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HYDROELECTRIC PROJECT

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MIDDLE AND LOWER SUSITNA RIVER
WATER SURFACE PROFILES AND DISCHARGE RATING CURVES

VOLUME I

DRAFT REPORT

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WATER SURFACE PROFILES AND DISCHARGE RATING CURVES FOR MIDDLE AND LOWER SUSITNA RIVER

Volume 1

Report by

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NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
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SUSITNA PROJECT OFFICE

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INTRODUCTION

1.0 INTRODUCTION

This report presents the results of a study on water surface profiles of the Susitna River between Sunshine and the downstream end of Devil Canyon (Exhibit 1) under open water conditions for a selected range of discharges between 3,000 and 52,000 cubic feet per second (cfs). The discharges are referred to the stream gaging station at Gold Creek maintained by the U.S. Geological Survey (USGS). For the computations of water surface profiles, the discharges are increased for the reach downstream from the Gold Creek gage and decreased for the reach downstream from the gage. The USGS also is maintaining a stream gaging station at Sunshine, downstream end of the study reach. The station is located about 84 miles from the mouth of the Susitna River at Cook Inlet (the mouth). The river stages corresponding to the discharges at this station are used as starting elevations for the computations of water surface profiles. The upper end of the study reach near the mouth of Devil Canyon is about 150 miles from the mouth.

The study reach covers about 66 miles of river segmnet, about 52 miles upstream from the confluence of the Chulitna and Susitna rivers and about 14 miles below the confluence upto Sunshine. The upper segment is referred as the Middle Susitna River and lower segment is referred as the lower Susitna River.

The discharge rating curves based on the computed water surface profiles are presented for selected locations, especially at immediate upstream and downstream from important sloughs. Mean river velocities also are provided at surveyed cross sections for a range of discharge values.

The hydraulic data presented in this report are adequate for evaluating changes in mainstem stages due to operation of the Susitna project which, in turn, can be used to assess the frequency of the slough berms being overtopped, the access of fishes to the sloughs and tributaries and to study

the flood potential for Talkeetna and other areas along the reach of the river. The data also can be used to study potential aggradation or degradation in the mainstem below the proposed dams and for hydrothermal study of the Susitna River during ice-free periods.

The accuracy of the computed water surface elevations is within ± 0.5 feet (ft) at most of the cross-sections where observed data are available. The accuracy at other sections may be somewhat lesser as discussed in the section entitled "Discussion". The needs for additional data to improve the results of the study are identified and discussed under the section entitled "Recommendations".

1.1 BACKGROUND

The water surface profiles for the Susitna River between the downstream end of Devil Canyon and the confluence of the Susitna and Chulitna rivers were developed previously by R&M Consultant Incorporated, Anchorage, Alaska (R&M) for the discharges of 9,700, 13,400, 17,000, 23,400, 34,500 and 52,000 cfs at the Gold Creek gage. The results of R&M studies including field surveys are presented in various reports (1, 2, 3,)[1/]. These reports were prepared by R&M for Acres American Incorporated (ACRES) for submission to Alaska Power Authority (APA).

Since the R&M study of March 1982 (2), 32 additional river cross sections have been surveyed (3) in the study reach. Five old cross sections were also resurveyed. The old and new cross-sections are identified on Exhibit 1.

[1/] Refers to reference at the end of text.

Alaska Department of Fish and Games (ADF&G) has established a number of staff gages in the study reach. The water levels at these gages were observed periodically during July through October, 1982 and were referenced to the flow at the Gold Creek gage (4). The water levels data also are available for 1983.

1.2 SCOPE OF PRESENT STUDY

The availability of additional surveyed river cross sections and river stage data permits the refinement of water surface computations made by R&M. The major works involved in the present study include:

1. a review of basic data, study approach and assumptions used by R&M in the computations of water surface profiles;

2. a refinement of previous calibration by R&M of the HEC-2 Computer model developed by the U.S. Army Corps of Engineers (5) based on additional cross sections and river stage data; and

3. a recomputation of water surface profiles for 9 discharges (also used by R&M) at appropriate intervals to define stage-discharge rating curves at selected locations.

SECTION 2

REVIEW OF PREVIOUS STUDY

2.0 REVIEW OF PREVIOUS STUDY

The HEC-2 model uses standard step method (6) to compute water surface profiles based on the Bernoulli theorem and the Manning's equation between river cross sections. This model was used by R&M to compute water surface profile by using a total of 66 river cross sections (No. 3 to No. 68) as identified on Exhibit 1.

An extensive analysis was made by R&M to estimate the values of Manning's roughness coefficients (the 'n' values). Initially, these values were estimated at eight staff gages (see Table 2) using observed water surface elevations and corresponding discharges with the assumption that the friction slope at each cross section is approximately equal to the average bed slope over the reach from the next-upstream cross section to the next dowstream cross section. The 'n' values were computed for discharges ranging between 3,000 to 50,000 cfs, and an average relationship between the 'n' values and the discharges was developed (Figure 4.4, reference 2).

The 'n' values also were estimated using bed material size distribution (7) determined by the "Grid-by-Number method (8). However, the 'n' values derived by the two methods were used only as a reference in selecting an initial values for each cross sections at a discharge of 9,700 cfs at Gold Creek. No horizontal or vertical variation of 'n' value was considered except at cross section No. 25 where the 'n' values were adjusted horizontally. Multi-channels exist at this cross section and the velocities in each channel are significantly different. Therefore, the 'n' values were increased in some channels to decrease the conveyance.

R&M first calibrated the HEC-2 model for a discharge of 9,700 cfs at the Gold Creek gage. For the computations of water surface profile, this flow was decreased for the river reach upstream from the Gold Creek gage and increased for the downstream reach based on the intervening drainage areas.

The adjustment factors used for different sub-reaches (see Exhibit 1 for locations) are shown in the following table:

ADJUSTMENT FACTORS BASED ON DRAINAGE AREAS

Reach		Cross Sections		Factor to adjust
From	To	From	To	Gold Creek Flow
Confluence	Curry Creek	3	23	1.030
Curry Creek	Indian River	24	50	1.000
Indian River	Portage Creek	51	61	0.983
Portage Creek	Devil Canyon	62	68	0.942

R&M's refinement of the initial 'n' values during the calibration took into consideration several criteria including bed material size, river sinuosity, presence of and type of vegetation, existence of multiple channels, etc. The final 'n' values derived by R&M are given Table 1.

The 'n' values derived for 9,700 cfs were adjusted by the following factors to estimate those for other calibration discharges of 17,000, 34,500 and 52,000 cfs. These factors were estimated through a trial-and-error procedure.

ADJUSTMENT FACTORS FOR 'n' VALUES

Discharge	Adjustment Factor
17,000	0.90
34,500	0.81
52,000	0.81

A comparison of observed and computed stages at eight staff gage locations (LRX-4, LRX-9, LRX-24, LRX-28, LRX-35, LRX-45, LRX-62 and LRX-68 used as control points) given in R&M's March 1982 report (2, Table 8.15) is shown in Table 2.

Based on their field experience, aerial photos, and surveyed river cross sections, R&M classifed flows in the Susitna River into two flow regime; a low flow regime and a high flow regime. A threshold discharge of 20,000 cfs

at Gold Creek gage was assumed to differentiate between the two flow regimes. Therefore, two versions of HEC-2 model were set up. For discharges up to 20,000 cfs, the assumption was made that some selected side channels and sloughs are not hydraulically connected with the mainstem. In the second version, flow was assumed to exist in all channels for discharges higher than 20,000 cfs.

The following table indicates that the differences between observed and computed stages at the eight control points used by R&M are mostly within ± 0.5 ft (also see Table 2).

DIFFERENCE BETWEEN OBSERVED AND COMPUTED WATER SURFACE ELEVATIONS (R&M STUDY)

Gage Location	Difference[1] (ft) for Indicate Discharge (cfs)					
	9,700	13,400	17,000	23,400	34,500	52,000
LRX-4	-0.5	-0.5	-0.3	-0.2	-0.2	-0.5
LRX-9	+0.3	-0.4	-0.5	-0.2	-0.3	-0.8
LRX-24	-0.4	-0.6	-0.3	-0.5	0	+0.3
LRX-28	-1.2	-0.4	-0.2	0	+0.1	-0.3
LRX-35	-0.4	-0.8	-0.4	-0.3	-0.3	0
LRX-45	+0.1	+0.1	+0.1	0	+0.3	+0.1
LRX-62	+0.3	-0.5	0	+0.3	-0.1	-0.3
LRX-68	+0.8	+0.4	+0.1	+0.1	+0.2	+0.3

[1] Observed minus computed

The higher differences at a few cross sections for a few discharges (especially for lower flow ranges) are mostly due to multi-channel situation with the staff gages being located in the side channels where the mainstem water level is not accurately represented. Water surface elevation across a multi-channel cross section is not uniform as assumed in the computations of water surface profiles by the HEC-2 model. R&M collected data on differences in elevations across multiple-channel cross sections (2, Tables 4.5 and 4.6). These data are shown in Table 3 which provides an indication of possible deviation between observed and computed water surface elevations.

SECTION 3

PRESENT STUDY

3.0 PRESENT STUDY

The HEC-2 computer model used by R&M was used to compute water surface profiles for this study. The model calibration was refined using additional cross-sections and river stage data. The basic data and assumptions used and the results obtained are discussed below.

3.1 STUDY REACH

The length of the study reach is about 66 miles between cross sections Nos. 68 and 001 (Exhibit 1) in comparison to the reach between cross sections Nos. 68 and 3 used by R&M. The study reach was extended downstream approximately about 14 miles to the Sunshine gaging station (cross section Number 001)to provide approximate estimation of water surface elevations for varius discharges near the confluence of the Sustina, Talkeetna and Chulitna rivers.

3.2 RIVER CROSS SECTIONS

A total of 107 cross sections were used for the computations. This included 68 cross sections surveyed in 1981, 33 cross sections surveyed in 1982, five cross sections estimted from USGS topographic maps of 1:63360 scale and one cross section taken from field notes of a discharge measurement by USGS at Sunshine Station. All of these cross sections are identified on Exhibit 1.

During the 1982 survey, the cross sections were surveyed in the river channels only and were not extended to higher bank elevations. These cross sections were extended to both banks using cross sections surveyed in 1981, located upstream and downstream from a given 1982 cross section.

The cross sections derived from the topograhic maps are only approximate because of the small scale (1:63,360) and large contour interval.

3.3 INITIAL 'N' VALUES

The derivation of 'n' values by R&M is discussed under the section entitled "Review of Previous Study" and the resulting values are listed in Table 1. These values were used as initial values for refining the calibration.

3.4 CONTROL POINTS

ADF&G has developed stage discharge relationships for all staff gages established on the mainstem, side-channels or sloughs (4). The discharges used in these relationships are those at the Gold Creek gage.

All gages designated as mainstem gages ADF&G were initially selected as control points to compare observed gage heights with the gage heights of corresponding discharges computed by the HEC-2 model. However, during the calibration of the model, some of these control points had to be ignored because of its inconsistency with the next upstream or next downstream control point. The control points used in the study are identified in Table 2. The following table shows a list of mainstem gages initially selected and those used in the analysis.

MAINSTEM ADF&G STAFF GAGES
SELECTED FOR HEC-2 STUDY

Gage Locations (initial selections)
Left bank[1] LRX-6, RM[2] 101.0
Mainstem at Whiskers Creek slough, RM 101.15*
Talkeetna Fish Wheel Camp, RM 102.90*
Right bank LRX-9, RM 103.22*
Right bank LRX-10.2, RM 105.9*
Right bank LRX-10.3, RM 106.4*
Right bank LRX-11, RM 106.68*
Left bank LRX-12, RM 108.41*
Side channel at Gash Creek, RM 111.50*
Head Gash Creek side channel, RM 112.10*

Mainstem at slough 6A, RM 112.30*
Right bank LRX-18, RM 113.02*
Mainstem above Lane Creek, RM 113.70
Mainstem upstream LRX-18.1, RM 114.40
Curry Fish Wheel Camp, RM 120.60*
Right bank, LRX-24, RM 120.66*
Right bank, LRX-28, RM 124.41*
Right bank, LRX-29, RM 126.10*
Right bank, LRX-31, RM 128.66*
Right bank, LRX-35, RM 130.87*
Mainstem at 4th of July Creek, RM 131.10
Left bank LRX-37, RM 131.80
Left bank LRX-40, RM 134.28*
Side channel below mouth of slough 11, RM 135.30
Side channel above mouth of slough 11, RM 135.30
Mainstem at mouth of slough 16B, RM 137.90
Mainstem at head of slough 16B, RM 138.30
Left bank at LRX-50, RM 138.48*
Left bank at LRX-51, RM 138.89*
Mainstem at slough 19, RM 139.80*
Right bank LRX-53, RM 140.15*
Mainstem at head of slough 20, RM 140.6
Right bank LRX-54, RM 140.83*
Right bank LRX-56, RM 142.10
Right bank LRX-57, RM 142.30
Mainstem at slough 22, RM 144.70*
Left bank LRX-61, RM 148.73*
Left bank LRX-62, RM 148.94*

1/ ADF&G designated left bank or right bank looking upstream.

2/ River miles.

* Gages used in the study.

The ADF&G stage - discharge relationships are developed for discharges ranging between about 7,000 and about 32,000 cfs. Five of the ADF&G gages are located close to five of the eight gages (gage No. LRX-9, LRX-24, LRX-28, LRX-35 and LRX-62, Table 2) used by R&M. The gage heights for selected discharges used by R&M at those gages were compared with those obtained from the stage - discharge relationships developed by ADF&G. The two sets of values were slightly different. For the cases where both ADF&G and R&M data were available (Table 2), the ADF&G data were used to calibrate the model so that consistency with the upstream and downstream control

points (ADF&G gages) is properly maintained. However, R&M data were used for discharges higher than 32,000 cfs and also at three locations (LRX-4, LRX-5 and LRX-68) where ADF&G data were not available.

The observed gage heights for various discharges either taken from R&M data or the stage-discharge relationships developed by ADF&G are given in Table 2.

3.5 HEC-2 MODEL SET-UP

Multi-channels (sloughs and side channels) exist at a number of cross sections (see Exhibit 2). As discussed under the section entitled "Review of Previous Study", R&M estimated a threshold discharge of 20,000 cfs (based on aerial photographs and field experience) above which flow will enter all the channels. Subsequent field investigations indicated that the configuration of the main channel and the side channel or sloughs varies depending on the location and there is no single threshold value at which all side channels and sloughs are dewatered. However, the variation of the threshold value throughout the reach is relatively small and the value of 20,000 cfs was considered reasonable for the present study. Therefore, two data files were set-up for HEC-2. In one file, the option of artificial levees available in HEC-2 was used to restrict flows in the main channel (for discharges up to 20,000 cfs at Gold Greek). In the other file, the flow was allowed to exist in all channels (for discharges above 20,000 cfs at Gold Creek).

3.6 REFINEMENT OF HEC-2 MODEL CALIBRATION

The HEC-2 model calibration made by R&M was tested for three discharge levels (9,700 cfs, 13,400 cfs and 17,000 cfs) below and three discharge levels (23,400 cfs, 34,500 cfs and 52,000 cfs) above 20,000 cfs.

Because the above discharges are at Gold Creek, these were adjusted by the factors derived by R&M (discussed under the section entitled "Review of

Previous Study") for the corresponding discharges at various sections. The adjustment to the discharges for the reaches downstream of the confluence of the Susitna and Chulitna rivers and the confluence of the Susitna and Talkeetna rivers also were based on drainage area ratios. Table 4 shows the discharge in each study reach for a given discharge at Gold Creek.

The first HEC-2 run was made for 9,700 cfs using the 'n' values derived by R&M and the 107 river cross sections identified on Exhibits 1 and 2. One cross sections interpolated by R&M between cross sections 43.0 and 44.0 also was used. R&M used this cross section to avoid critical depth at cross sections 44.0. Exhibit 3 shows a water surface profile computed by R&M based on the cross sections surveyed in 1981 and the corresponding profile computed using all surveyed cross sections and the refined 'n' values. Since the refinement in the 'n' values is relatively minor, the difference in the two profiles indicates largely the sensitvity of water surface elevations when new surveyed cross sections are introduced in the computations. This will be discussed further under the sections entitled "Discussion" and "Recommendations".

The refinement of the model calibration for 9,700 cfs was continued by successively changing the 'n' values and the values of expansion and contraction coefficients until the observed water surface elevation at the control points are properly reproduced. The outputs indicated critical depth at cross secton 18.1. A careful review of the locations of cross sections 18.0, 18.1 and 18.2 (Exhibit 2) indicated that steep slope starts at about half way between cross sections 18.1 and 18.0 and critical depth should not occur at 18.1. The river is wider at cross section 18.1 compared to its width at cross section 18.0. Therefore, a cross-section, 18.05, was interpolated between cross sections 18.0 and 18.1, and the values of expansion and contraction coefficients were also changed. This avoided the critical depth at section 18.1

A comparison of computed and observed water surface elevations is shown on Table 2. Except in a few cases the two values match reasonably well.

The difference in the observed and computed water surface elevation at cross section 28.0 is about-1.3 feet when using the observed gage height derived from the stage-discharge curve developed by ADF&G and about-0.6 feet when using the observed height given by R&M (see Table 2). The R&M calibration indicates a difference of -1.2 feet. The difference in the observed water surface elevations is because the gages maintained by the two organisations are not at exactly the same location. To properly reproduce the observed water surface elevation (Table 2) the 'n' values at this cross section and the next upstream or downstream cross section had to be lowered from those shown in Table 1. Further lowering of the 'n' values was considered inappropriate. The still high difference in the observed and computed water surface elevations is probably due to the multichannel situation at the cross-section.

At cross section 35.0, two observed water surface elevations are available (Table 2), the computed elevation is about 0.1 feet higher than the R&M value and about 0.7 feet higher than the ADF&G value. The 'n' values in the reach are reasonably low. Because the computed value was close to the R&M value, further adjustment to 'n' values was not made. Secondly, the stage-discharge curve developed by ADF&G showed considerable scatter for 8,000 to 12,000 cfs discharge range (4).

The model refinement for the discharges of 13,400, 17,000, 23,400, 34,500 and 52,000 cfs was continued essentially following the above procedures, that is successively changing the 'n' values. A comparison of computed and observed water surface elevations are given in Table 2. The final 'n' values are shown in Table 1.

In a few cases when a control point is not located on a surveyed cross section, the computed stages are interpolated from the values computed at the surveyed cross sections to compare with the observed values.

The 'n' values generally decrease with increase in discharge in a natural channel. The calibrated 'n' values by Harza (Table 1) also indicate that in general, lower 'n' values were used for higher discharges. However, in certain reaches of the river and also to match the observed and computed gage heights at the control points, some deviation was allowed. Therefore, Table 1 indicates higher 'n' values for higher discharges in a few cases. This situation is physically possible particularly at multi-channel cross sections where the side channels could exhibit higher roughness.

The HEC-2 model was also applied for the discharges of 3,000, 5,000 and 7,000 cfs. Six control points were available from R&M for the discharge of 3,000 cfs. The model was calibrated using these control points. The computed and observed water surface elevations are given below:

COMPARISON OF WATER SURFACE ELEVATION
Discharge = 3,000 cfs

Control Point	Computed (ft)	Observed (cfs)
3	339.7	340.2
9	374.7	375.1
24	519.2	519.1
35	615.0	614.7
45	681.1	681.4
62	831.4	831.9

The 'n' values for 5,000 and 7,000 cfs were interpolated from the values for 3,000 and 9,700 cfs.

The computed water surface profiles for the discharges of 3,000, 5,000 and 7,000 are not as accurate as the profiles for higher discharges because only six control points were available for calibration at 3,000 cfs and the 'n'

values for 5,000 and 7,000 cfs were interpolated. The available cross-section data also may not properly represent the more variable cross sectional geometry for low flows. However, these profiles do provide some indication of hydraulic conditions in the river for lower discharges and therefore, are included in this report. These profiles could be improved if water surface elevations at various control points are observed for discharges below 9,000 cfs and additional cross sections are surveyed.

The computed water surface elevations for all discharges are given in Table 5. The computer input and output files for all discharges for which water elevations are given in Table 5, are provided as Appendices A through I. These appendices also identify the cross sections where the flow was comfined in the main channel for discharges upto 20,000 cfs. The side channels or sloughs at those sections were considered not hydraulically connected with the main channel for those discharges.

3.7 STAGE-DISCHARGE RATING CURVES

Stage-discharge rating curves at 74 locations, based on the water surface elevations given in Table 5, are shown on Exhibit 5 to 78. The locations were selected at all control points to provide comparison of observed and computed water surface elevations, and upstream and downstream from the important sloughs. Smooth curves are drawn through the plotted points.

3.8 MAINSTEM RIVER VELOCITY

Mean velocity at a given cross section are computed as part of the computations made by the HEC-2 model. These velocities, derived from the computer outputs given in Appendices A through I, are summarized in Table 6.

SECTION 4
DISCUSSION

4.0 DISCUSSION

The HEC-2 model provides an acceptable procedure for the computations of water surface profiles in a natural river. However, some assumptions involved in the model should be recognized. This will help in the proper interpretation of results provided by the model.

The model assumes a uniform water surface elevation across a given cross section. Such a condition does not necessarily exist in a natural river especially at bends and multiple-channel cross sections. Table 3 provides some idea about the magnitude of difference between water surface elevations at a given cross section. At bends, the difference depends upon the radius of bend, river width and velocity. Even in a straight reach of a wide river, some difference in water surface elevations between the left and right banks could exist because of oblique flow conditions.

At a multiple channel cross section, reasonably accurate water surface elevations can be computed in two or three channels by trial-and-error using HEC-2 if control point is available in each channel. Since these data are not available for the present study, the procedure was not used.

At some multiple-channel cross sections, the side channels are connected to the main channel when the flow exceeds some threshold discharge. A discharge at 20,000 cfs has been used for this purpose based on the initial calibration by R&M. However, this discharge could vary from cross section to cross section as discussed previously and as can be seen from the discontinuity in a few stage-discharge rating curves (Exhibits 5 to 78) based on actual observations.

The flow velocity computed by the model at each cross section is the average velocity over the entire flow area. Field observations indicate that at a multiple-channel cross section, the velocities are different in various channels. This should be recognized while using the velocity data.

SECTION 5

RECOMMENDATIONS

5.0 RECOMMENDATIONS

Exhibit 3 shows a comparison of two water surface profiles for the discharge of 9,700 cfs at the Gold Creek station. The first profile is computed by R&M and the second profile is computed by Harza using the re-calibrated 'n' values and additional cross sections surveyed in 1982. The difference between these profiles is about 5 feet near cross sections 18.1, 18.2 and 18.3 although the differences at other locations vary $\pm$0.5 to $\pm$2.0 feet. The reason for this difference is because the sections (18.1, 18.2 and 18.3) were not used in the R&M's Computation, and the thalweg elevation at cross section 18.1 (surveyed in 1982) is about 3 feet higher than the elevation interpolated between cross sections 18.0 and 19.0.

The large difference in the two computed water surface profiles due to introduction of new cross sections indicates the necessity of surveying additional cross sections if further refinement of water surface profiles are needed for any particular location.

For the present study, the control points (Table 2) were taken from the 1982 ADF&G study (4) and also the 1983 preliminary data. The ADF&G study covers the discharge range of about 7,000 to about 32,000 cfs and the 1983 preliminary data which include the new control points (LRX-10.2, LRX-10.3, LRX-11 and LRX-12, Table 2), cover the range of about 15,000 to about 32,000 cfs. Since the range of calibration is between 9,700 and 52,000 cfs, the first set of data does not cover the high range above 32,000 cfs and the second set of data does not cover the low range below 15,000 cfs and the high range above 32,000 cfs. Therefore, it is recommended that river stages be observed at all mainstem gages to cover the entire range of calibration.

Some of the mainstem gages could not be used in the calibration because of inconsistency in the recorded stages when compared with the next upstream or downstream gage. The gages are identified in the section entitled "Present Study". It is likely that these differences are due to inaccurate designa-

tion of river mileage at some gages. In a relatively steep channel, a difference of ±0.2 mile in a gage location could cause a significant difference in the water surface elevation. It is recommended that for any future refinement of the water surface profiles, effort must be made to determine accurate river mileage of the gage locations.

The number and locations of the surveyed river cross sections between the confluence (of the Talkeetna and Susitna rivers) and the mouth of the Devil Canyon are adequate and the water surface elevations given by the profiles are expected to be within ±0.5 ft of observed elevations at the surveyed cross sections. However, the elevations interpolated between two surveyed cross sections could have lower accuracies. Therefore, if any important location of interest, such as the outlet of a major slough, is located far from a surveyed cross section, additional cross sections should be surveyed at or near the location. With the additional surveyed cross sections, the model can be re-run to predict water surface elevations at a comparable accuracy of about ±0.5 ft.

Five cross sections downstream of cross section 0.3 should be surveyed for more accurate water surface profiles of the river reach between the confluence and the Sunshine bridge. Observation of river stages also will be required at these cross sections.

Additional control points (staff gages) also are required at some multiple-channel cross sections. At least two staff gages should be established in each major channel of a cross section. Twenty additional control points (staff gages) are recommended as shown on Exhibit 2.

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REFERENCE

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TABLES

Table 1

MANNING's ROUGHNESS COEFFICIENTS ('n' VALUES)

Section No.	Distance (Miles)	Manning's 'n' Values 9,700 (cfs) R&M	9,700 (cfs) Harza	13,400 (cfs) R&M	13,400 (cfs) Harza	17,000 (cfs) R&M	17,000 (cfs) Harza	23,400 (cfs) R&M	23,400 (cfs) Harza	34,500 (cfs) R&M	34,500 (cfs) Harza	52,000 (cfs) R&M	52,000 (cfs) Harza
.001	83.90		.060		.045		.040		.041		.041		.035
.01	84.83		.060		.045		.040		.041		.041		.035
.02	86.93		.060		.045		.040		.041		.041		.035
.03	88.13		.060		.045		.040		.041		.041		.035
.04	89.83		.060		.045		.040		.041		.041		.035
.05	91.63		.060		.045		.040		.041		.041		.035
.3	94.23		.060		.045		.040		.041		.041		.035
.4	94.55		.060		.045		.040		.041		.041		.035
.5	94.92		.060		.045		.040		.041		.041		.035
.6	95.37		.060		.045		.040		.041		.041		.035
.7	95.76		.060		.045		.040		.041		.041		.035
.8	96.13		.060		.045		.040		.041		.041		.035
.9	96.61		.060		.045		.040		.041		.041		.035
1.0	97.02		.060		.045		.040		.041		.041		.035
1.1	97.31		.060		.045		.040		.041		.041		.035
1.2	97.62		.060		.045		.040		.041		.041		.035
2.0	97.93		.060		.045		.040		.041		.041		.035
2.1	98.03		.060		.045		.040		.041		.041		.035
2.2	98.23		.060		.045		.040		.041		.041		.035
2.3	98.42		.060		.045		.040		.041		.041		.035
3.0	98.59	.040	.060	.038	.045	.036	.040	.036	.041	.032	.041	.032	.030
3.1	98.75		.025		.028		.035		.035		.035		.035
3.2	98.93		.025		.028		.035		.035		.035		.035
3.3	99.10		.025		.028		.035		.035		.035		.035
3.4	99.31		.025		.028		.030		.035		.035		.035
4.0	99.58	.040	.025	.038	.028	.036	.030	.036	.035	.032	.035	.032	.035
4.1	99.75		.025		.028		.030		.035		.035		.035
4.2	99.94		.025		.028		.030		.035		.035		.035
4.3	100.17		.025		.028		.030		.035		.035		.035
4.4	100.28		.025		.028		.030		.035		.035		.035
5.0	100.36	.040	.025	.038	.028	.036	.030	.036	.035	.032	.035	.032	.035
6.0	100.96	.040	.025	.038	.025	.036	.025	.036	.033	.032	.035	.032	.035
7.0	101.52	.040	.025	.038	.035	.036	.025	.036	.033	.032	.035	.032	.035
8.0	102.38	.050	.045	.048	.036	.045	.038	.045	.038	.041	.038	.041	.038
9.0	103.22	.055	.055	.052	.048	.050	.046	.050	.042	.045	.041	.045	.038
9.1	104.12		.055		.048		.046		.042		.041		.038
10.0	104.75	.055	.040	.052	.030	.050	.030	.050	.030	.045	.030	.045	.030
10.1	105.01		.030		.025		.025		.025		.025		.025
10.2	105.81		.030		.025		.025		.025		.025		.025
10.3	106.34		.035		.030		.030		.030		.030		.030
11.0	106.68	.055	.035	.052	.030	.050	.030	.050	.030	.045	.030	.045	.030
12.0	108.41	.055	.040	.052	.040	.050	.040	.050	.036	.045	.035	.045	.035
13.0	110.36	.055	.040	.052	.040	.050	.035	.050	.036	.045	.035	.045	.035

Table 1 (Cont'd)

MANNING's ROUGHNESS COEFFICIENTS ('n' VALUES)

Section No.	Distance (Miles)	Manning's 'n' Values											
		9,700 (cfs)		13,400 (cfs)		17,000 (cfs)		23,400 (cfs)		34,500 (cfs)		52,000 (cfs)	
		R&M	Harza	R&M	Harza	R&M	Harza	R&M	Harza	R&M	Harza	R&M	Harza
14.0	110.89	.055	.040	.052	.030	.050	.030	.050	.030	.045	.030	.045	.030
15.0	111.83	.045	.038	.043	.035	.041	.030	.041	.030	.036	.030	.036	.030
16.0	112.34	.040	.038	.038	.038	.036	.035	.036	.034	.032	.032	.032	.032
17.0	112.69	.040	.030	.038	.034	.036	.032	.036	.030	.032	.032	.032	.032
18.0	113.02	.040	.030	.038	.034	.036	.032	.036	.030	.032	.032	.032	.032
18.1	114.11		.045		.040		.040		.036		.032		.032
18.2	115.08		.045		.040		.036		.036		.032		.032
18.3	115.86		.045		.038		.036		.036		.032		.032
19.0	116.44	.040	.040	.038	.038	.036	.036	.036	.036	.032	.032	.032	.032
19.1	116.89		.040		.038		.036		.036		.032		.032
20.0	117.19	.040	.040	.038	.038	.036	.036	.036	.036	.032	.032	.032	.032
20.1	117.61		.040		.038		.036		.036		.032		.032
20.2	118.31		.040		.038		.036		.036		.032		.032
21.0	119.15	.040	.040	.038	.038	.038	.036	.036	.036	.032	.032	.032	.032
22.0	119.32	.030	.030	.029	.029	.027	.027	.027	.027	.024	.024	.024	.024
23.0	120.26	.030	.025	.029	.025	.027	.025	.027	.025	.024	.024	.024	.024
24.0	120.66	.030	.025	.029	.025	.027	.025	.027	.025	.024	.024	.024	.024
24.1	120.85		.050		.045		.035		.027		.024		.024
25.0	121.63	.030	.050	.029	.045	.027	.035	.027	.027	.024	.024	.024	.024
25.1	122.05		.035		.033		.030		.030		.028		.028
26.0	122.57	.035	.035	.033	.028	.032	.030	.032	.030	.028	.028	.028	.028
27.0	123.31	.035	.030	.033	.028	.032	.030	.032	.028	.028	.028	.028	.028
28.0	124.41	.035	.030	.033	.028	.032	.032	.032	.032	.028	.028	.028	.028
28.1	125.54		.030		.030		.032		.031		.028		.028
29.0	126.11	.035	.030	.033	.035	.032	.035	.032	.031	.028	.031	.028	.028
30.0	127.50	.038	.050	.036	.048	.034	.047	.034	.040	.031	.040	.031	.045
31.0	128.66	.038	.050	.036	.048	.034	.047	.034	.045	.031	.045	.031	.040
32.0	129.67	.038	.038	.036	.036	.034	.034	.034	.032	.031	.031	.031	.031
33.0	130.12	.036	.032	.034	.032	.032	.030	.032	.030	.029	.029	.029	.029
34.0	130.47	.036	.032	.034	.032	.032	.030	.032	.030	.029	.029	.029	.029
35.0	130.87	.036	.032	.034	.032	.032	.030	.032	.030	.029	.029	.029	.029
36.0	131.19	.036	.036	.034	.032	.032	.030	.032	.030	.029	.029	.029	.029
37.0	131.80	.036	.036	.034	.036	.032	.034	.032	.032	.029	.029	.029	.029
38.0	132.90	.036	.036	.034	.036	.032	.034	.032	.032	.029	.029	.029	.029
39.0	133.33	.036	.036	.034	.036	.032	.034	.032	.032	.029	.029	.029	.029
40.0	134.28	.038	.040	.036	.036	.034	.034	.034	.034	.031	.031	.031	.031
41.0	134.72	.038	.038	.036	.036	.034	.034	.034	.033	.031	.031	.031	.031
42.0	135.36	.038	.038	.036	.036	.034	.034	.034	.033	.031	.031	.031	.031
43.0	135.72	.040	.040	.038	.038	.036	.036	.036	.034	.032	.032	.032	.032
44.0	136.40	.040	.040	.038	.038	.036	.036	.036	.036	.032	.032	.032	.032
45.0	136.68	.040	.040	.038	.038	.036	.038	.036	.036	.032	.032	.032	.030
46.0	136.96	.045	.038	.043	.036	.041	.034	.041	.034	.037	.031	.037	.030

Table 1 (Cont'd)

MANNING's ROUGHNESS COEFFICIENTS ('n' VALUES)

Section No.	Distance (Miles)	Manning's 'n' Values 9,700 (cfs) R&M	9,700 (cfs) Harza	13,400 (cfs) R&M	13,400 (cfs) Harza	17,000 (cfs) R&M	17,000 (cfs) Harza	23,400 (cfs) R&M	23,400 (cfs) Harza	34,500 (cfs) R&M	34,500 (cfs) Harza	52,000 (cfs) R&M	52,000 (cfs) Harza
47.0	137.15	.040	.038	.038	.036	.036	.034	.036	.034	.032	.031	.032	.030
48.0	137.41	.040	.038	.038	.036	.036	.034	.036	.034	.032	.031	.032	.030
49.0	138.23	.040	.030	.038	.036	.036	.034	.036	.034	.032	.031	.032	.030
50.0	138.48	.045	.035	.043	.035	.041	.034	.041	.033	.037	.030	.037	.025
51.0	138.89	.050	.060	.048	.055	.045	.053	.045	.050	.041	.050	.041	.025
52.0	139.44	.050	.050	.048	.050	.045	.047	.045	.047	.041	.040	.041	.040
53.0	140.15	.050	.035	.048	.035	.045	.035	.045	.035	.041	.035	.041	.035
54.0	140.83	.055	.035	.052	.030	.050	.030	.050	.027	.045	.027	.045	.027
55.0	141.59	.055	.035	.052	.030	.050	.030	.050	.027	.045	.027	.045	.027
56.0	142.13	.055	.045	.052	.030	.050	.030	.050	.030	.045	.030	.045	.030
57.0	142.34	.050	.055	.048	.045	.045	.040	.045	.035	.041	.035	.041	.035
58.0	143.18	.050	.060	.048	.055	.045	.055	.045	.045	.041	.046	.041	.035
59.0	144.83	.050	.065	.048	.060	.045	.060	.045	.055	.041	.041	.041	.035
60.0	147.56	.055	.060	.052	.055	.050	.055	.050	.055	.045	.041	.045	.035
61.0	148.73	.055	.060	.052	.055	.050	.045	.050	.041	.045	.041	.045	.035
62.0	148.94	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.035
63.0	149.15	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.035
64.0	149.35	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.041
65.0	149.46	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.041
66.0	149.51	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.041
67.0	149.81	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.041
68.0	150.19	.055	.060	.052	.055	.050	.050	.050	.045	.045	.041	.045	.041

Table 2

COMPARISON OF OBSERVED AND COMPUTED WATER SURFACE ELEVATIONS

Control Point Used by Harza	Distance[1] (mi)	Gage Heights (ft) for Indicated Discharges (cfs)											
		9,700		13,400		17,000		23,400		34,500		52,000	
		Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Sunshine		274.1	274.1	275.1	275.1	275.9	275.9	277.2	277.2	279.3	279.3	282.2	282.2
LRX-4[2]	99.58		348.6		349.5		350.5		351.6		352.8		354.5
		(348.1)	(348.6)	(349.5)[4]	(349.5)	(350.5)	(350.8)	(352.0)	(352.0)	(352.9)	(353.1)	(354.6)	(355.1)
Mainstem Wisker Slough	101.15	363.1	363.2	363.7	363.9	364.3	364.5	365.1	364.8				
Talkeetna Fishwheel	102.90	375.6	375.8	376.3	376.7	377.1	377.6	378.3	378.9				
LRX-9[3]	103.22	378.0	378.0	379.0	378.6		379.8		381.2		383.3		385.8
		(378.4)	(378.1)	(379.0)	(379.4)	(379.8)	(380.3)	(381.6)	(381.8)	(383.1)	(383.4)	(385.4)	(386.2)
LRX-10.2	105.90					402.1	402.2	403.1	403.1				
LRX-10.3	106.40					407.6	406.8	408.3	407.7				
LRX-11	106.68					409.2	409.3	410.1	410.2				
LRX-12	108.41					423.4	422.6	424.3	423.7				
Side Channel Gash Creek	111.50	448.7	448.7	449.0	449.5	449.4	449.8	449.8	450.6				
Head Gash Creek Side Channel	112.10	453.7	453.8	454.3	454.5	454.8	455.1	455.5	455.8				
Mainstem Slough 6A	112.30	455.2	455.2	455.9	455.9	456.4	456.4	457.3	457.3				
LRX-18	113.02	460.4	460.7	461.4	461.8	461.9	462.4	462.8	463.2				

Table 2 (Cont'd)

COMPARISON OF OBSERVED AND COMPUTED WATER SURFACE ELEVATIONS

Control Point Used by Harza	Distance[1] (mi)	Gage Heights (ft) for Indicated Discharges (cfs)											
		9,700		13,400		17,000		23,400		34,500		52,000	
		Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Curry Fish Wheel	120.60			521.8	521.9	522.3	522.6	523.2	523.7				
LRX-24[3]	120.66	521.1	521.2	522.0	522.2	522.8	523.0	524.4	524.1		525.4		527.2
		(521.1)	(521.2)	(522.0)	(522.6)	(522.9)	(523.2)	(523.8)	(524.3)	(524.4)	(525.4)	(527.5)	(527.2)
LRX-28[3]	124.41	553.1	554.4	554.2	555.2	555.5	556.1	557.1	556.8		558.1		560.1
		(553.8)	(555.0)	(555.3)	(555.7)	(556.0)	(556.2)	(557.0)	(557.0)	(558.2)	(558.1)	(559.8)	(560.1)
LRX-29	126.11	569.1	569.4	570.4	570.4	571.1	571.2	572.1	572.0				
LRX-31	128.66	595.6	595.3	596.7	596.2	597.4	597.1	598.3	598.2				
LRX-35[3]	130.87	616.7	617.4	618.0	618.4	618.7	619.1	619.8	620.5		621.6		623.6
		(617.3)	(617.7)	(617.9)	(618.7)	(619.0)	(619.4)	(620.0)	(620.3)	(621.3)	(621.6)	(623.3)	(623.3)
LRX-40	134.28	655.2	655.2	656.0	655.9	656.6	656.5	657.1	657.5				
LRX-45[2]	136.68		684.0		685.1		686.0		687.2		688.4		690.5
		(684.1)	(684.0)	(685.2)	(685.1)	(685.9)	(685.8)	(687.0)	(687.0)	(688.4)	(688.1)	(690.0)	(689.9)
LRX-50	138.48	702.5	702.7	703.6	704.3	704.7	705.1	705.5	706.2				
LRX-51	138.89	707.4	706.9	708.2	707.6	708.9	708.3	710.0	709.8				
Mainstem at Slough 19	139.80	719.6	719.8	720.5	720.7	721.1	721.3	721.8	722.3				
LRX-53	140.15	722.9	722.7	723.8	723.7	724.6	724.4	725.5	725.4				
LRX-54	140.83			732.1	732.3	733.0	733.1	733.8	734.1				

Table 2 (Cont'd)

COMPARISON OF OBSERVED AND COMPUTED WATER SURFACE ELEVATIONS

Control Point Used by Harza	Distance[1] (mi)	Gage Heights (ft) for Indicated Discharges (cfs)											
		9,700		13,400		17,000		23,400		34,500		52,000	
		Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.	Obs.	Comp.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Maistem at Slough 22	144.70	784.8	785.0	786.6	786.1	787.3	787.4	788.3	787.5				
LRX-61	148.73			834.2	834.7	835.1	835.6	836.3	836.7				
LRX-62[3]	148.94		835.4	836.5	836.6	837.3	837.1	838.7	838.5		841.0		843.0
		(835.4)	(835.1)	(835.9)	(836.4)	(837.5)	(837.5)	(838.3)	(838.0)	(840.7)	(840.8)	(843.9)	(844.2)
LRX-68[2]	150.19		851.0		852.1		852.8		854.0		855.8		858.8
		(851.4)	(850.6)	(852.2)	(851.8)	(852.9)	(852.8)	(854.1)	(854.0)	(856.0)	(855.8)	(859.0)	(858.7)

1/ Distance from mouth of the river.

2/ Staff gages used by R&M in model calibration

3/ Staff gages used by R&M in model calibration and for which stage-discharge relationships also are available from ADF&G.

4/ The observed and computed values taken from R&M study (2) are parenthesised.

Table 3

VARIATION IN WATER SURFACE ELEVATION BETWEEN CHANNELS[1/]
AT A CROSS SECTION

Flow Less Than 10,000 cfs

Station Numbers	Date of Survey	Flow (cfs)	Water Surface Elevation (ft.) Main Channel	Side Channel(s)	Comments
LRX-4	10/4/80	9800	350.4	348.2	
LRX-7	10/6/80	9380	364.6	365.7	
LRX-16	10/10/80	9695	455.2	455.5	
LRX-31	10/30/80	2400	594.1	592.6	
LRX-36	10/36/80	5525	619.0	618.5	Frazil ice accum.; 10' wide shore ice.
LRX-39	10/28/80	5400	645.6	644.7	Shore ice; ice floes.
LRX-42	10/20/80	7230	668.7	666.8 (slough) 667.8	Variation of 0.4' in water surface across main channel
LRX-43	10/17/80	7350	670.9	673.7	Frazil ice
LRX-44	10/17/80	7350		680.8	
	10/20/80	7230	679.9		
LRX-48	10/14/80	7290	691.7	689.7 (ponded)	
LRX-52	10/24/80	6420	713.8	716.3	
LRX-53	10/14/80	6420	722.2	724.0	Small side channel w/flowing water
LRX-54	10/24/80	6420	731.8	733.5	
LRX-55	10/23/80	6270	742.6	739.9	

Flow Greater than 21,000 cfs

LRX-4	8/31/81	22300	351.4(M)	351.5(L), 352.6(R)[2/]	
LRX-7	8/31/81	22300	367.6(L)	368.0(R)	
LRX-16	8/31/81	22300	457.4(L)	457.6(R), 455.9(M.SL) 457.3(RSL)	
LRX-28	8/31/81	22300	557.7(M)	556.4(L), 557.2(R)	
LRX-29	8/31/81	22300	572.4(R)	574.0(L.SL)	ponded water in left slough
LRX-31	8/31/81	22300	598.2(R)	594.8(M.SL), 593.0(L.SL)	
LRX-36	9/1/81	21100	622.4(L)	621.6(R),	
LRX-39	9/1/81	21100	648.5(R)	647.0(L) 646.1(L.SL)	
LRX-42	9/21/81	21100	672.2(R)	669.5(LSL)	Flowing ater in left slough
LRX-43	9/1/81	21100	673.5(R)	673.5(M.SL), 674.8(LSL)	
LRX-44	9/1/81	21100	683.8(R)	681.8(M.SL) 682.8(L.SL)	
LRX-47	9/1/81	21100	693.7(M)	691.1(L.SL)	
LRX-48	9/1/81	21100	695.3(R)	692.7(L.SL)	
LRX-53	9/1/81	21100	725.4(R)	725.1(L.SL)	
LRX-55	9/1/81	21100	743.6(LB) 744.9(RB)	743.1(L.SL)	

1/ Source: R&M Report (2, Tables 4.5 and 4.6)

2/ Abbreviations L = Left Channel; R - Right Channel; M - Middle Channel; SL - Slough;

Table 4

RIVER REACHES AND CORRESPONDING DISCHARGES

Cross Sections		Gold Creek Discharges (cfs)					
From	To	9,700	13,400	17,000	23,400	34,500	52,000
		Discharges in River Reach (cfs)					
001	1.0	17,000	23,480	29,790	41,020	60,470	91,140
1.1	2.3	13,930	19,240	24,405	33,610	49,540	74,670
3.0	23.0	9,990	13,880	17,508	24,107	35,540	53,566
24.0	50.0	9,700	13,400	17,000	23,400	34,500	52,000
51.0	61.0	9,540	13,179	16,720	23,000	33,910	51,109
62.0	68.0	9,140	12,626	16,019	22,045	32,500	48,984

Table 5

WATER SURFACE ELEVATIONS

Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
0.001	83.90	272.1	272.7	273.3	274.1	275.1	275.9	277.2	279.3	282.2
0.01	84.83	276.6	278.2	279.0	281.4	281.6	282.3	284.8	291.7	292.4
0.02	86.93	281.7	282.8	283.5	285.5	285.7	286.4	288.5	294.1	295.3
0.03	88.13	285.1	286.0	286.4	288.0	288.1	288.6	290.4	294.9	296.3
0.04	89.83	291.4	292.2	292.7	294.0	294.1	294.5	295.9	298.8	300.3
0.05	91.63	298.7	299.4	299.7	300.9	301.0	301.3	302.5	304.7	305.9
0.3	94.23	314.3	315.3	315.7	316.7	316.7	317.1	318.2	318.7	319.7
0.4	94.55	316.1	317.0	317.5	318.7	318.8	319.2	320.3	321.6	322.7
0.5	94.92	317.3	318.5	319.1	320.7	320.8	321.2	322.4	323.9	325.0
0.6	95.37	319.2	320.8	321.5	323.4	323.6	324.2	325.5	327.0	327.8
0.7	95.76	323.5	324.3	324.8	326.3	326.5	326.9	328.2	329.6	330.4
0.8	96.13	326.5	327.2	327.6	328.8	328.9	329.3	330.4	331.9	332.6
0.9	96.61	330.5	331.1	331.4	332.4	332.5	332.8	333.6	334.8	335.4
1.0	97.02	332.0	332.9	333.4	334.6	334.7	335.0	335.9	336.9	337.7
1.1	97.31	332.9	333.9	334.5	335.7	335.8	336.2	337.2	338.4	339.2
1.2	97.62	335.0	335.7	336.1	337.3	337.4	337.7	339.0	340.3	341.0
2.0	97.93	336.7	338.0	338.3	339.3	339.4	339.7	340.9	342.1	342.9
2.1	98.03	337.1	338.3	338.7	339.7	339.8	340.1	341.3	342.7	343.6
2.2	98.23	337.7	338.9	339.3	340.5	340.5	340.9	342.3	344.1	345.0
2.3	98.42	338.5	340.0	340.5	342.5	342.7	343.5	345.4	347.1	347.9
3.0	98.59	339.7	341.2	341.8	344.1	344.5	345.3	346.9	348.4	349.1
3.1	98.75	340.9	342.1	342.7	344.6	345.1	346.0	347.5	348.9	350.0
3.2	98.93	343.4	344.1	344.6	345.2	345.8	346.8	348.0	349.4	350.8
3.3	99.10	344.8	345.5	346.0	346.1	346.8	347.7	348.6	350.0	351.6
3.4	99.31	345.9	346.4	346.9	347.2	348.0	348.8	349.8	351.1	352.8
4.0	99.58	347.1	347.5	348.0	348.6	349.5	350.3	351.7	352.9	354.6
4.1	99.75	351.0	351.4	351.7	351.9	352.6	353.2	354.3	355.3	356.7
4.2	99.94	351.9	352.5	352.8	353.0	353.8	354.4	355.5	356.6	358.0
4.3	100.17	352.5	353.1	353.5	353.8	354.7	355.5	357.0	358.2	359.7
4.4	100.28	353.1	353.9	354.2	354.5	355.5	356.3	357.9	359.0	360.3
5.0	100.36	356.5	356.9	357.2	357.4	358.0	358.5	359.6	360.8	362.1
6.0	100.96	360.2	360.9	361.3	361.9	362.7	363.3	364.4	365.6	367.3
7.0	101.52	363.1	364.0	364.6	365.3	366.5	366.6	368.2	369.5	371.0
8.0	102.38	370.2	371.2	371.7	372.4	373.4	374.0	375.1	376.6	378.4
9.0	103.22	374.9	376.2	376.9	378.0	378.6	379.8	381.2	383.3	385.8
9.1	104.12	381.9	383.0	383.7	384.9	385.8	386.6	387.7	389.7	391.8
10.0	104.75	391.1	391.6	391.8	392.2	392.2	392.8	393.6	395.0	396.7
10.1	105.01	393.5	394.2	394.6	395.1	395.3	395.8	396.6	397.9	399.4
10.2	105.81	399.7	400.2	400.8	401.4	401.7	402.2	403.0	404.2	405.6
10.3	106.34	403.8	404.9	405.4	406.0	406.3	406.8	407.7	409.0	410.8
11.0	106.68	406.3	407.4	407.8	408.3	408.7	409.3	410.2	411.5	413.2

Table 5 (Continued)

WATER SURFACE ELEVATIONS

Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
12.0	108.41	419.0	419.7	420.4	420.8	421.7	422.6	423.7	425.6	428.0
13.0	110.36	433.2	434.3	435.6	436.2	437.6	438.1	439.6	441.5	444.9
14.0	110.89	441.3	442.0	442.4	442.9	443.4	443.9	445.0	446.7	449.3
15.0	111.83	450.2	451.2	451.6	452.1	452.6	452.9	453.7	454.9	456.3
16.0	112.34	453.4	454.2	454.8	455.4	456.3	456.6	457.7	459.0	460.8
17.0	112.69	457.6	458.1	458.6	459.0	459.9	460.4	461.1	462.4	463.9
18.0	113.02	459.1	459.7	460.2	460.7	461.8	462.4	463.2	464.9	466.6
18.1	114.11	471.9	472.8	473.4	474.2	474.5	475.3	476.0	477.0	478.9
18.2	115.08	477.0	478.1	479.1	480.2	481.2	481.8	482.9	484.2	486.1
18.3	115.86	480.4	481.6	482.5	483.9	484.7	485.5	487.0	488.6	490.9
19.0	116.44	484.3	485.1	485.7	486.8	487.6	488.5	490.1	491.6	494.2
19.1	116.89	490.7	491.4	492.1	492.7	493.5	494.0	495.5	496.8	499.0
20.0	117.19	492.0	493.0	493.9	494.8	495.8	496.4	497.9	499.0	501.0
20.1	117.61	497.8	498.7	499.4	500.1	501.0	501.5	502.5	503.5	504.9
20.2	118.31	502.1	503.3	504.1	504.8	505.5	506.1	507.2	508.2	509.8
21.0	119.15	506.0	507.3	508.3	509.2	510.2	510.9	512.2	513.5	515.7
22.0	119.32	508.9	509.8	510.5	511.5	512.3	512.9	514.0	515.3	517.3
23.0	120.26	518.1	518.8	519.3	519.7	520.4	520.9	521.8	522.9	524.6
24.0	120.66	519.2	520.1	520.7	521.2	522.2	523.0	524.1	525.4	527.2
24.1	120.85	520.0	521.2	522.0	522.7	524.0	524.4	525.4	526.8	529.8
25.0	121.63	530.9	531.4	532.0	533.2	533.8	533.9	534.6	537.8	539.6
25.1	122.05	532.5	533.1	533.7	534.8	535.5	535.6	536.7	539.6	541.7
26.0	122.57	535.6	536.4	536.9	537.6	538.2	538.9	540.1	542.0	544.2
27.0	123.31	540.2	541.3	542.0	542.8	543.3	544.4	545.5	547.2	549.4
28 0	124.41	551.6	552.7	553.6	554.4	555.2	556.1	556.8	558.1	560.1
28.1	125.54	563.6	564.3	564.9	565.3	566.0	566.8	567.6	568.3	570.1
29.0	126.11	567.5	568.4	568.8	569.4	570.4	571.2	572.0	573.1	574.9
30.0	127.50	584.7	585.6	586.0	586.7	587.3	587.7	588.0	589.2	590.8
31.0	128.66	592.0	593.3	594.3	595.3	596.2	597.1	598.2	599.6	601.4
32.0	129.67	604.0	604.6	605.2	606.1	607.0	607.7	608.4	610.0	611.8
33.0	130.12	610.6	611.3	611.7	612.2	613.0	613.5	613.8	614.6	615.9
34.0	130.47	614.1	614.7	615.2	615.7	616.6	617.2	617.9	619.1	620.4
35.0	130.87	615.0	616.0	616.6	617.4	618.4	619.1	620.1	621.7	623.6
36.0	131.19	616.4	617.1	617.8	618.9	620.2	621.0	622.4	624.2	626.6
37.0	131.80	625.1	626.0	626.5	627.1	627.8	628.1	628.9	629.4	630.4
38.0	132.90	637.0	637.7	638.2	638.9	640.0	640.7	641.8	643.4	645.6
39.0	133.33	644.5	645.1	645.4	645.9	646.4	646.7	647.4	648.2	649.7
40.0	134.28	653.1	653.8	654.4	655.2	655.9	656.5	657.5	658.6	660.4
41.0	134.72	657.9	658.6	659.2	659.9	660.6	661.2	662.3	663.6	665.8
42.0	135.36	667.4	668.0	668.4	668.8	669.4	669.8	670.4	671.5	672.8

Table 5 (Continued)

WATER SURFACE ELEVATIONS

Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
43.0	135.72	668.4	669.4	670.2	671.2	672.1	672.7	673.8	675.3	676.9
44.0	136.40	678.8	679.6	680.2	681.2	682.2	683.0	684.2	685.4	687.4
45.0	136.68	681.1	682.2	683.0	684.0	685.1	686.0	687.2	688.4	690.5
46.0	136.96	684.1	685.1	685.9	686.9	687.9	688.8	690.2	691.7	694.1
47.0	137.15	687.5	688.6	689.3	690.4	691.3	691.9	692.9	694.2	696.3
48.0	137.41	689.8	690.9	691.7	692.9	693.9	694.6	695.5	697.0	699.1
49.0	138.23	698.6	699.6	700.2	700.9	702.7	703.4	704.3	705.2	706.6
50.0	138.48	700.2	701.3	702.0	702.7	704.3	705.1	706.2	707.3	708.6
51.0	138.89	705.4	706.0	706.5	706.9	707.6	708.5	709.7	711.4	711.7
52.0	139.44	713.0	714.4	715.8	717.1	717.8	718.2	718.6	719.5	720.1
53.0	140.15	719.9	720.8	722.1	722.7	723.7	724.4	725.4	726.5	728.8
54.0	140.83	730.2	730.8	731.3	731.8	732.3	733.1	734.1	735.8	737.6
55.0	141.59	740.7	741.6	742.2	742.9	743.4	743.9	744.3	745.3	746.8
56.0	142.13	749.5	750.2	750.5	751.4	751.4	752.1	753.2	755.0	756.9
57.0	142.34	751.7	752.7	753.1	754.2	754.4	755.0	756.0	757.8	759.9
58.0	143.18	762.4	763.5	764.1	764.8	765.7	766.2	766.2	767.9	769.2
59.0	144.83	783.0	784.3	785.4	786.8	787.8	789.2	790.4	791.2	792.3
60.0	147.56	816.4	817.5	818.5	819.5	820.6	821.6	823.4	823.8	825.8
61.0	148.73	828.7	830.3	831.3	833.1	834.3	834.8	836.4	838.7	840.5
62.0	148.94	831.4	832.9	833.7	835.4	836.6	837.1	838.5	841.0	843.0
63.0	149.15	834.4	835.6	836.4	837.9	839.0	839.7	841.0	843.2	845.2
64.0	149.35	836.2	837.6	838.5	839.9	841.1	841.9	843.2	845.4	848.0
65.0	149.46	839.0	840.0	840.6	841.9	842.9	843.5	844.7	847.0	850.0
66.0	149.51	842.3	843.0	843.6	844.5	845.2	845.8	846.8	848.5	850.9
67.0	149.81	845.7	846.8	847.5	848.7	849.6	850.2	851.1	852.4	854.7
68.0	150.19	847.3	848.6	849.5	851.0	852.1	852.8	854.0	855.8	858.8

Table 6

MEAN VELOCITIES

Mean Velocities (ft/sec) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
0.001	83.90	1.5	2.2	2.7	3.4	4.1	4.6	5.4	6.3	7.2
0.01	84.83	1.6	2.1	2.6	2.7	3.7	4.3	4.7	3.0	3.6
0.02	86.93	.9	1.1	1.3	1.3	1.7	1.9	2.0	1.6	2.2
0.03	88.13	1.3	1.7	2.2	2.1	2.8	3.3	3.3	2.7	3.6
0.04	89.83	1.0	1.4	1.7	1.8	2.4	2.9	3.2	3.2	3.8
0.05	91.63	1.2	1.5	1.9	1.8	2.4	2.8	2.9	2.6	3.3
0.3	94.23	1.4	1.7	2.1	2.2	2.9	3.4	3.6	4.6	5.4
0.4	94.55	1.3	1.6	2.0	2.0	2.6	3.0	3.2	3.5	4.1
0.5	94.92	1.3	1.7	2.1	2.0	2.7	3.1	3.2	3.3	4.0
0.6	95.37	2.2	2.4	2.8	2.4	3.2	3.5	3.3	3.2	3.8
0.7	95.76	1.6	2.0	2.4	2.1	2.7	3.1	3.0	3.1	3.9
0.8	96.13	1.3	1.7	2.1	1.9	2.6	3.0	3.0	2.9	3.5
0.9	96.61	1.3	1.7	2.0	1.9	2.6	2.9	3.0	3.2	4.2
1.0	97.02	1.0	1.3	1.5	1.5	2.1	2.4	2.7	3.1	4.1
1.1	97.31	1.3	1.5	1.8	1.7	2.3	2.7	2.9	3.1	3.9
1.2	97.62	1.4	1.8	2.1	2.1	2.8	3.2	3.0	3.1	3.9
2.0	97.93	1.3	1.5	1.9	1.9	2.6	3.0	3.2	3.6	4.8
2.1	98.03	1.0	1.2	1.5	1.6	2.2	2.6	2.8	3.2	4.0
2.2	98.23	1.6	2.1	2.8	3.3	4.5	5.3	5.7	5.3	6.3
2.3	98.42	2.5	3.2	4.1	3.9	5.2	5.4	4.3	3.8	4.6
3.0	98.59	1.6	2.0	2.4	2.3	3.1	3.4	3.3	3.3	4.3
3.1	98.75	4.0	3.4	3.7	2.4	2.8	2.8	2.7	3.1	4.0
3.2	98.93	3.0	2.9	3.0	3.0	3.2	3.0	3.1	3.4	4.1
3.3	99.10	2.1	2.2	2.5	3.2	3.4	3.2	3.4	3.7	4.3
3.4	99.31	2.1	2.7	3.0	3.8	4.0	4.0	4.3	4.8	5.4
4.0	99.58	3.6	4.6	5.0	5.3	5.1	5.0	4.6	5.0	5.1
4.1	99.75	2.5	2.9	3.5	4.2	4.1	4.0	3.7	4.0	4.3
4.2	99.94	1.3	1.8	2.3	2.8	3.1	3.4	3.6	4.2	4.9
4.3	100.17	1.8	2.5	3.1	3.9	4.1	4.1	3.7	3.9	4.2
4.4	100.28	4.7	4.8	5.3	6.2	5.2	4.9	4.4	4.7	5.3
5.0	100.36	2.4	3.2	4.0	5.1	5.7	6.1	4.9	5.3	6.4
6.0	100.96	2.5	2.9	3.2	3.6	3.9	4.2	3.9	4.5	5.2
7.0	101.52	3.5	4.1	4.5	4.8	4.4	5.5	4.6	5.1	5.8
8.0	102.38	1.9	2.5	3.1	3.8	4.3	4.7	5.4	6.5	7.9
9.0	103.22	1.6	2.1	2.6	3.2	4.0	4.4	5.1	6.0	7.2
9.1	104.12	5.1	4.4	4.7	4.4	4.9	5.2	5.7	6.1	6.8

Table 6 (Continued)

MEAN VELOCITIES

Mean Velocities (ft/sec) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
10.0	104.75	1.4	2.1	2.7	3.3	4.5	4.9	5.6	6.4	7.5
10.1	105.01	2.8	3.2	3.7	4.1	5.3	5.6	6.1	6.7	7.6
10.2	105.81	2.4	3.0	3.4	3.8	4.8	5.3	6.2	7.3	8.9
10.3	106.34	3.7	3.5	3.9	4.2	5.3	5.7	6.3	7.2	8.2
11.0	106.68	2.1	2.4	2.9	3.6	4.5	5.0	5.9	7.0	8.5
12.0	108.41	2.1	2.8	3.3	4.2	4.8	5.2	6.1	7.0	8.2
13.0	110.36	2.4	3.1	3.4	4.2	4.6	5.4	6.1	7.1	7.2
14.0	110.89	3.9	4.4	4.8	5.3	6.1	6.5	6.4	6.5	6.3
15.0	111.83	1.6	1.9	2.4	2.9	3.7	4.4	5.2	6.1	7.6
16.0	112.34	2.5	2.9	3.4	3.9	4.2	4.8	5.0	5.6	6.2
17.0	112.69	2.4	3.2	3.7	4.3	4.4	4.9	5.6	6.3	7.2
18.0	113.02	1.4	2.1	2.6	3.3	3.7	4.3	5.3	6.4	8.1
18.1	114.11	1.7	2.2	2.6	3.1	4.1	4.3	5.2	6.7	7.5
18.2	115.08	2.1	2.7	3.1	3.4	3.9	4.5	4.9	6.0	7.1
18.3	115.86	1.9	2.5	2.9	3.2	4.0	4.6	5.2	6.6	7.9
19.0	116.44	3.3	3.8	4.4	4.5	5.3	5.7	6.1	7.2	8.3
19.1	116.89	2.3	3.0	3.4	4.0	4.6	5.2	5.1	5.7	5.4
20.0	117.19	2.2	2.9	3.4	3.7	4.0	4.4	4.4	5.1	5.0
20.1	117.61	4.5	4.1	4.0	4.0	4.1	4.5	4.5	5.2	5.7
20.2	118.31	1.5	1.9	2.3	2.7	3.3	3.8	4.4	5.6	7.2
21.0	119.15	4.9	4.6	4.9	5.3	6.0	6.6	7.0	8.3	9.2
22.0	119.32	3.4	4.3	4.8	5.0	5.6	6.2	6.7	8.0	9.1
23.0	120.26	2.9	3.3	3.9	4.6	5.2	5.8	6.4	7.5	8.5
24.0	120.66	1.8	2.5	3.2	4.1	4.9	5.5	6.6	8.2	10.3
24.1	120.85	8.4	8.5	9.1	9.9	9.3	10.8	11.9	13.3	11.4
25.0	121.63	1.6	2.1	2.3	2.0	2.3	2.9	3.3	2.4	2.7
25.1	122.05	1.9	2.6	3.0	3.2	3.8	4.7	5.3	5.0	5.5
26.0	122.57	2.7	3.3	3.9	4.4	5.3	5.8	6.6	7.4	8.6
27.0	123.31	2.7	3.4	4.0	4.6	5.7	5.9	7.0	8.3	9.8
28 0	124.41	7.1	6.5	6.5	6.5	6.6	6.4	6.3	6.9	7.0
28.1	125.54	1.9	2.4	2.7	3.3	3.9	4.1	4.7	5.6	5.8
29.0	126.11	4.0	4.3	5.0	5.8	6.0	6.4	7.4	9.0	10.7
30.0	127.50	1.8	1.9	2.2	2.3	2.5	2.7	3.3	3.5	3.7
31.0	128.66	2.1	2.5	2.9	3.4	4.1	4.7	5.6	7.1	9.1
32.0	129.67	4.5	5.2	5.4	5.4	5.6	5.9	5.8	6.2	7.0

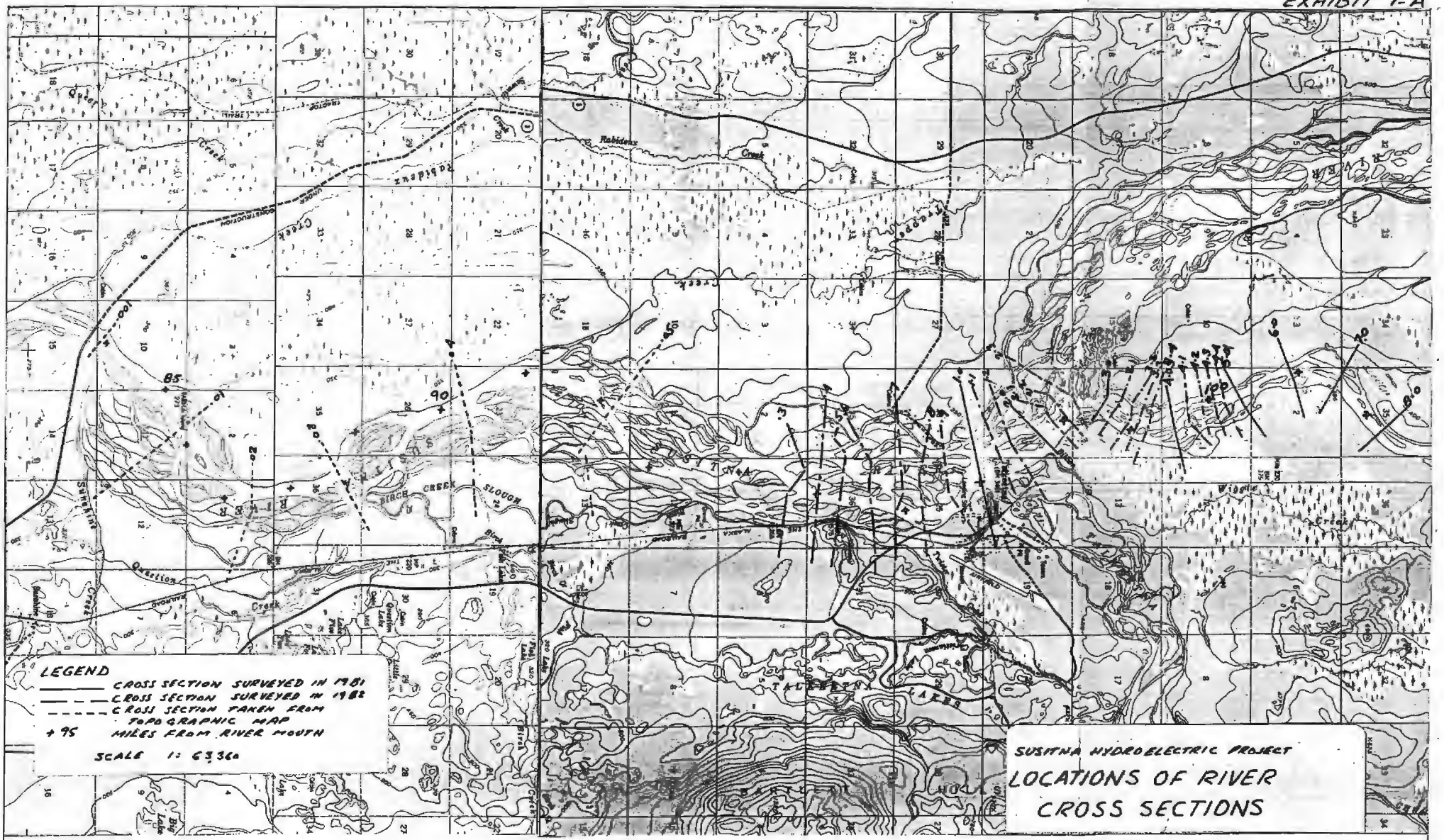
MEAN VELOCITIES ELEVATIONS

Mean Velocities (ft/sec) for Indicated Discharge (cfs)

Cross Section	River Mileage	3,000	5,000	7,000	9,700	13,400	17,000	23,400	34,500	52,000
38.0	132.90	4.5	5.0	5.3	5.7	5.6	5.9	6.3	6.8	7.0
39.0	133.33	2.1	2.6	3.2	3.8	4.4	5.0	5.8	7.2	8.2
40.0	134.28	2.5	3.1	3.6	4.0	4.7	5.4	6.2	7.7	9.3
41.0	134.72	2.2	3.1	3.8	4.5	5.5	6.3	7.1	8.4	8.9
42.0	135.36	2.8	3.1	3.4	3.7	4.1	4.5	5.0	5.6	6.4
33.0	130.12	2.1	2.8	3.4	4.1	4.4	4.8	5.2	6.2	7.0
34.0	130.47	2.7	3.4	4.1	4.8	5.3	5.9	6.6	8.0	9.9
35.0	130.87	1.6	2.3	3.0	3.7	4.4	5.2	6.4	8.1	10.2
36.0	131.19	7.0	7.7	7.6	7.2	5.9	5.9	5.5	5.3	5.4
37.0	131.80	2.1	2.7	3.3	4.0	4.9	5.8	6.9	9.5	12.1
43.0	135.72	1.7	2.4	3.1	3.8	4.7	5.5	6.6	7.9	9.4
44.0	136.40	3.4	4.4	5.1	5.5	5.9	6.3	6.9	8.3	9.6
45.0	136.68	2.3	3.0	3.6	4.3	5.1	5.8	6.9	8.8	11.1
46.0	136.96	7.3	7.2	7.3	7.2	7.8	8.1	8.3	9.6	10.4
47.0	137.15	3.0	3.8	4.5	5.0	5.9	6.8	7.4	9.1	10.6
48.0	137.41	4.2	4.4	4.7	4.8	5.4	6.0	6.1	7.2	8.1
49.0	138.23	3.1	3.9	4.7	5.5	4.9	5.4	6.0	7.3	8.7
50.0	138.48	2.0	2.5	3.1	3.7	4.0	4.6	5.5	7.2	9.6
51.0	138.89	4.3	4.9	5.3	6.1	6.5	6.5	6.8	7.6	10.8
52.0	139.44	2.2	2.7	2.6	2.4	2.7	3.2	3.5	4.3	5.7
53.0	140.15	4.0	4.2	4.0	4.6	5.2	5.8	6.8	8.5	9.7
54.0	140.83	3.4	4.5	5.4	6.4	7.7	8.0	8.9	9.3	10.6
55.0	141.59	3.2	3.7	4.3	4.8	5.8	6.4	7.9	9.5	11.1
56.0	142.13	2.4	3.3	4.3	4.7	6.6	7.2	8.1	8.7	9.9
57.0	142.34	2.0	2.4	3.0	3.2	4.3	4.8	5.6	6.4	7.6
58.0	143.18	2.3	2.9	3.5	4.1	4.8	5.6	7.1	7.9	10.0
59.0	144.83	2.3	2.8	3.1	3.4	4.1	4.3	5.2	7.1	9.5
60.0	147.56	2.6	3.3	3.8	4.4	5.2	5.7	6.4	9.1	11.2
61.0	148.73	2.5	3.2	3.9	4.2	5.0	6.0	7.0	8.5	11.3
62.0	148.94	3.1	3.5	4.2	4.4	5.1	6.1	7.2	8.4	10.8
63.0	149.15	2.4	3.1	3.8	4.3	5.1	6.0	7.2	8.7	11.3
64.0	149.35	2.4	3.0	3.6	4.0	4.8	5.5	6.6	8.1	10.1
65.0	149.46	7.0	6.8	7.4	6.8	7.2	7.9	8.6	8.5	8.4
66.0	149.51	2.4	3.2	3.8	4.3	5.0	5.6	6.3	7.1	7.9
67.0	149.81	1.9	2.5	3.1	3.5	4.3	5.0	6.2	7.9	9.8
68.0	150.19	1.6	2.1	2.7	3.1	3.8	4.5	5.6	7.2	8.9

EXHIBITS

EXHIBIT 1-A



HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT 1-B

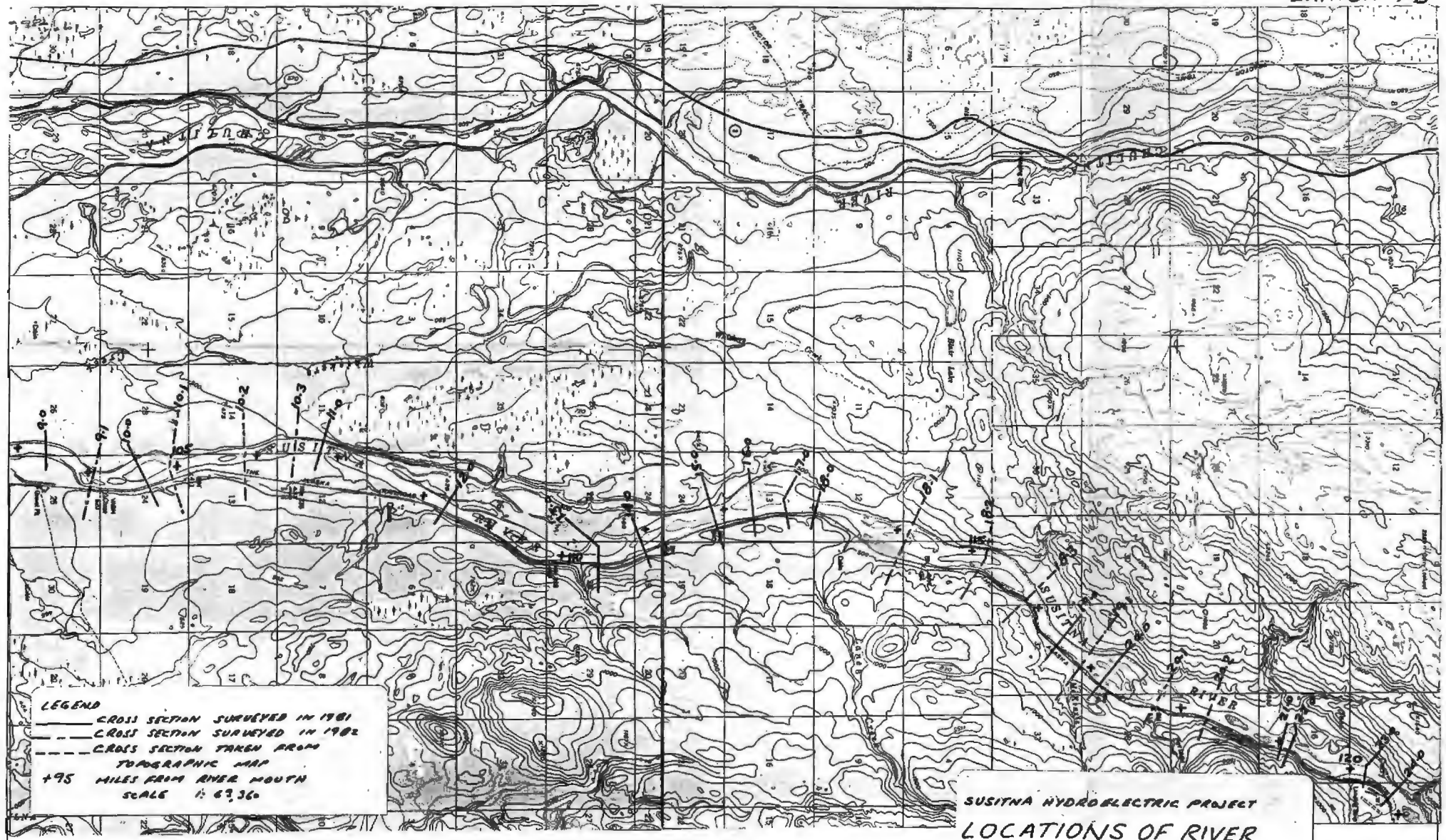
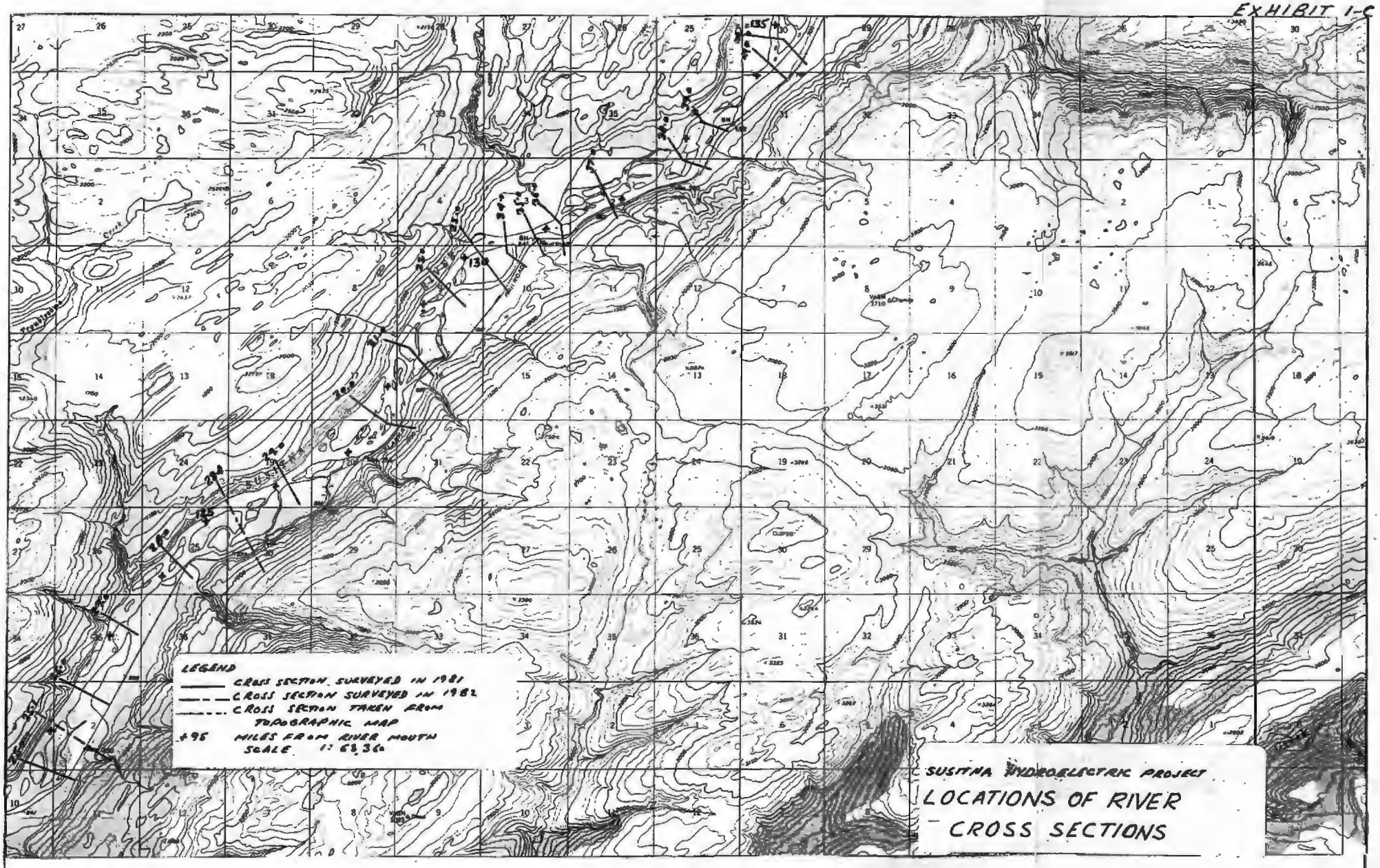

LEGEND
CROSS SECTION SURVEYED IN 1981
CROSS SECTION SURVEYED IN 1982
CROSS SECTION TAKEN FROM TOPOGRAPHIC MAP
+95 MILES FROM RIVER MOUTH
SCALE 1" = 6,336'
SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT 1-C



HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT I-D

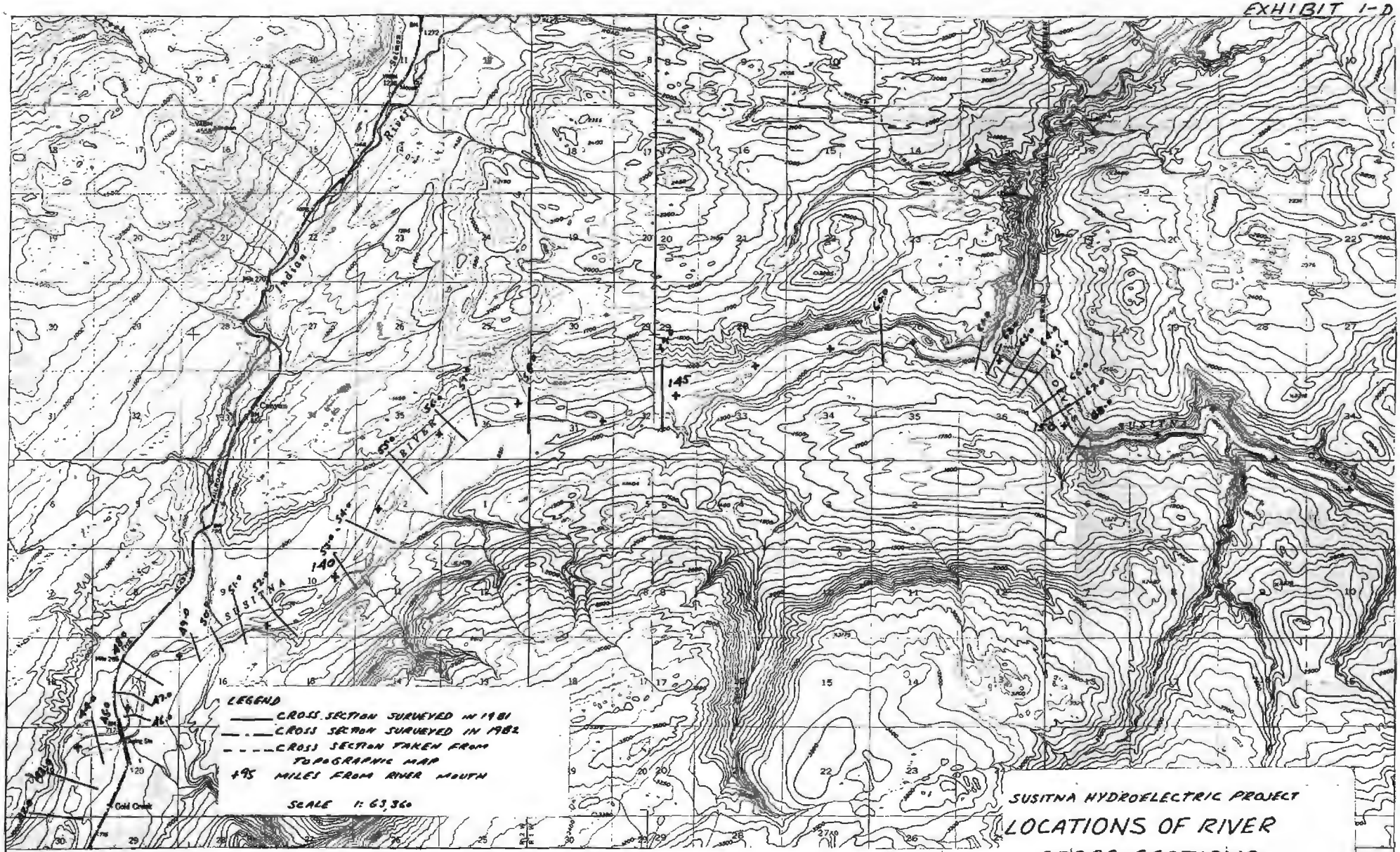
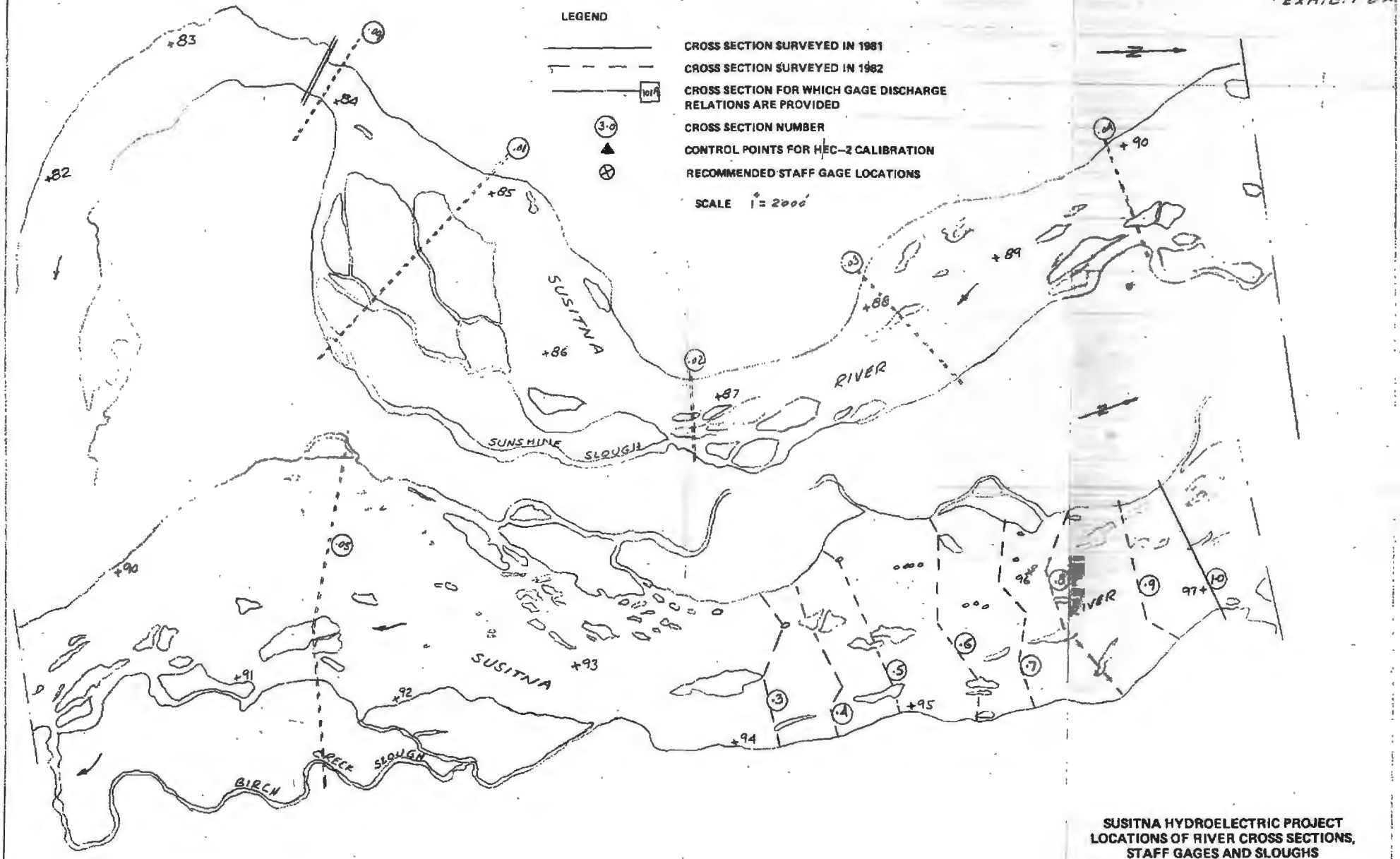

LEGEND
CROSS SECTION SURVEYED IN 1981
CROSS SECTION SURVEYED IN 1982
CROSS SECTION TAKEN FROM TOPOGRAPHIC MAP
+95 MILES FROM RIVER MOUTH
SCALE 1: 63,360
SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

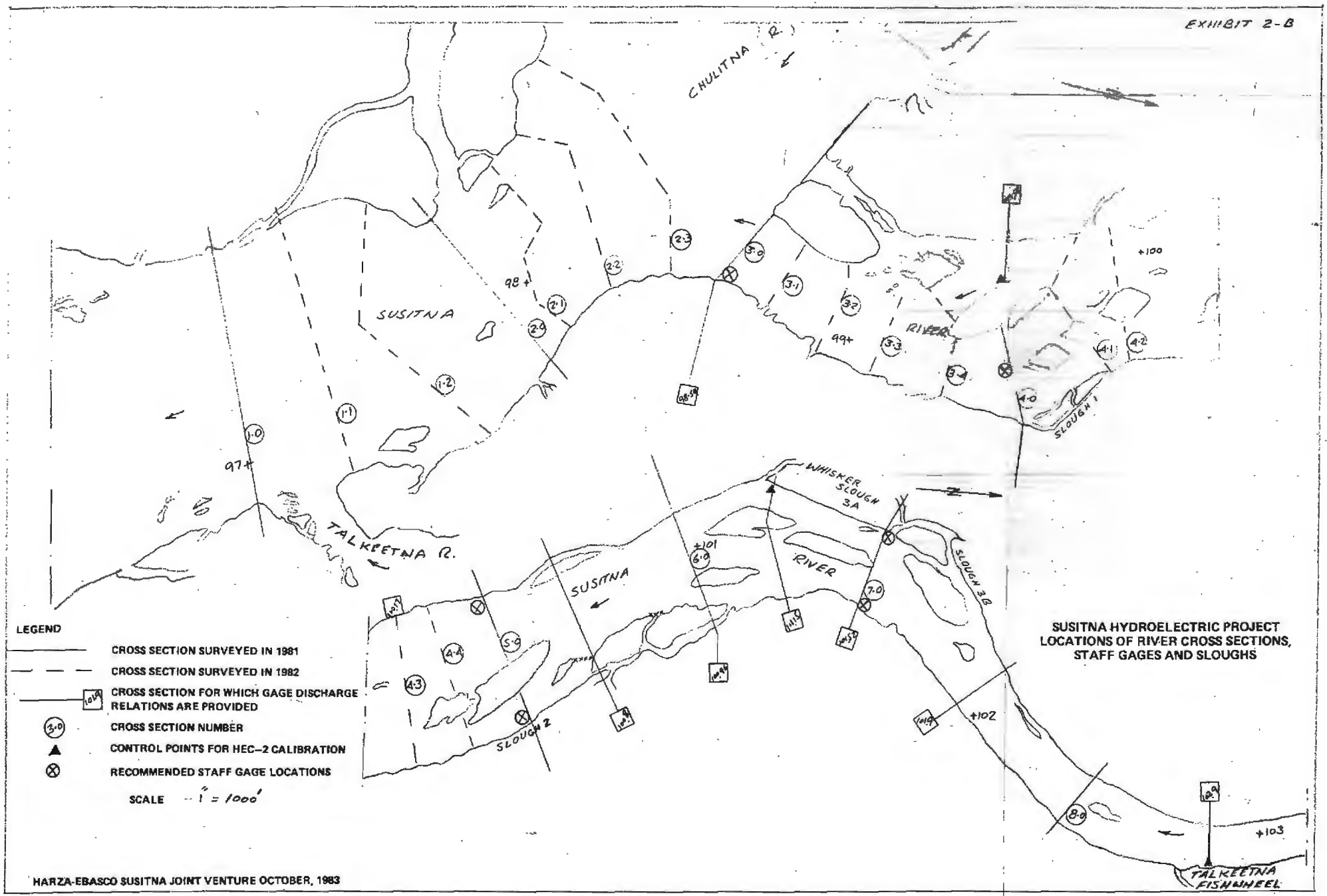
EXHIBIT 2.4



SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

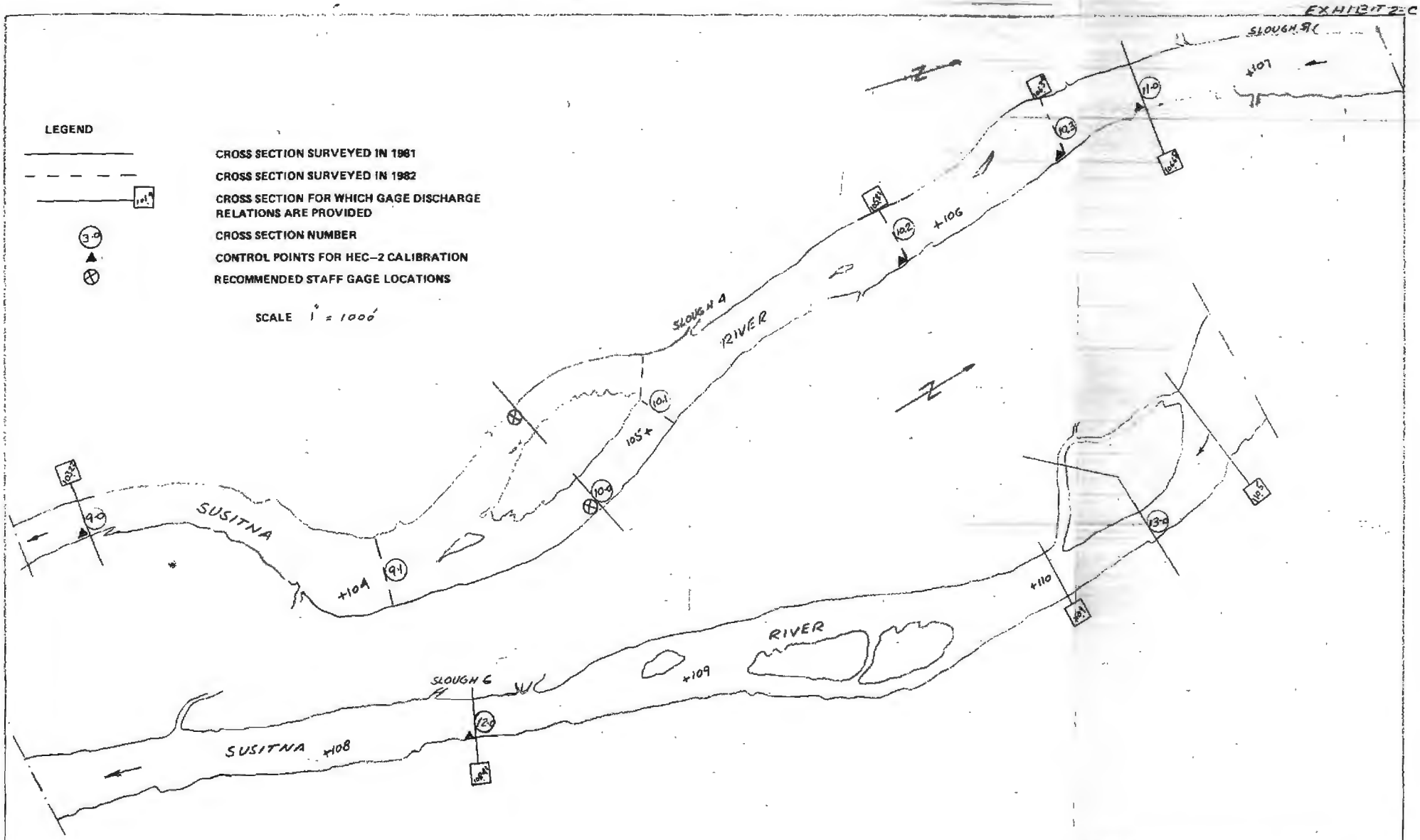
EXHIBIT 2-B



SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

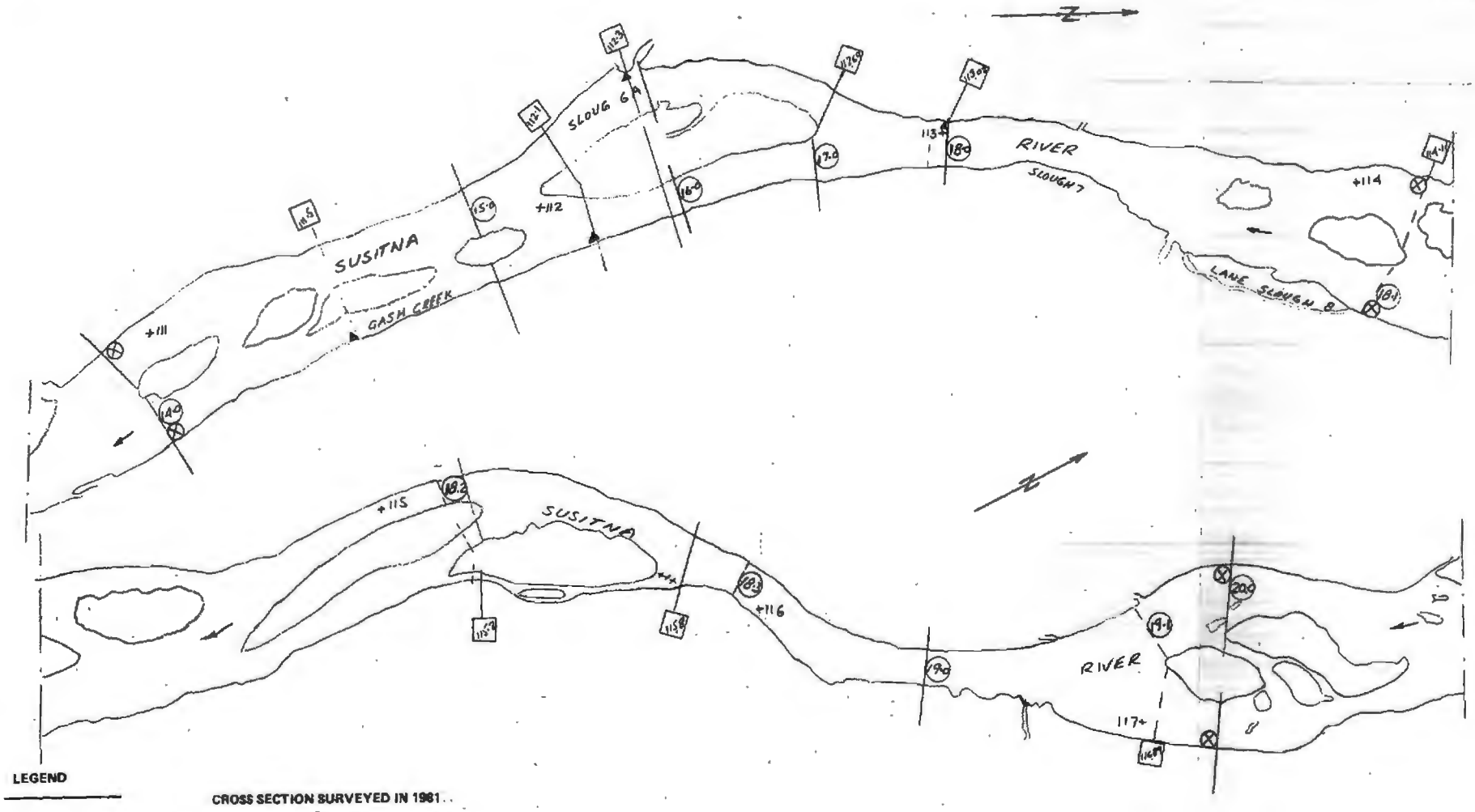
EXHIBIT 2-C



SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-D



LEGEND

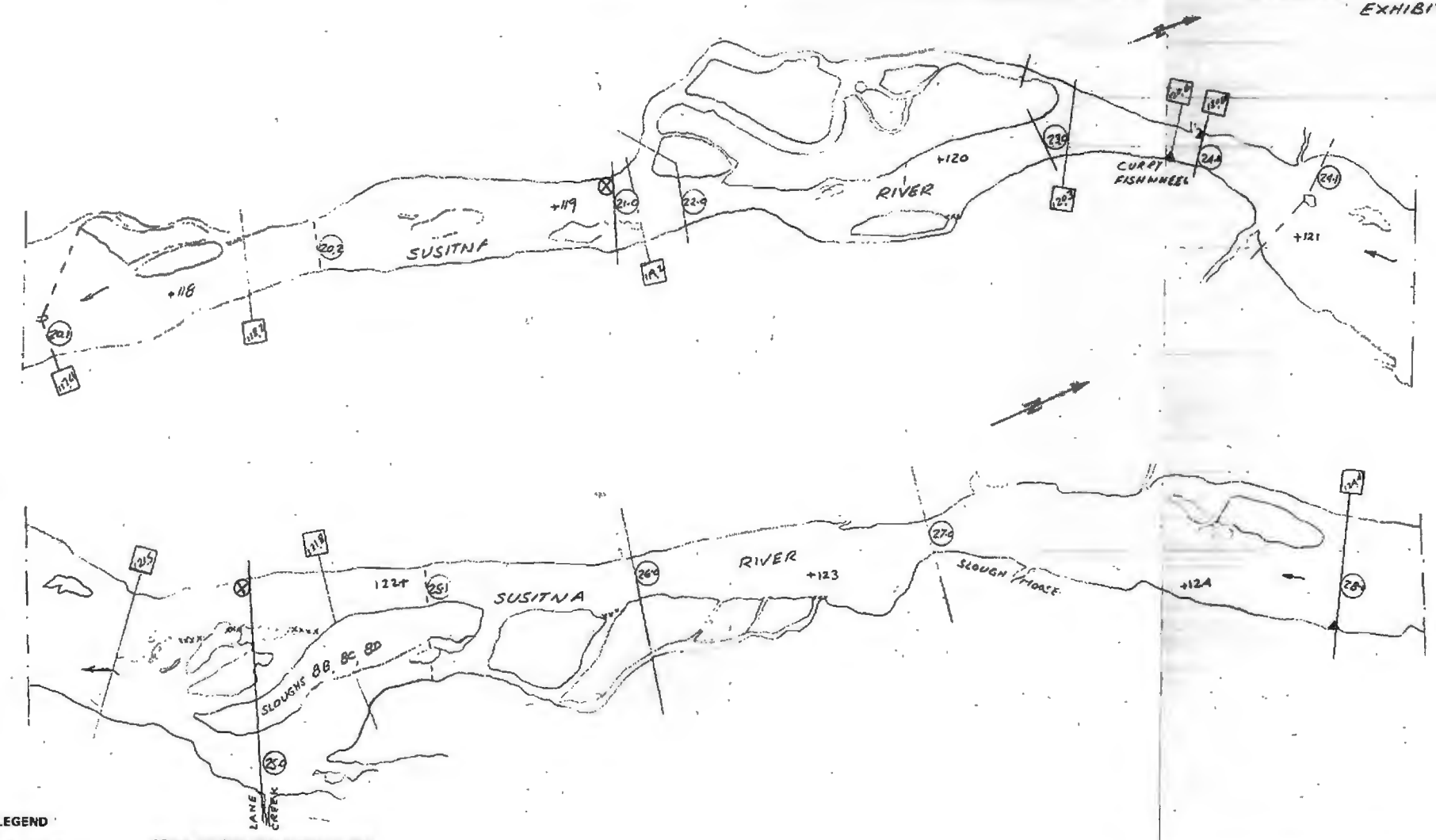
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- CROSS SECTION NUMBER
- CONTROL POINTS FOR HEC–2 CALIBRATION
- RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-E



LEGEND

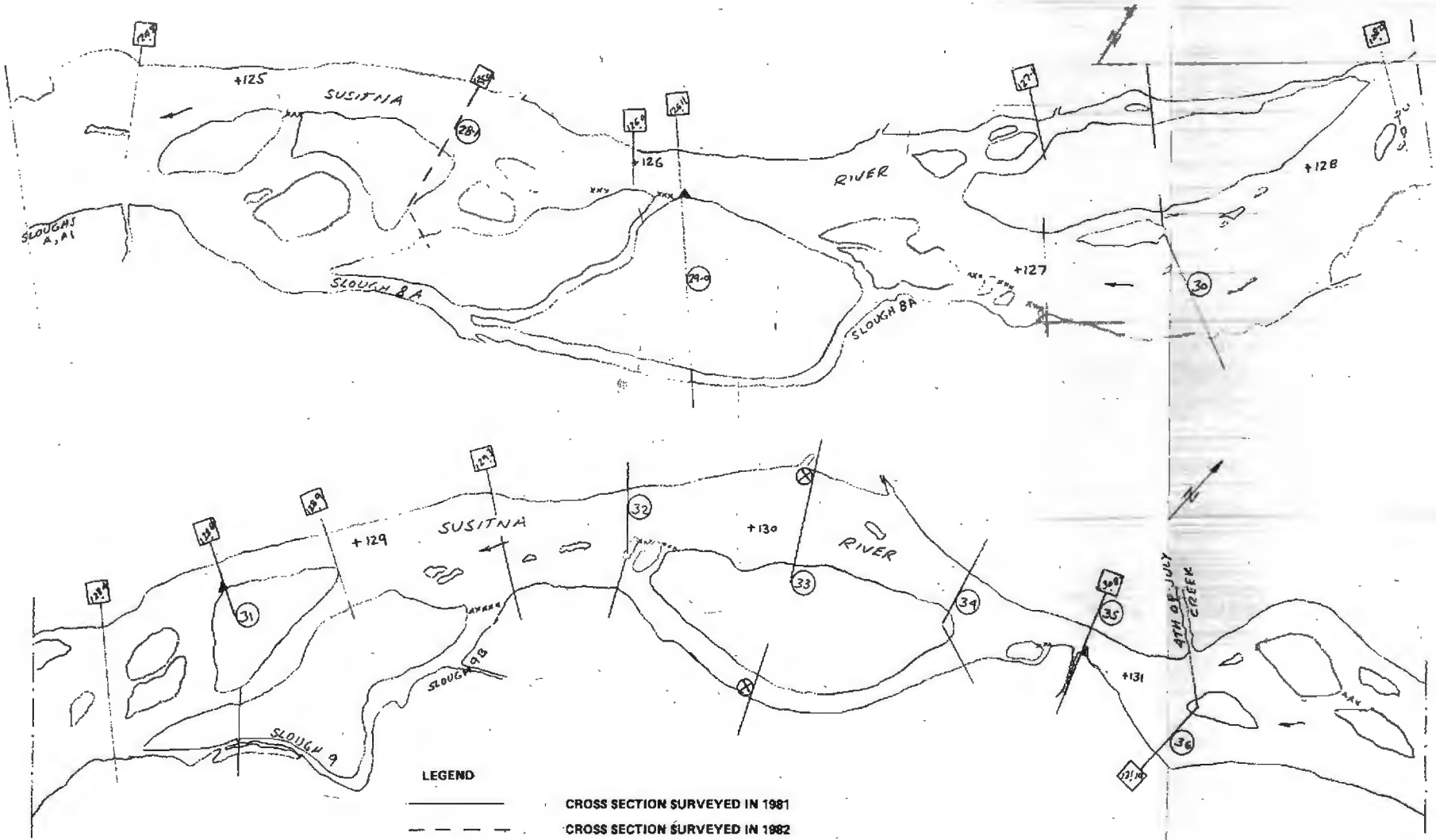
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- CROSS SECTION NUMBER
- CONTROL POINTS FOR HEC–2 CALIBRATION
- RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-F



LEGEND

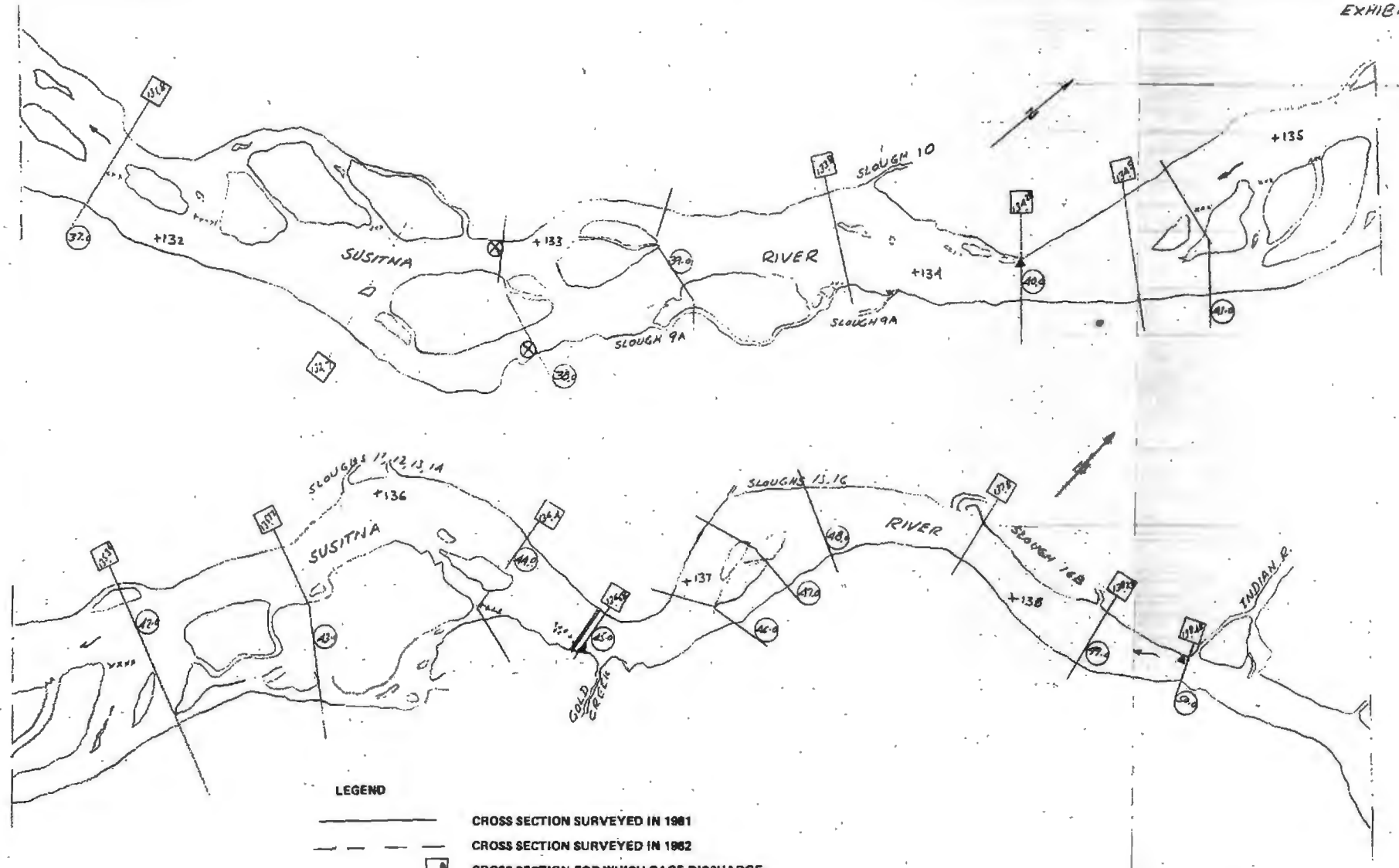
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- (3.0) CROSS SECTION NUMBER
- ▲ CONTROL POINTS FOR HEC-2 CALIBRATION
- ⊗ RECOMMENDED STAFF GAGE LOCATIONS

SCALE — 1" = 1000'

SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983.

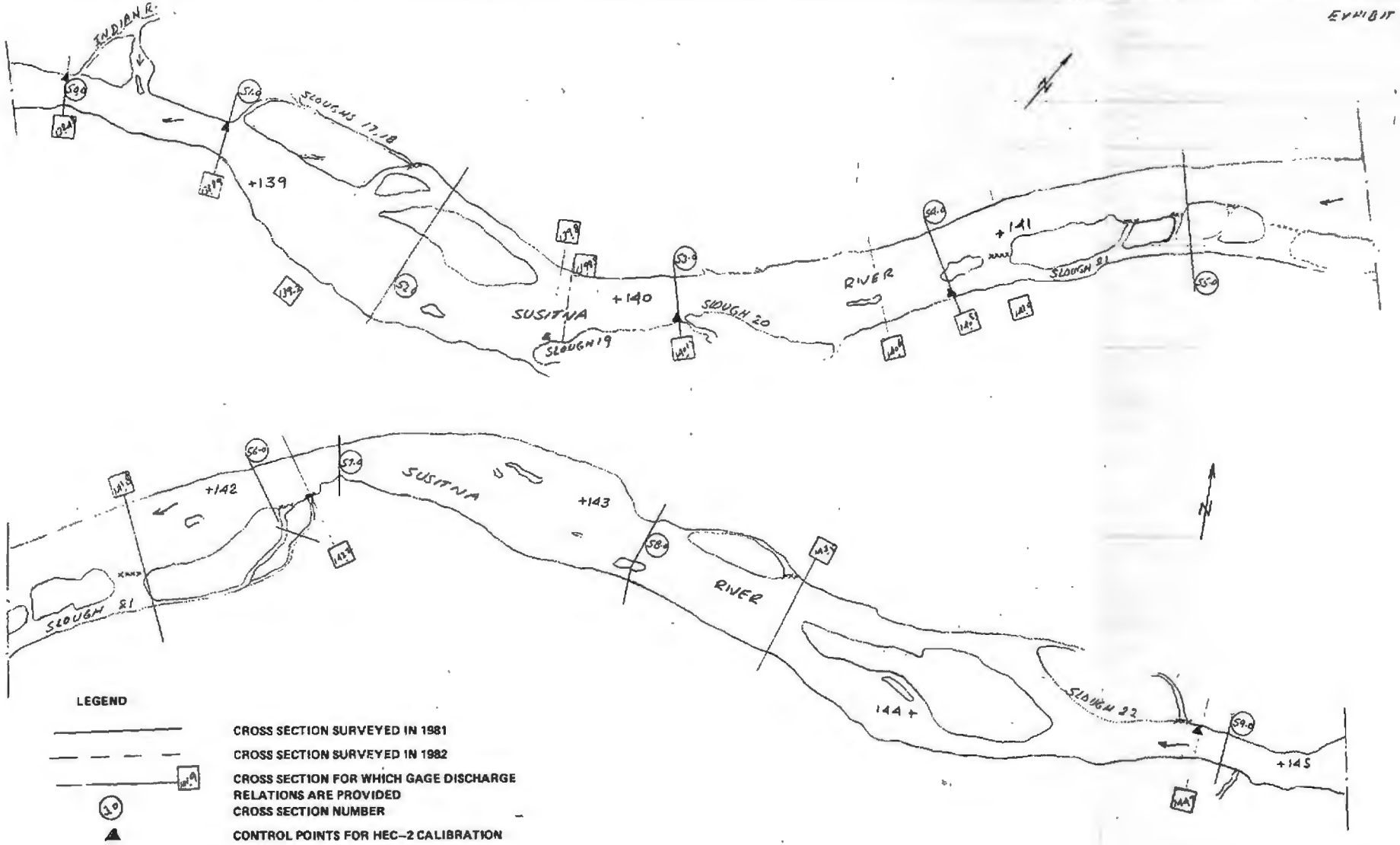
EXHIBIT 2-G



SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS,
STAFF GAGES AND SLOUGHS

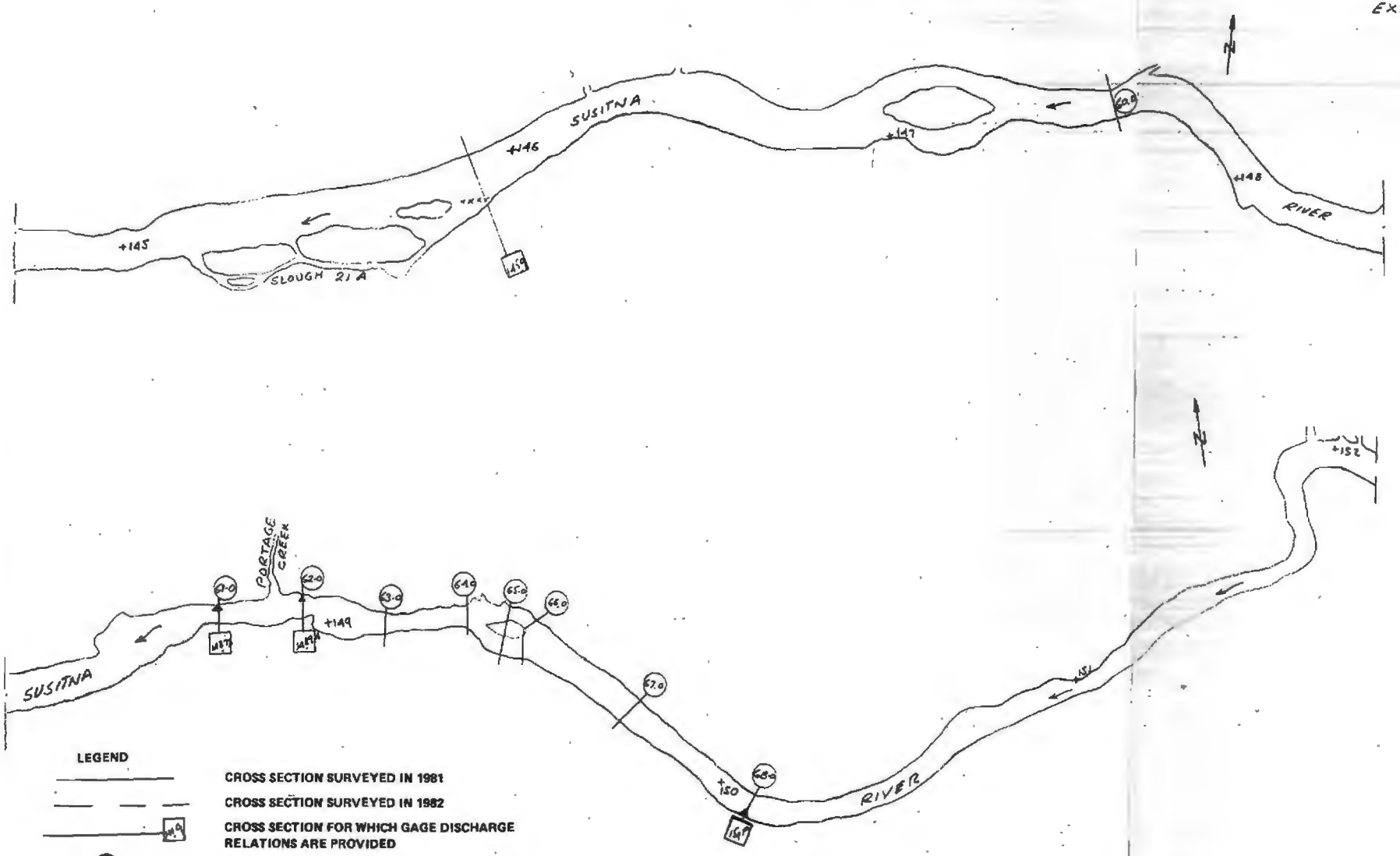
HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-H



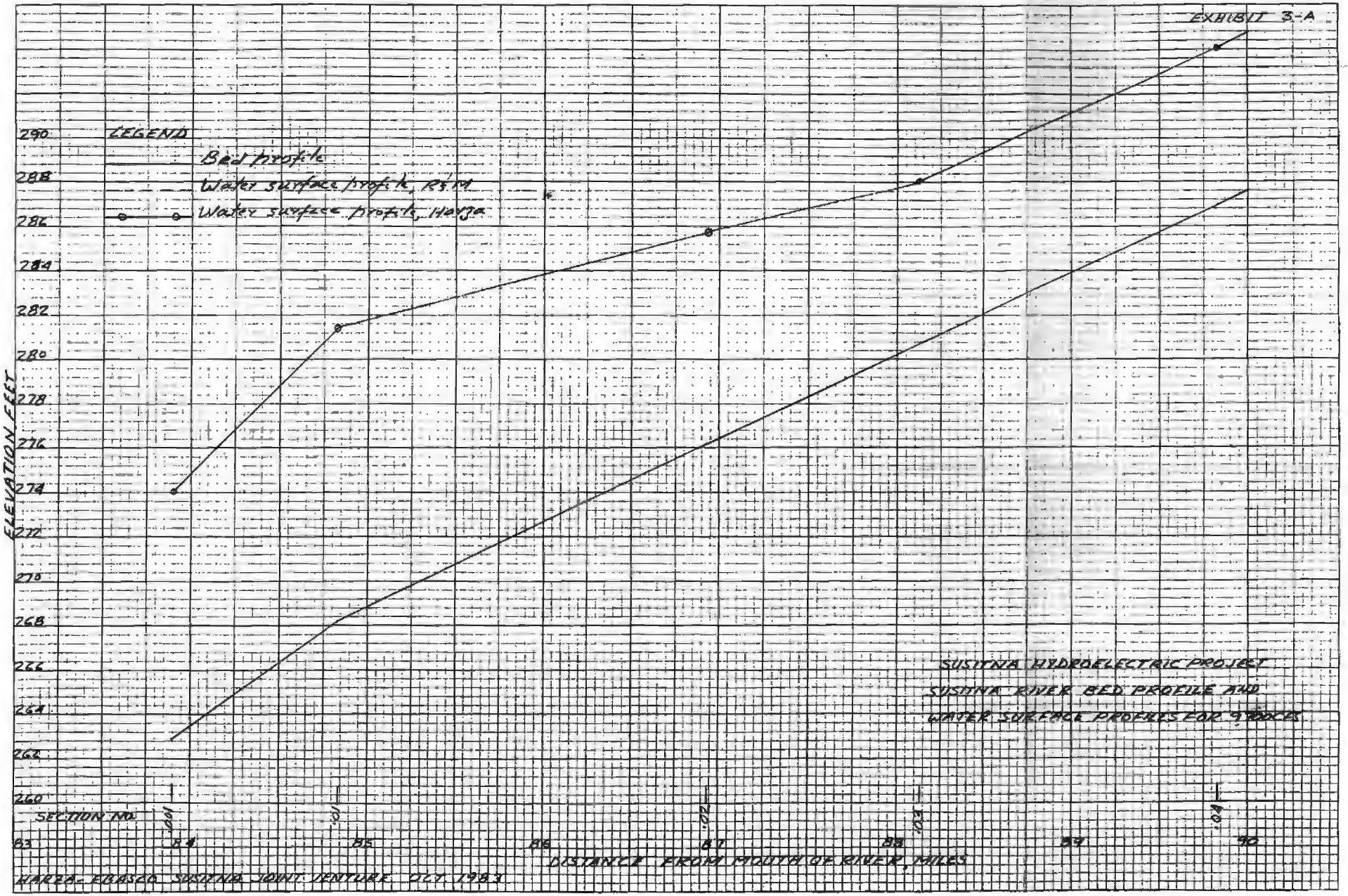
SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

EXHIBIT 2-I



SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS, STAFF GAGES AND SLOUGHS

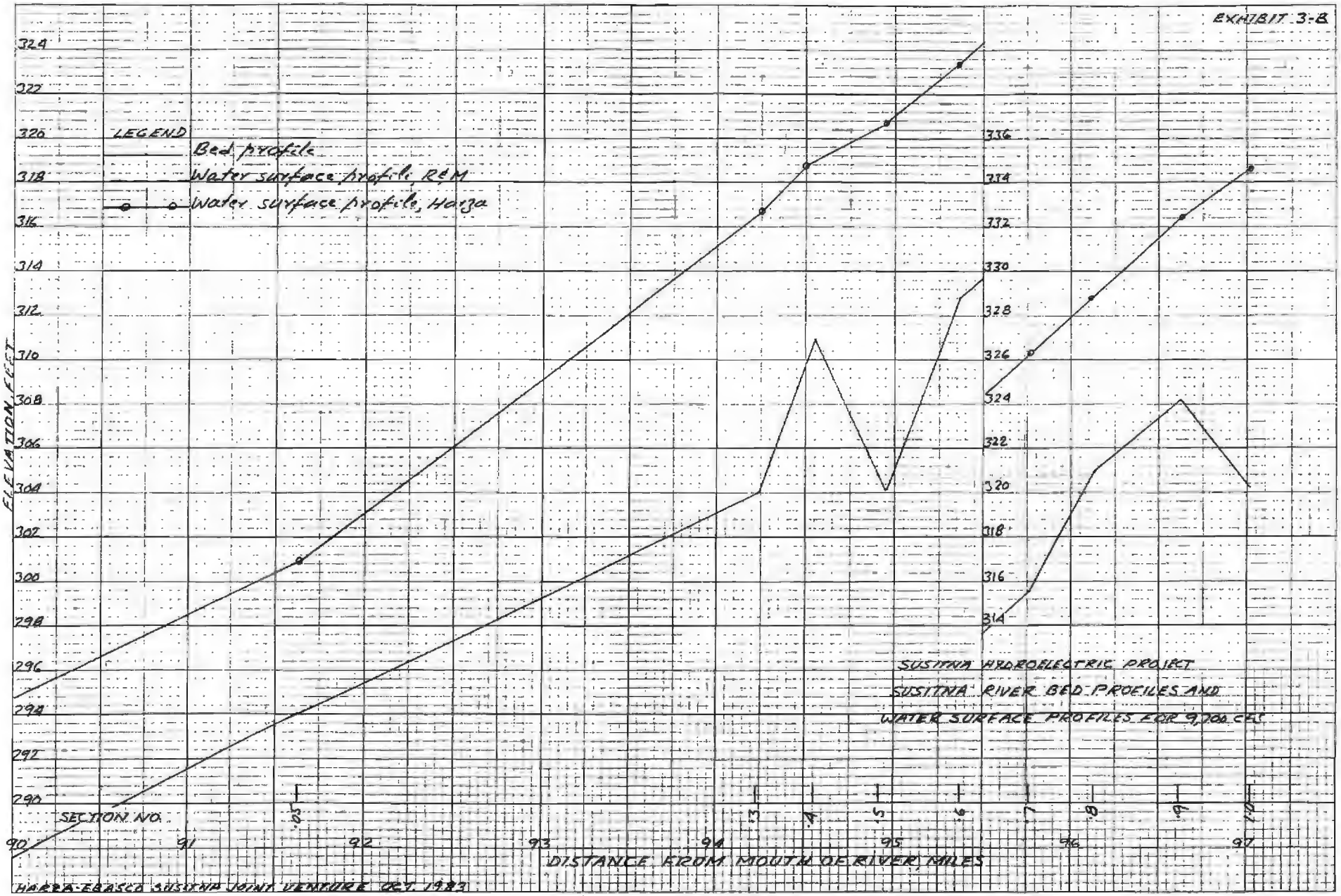
EXHIBIT 3-A



SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9 REACHES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT 1983

EXHIBIT 3-8



SUSITNA HYDROELECTRIC PROJECT

SUSITNA RIVER BED PROFILES AND

WATER SURFACE PROFILES FOR 9,700 CFS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT 3-C

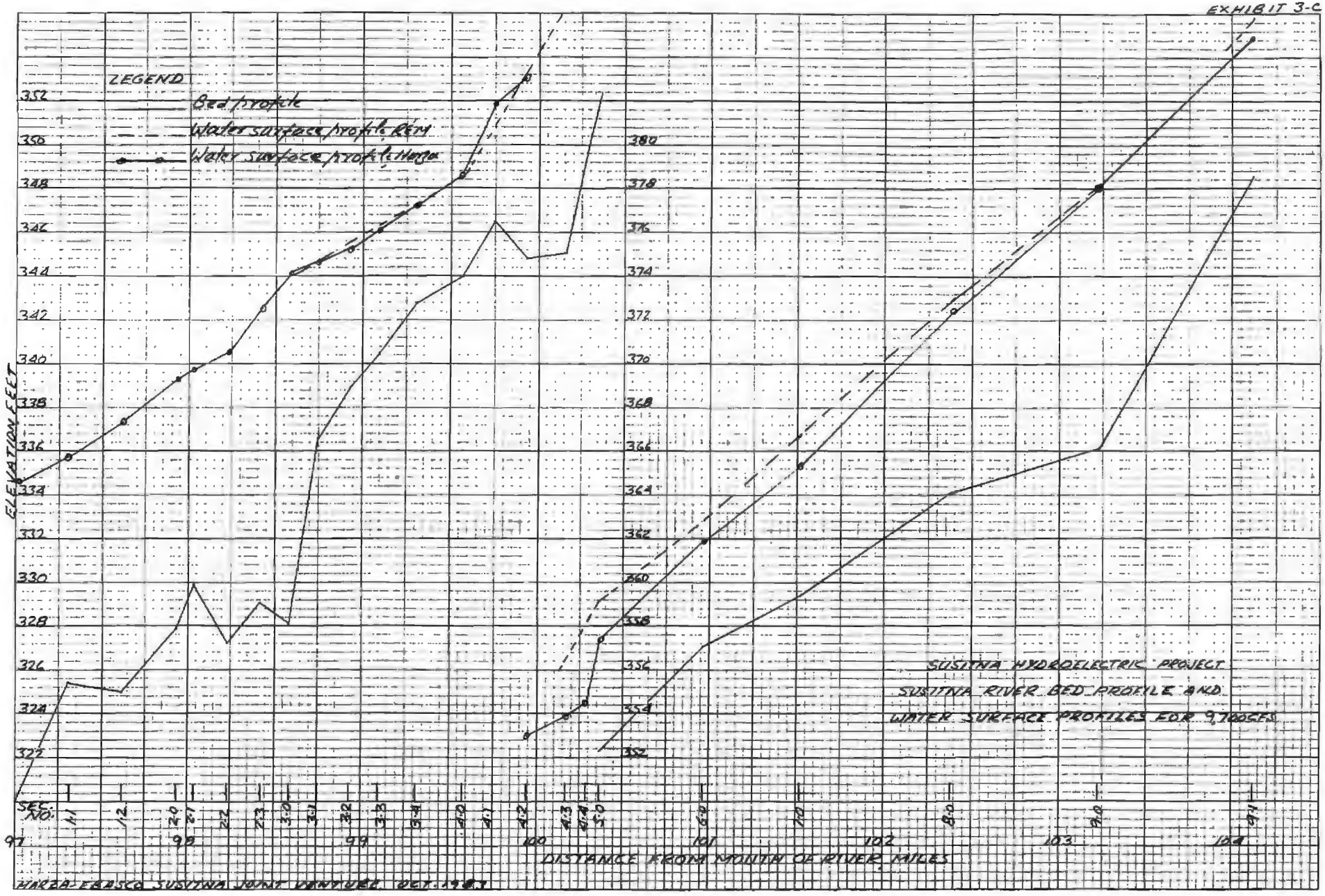
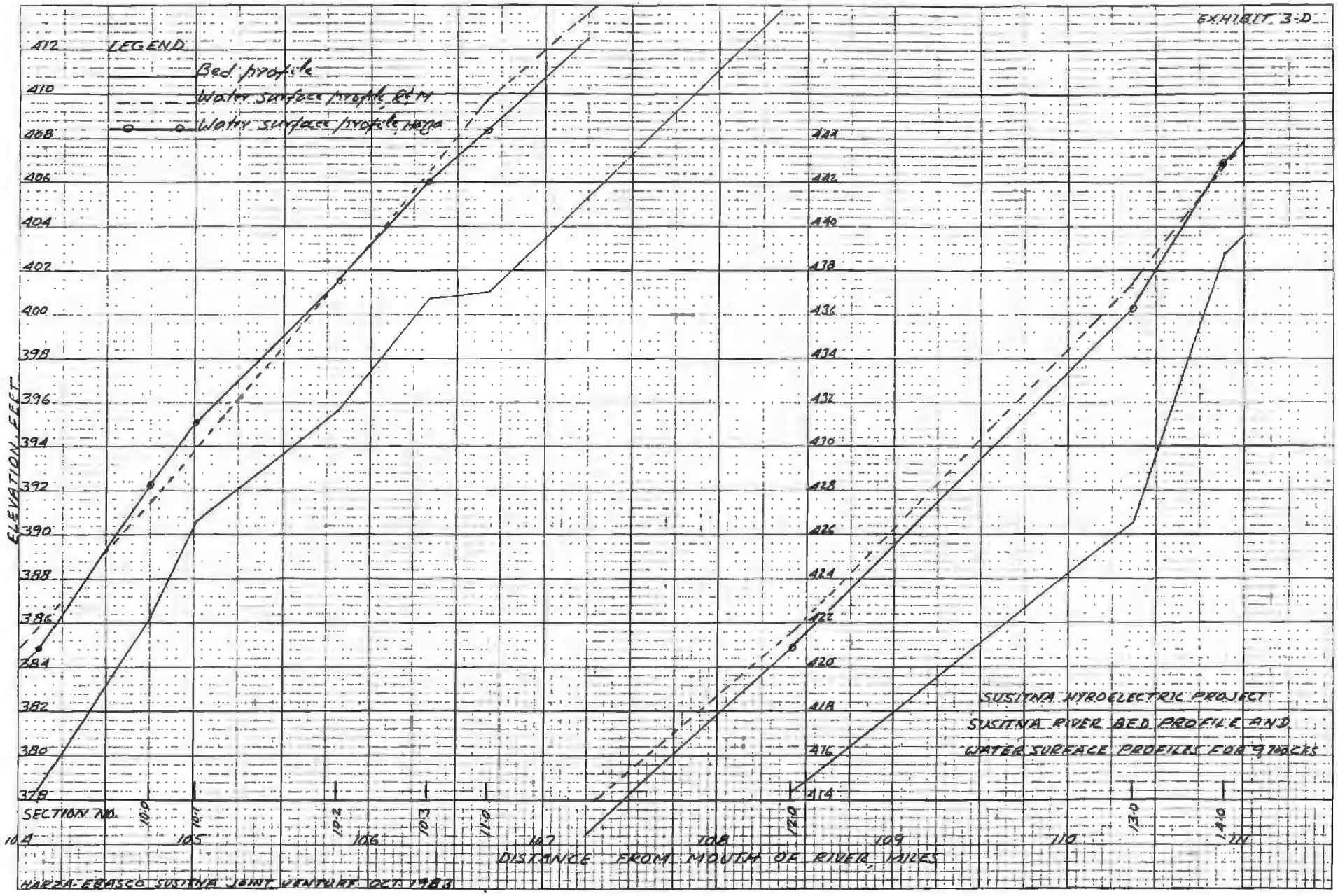

LEGEND
Bed profile
Water surface profile, EOR
Water surface profile, Mean
ELEVATION FEET
352
350
348
346
344
342
340
338
336
334
332
330
328
326
324
322
380
378
376
374
372
370
368
366
364
362
360
358
356
354
352
SEC. NO.
1.1
1.2
2.0
2.1
2.2
2.3
3.0
3.1
3.2
3.3
3.4
4.0
4.1
4.2
4.3
4.4
5.0
6.0
7.0
8.0
9.0
97
98
99
100
101
102
103
104
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9,700 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE, DEC. 1983

EXHIBIT 3-D


LEGEND
Bed profile
Water surface profile, RFM
Water surface profile, HEC2
ELEVATION, FEET
412
410
408
406
404
402
400
398
396
394
392
390
388
386
384
382
380
378
SECTION NO.
104
105
106
107
108
109
110
111
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9 FLOWS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT 1983

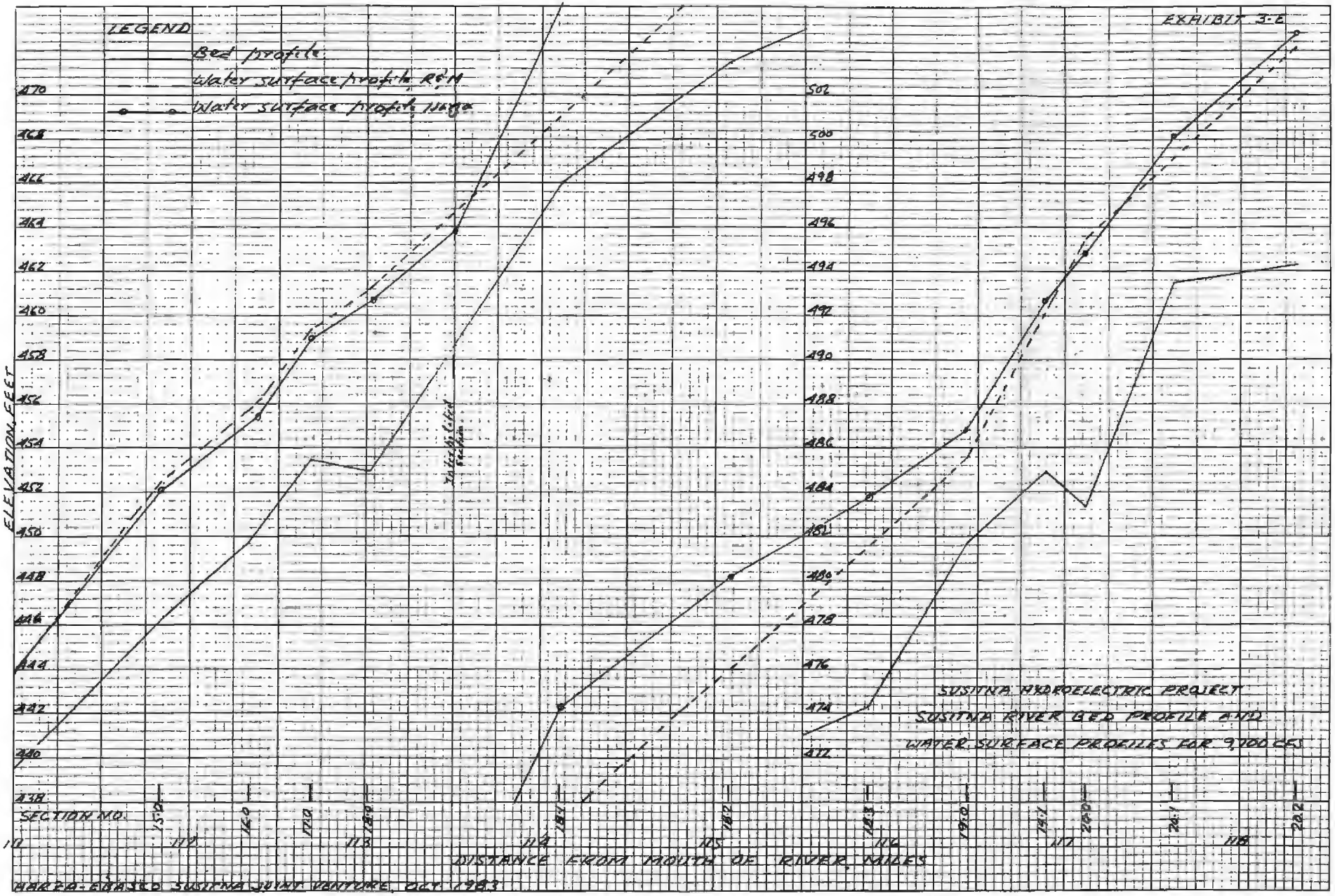


EXHIBIT 3-E
LEGEND
Bed profile
Water surface profile R&M
Water surface profile USGS
ELEVATION, FEET
SECTION NO.
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9,100 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE, OCT 1983

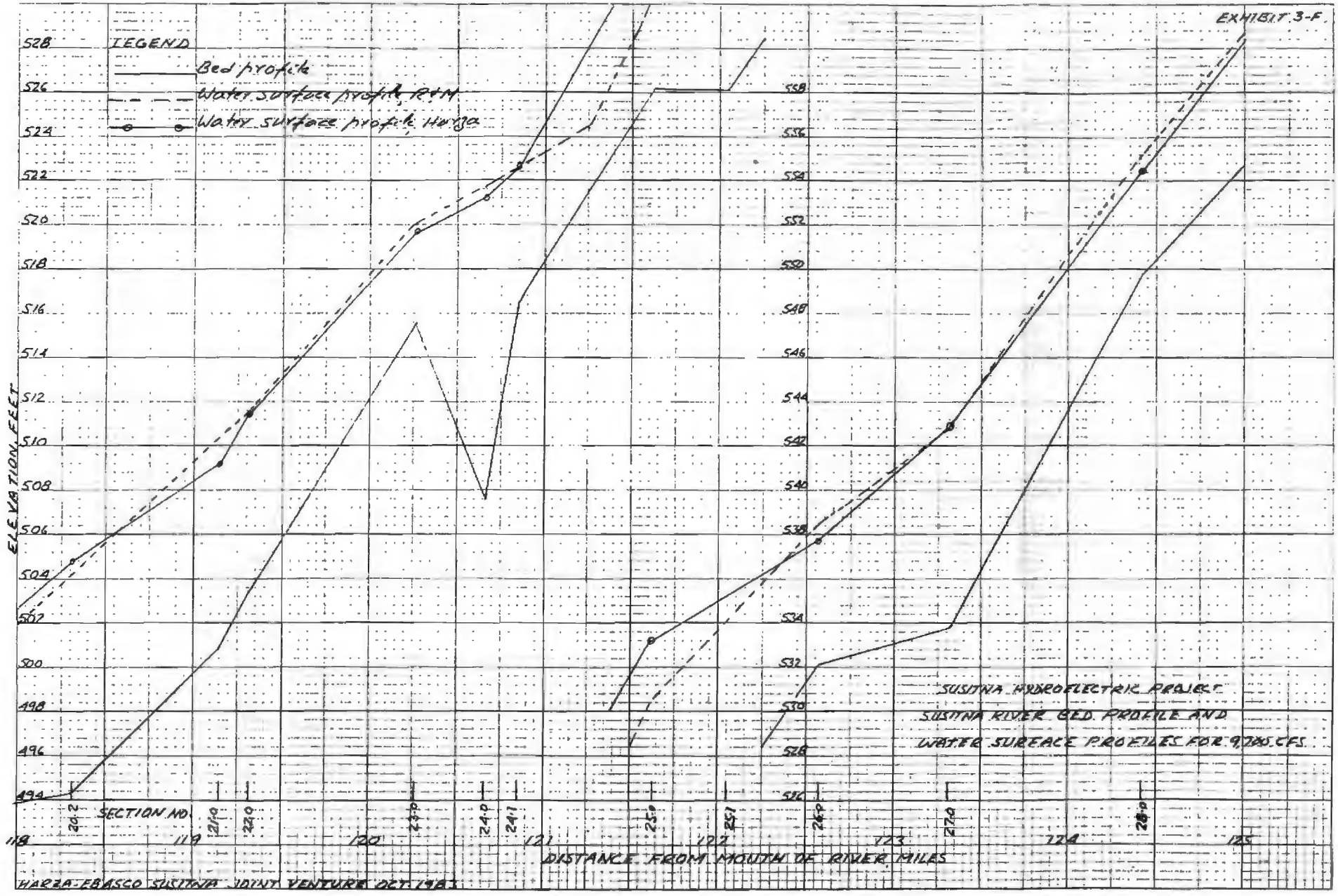


EXHIBIT 3-F
LEGEND
Bed profile
Water surface profile, 12 M
Water surface profile, Harza
ELEVATION, FEET
528
526
524
522
520
518
516
514
512
510
508
506
504
502
500
498
496
494
558
556
554
552
550
548
546
544
542
540
538
536
534
532
530
528
526
SECTION NO.
119
120
121
122
123
124
125
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9,735 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT 1983

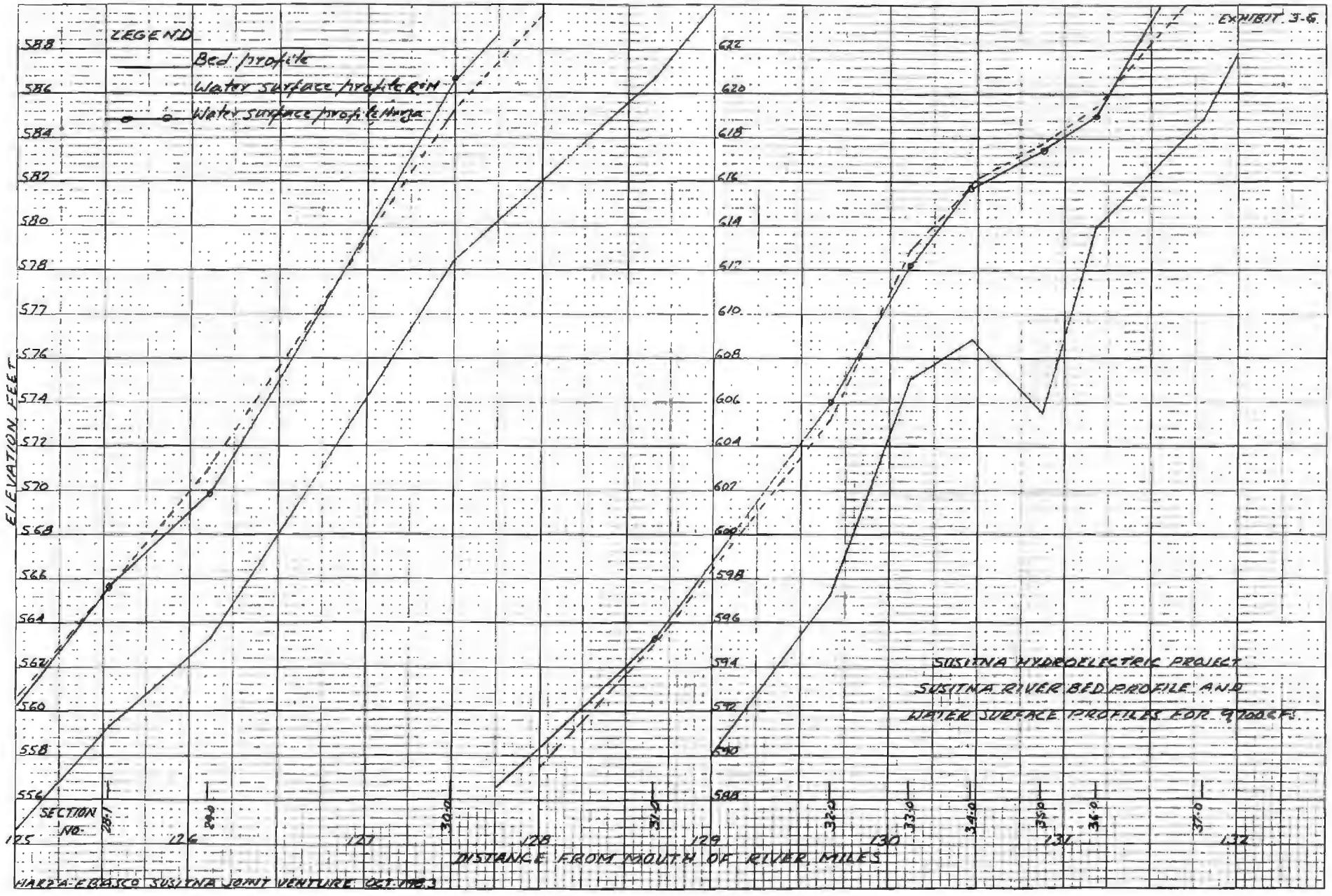


EXHIBIT 3-6
LEGEND
Bed profile
Water surface profile RIM
Water surface profile Nenana
ELEVATION FEET
588
586
584
582
580
578
577
576
574
572
570
568
566
564
562
560
558
556
622
620
618
616
614
612
610
608
606
604
602
600
598
596
594
592
590
588
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9000 CFS
SECTION NO.
125
126
127
128
129
130
131
132
INSTANCE FROM MOUTH OF RIVER, MILES
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

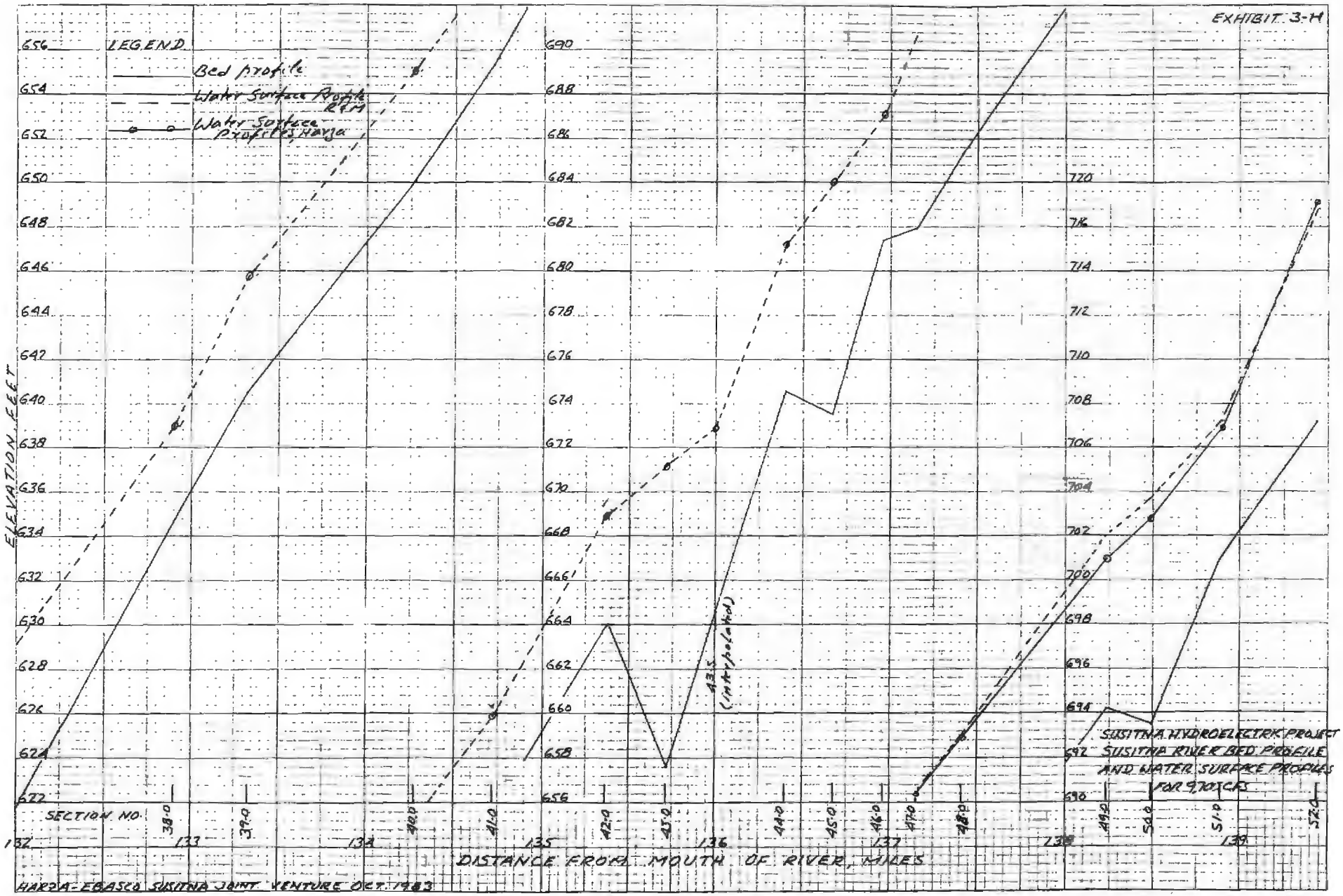
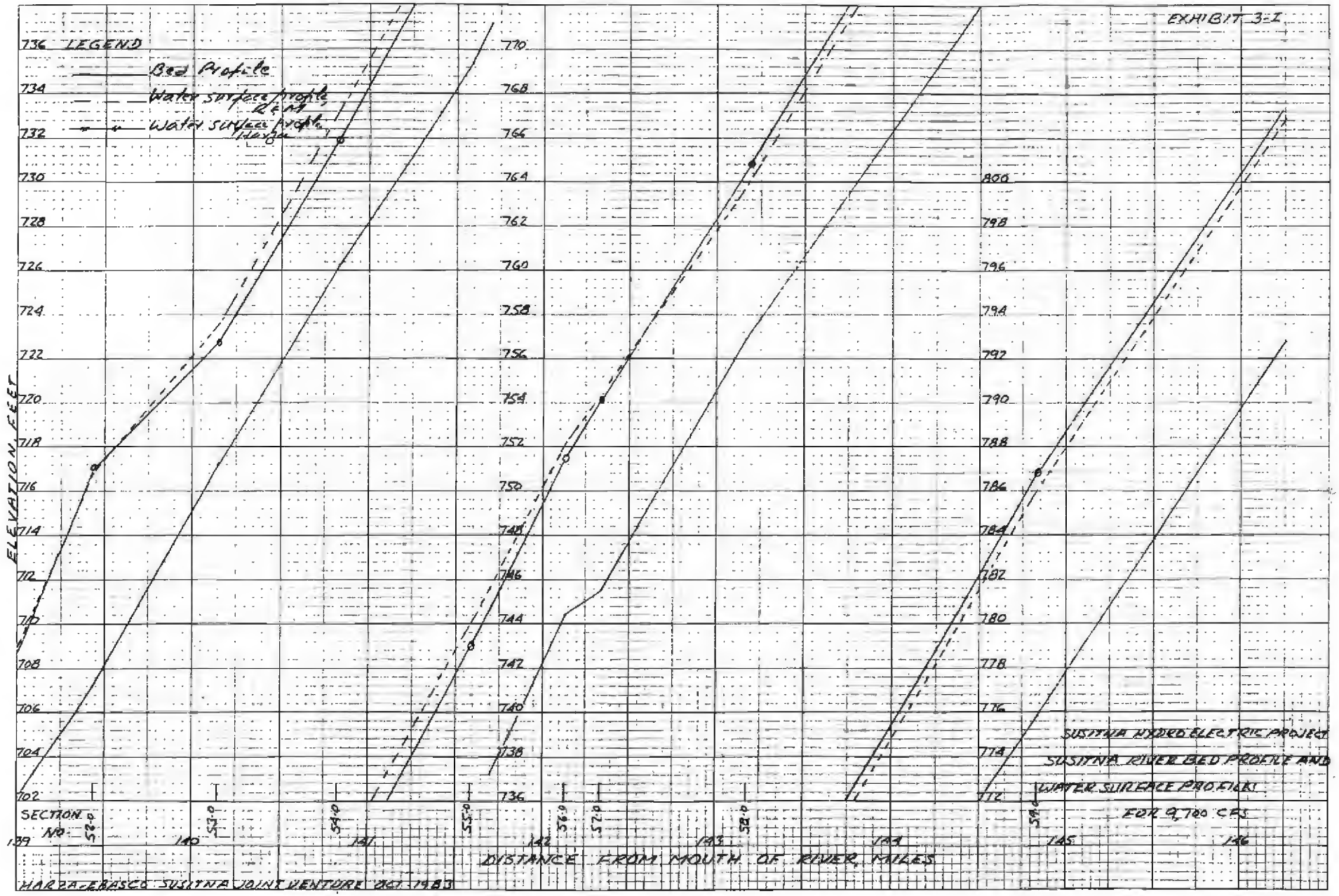


EXHIBIT 3-H
LEGEND
Bed Profile
Water Surface Profile RFM
Water Surface Profiles Harza
ELEVATION FEET
656
654
652
650
648
646
644
642
640
638
636
634
632
630
628
626
624
622
690
688
686
684
682
680
678
676
674
672
670
668
666
664
662
660
658
656
720
718
716
714
712
710
708
706
704
702
700
698
696
694
692
690
SECTION NO.
38.0
39.0
40.0
41.0
42.0
43.0
43.5 (interpolated)
44.0
45.0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
132
133
134
135
136
137
138
139
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND WATER SURFACE PROFILES FOR 9,700 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

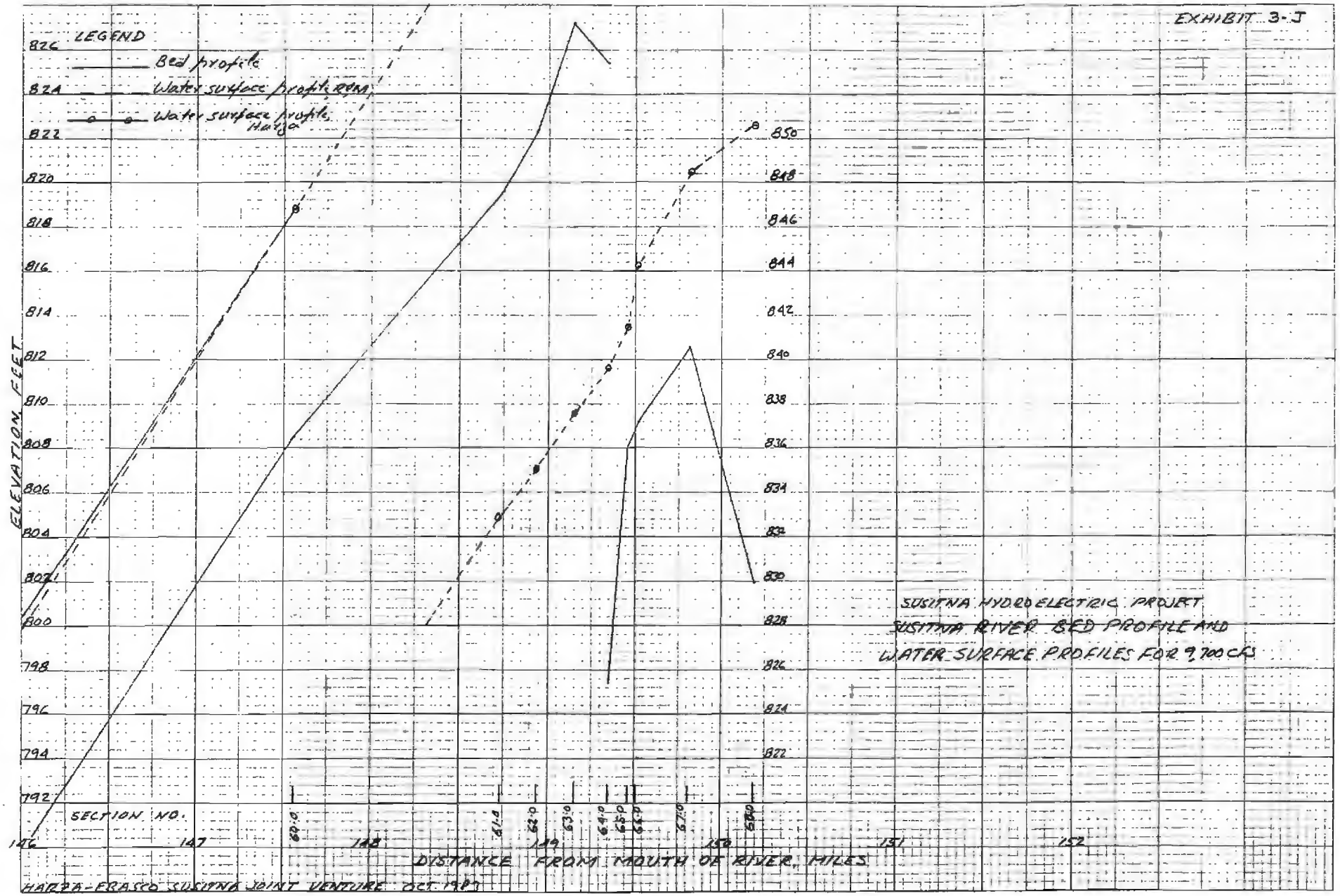
EXHIBIT 3-I



SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND WATER SURFACE PROFILES FOR 9,780 CFS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT 1983

EXHIBIT 3-J


LEGEND
Bed profile
Water surface profile, RSHA
Water surface profile, Harza
ELEVATION, FEET
826
824
822
820
818
816
814
812
810
808
806
804
802
800
798
796
794
792
850
848
846
844
842
840
838
836
834
832
830
828
826
824
822
SECTION NO.
146
147
148
149
150
151
152
60.0
61.0
62.0
63.0
64.0
65.0
66.0
67.0
68.0
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9,700 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1982

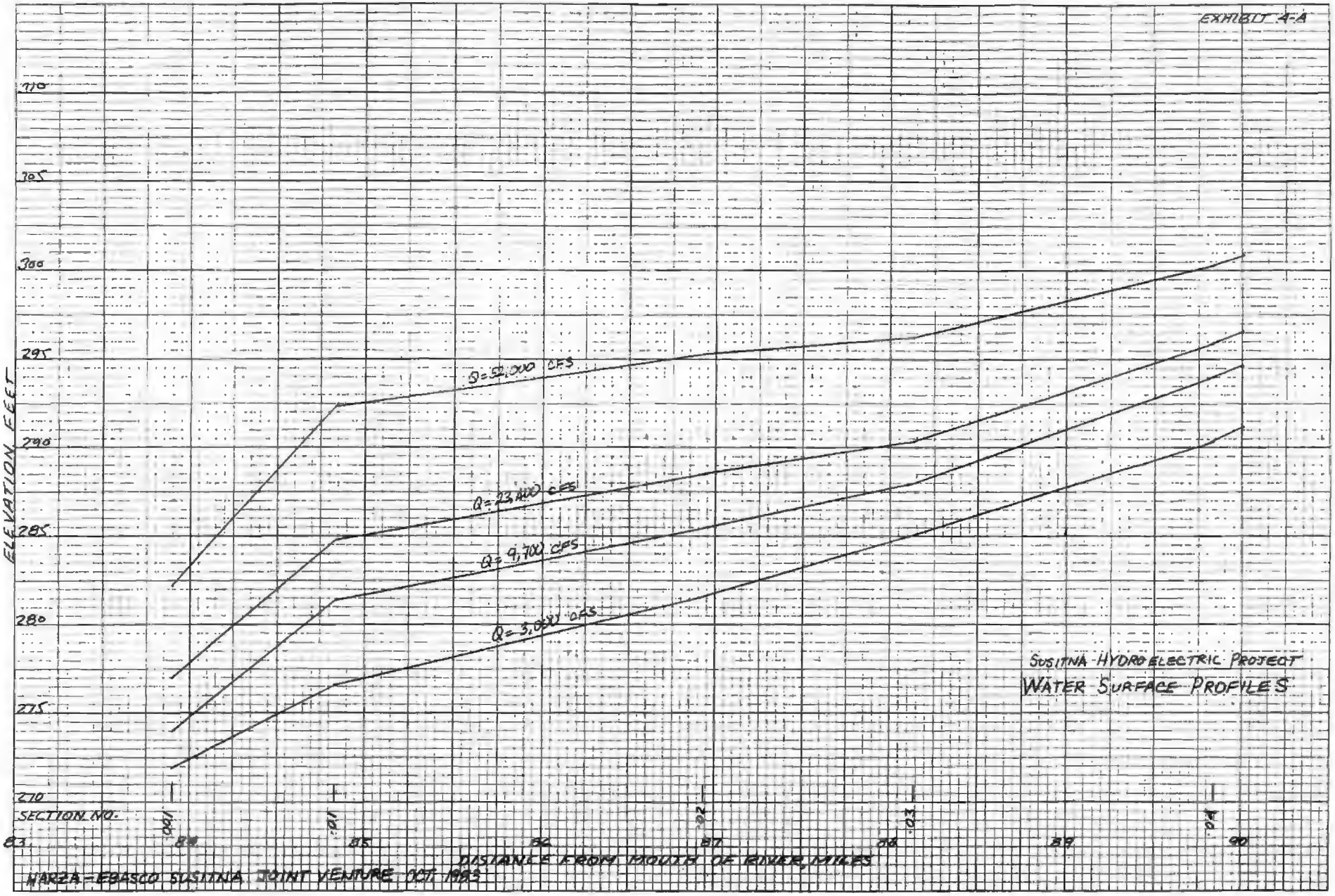


EXHIBIT 4-A
ELEVATION, FEET
310
305
300
295
290
285
280
275
270
Q=52,000 CFS
Q=23,400 CFS
Q=9,700 CFS
Q=3,000 CFS
SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES
SECTION NO.
84
85
86
87
88
89
90
DISTANCE FROM MOUTH OF RIVER, MILES
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1982

EXHIBIT 4-B

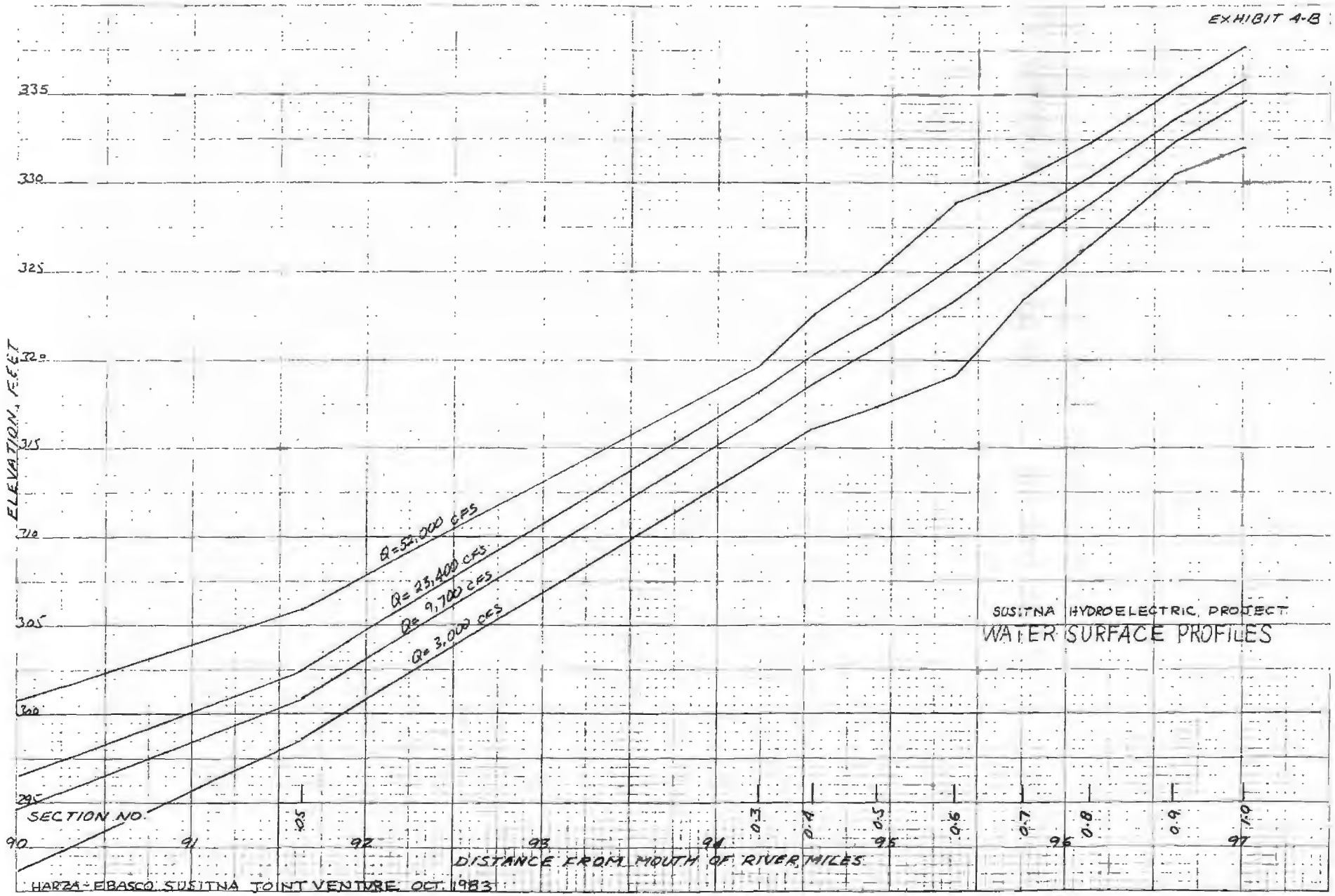

ELEVATION, FEET
335
330
325
320
315
310
305
300
295
Q=52,000 CFS
Q= 23,400 CFS
Q= 9,700 CFS
Q= 3,000 CFS
SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES
SECTION NO.
90
91
92
93
94
95
96
97
0.5
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
DISTANCE FROM MOUTH OF RIVER, MILES
HARZA-EBASCO SUSITNA JOINT VENTURE, OCT. 1983

EXHIBIT A-C

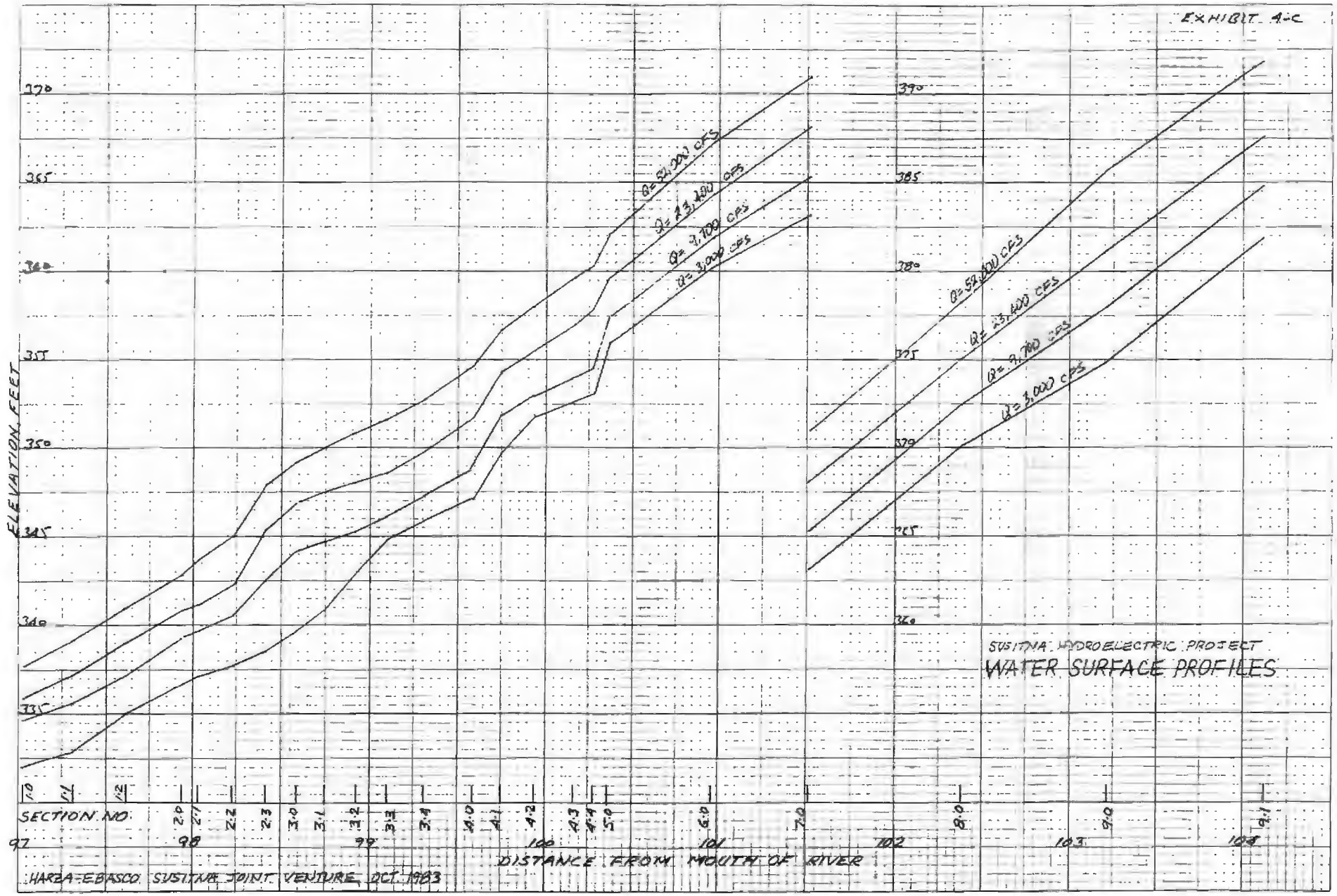
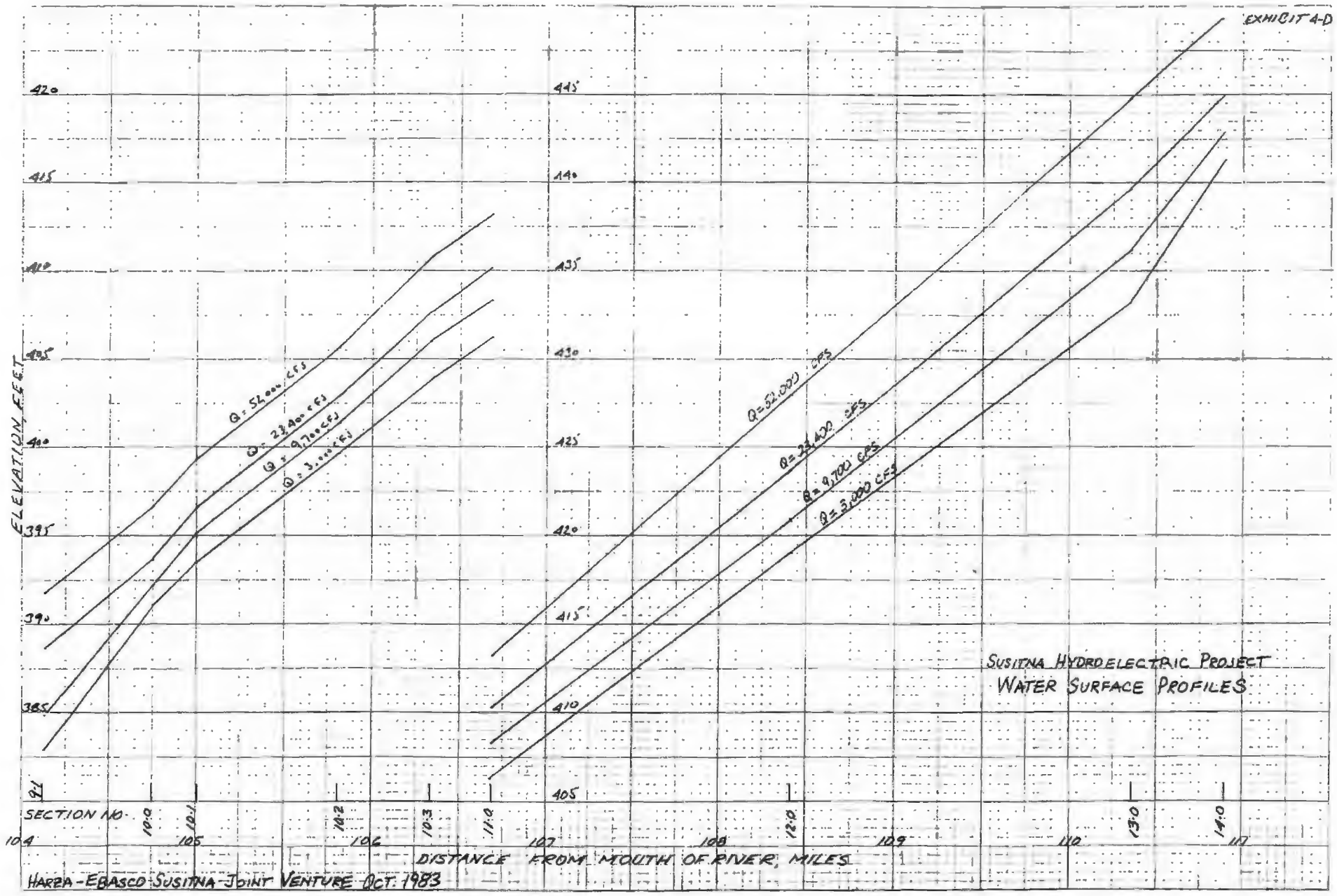

ELEVATION FEET
370
365
360
355
350
345
340
335
390
385
380
375
370
365
Q= 54,200 CFS
Q= 23,400 CFS
Q= 9,700 CFS
Q= 3,000 CFS
Q= 54,200 CFS
Q= 23,400 CFS
Q= 9,700 CFS
Q= 3,000 CFS
SECTION NO.
1.0
1.1
1.2
2.0
2.1
2.2
2.3
3.0
3.1
3.2
3.3
3.4
4.0
4.1
4.2
4.3
4.4
5.0
6.0
7.0
8.0
9.0
9.1
97
98
99
100
101
102
103
104
DISTANCE FROM MOUTH OF RIVER
HARZA-EBASCO SUSITNA JOINT VENTURE, OCT. 1983
SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

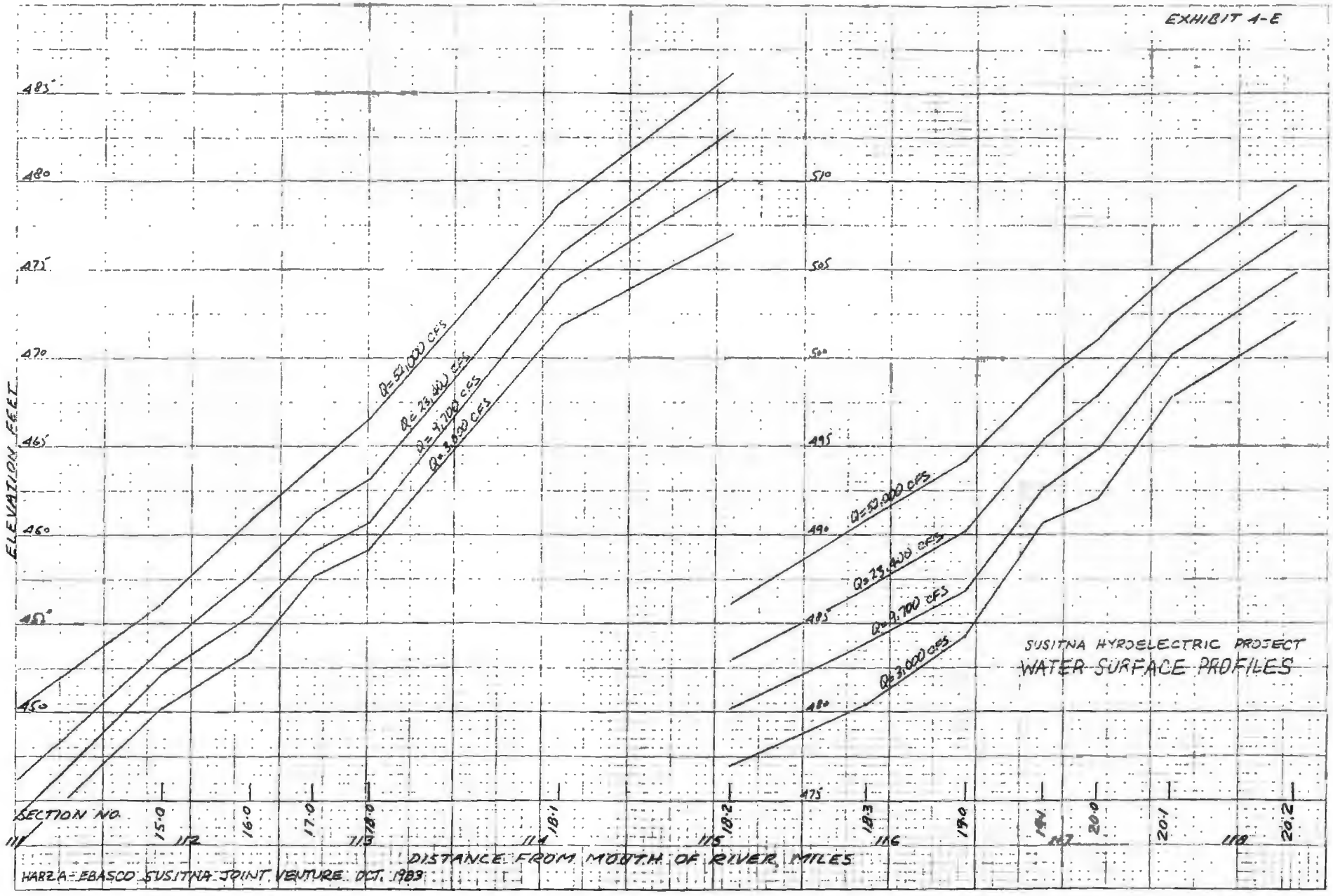
EXHIBIT 4-D



SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

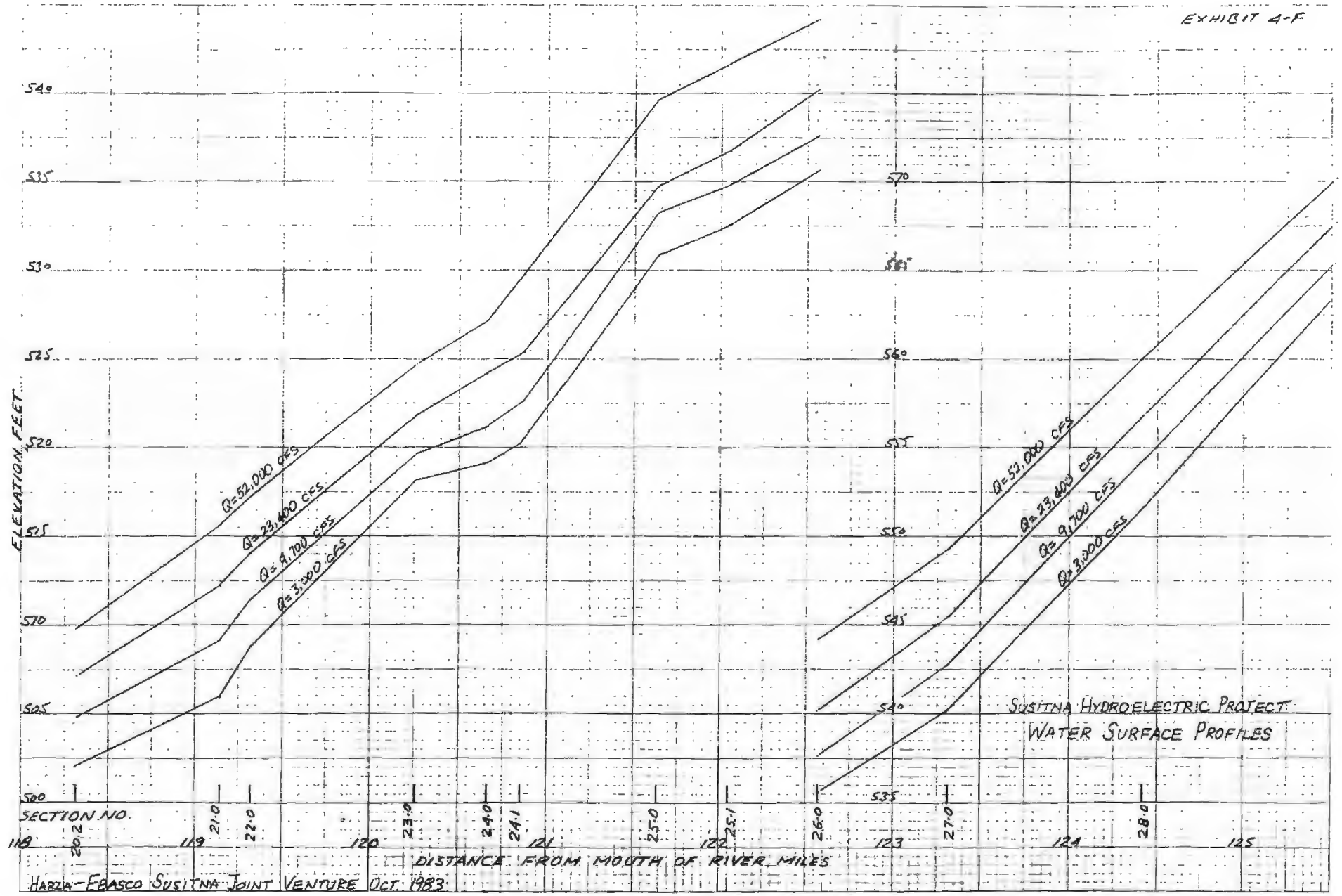
EXHIBIT 4-E



SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

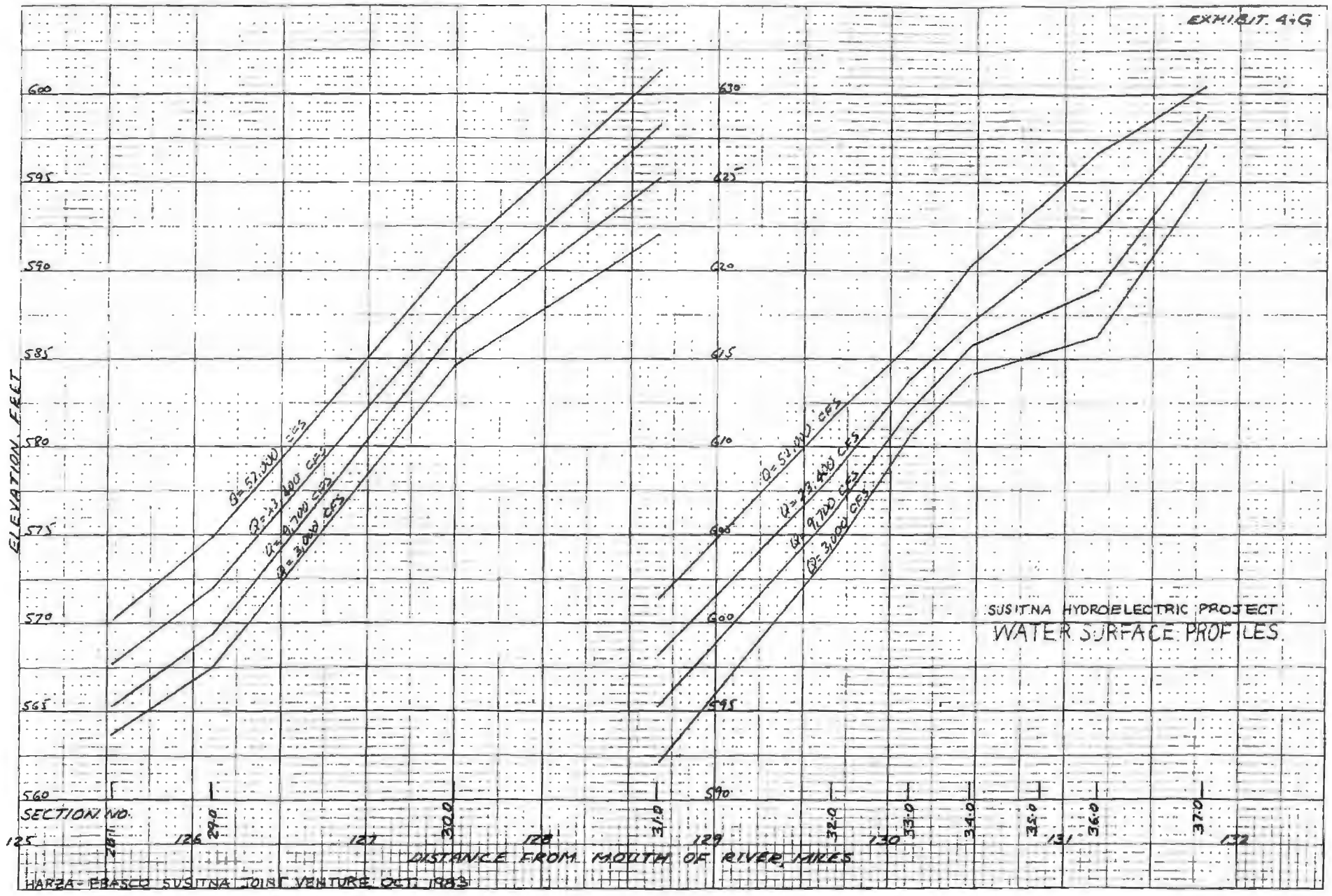
EXHIBIT 4-F



SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT 4-G



SUSITNA HYDROELECTRIC PROJECT

WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT A-H

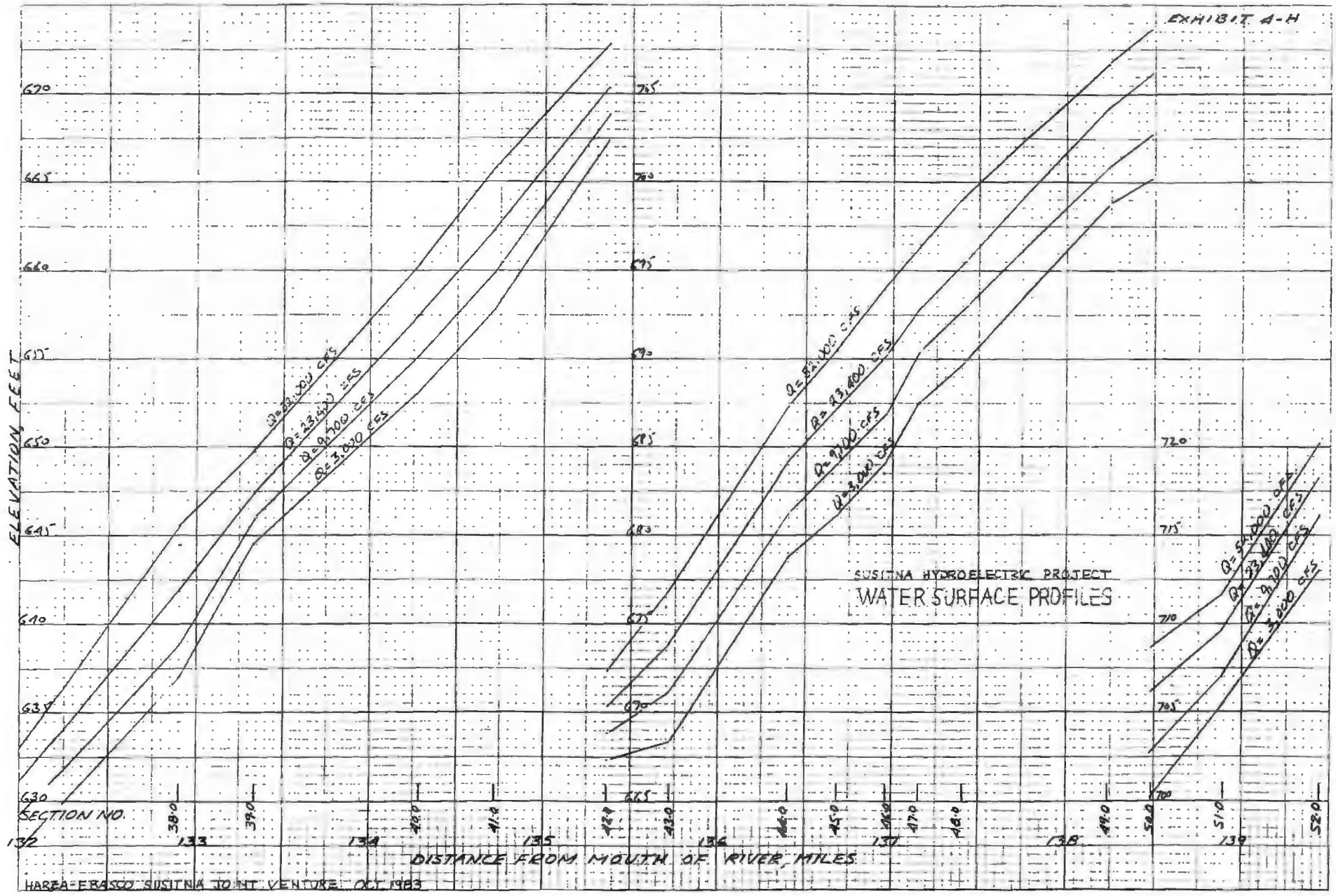
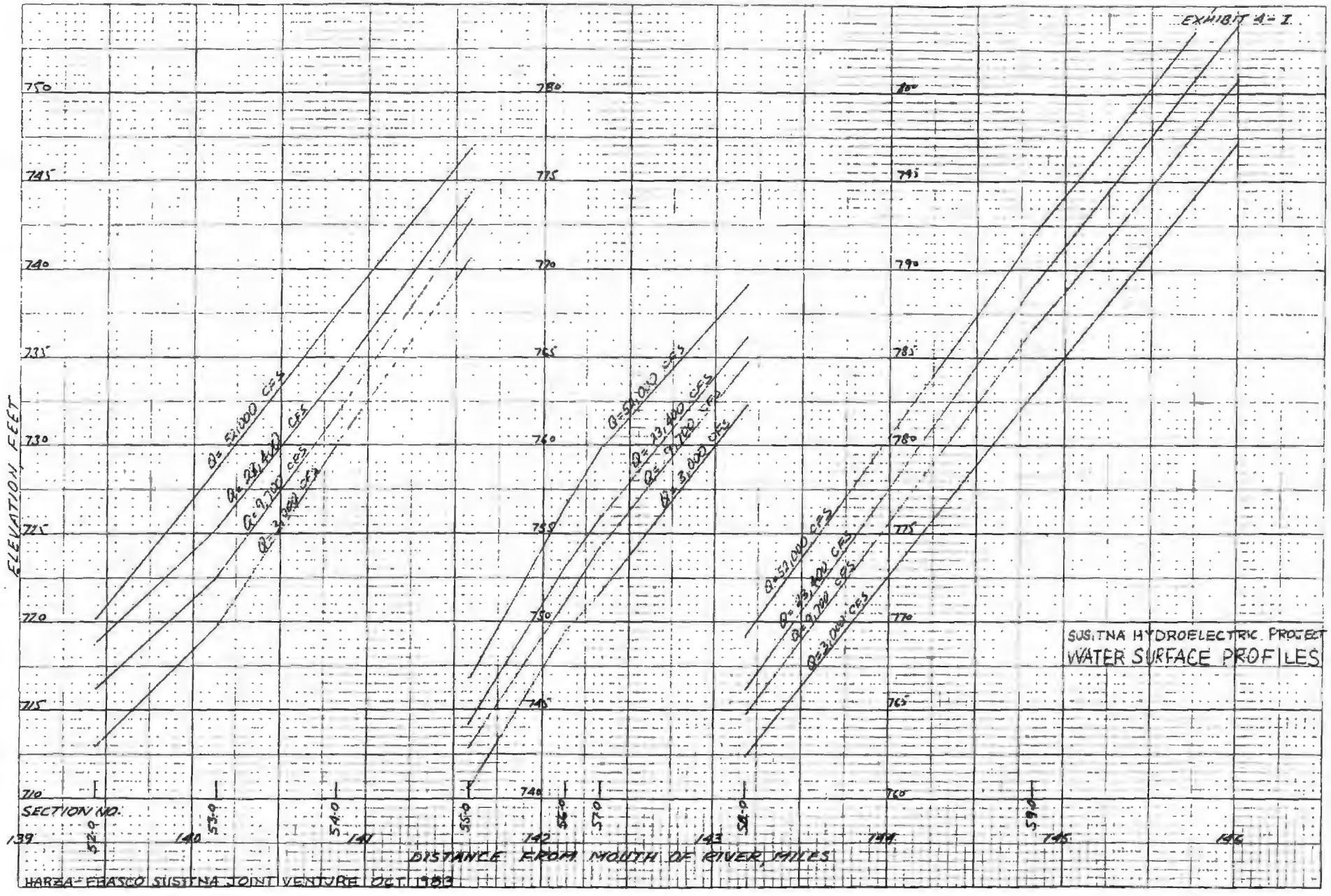
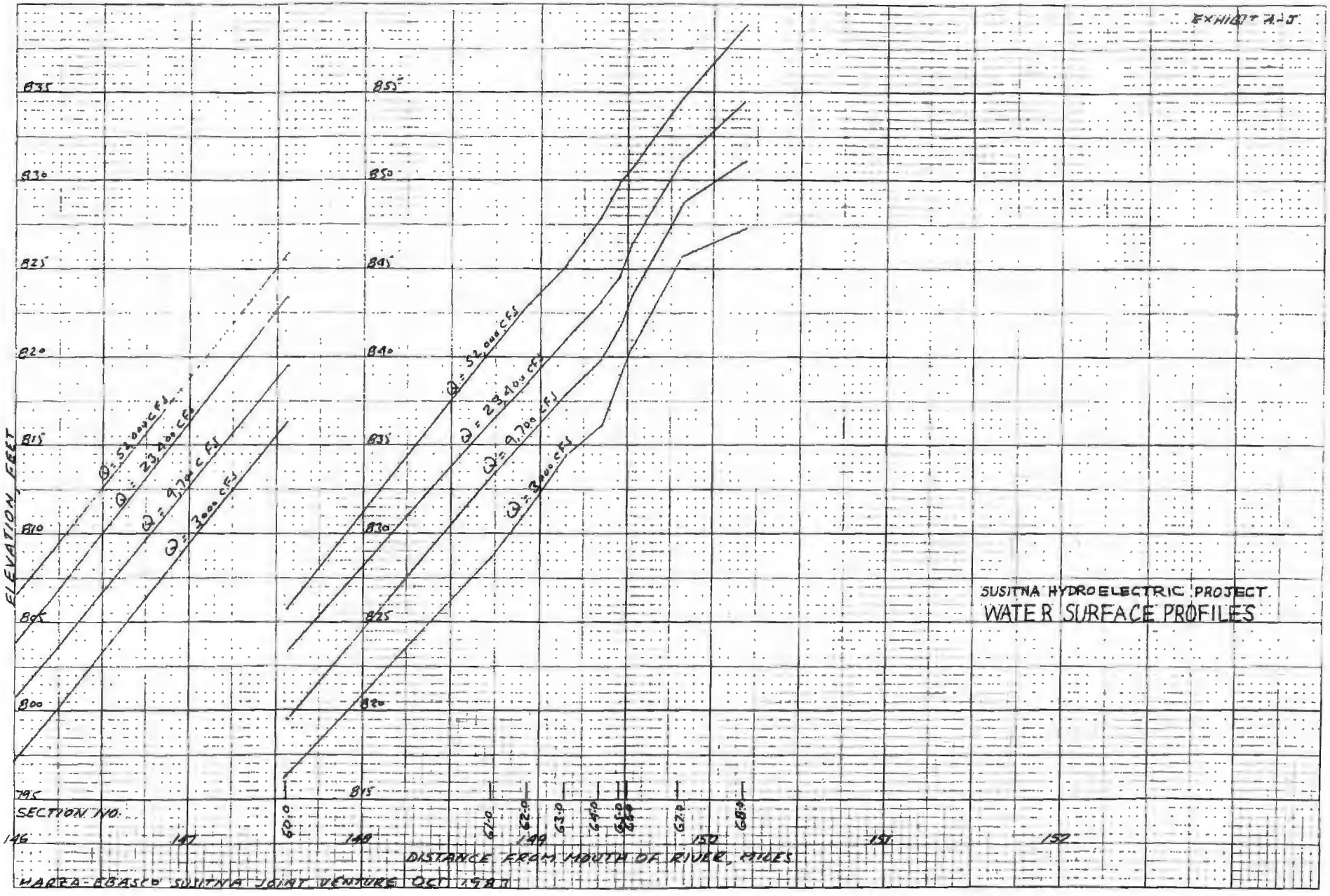

ELEVATION FEET
620
665
660
655
650
645
640
635
630
715
710
705
700
695
690
685
680
675
670
665
720
715
710
705
700
Q = 53,000 CFS
Q = 43,400 CFS
Q = 9,500 CFS
Q = 3,000 CFS
Q = 53,000 CFS
Q = 43,400 CFS
Q = 9,500 CFS
Q = 3,000 CFS
Q = 53,000 CFS
Q = 43,400 CFS
Q = 9,500 CFS
Q = 3,000 CFS
SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES
SECTION NO.
132
133
134
135
136
137
138
139
38.0
39.0
40.0
41.0
42.0
43.0
44.0
45.0
46.0
47.0
48.0
49.0
50.0
51.0
52.0
DISTANCE FROM MOUTH OF RIVER MILES
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT A-I



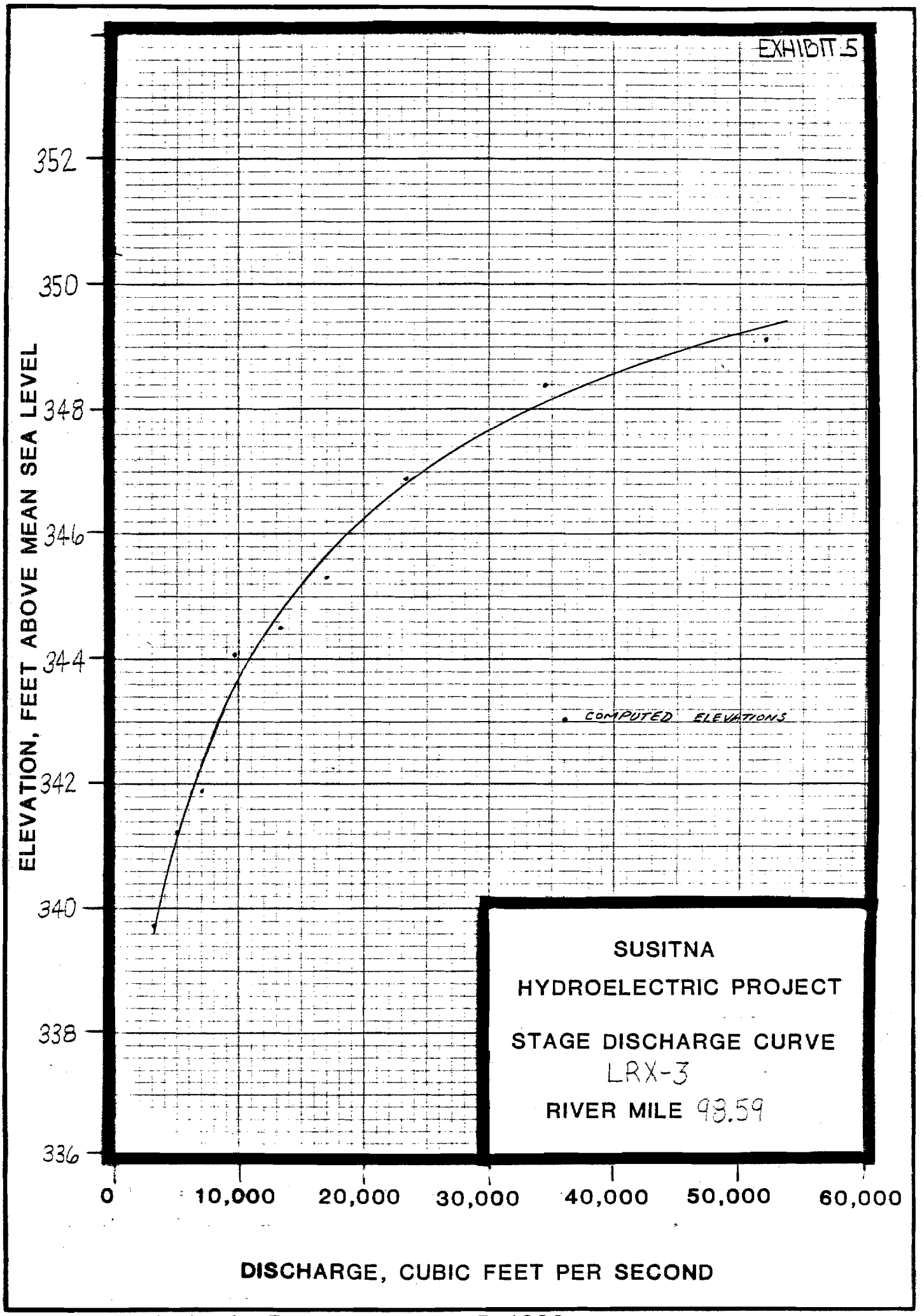
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT A-5

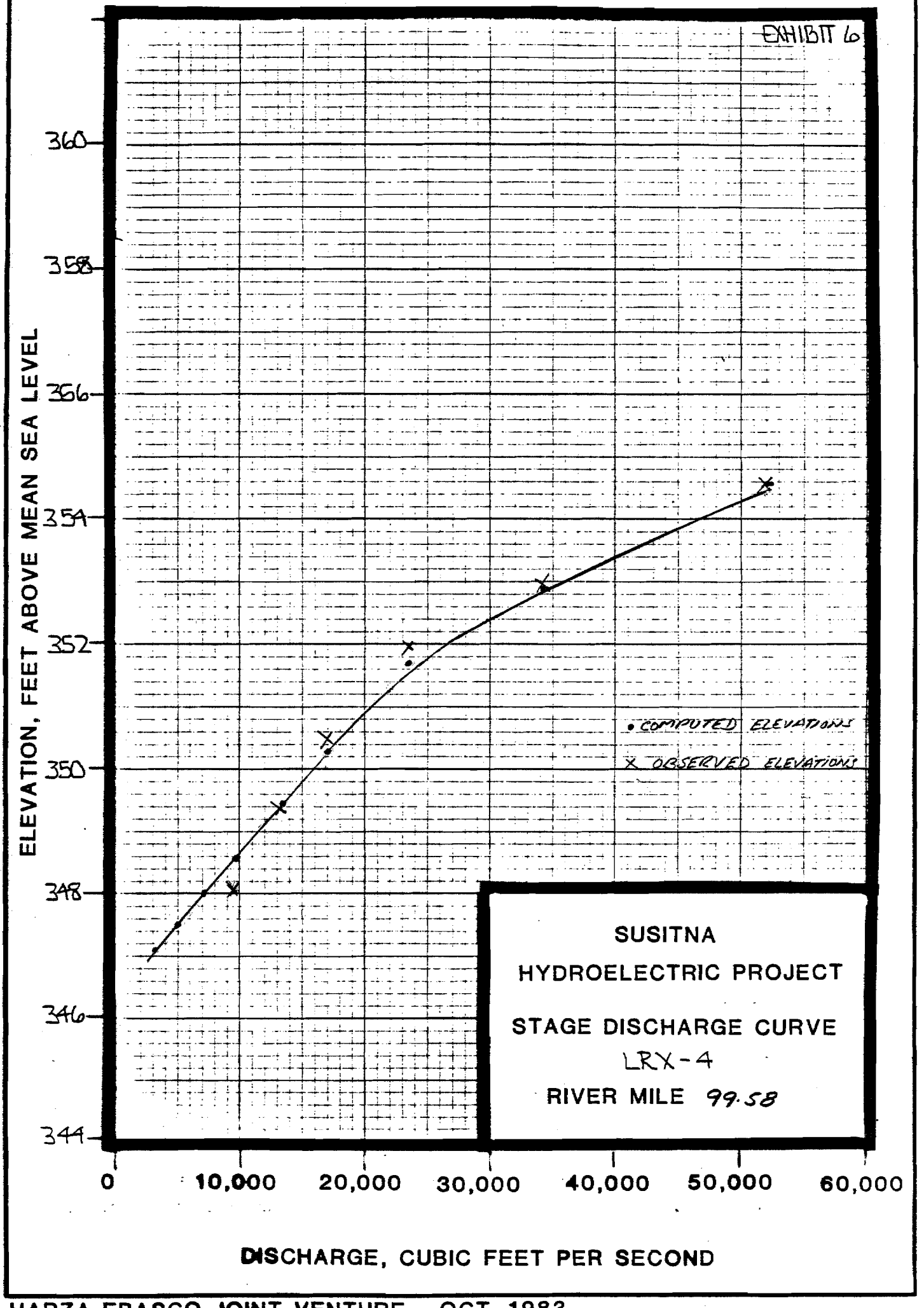


SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT 1980



HARZA-EBASCO JOINT VENTURE OCT. 1983



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 7

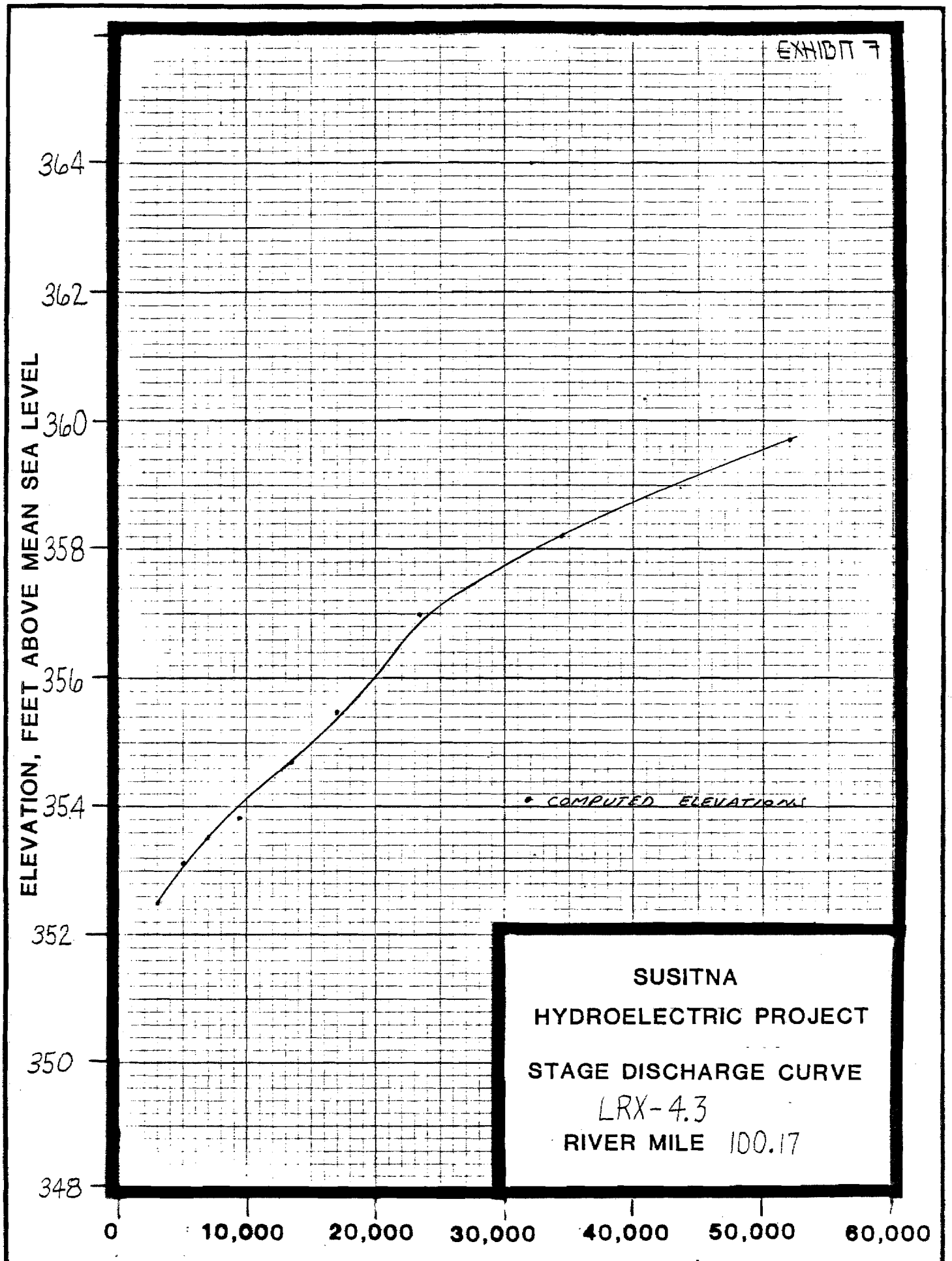

ELEVATION, FEET ABOVE MEAN SEA LEVEL
364
362
360
358
356
354
352
350
348
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-4.3
RIVER MILE 100.17

EXHIBIT 8

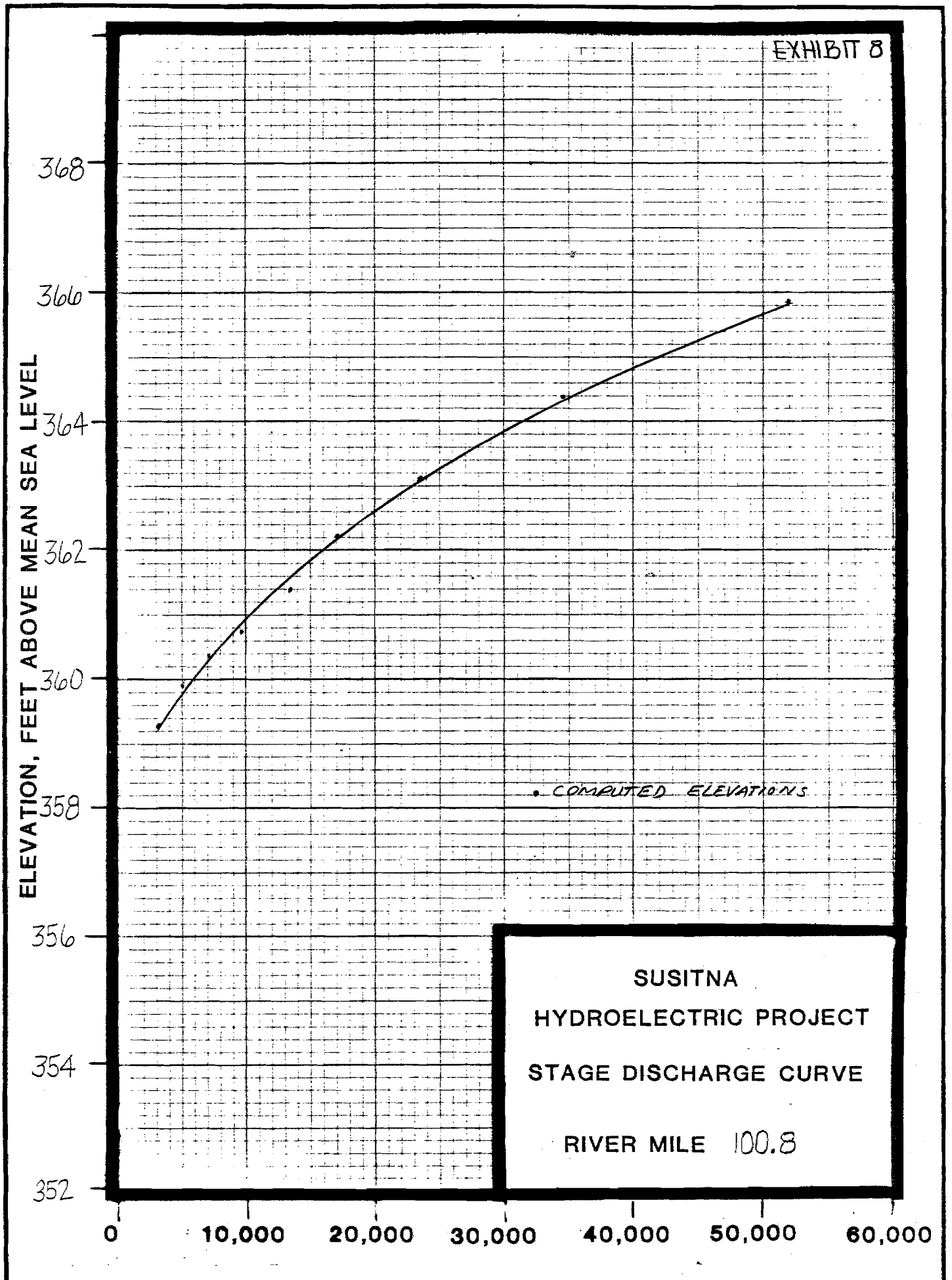

ELEVATION, FEET ABOVE MEAN SEA LEVEL
368
366
364
362
360
358
356
354
352
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 100.8

EXHIBIT 9

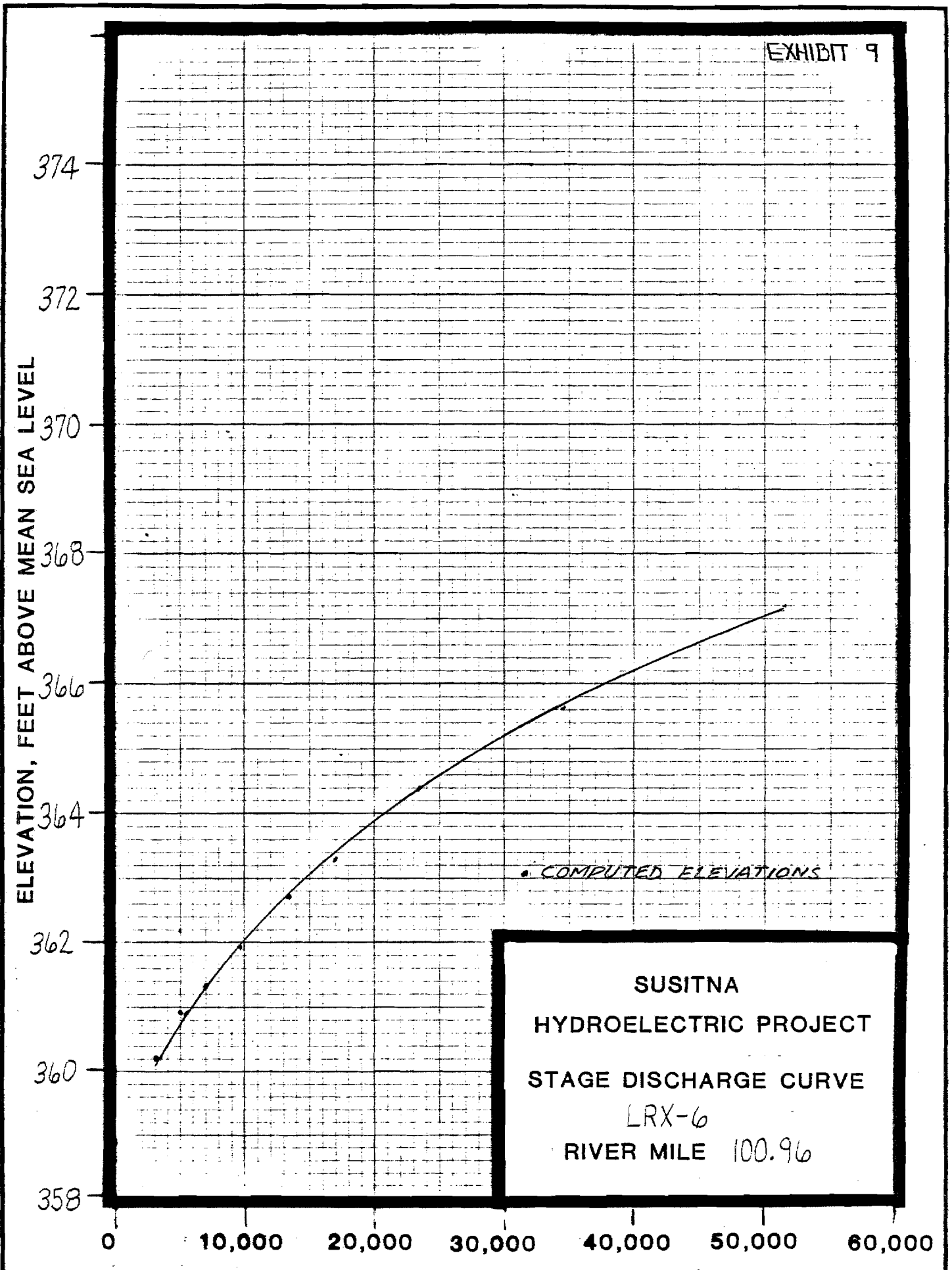

ELEVATION, FEET ABOVE MEAN SEA LEVEL
374
372
370
368
366
364
362
360
358
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-6
RIVER MILE 100.96

EXHIBIT 10

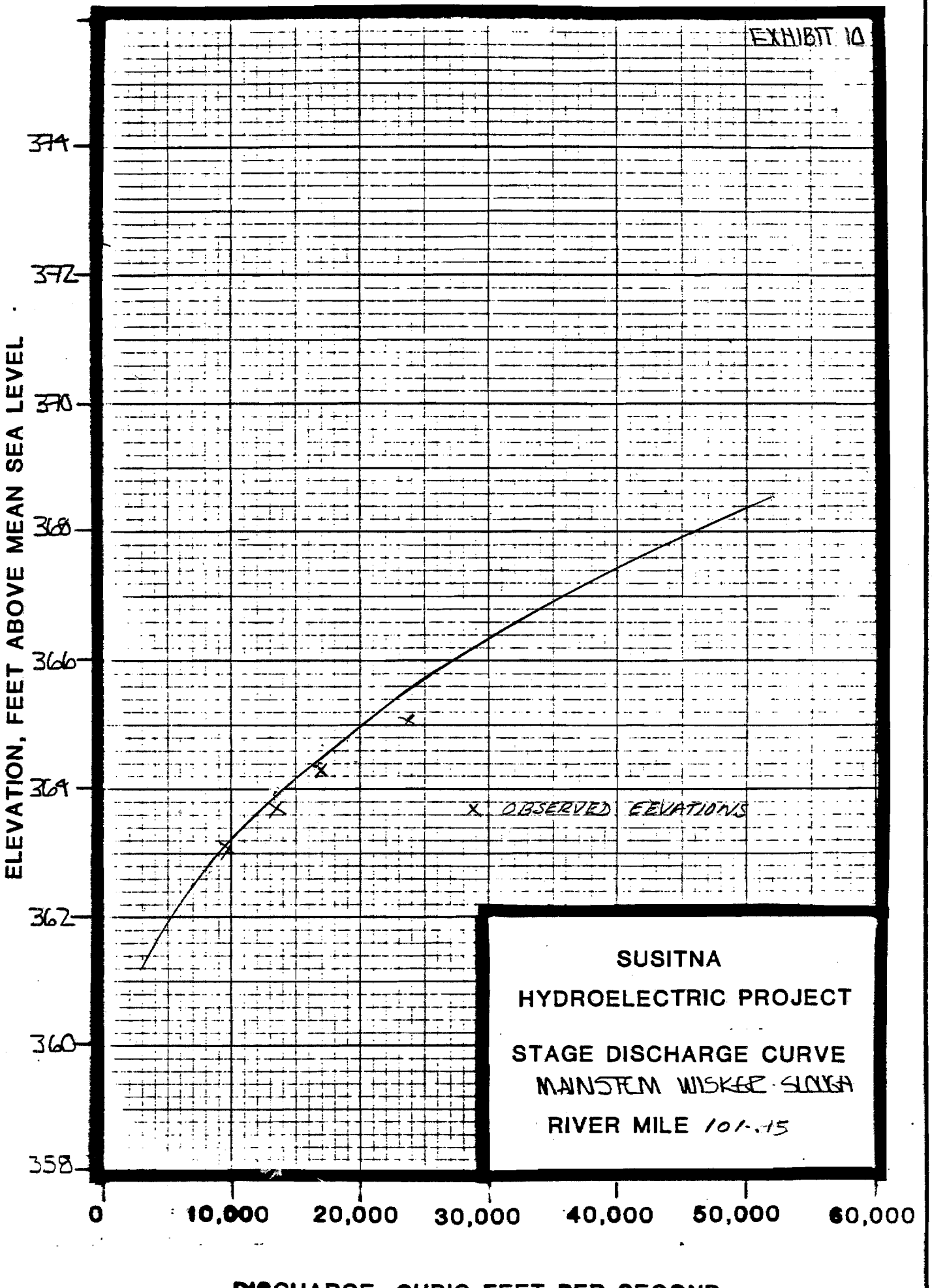
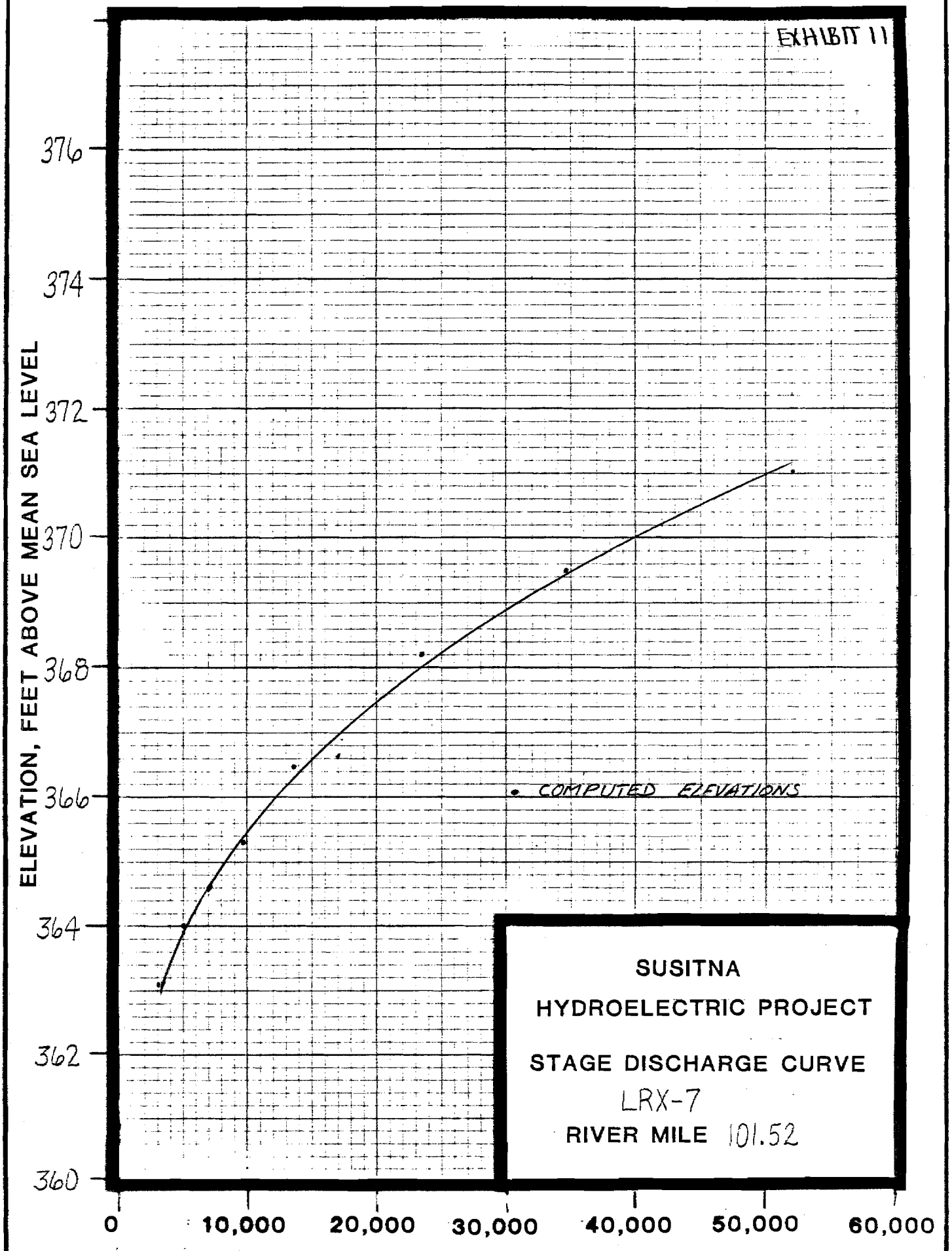

ELEVATION, FEET ABOVE MEAN SEA LEVEL
374
372
370
368
366
364
362
360
358
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
MAINSTEM WISKER-SLOUGH
RIVER MILE 101.15

EXHIBIT 11



SUSITNA

HYDROELECTRIC PROJECT

STAGE DISCHARGE CURVE

LRX-7

RIVER MILE 101.52

EXHIBIT 12

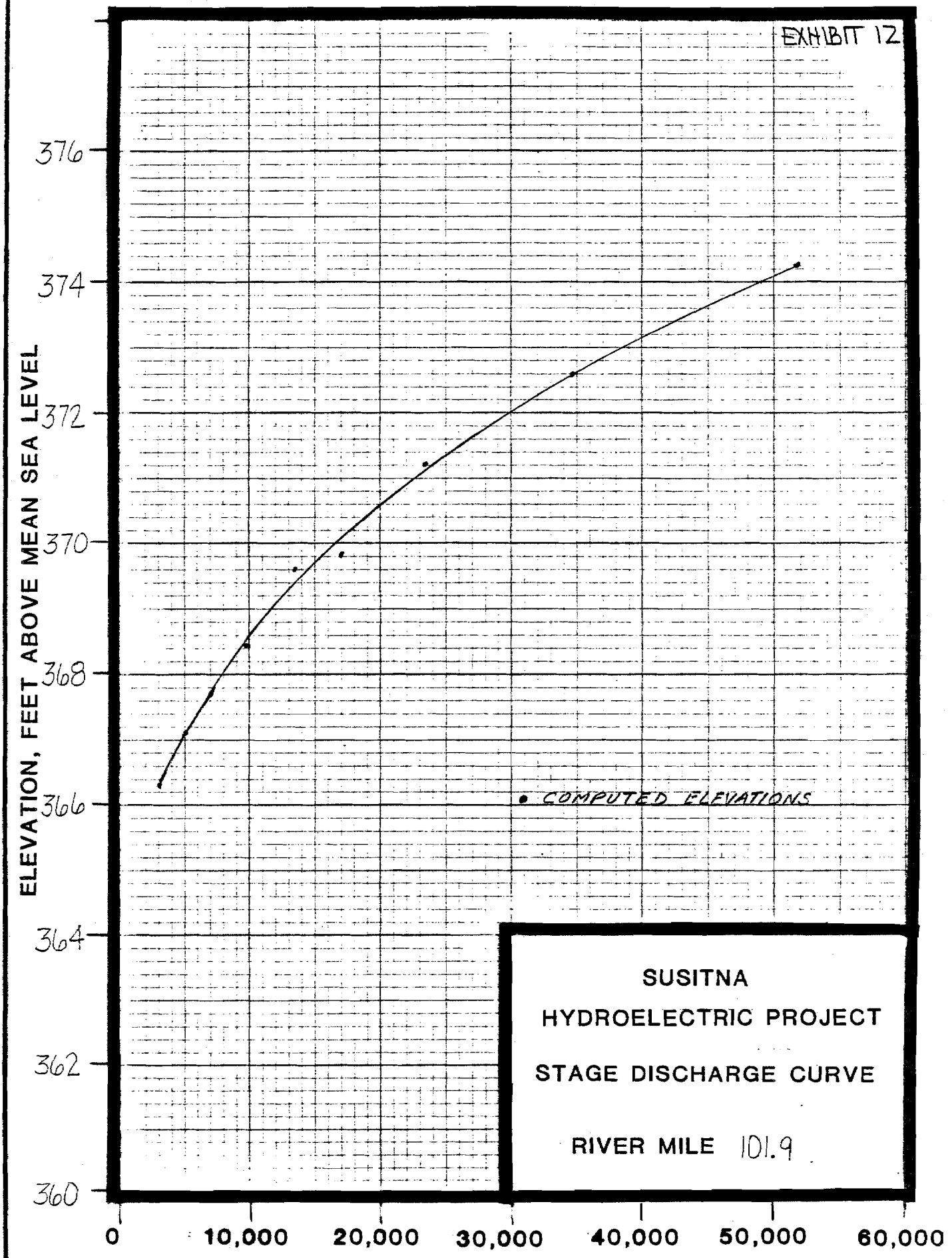
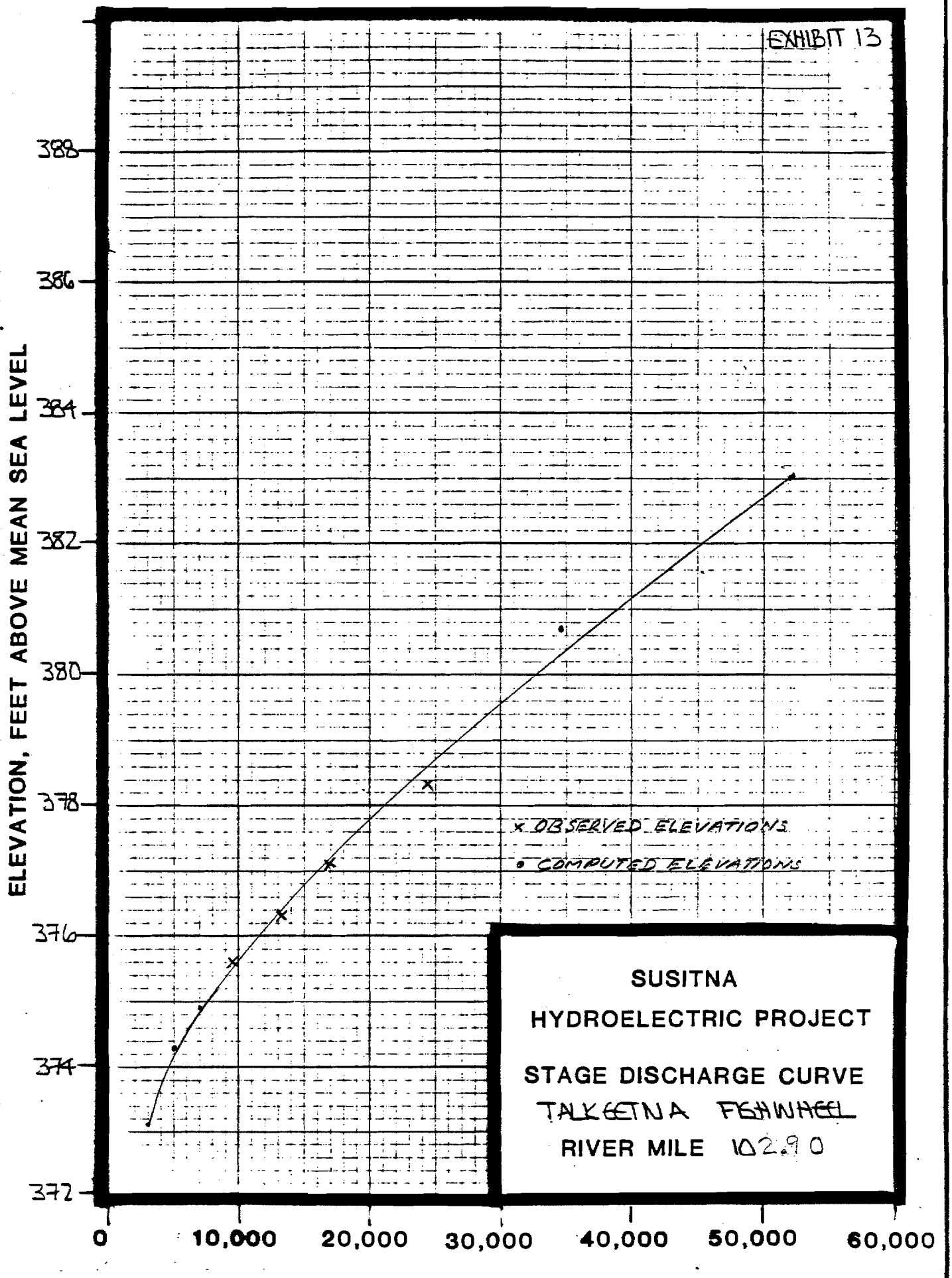

ELEVATION, FEET ABOVE MEAN SEA LEVEL
376
374
372
370
368
366
364
362
360
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 101.9

EXHIBIT 13


388
386
384
382
380
378
376
374
372
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
x OBSERVED ELEVATIONS
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
TALKEETNA FISHWHEEL
RIVER MILE 102.90

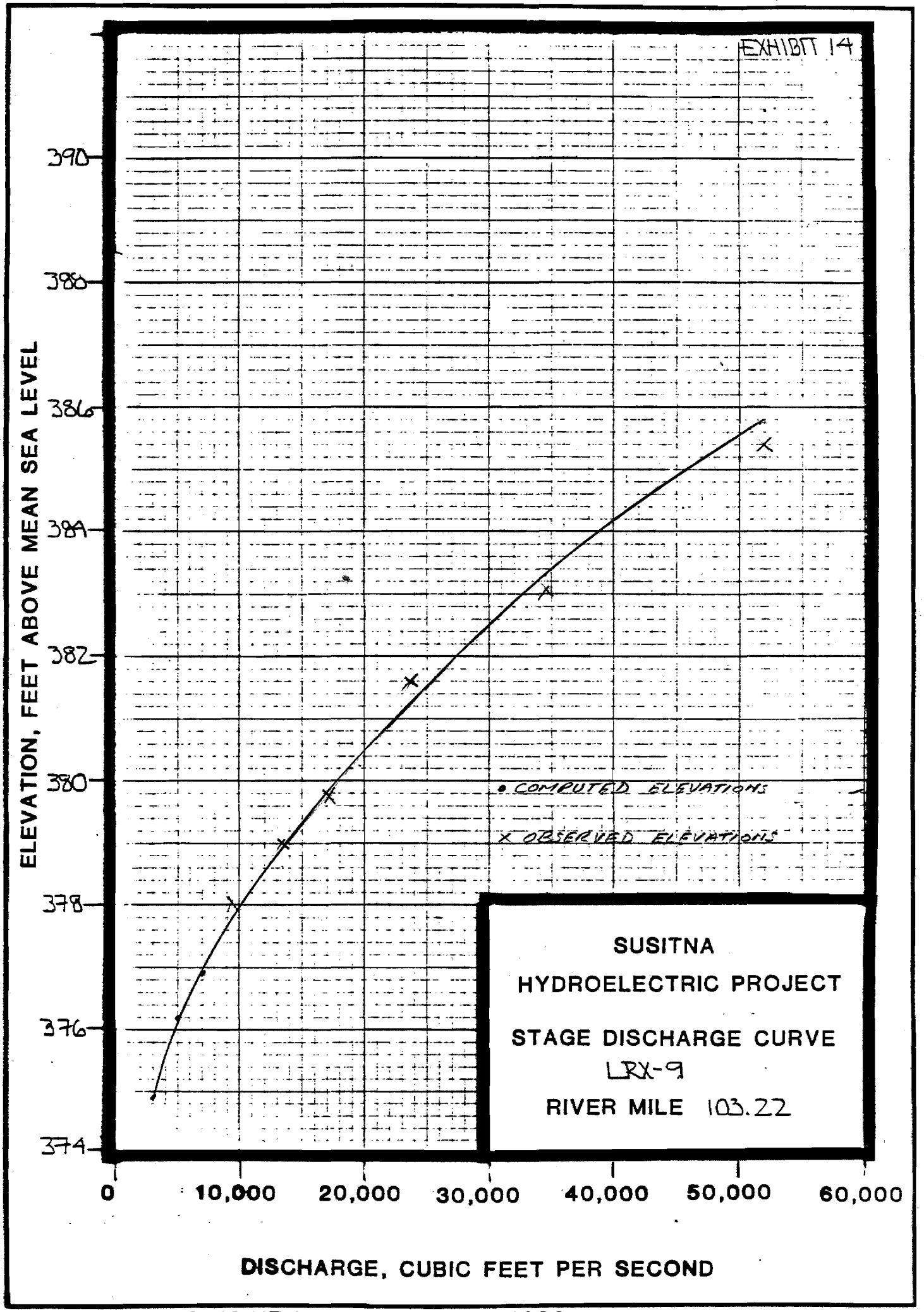
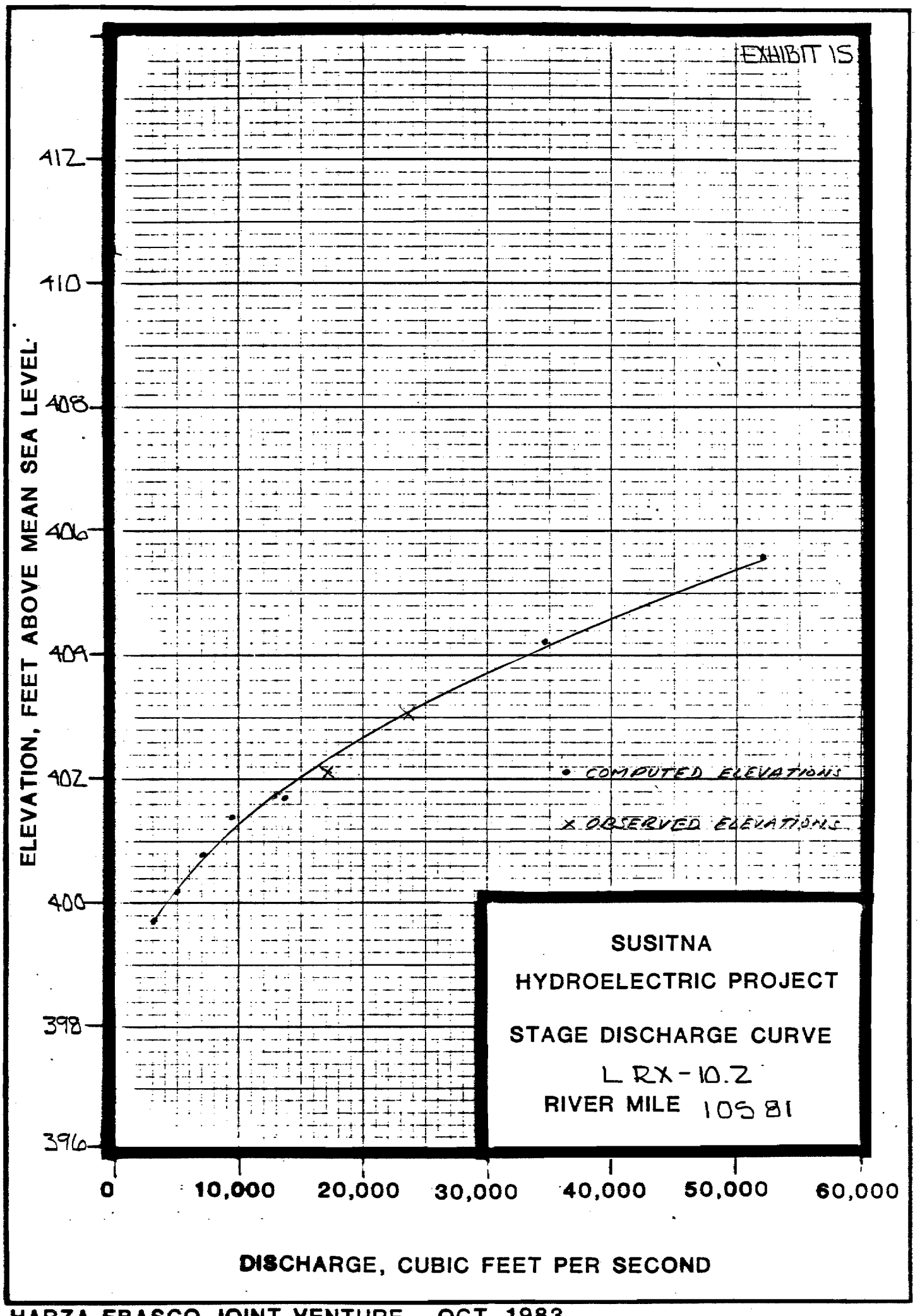
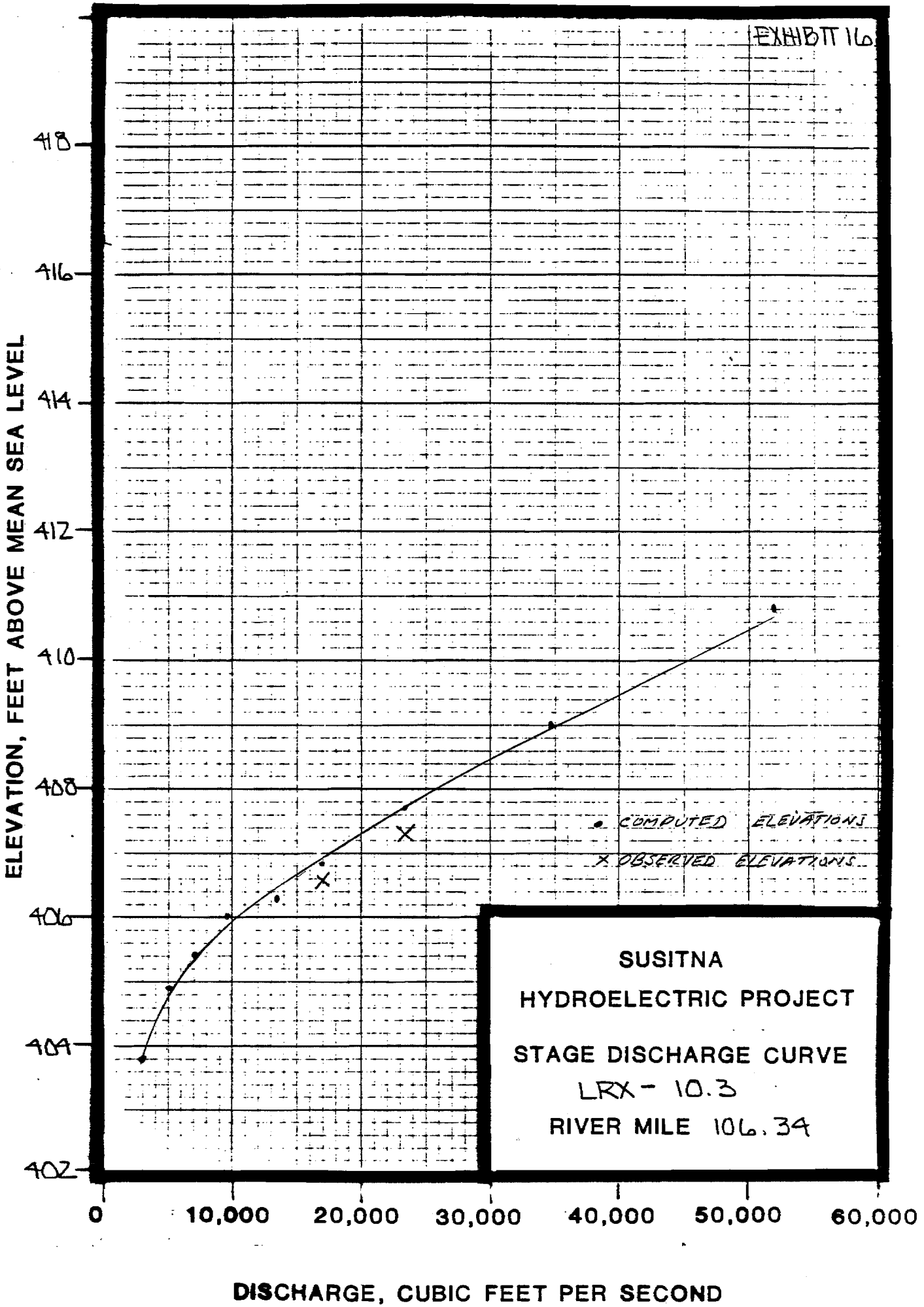


EXHIBIT 14
390
386
382
378
374
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-9
RIVER MILE 103.22
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND



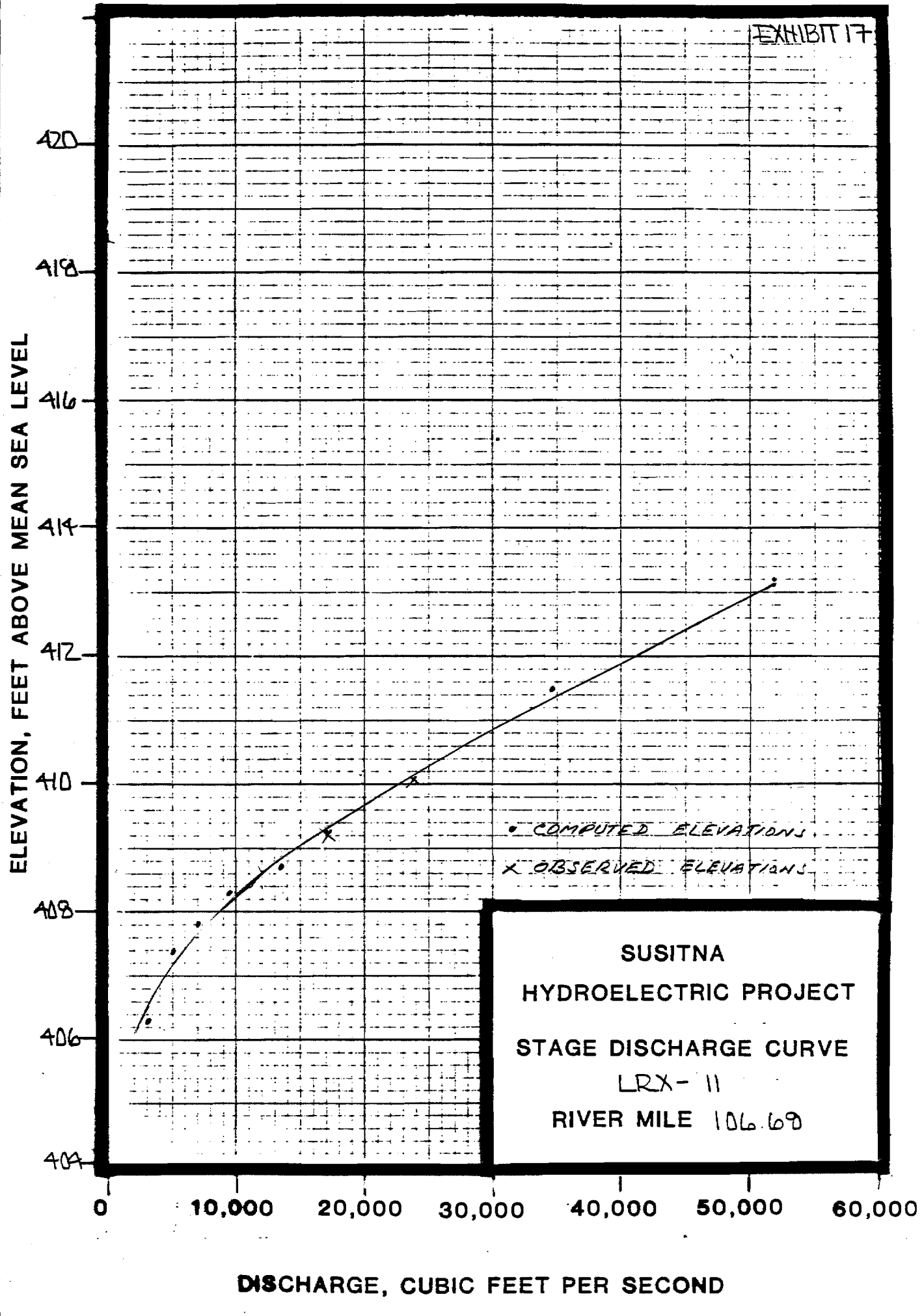
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 16

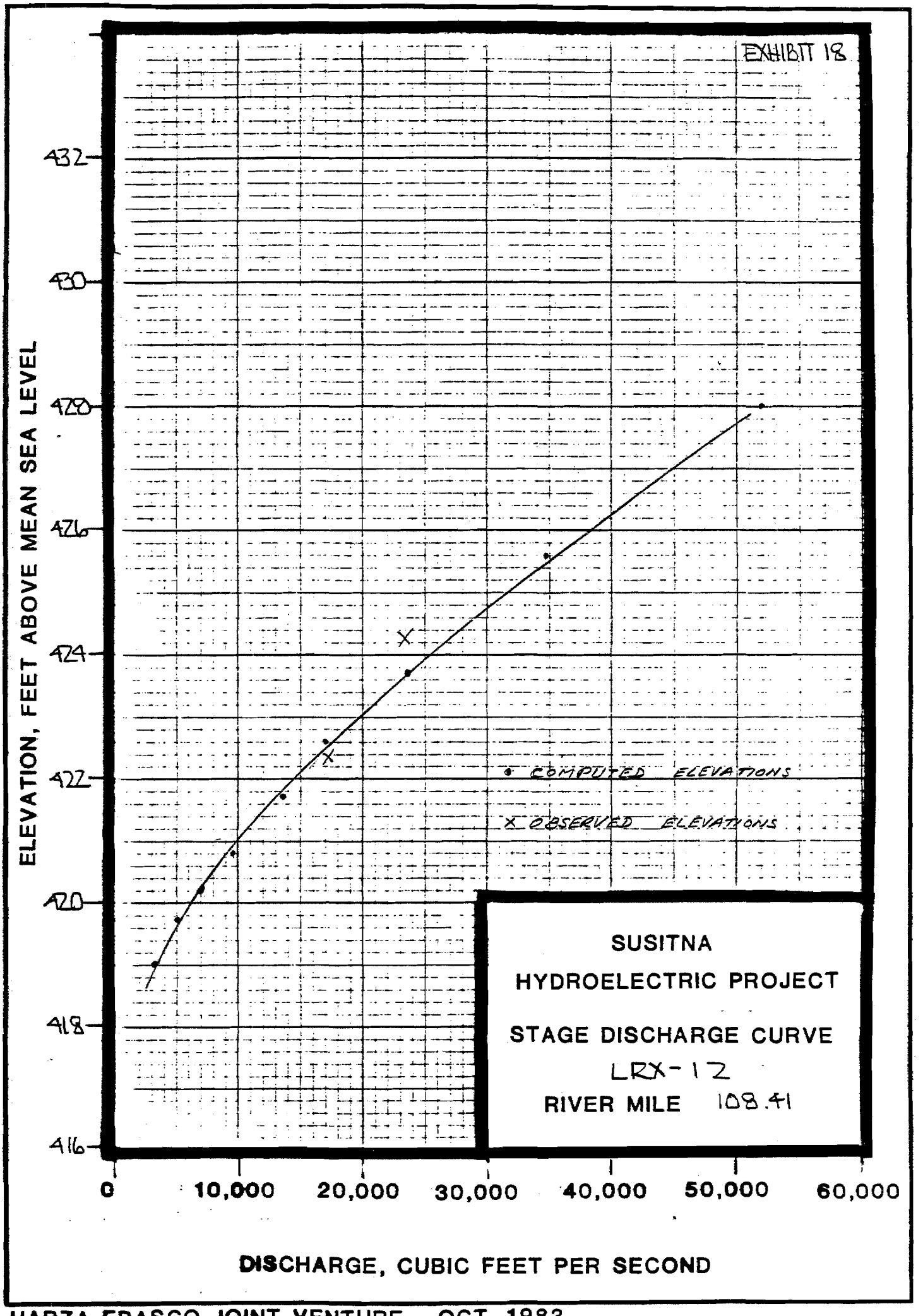


HARZA-EBASCO JOINT VENTURE OCT. 1983

EXHIBIT 17

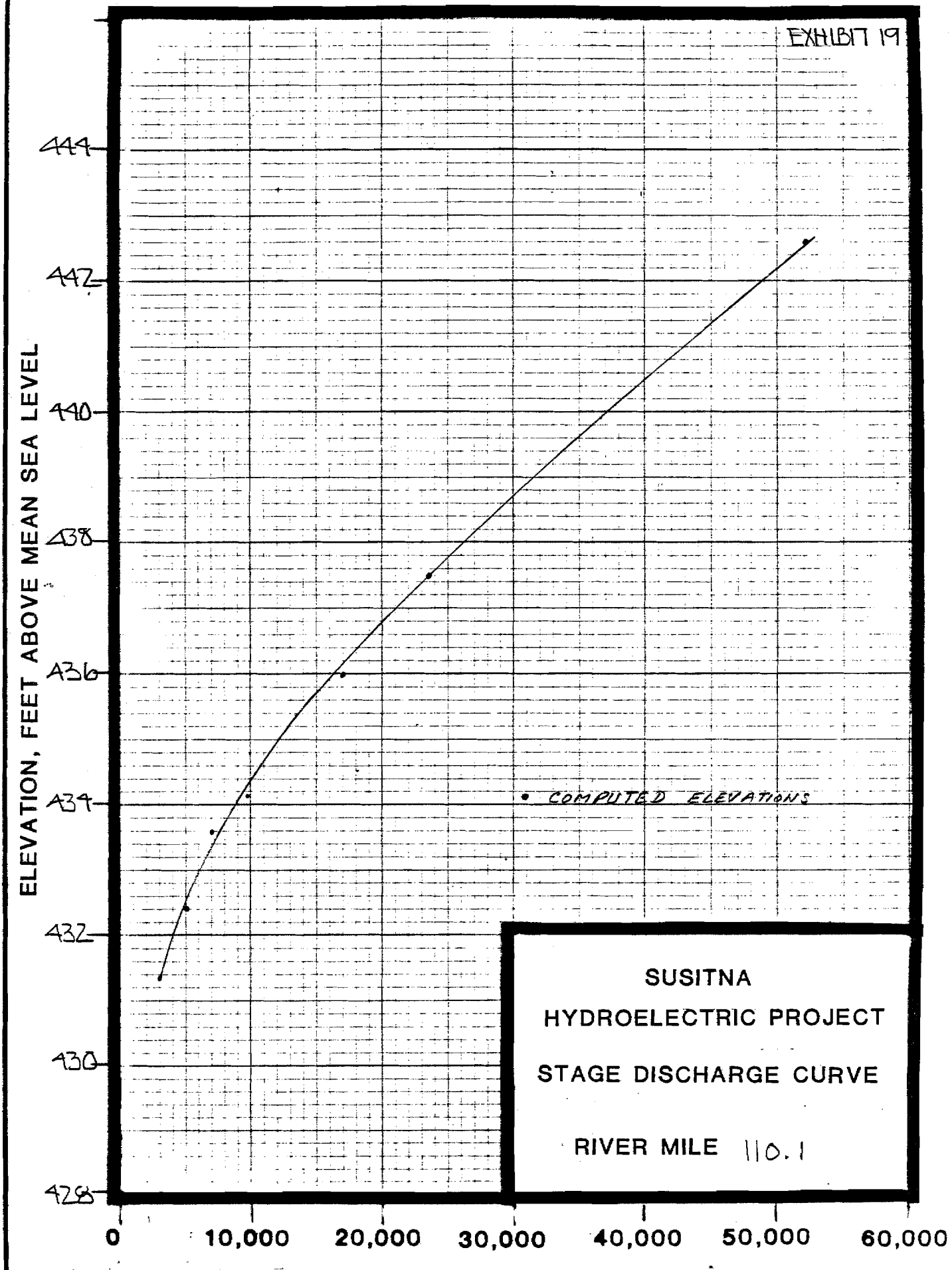


HARZA EBASCO JOINT VENTURE OCT 1983



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 19



SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 110.1

EXHIBIT ZD

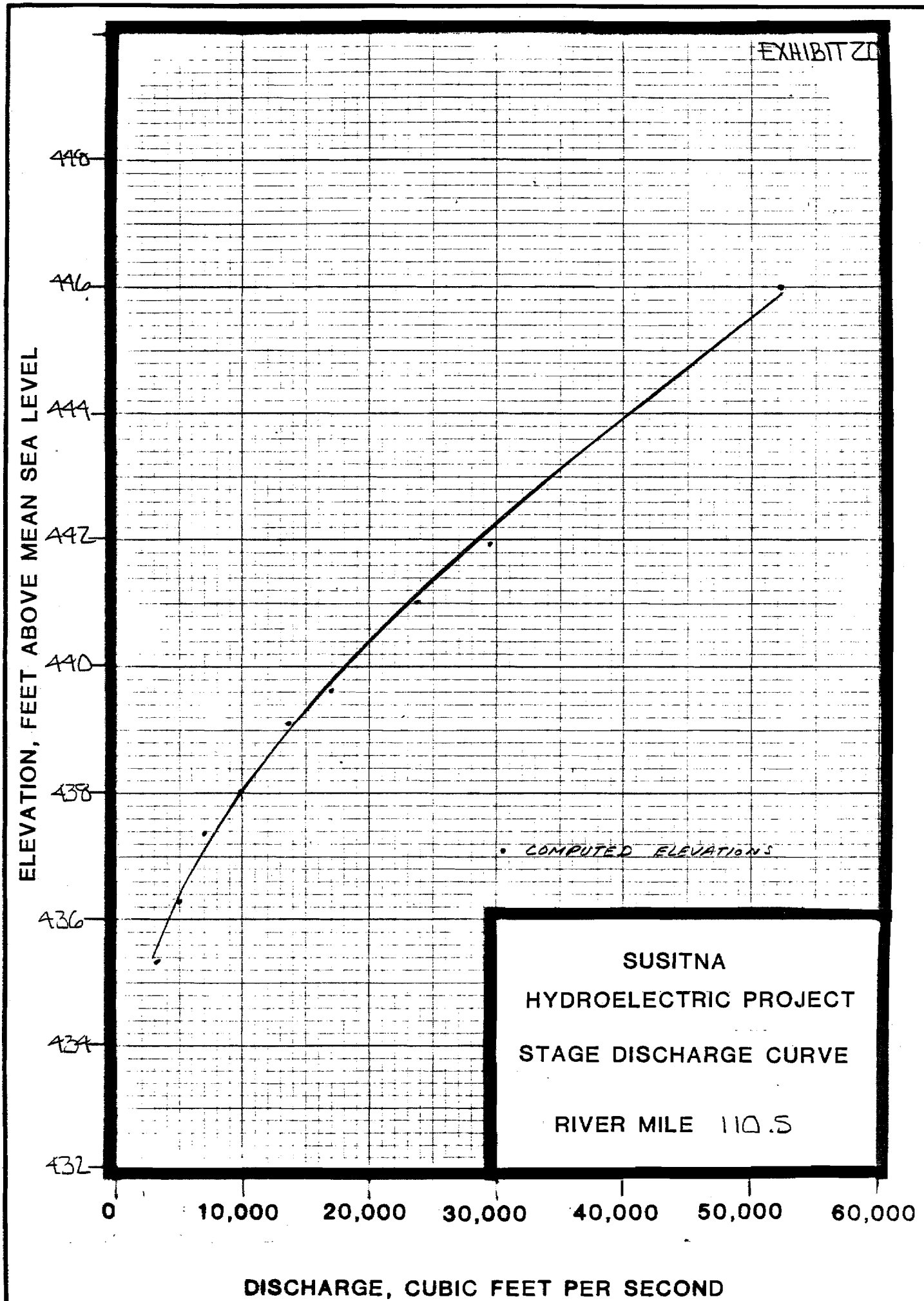
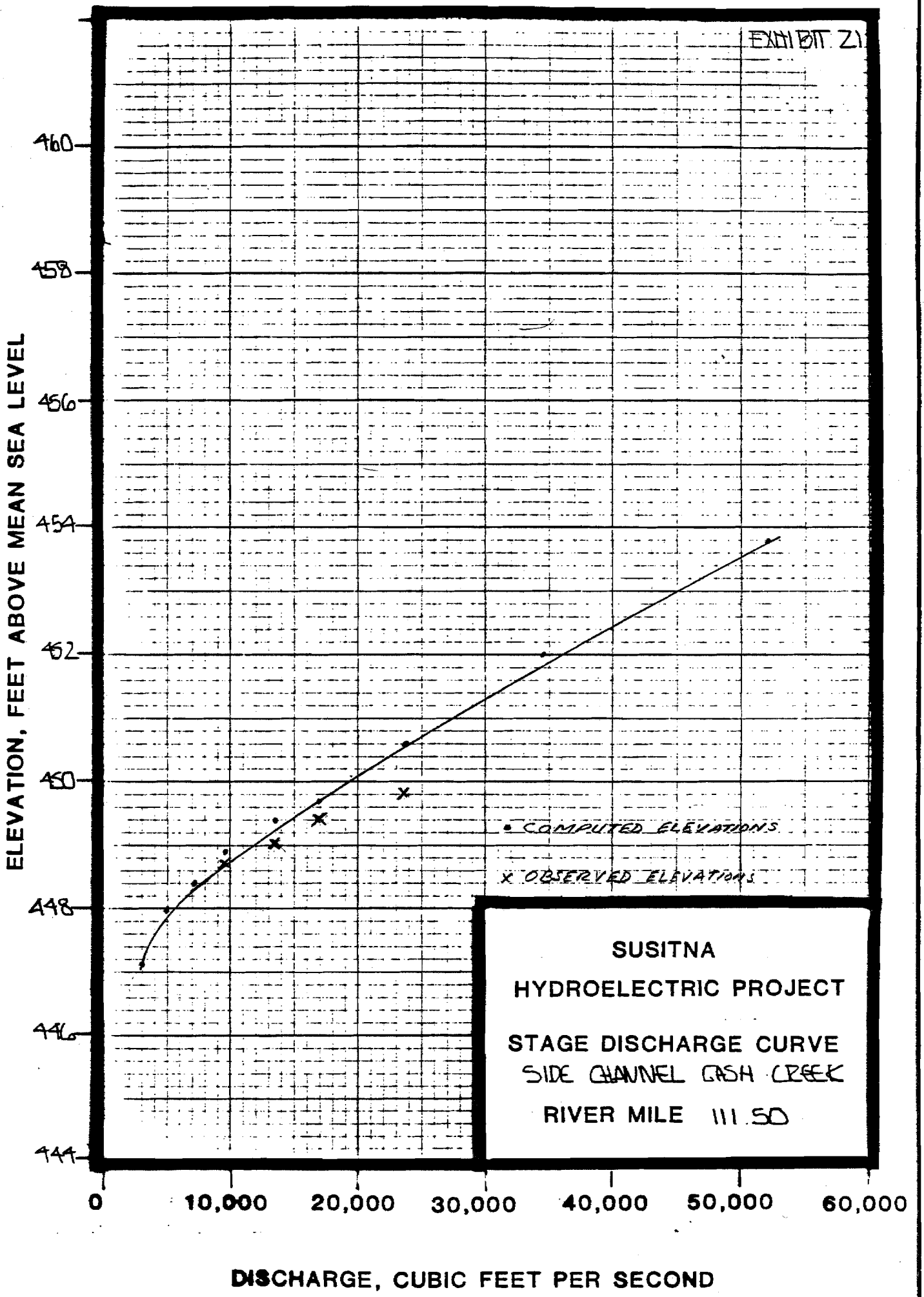

ELEVATION, FEET ABOVE MEAN SEA LEVEL
448
446
444
442
440
438
436
434
432
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 110.5

EXHIBIT Z1



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT ZZ

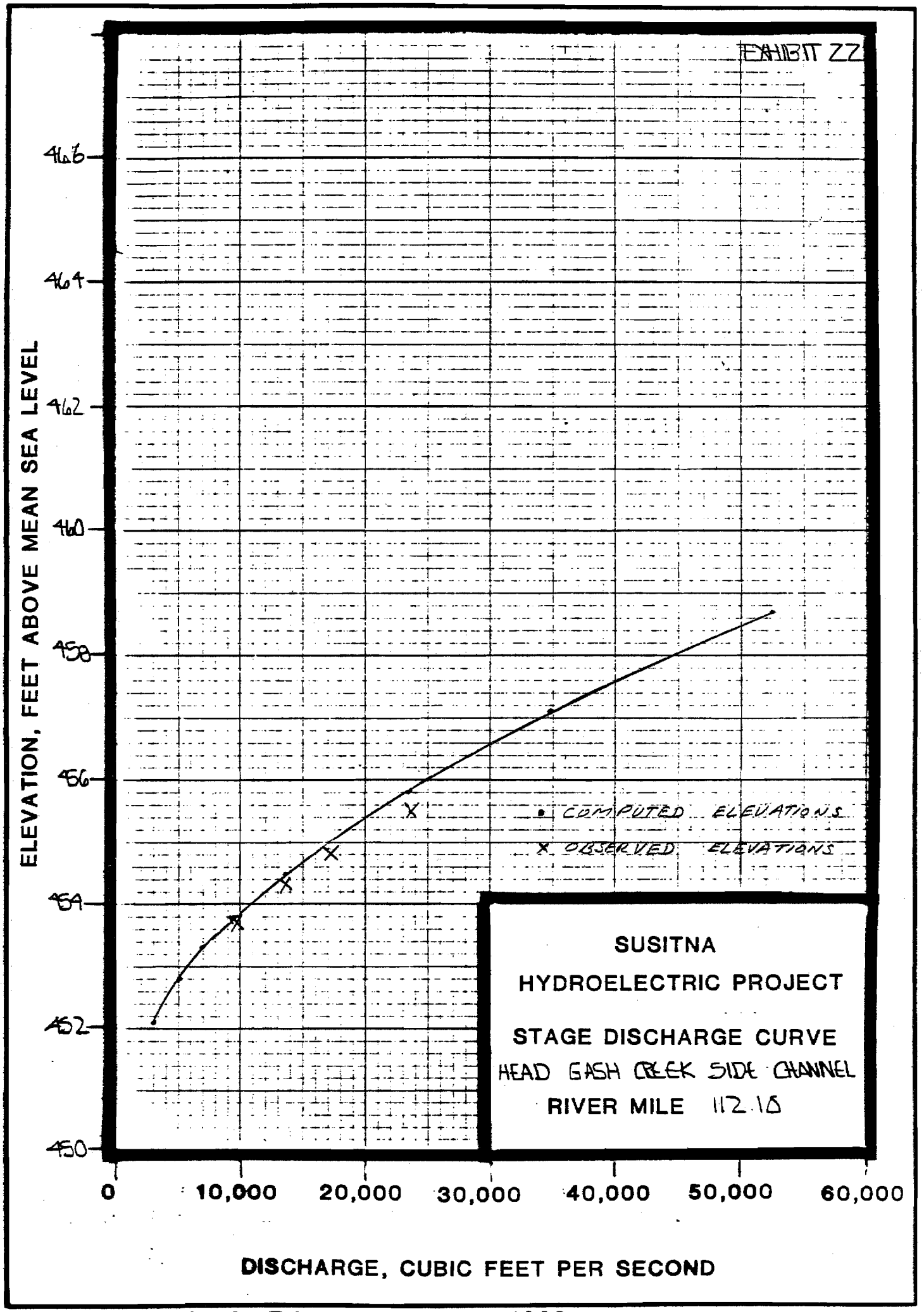

ELEVATION, FEET ABOVE MEAN SEA LEVEL
466
464
462
460
458
456
454
452
450
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
HEAD GASH CREEK SIDE CHANNEL
RIVER MILE 112.10

EXHIBIT 23

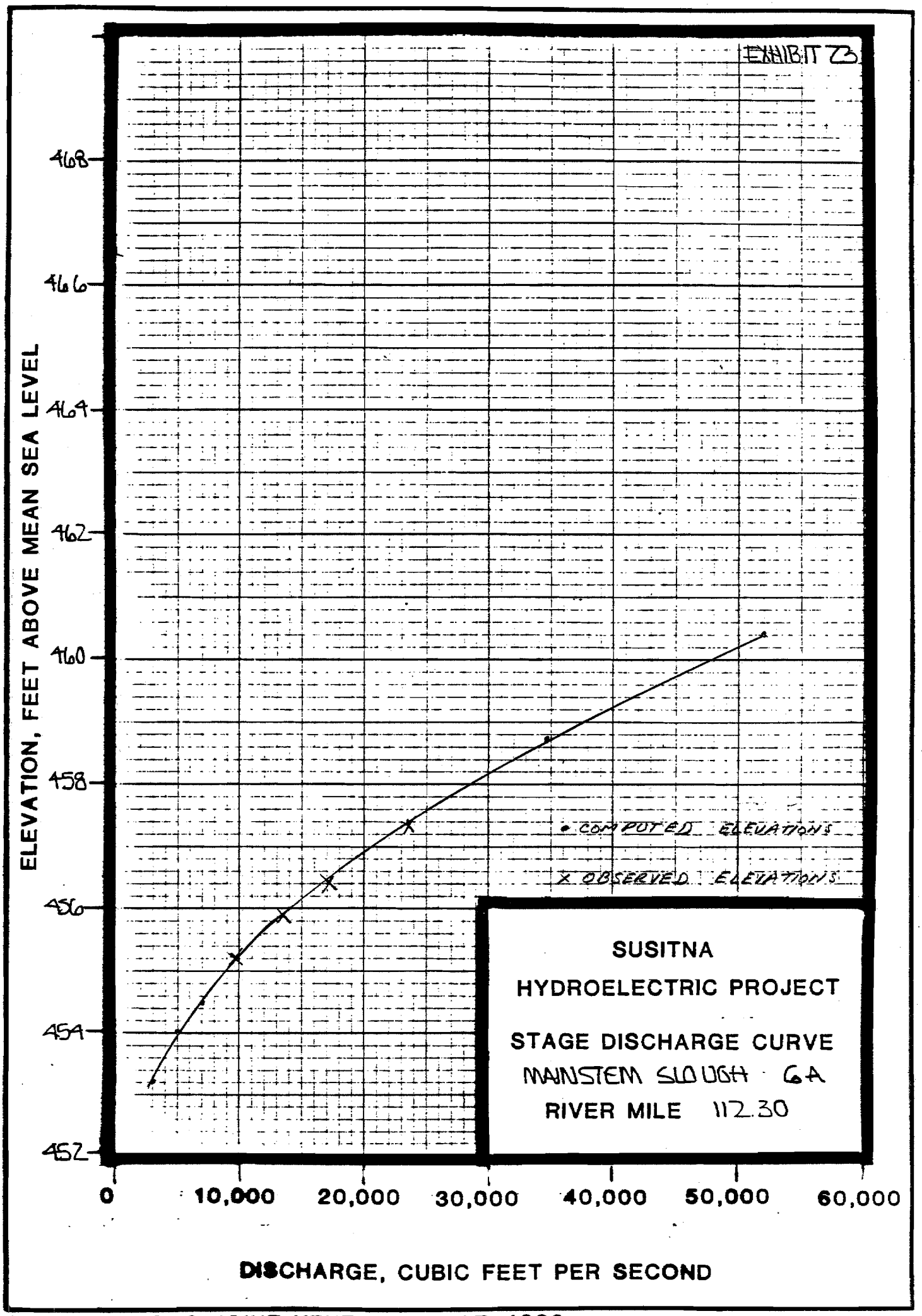

ELEVATION, FEET ABOVE MEAN SEA LEVEL
468
466
464
462
460
458
456
454
452
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
MAINSTEM SLOUGH 6A
RIVER MILE 112.30

EXHIBIT Z4

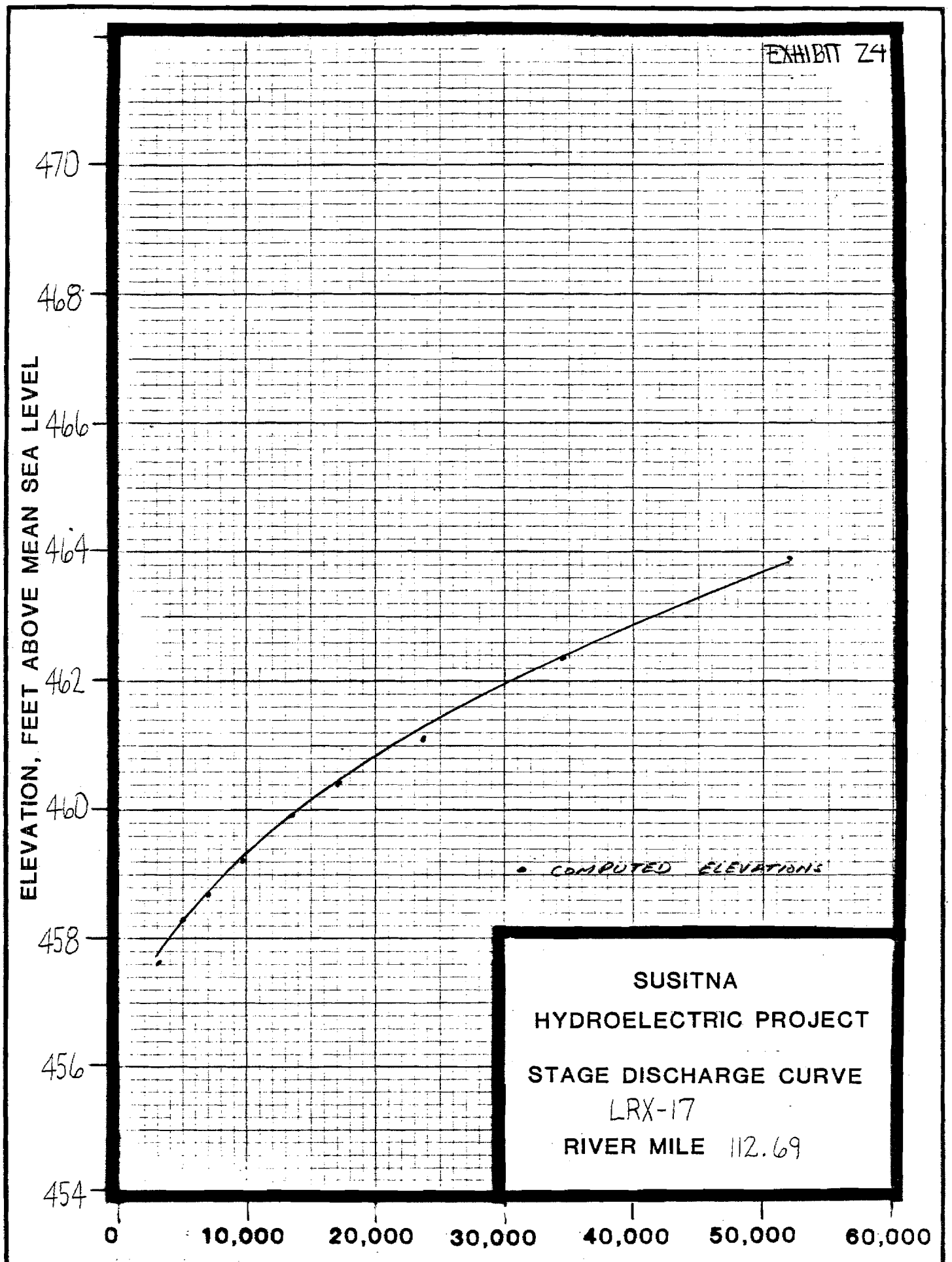
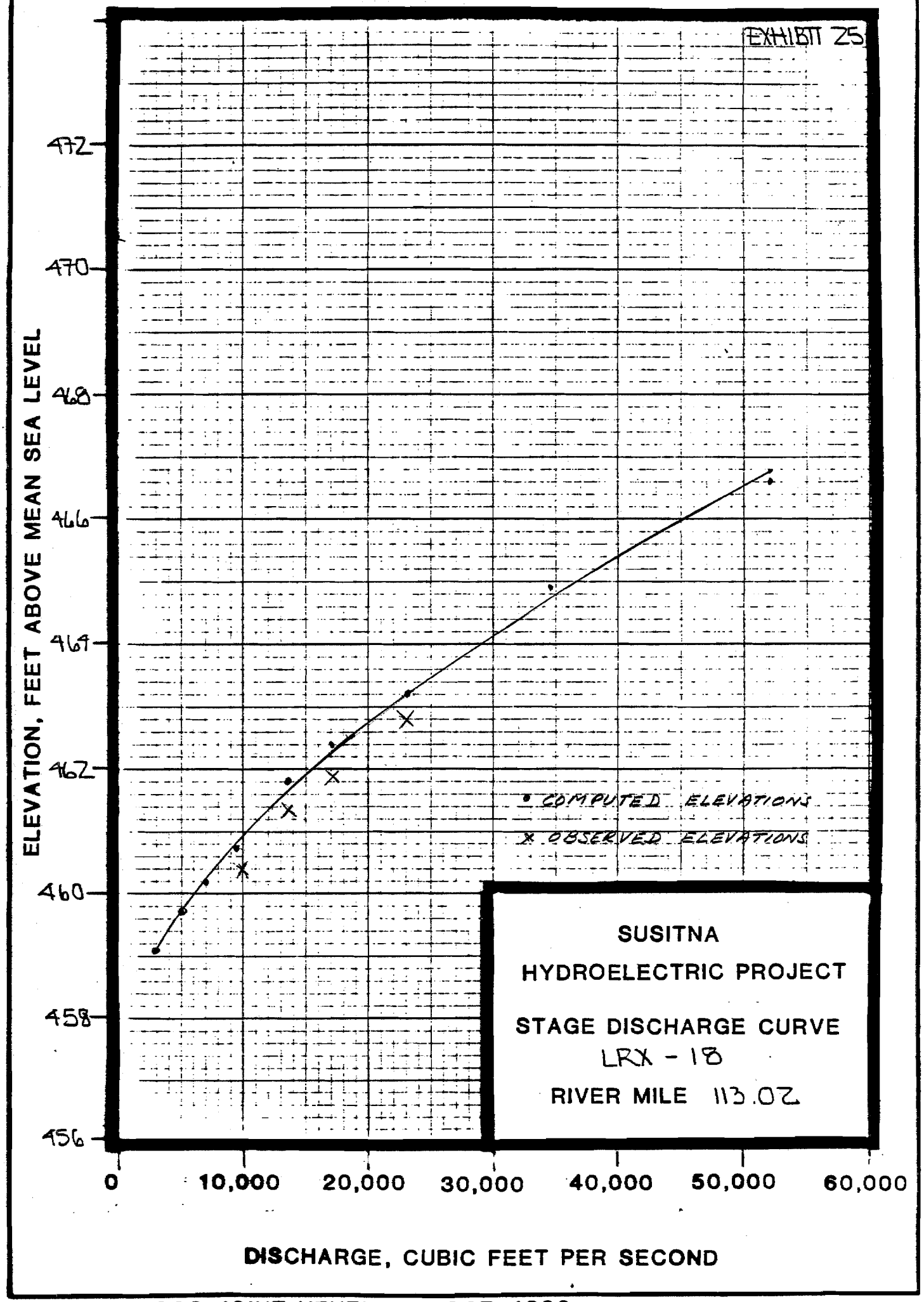

ELEVATION, FEET ABOVE MEAN SEA LEVEL
470
468
466
464
462
460
458
456
454
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-17
RIVER MILE 112.69

EXHIBIT 25



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 2L

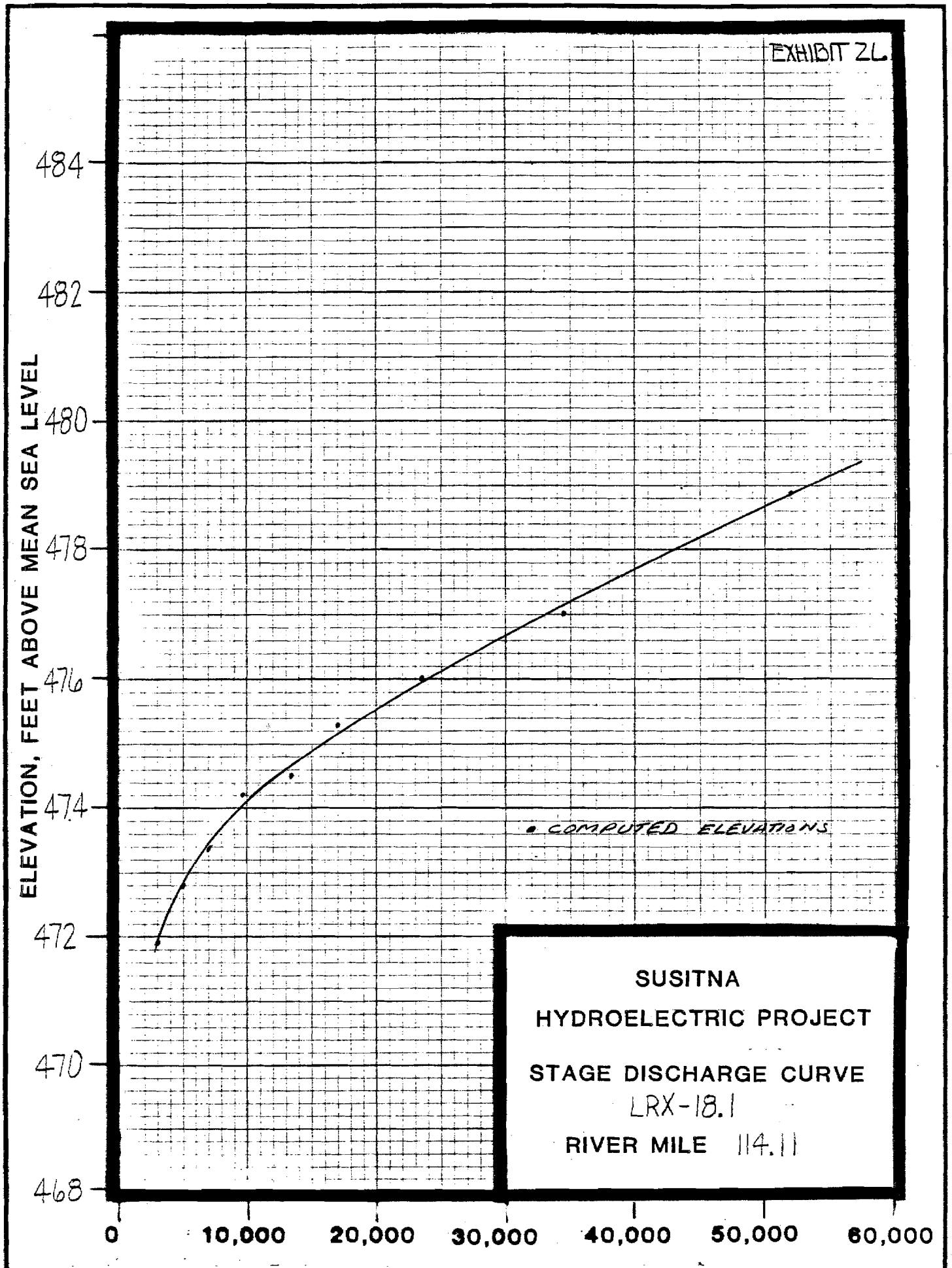
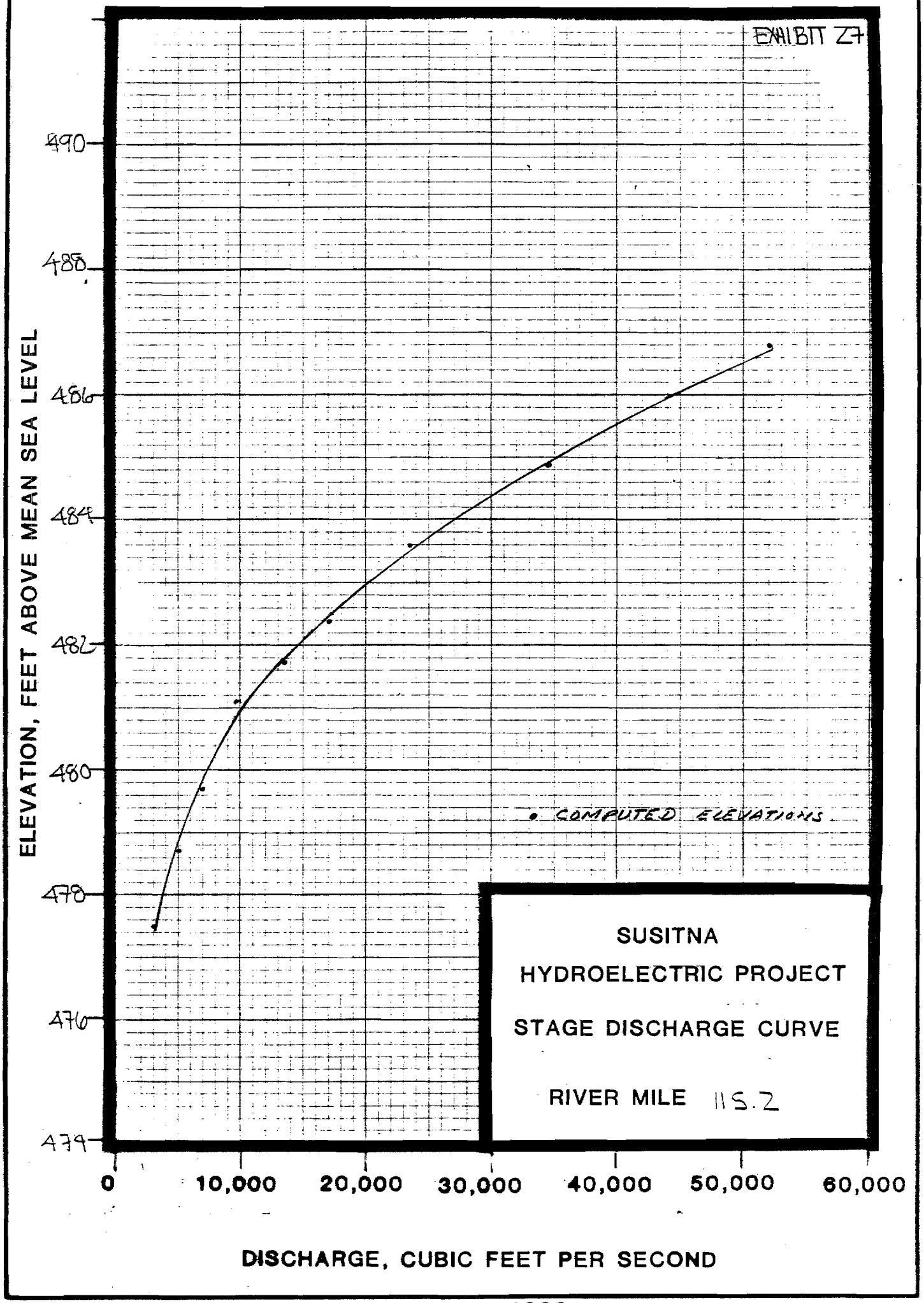

ELEVATION, FEET ABOVE MEAN SEA LEVEL
484
482
480
478
476
474
472
470
468
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-18.1
RIVER MILE 114.11

EXHIBIT Z-7



SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 115.2

EXHIBIT 28

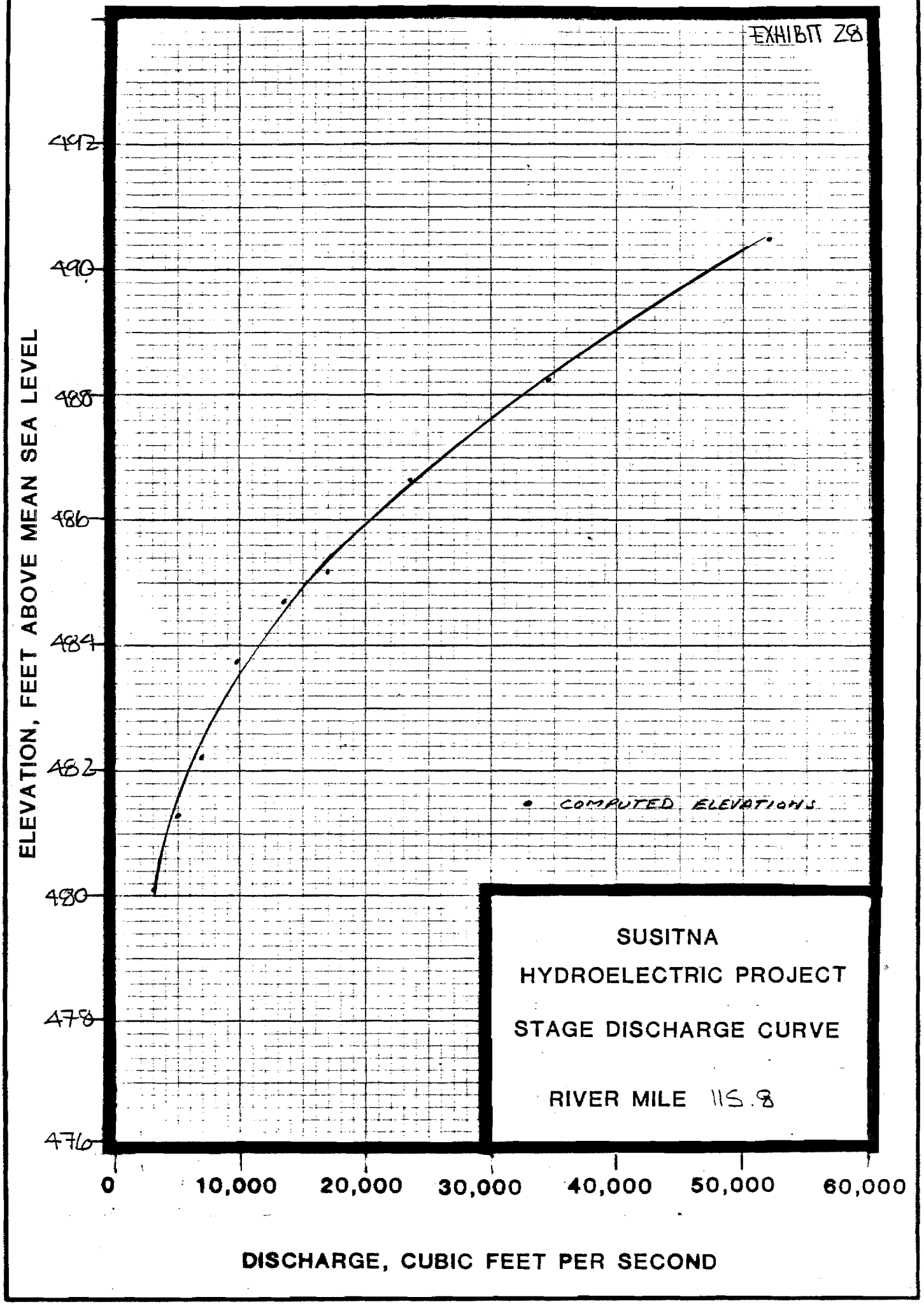

ELEVATION, FEET ABOVE MEAN SEA LEVEL
492
490
488
486
484
482
480
478
476
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 115.8

EXHIBIT 29

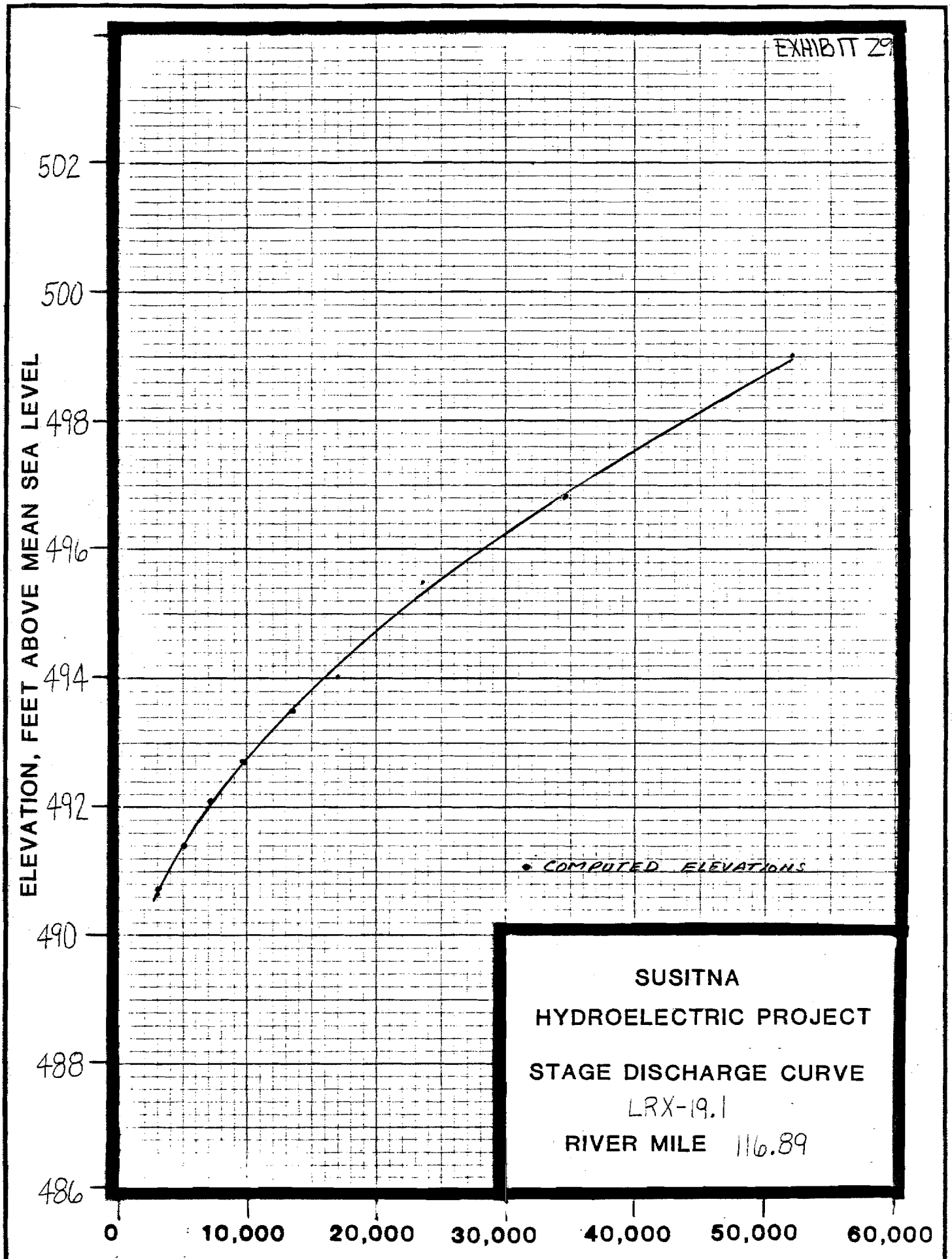

ELEVATION, FEET ABOVE MEAN SEA LEVEL
502
500
498
496
494
492
490
488
486
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-19.1
RIVER MILE 116.89

EXHIBIT 30

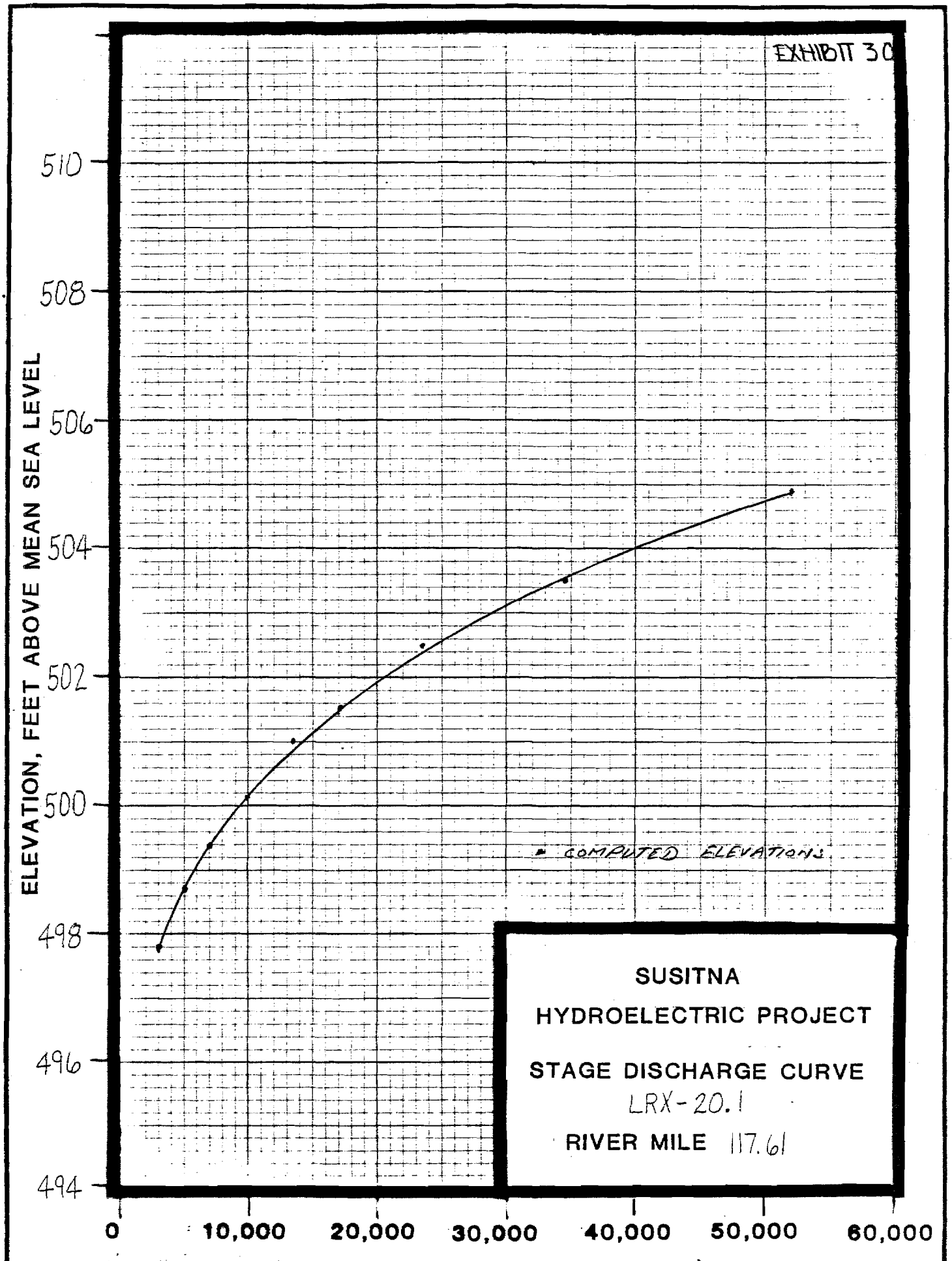
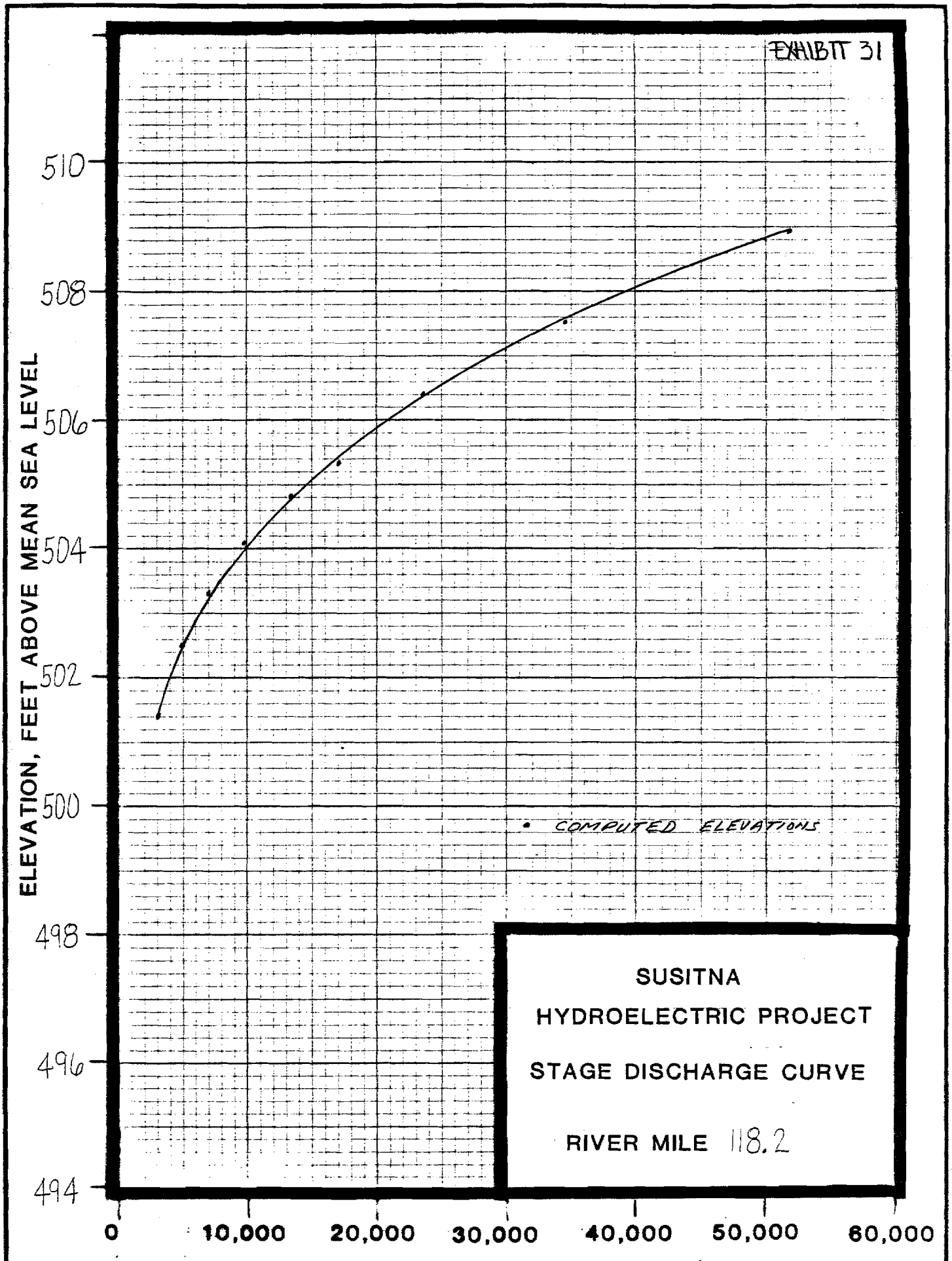

ELEVATION, FEET ABOVE MEAN SEA LEVEL
510
508
506
504
502
500
498
496
494
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
* COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-20.1
RIVER MILE 117.61

EXHIBIT 31


ELEVATION, FEET ABOVE MEAN SEA LEVEL
510
508
506
504
502
500
498
496
494
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 118.2
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

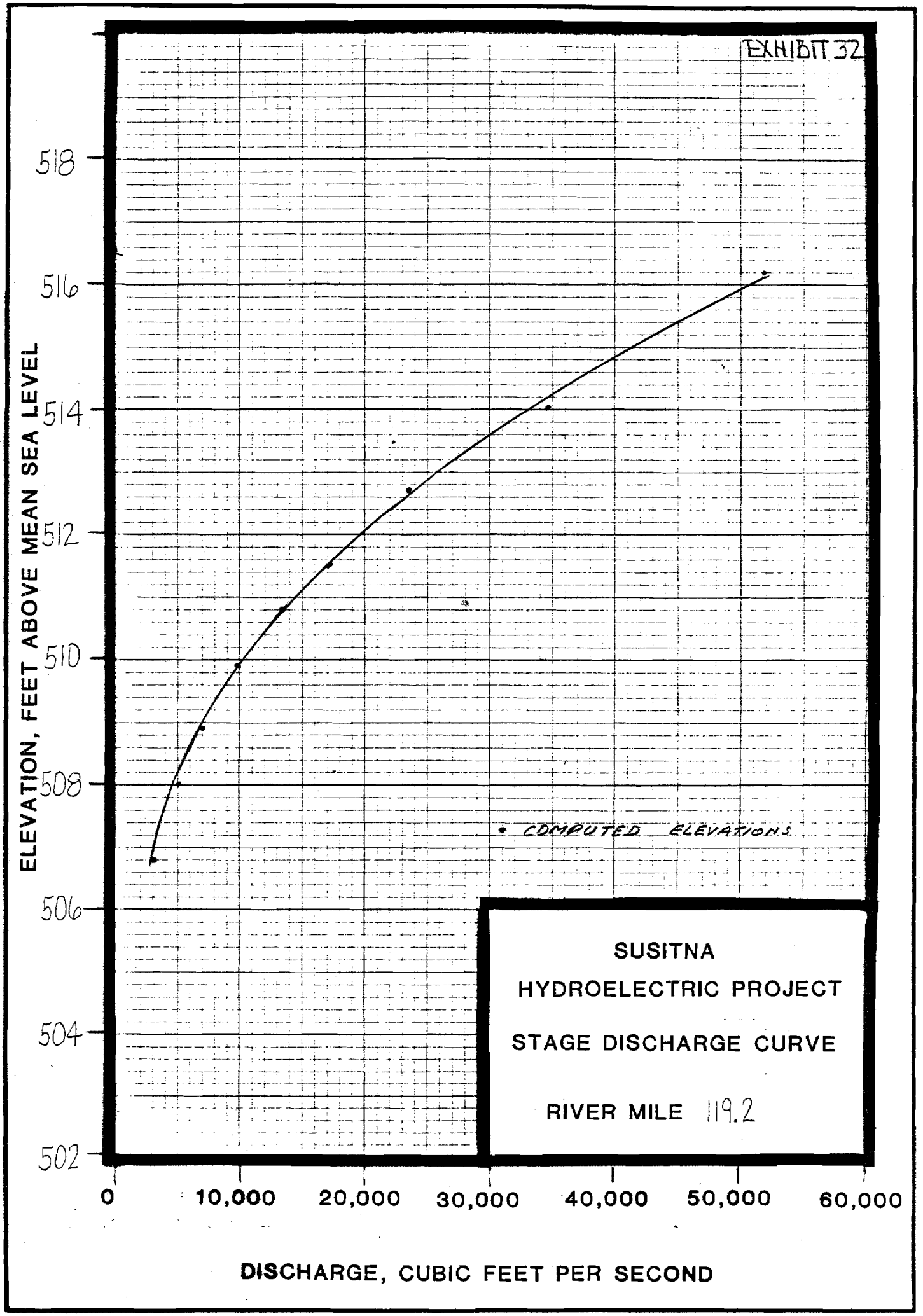
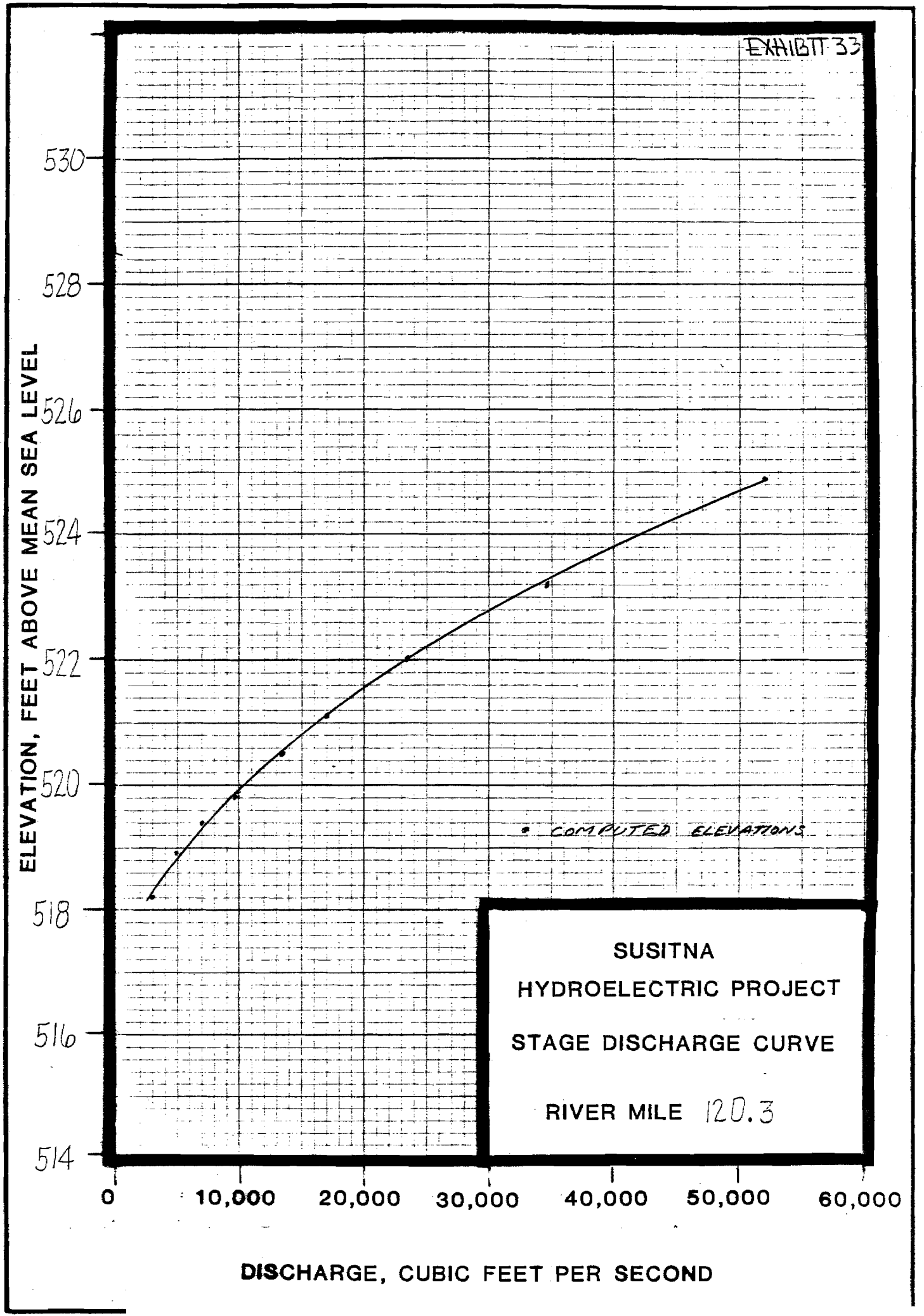


EXHIBIT 32
518
516
514
512
510
508
506
504
502
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 119.2
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 33


ELEVATION, FEET ABOVE MEAN SEA LEVEL
530
528
526
524
522
520
518
516
514
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 120.3

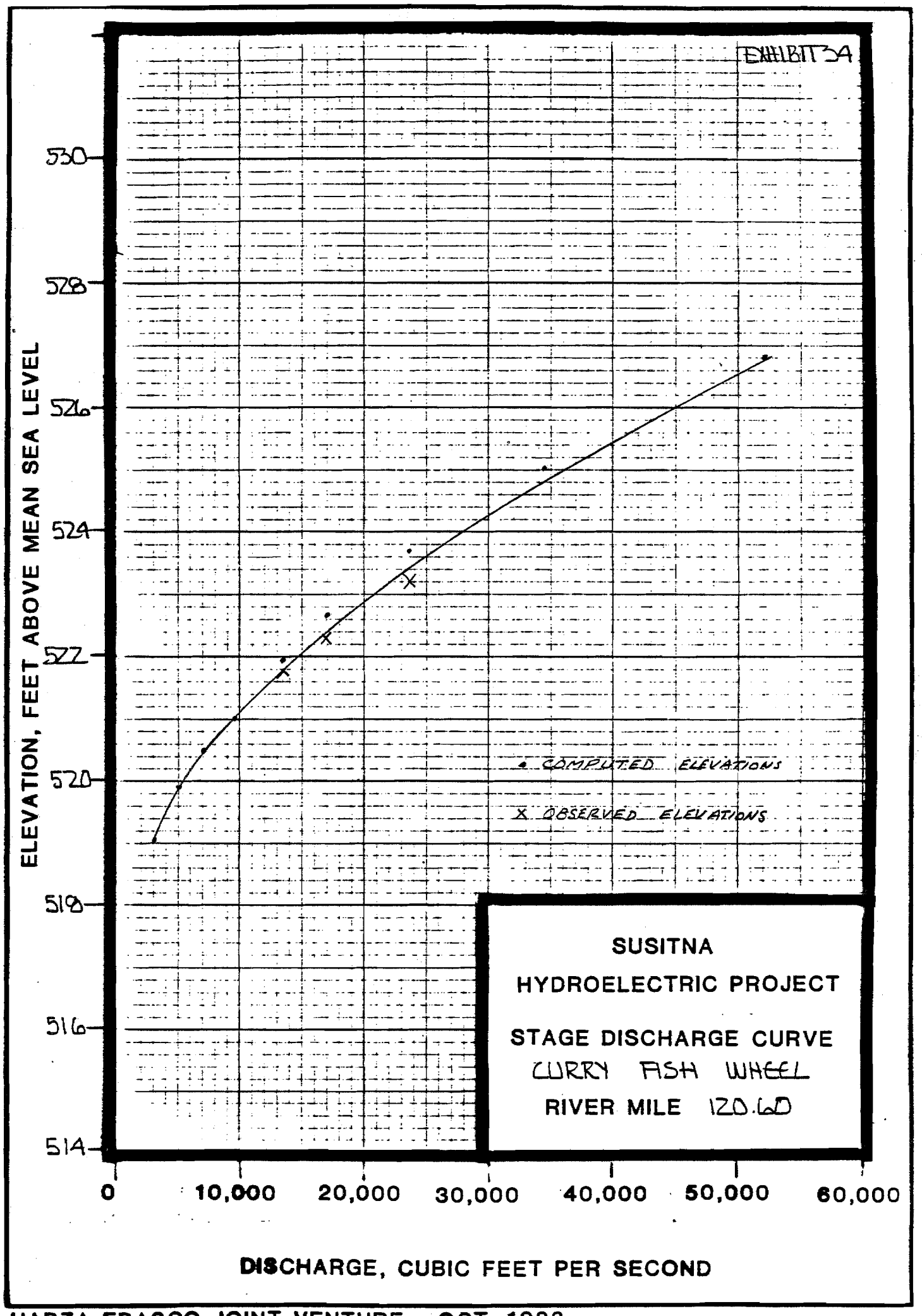


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EXHIBIT 35

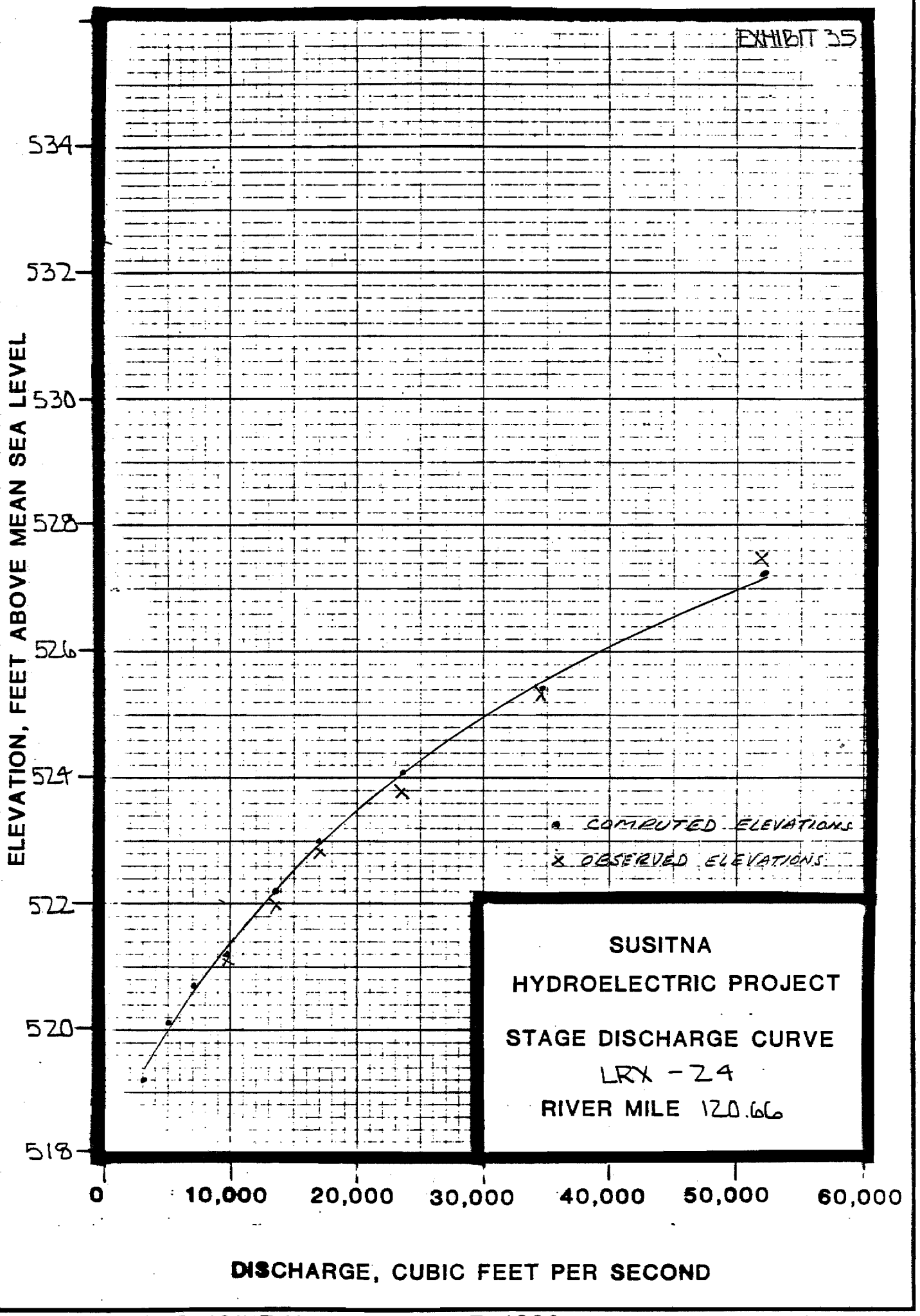

534
532
530
528
526
524
522
520
518
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX - 24
RIVER MILE 120.66

EXHIBIT 36

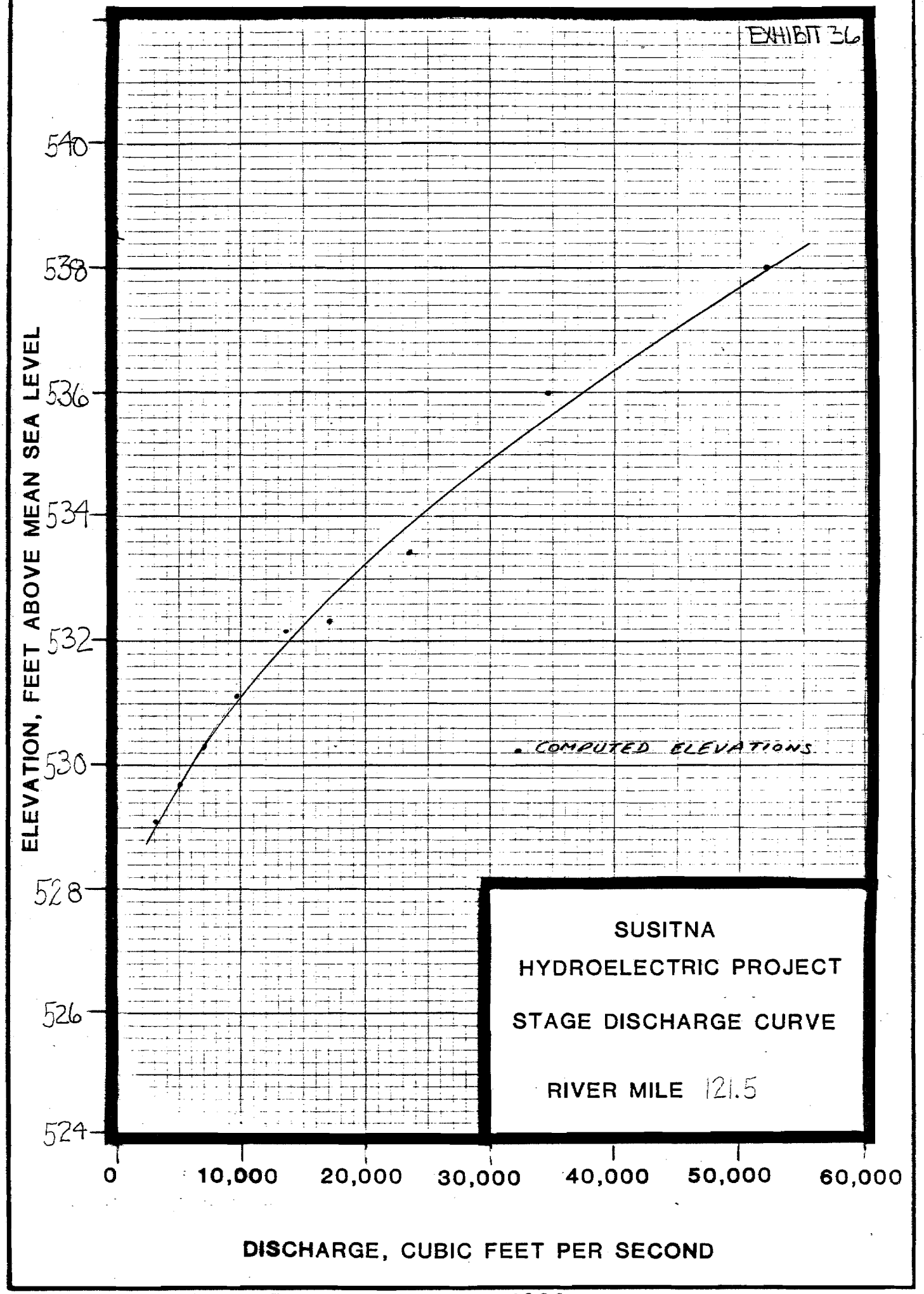

ELEVATION, FEET ABOVE MEAN SEA LEVEL
540
538
536
534
532
530
528
526
524
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 121.5

EXHIBIT 37

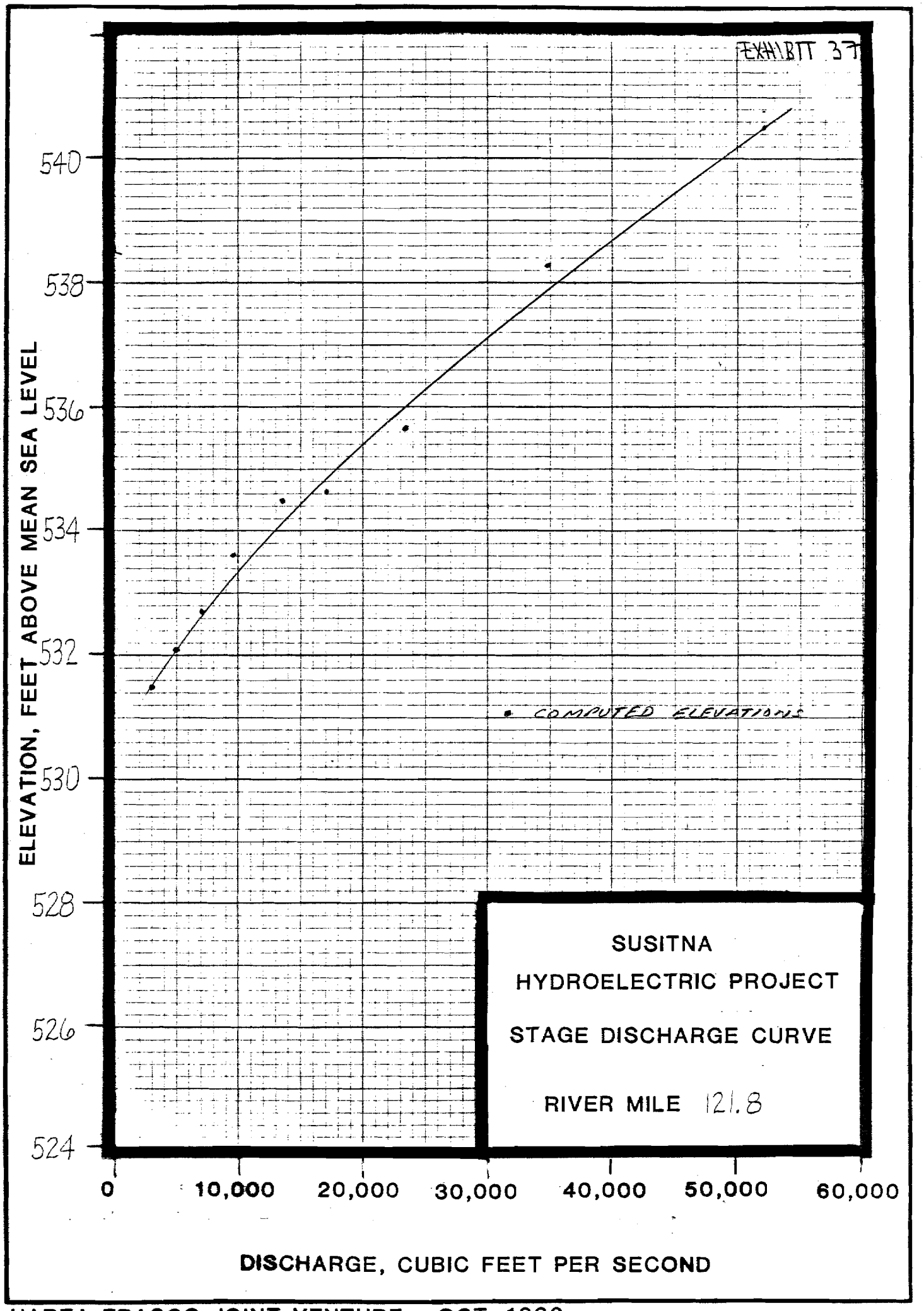

ELEVATION, FEET ABOVE MEAN SEA LEVEL
540
538
536
534
532
530
528
526
524
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 121.8

EXHIBIT 38

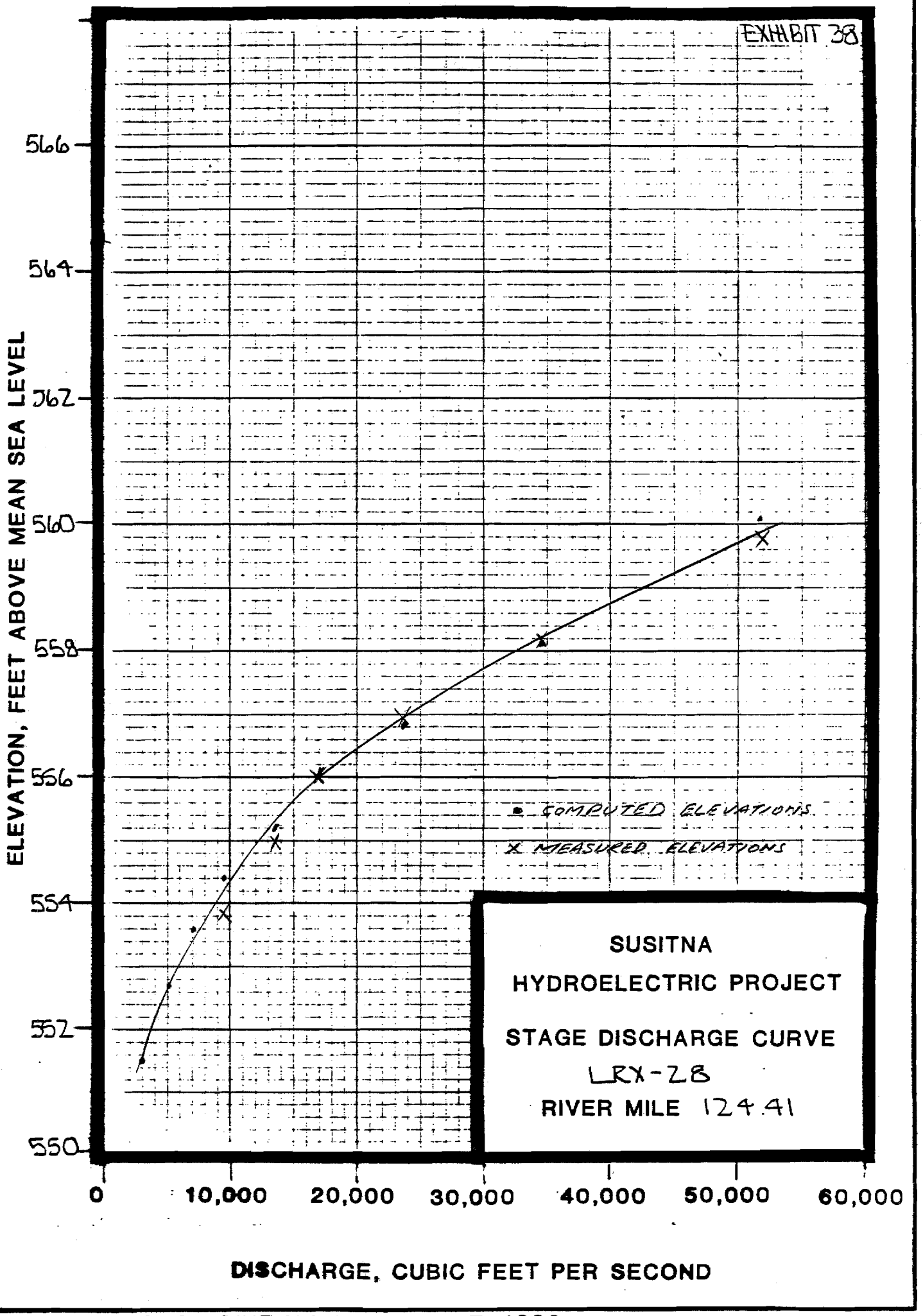

566
564
562
560
558
556
554
552
550
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
COMPUTED ELEVATIONS
MEASURED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-28
RIVER MILE 124.41

EXHIBIT 39

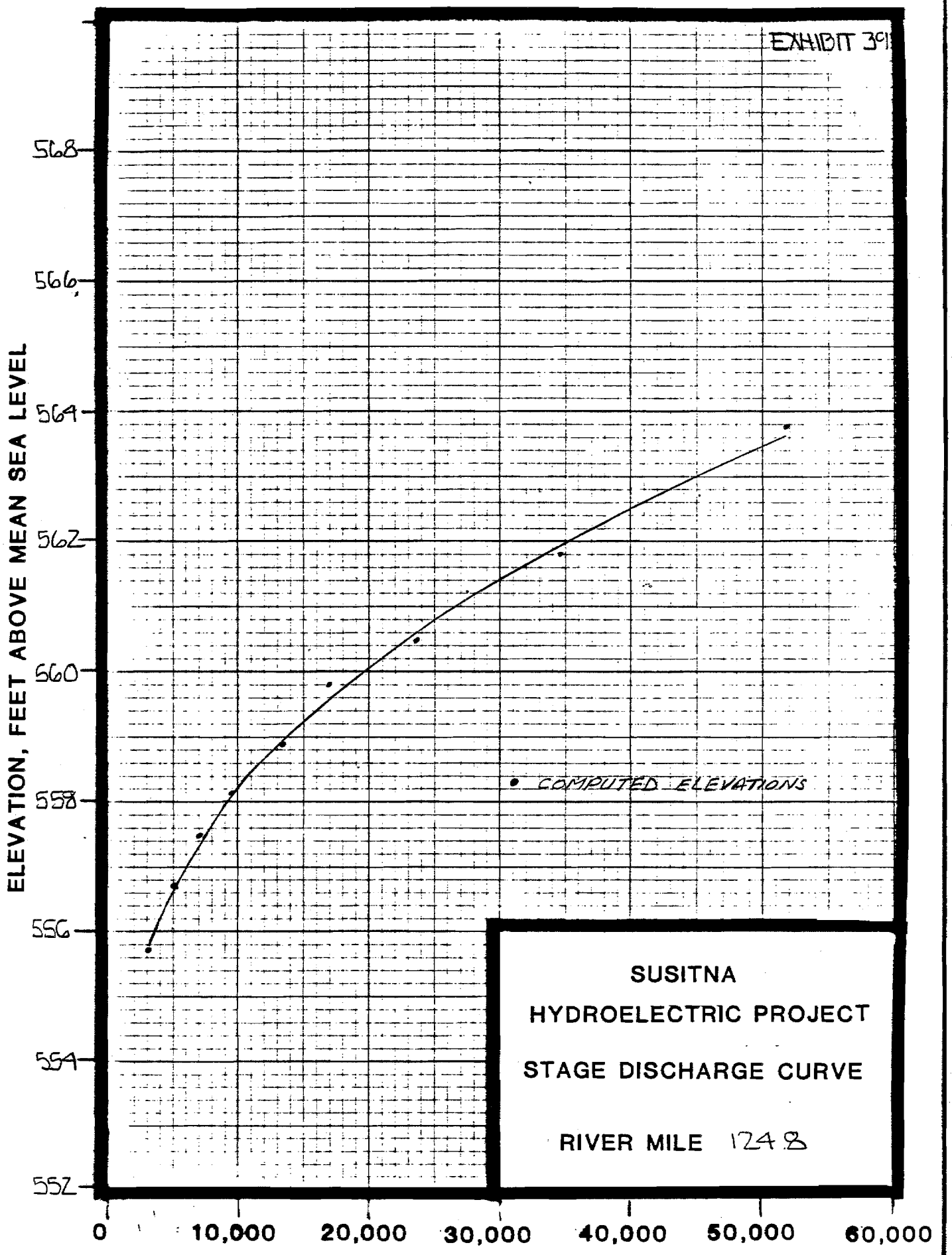
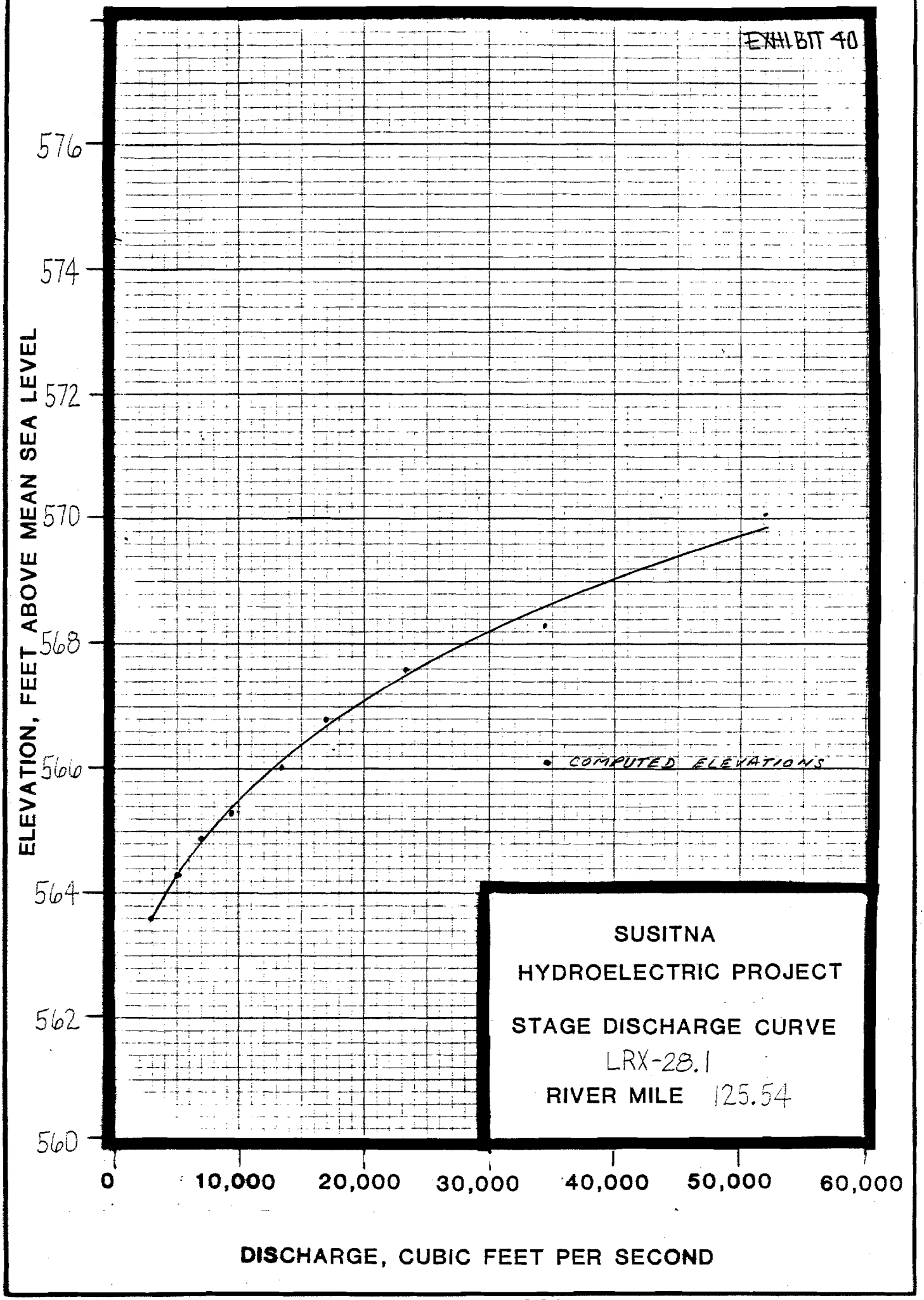

ELEVATION, FEET ABOVE MEAN SEA LEVEL
568
566
564
562
560
558
556
554
552
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 124.8

EXHIBIT 40



SUSITNA
HYDROELECTRIC PROJECT

STAGE DISCHARGE CURVE
LRX-28.1
RIVER MILE 125.54

EXHIBIT 41

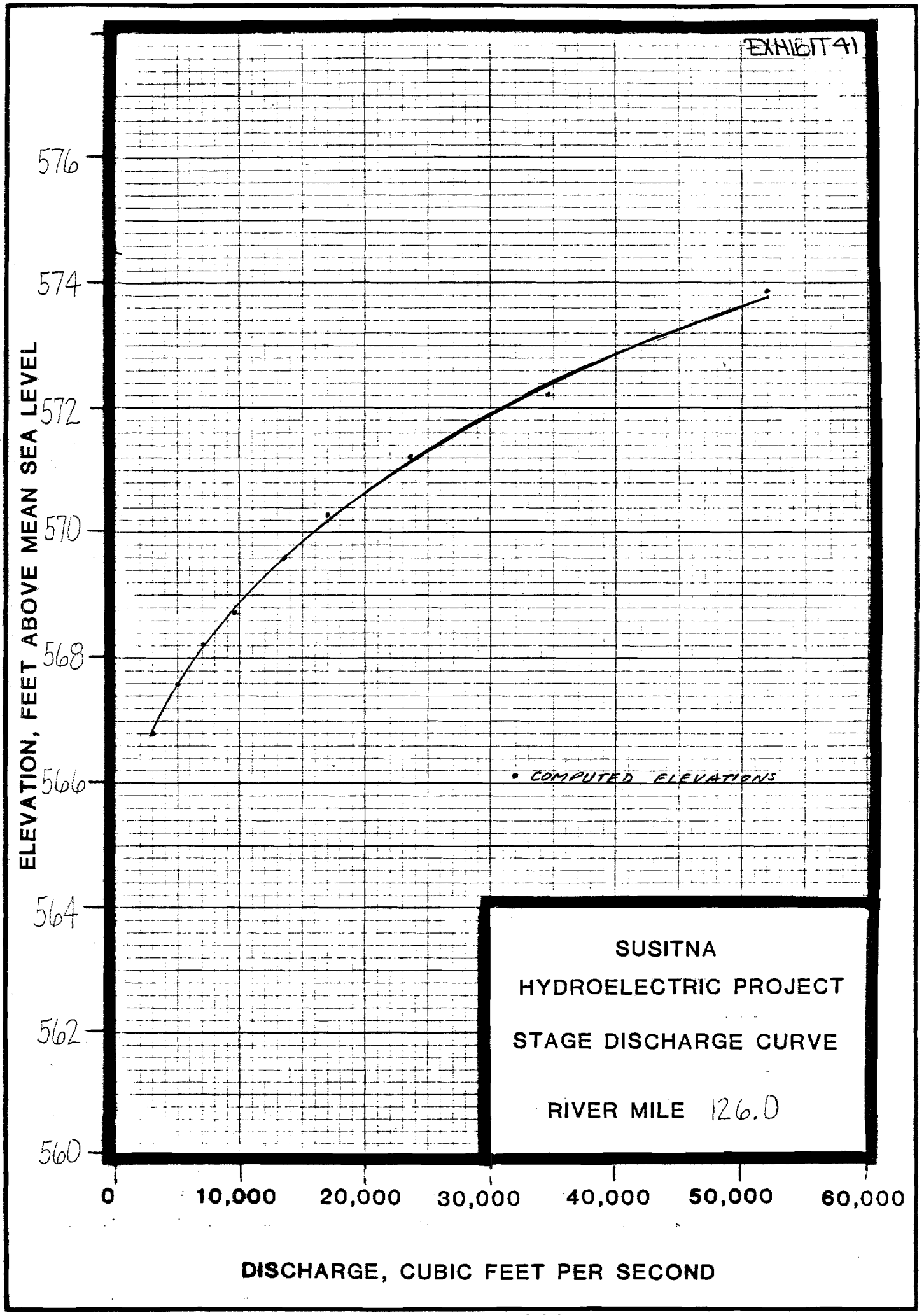
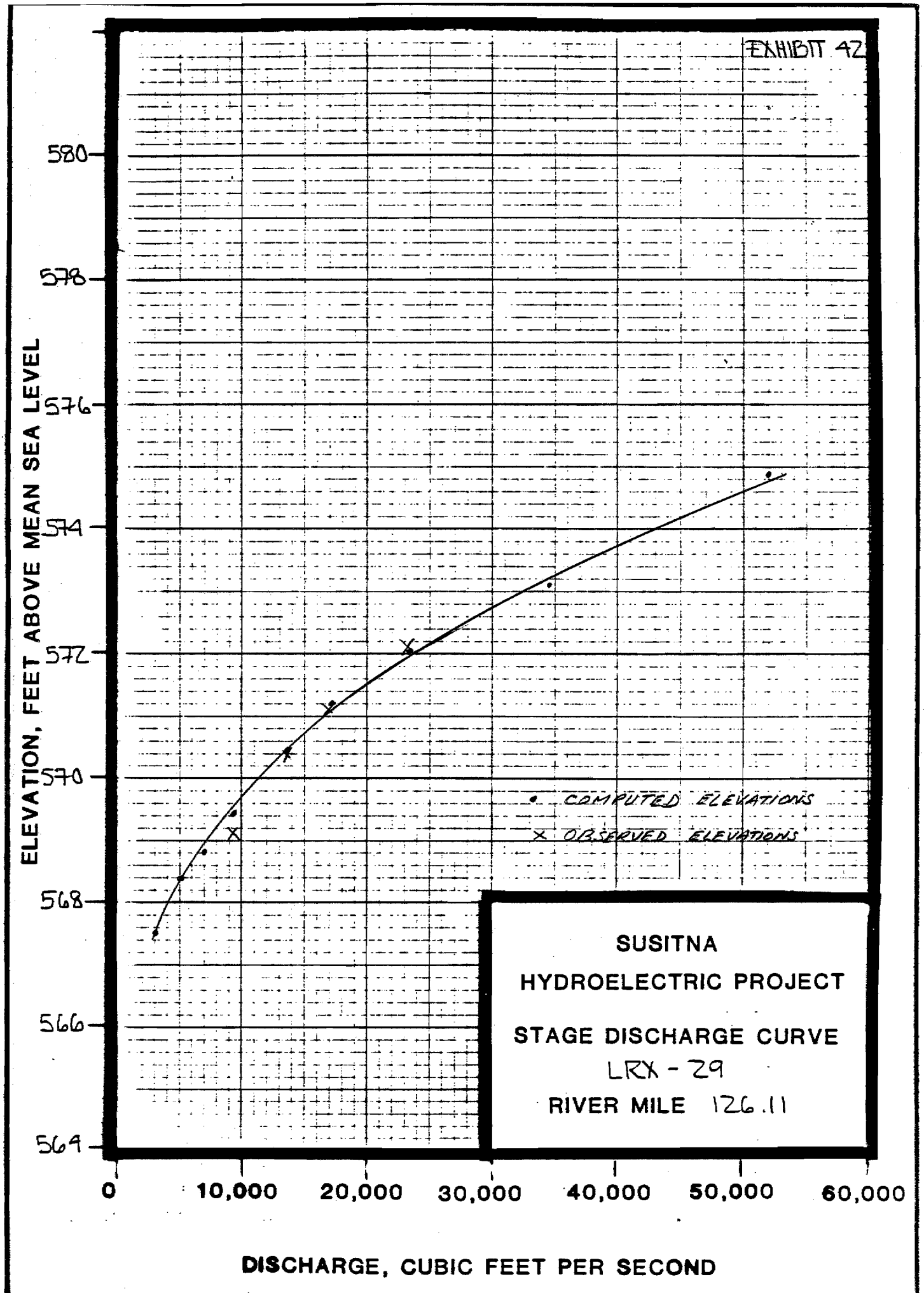

576
574
572
570
568
566
564
562
560
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 126.0

EXHIBIT 42



SUSITNA

HYDROELECTRIC PROJECT

STAGE DISCHARGE CURVE

LRX - 29

RIVER MILE 126.11

HARZA EBASCO JOINT VENTURE OCT 1983

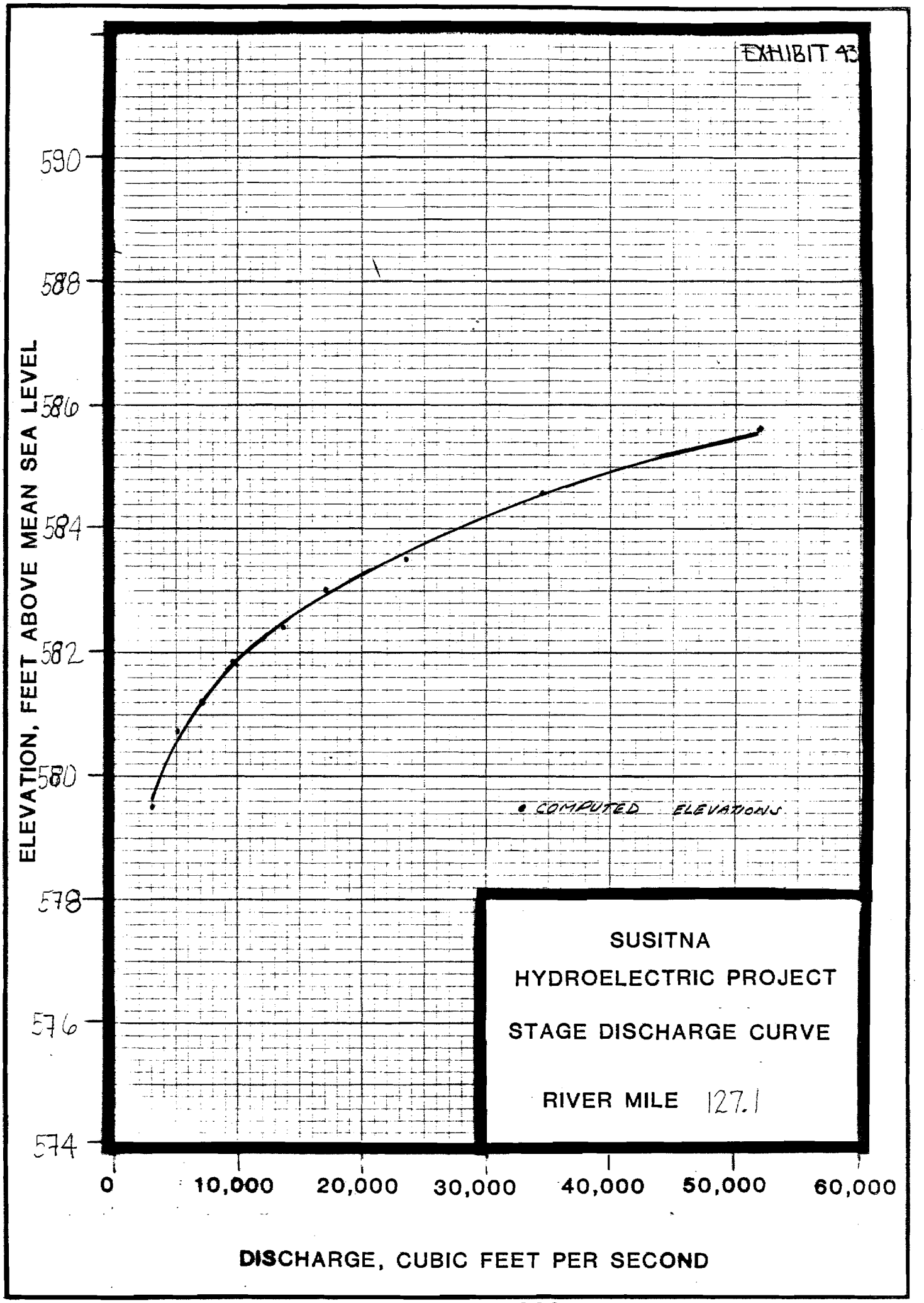


EXHIBIT 43
590
588
586
584
582
580
578
576
574
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 127.1
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 44

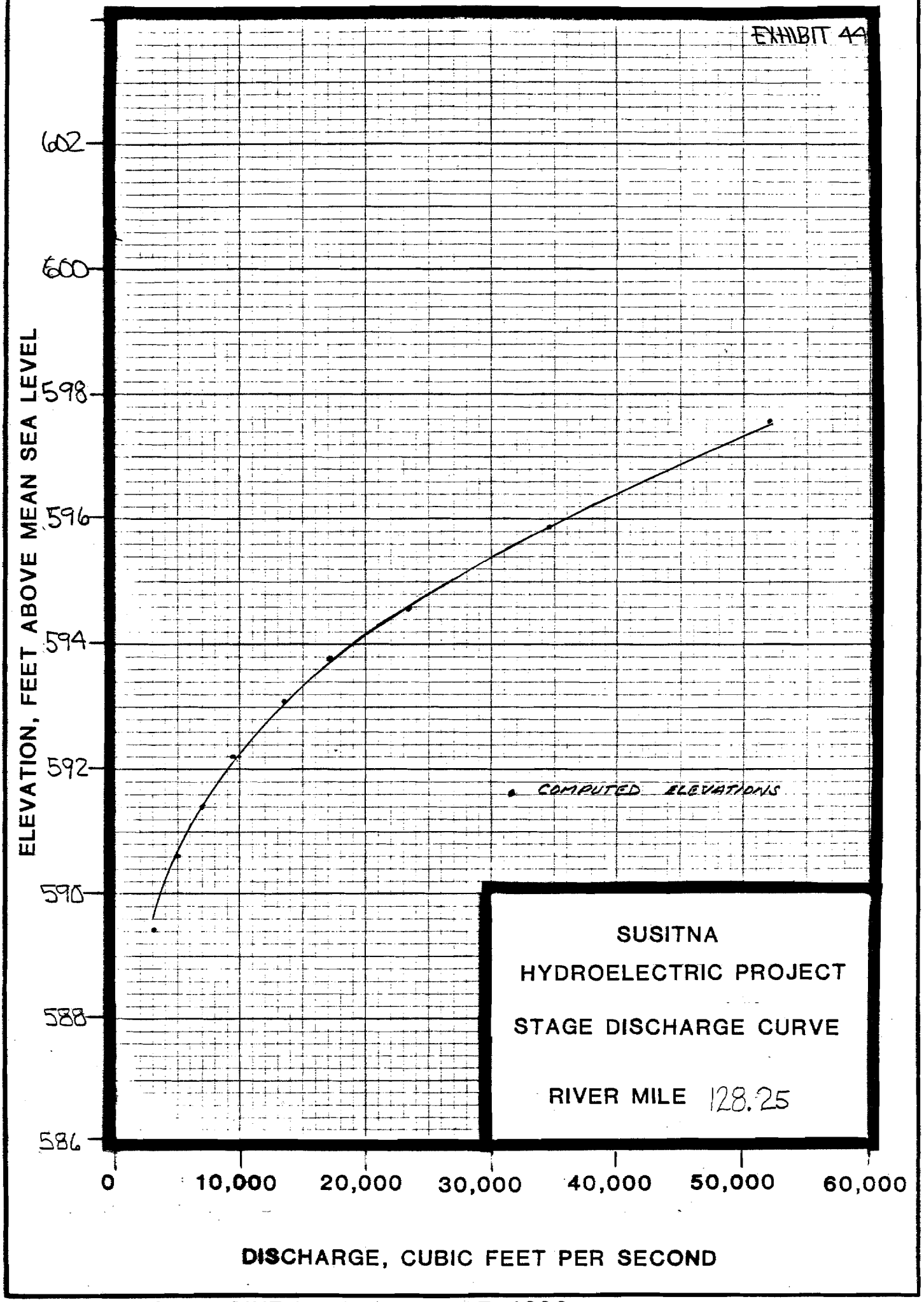
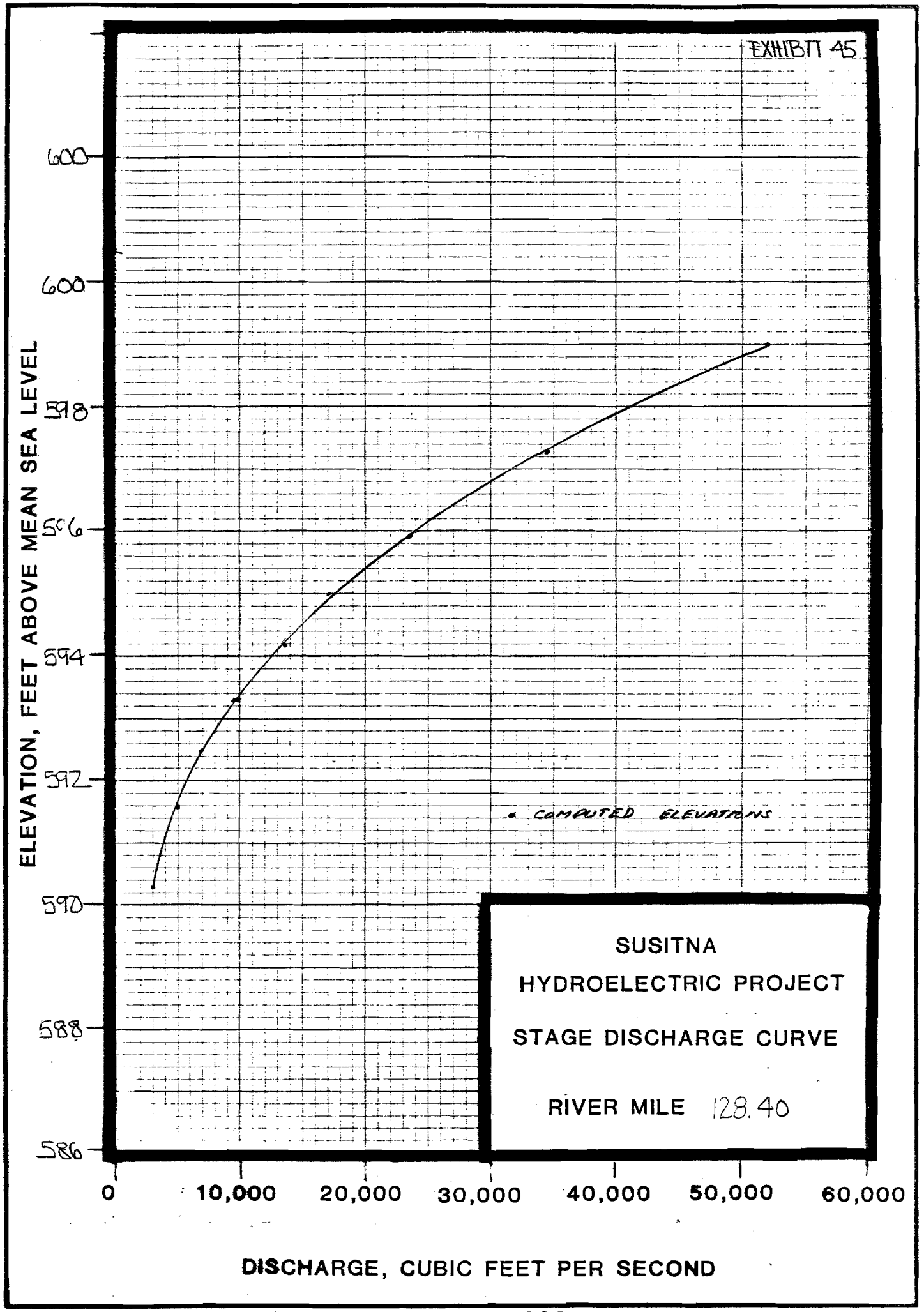

602
600
598
596
594
592
590
588
586
ELEVATION, FEET ABOVE MEAN SEA LEVEL
COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 128.25
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 45



SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 128.40

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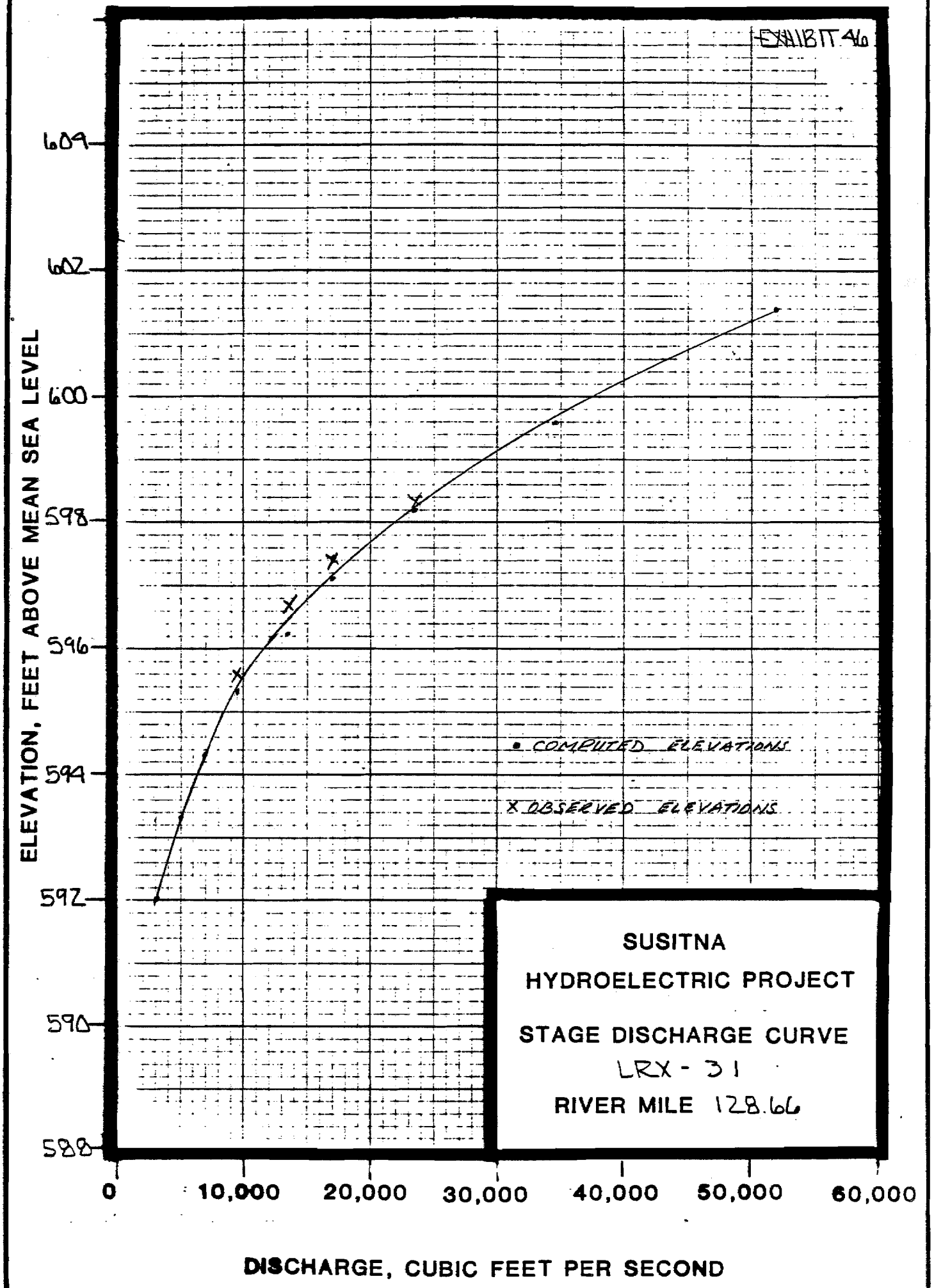
EXHIBIT 46



HARZA EBASCO JOINT VENTURE OCT 1983

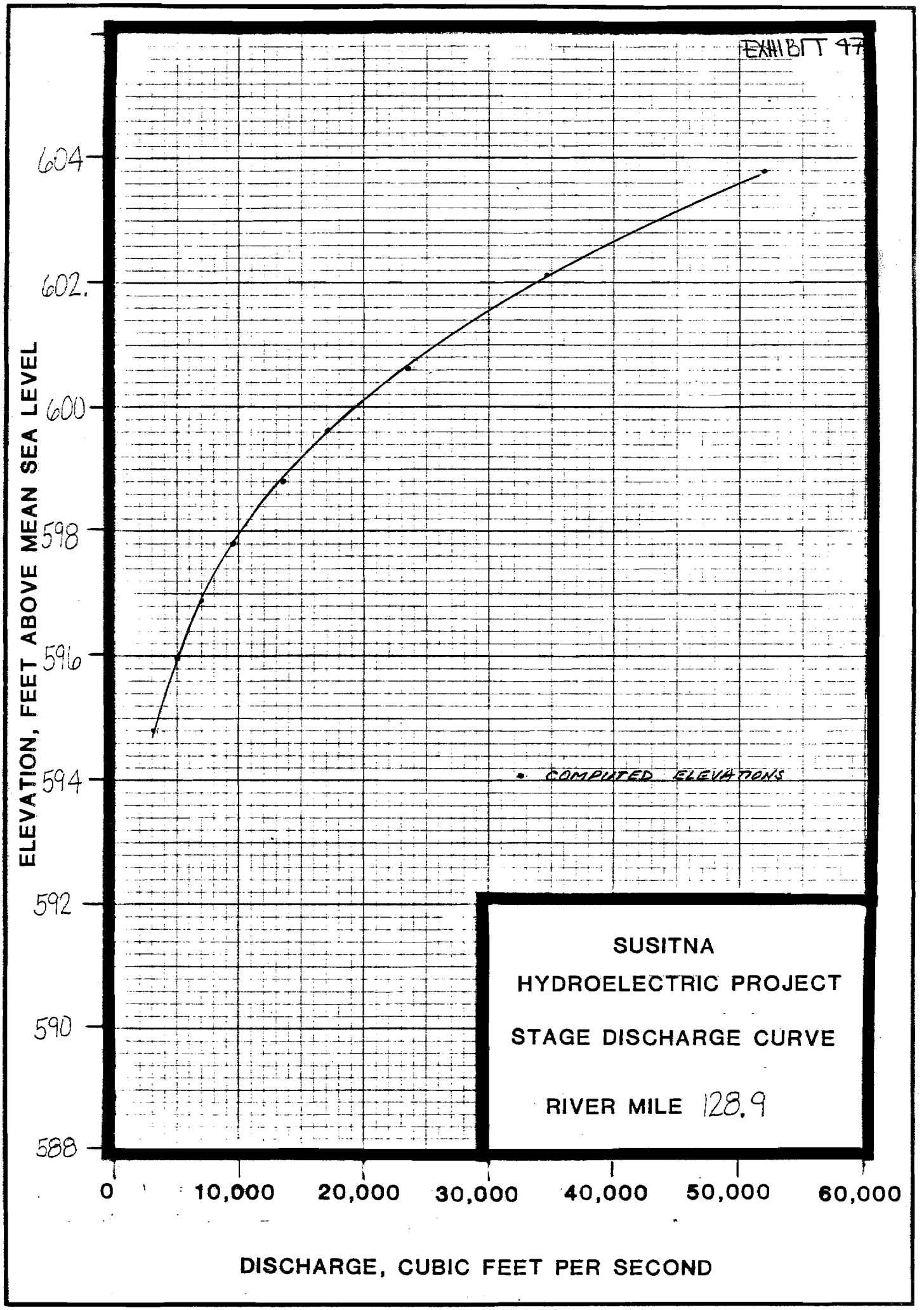


EXHIBIT 47
604
602
600
598
596
594
592
590
588
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 128.9
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 4C

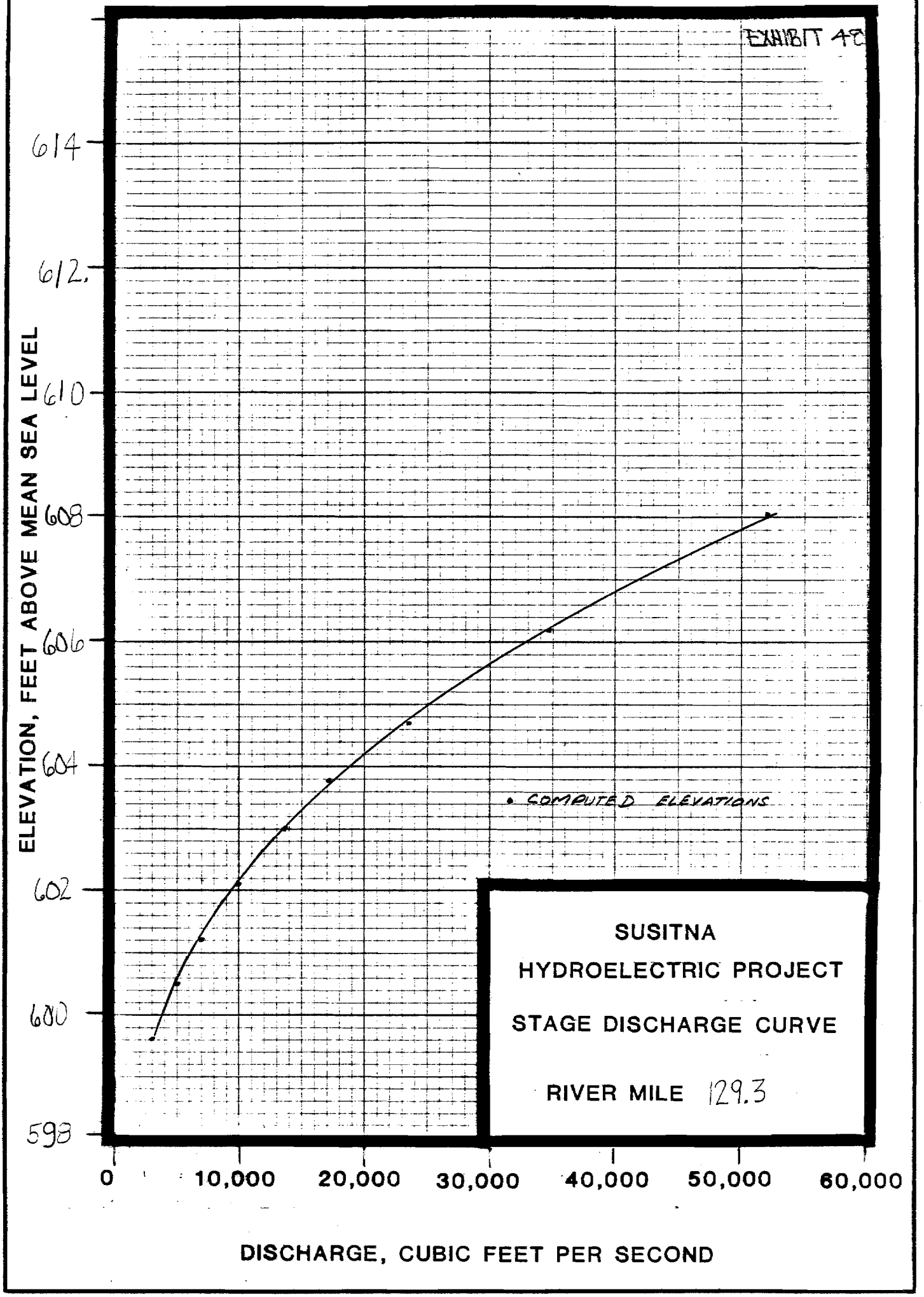
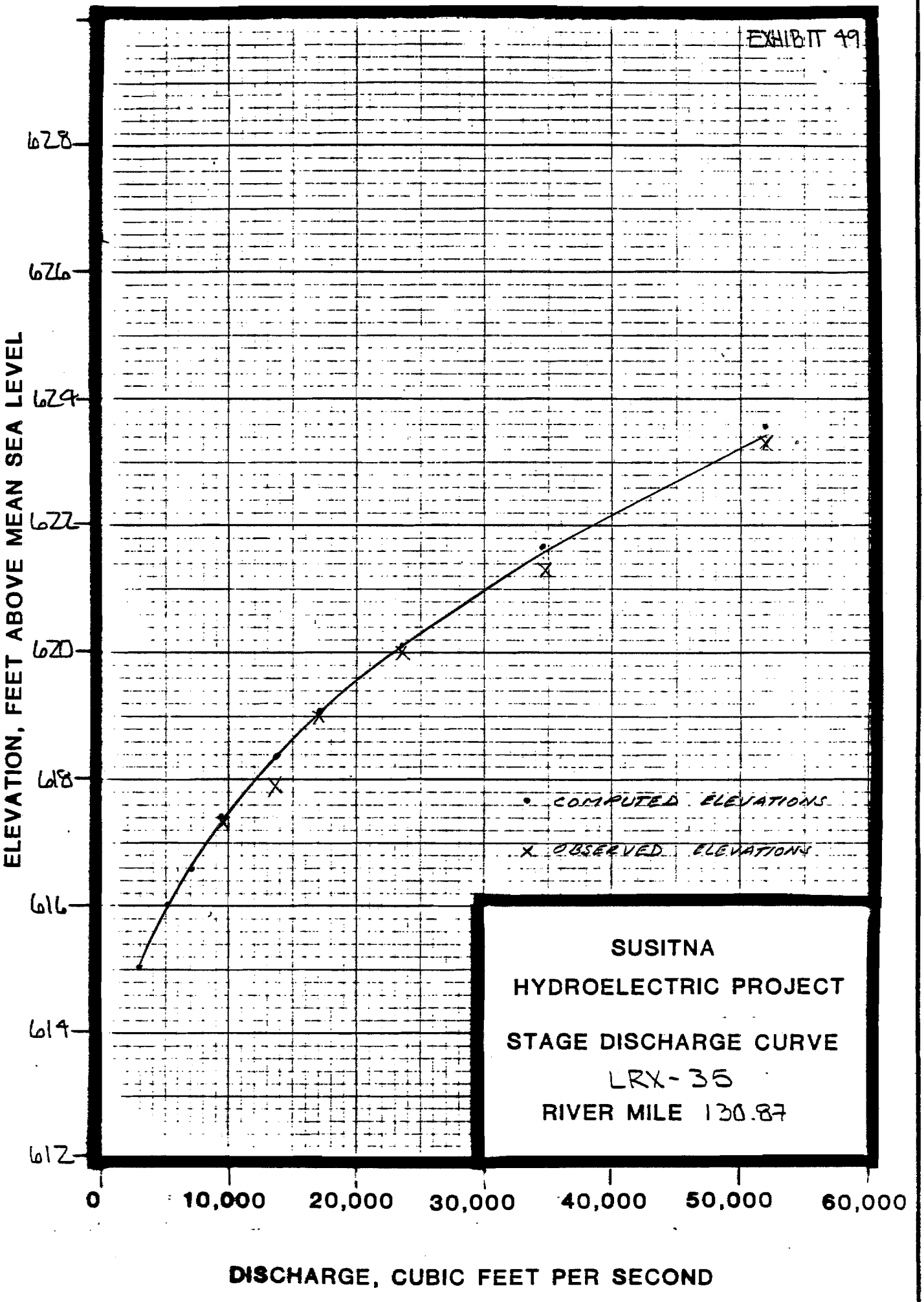

614
612
610
608
606
604
602
600
598
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 129.3

EXHIBIT 49



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 50

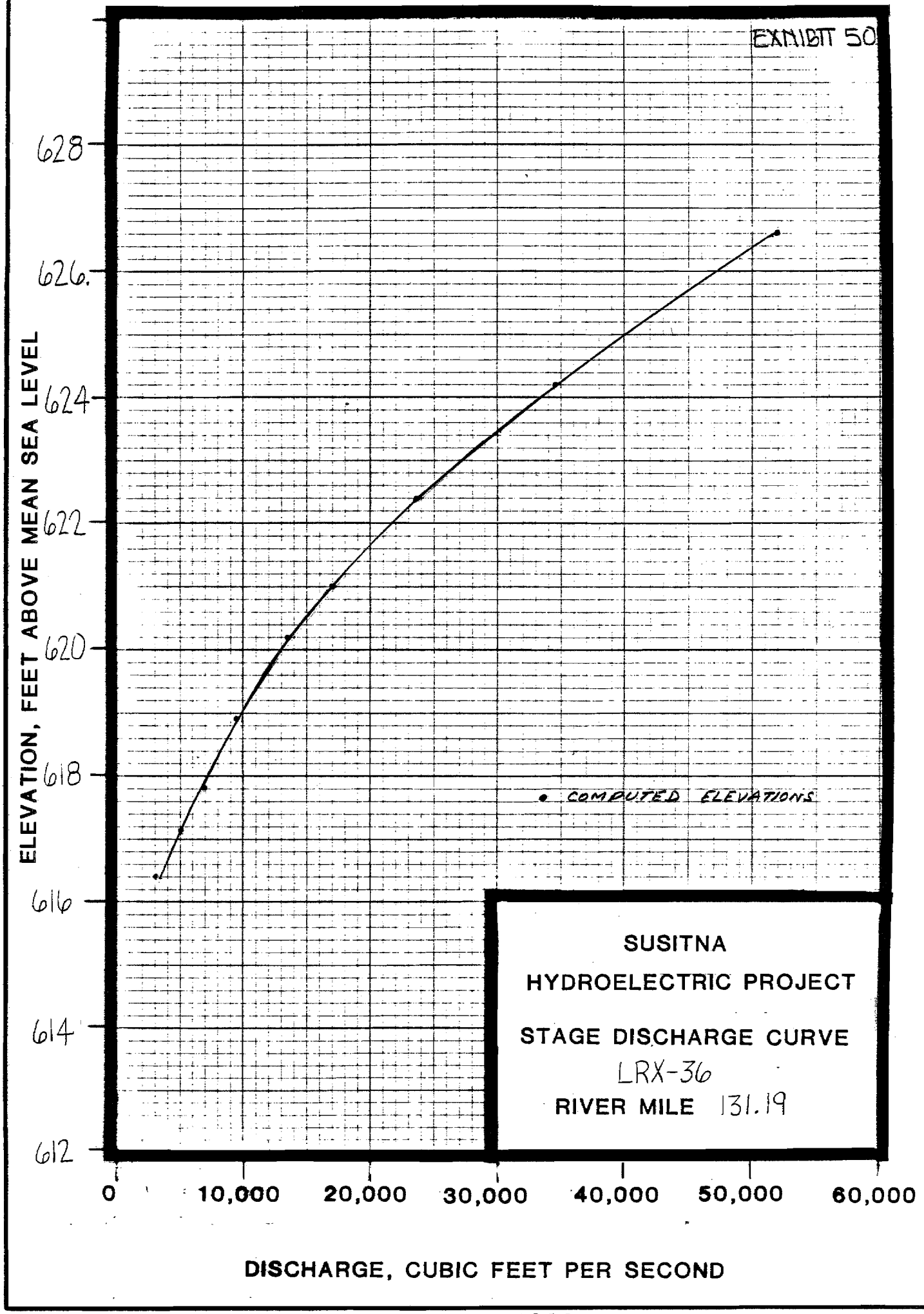

628
626
624
622
620
618
616
614
612
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-36
RIVER MILE 131.19

EXHIBIT 51

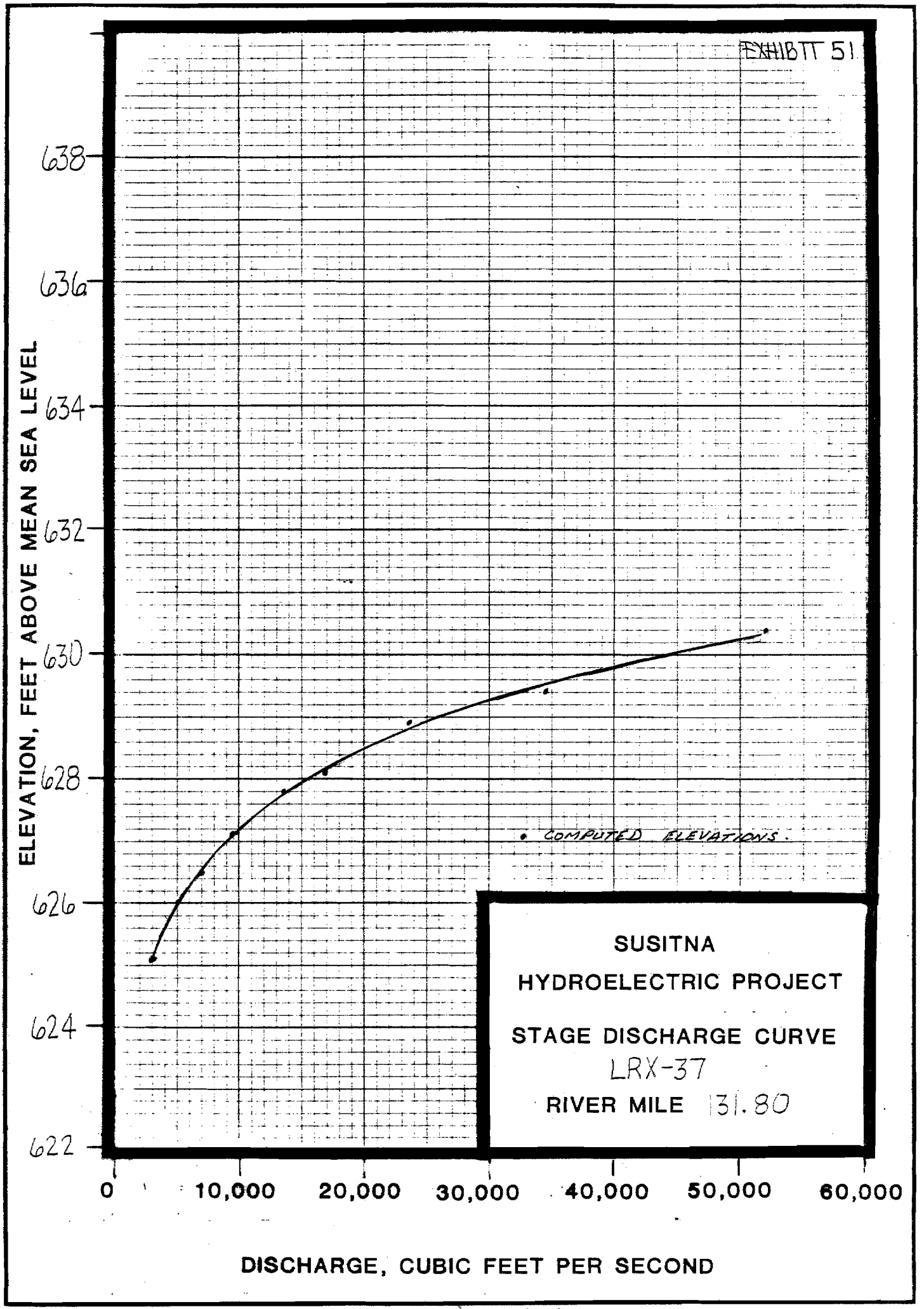


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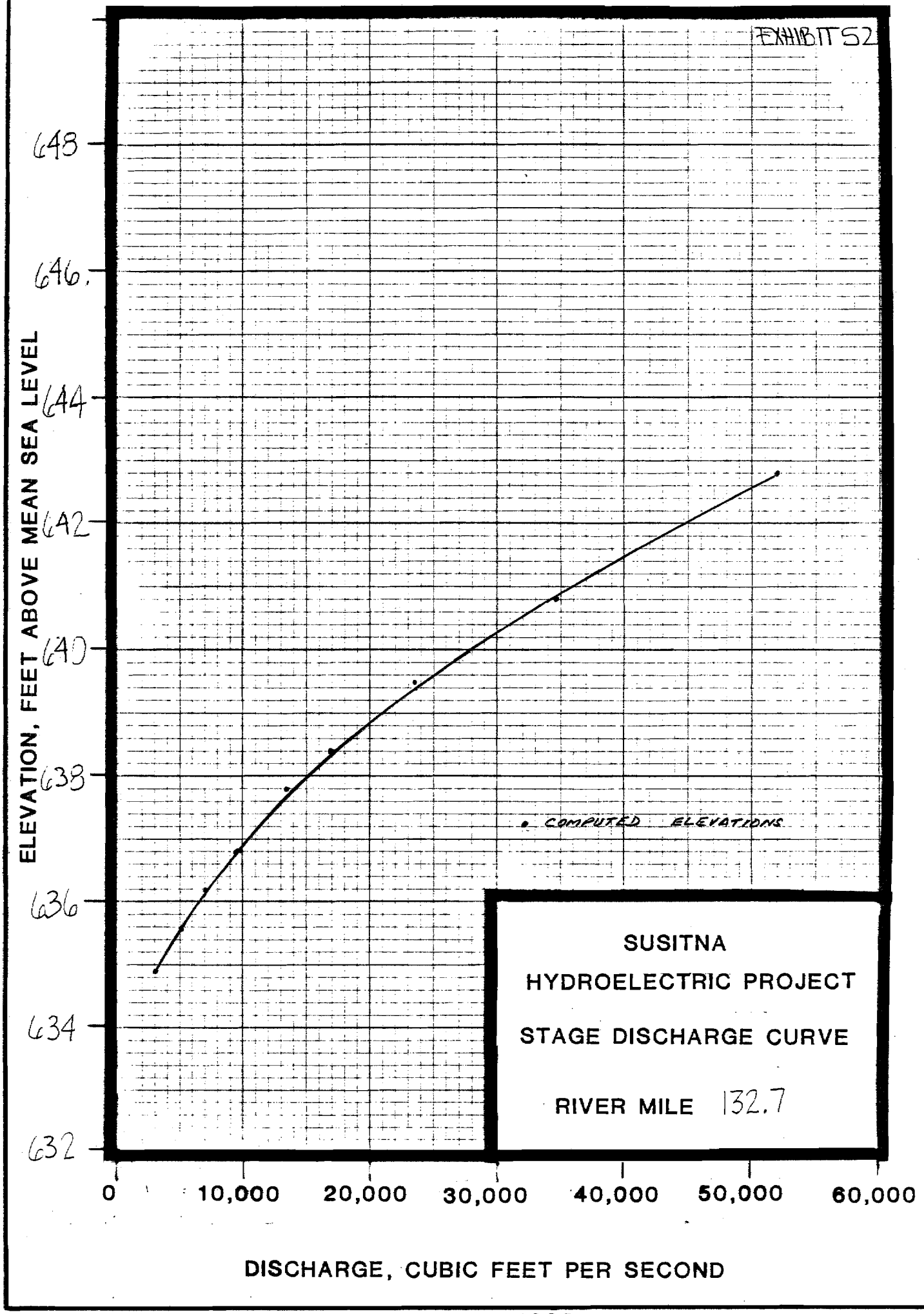
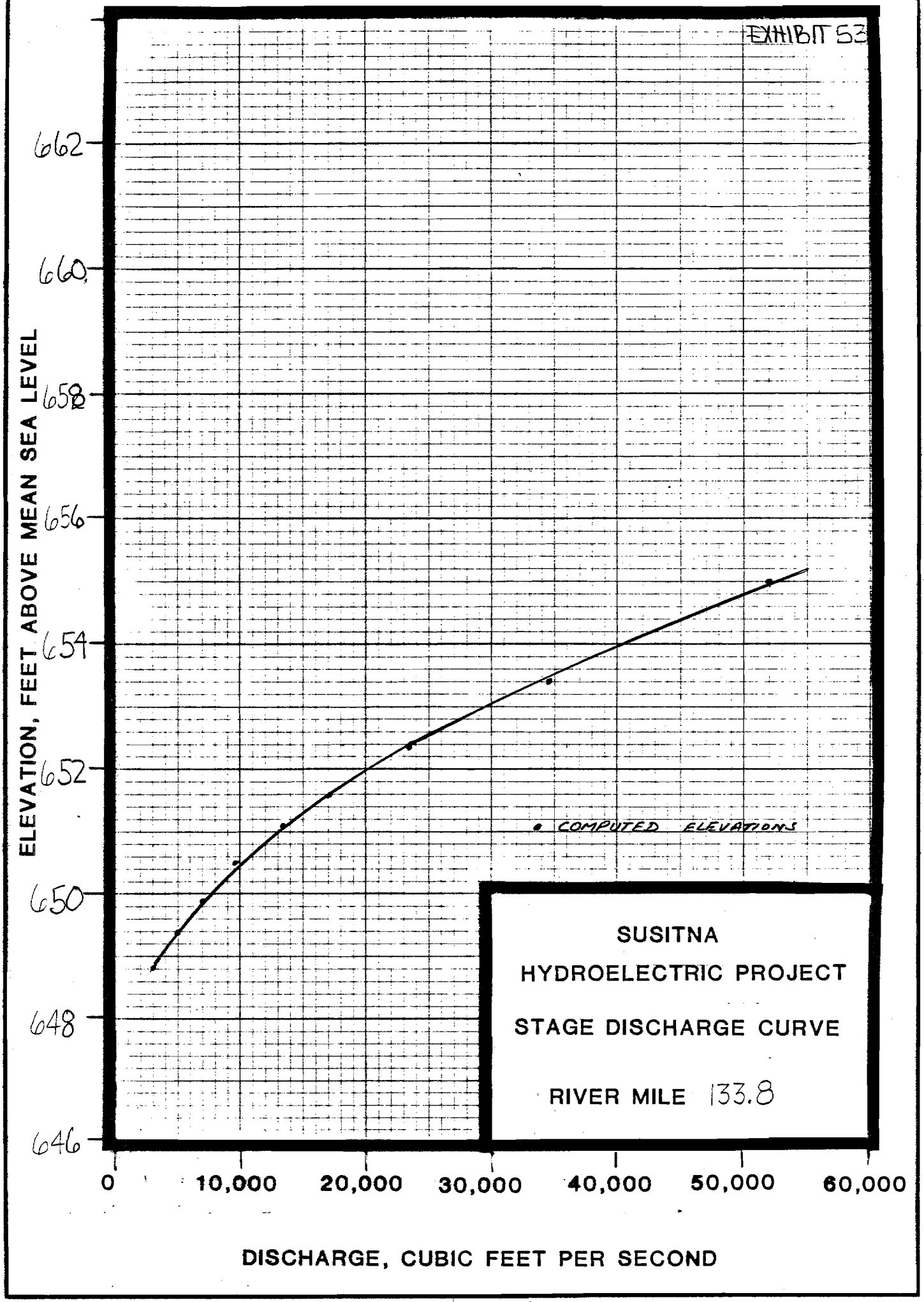
EXHIBIT S2



HARZA-EBASCO JOINT VENTURE OCT. 1983

EXHIBIT 53


662
660
658
656
654
652
650
648
646
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 133.8

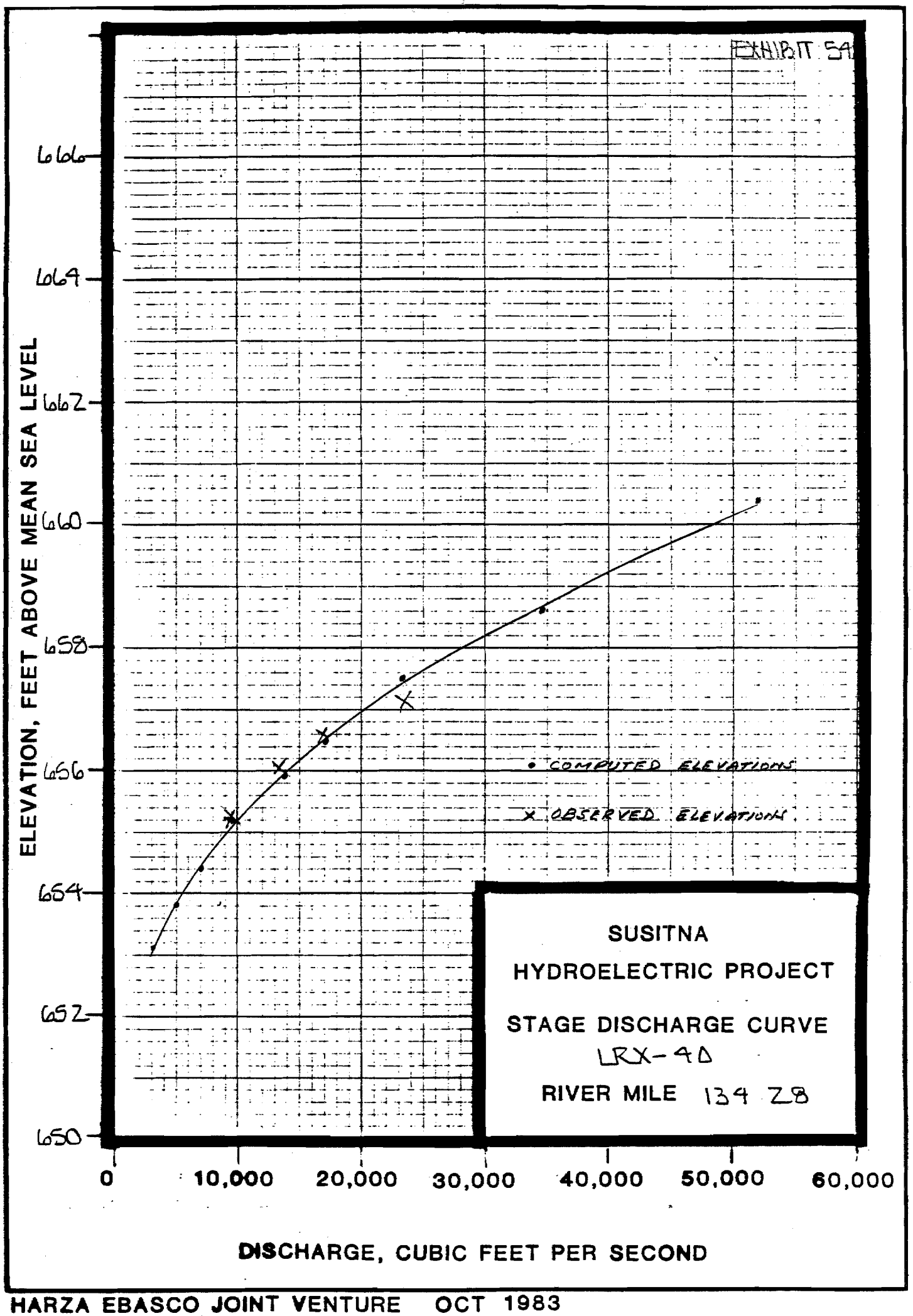
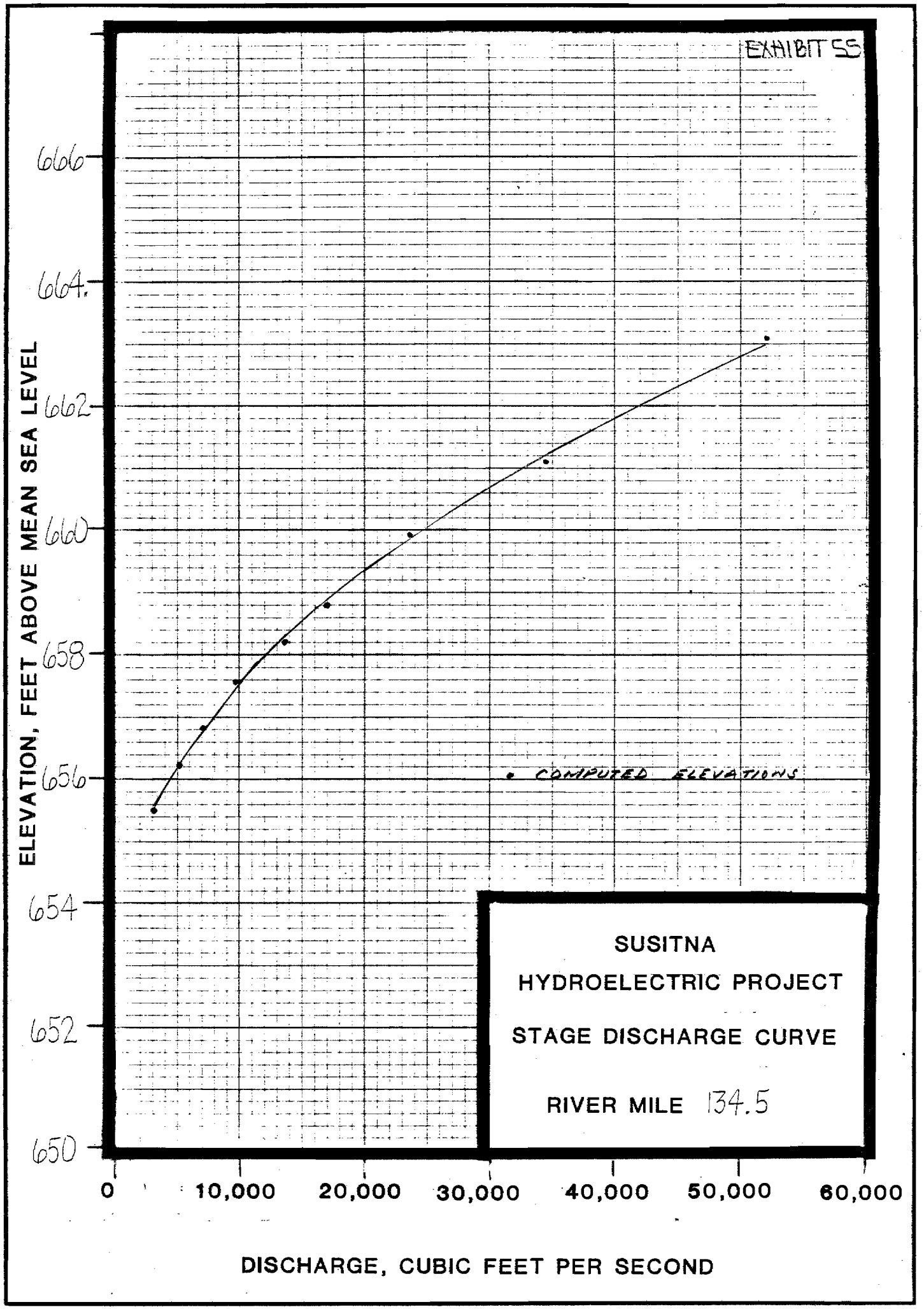


EXHIBIT 5A
ELEVATION, FEET ABOVE MEAN SEA LEVEL
1066
1064
1062
1060
1058
1056
1054
1052
1050
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-40
RIVER MILE 134.2.8
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 55



HARZA-EBASCO JOINT VENTURE OCT. 1983

EXHIBIT 56

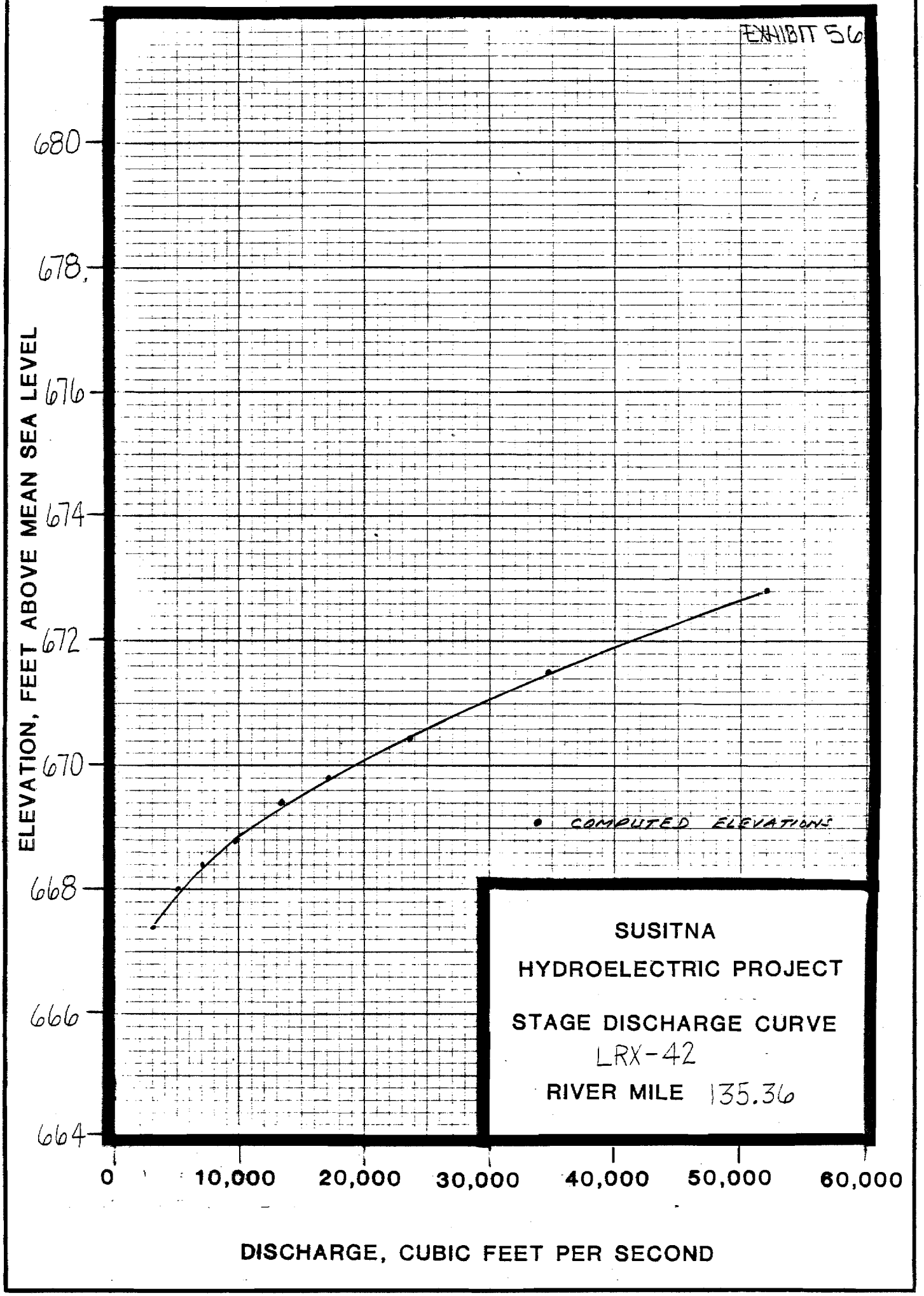

680
678
676
674
672
670
668
666
664
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-42
RIVER MILE 135.36

EXHIBIT 57

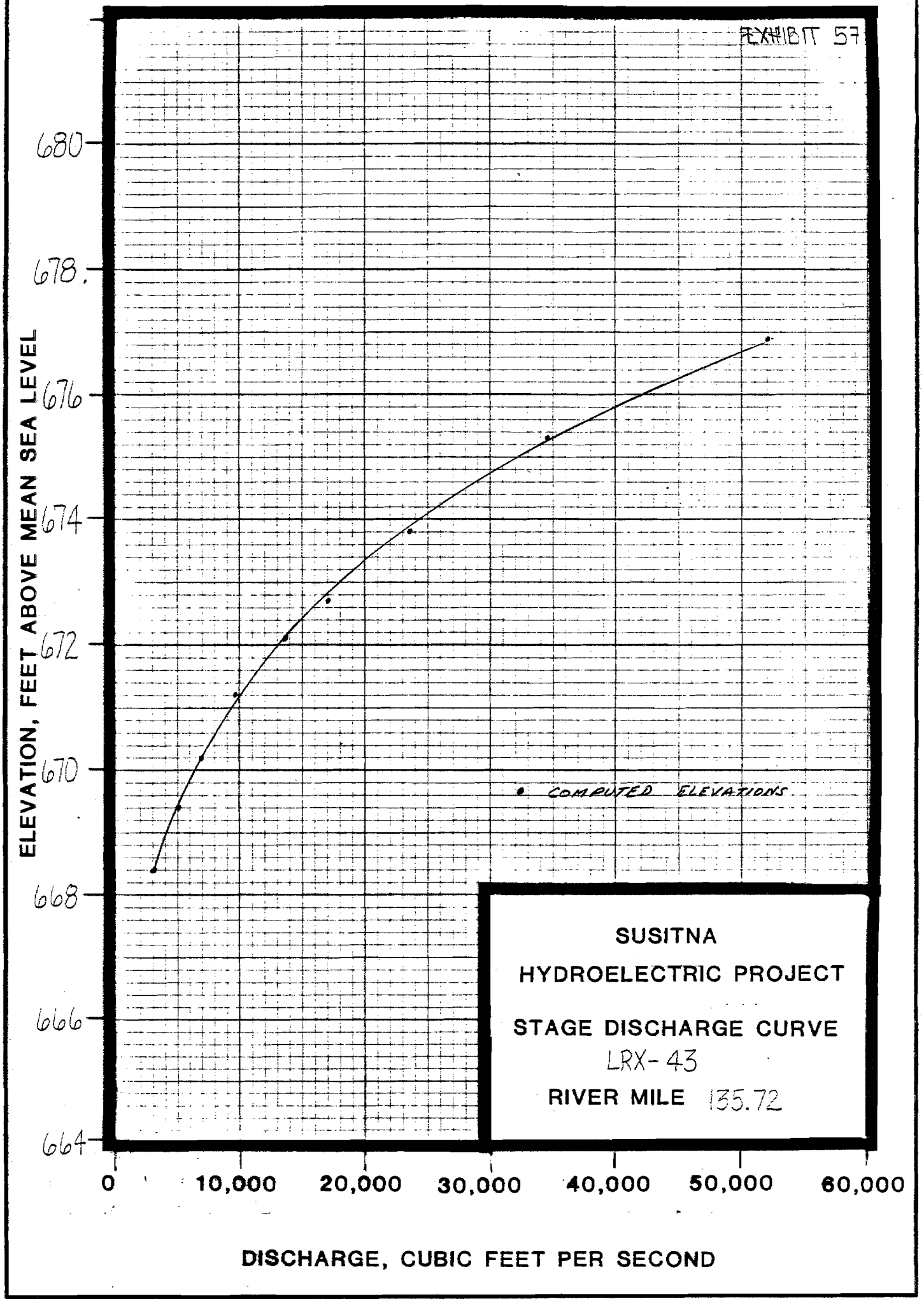
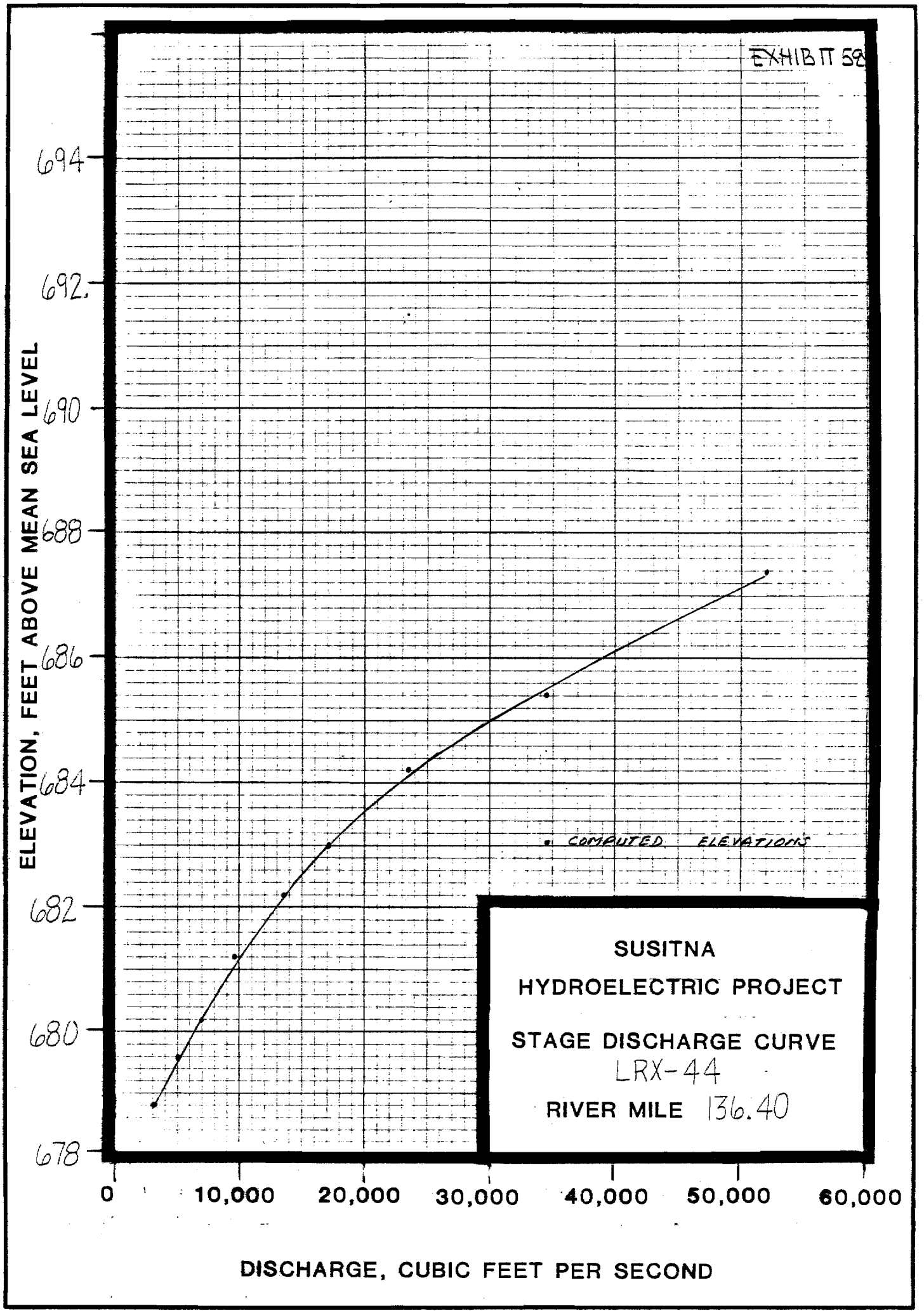
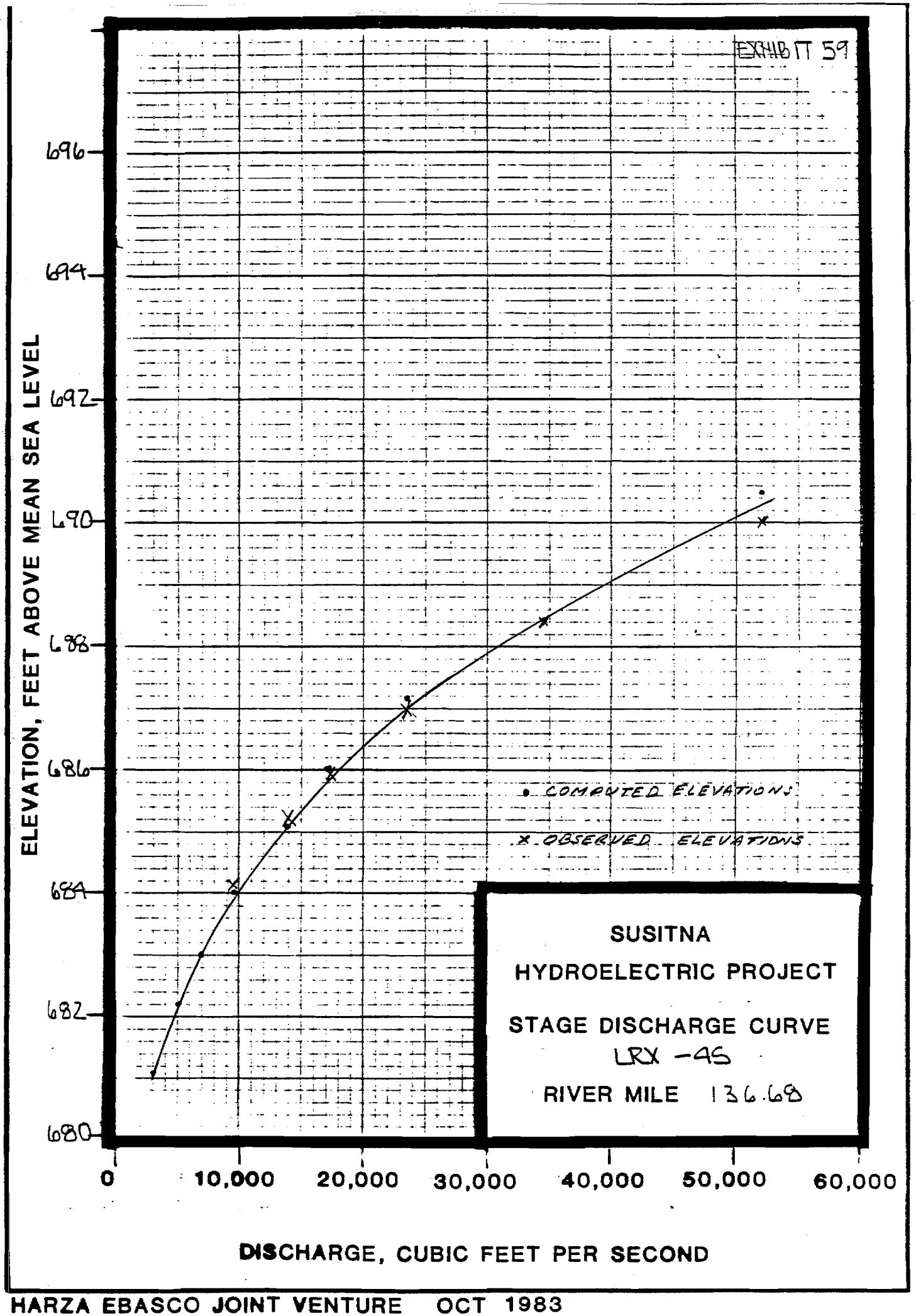

680
678
676
674
672
670
668
666
664
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-43
RIVER MILE 135.72

EXHIBIT 58


694
692
690
688
686
684
682
680
678
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-44
RIVER MILE 136.40



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 60

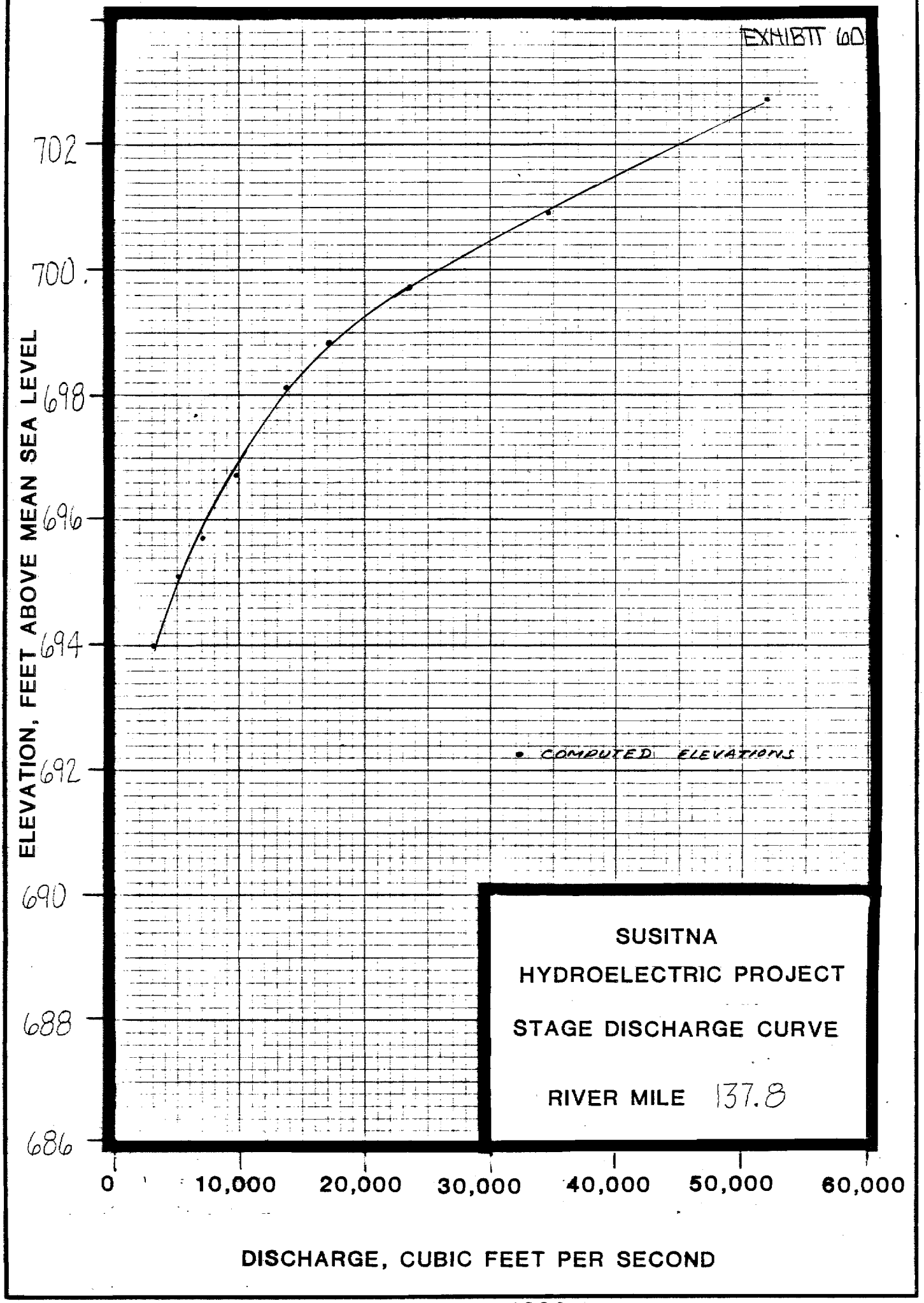
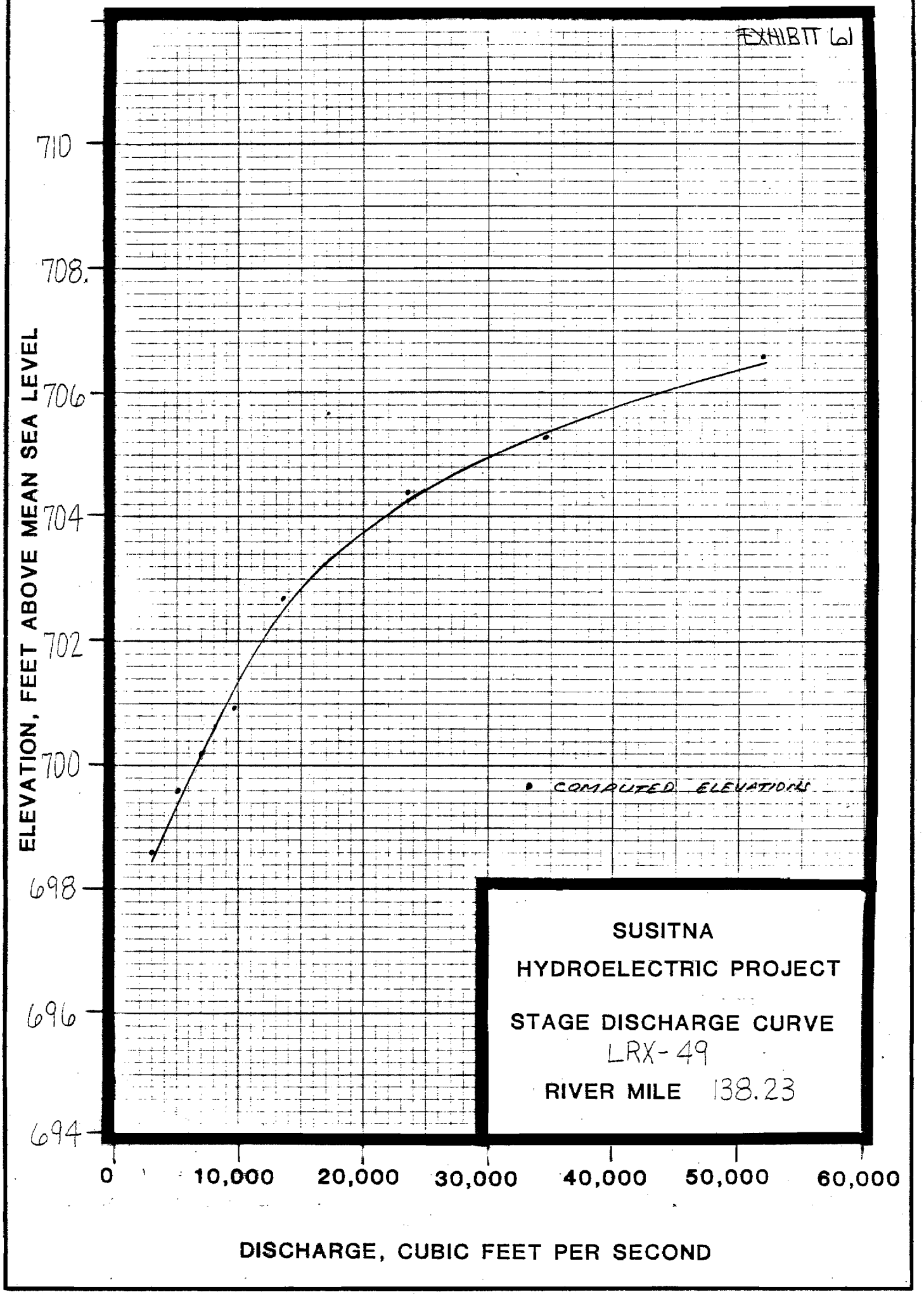

ELEVATION, FEET ABOVE MEAN SEA LEVEL
702
700
698
696
694
692
690
688
686
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 137.8
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 61



SUSITNA

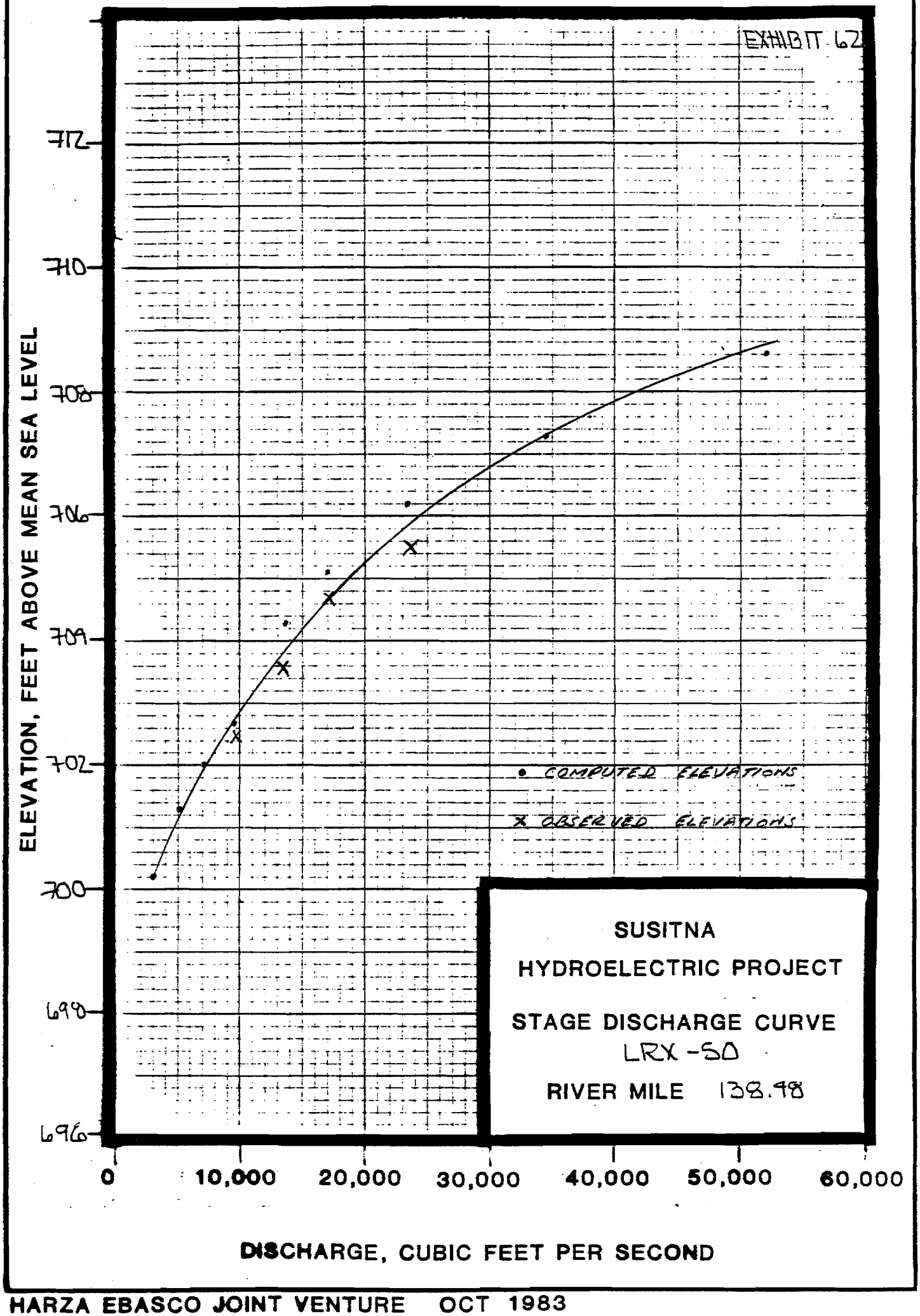
HYDROELECTRIC PROJECT

STAGE DISCHARGE CURVE

LRX-49

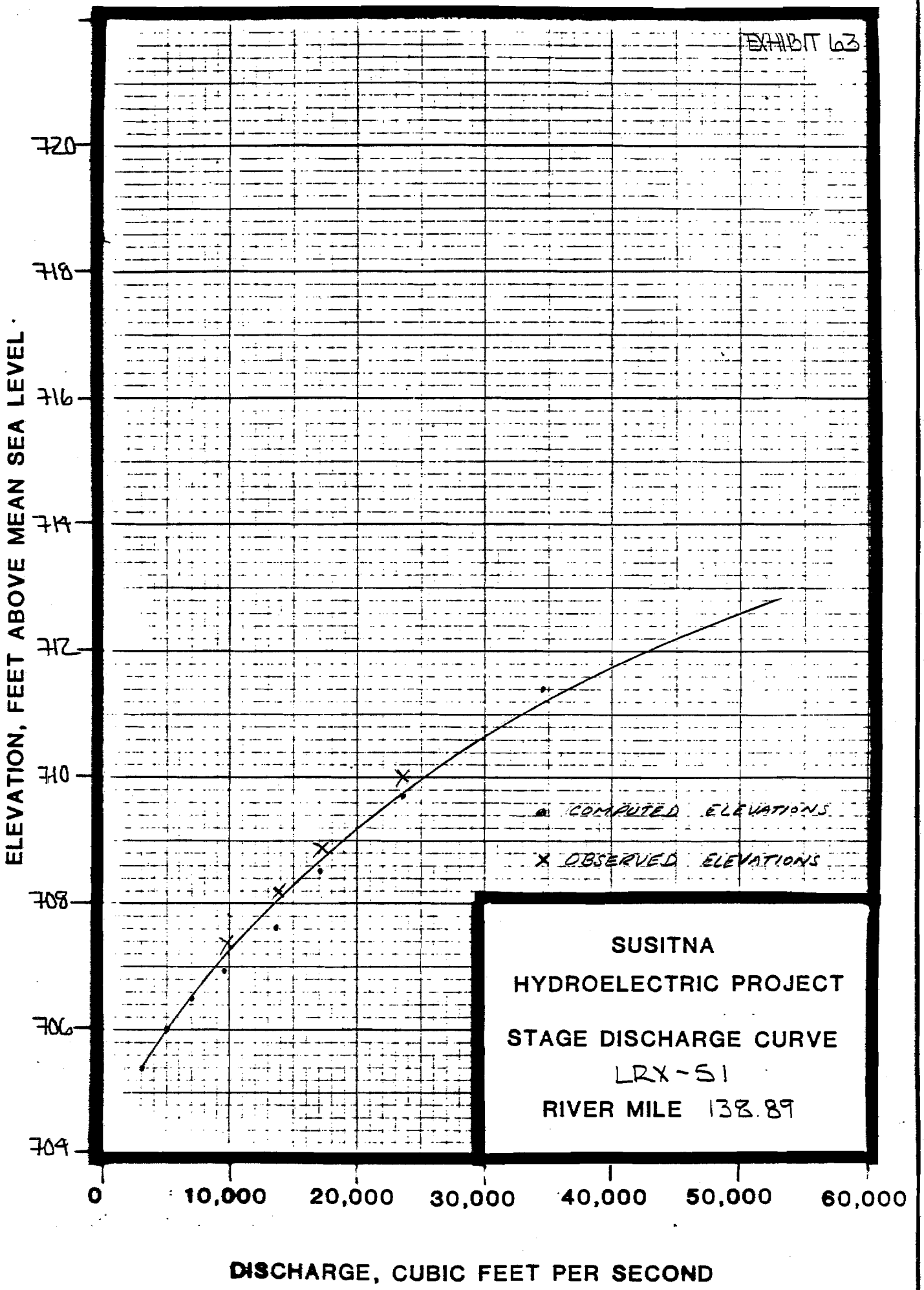
RIVER MILE 138.23

EXHIBIT 62



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 63



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 1A

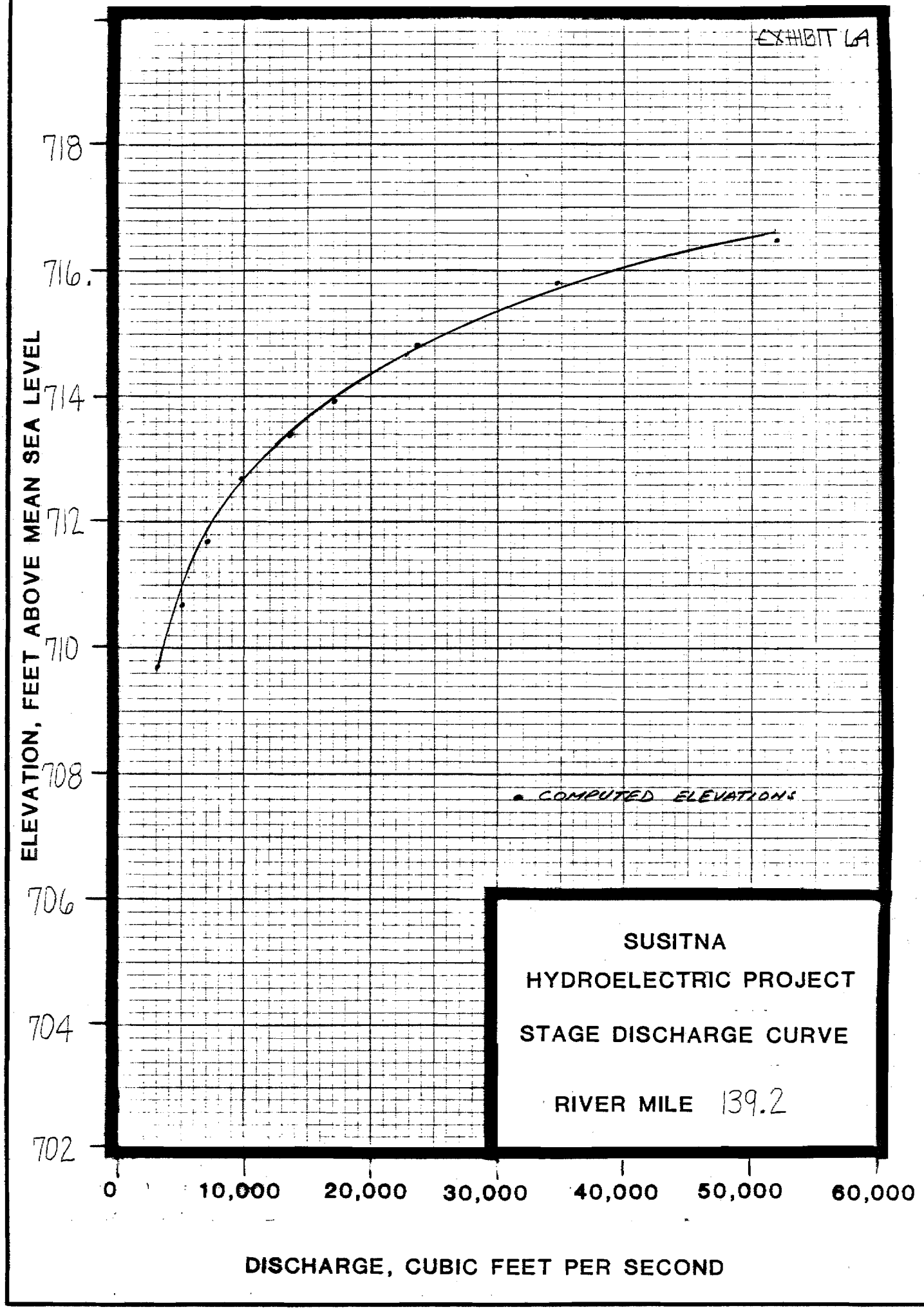
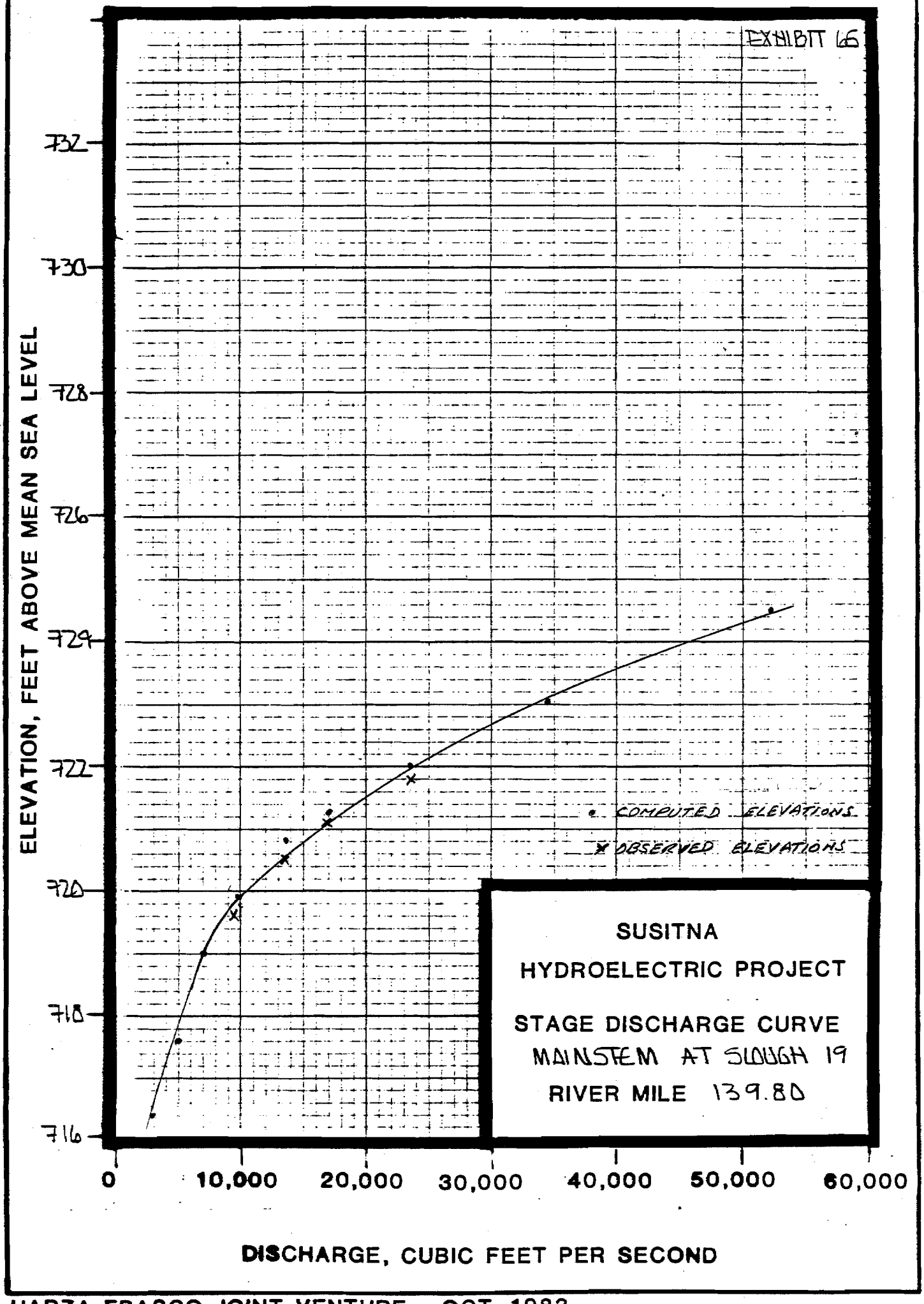

718
716
714
712
710
708
706
704
702
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 139.2

EXHIBIT 66



HARZA EBASCO JOINT VENTURE OCT 1983

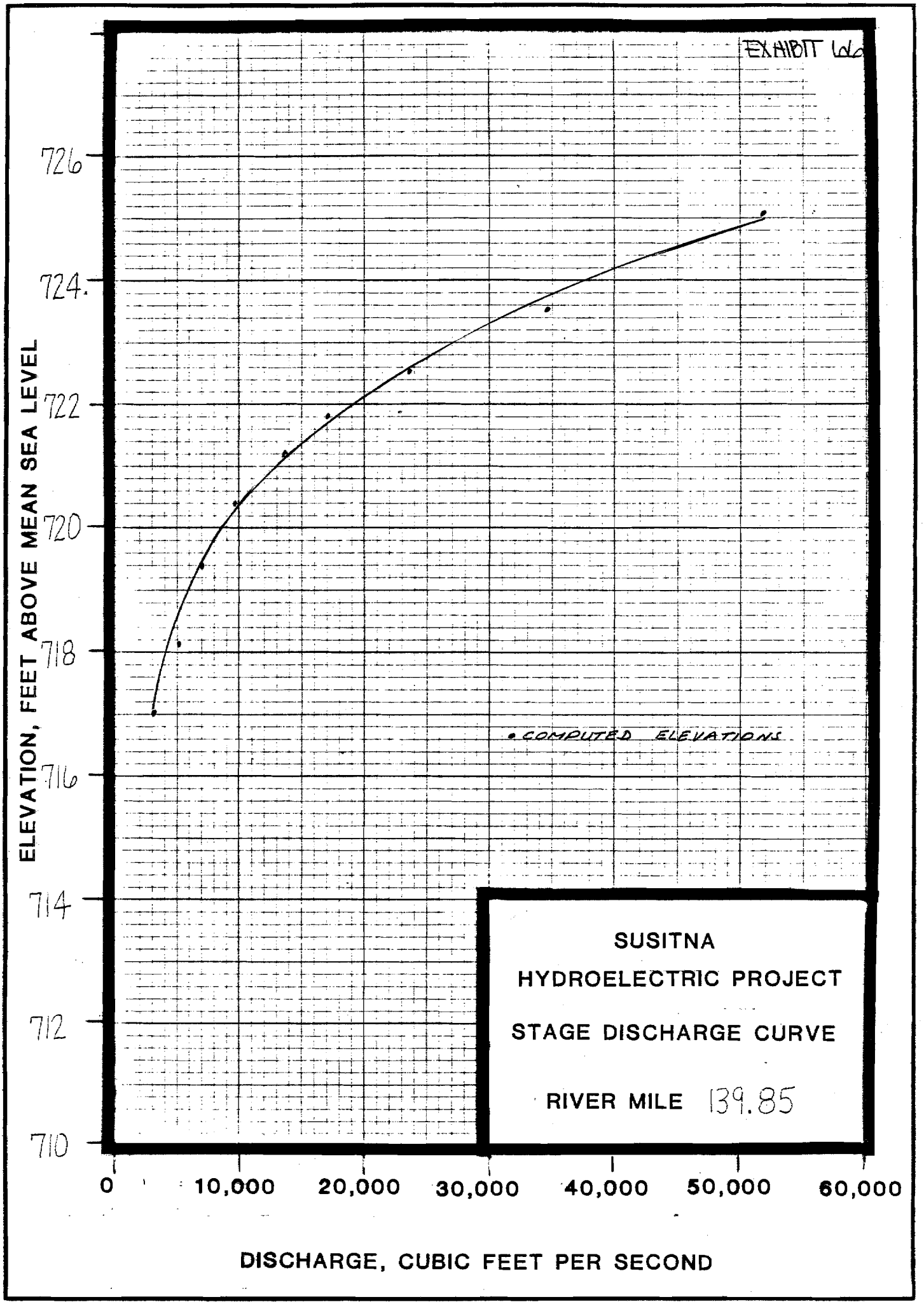
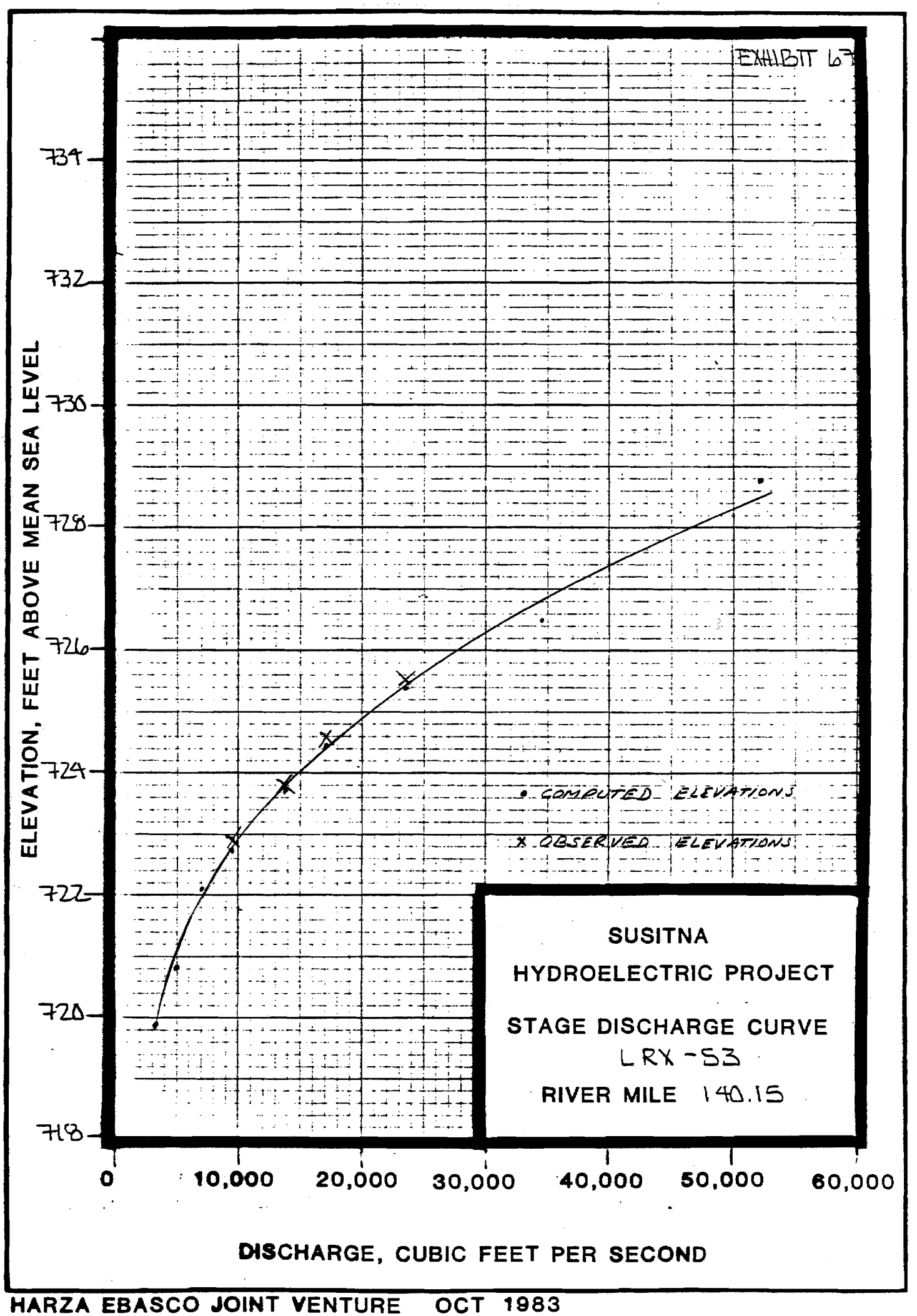


EXHIBIT 4a
726
724
722
720
718
716
714
712
710
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 139.85
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 68

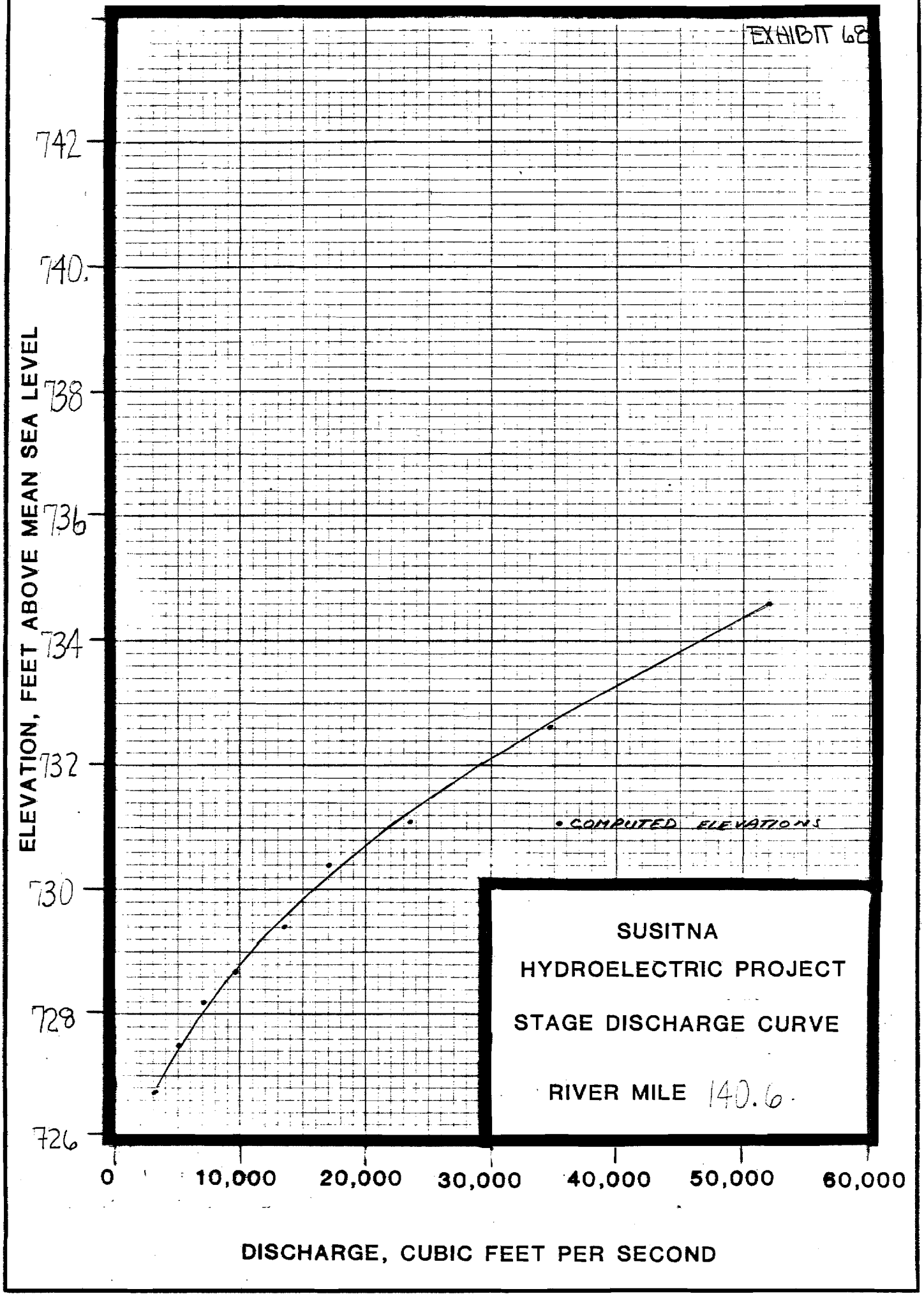
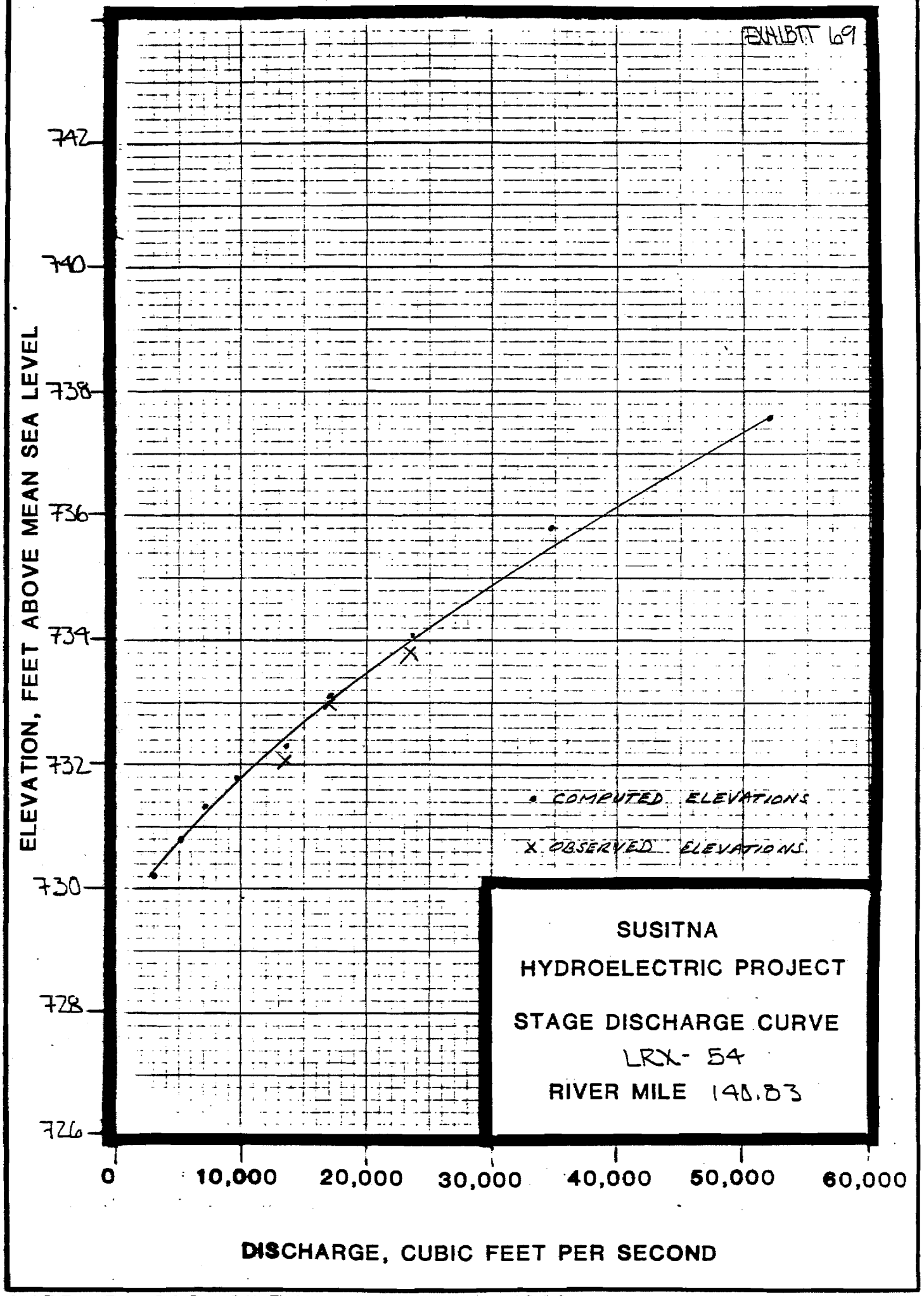

742
740.
738
736
734
732
730
728
726
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 140.6

EXHIBIT 69



HARZA EBASCO JOINT VENTURE OCT 1983

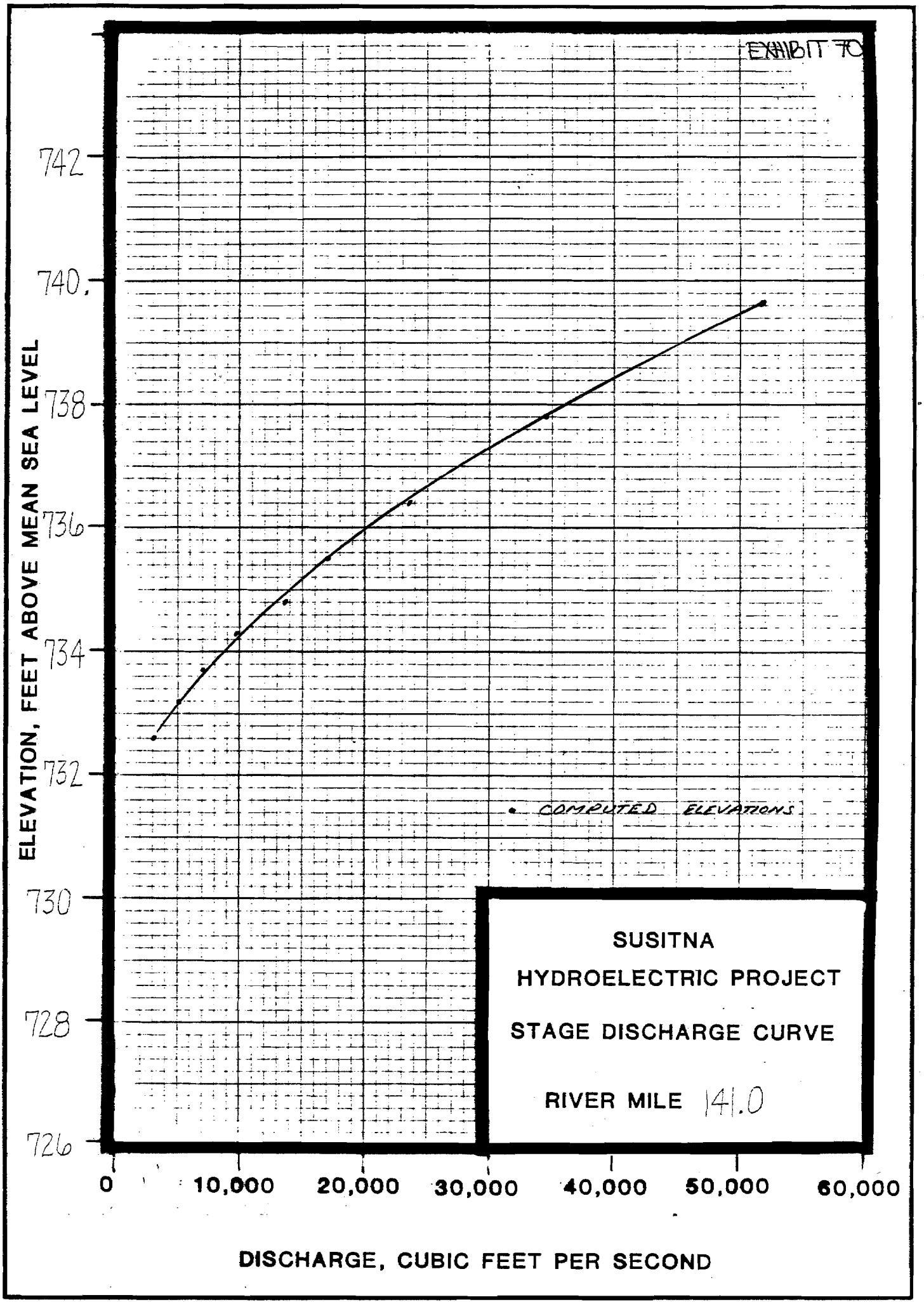


EXHIBIT 70
742
740
738
736
734
732
730
728
726
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 141.0
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 71

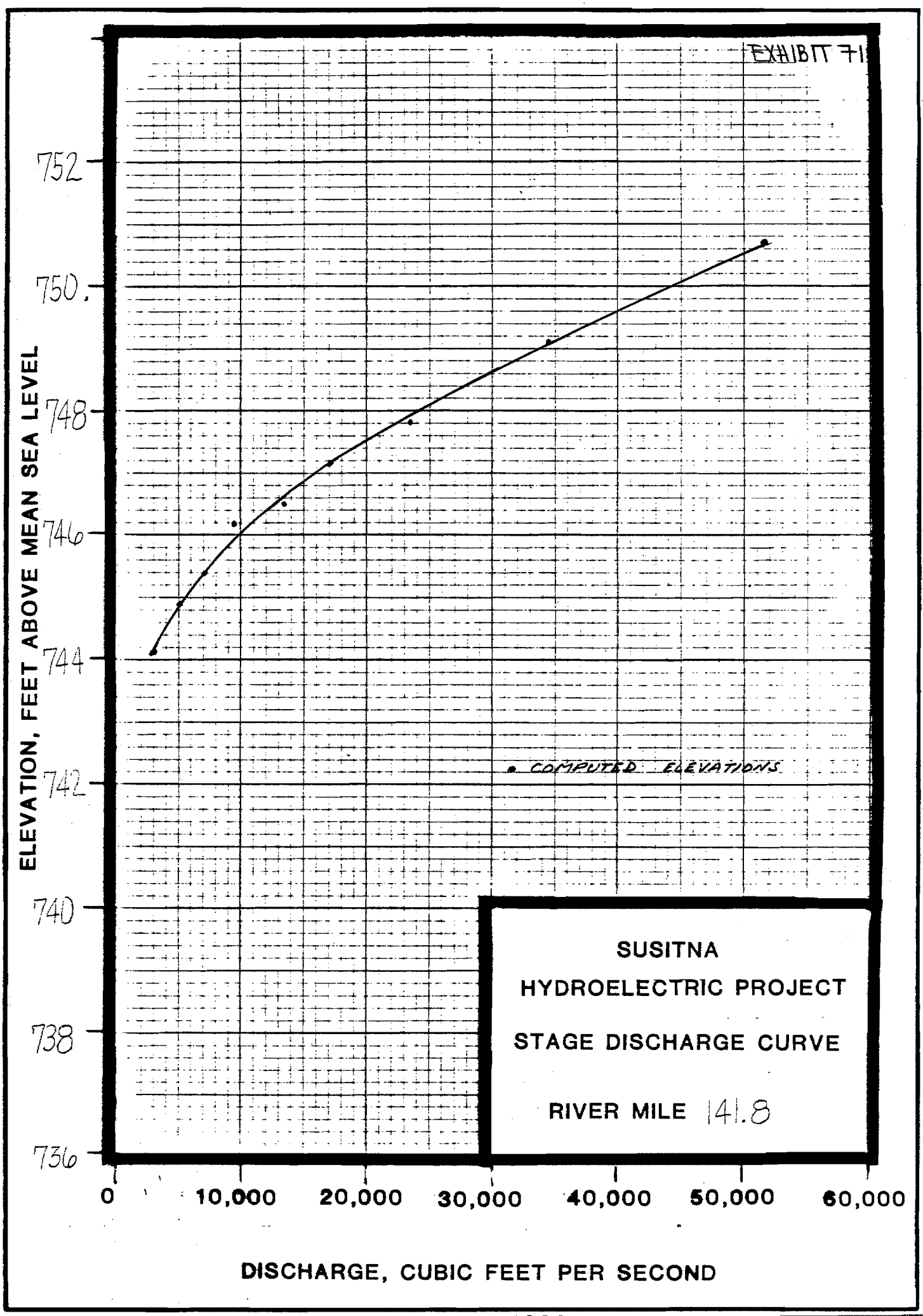
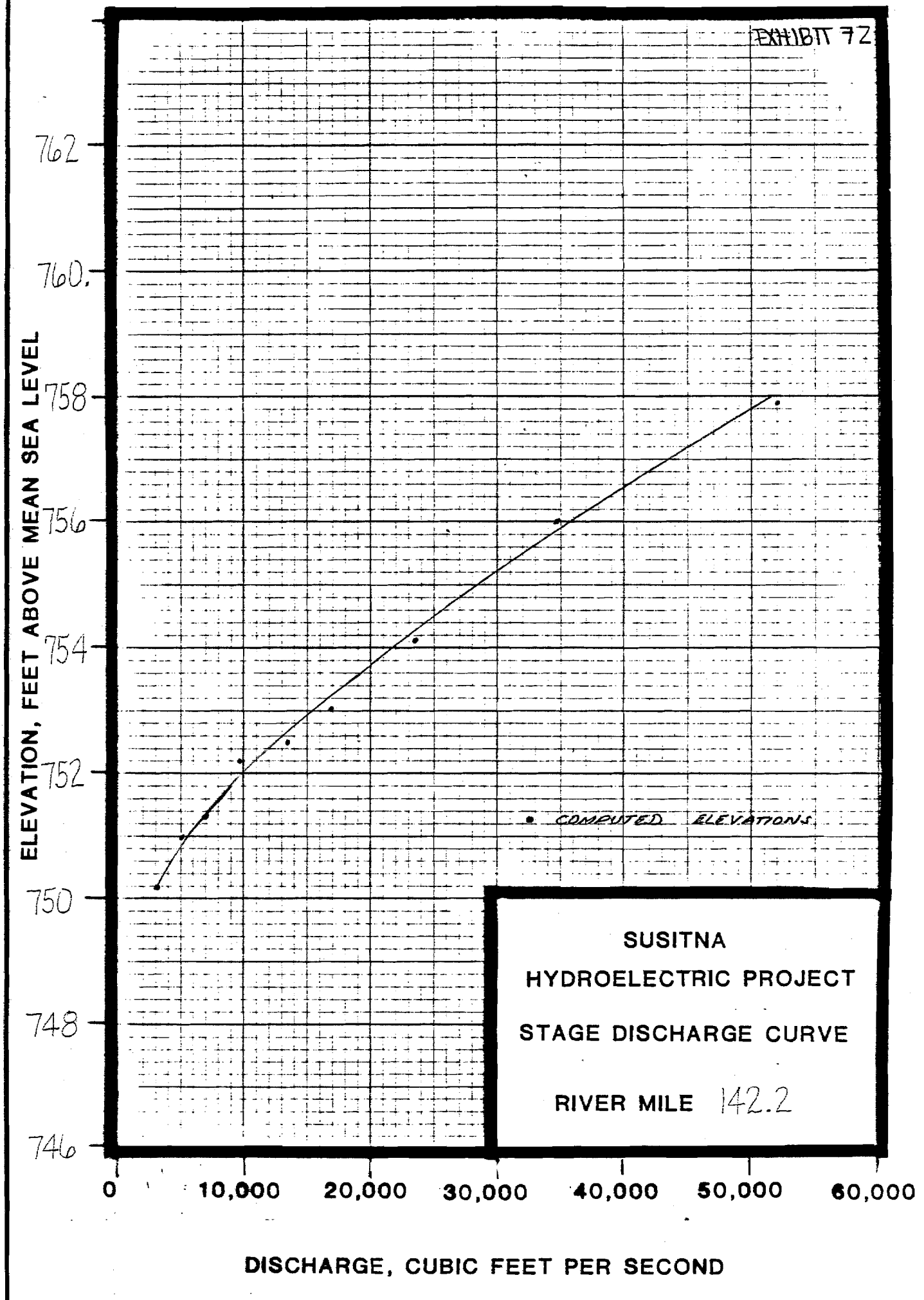

752
750
748
746
744
742
740
738
736
ELEVATION, FEET ABOVE MEAN SEA LEVEL
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 141.8
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND

EXHIBIT 72



SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 142.2

EXHIBIT 73

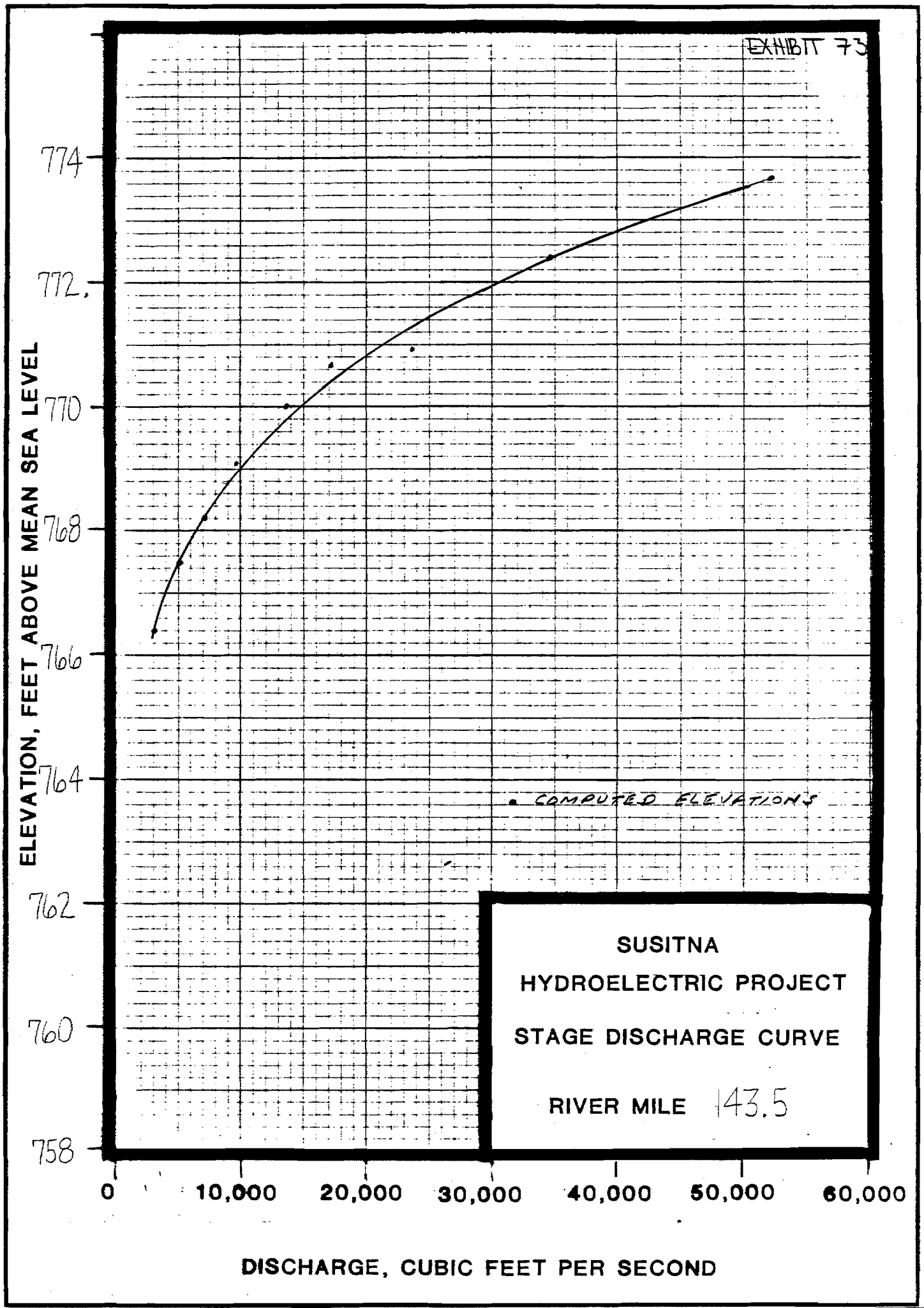

ELEVATION, FEET ABOVE MEAN SEA LEVEL
774
772
770
768
766
764
762
760
758
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 143.5

EXHIBIT 7-9

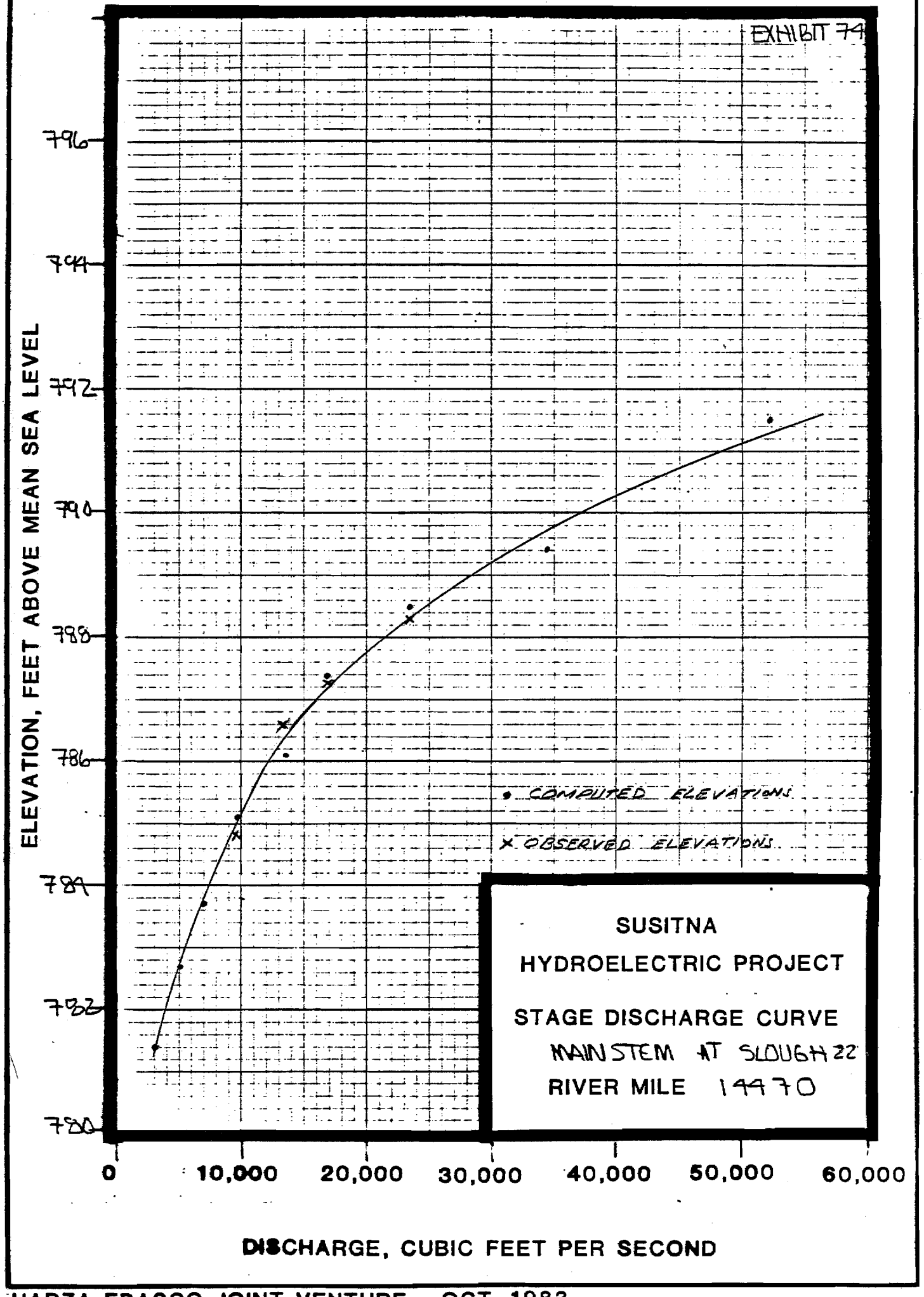


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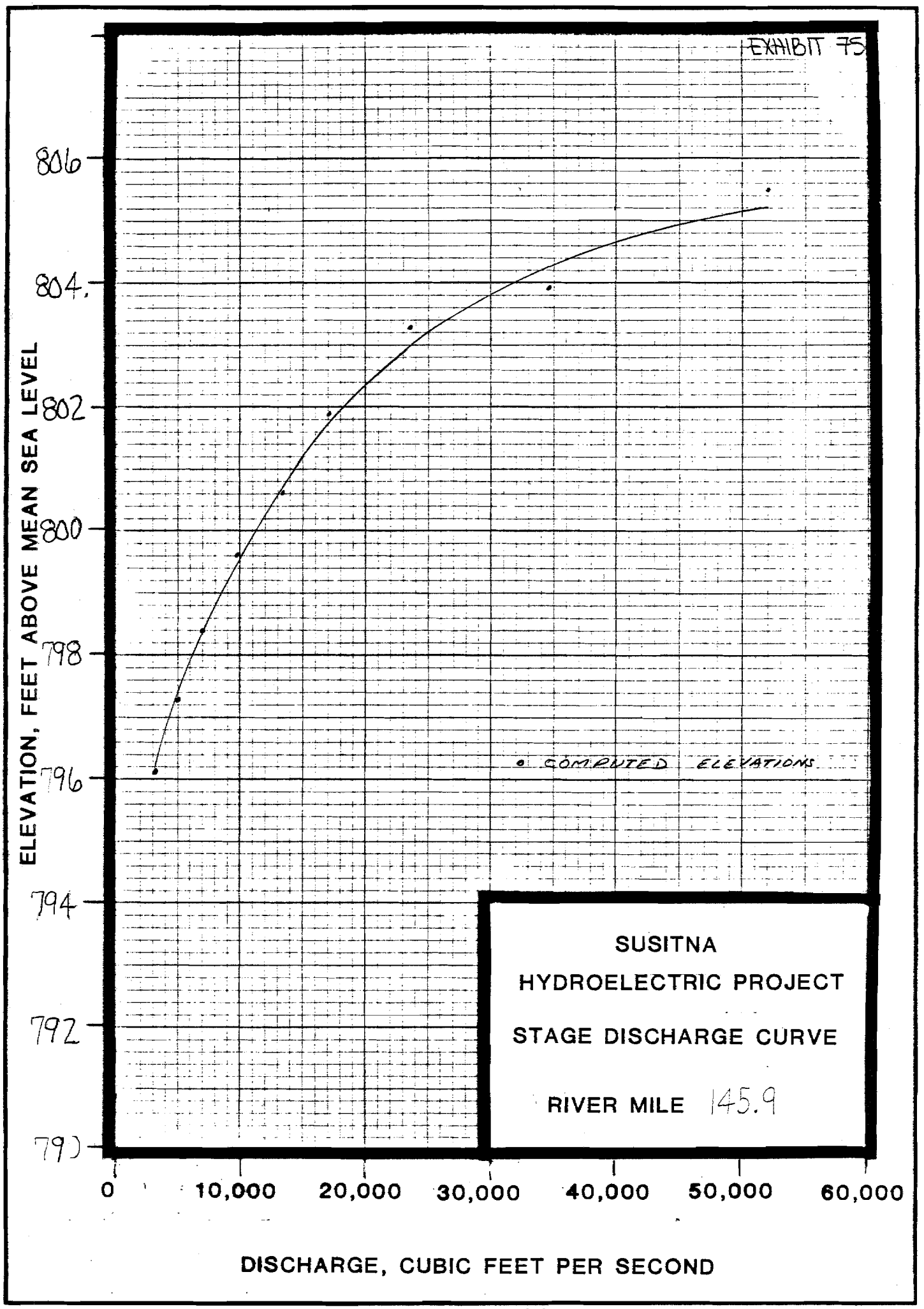
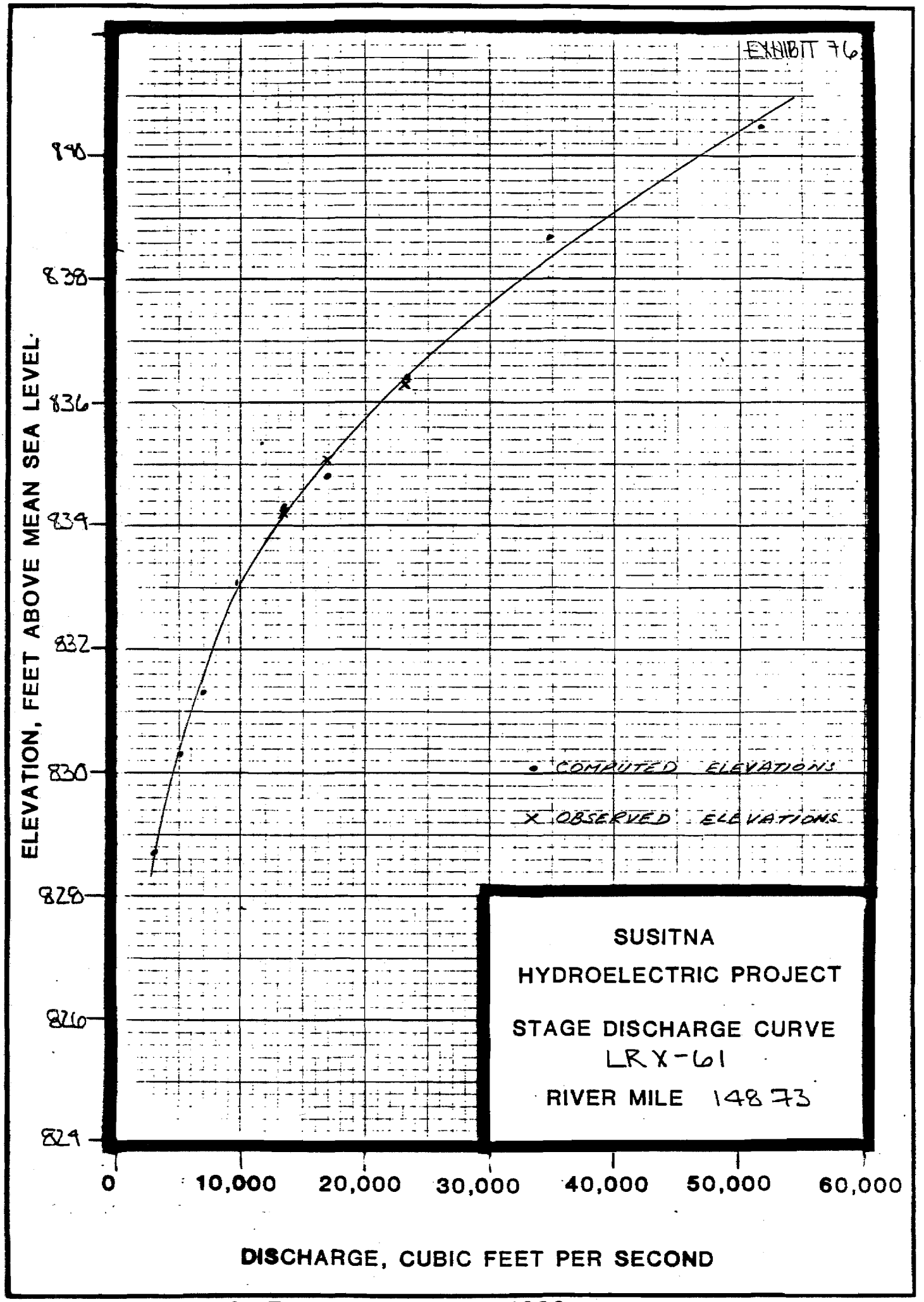
EXHIBIT 75



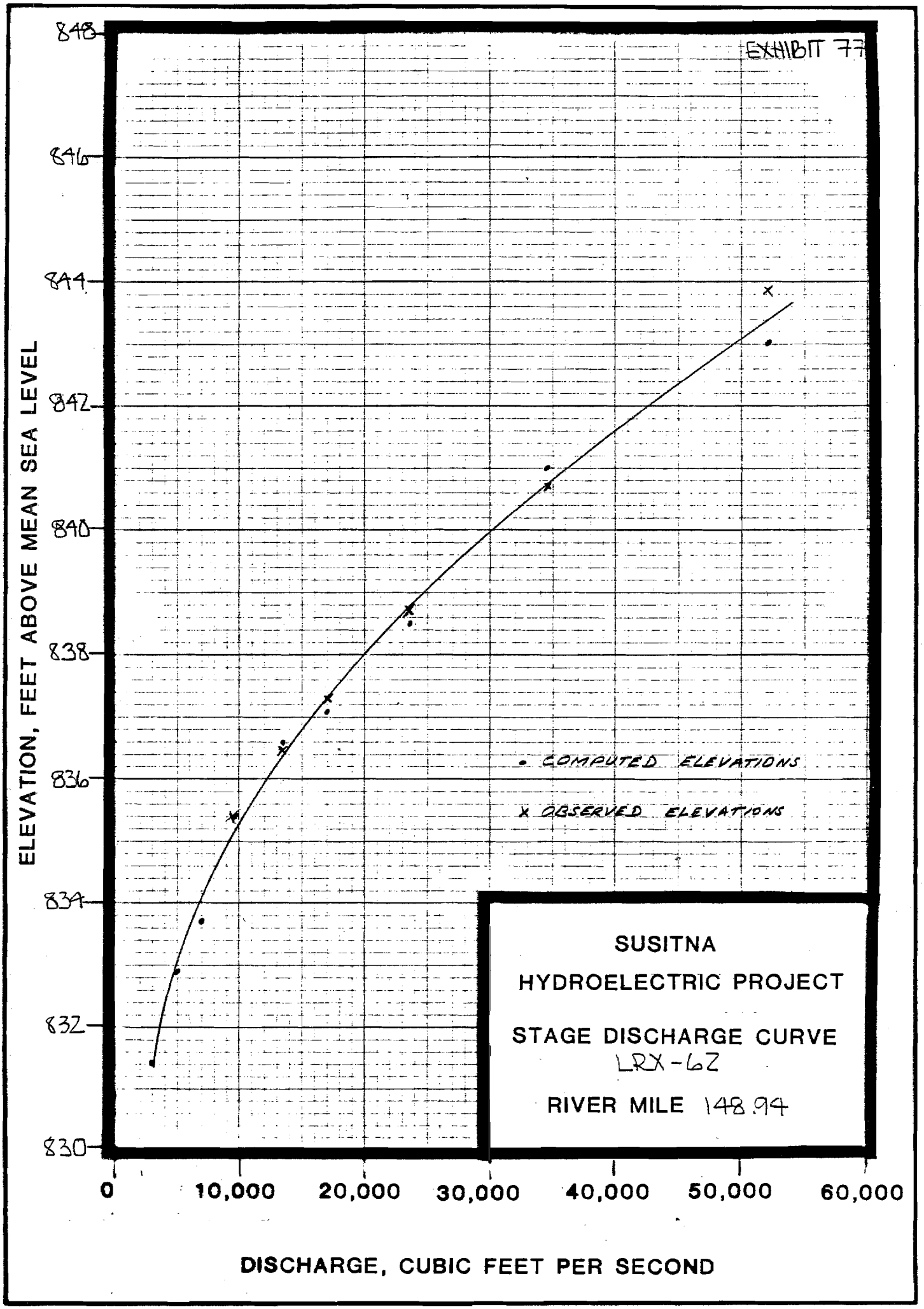
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 145.9

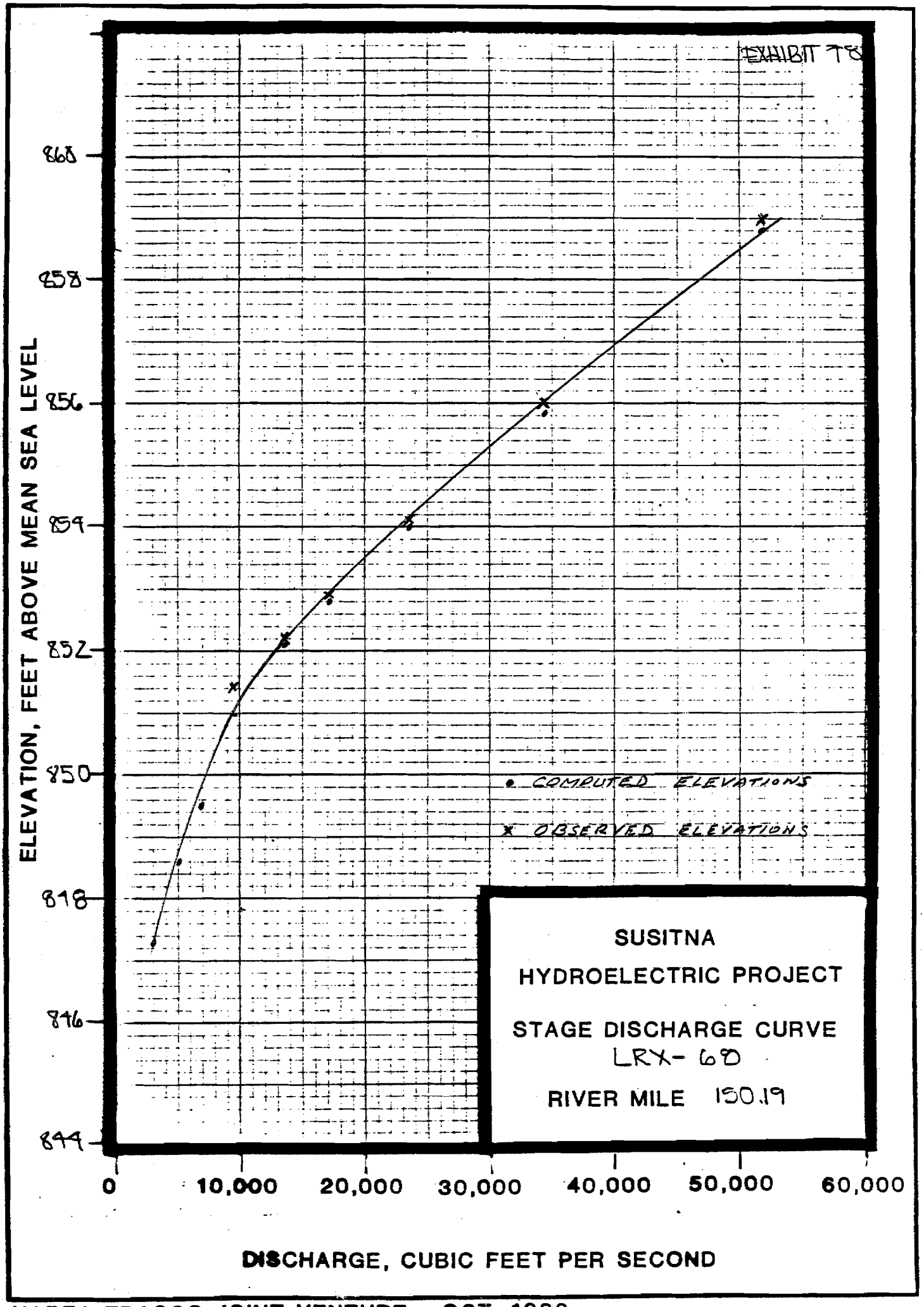
HARZA-EBASCO JOINT VENTURE OCT. 1983



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 77


848
846
844
842
840
838
836
834
832
830
ELEVATION, FEET ABOVE MEAN SEA LEVEL
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
• COMPUTED ELEVATIONS
X OBSERVED ELEVATIONS
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-62
RIVER MILE 148.94



HARZA EBASCO JOINT VENTURE OCT 1983