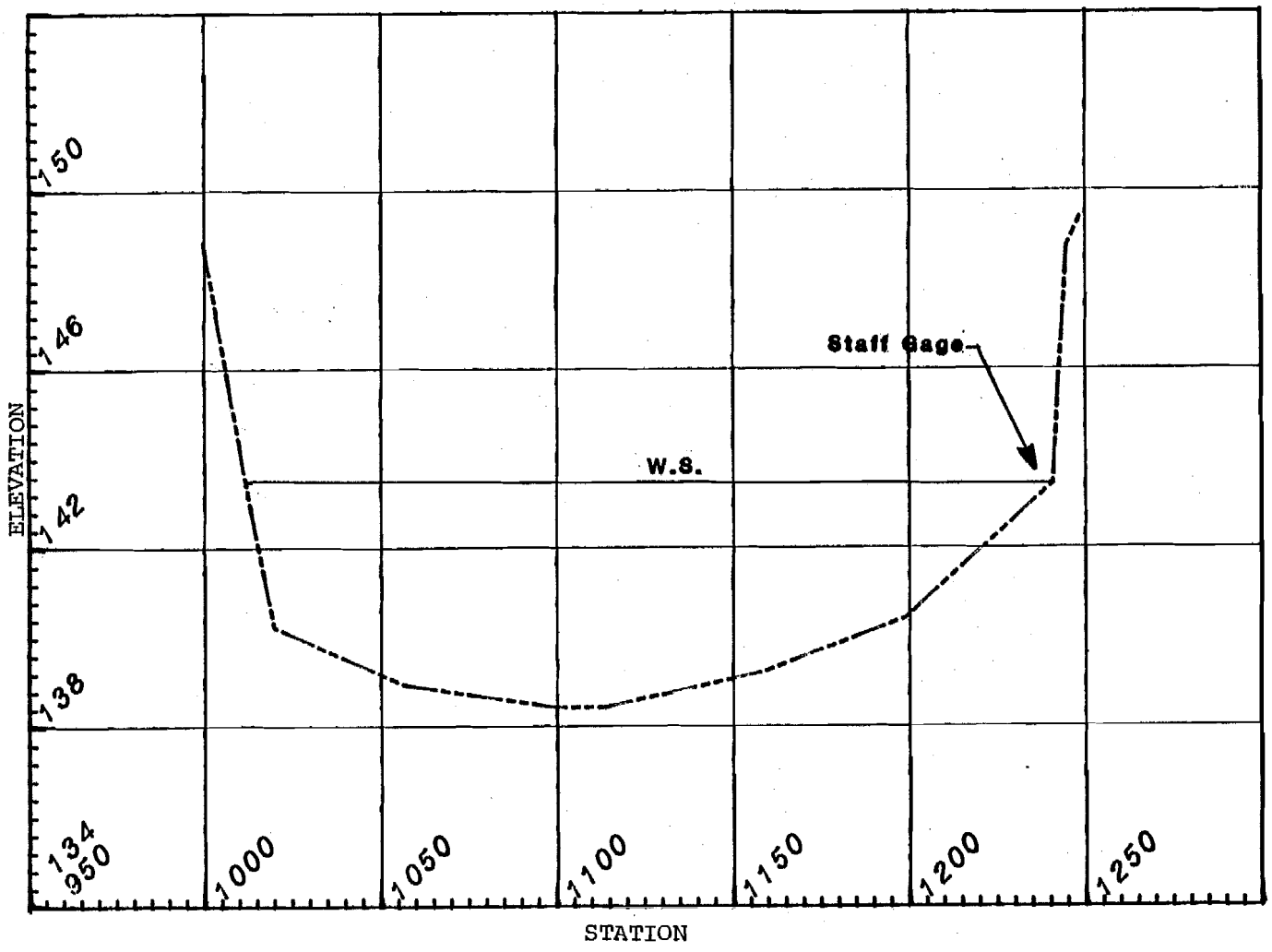

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FIGURE 6

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **WLO-1**

Note: Elevations Are Based On Arbitrary Datums

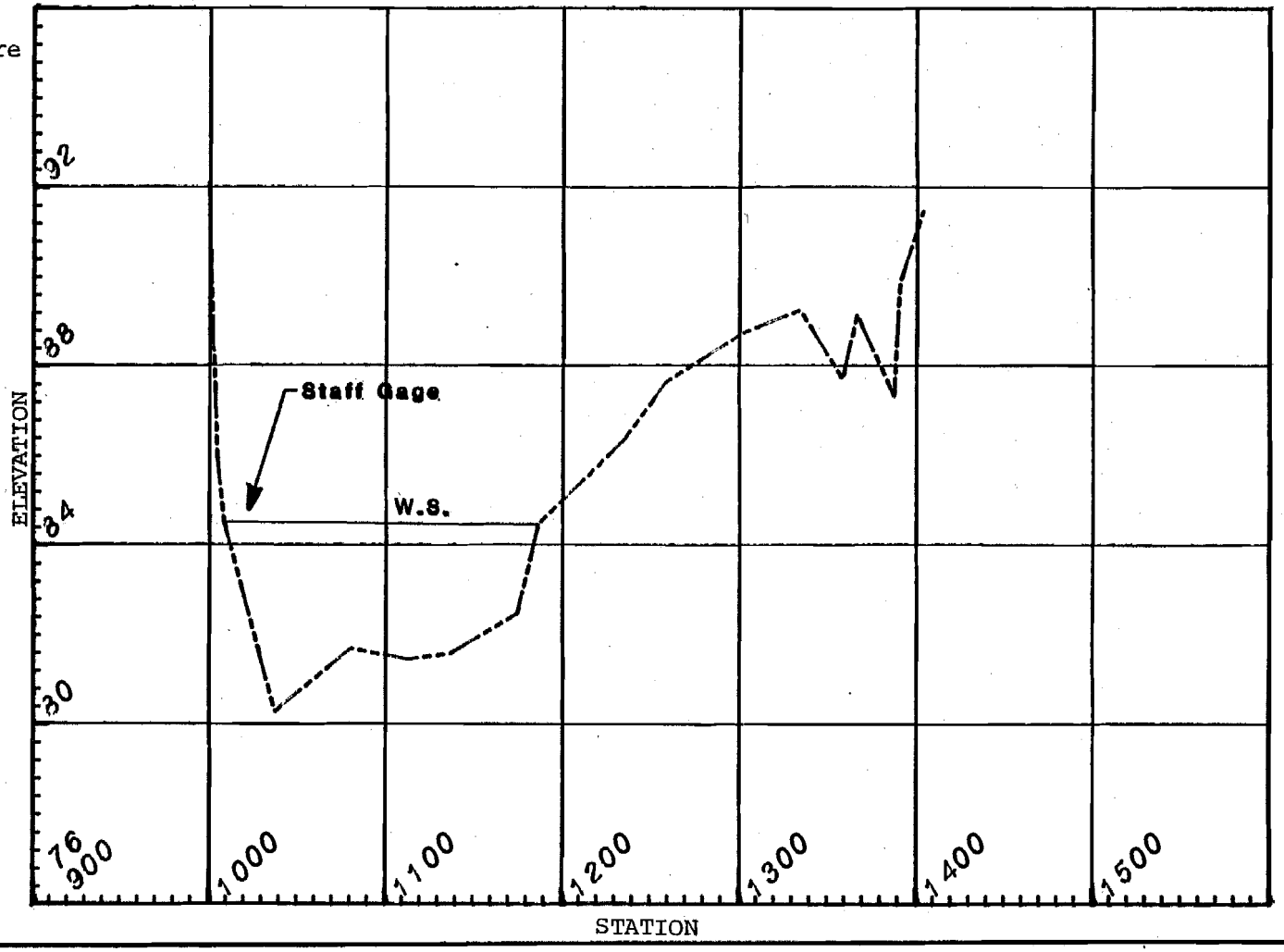

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FIGURE 7

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **WLO-3**

Note: Elevations Are Based On Arbitrary Datums

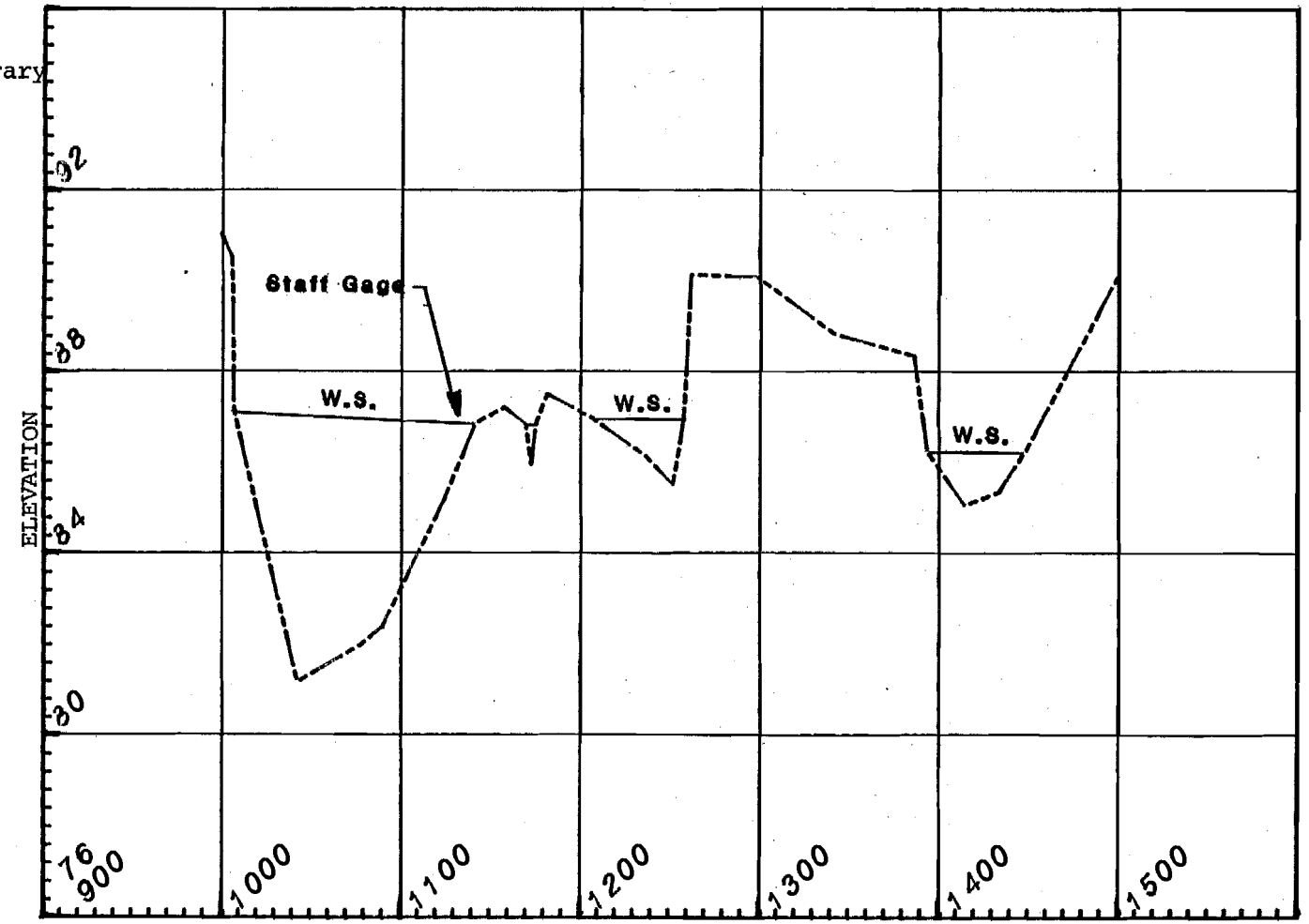

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FIGURE 8

SUSITNA HYDROELECTRIC PROJECT

CROSS-SECTION **ALEX**

Note: Elevations Are Based On Arbitrary Datums

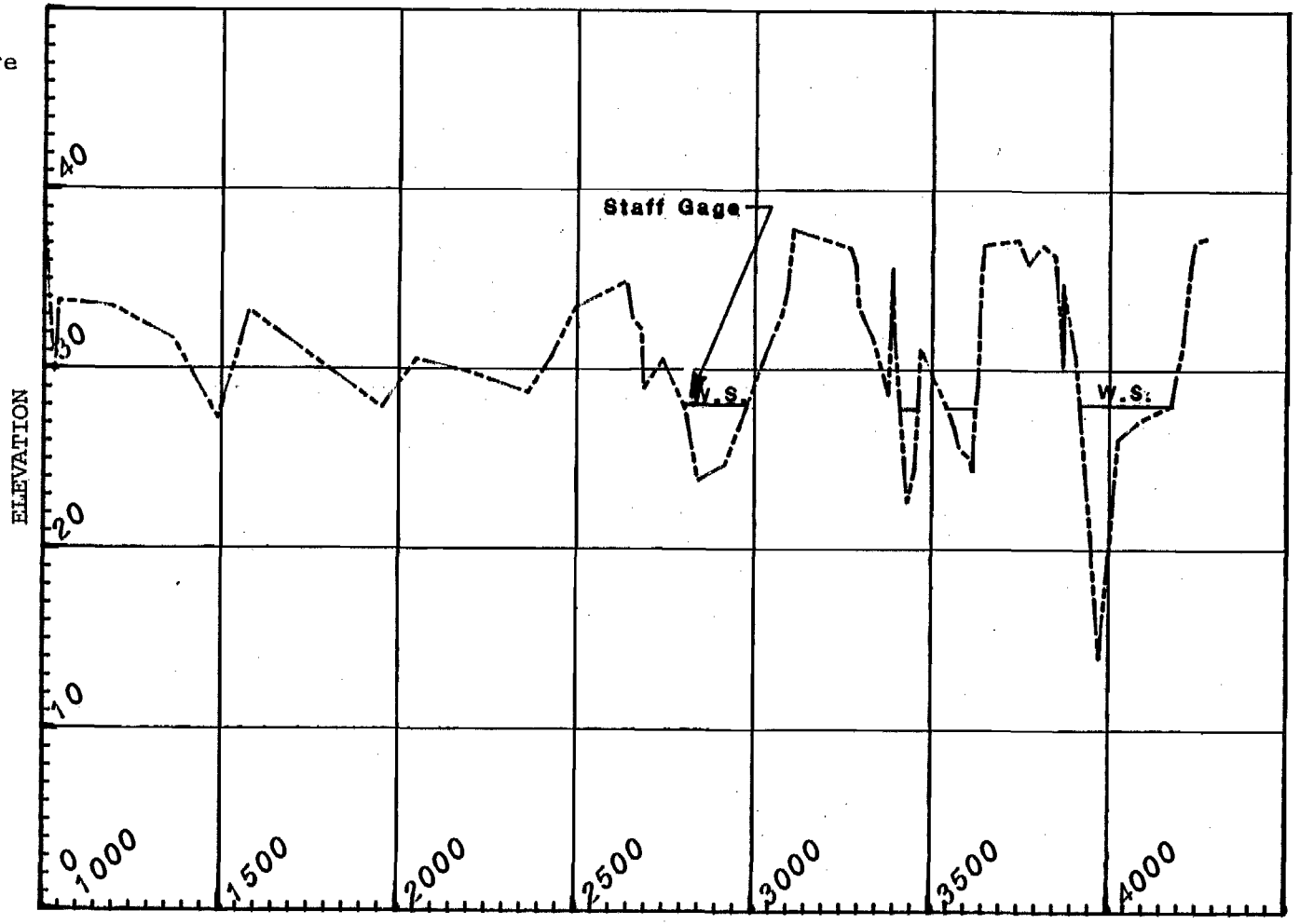

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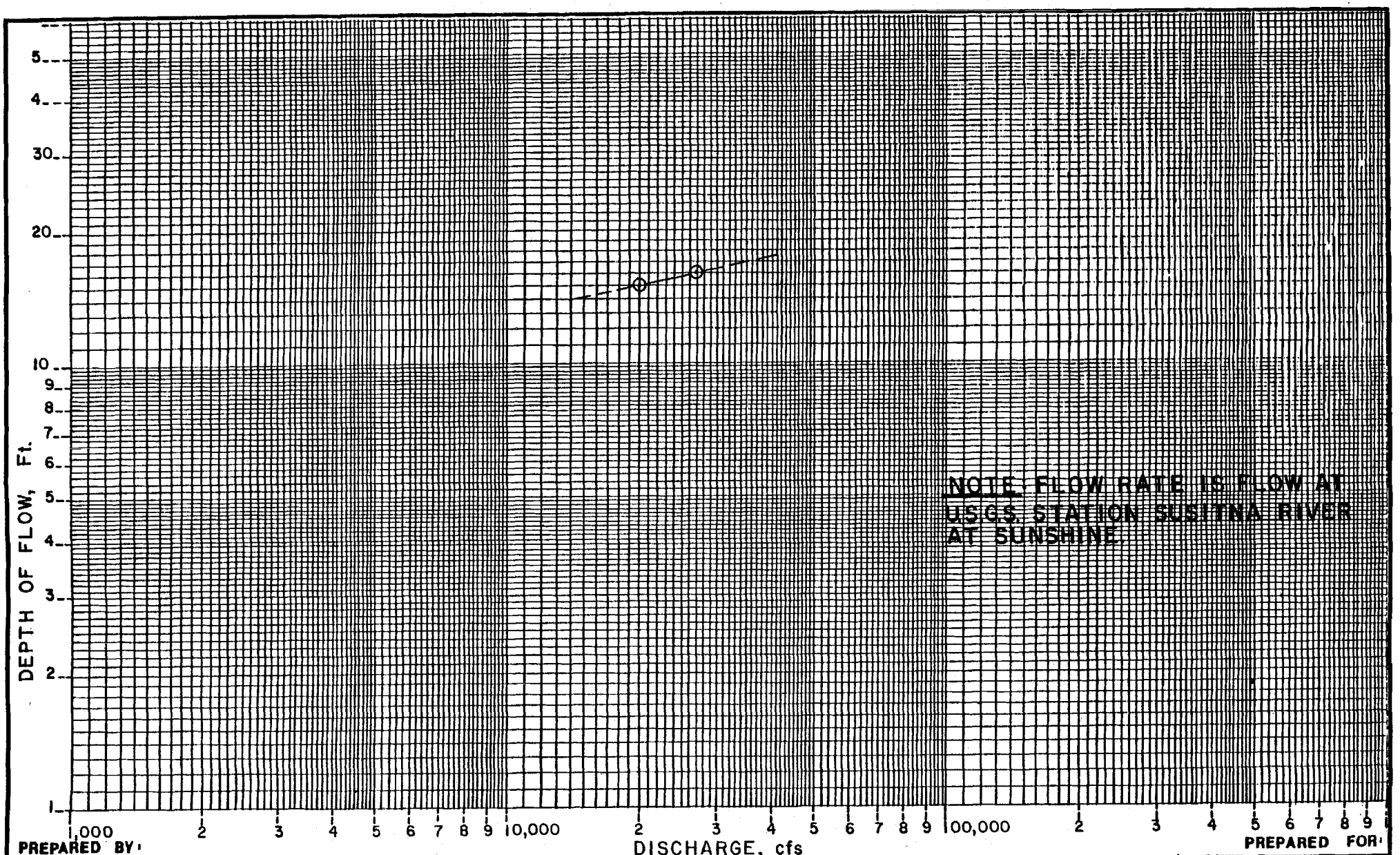
FIGURE 9

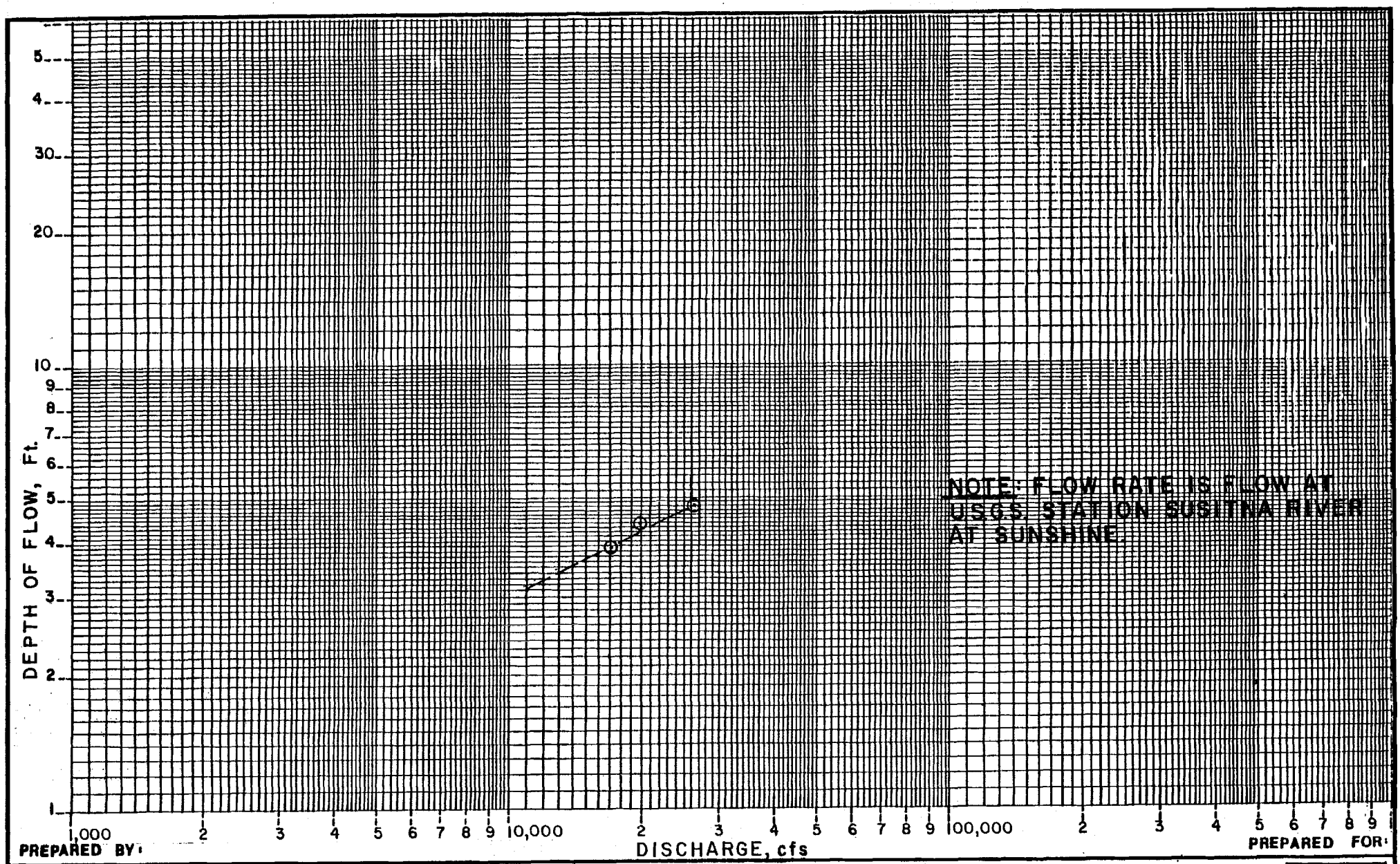


R&M CONSULTANTS, INC.

STAGE - DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX-TKA I
(NEAR TALKEETNA)
(AFTER ORIGINAL CURVE BY ADNR)

FIGURE 10

ACRES

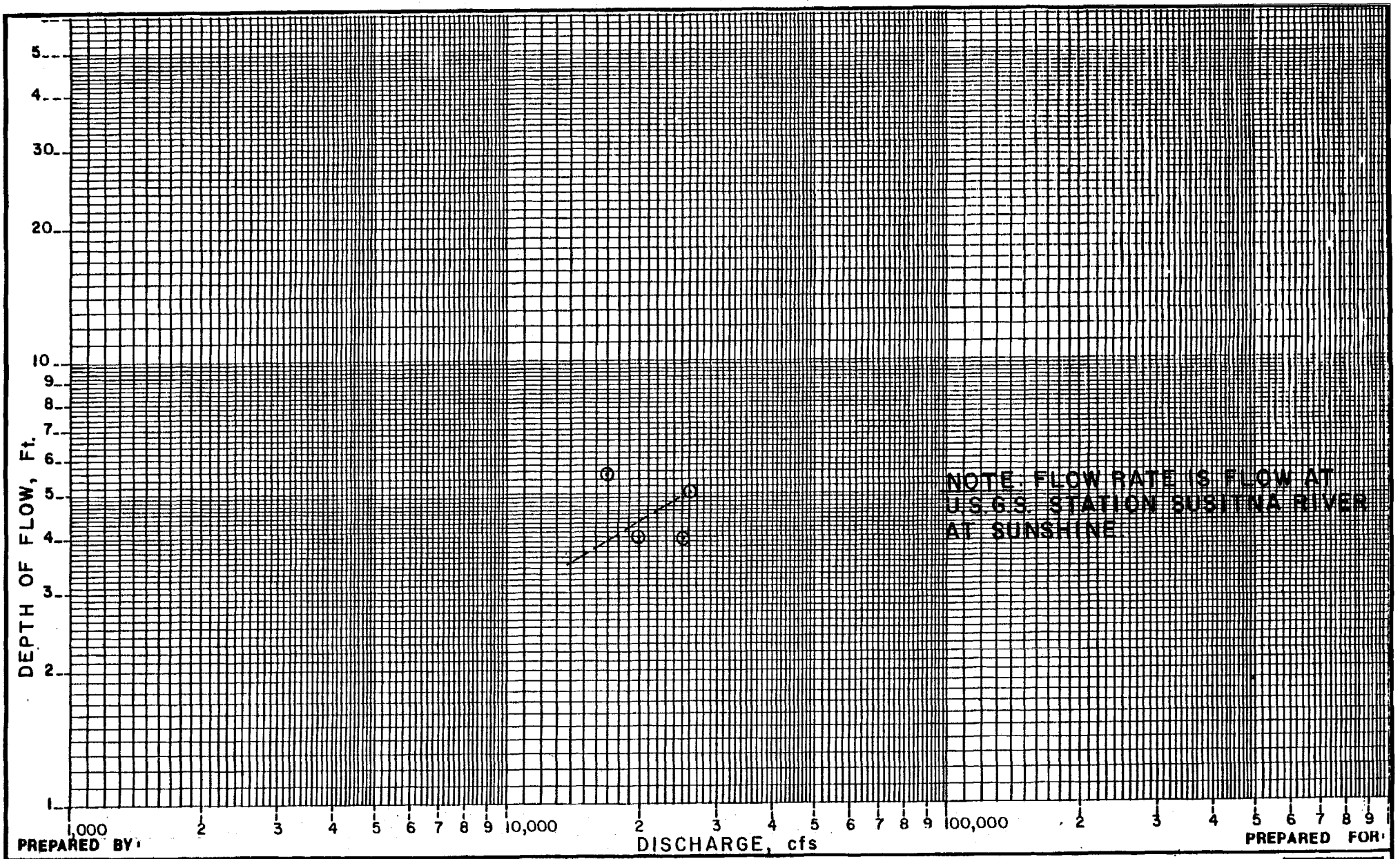


R&M CONSULTANTS, INC.

STAGE - DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX-KTA 2
(KASHWITNA LANDING UPSTREAM)
(AFTER ORIGINAL CURVE BY ADNR)

ACRES

FIGURE 11

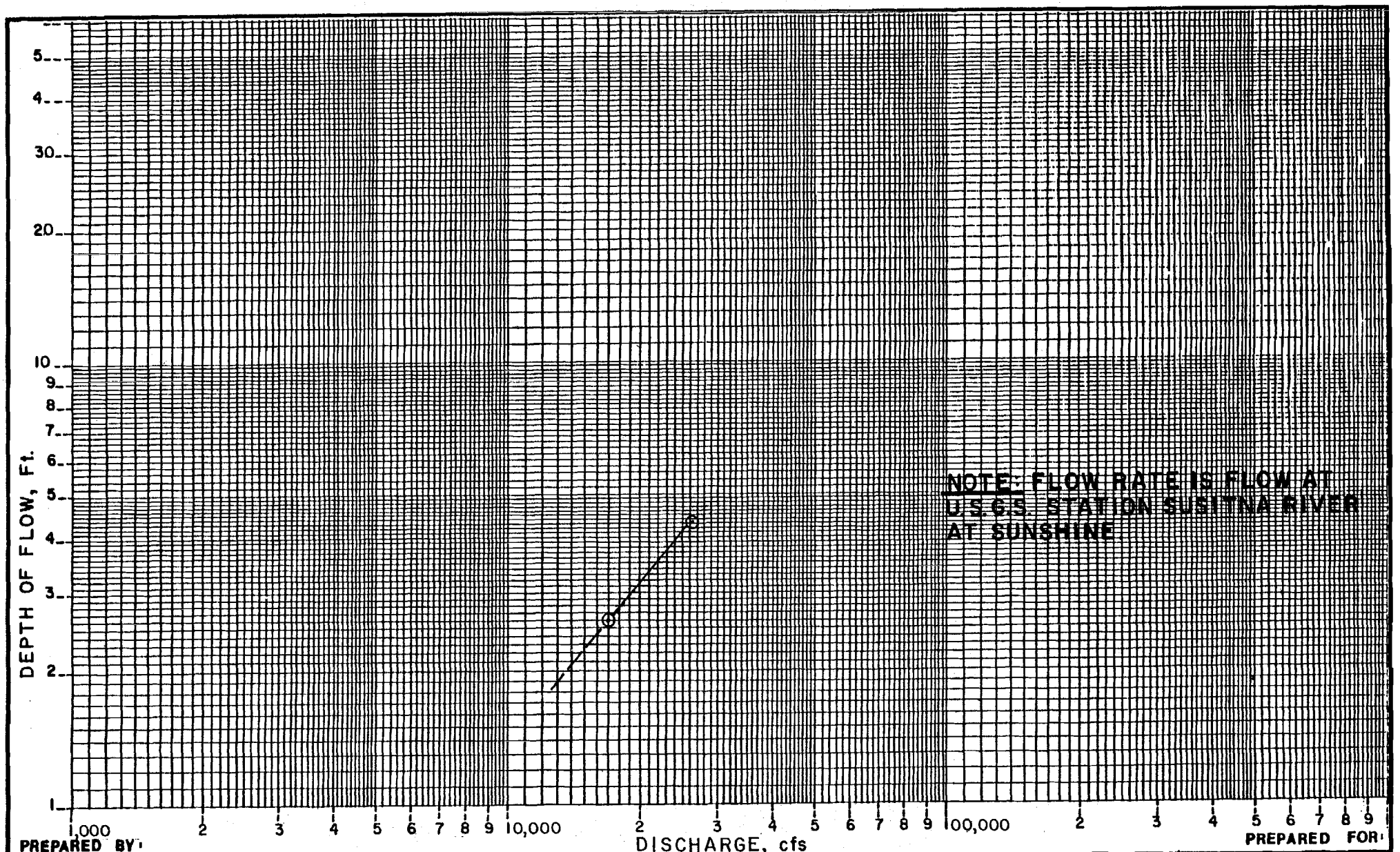


R&M CONSULTANTS, INC.

STAGE-DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX-KTA 3
(KASHWITNA LANDING DOWNSTREAM)
(AFTER ORIGINAL CURVE BY ADNR)

FIGURE 12

ACRES

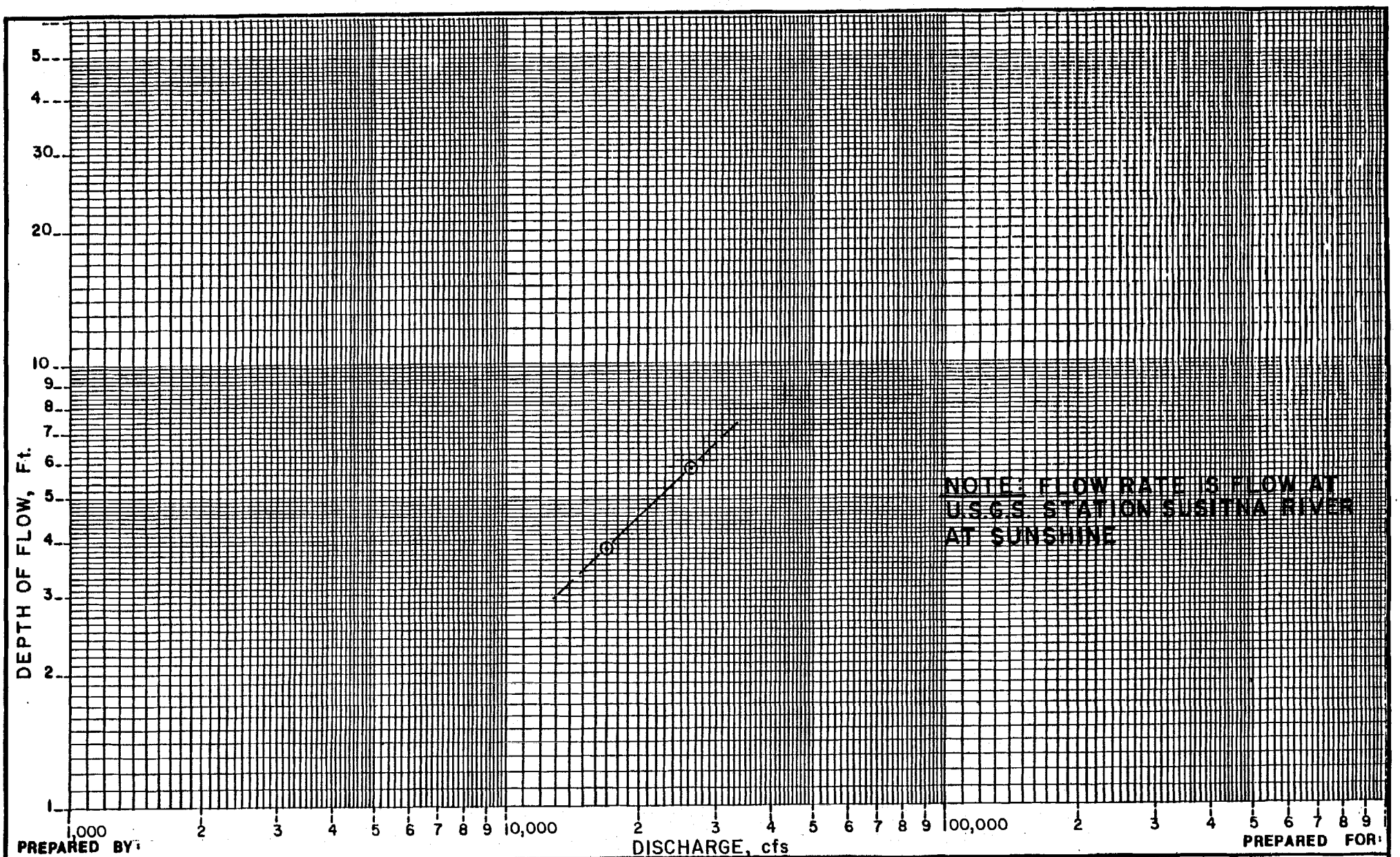


R&M CONSULTANTS, INC.

STAGE - DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX - WLO I
(NEAR WILLOW CREEK)
(AFTER ORIGINAL CURVE BY ADNR)

FIGURE 13

ACRES

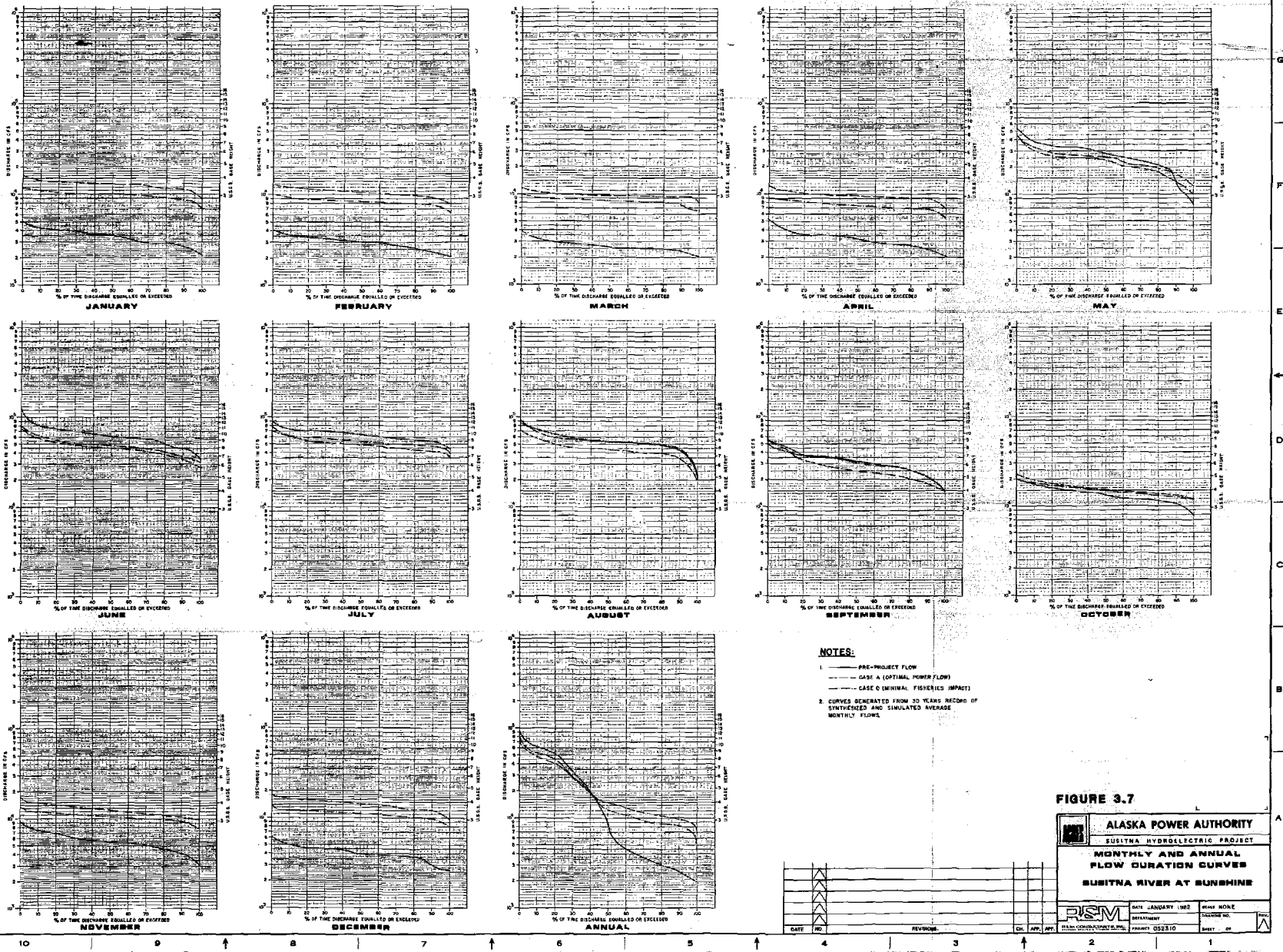


R&M CONSULTANTS, INC.

STAGE – DISCHARGE RATING CURVE
SUSITNA RIVER AT LRX-WLO 3
(NEAR WILLOW CREEK, MIDDLE CHANNEL)
(AFTER ORIGINAL CURVE BY ADNR)

FIGURE 14

ACRES



NOTES:

1. ——— PRE-PROJECT FLOW
   - - - - CASE A (OPTIMAL POWER FLOW)
   — - — - CASE C (MINIMAL FISHERIES IMPACT)
2. CURVES GENERATED FROM 30 YEARS RECORD OF SYNTHESIZED AND SIMULATED AVERAGE MONTHLY FLOWS.

FIGURE 3.7

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

MONTHLY AND ANNUAL FLOW DURATION CURVES

SUSITNA RIVER AT SUNSHINE

DATE	NO.	REVISIONS	CH.	APP.	APP.

R&M CONSULTANTS, INC. | DATE JANUARY 1982 | SCALE NONE | DRAWING NO. | PROJECT 052310 | SHEET ... OF ... | REV.