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SUSITNA HYDROELECTRIC PROJECT

LOWER SUSITNA RIVER

WATER SURFACE PROFILES AND DISCHARGE RATING CURVES

Prepared by Harza-Ebasco Joint Venture

For Alaska Power Authority

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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 under open water conditions for a selected range of discharges (see Exhibit 1). The U.S. Geological Survey (USGS) 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 upper end of the study reach near the mouth of Devil Canyon is about 150 miles from the mouth.

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

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 cubic feet per second (cfs). All discharges were referenced to the gaging station at Gold Creek (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.

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.

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

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1/ Refers to reference at the end of text.

of Engineers (5) based on additional cross sections and river stage data; and

3. a recomputation of water surface profiles for 9 different discharges at appropriate intervals to define stage-discharge rating curves at selected locations.

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 were also 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.

The HEC-2 model was first calibrated for the 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 are (see Exhibit 1 for locations) shown in the following table:

ADJUSTMENT FACTORS BASED ON DRAINAGE AREAS

Cross Sections		Factor to adjust
From	To	Gold Creek Flow
3	23	1.030
24	50	1.000
51	61	0.983
62	68	0.942

The refinement of the initial 'n' values during the clibration took into consideration several criteria including bed material size, river sinuosity, presence of and type of vegeta-

tion, existence of multiple channels, etc. The final 'n' values 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 probably derived through a trial-and-error procedure although it is not mentioned in the reports (2).

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 (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 number of side channels and sloughs which receive water during the high flow regime of over 20,000 cfs at Gold Creek are practically dry during the low flow regime of below 20,000 cfs. Therefore, two versions of HEC-2 model were set up. For discharges up to 20,000 cfs, the assumption was made that there are no flows in some selected side channel and sloughs. In the second version, flow was assumed to exist in all channels for discharges higher than 20,000 cfs.

A review of Table 2, indicates that the differences between observed and computed stages at the eight control points used by R&M are within ± 0.5 ft except at a few coss sections for a few discharges. The higher differences at these cross sections (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.

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.

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 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.

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 se- ions 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.

Initial 'n' Values

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

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 were selected as control points to compare observed gage heights with the gage heights of corresponding discharges computed by the HEC-2 model. Lowever, during the calibration of the model, some of these control points had to be ignored because of inconsistency between the next upstream or next downstream control point. The control points used in the study are identified in Table 2.

Five of the ADF&G gages are the same as five of the eight gages used by R&M (gage No. LRX-9, LRX-24, LRX-28, LRX-35 and LRX-62, Table 2). The gage heights used by R&M at these gages were compared with those obtained from the stage-discharge rating curves provided by ADF&G. The two set of values were slightly different at some locations. For consistency with the upstream and downstream control points (ADF&G gages), the gage heights determined from the ADF&G relationships were used. At the other three locations used by R&M, ADF&G data were not available. At these locations (LRX-4, LRX-5 and LRX-68, Table 2), the data used by R&M, was used in this study.

The ADF&G stage-discharge relationships are developed for dischrges ranging between about 8,000 cfs and about 25,000 cfs. To calibrate the model for higher discharge, R&M data (see Table 2) were used.

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.

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 above which flow will enter all the channels. This value is considered to be reasonable based on the available surveyed cross sections and is used in 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).

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.

First HEC-2 run was made for 9,700 cfs using the 'n' values derived by R&M and the 107 river cross sections shown 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 also 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. The difference in the two profiles indicates 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 section 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 computed and observed 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 difference in the observed water surface elevation is probably because of judgement exercised by two different organizations in developing the stage-discharge curves. The 'n' values at this cross section and the next upstream or downstream cross section had to be lowered to match the computed water surface elevaion with the observed value (see Table 2). Further lowering of the 'n' values was considered inappropriate.

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.

In general, lower 'n' values were used for higher discharges. However, in certain reaches of the river and also dictated by observed gage heights at the control points, some deviation was allowed. Therefore, Table 1 indicates higher 'n' values for higher discharges compared to the 'n' values for lower discharges in a few cases. This situation is physically possible particularly at multi-channel cross sections because at higher stage, 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 elevations 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 provide information on cross sections where the flow was comfined in main channel or allowed over the full channel width for different discharges.

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.

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. The velocities for locations between two surveyed cross sections can be interpolated from the table.

Dicussion

The HEC-2 model provides an acceptable procedure for the computation 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 at some threshold discharges. 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 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 differents in various channels. This should be recognized while using the velocity data.

Recommendations

Exhibit 3 shows a comparison of two water surface profiles for a discharge at 9,700 cfs. 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. This difference is caused because 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. R&M did not use cross sections 18.1, 18.2 and 18.3 in their calibration. Therefore, a lower surface profile resulted when using a lower thalweg.

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

For the present study, additional 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 point (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 near Lane Slough and at cross section numbers 56 and 57 are examples. It is likely that these differences are due to inaccurate designation of river mileage at some gages. In a relatively steep channel, a difference of $\pm$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 unless as discussed previously, further refinements of water surface profiles for any partcular subreach are needed. However, at least 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 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 are recommended as shown on Exhibit 2.

Reference

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Table 1

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
.001	83.90		.060		.045		.040		.041		.041		.035
.01	84.83		.060		.045		.040		.041		.041		.035
.02	86.33		.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	.035
3.1	98.75		.025		.028		.035		.035		.035		.030
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

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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

Gage Location	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 LRX-4[2]	99.58	274.1 (348.1)	274.1 348.6 (348.6)	275.1 (349.5)[4]	275.1 349.5 (349.5)	275.9 (350.5)	275.9 350.5 (350.8)	277.2 (352.0)	277.2 351.6 (352.0)	279.3 (352.9)	279.3 352.8 (353.1)	282.2 (354.6)	282.2 354.5 (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	102.95	375.6	375.8	376.3	376.7	377.1	377.6	378.3	378.9				
LRX-9[3]	103.22	378.0 (378.4)	378.0 (378.1)	379.0 (379.0)	378.6 (379.4)	(379.8)	379.8 (380.3)	(381.6)	381.2 (381.8)	(383.1)	383.3 (383.4)	(385.4)	385.8 (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

Gage Location	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 (521.1)	521.2 (521.2)	522.0 (522.0)	522.2 (522.6)	522.8 (522.9)	523.0 (523.2)	524.4 (523.8)	524.1 (524.3)	(524.4)	525.4 (525.4)	(527.5)	527.2 (527.2)
LRX-28[3]	124.41	553.1 (553.8)	554.4 (555.0)	554.2 (555.3)	555.2 (555.7)	555.5 (556.0)	556.1 (556.2)	557.1 (557.0)	556.8 (557.0)	(558.2)	558.1 (558.1)	(559.8)	560.1 (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 (617.3)	617.4 (617.7)	618.0 (617.9)	618.4 (618.7)	618.7 (619.0)	619.1 (619.4)	619.8 (620.0)	620.5 (620.3)	(621.3)	621.6 (621.6)	(623.3)	623.6 (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	(684.1)	684.0 (684.0)	(685.2)	685.1 (685.1)	(685.9)	686.0 (685.8)	(687.0)	687.2 (687.0)	(698.4)	688.4 (688.1)	(690.0)	690.5 (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

Gage Location	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)	835.4 (835.1)	836.5 (835.9)	836.6 (836.4)	837.3 (837.5)	837.1 (837.5)	838.7 (838.3)	838.5 (838.0)	(840.7)	841.0 (840.8)	(843.9)	843.0 (844.2)
LRX-68[2]	150.19	(851.4)	851.0 (850.6)	(852.2)	852.1 (851.8)	(852.9)	852.8 (852.8)	(854.1)	854.0 (854.0)	(856.0)	855.8 (855.8)	(859.0)	858.8 (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/ Gage heights paranthesised, are either the observed or computed values by R&M.

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, 350 9	
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, 593.7	
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, 642.9	Shore ice; ice floes.
LRX-42	10/20/80	7230	668.7	666.8 (slough) 667.8	Variation of 0.4' in water surfac 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: K&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

Cross Section	River Mileage	Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)								
		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

Cross Section	River Mileage	Water Surface Elevations (ft,msl) for Indicated Discharge (cfs)								
		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,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	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
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

Table 6 (Continued)

MEAN VELOCITIES

Mean Velocities (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	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
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	1.9	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
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

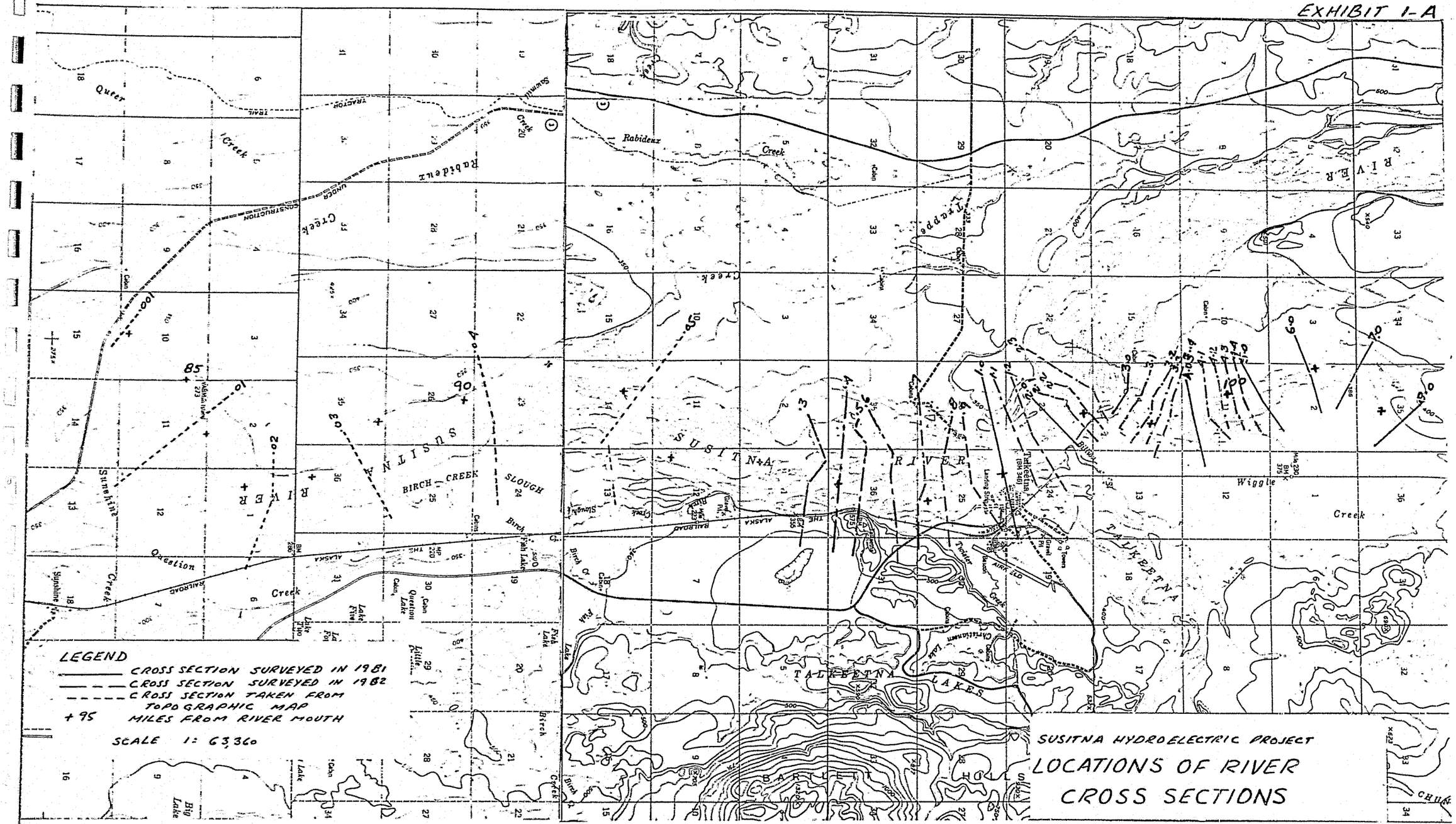
Table 6 (Continued)

MEAN VELOCITIES ELEVATIONS

Mean Velocities (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	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

EXHIBIT 1-A


Queer
Creek
Rabideux
Creek
Susitna
River
Birch Creek
Slough
Question
Creek
Talkeetna
Lakes
Fish
Lake
Big
Lake
Little
Lake
Wiggle
Creek
Alaska
Railroad
Trapper
Creek
Yanert
Fork
Chulitna
Barge
Slough
Slough
Creek
Lake
Cabin
Landing Strip
Trail
Bridge
Mile 230
Mile 375
Mile 223
Mile 266
Mile 275
Mile 295
Mile 335
Mile 350
Mile 360
Mile 380
Mile 400
Mile 410
Mile 420
Mile 430
Mile 440
Mile 450
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Mile 470
Mile 480
Mile 490
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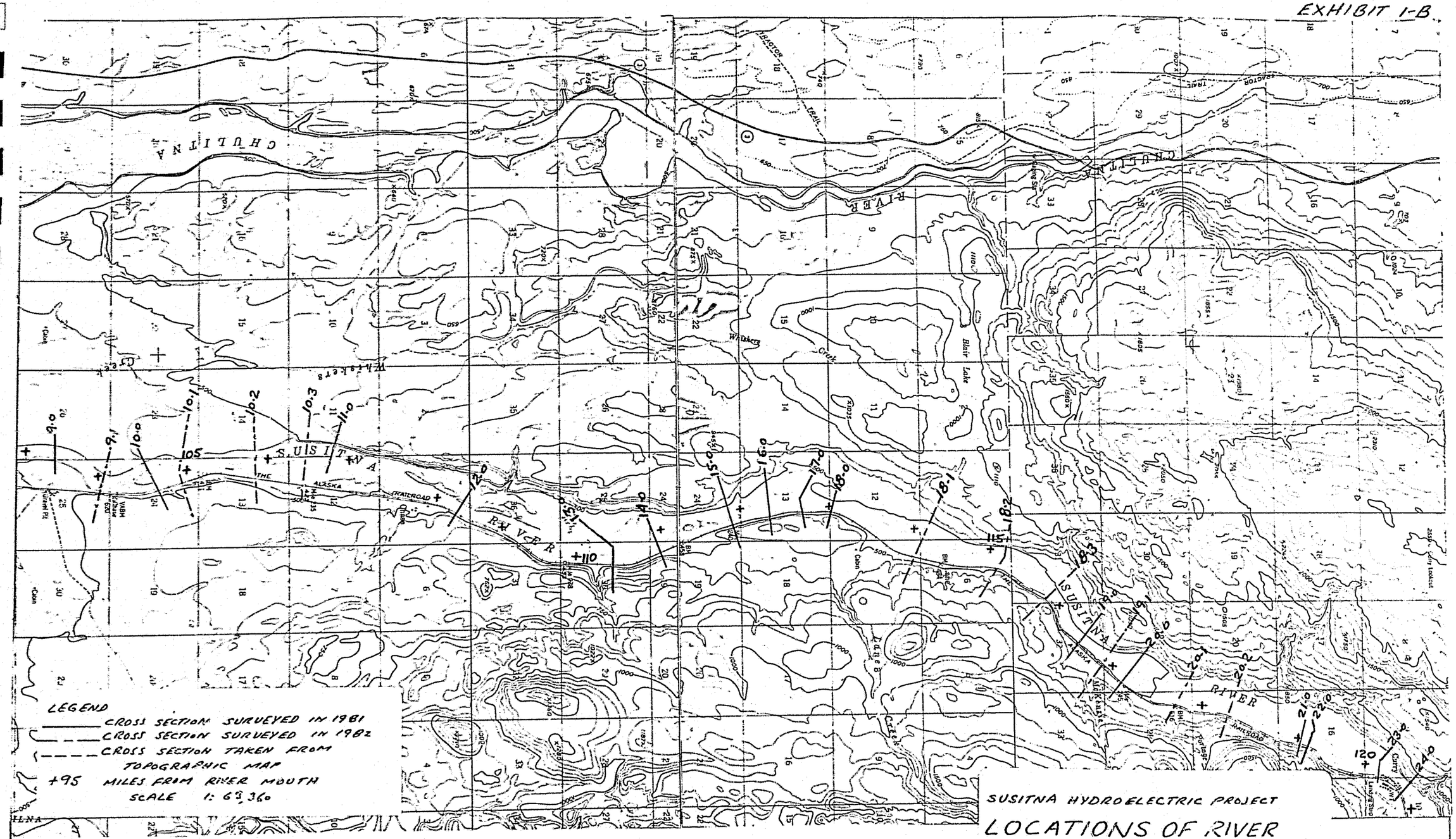
Mile 590
Mile

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: 63,360

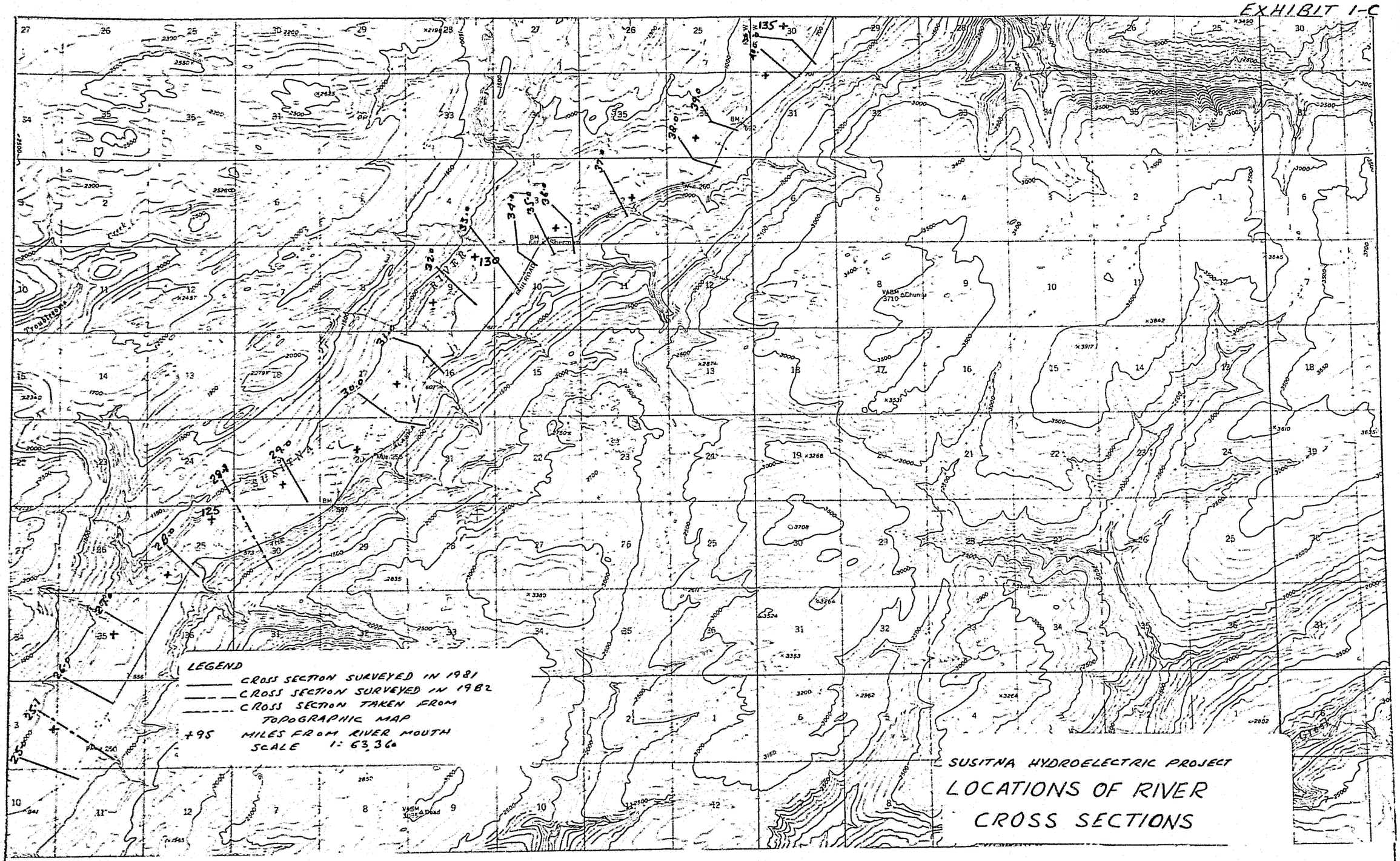
SUSITNA HYDROELECTRIC PROJECT

LOCATIONS OF RIVER CROSS SECTIONS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

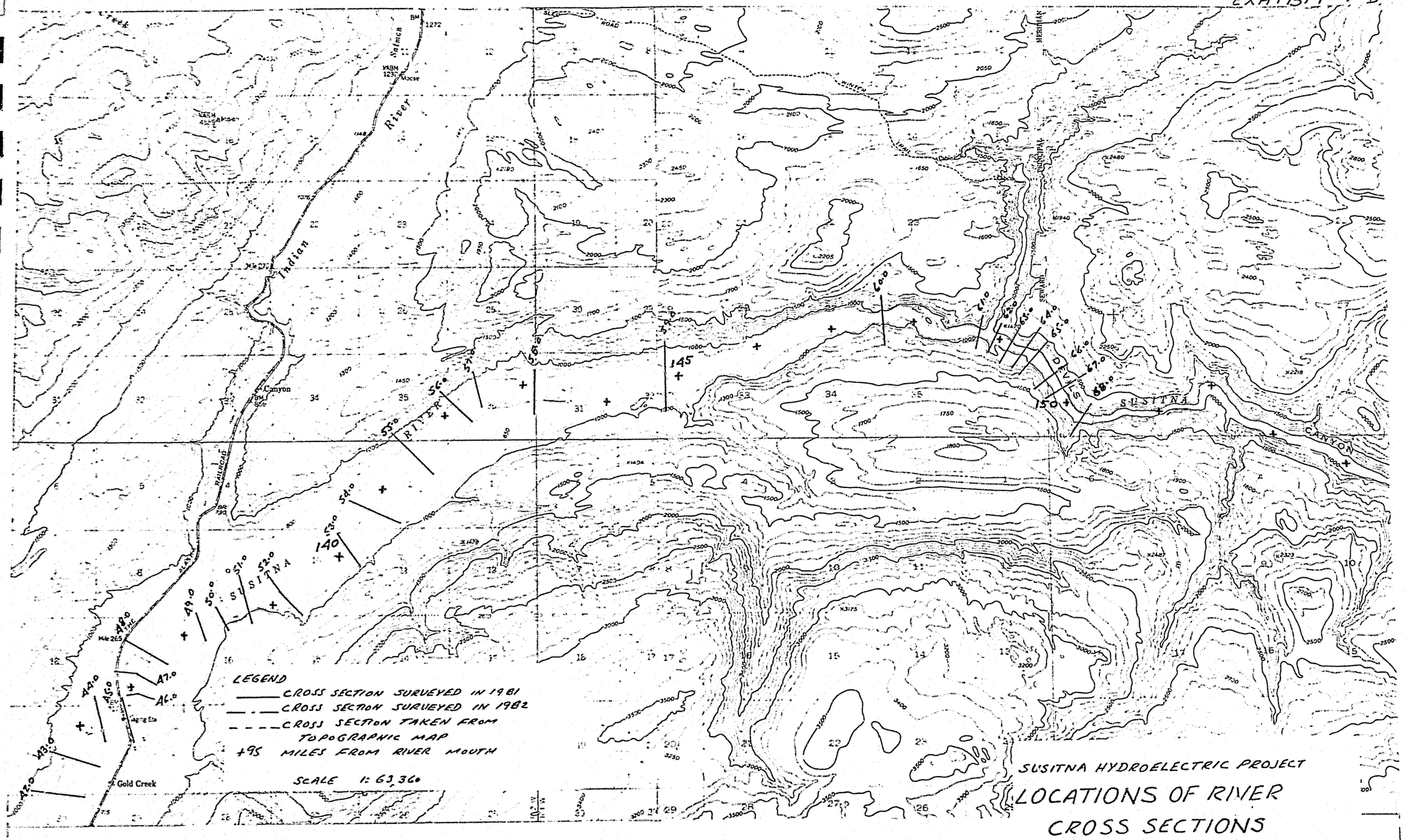
EXHIBIT 1-C



HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

FOLD LENGT
12
11
8.5
8
AUTO
MANUA
FEED

EXHIBIT 1-D

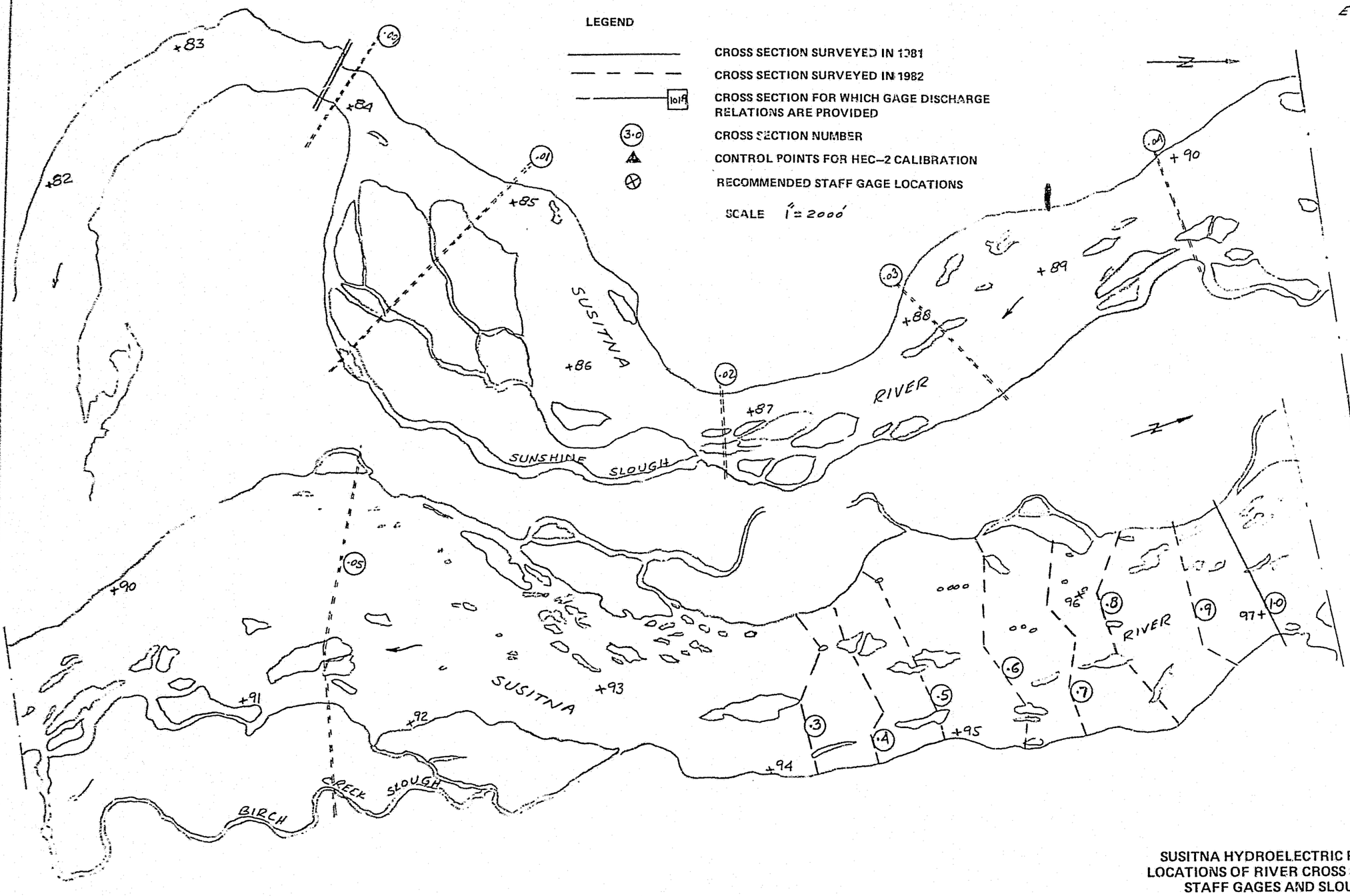


SUSITNA HYDROELECTRIC PROJECT

LOCATIONS OF RIVER CROSS SECTIONS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

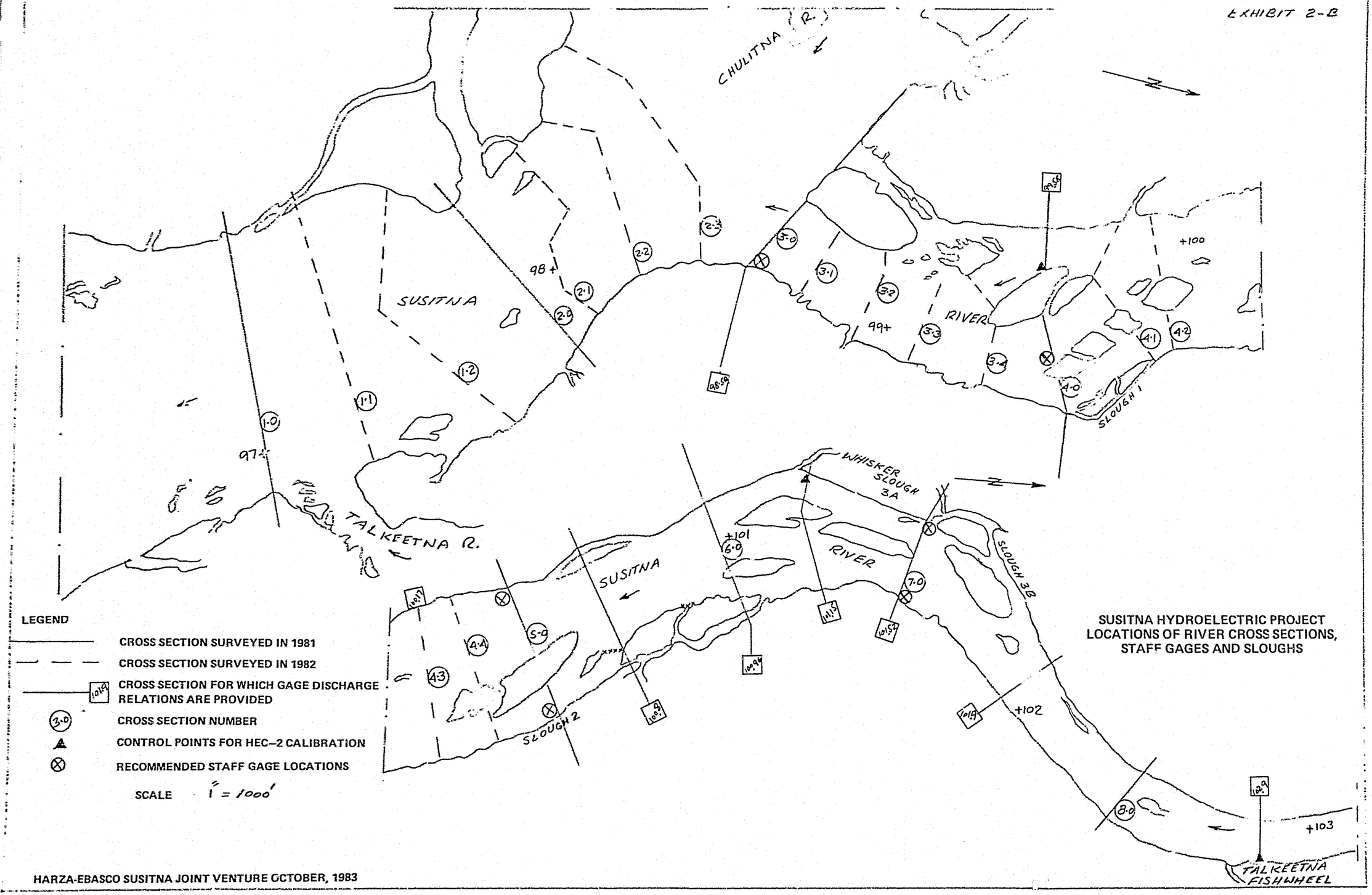
EXHIBIT 2-A



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

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-B



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-C

LEGEND

CROSS SECTION SURVEYED IN 1981

CROSS SECTION SURVEYED IN 1982

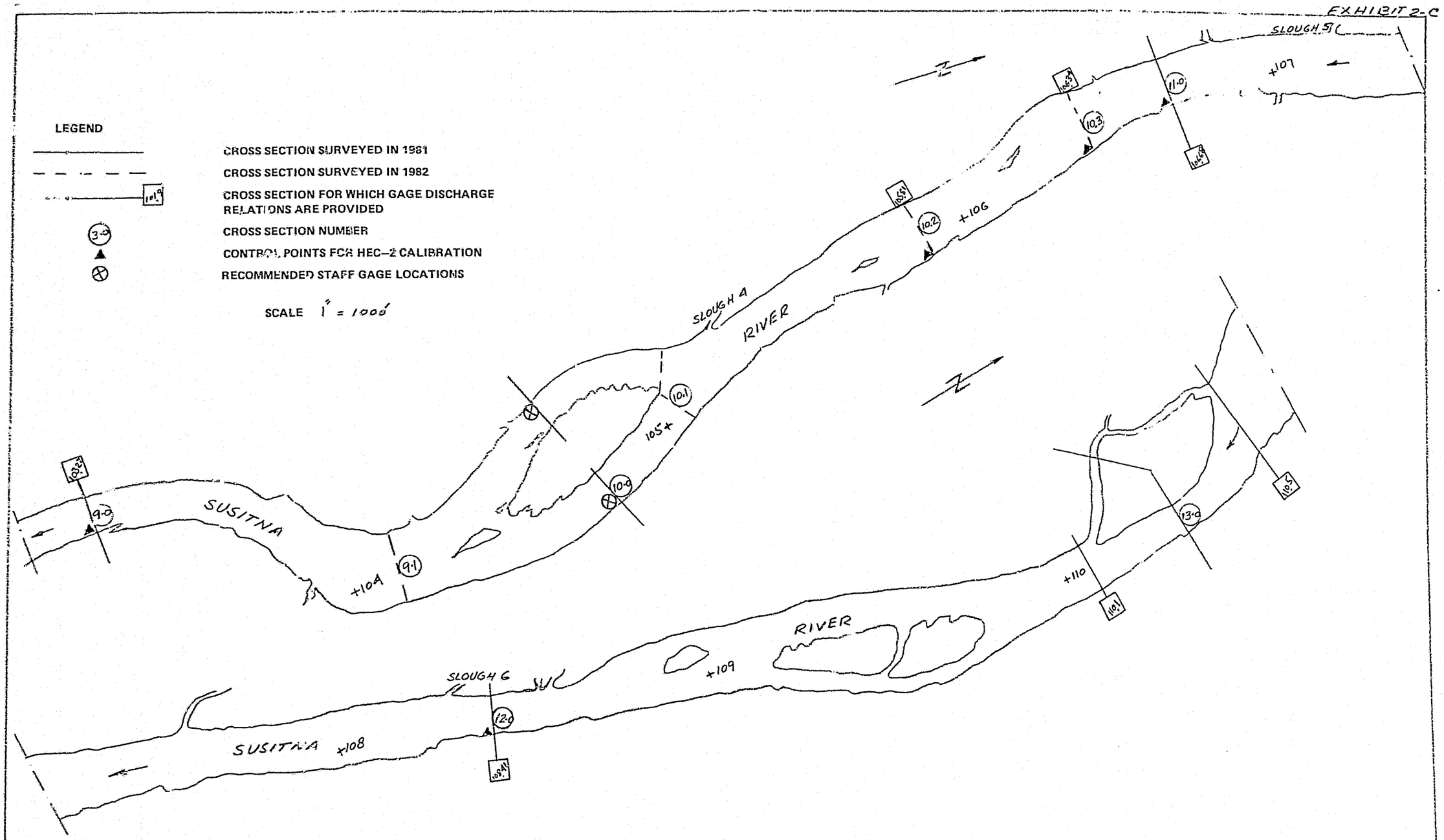
CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED

CROSS SECTION NUMBER

CONTROL POINTS FOR HEC–2 CALIBRATION

RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

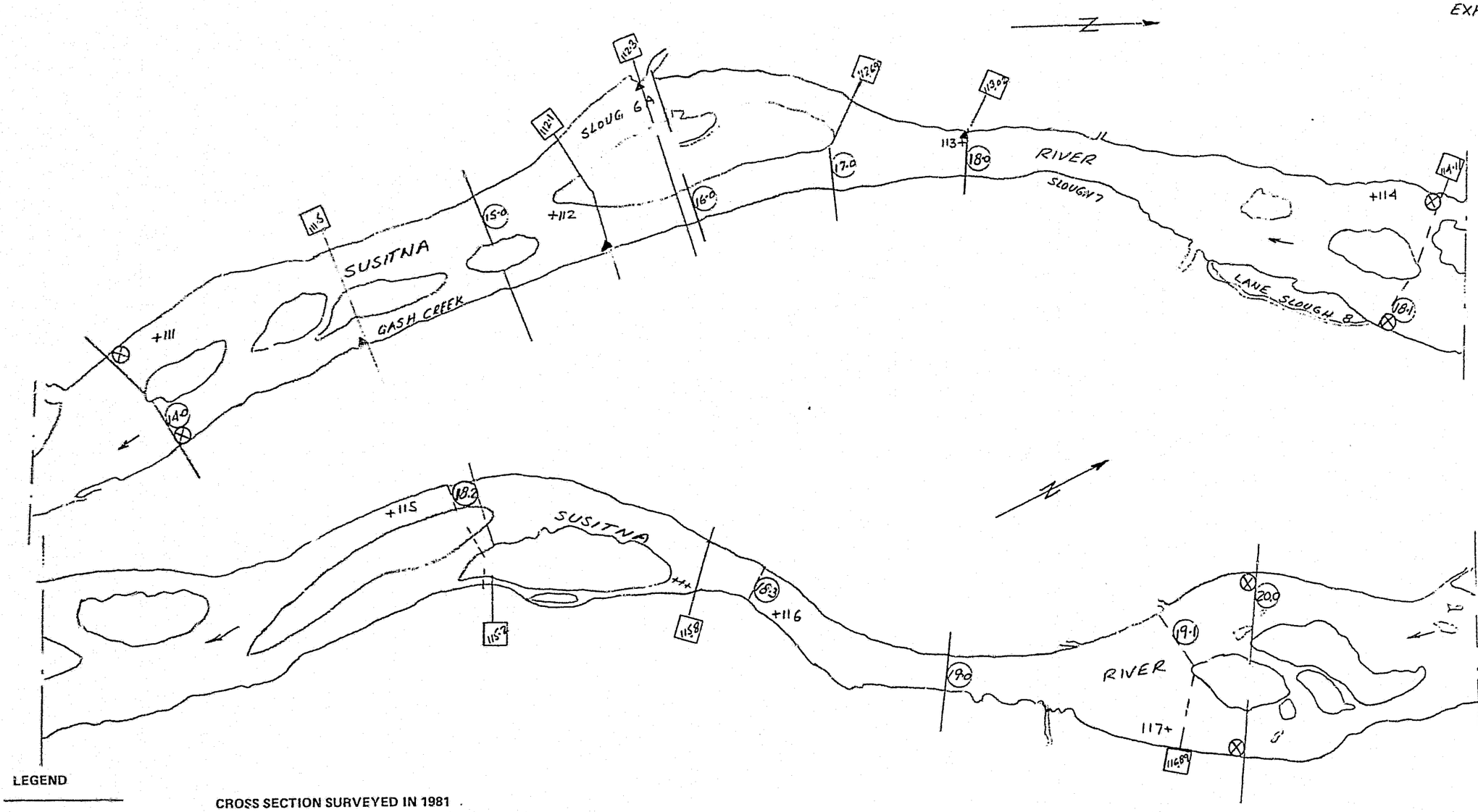


SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS,
STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

FOLD
LENGT
12
11
8.5
8
AUTO
ANUA
FEED

EXHIBIT 2-D



LEGEND

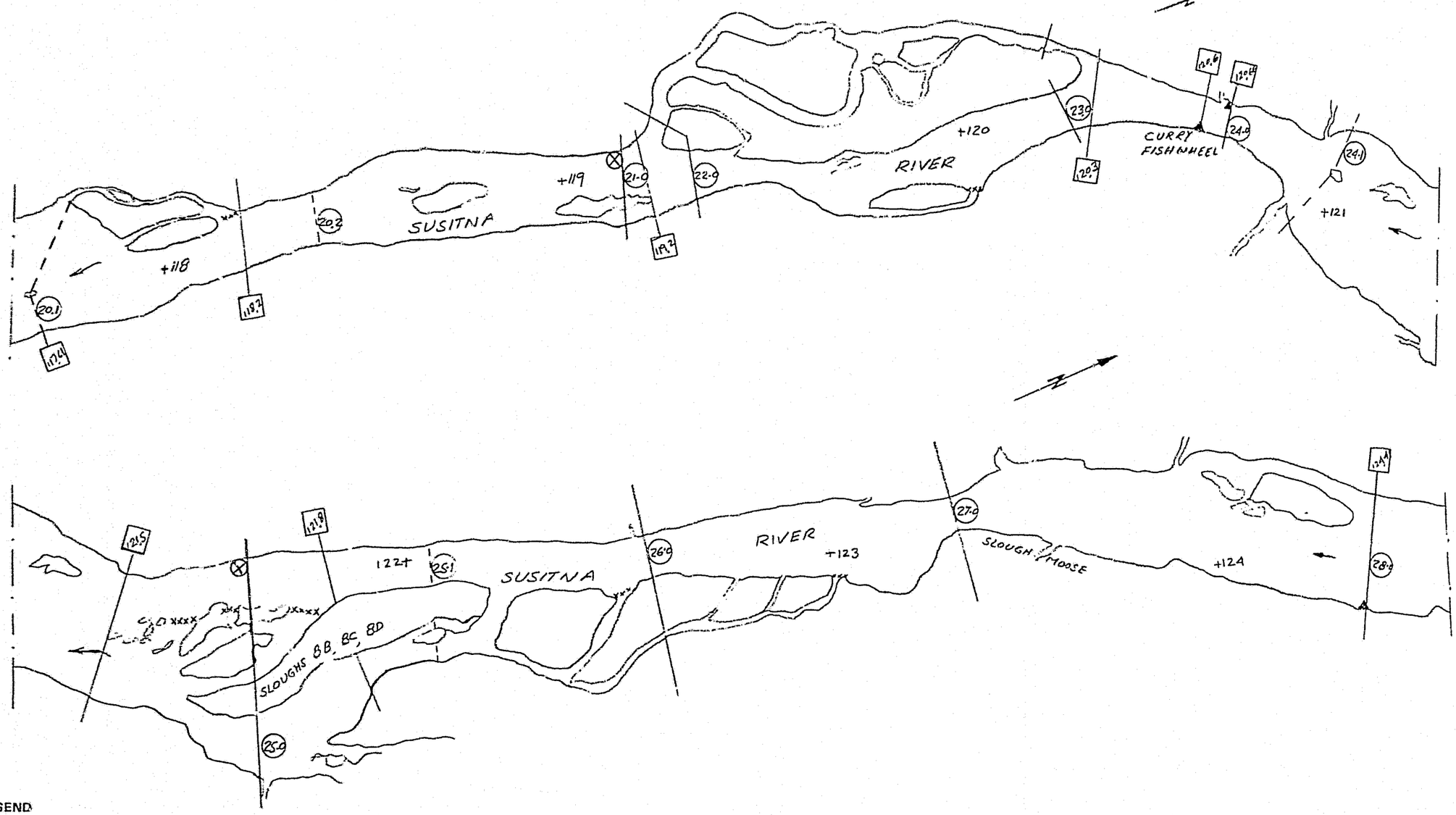
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- CROSS SECTION NUMBER
- CONTROL POINTS FOR HEC–2 CALIBRATION
- RECOMMENDED STAFF GAGE LOCATIONS

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
- 101.9 CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- (30) CROSS SECTION NUMBER
- ▲ CONTROL POINTS FOR HEC–2 CALIBRATION
- ⊗ RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

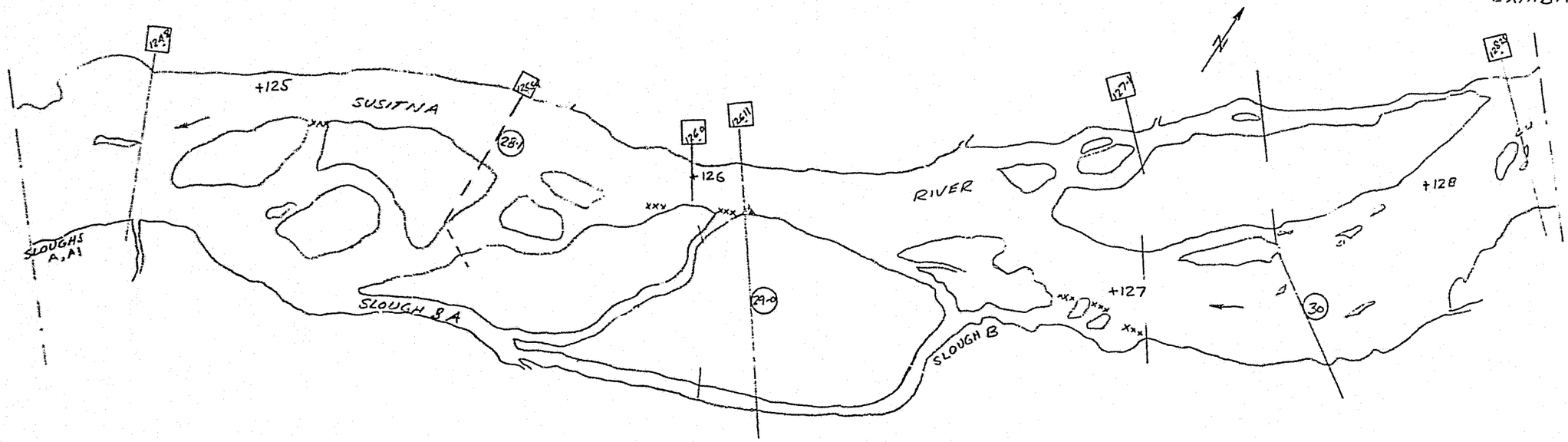
SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS,
STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

FOLD
LENGT
12
11
8.5
8
AUTO
MANUA
FEED

0 0 0 3 6 8

EXHIBIT 2-F



LEGEND

CROSS SECTION SURVEYED IN 1981

CROSS SECTION SURVEYED IN 1982

CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED

CROSS SECTION NUMBER

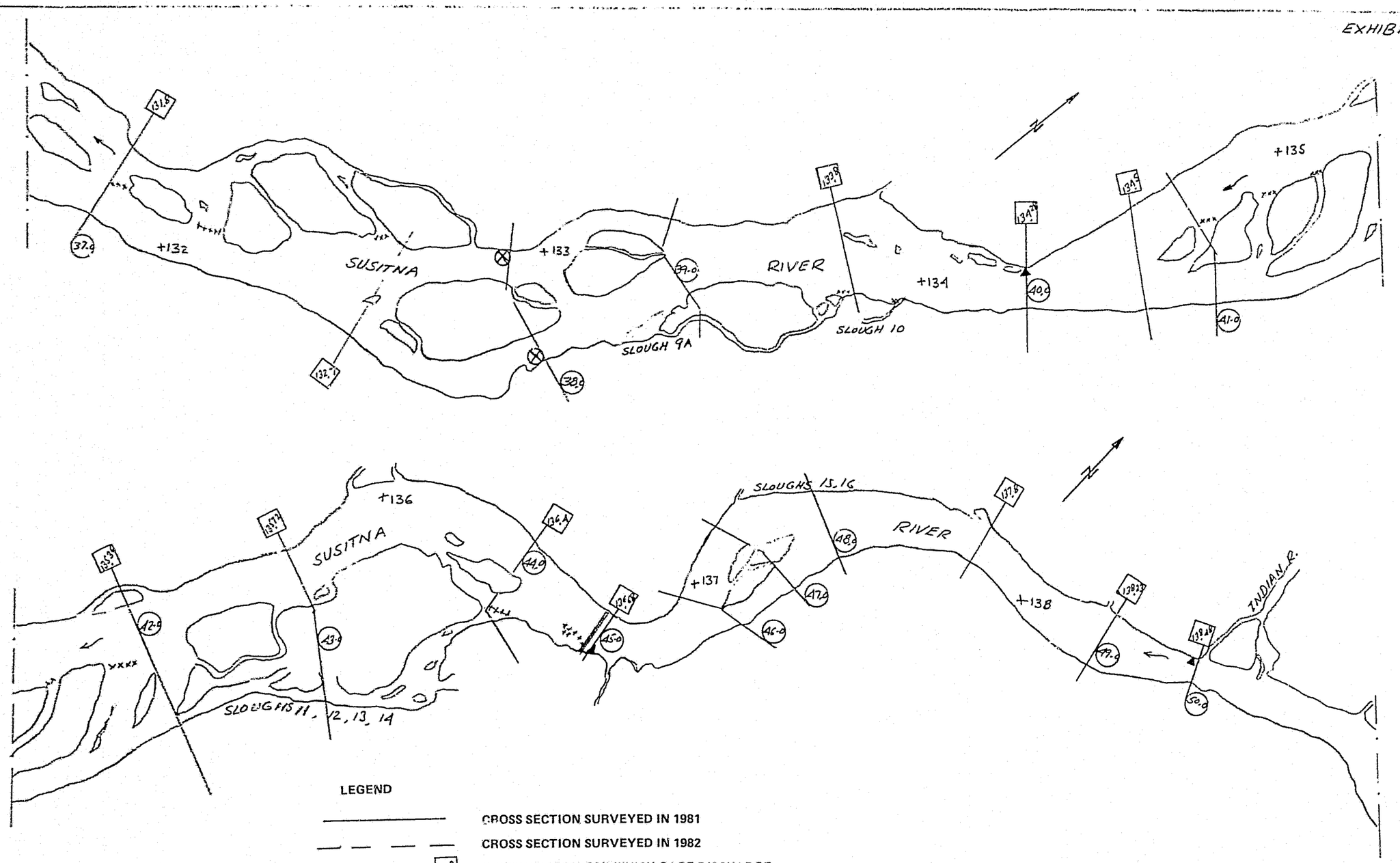
CONTROL POINTS FOR HEC–2 CALIBRATION

RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

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

EXHIBIT 2-G



LEGEND

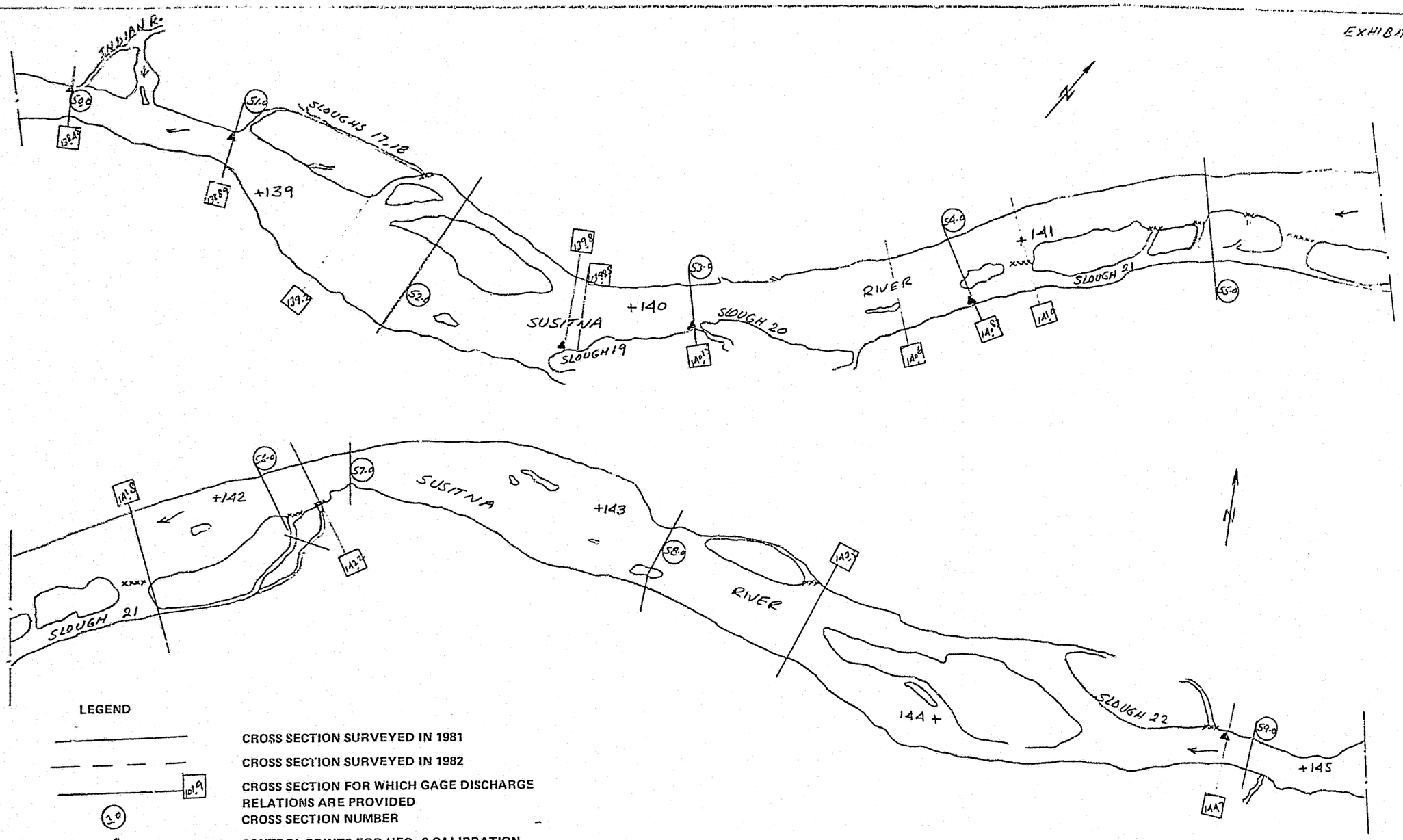
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- 101.9 CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- 3.0 CROSS SECTION NUMBER
- CONTROL POINTS FOR HEC–2 CALIBRATION
- RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1" = 1000'

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

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-H



LEGEND

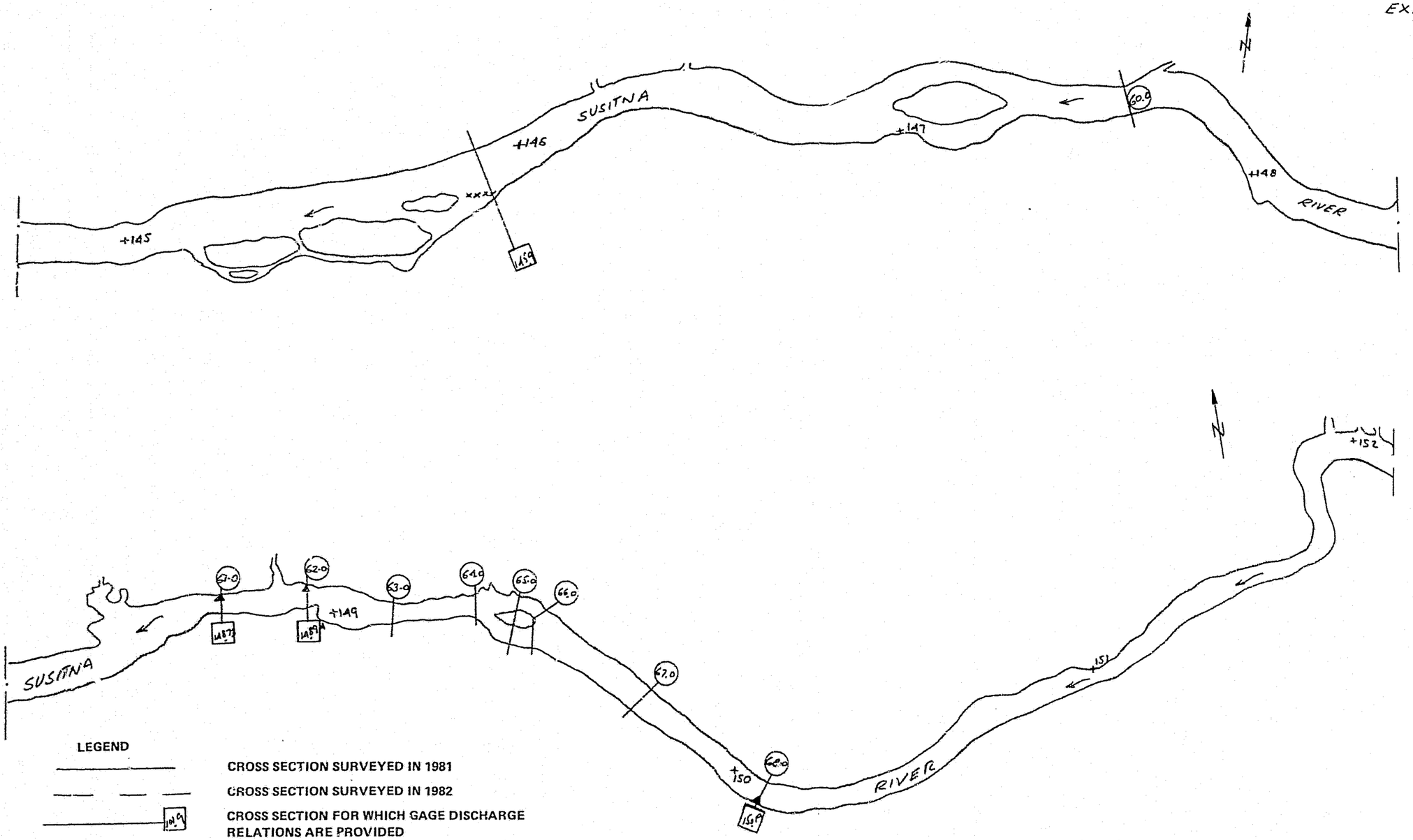
- CROSS SECTION SURVEYED IN 1981
- CROSS SECTION SURVEYED IN 1982
- CROSS SECTION FOR WHICH GAGE DISCHARGE RELATIONS ARE PROVIDED
- CROSS SECTION NUMBER
- CONTROL POINTS FOR HEC–2 CALIBRATION
- RECOMMENDED STAFF GAGE LOCATIONS

SCALE 1"=1000'

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

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

EXHIBIT 2-I

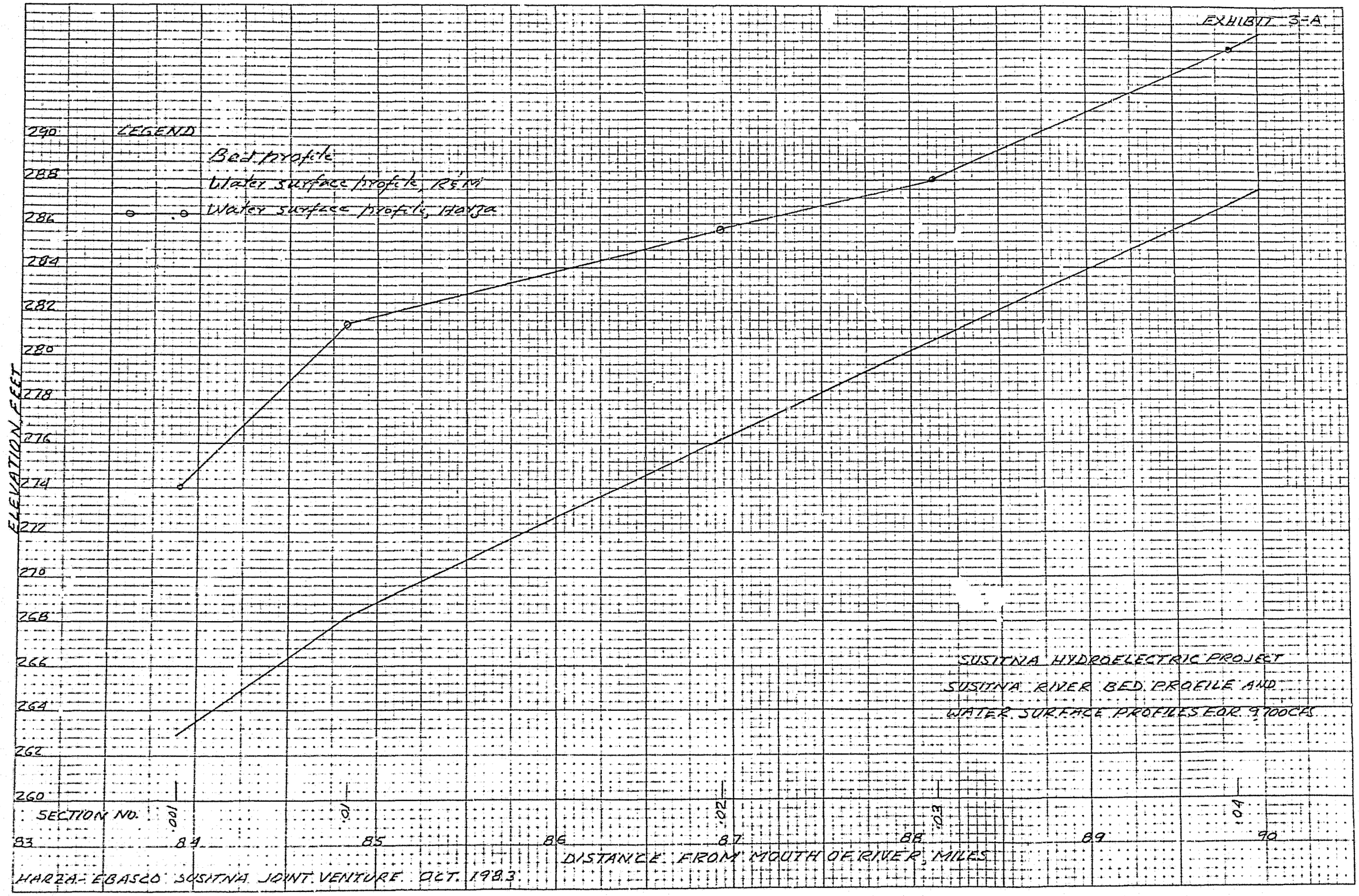


SUSITNA HYDROELECTRIC PROJECT
LOCATIONS OF RIVER CROSS SECTIONS,
STAFF GAGES AND SLOUGHS

HARZA-EBASCO SUSITNA JOINT VENTURE OCTOBER, 1983

FOLD LENGT
12
11
8.5
8
AUTO
MANUA
FEED

EXHIBIT 3-A

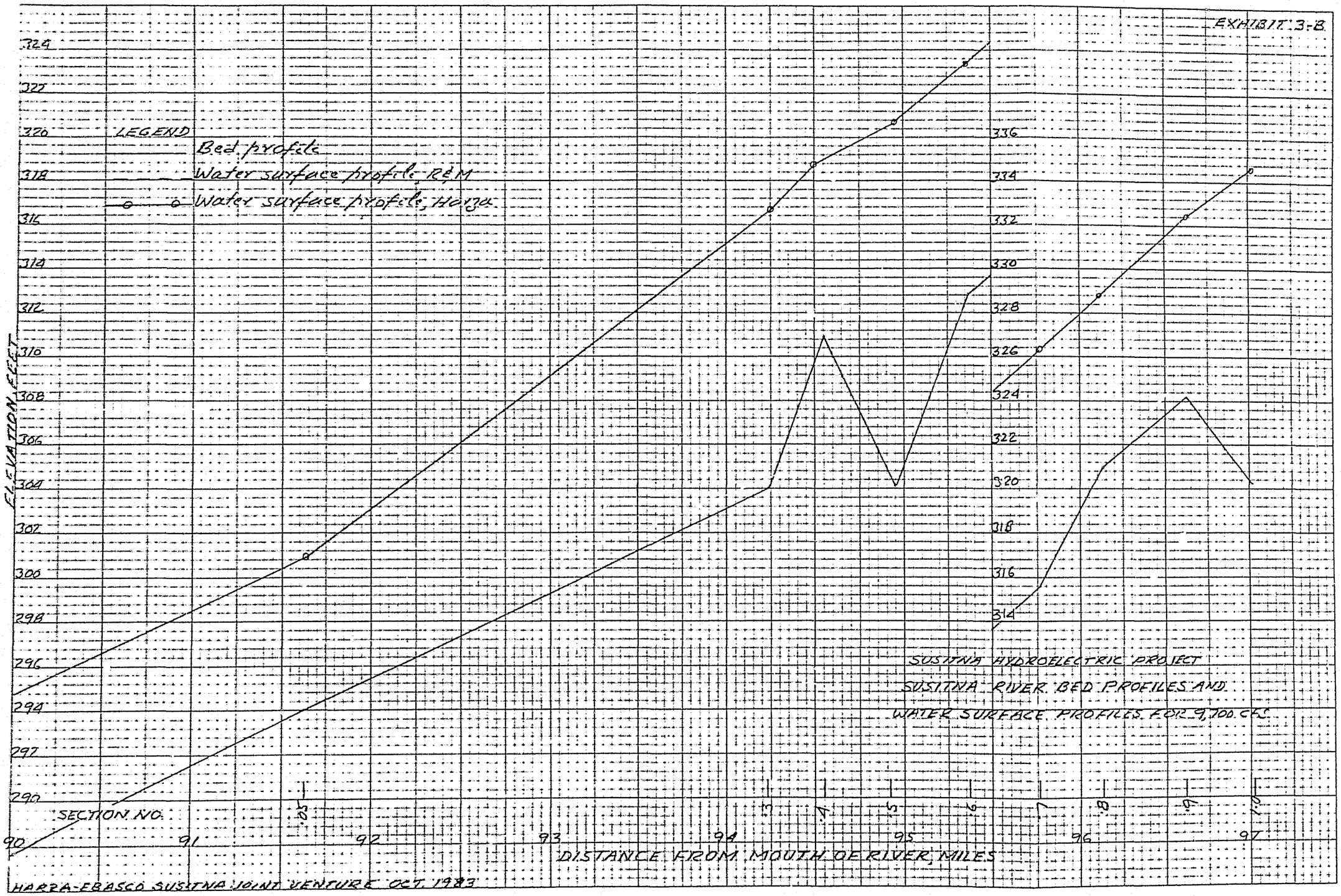


SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9700 CFS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

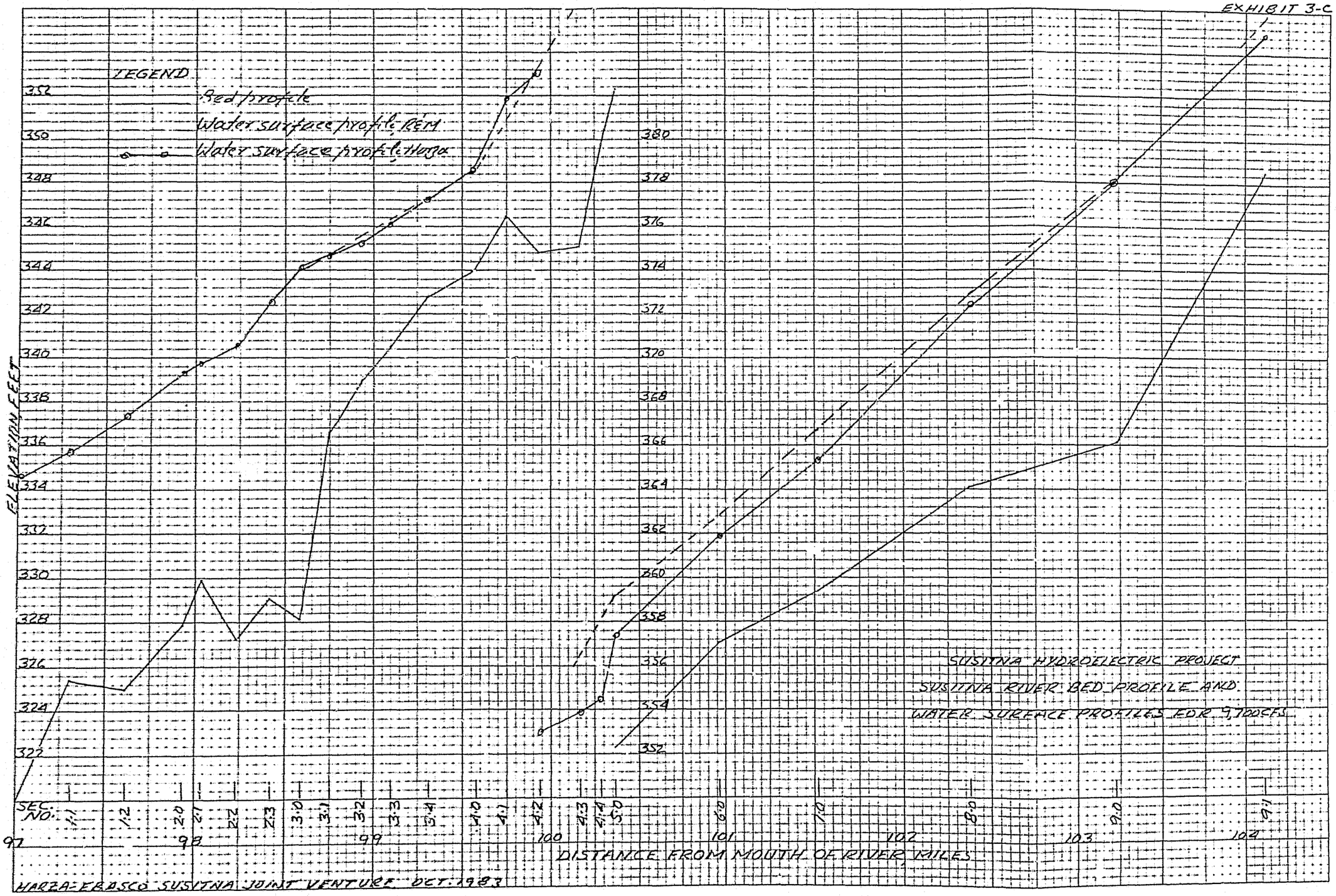
CLEARPRINT CHARTS
PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1015
KEUFFEL & ESSER CO. NO. 340 10 DIVISIONS PER INCH BOTH WAYS 150 X 100 DIVISIONS

EXHIBIT 3-8



000368

EXHIBIT 3-C



FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

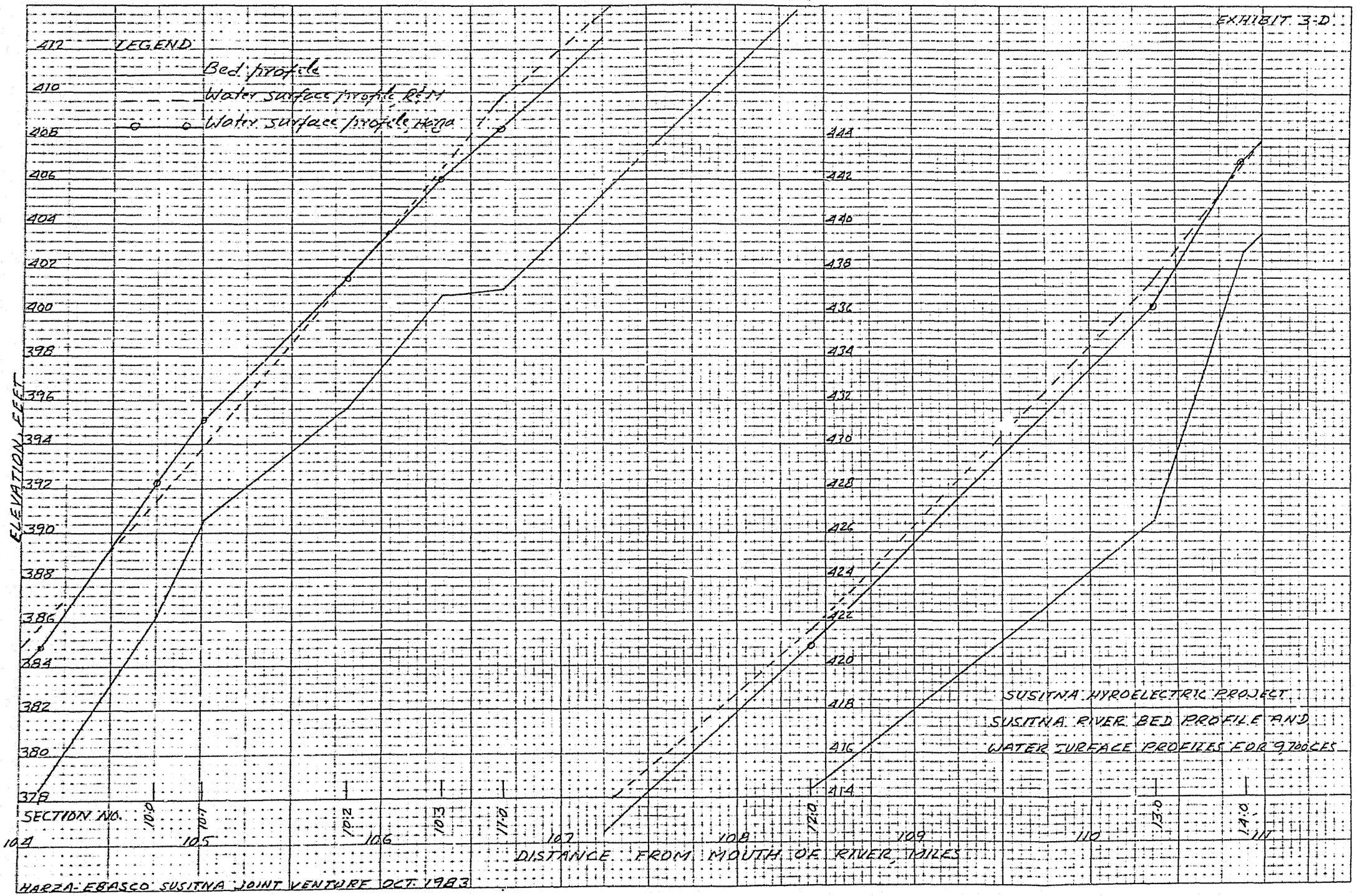


EXHIBIT 3-D
LEGEND
Bed profile
Water surface profile R&M
Water surface profile, Harza
ELEVATION, FEET
SECTION NO.
DISTANCE FROM MOUTH OF RIVER, MILES
SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9700 CFS
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

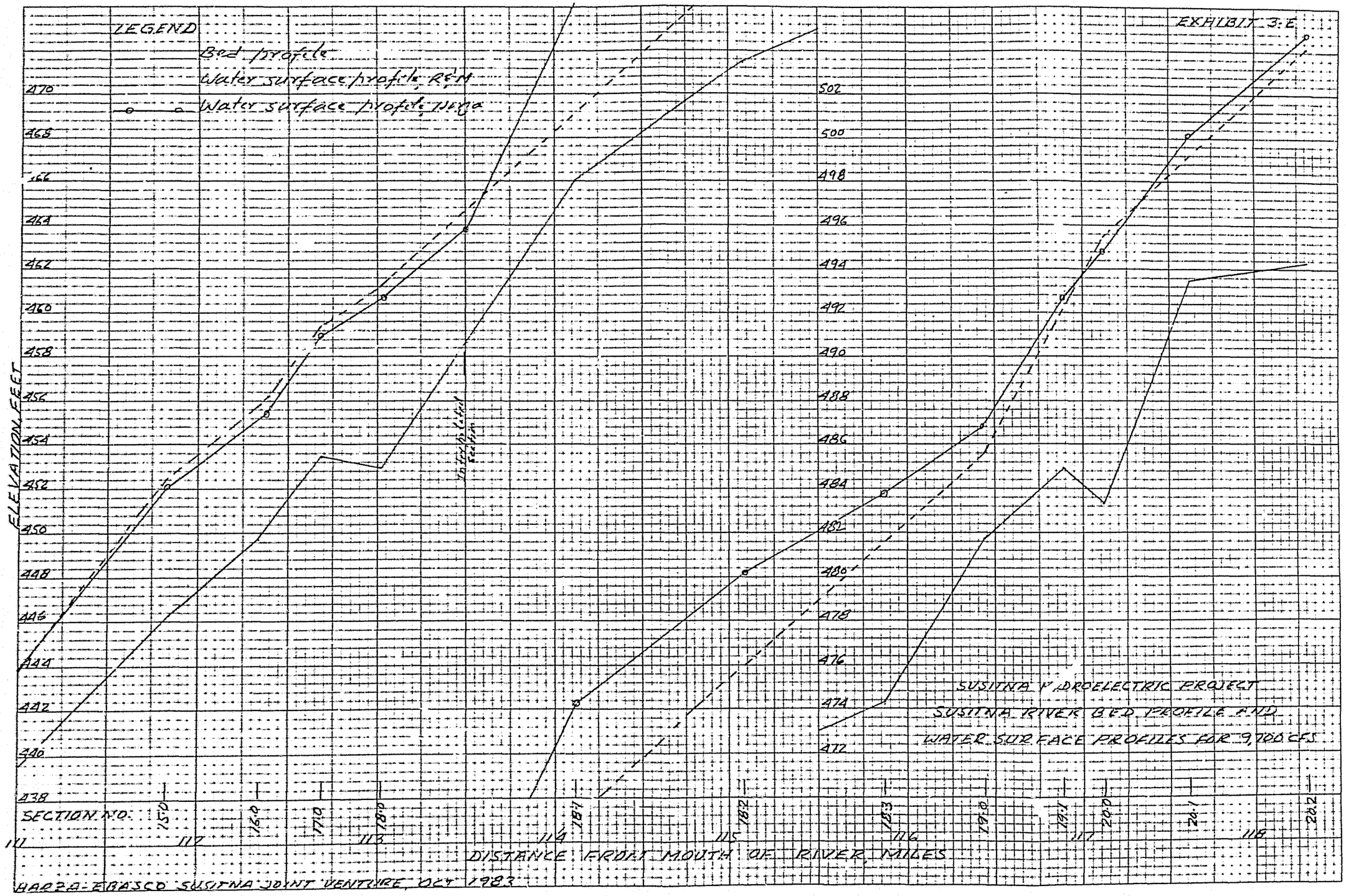
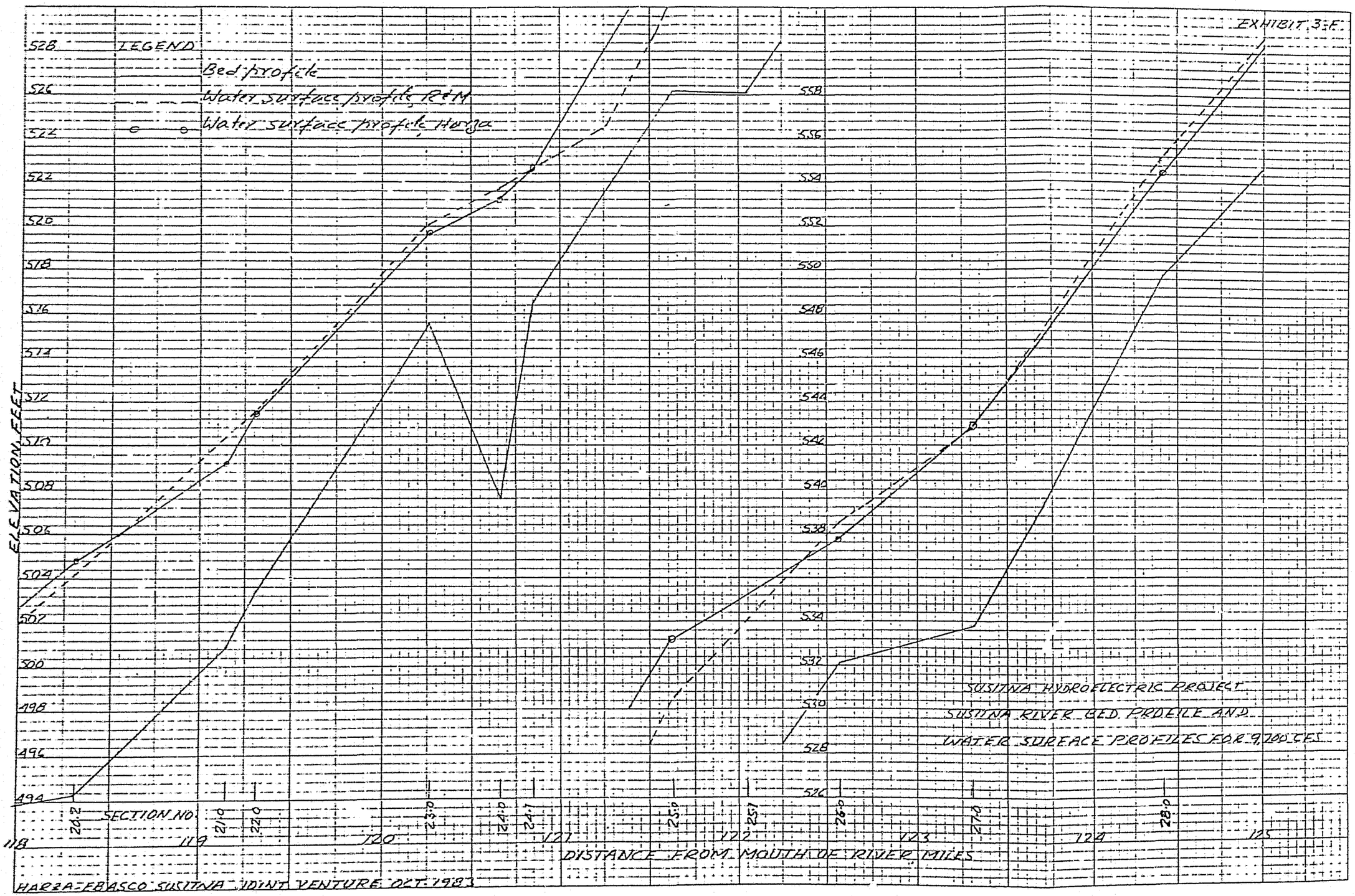


EXHIBIT 3-E
LEGEND
Bed profile
Water surface profile, R&M
Water surface profile, Nina
ELEVATION, FEET
470
468
466
464
462
460
458
456
454
452
450
448
446
444
442
440
438
502
500
498
496
494
492
490
488
486
484
482
480
478
476
474
472
Interpolated Section
SECTION NO.
15.0
16.0
17.0
18.0
18.1
18.2
18.3
19.0
19.1
20.0
20.1
20.2
111
112
113
114
115
116
117
118
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-F



SUSITNA HYDROELECTRIC PROJECT

SUSITNA RIVER BED PROFILE AND WATER SURFACE PROFILES FOR 9,100 CFS

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

FOLD LENGTH
12
11
8.5
8
AUTO
MANUA
FEED

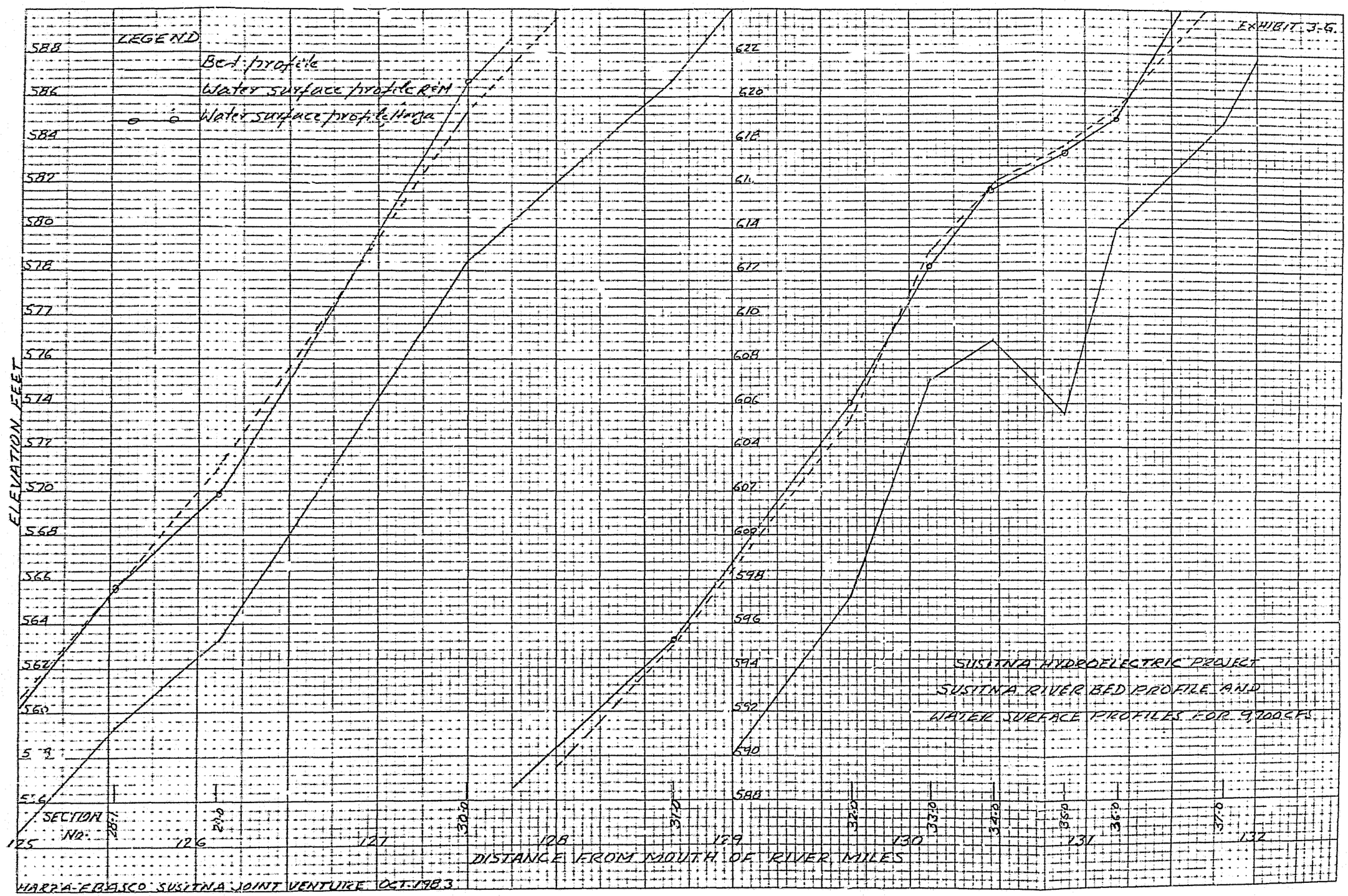
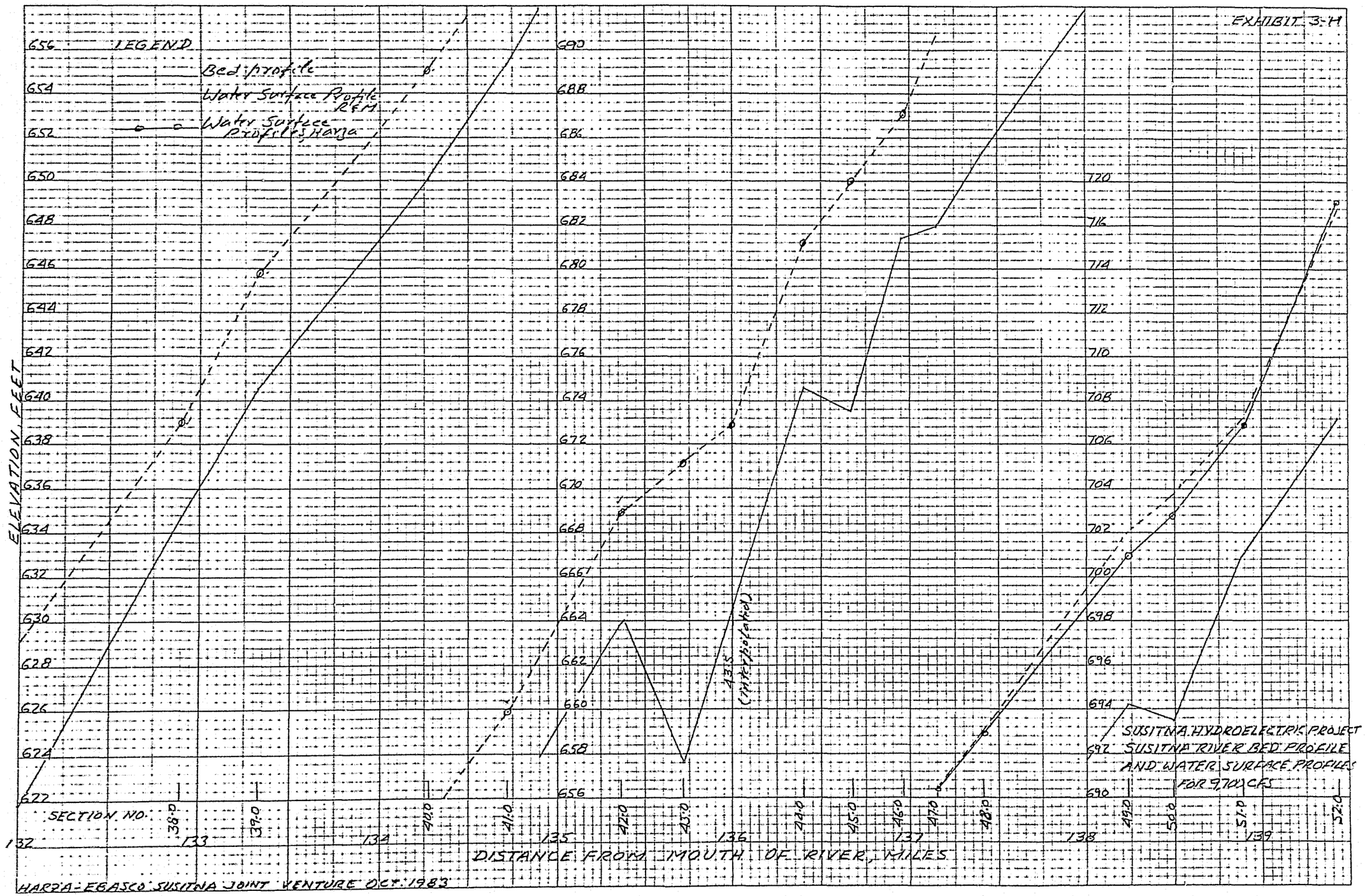


EXHIBIT 3-G
LEGEND
Bed profile
Water surface profile R&M
Water surface profile Harza
ELEVATION FEET
588
586
584
582
580
578
577
576
574
572
570
568
566
564
562
560
622
620
618
614
612
610
608
606
604
602
600
598
596
594
592
590
588
SECTION No.
28.1
29.0
30.0
31.0
32.0
33.0
34.0
35.0
36.0
37.0
125
126
127
128
129
130
131
132
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-H



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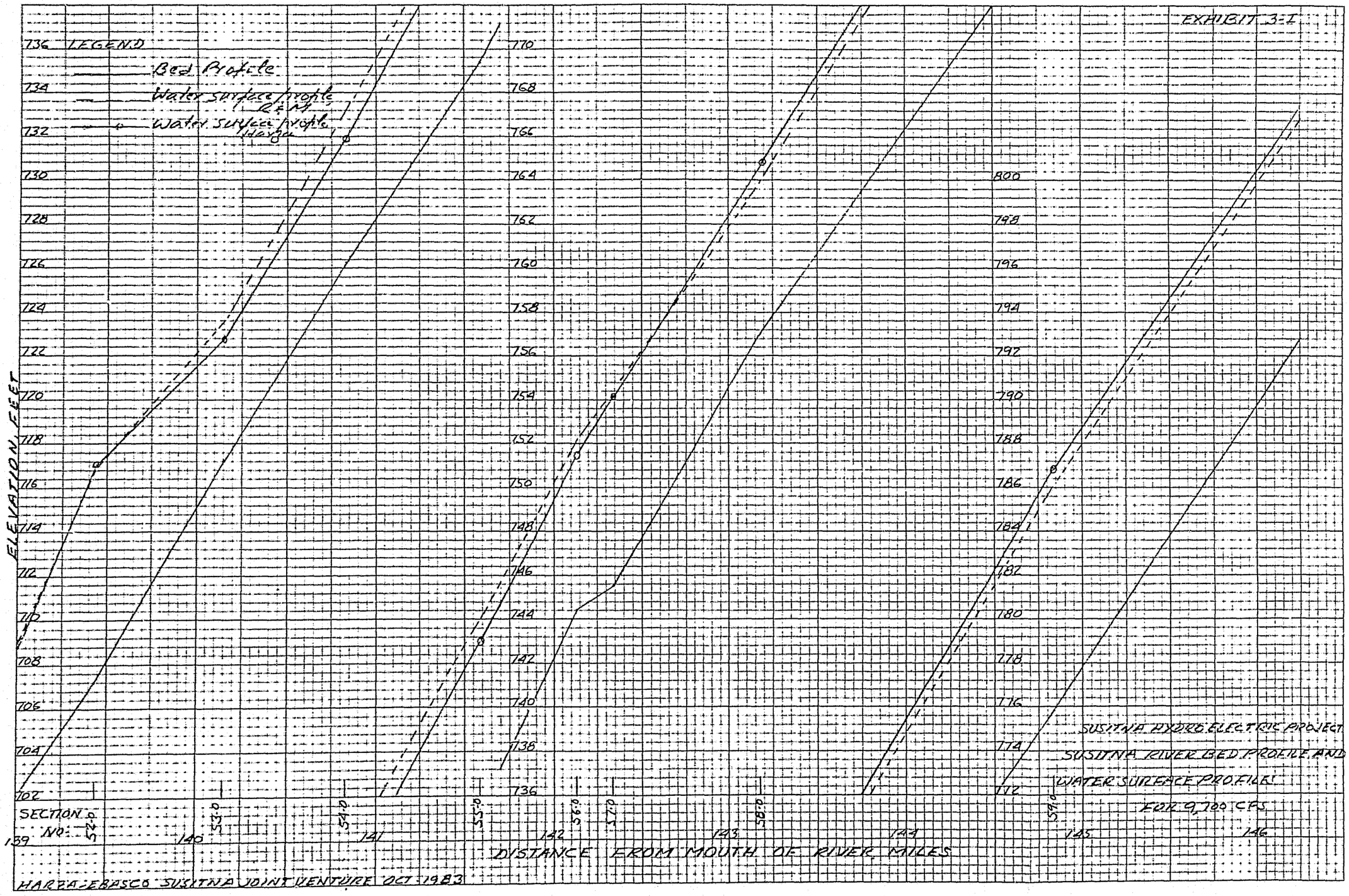
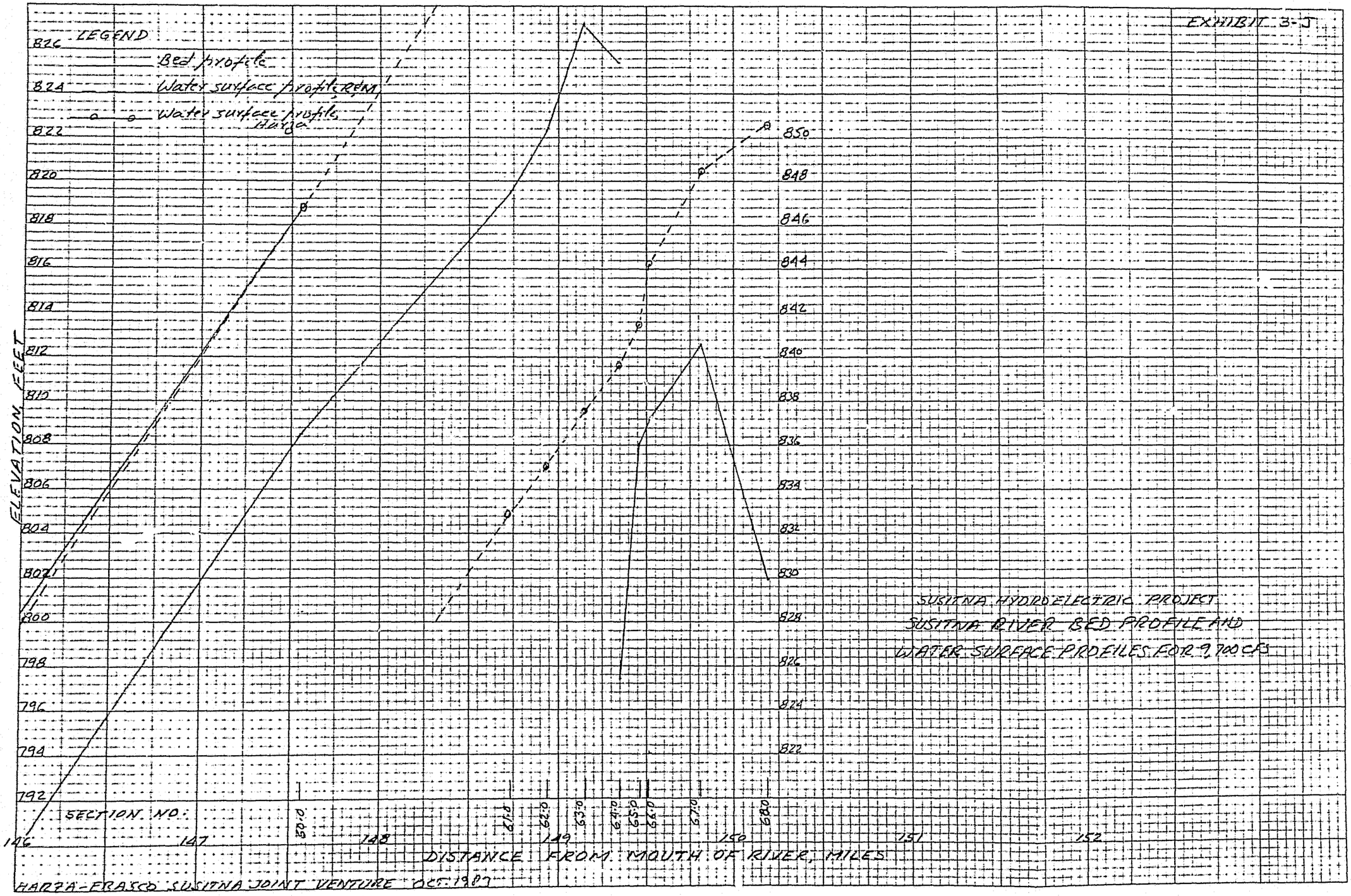


FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

000368

EXHIBIT B-J

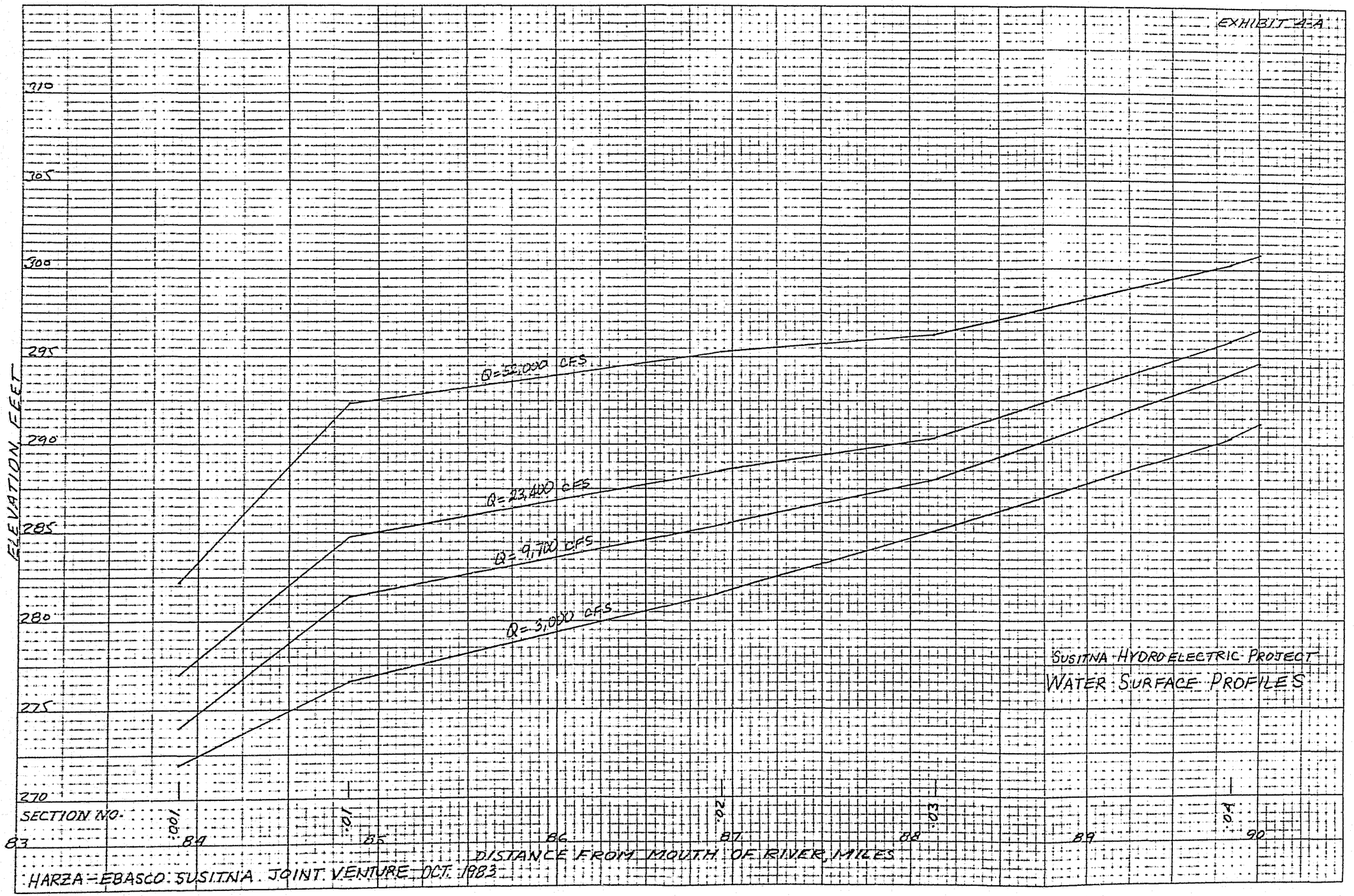


SUSITNA HYDROELECTRIC PROJECT
SUSITNA RIVER BED PROFILE AND
WATER SURFACE PROFILES FOR 9,700 CFS

HARZA-EBASCO SUSITNA JOINT VENTURE Oct. 1982

PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1015
10 DIVISIONS PER INCH BOTH WAYS 100 X 100 DIVISIONS
FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

EXHIBIT 2-A

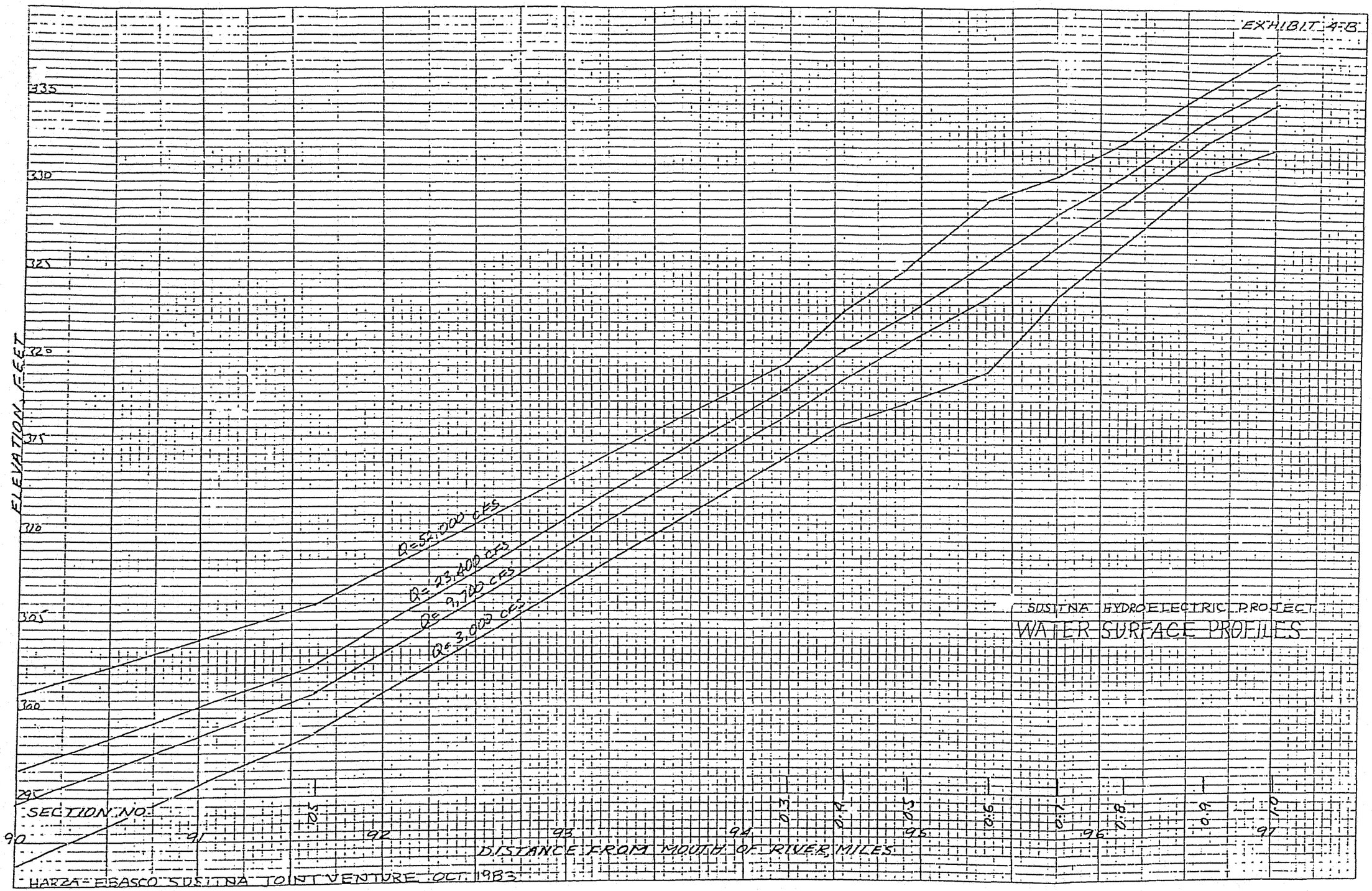


SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

CLEARPRINT PAPER CO NO. 1 CAN 10 DIVISIONS PER INCH BOTH WAYS 150 X 100 DIVISIONS
FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

EXHIBIT 4-B

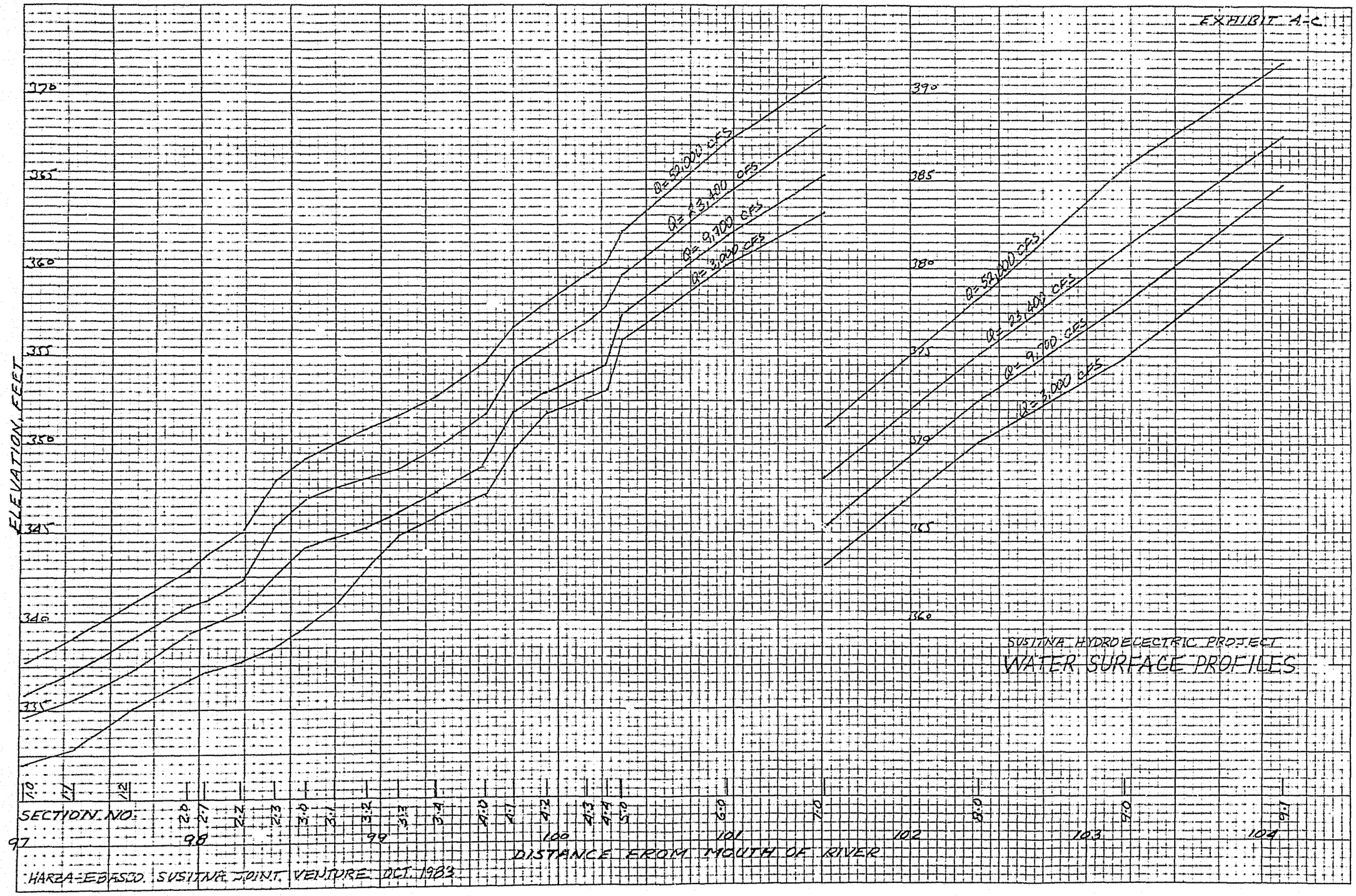


SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

FOLD
LENGT
12
11
8.5
8
AUTO
MANUA
FEED

EXHIBIT A-C



SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO 1015
NO FAS 10 DIVISIONS PER INCH BOTH WAYS 130 X 100 DIVISIONS
FOLD LENGT
12
11
8.5
8
AUTO
MANUA
FEED

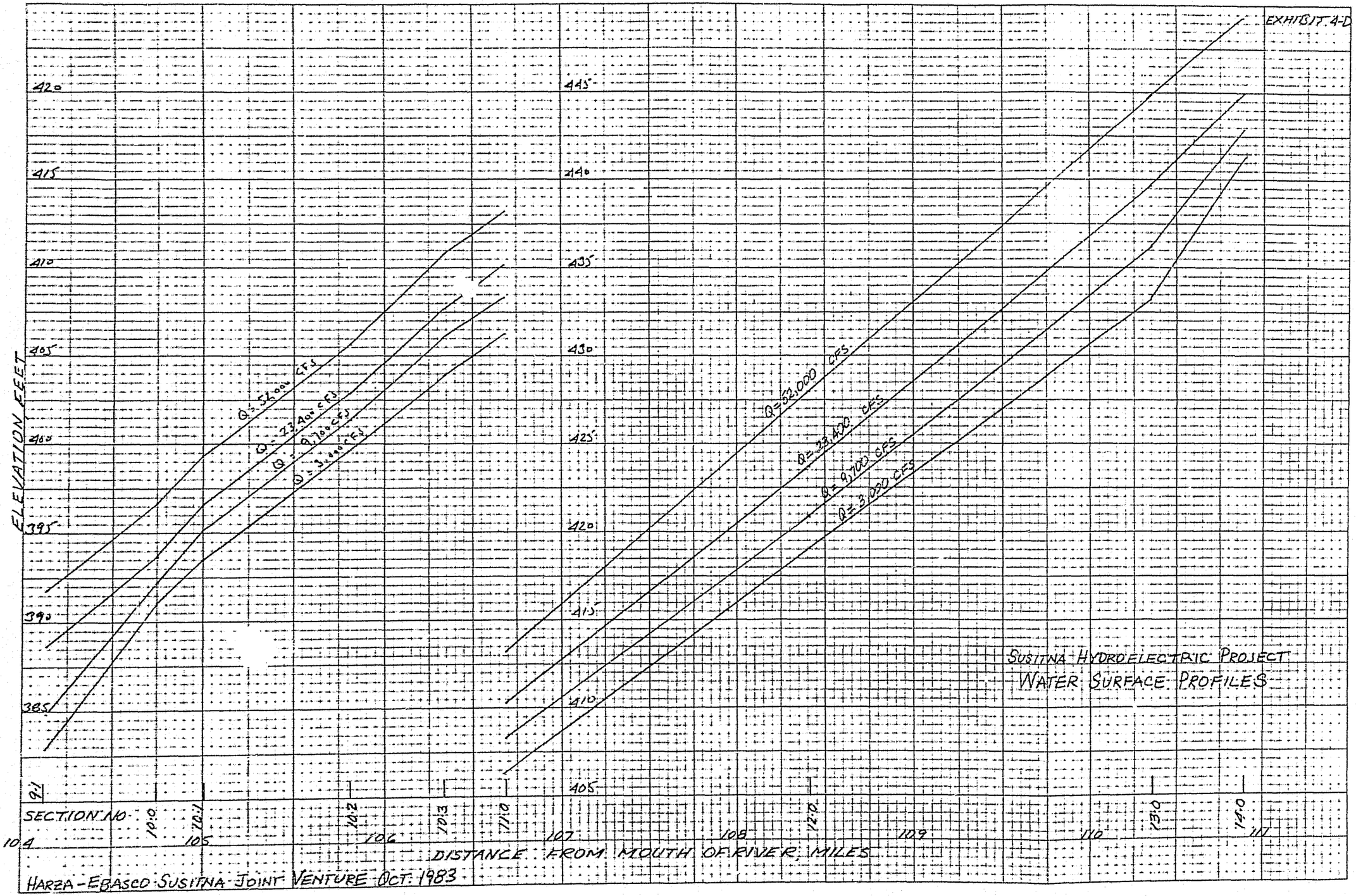
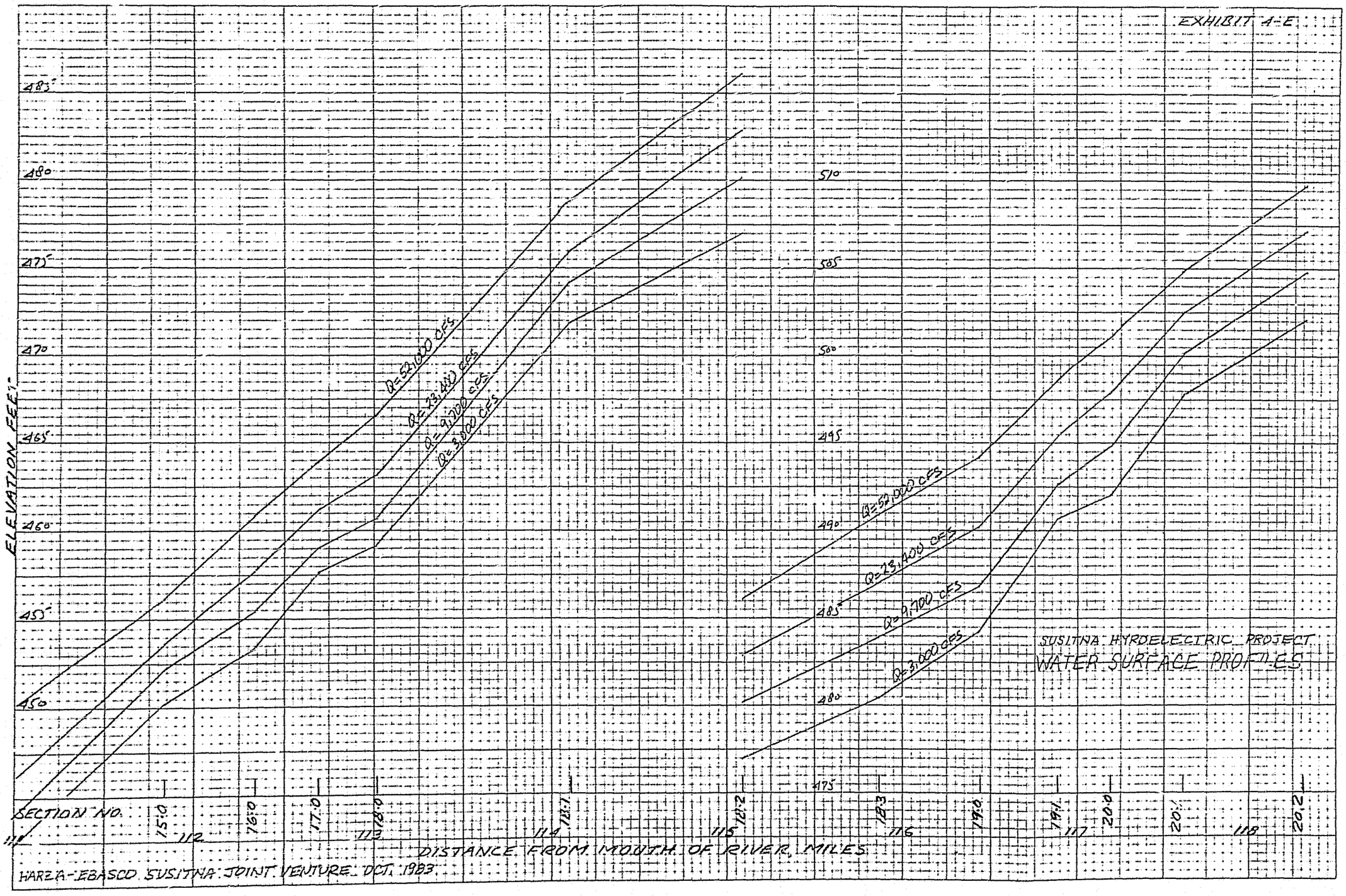


EXHIBIT 4-D
ELEVATION FEET
420
415
410
405
400
395
390
385
445
440
435
430
425
420
415
410
405
Q=52,000 CFS
Q=23,400 CFS
Q=9,700 CFS
Q=3,000 CFS
SUSITNA HYDROELECTRIC PROJECT
WATER SURFACE PROFILES
9.1
SECTION NO.
10.0
10.1
10.2
10.3
11.0
12.0
13.0
14.0
104
105
106
107
108
109
110
111
DISTANCE FROM MOUTH OF RIVER, MILES
HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

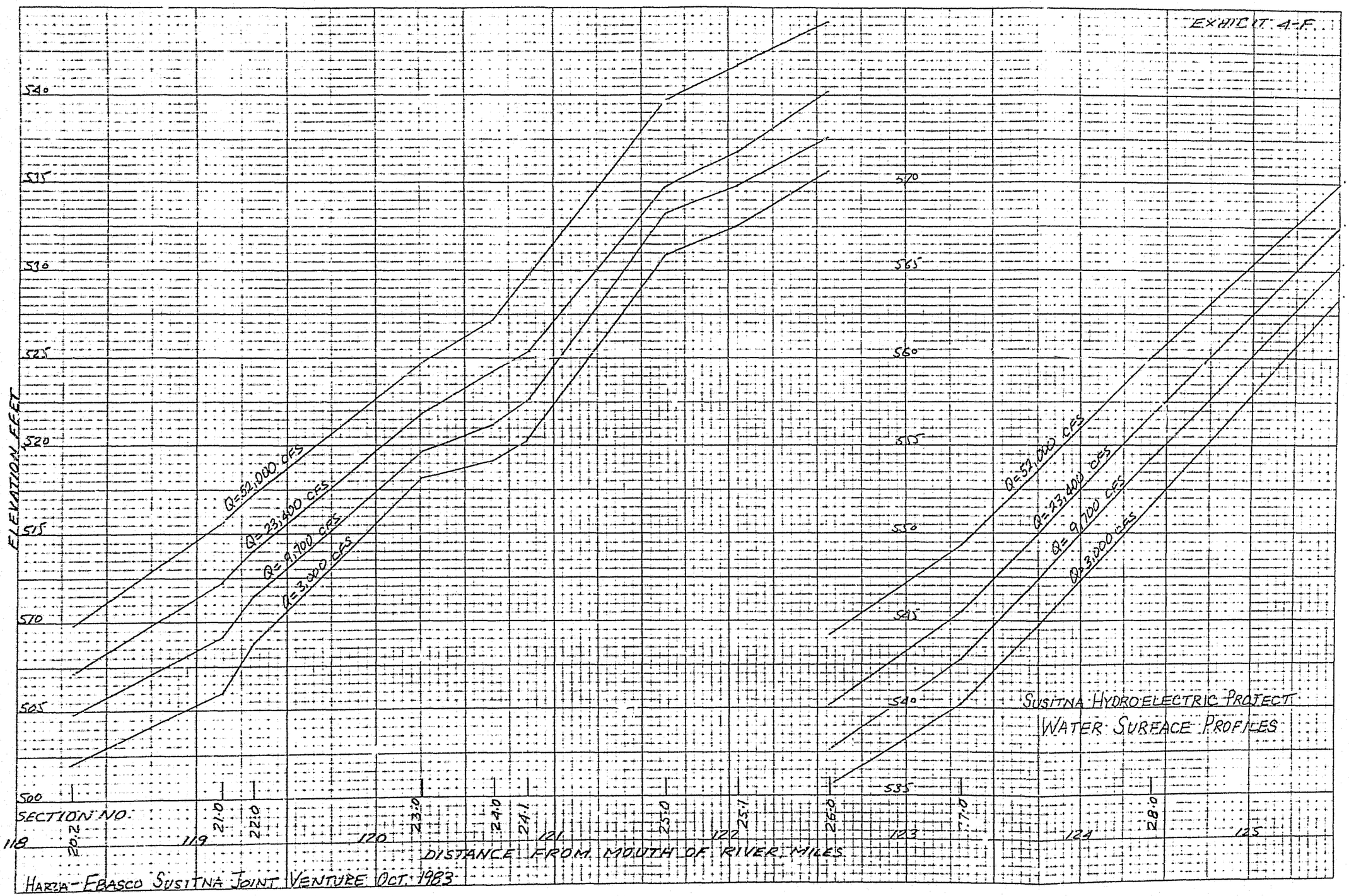
EXHIBIT 4-E



SUSITNA HYRDELECTRIC PROJECT
WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

EXHIBIT A-F

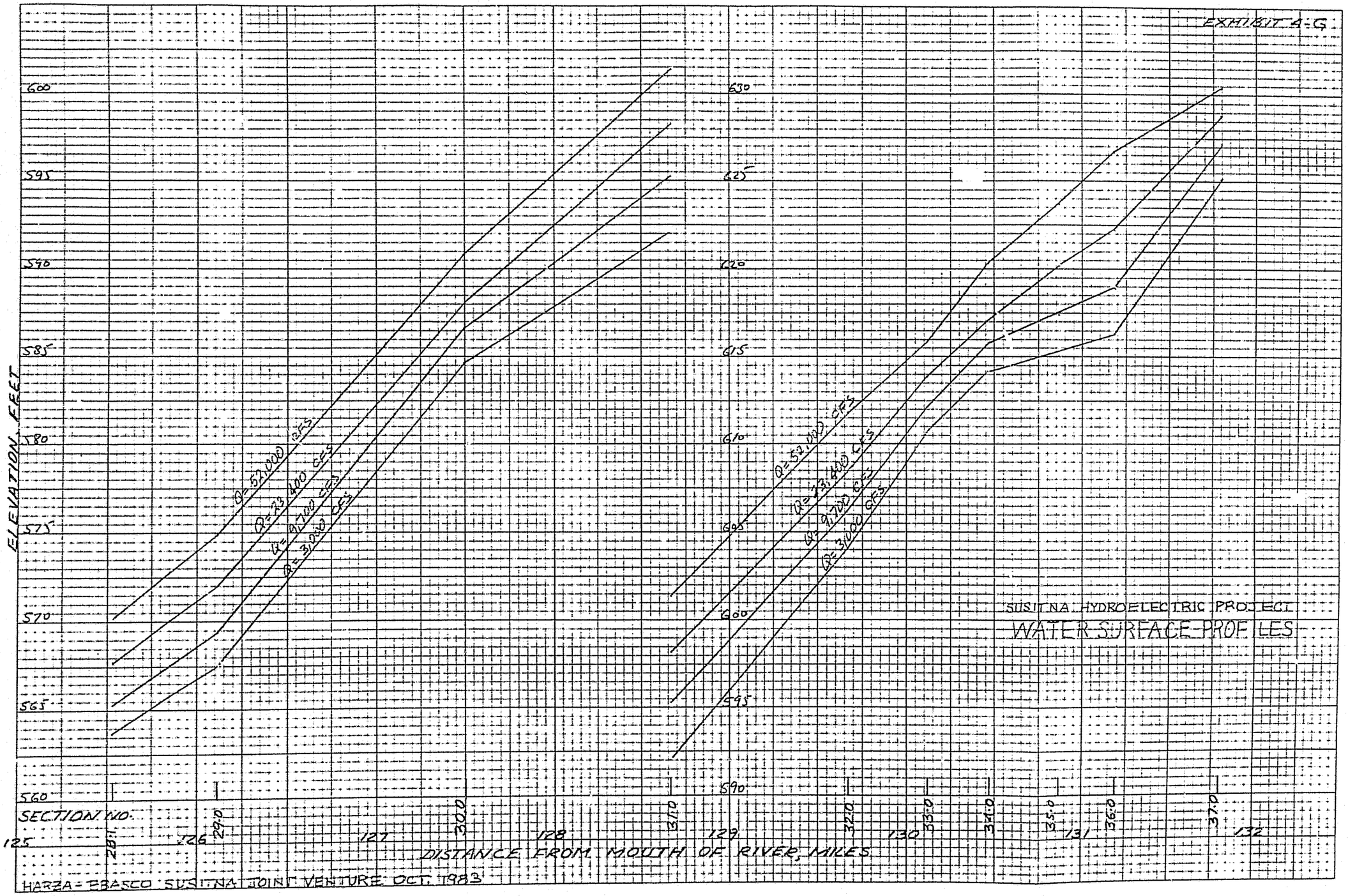


SUSITNA HYDROELECTRIC PROJECT

WATER SURFACE PROFILES

HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

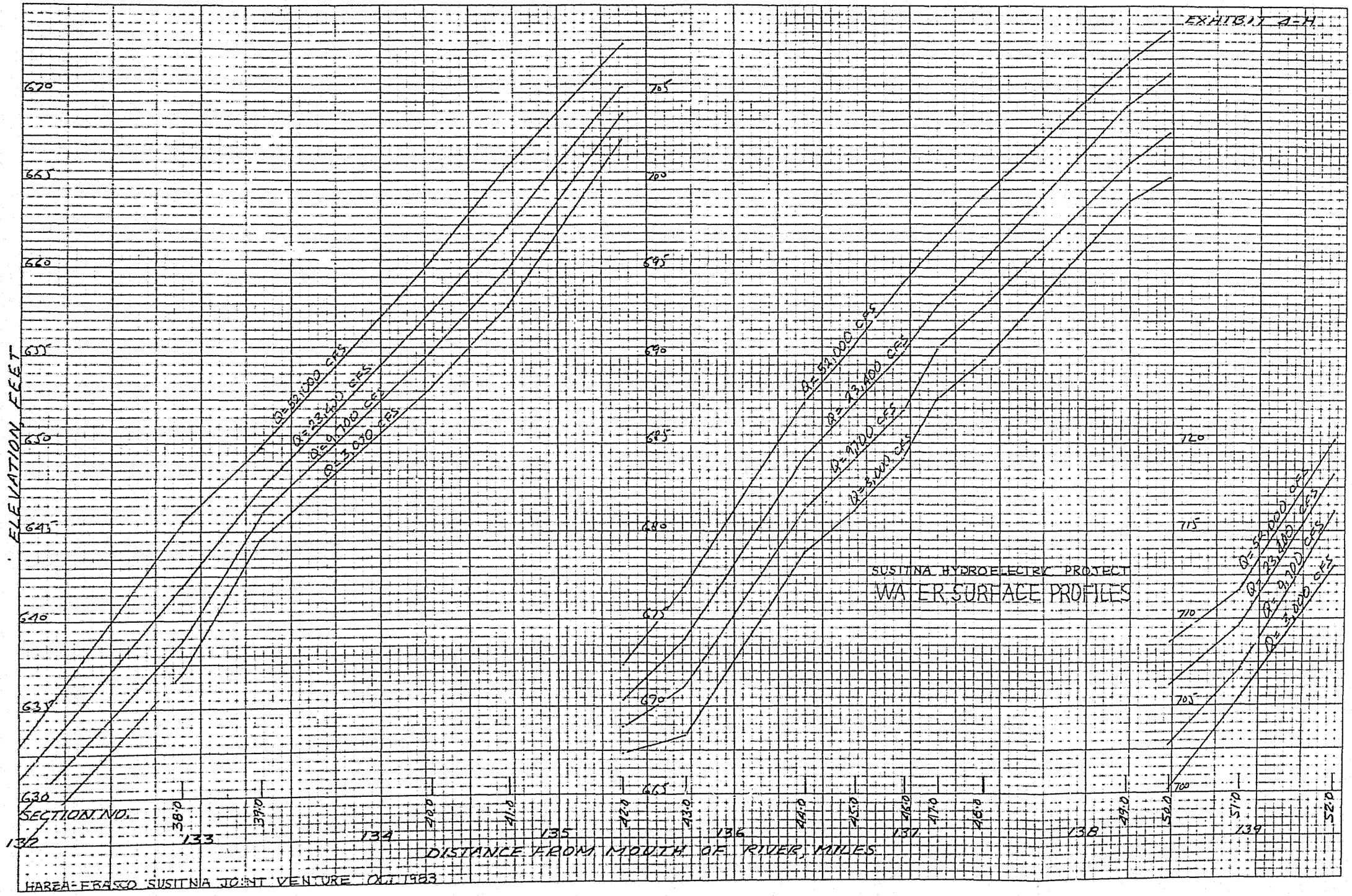
PRINTED IN U.S.A. ON KEUFFEL & ESSER CO. NO. C45 10 DIVISIONS PER INCH BOTH WAYS 1 INCH X 100 DIVISIONS
KEUFFEL & ESSER CO.
FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED



CLEARPRINT PAPER CO. NO. CAR. 10 DIVISIONS PER INCH BOTH WAYS 150 X 100 DIVISIONS
PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1011
FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

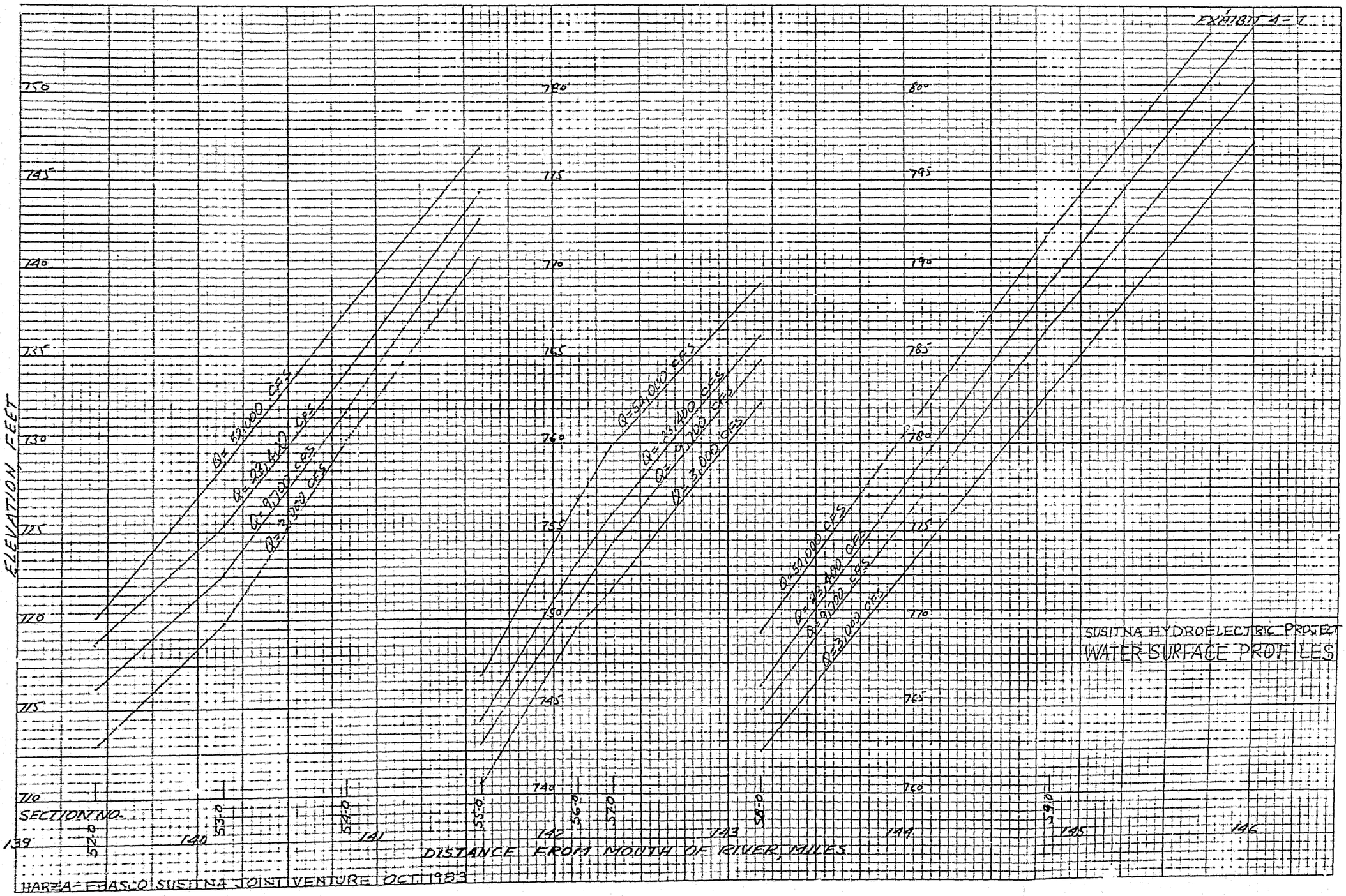
PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1015
CLEARPRINT PAPER CO. NO. C45 10 DIVISIONS PER INCH BOTH WAYS 150 X 100 DIVISIONS

EXHIBIT A-H



HARZA-EBASCO SUSITNA JOINT VENTURE OCT. 1983

FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED



PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1015
FOLD LENGTH
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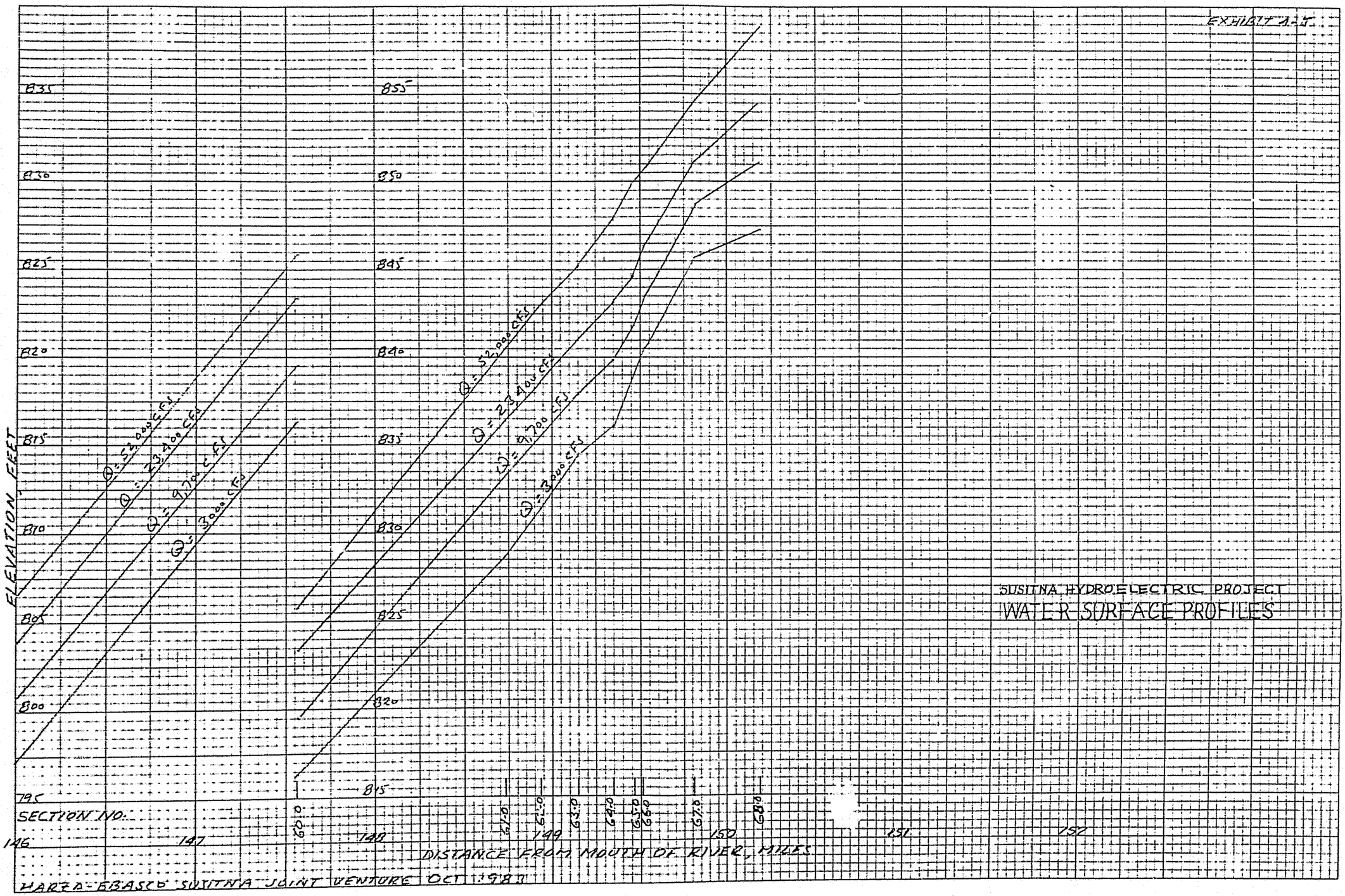
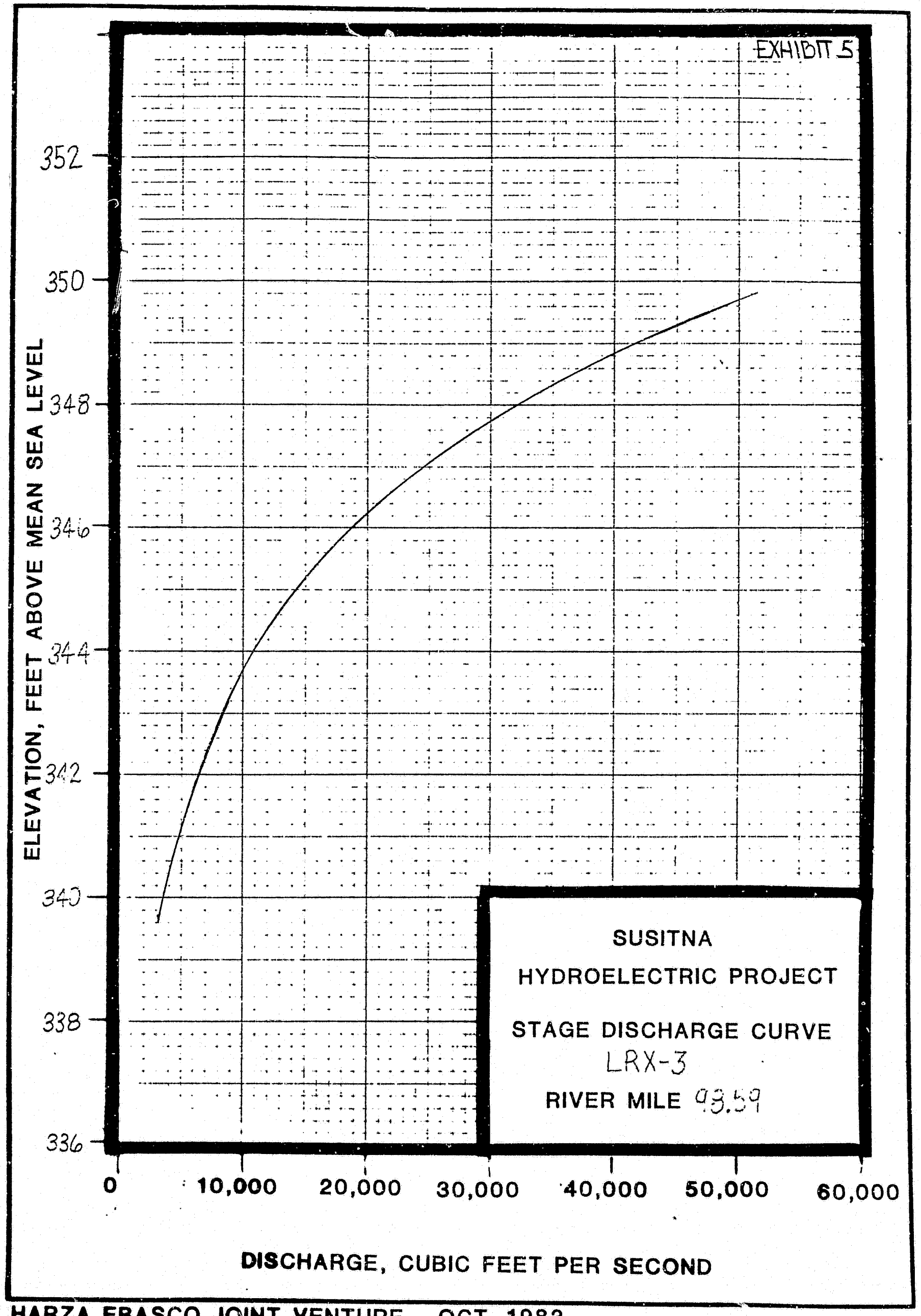
11
8.5
8
AUTO
MANUAL
FEED

EXHIBIT A-5



PRINTED IN U.S.A. ON CLEARPRINT TECHNICAL PAPER NO. 1015
NO. C45 10 DIVISIONS PER INCH BOTH WAYS 130 X 100 DIVISIONS
CLEARPRINT PAPER CO
FOLD LENGTH
12
11
8.5
8
AUTO
MANUAL
FEED

EXHIBIT 5



SUSITNA

HYDROELECTRIC PROJECT

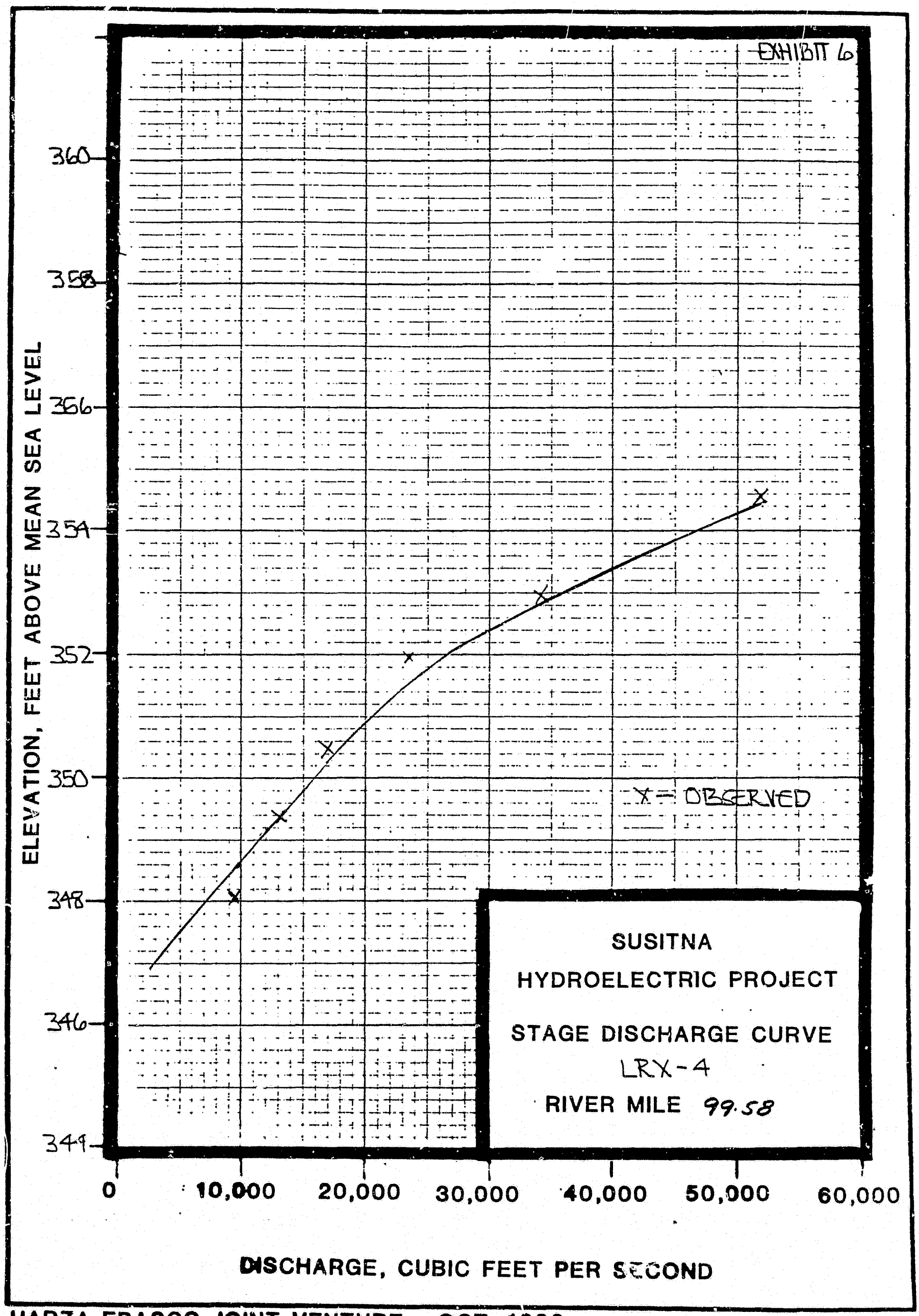
STAGE DISCHARGE CURVE

LRX-3

RIVER MILE 93.59

HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 6



HARZA EBASCO JOINT VENTURE OCT 1983

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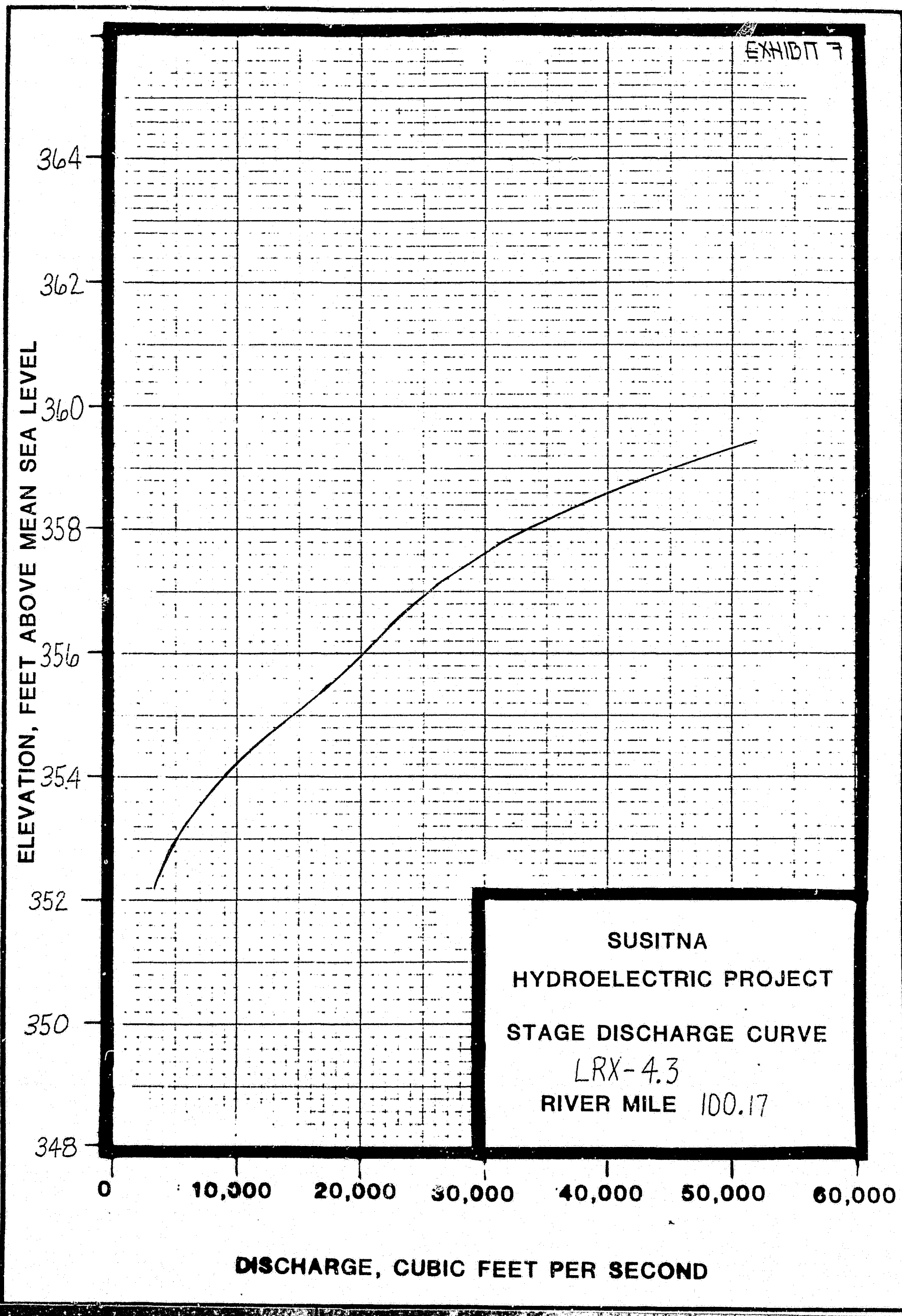

ELEVATION, FEET ABOVE MEAN SEA LEVEL
364
362
360
358
356
354
352
350
348
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-4.3
RIVER MILE 100.17

EXHIBIT B

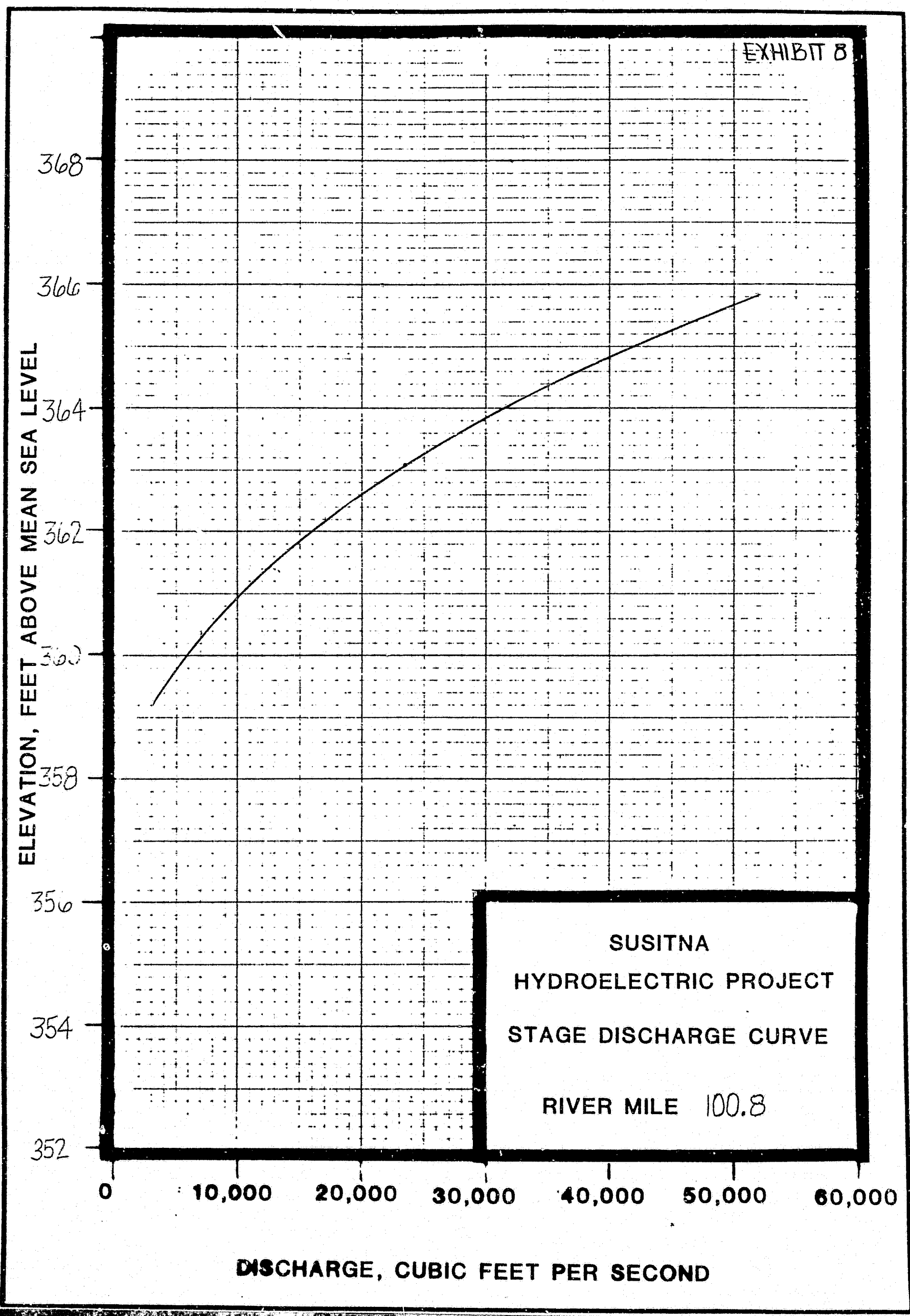

ELEVATION, FEET ABOVE MEAN SEA LEVEL
368
366
364
362
360
358
356
354
352
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 100.8

EXHIBIT 9

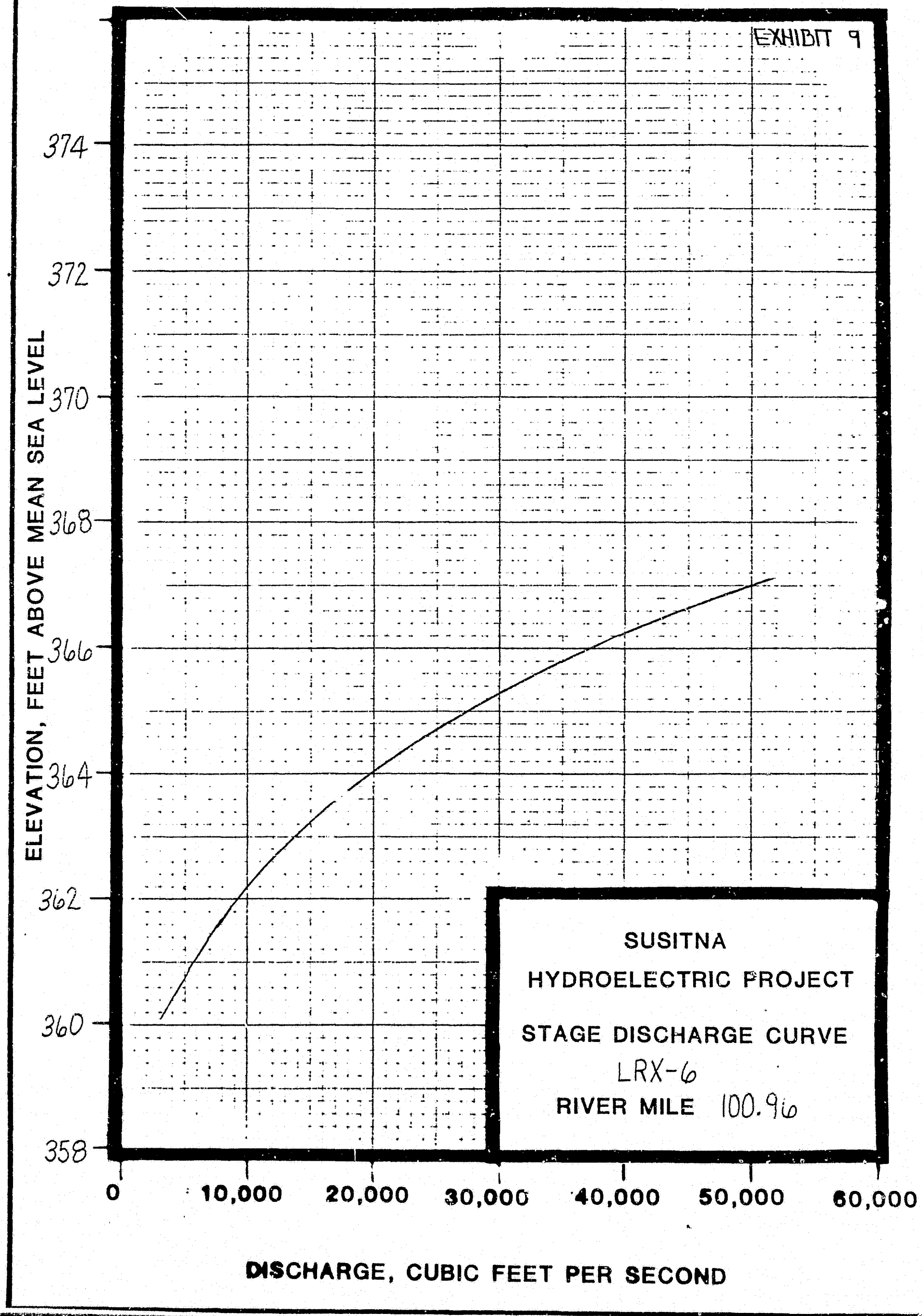
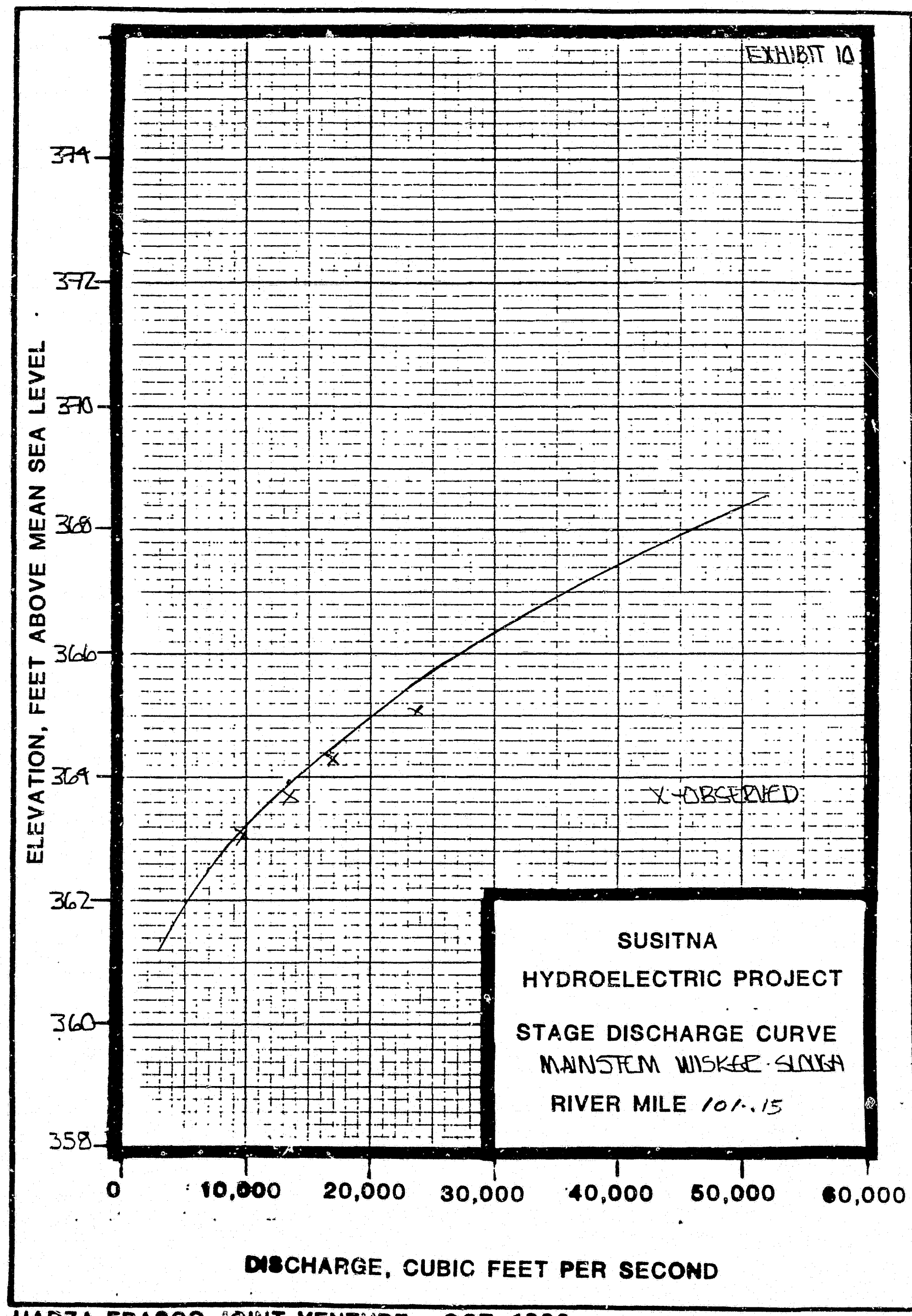

ELEVATION, FEET ABOVE MEAN SEA LEVEL
374
372
370
368
366
364
362
360
358
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-6
RIVER MILE 100.96

EXHIBIT 10



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 11

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

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-7
RIVER MILE 101.52

EXHIBIT 12

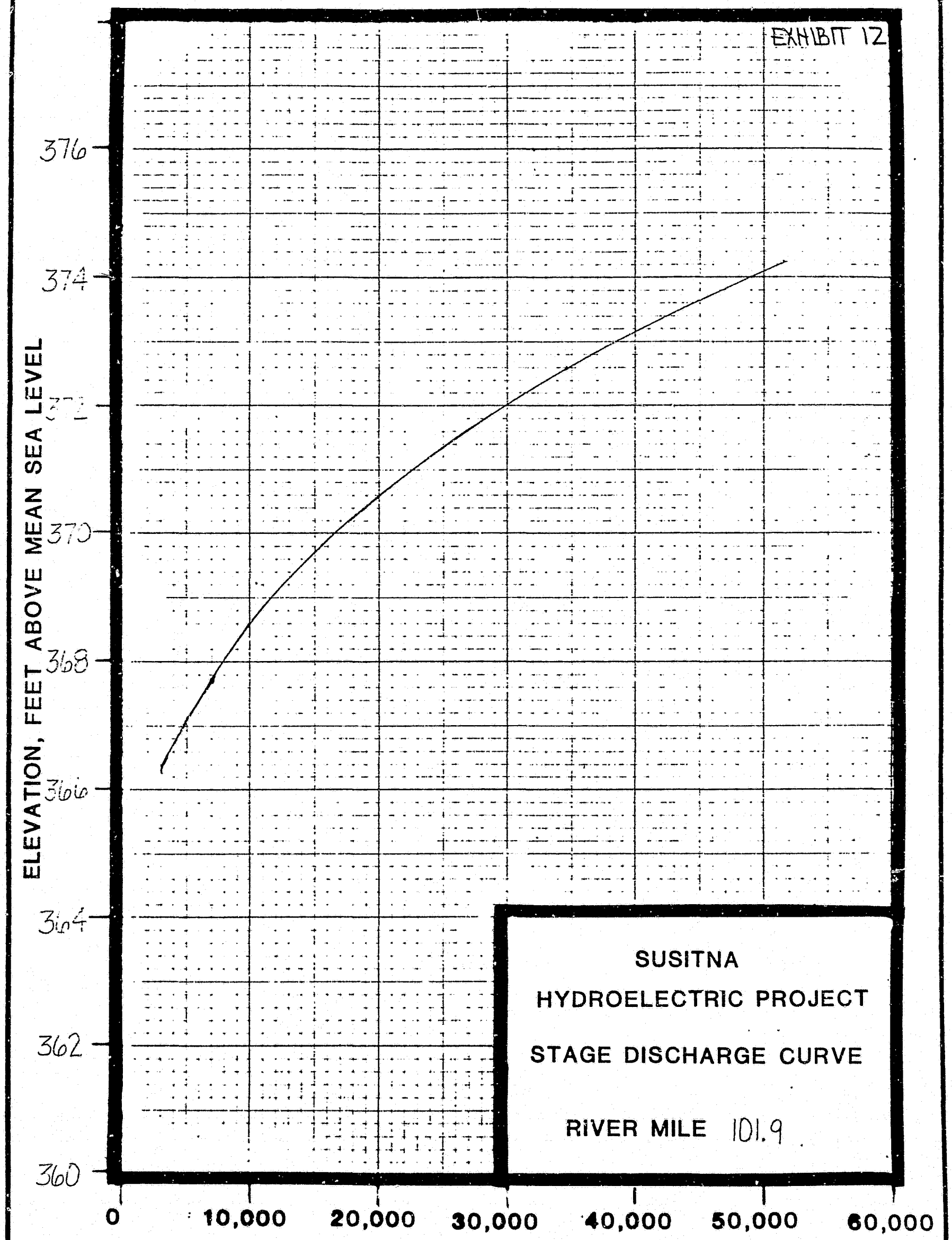
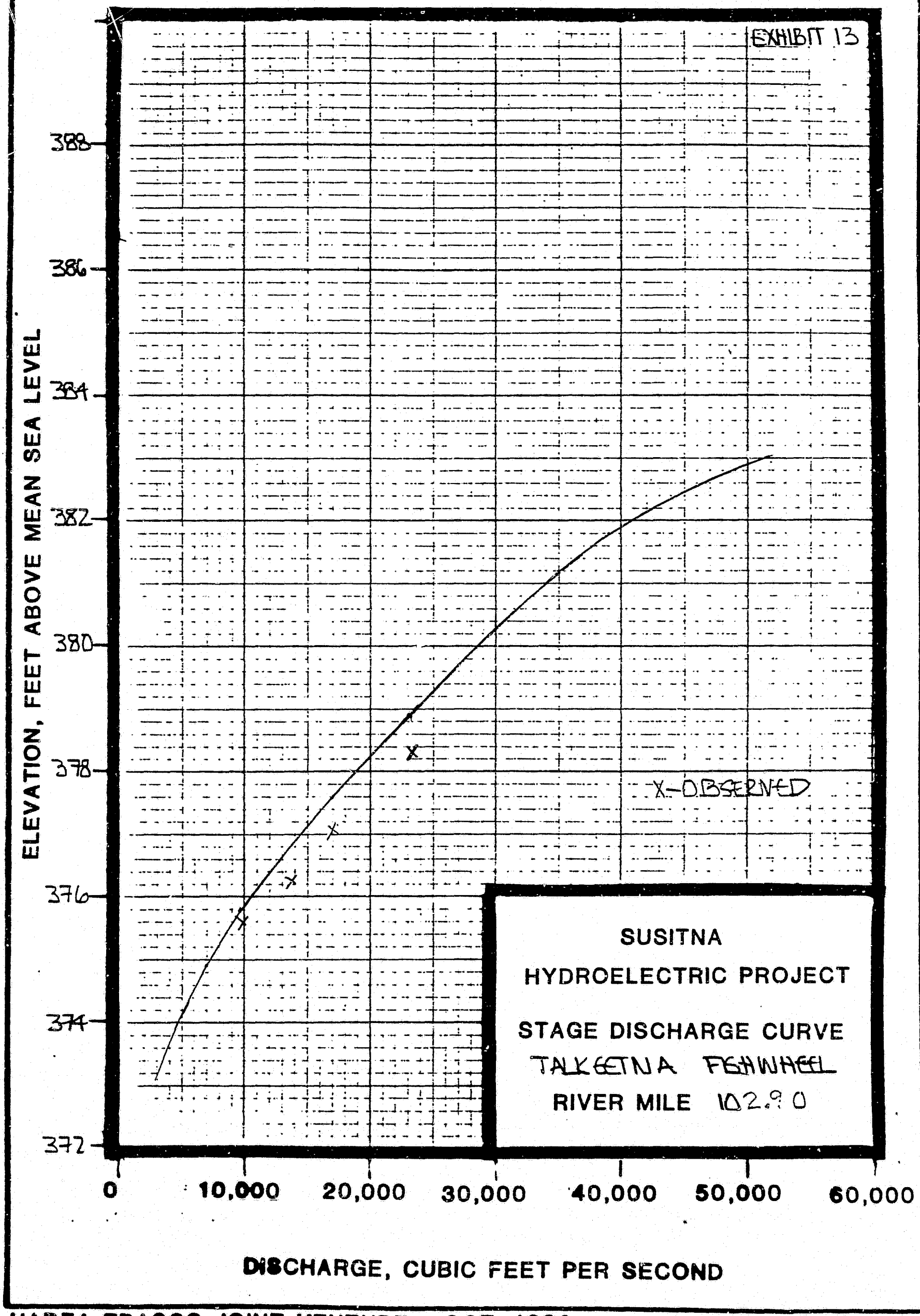

ELEVATION, FEET ABOVE MEAN SEA LEVEL
376
374
372
370
368
366
364
362
360
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 101.9

EXHIBIT 13



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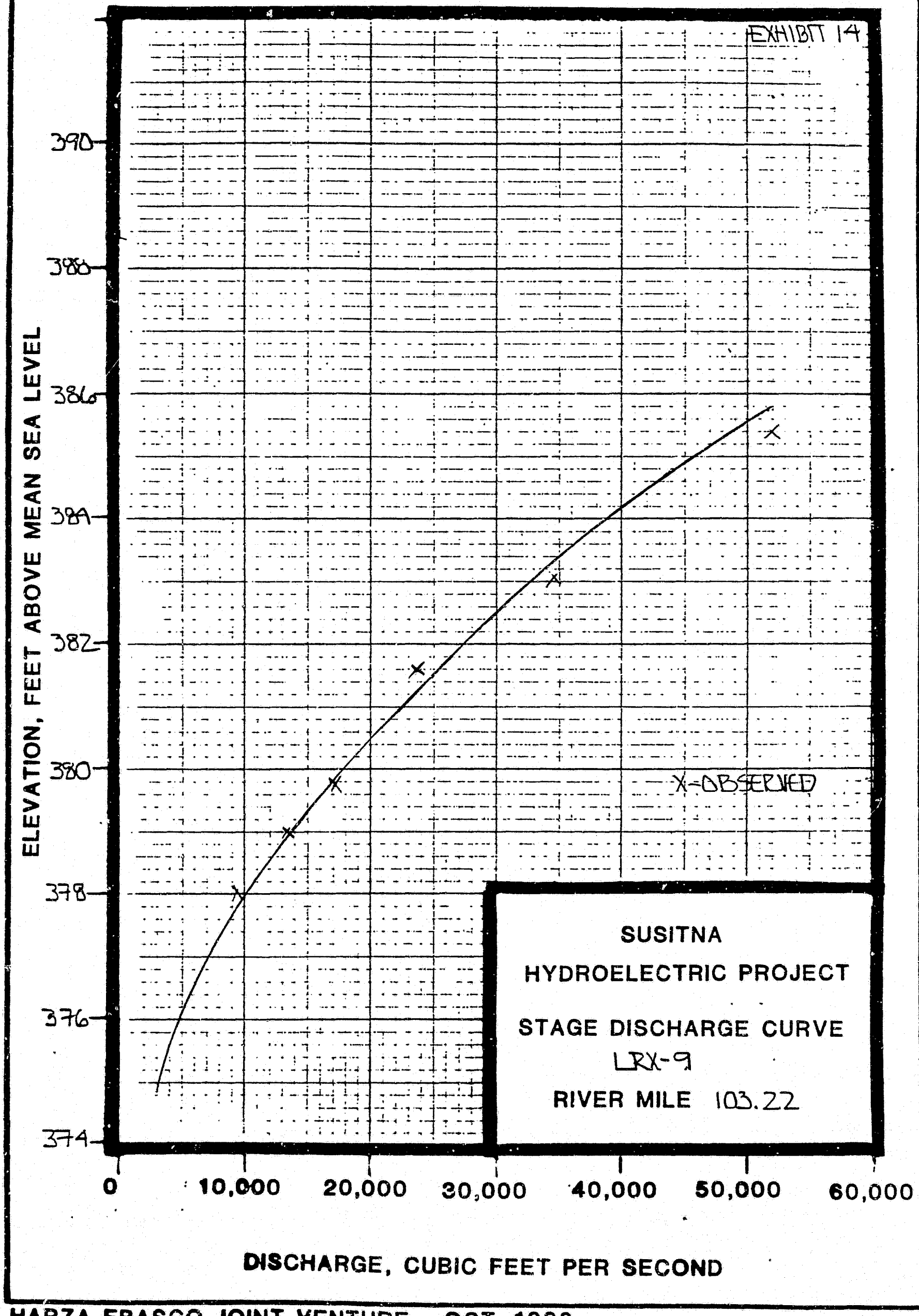

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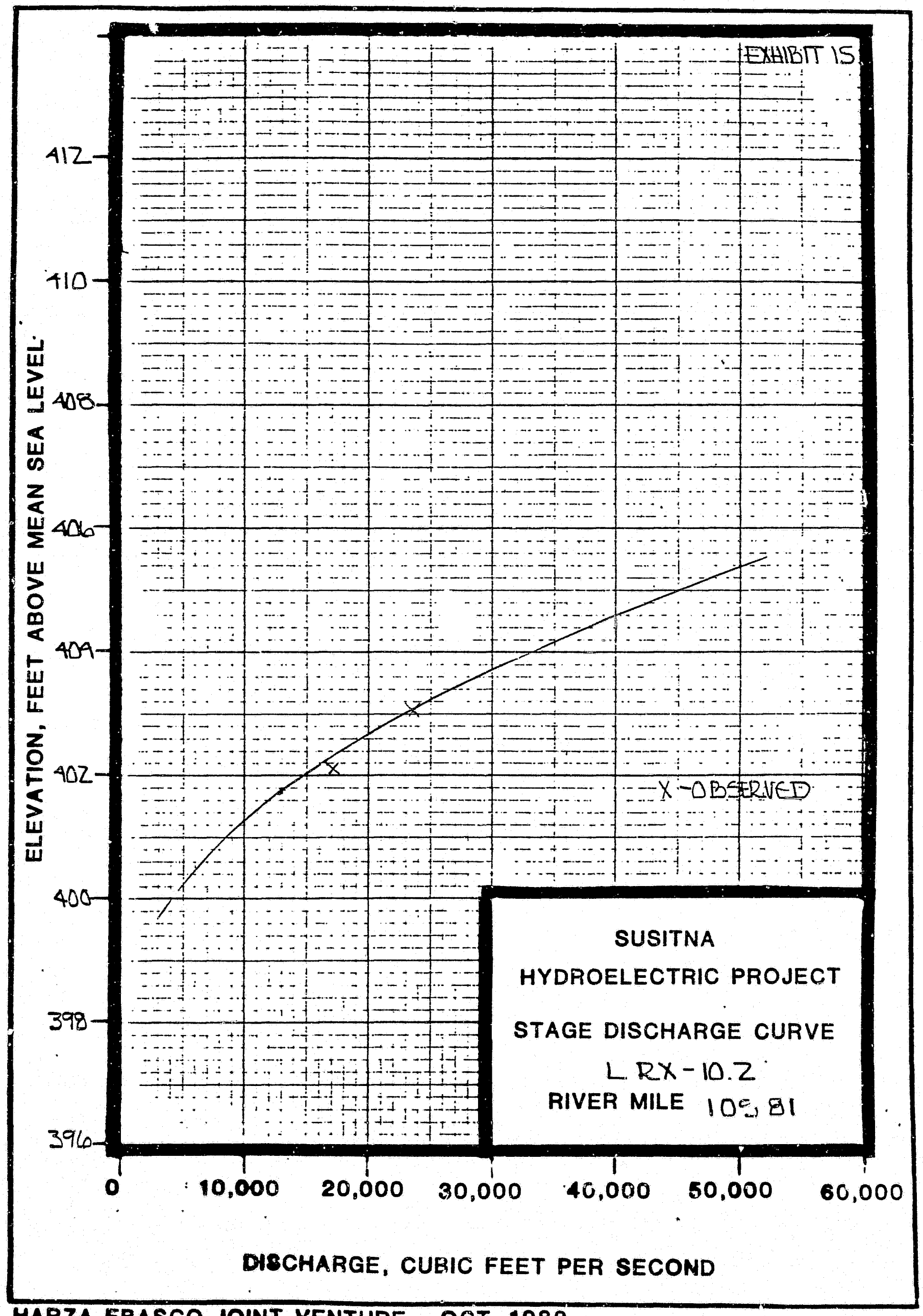

HARZA EBASCO JOINT VENTURE OCT 1983

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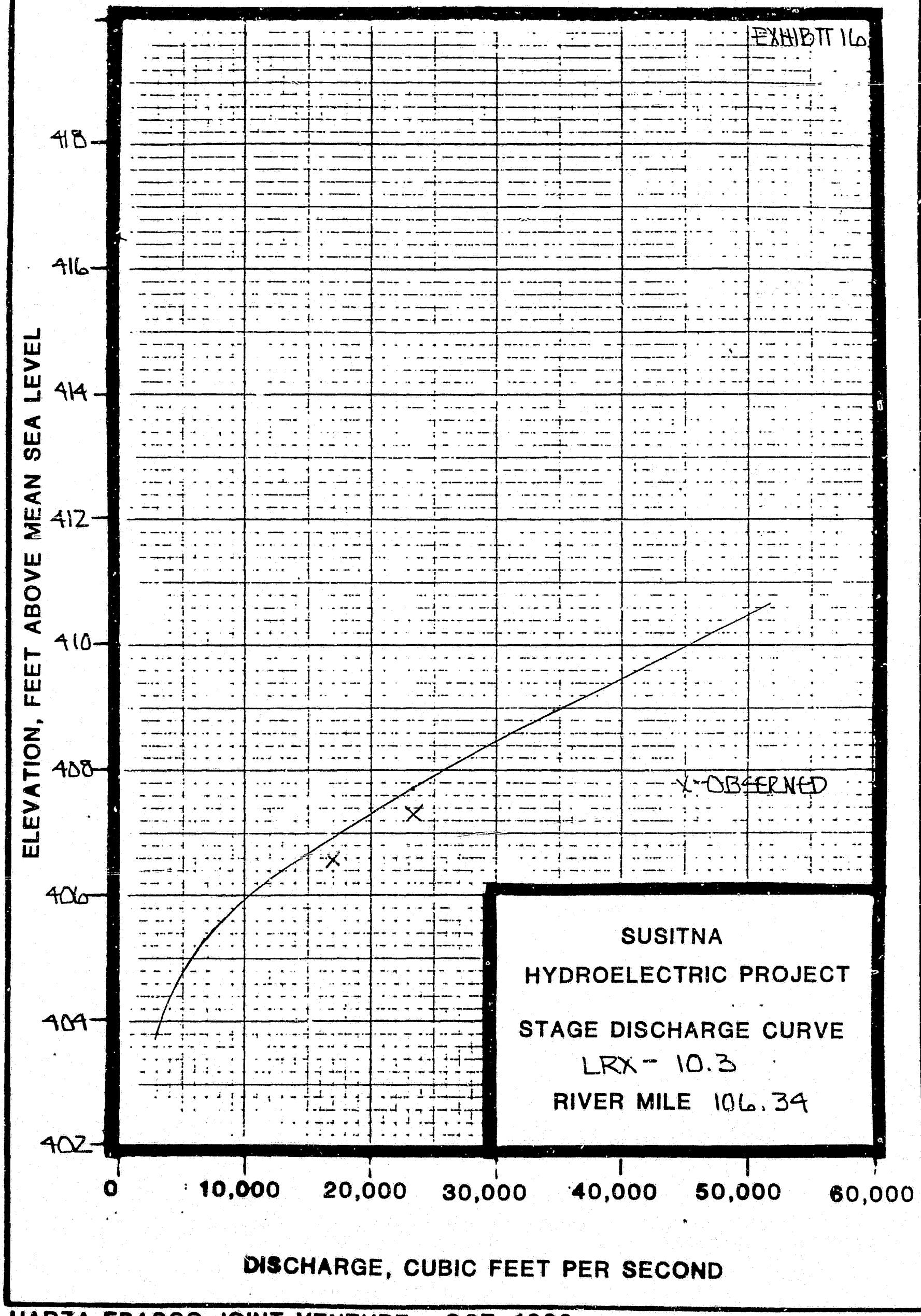

HARZA EBASCO JOINT VENTURE OCT 1983

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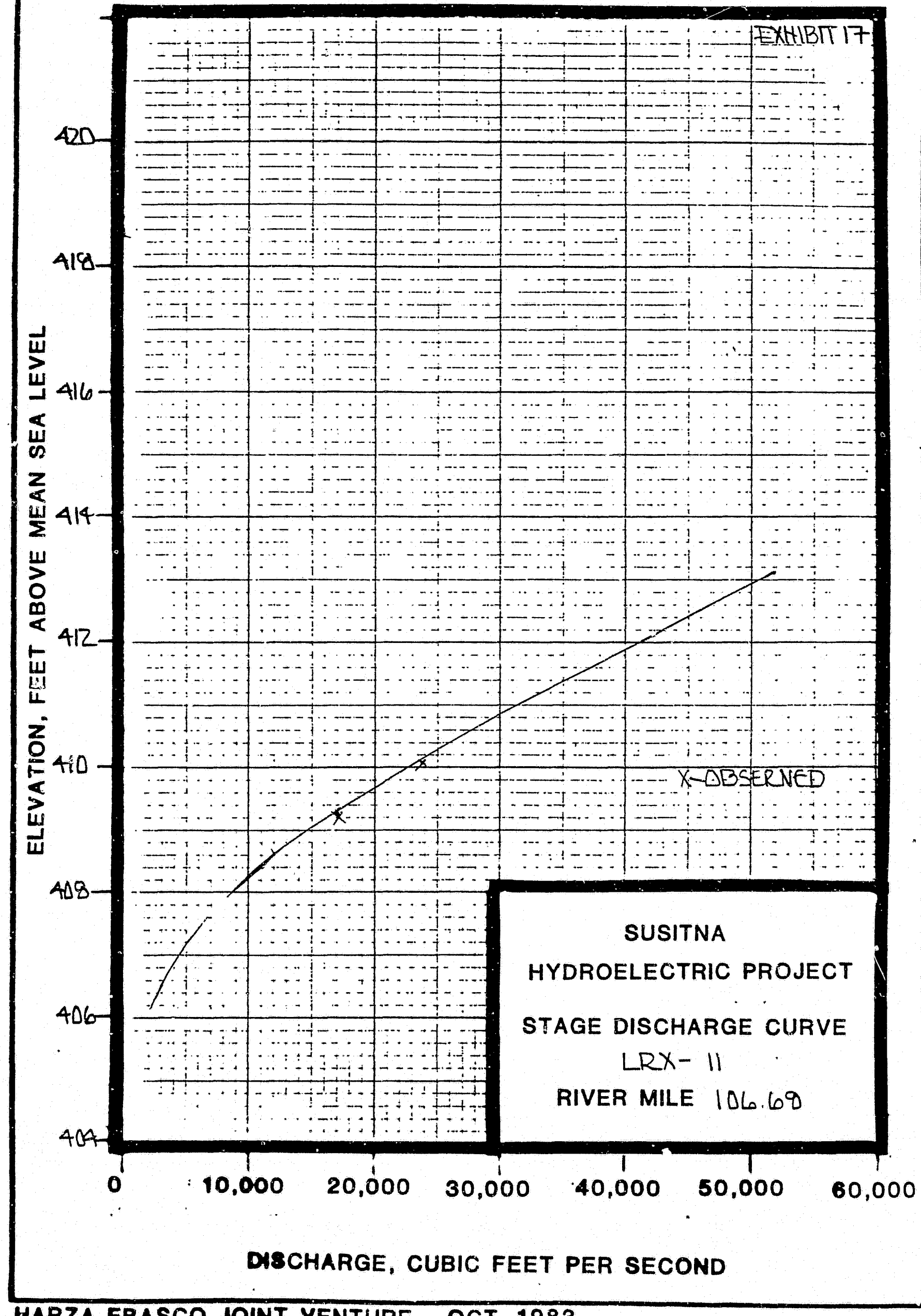

HARZA EBASCO JOINT VENTURE OCT 1983

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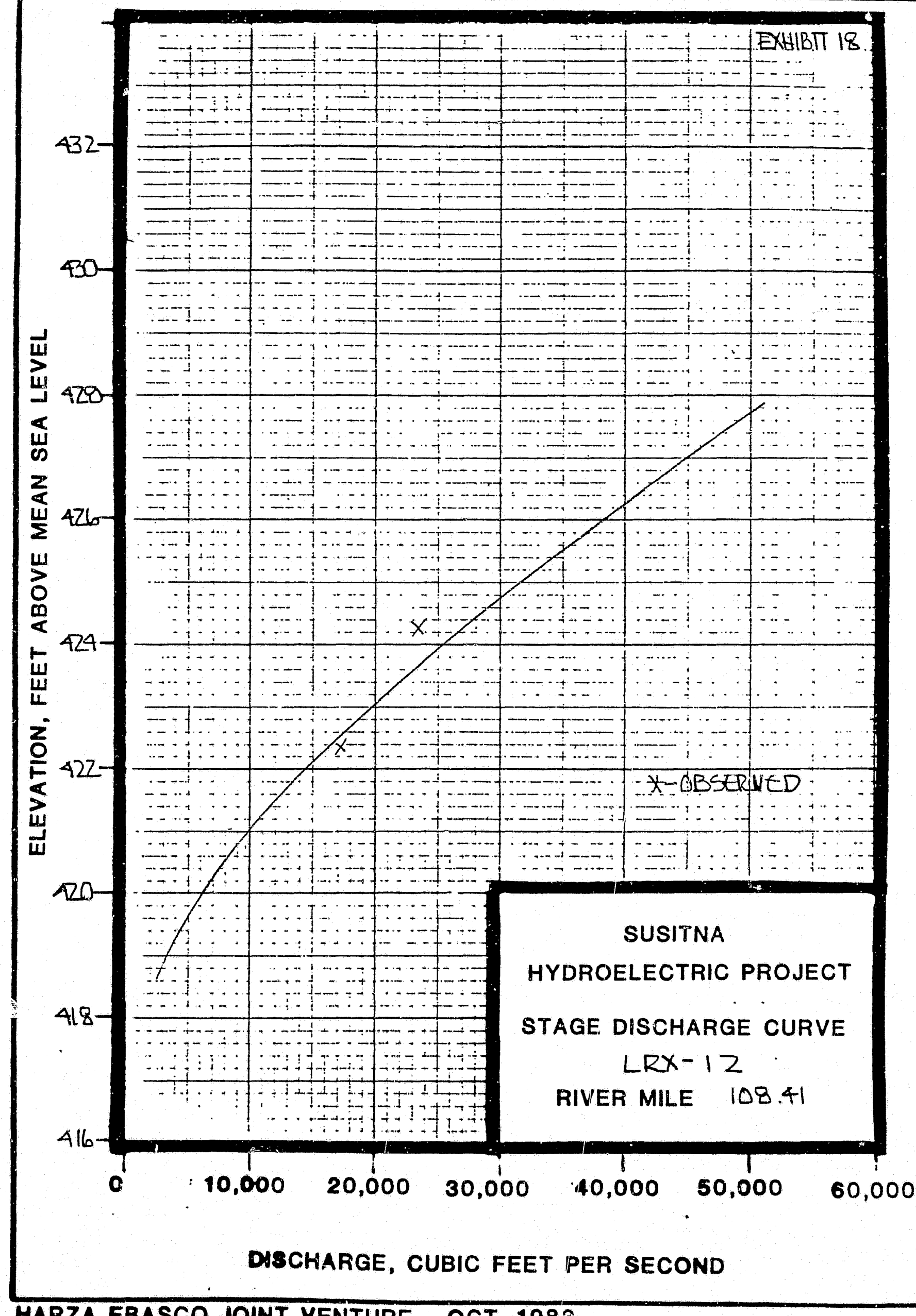

HARZA EBASCO JOINT VENTURE OCT 1983

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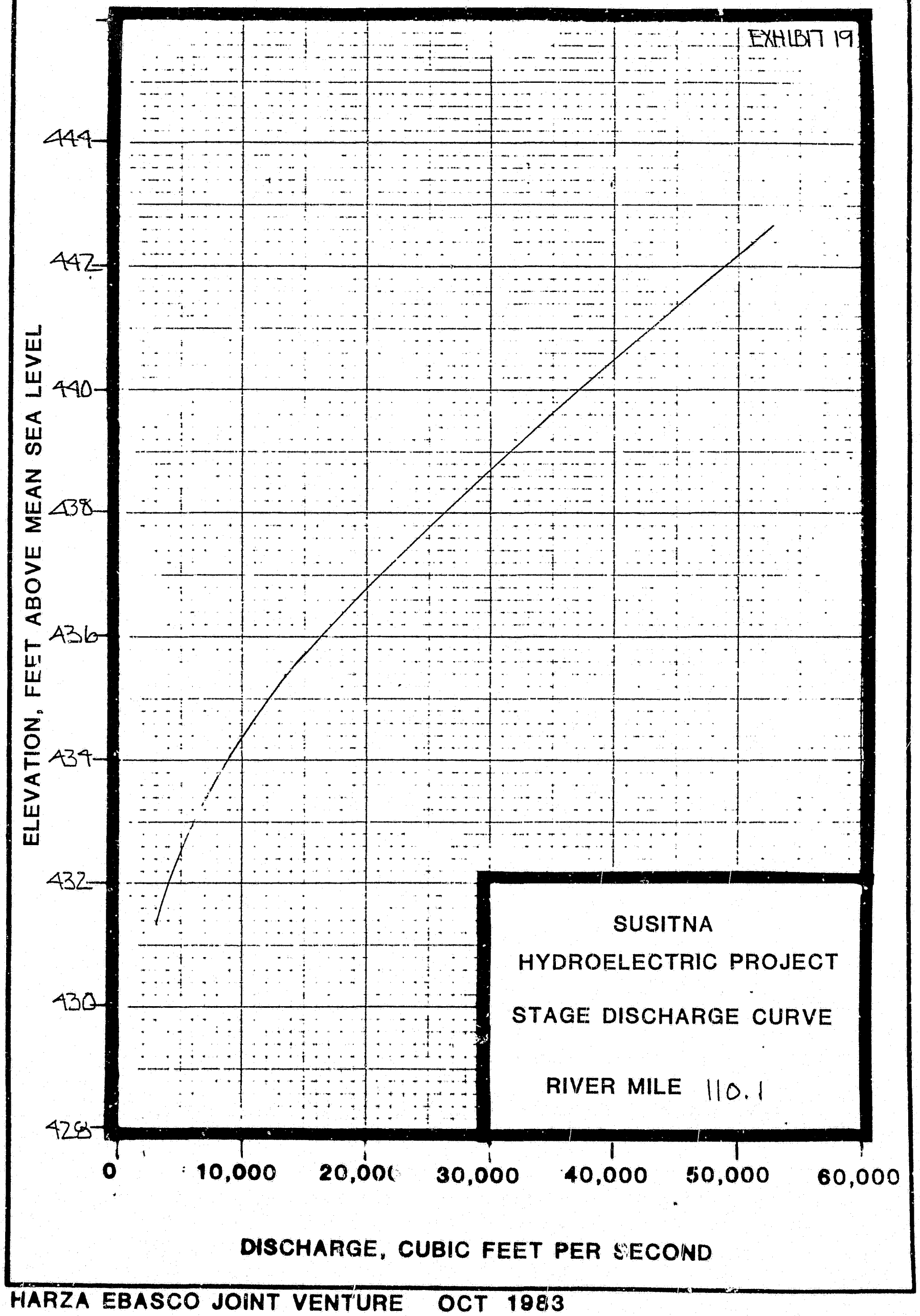

HARZA EBASCO JOINT VENTURE OCT 1983

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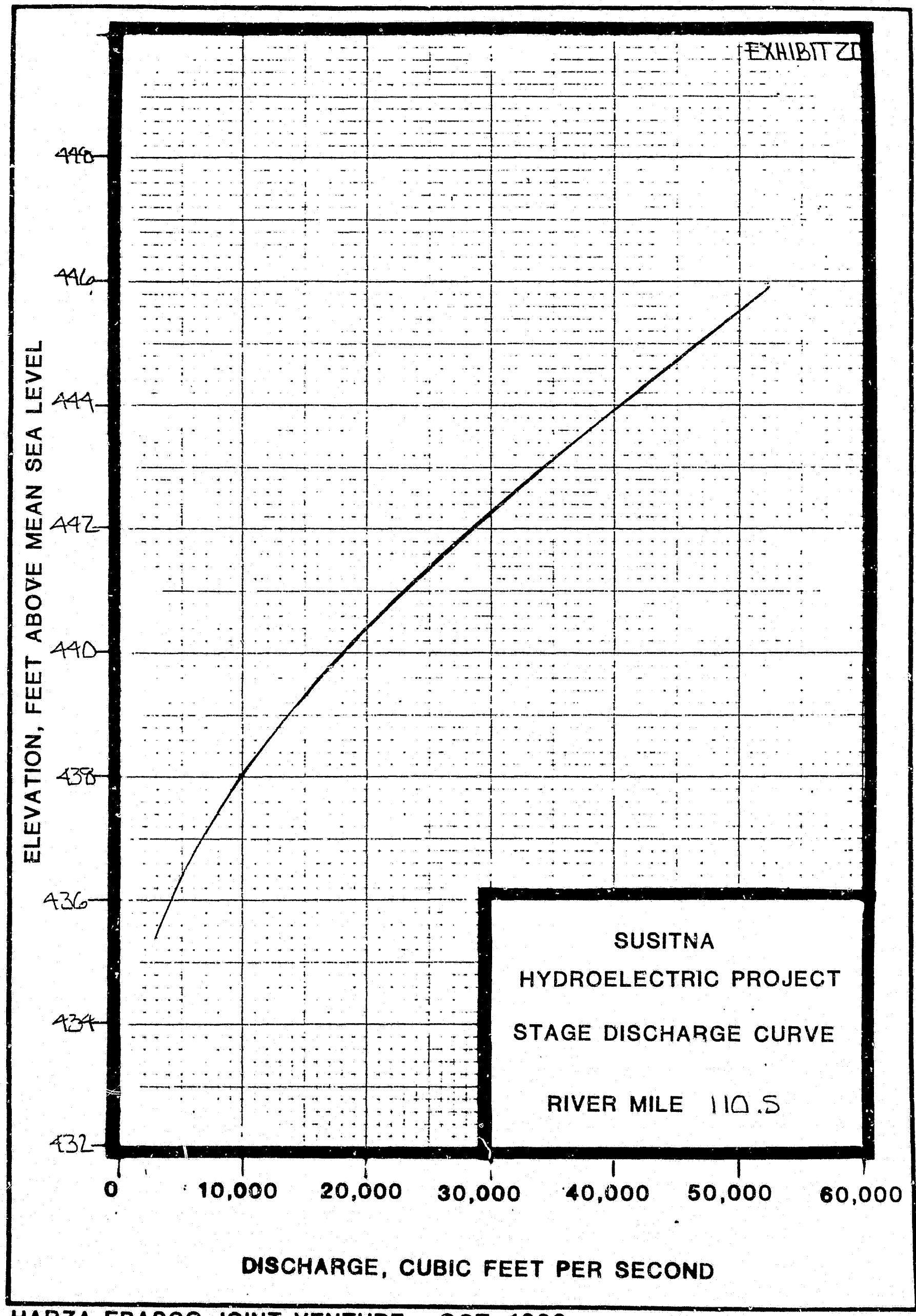
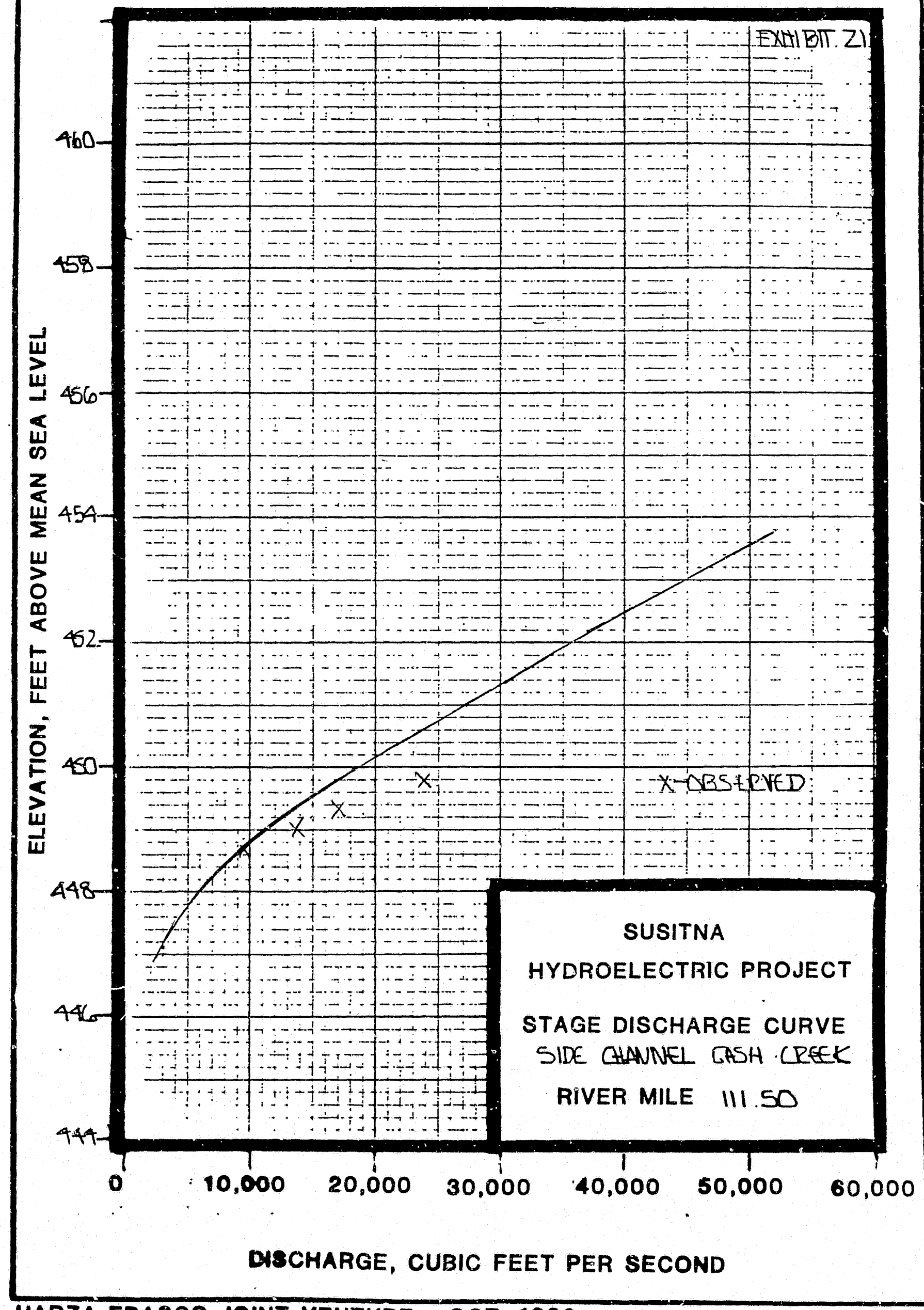


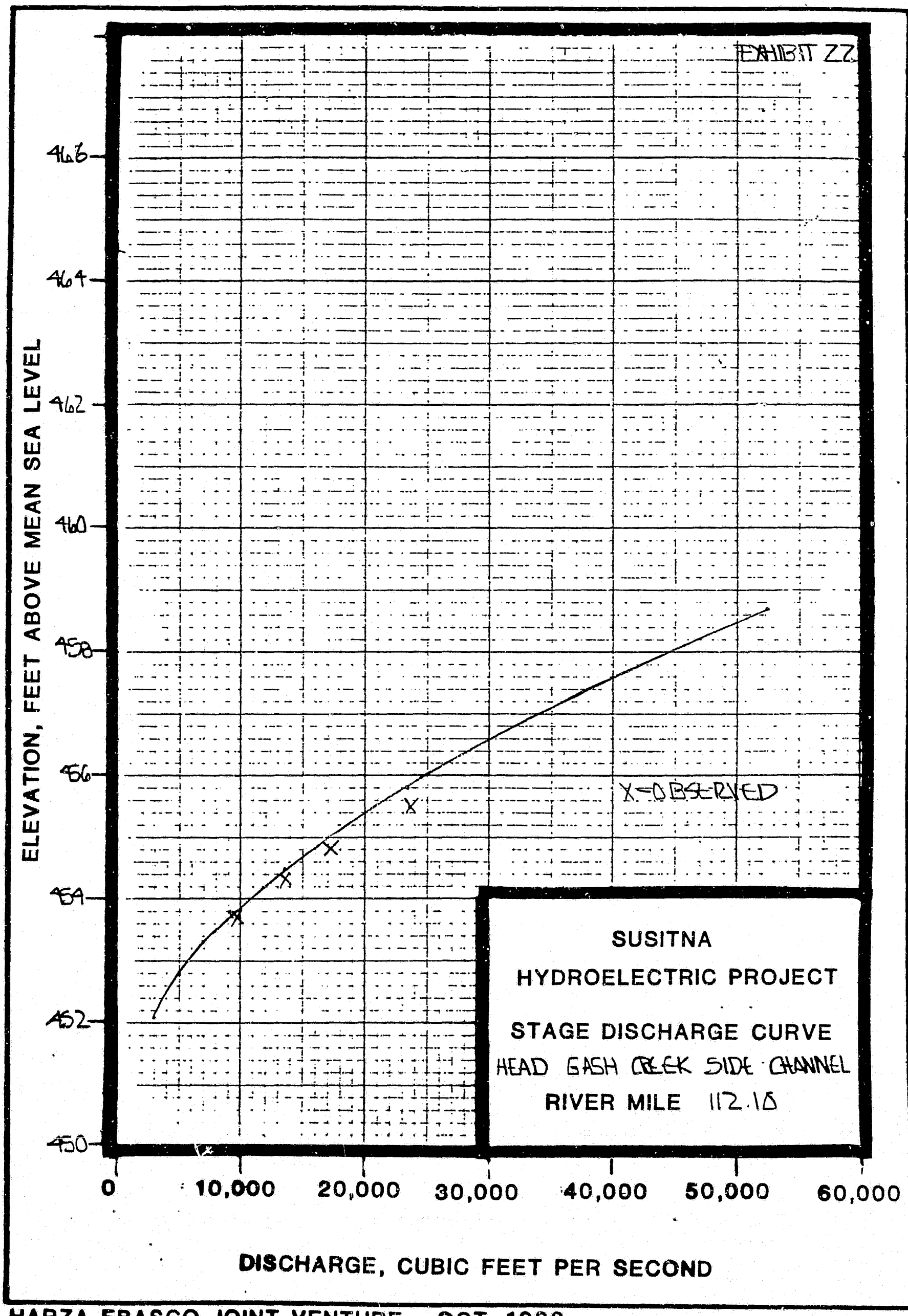
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT Z1



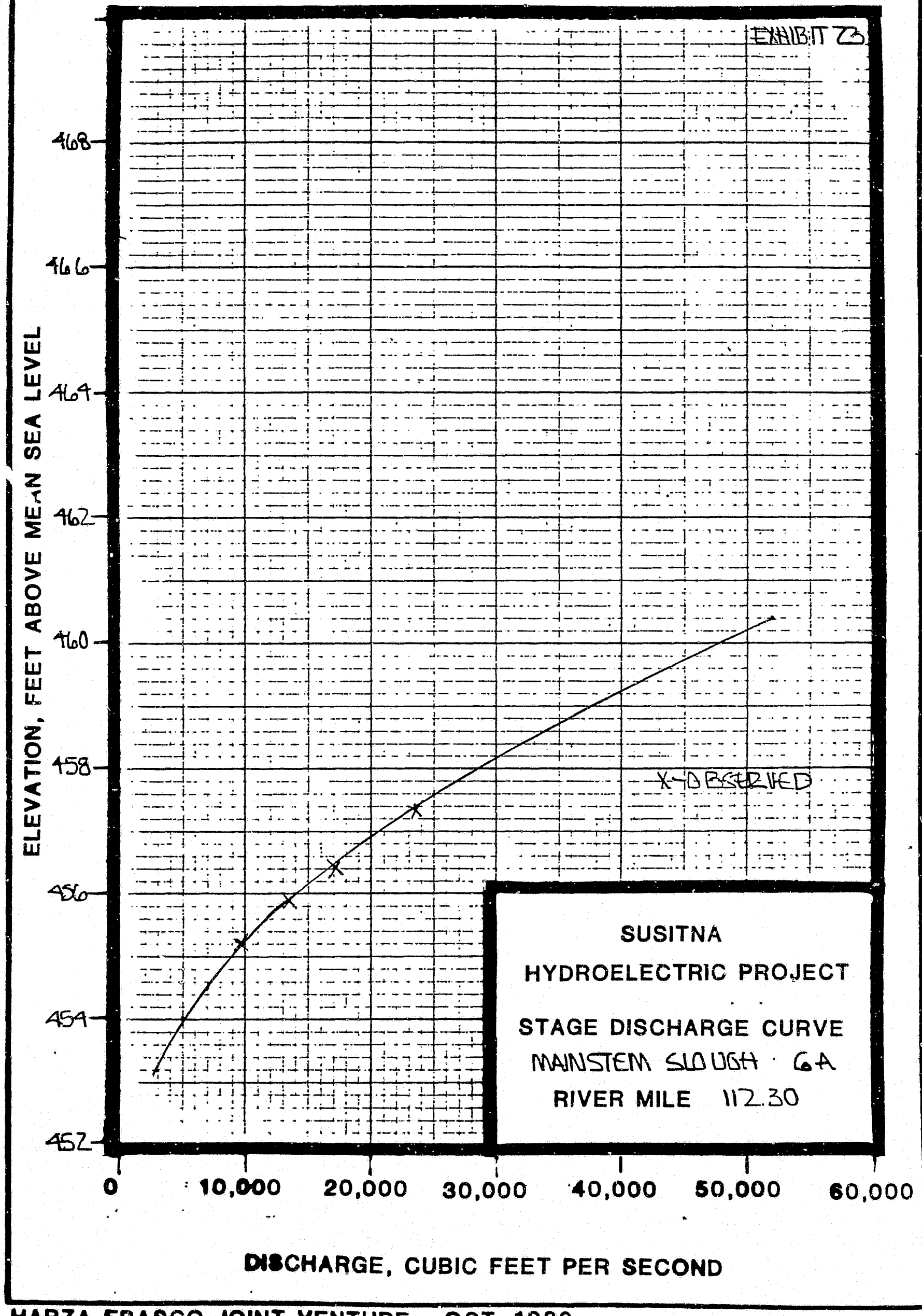
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT ZZ



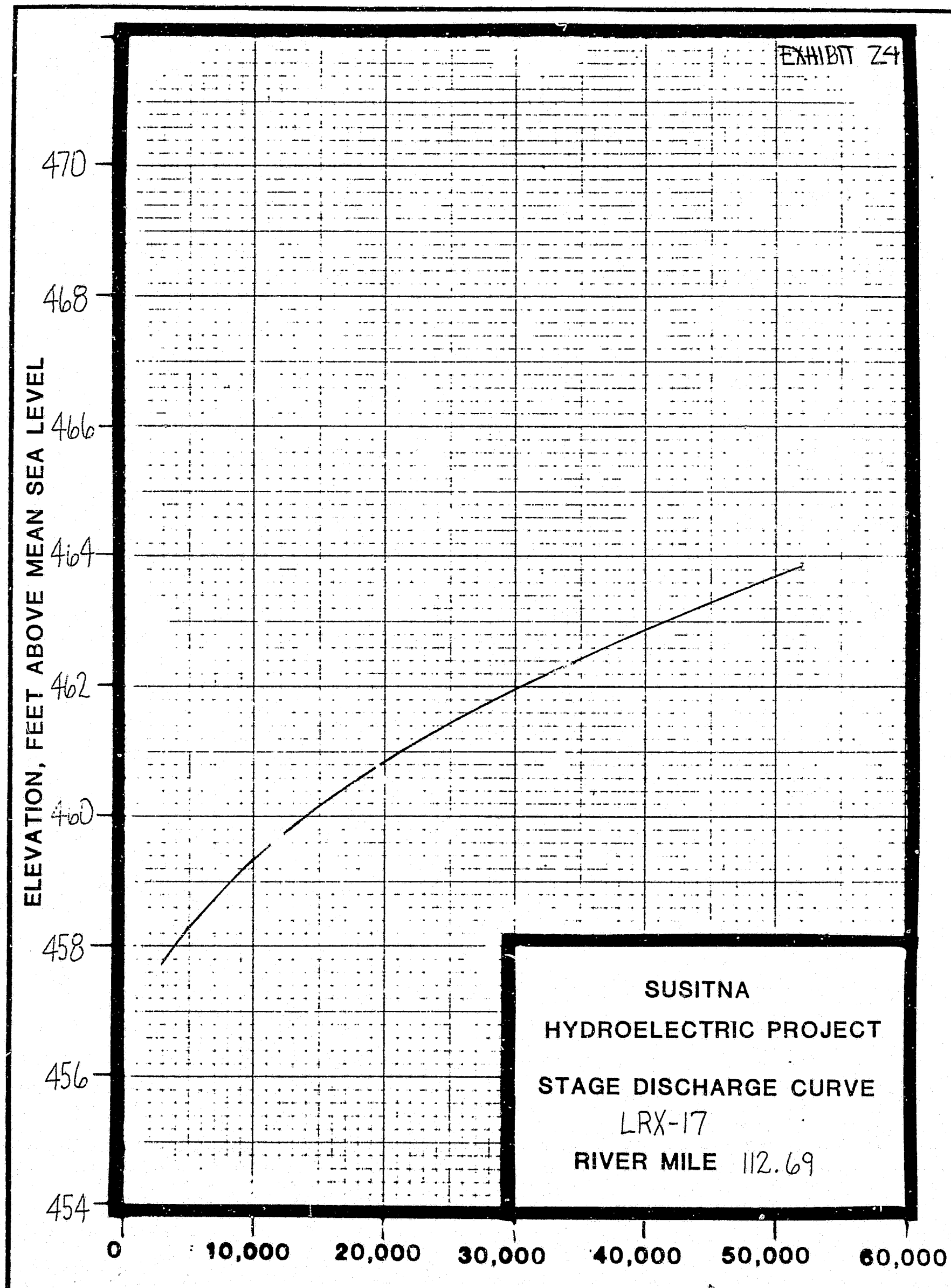
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 23



HARZA EBASCO JOINT VENTURE OCT 1983

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
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-17
RIVER MILE 112.69

0 0 0 3 6

EXHIBIT 25

ELEVATION, FEET ABOVE MEAN SEA LEVEL

472
470
468
466
464
462
460
458
456

X OBSERVED

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX - 18
RIVER MILE 113.02

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 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

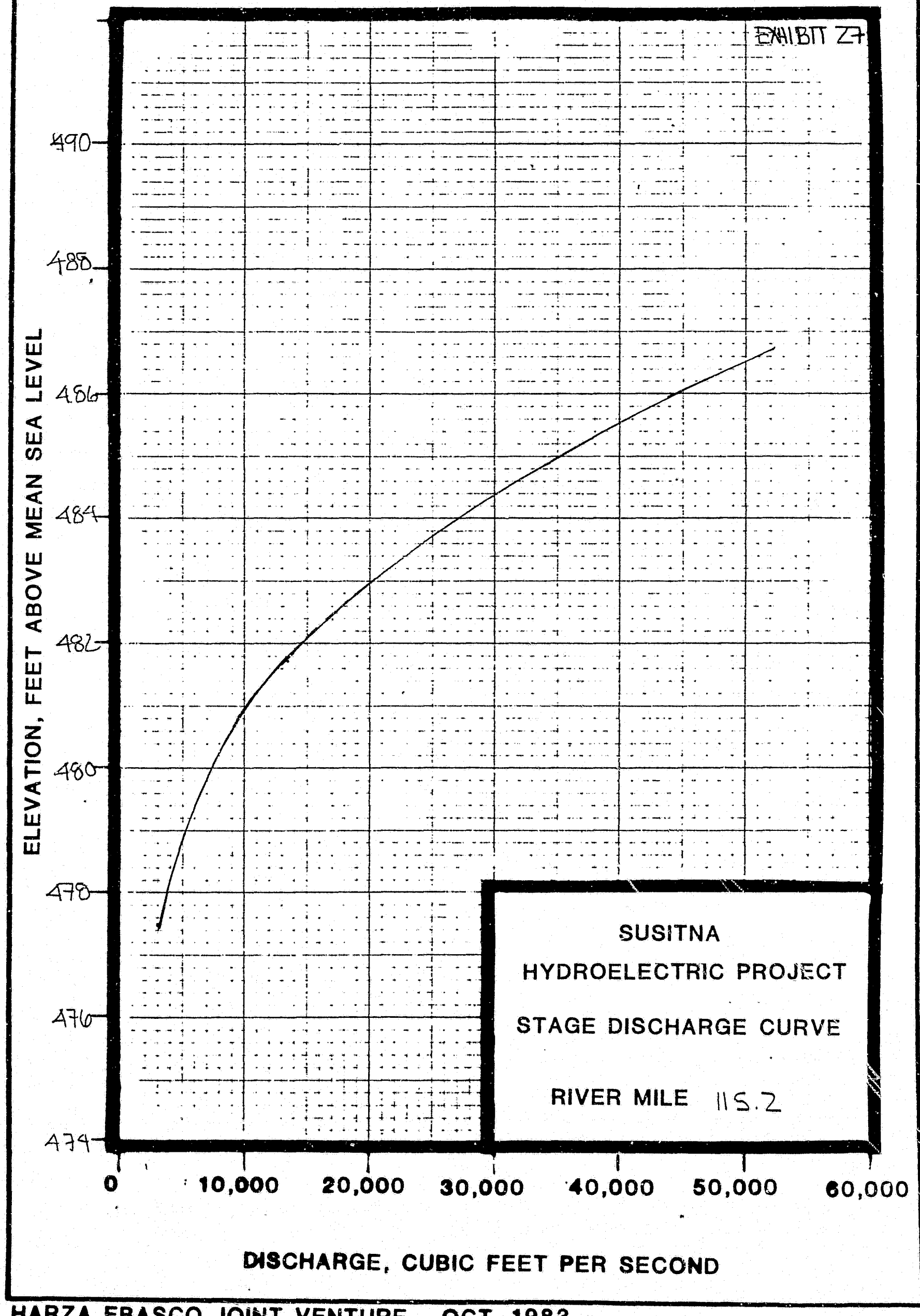
DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT

STAGE DISCHARGE CURVE
LRX-18.1
RIVER MILE 114.11

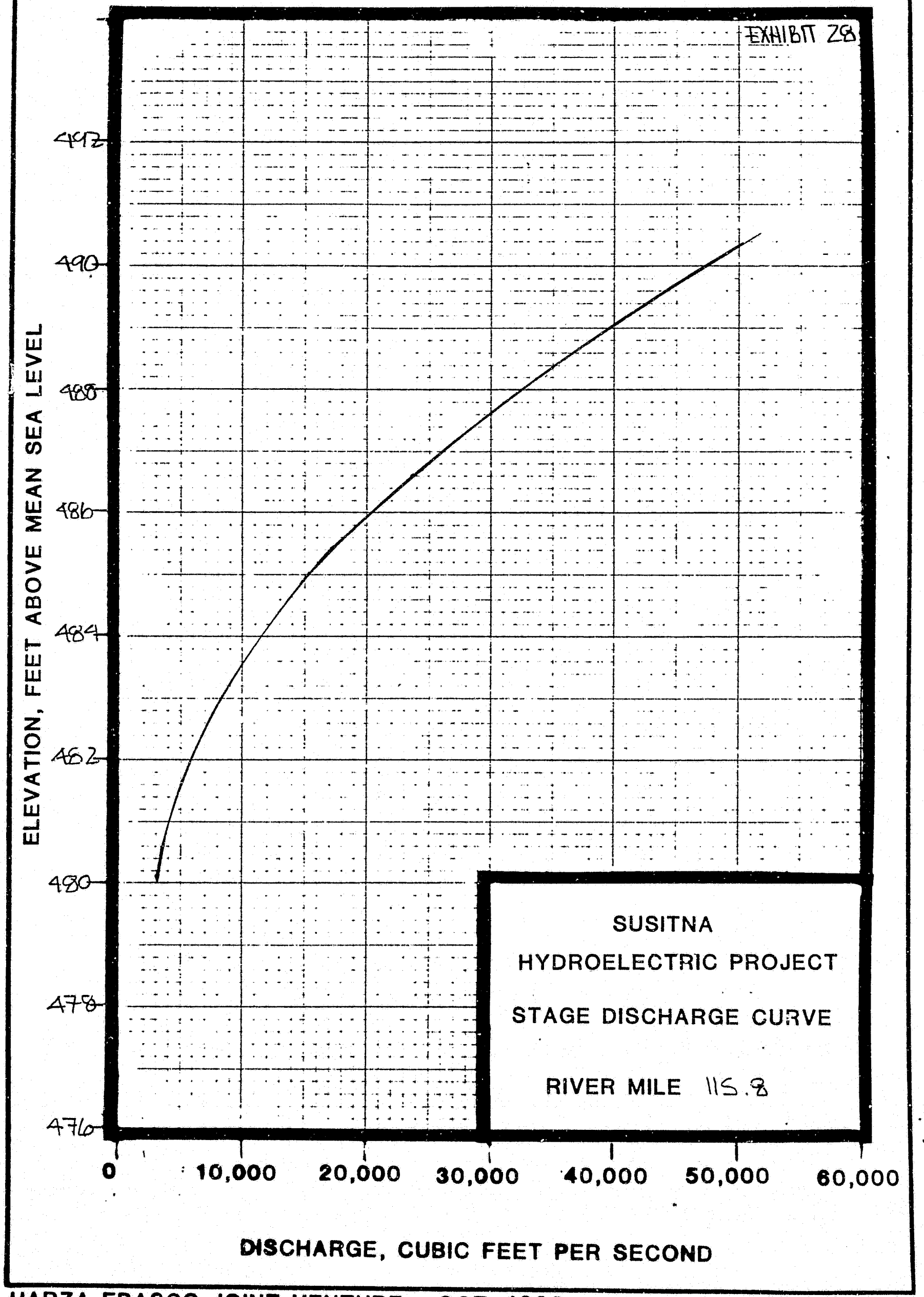
0 0 0 3 6

EXHIBIT Z-7



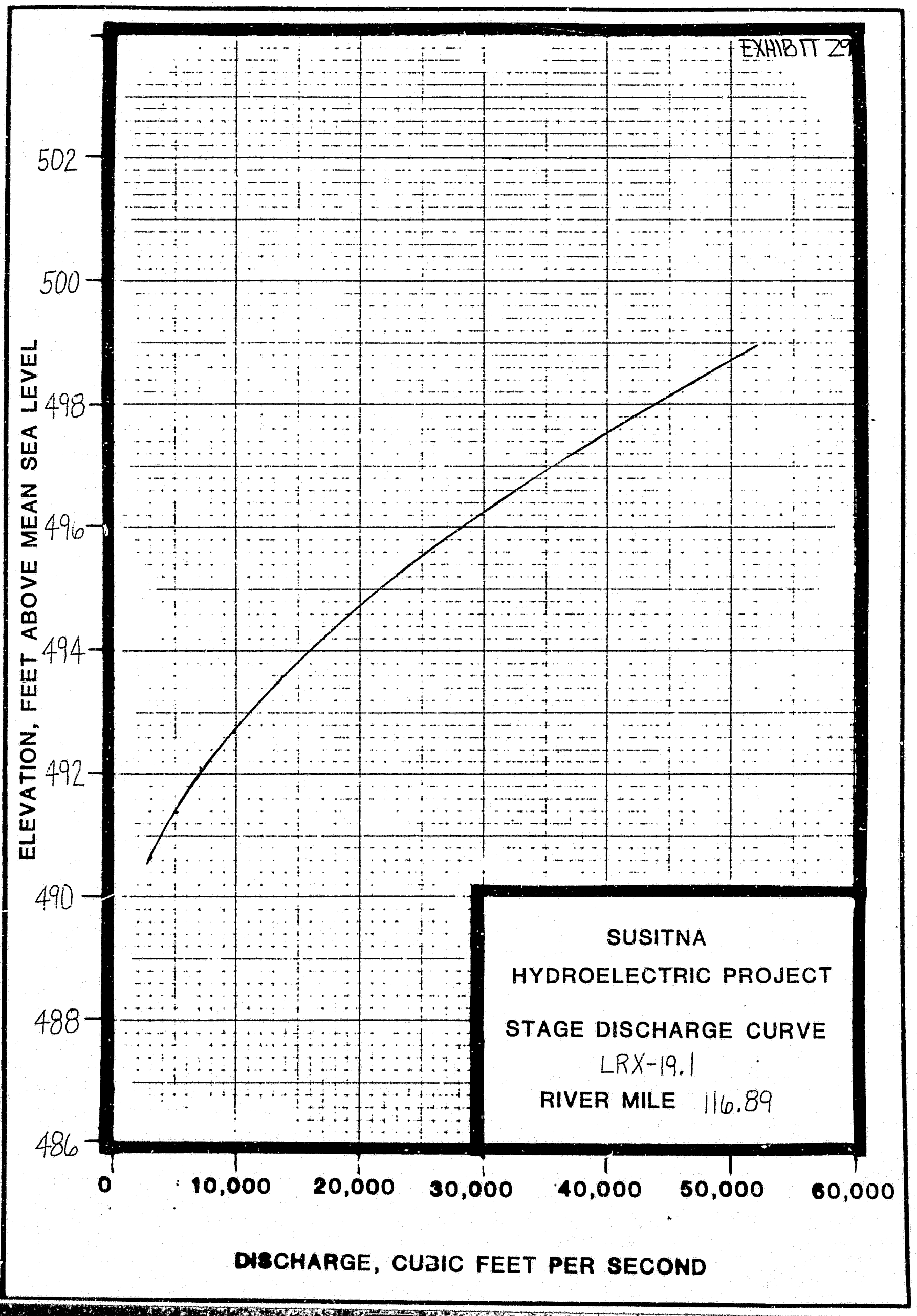
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 28



HARZA EBASCO JOINT VENTURE OCT 1983

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
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
LRX-19.1
RIVER MILE 116.89

0 0 0 0 3 6

EXHIBIT 30

ELEVATION, FEET ABOVE MEAN SEA LEVEL

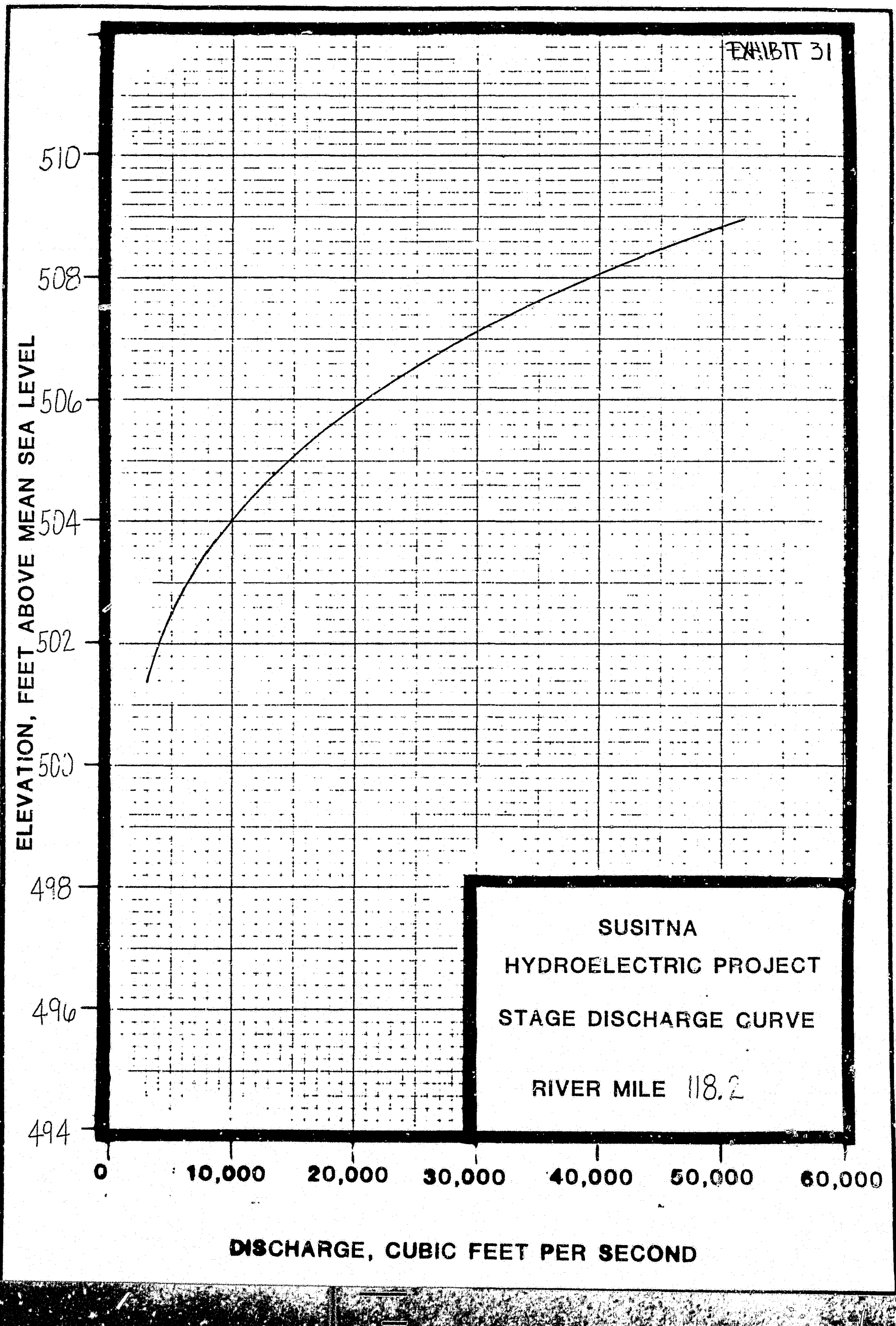
510
508
506
504
502
500
498
496
494

0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

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
0
10,000
20,000
30,000
40,000
50,000
60,000
DISCHARGE, CUBIC FEET PER SECOND
SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 118.2

0 0 0 0 3 6

EXHIBIT 32

ELEVATION, FEET ABOVE MEAN SEA LEVEL

518
516
514
512
510
508
506
504
502

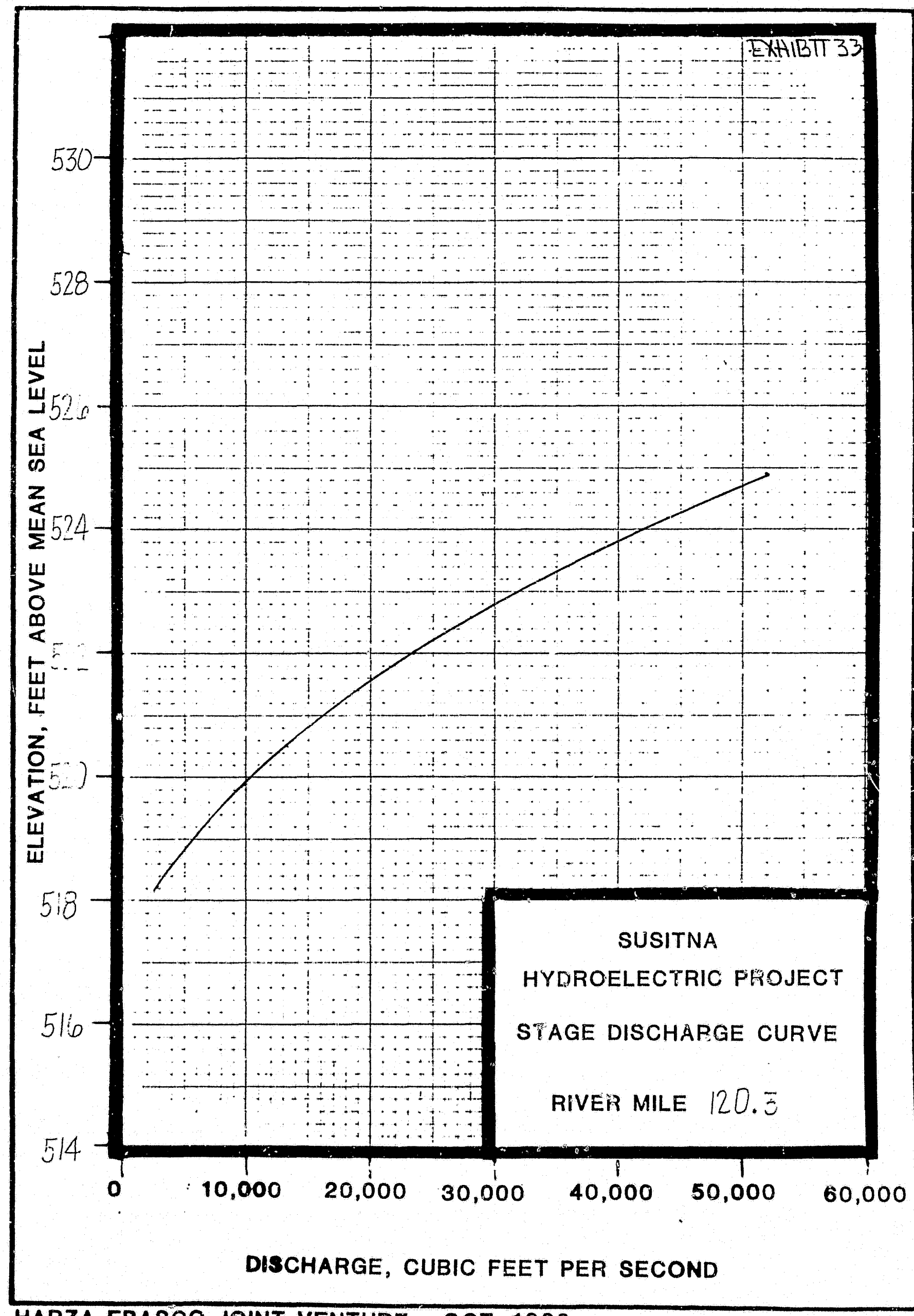
0 10,000 20,000 30,000 40,000 50,000 60,0

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 119.2

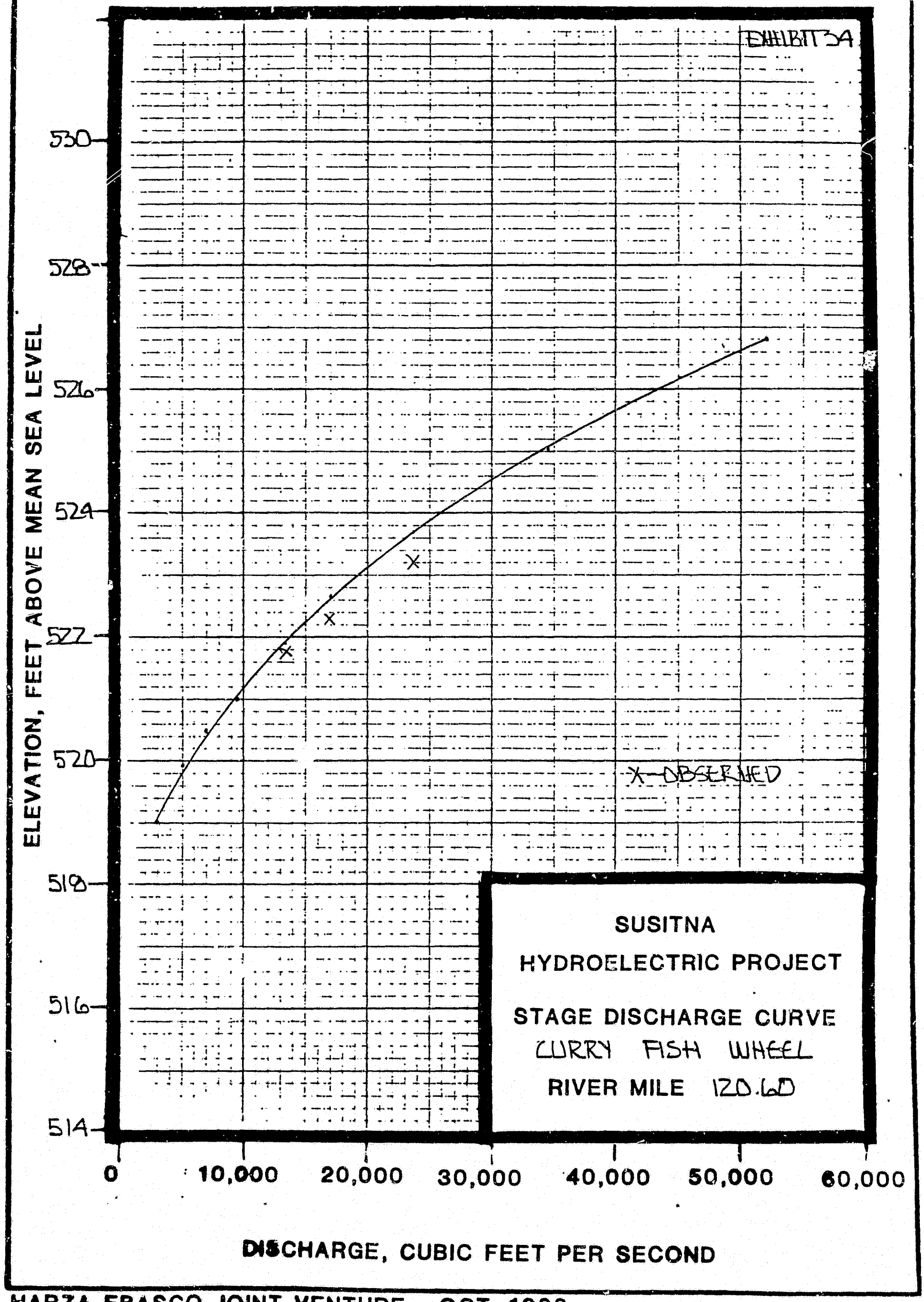
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 33



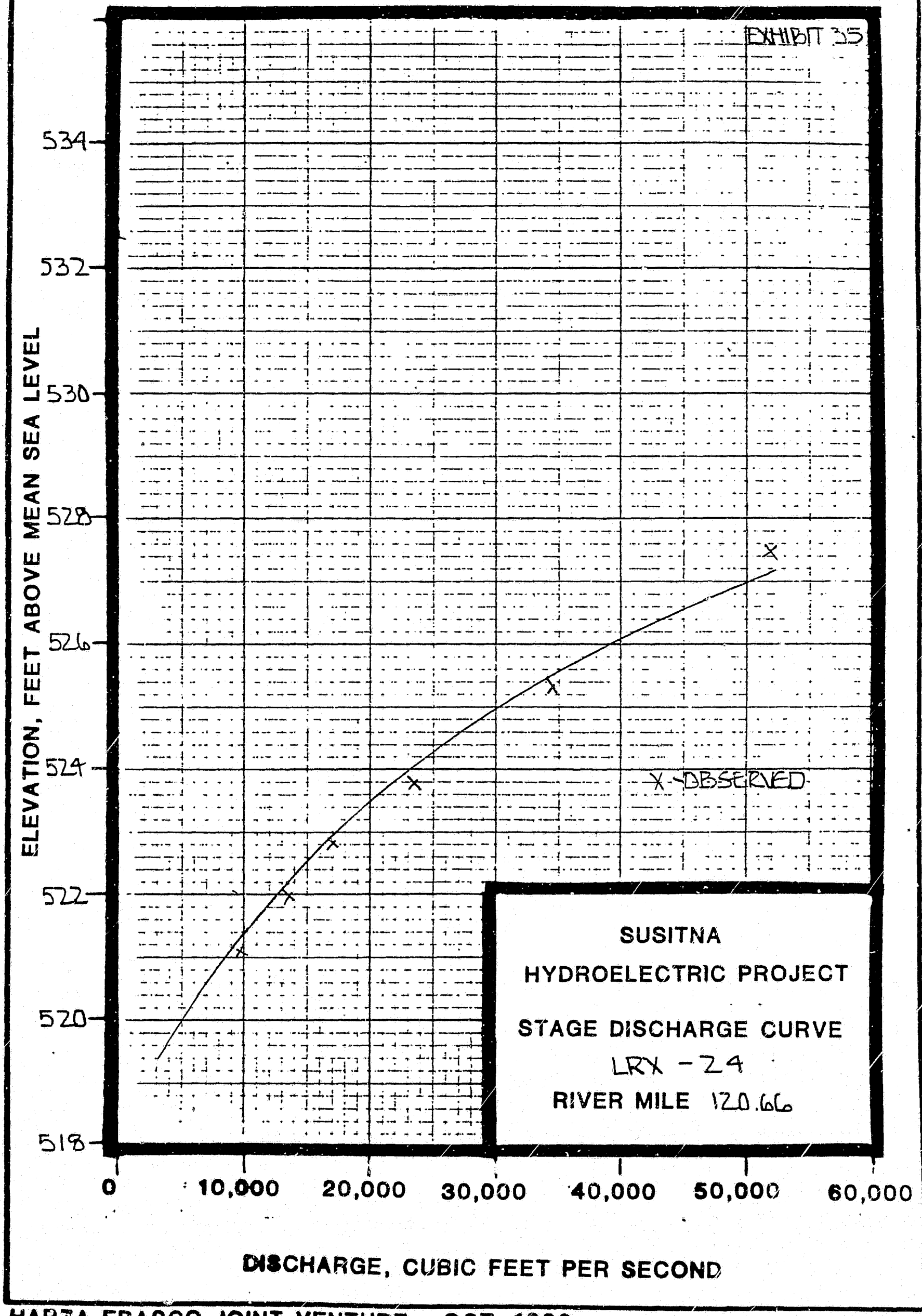
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 34



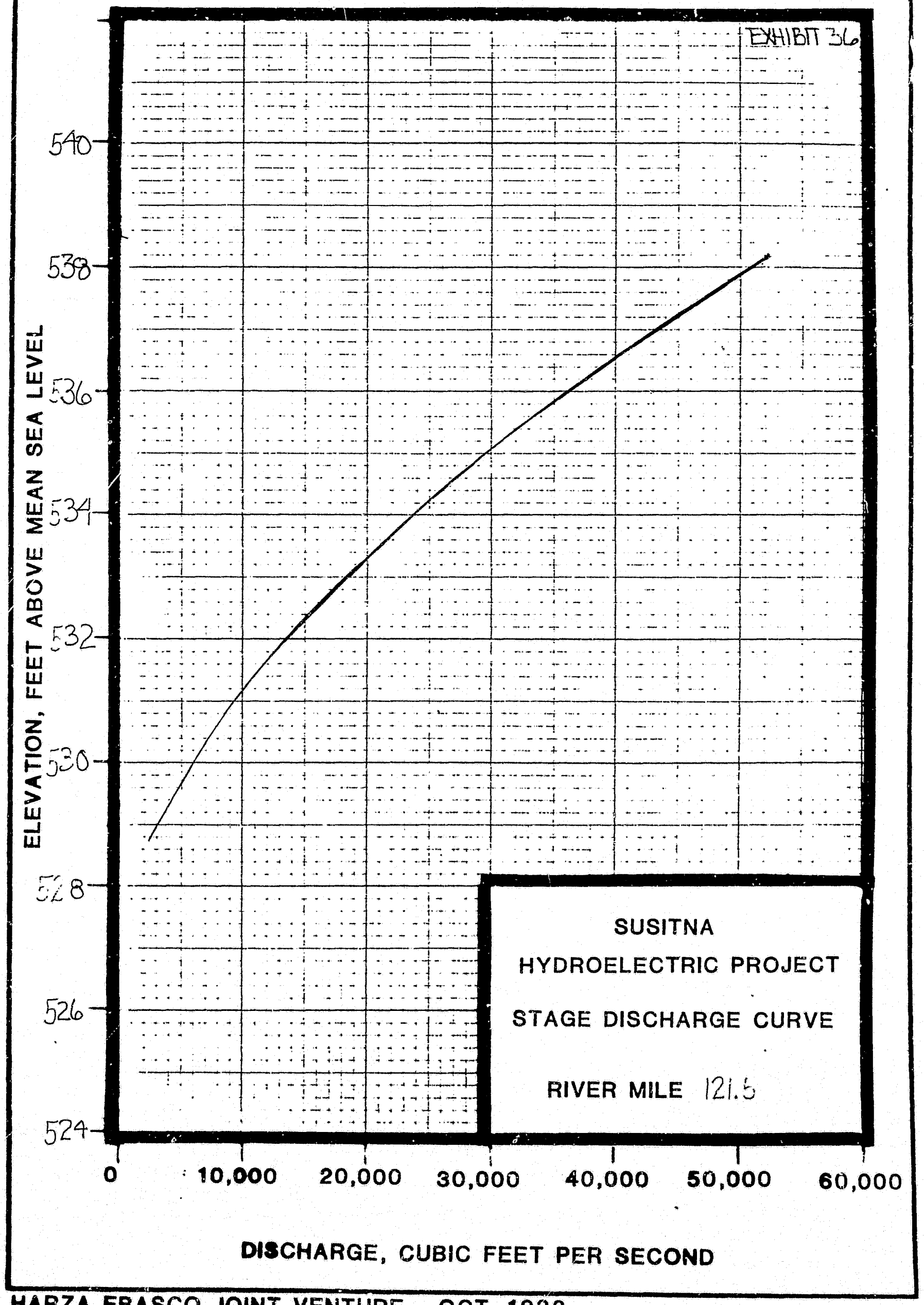
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 35



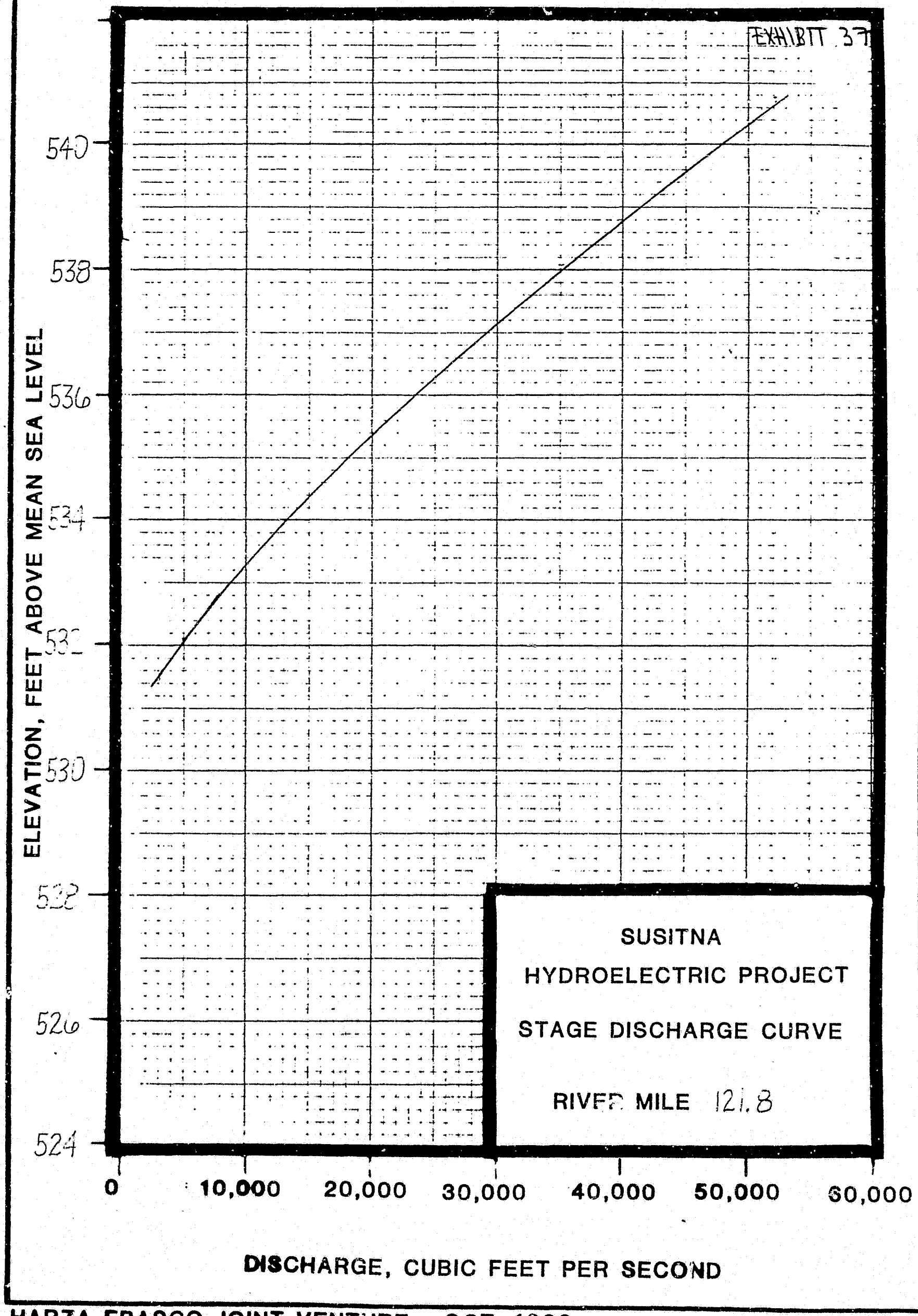
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 36



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 37



HARZA EBASCO JOINT VENTURE OCT 1983

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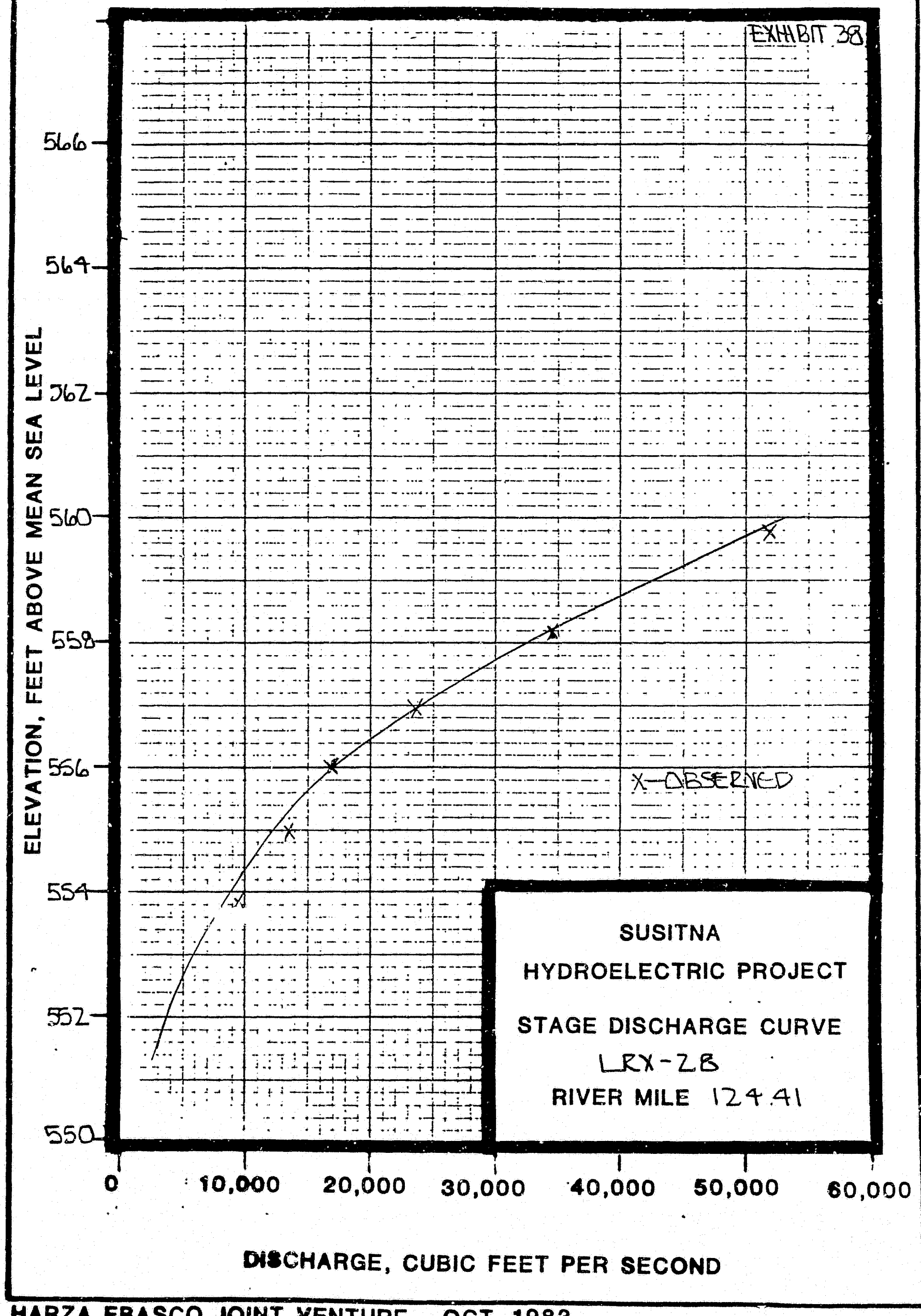


HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 39

ELEVATION, FEET ABOVE MEAN SEA LEVEL

568
566
564
562
560
558
556
554
552

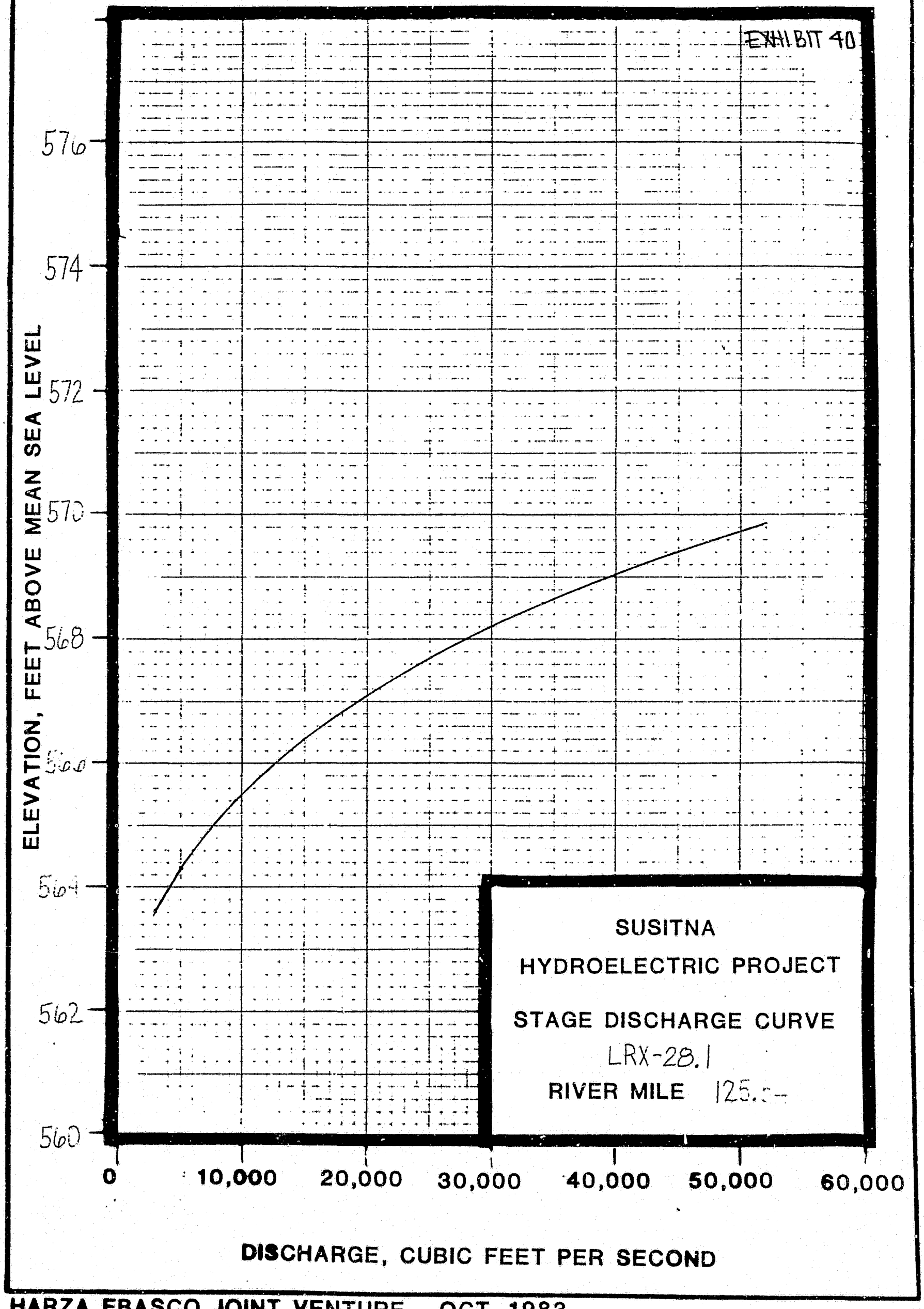
0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 124.8

HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 40



HARZA EBASCO JOINT VENTURE OCT 1983

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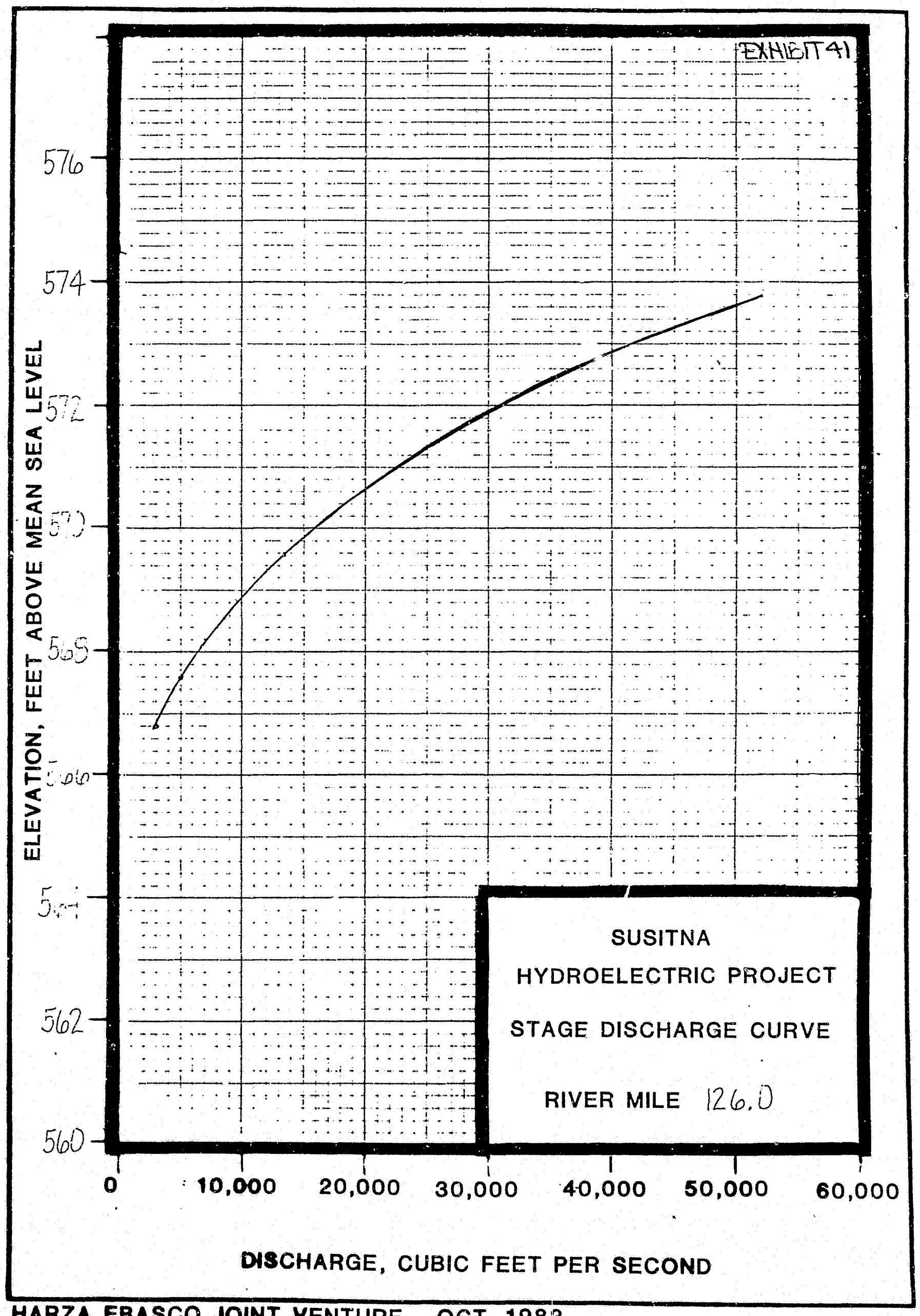
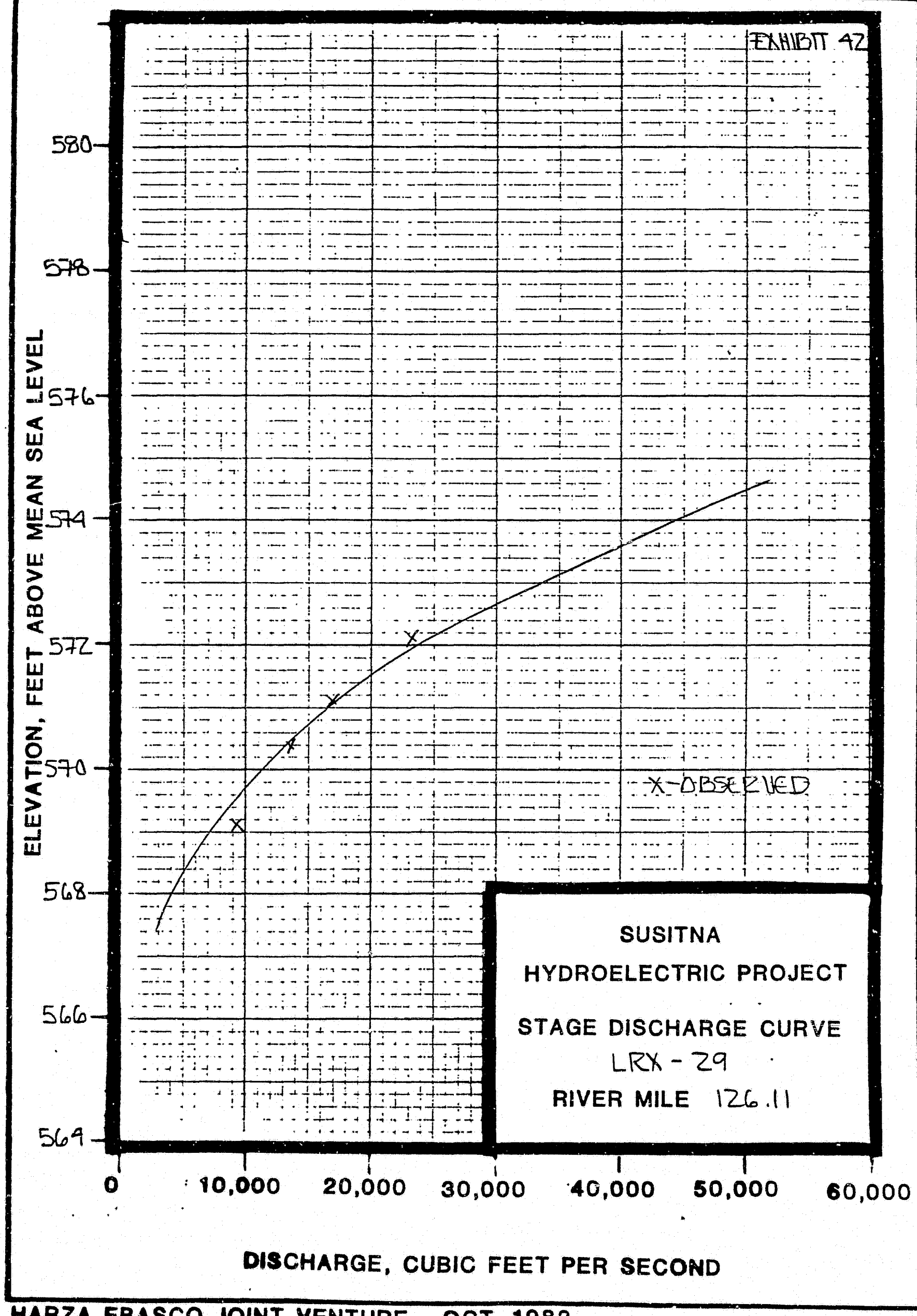


HARZA EBASCO JOINT VENTURE OCT 1983

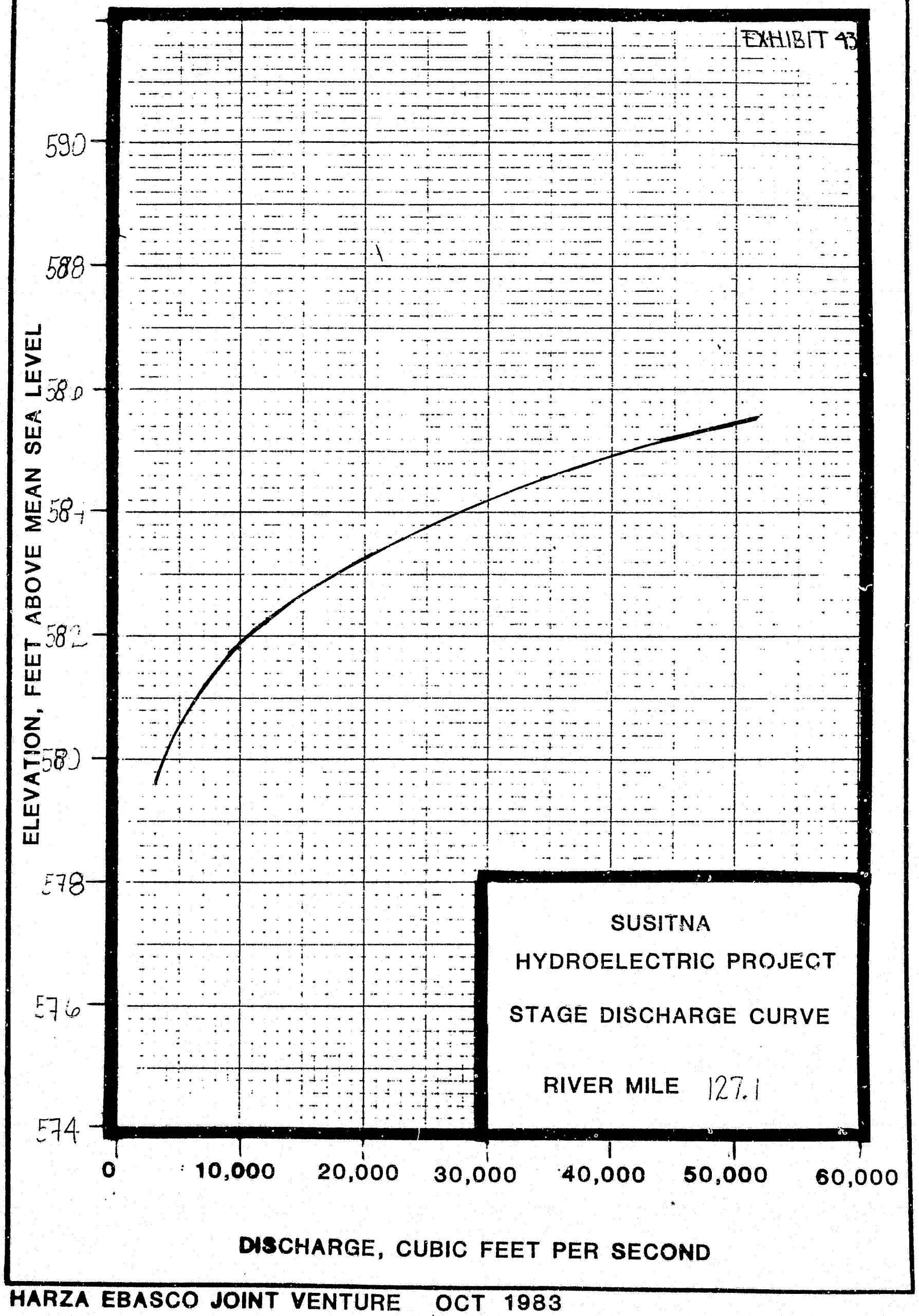
EXHIBIT 42



HARZA EBASCO JOINT VENTURE OCT 1983

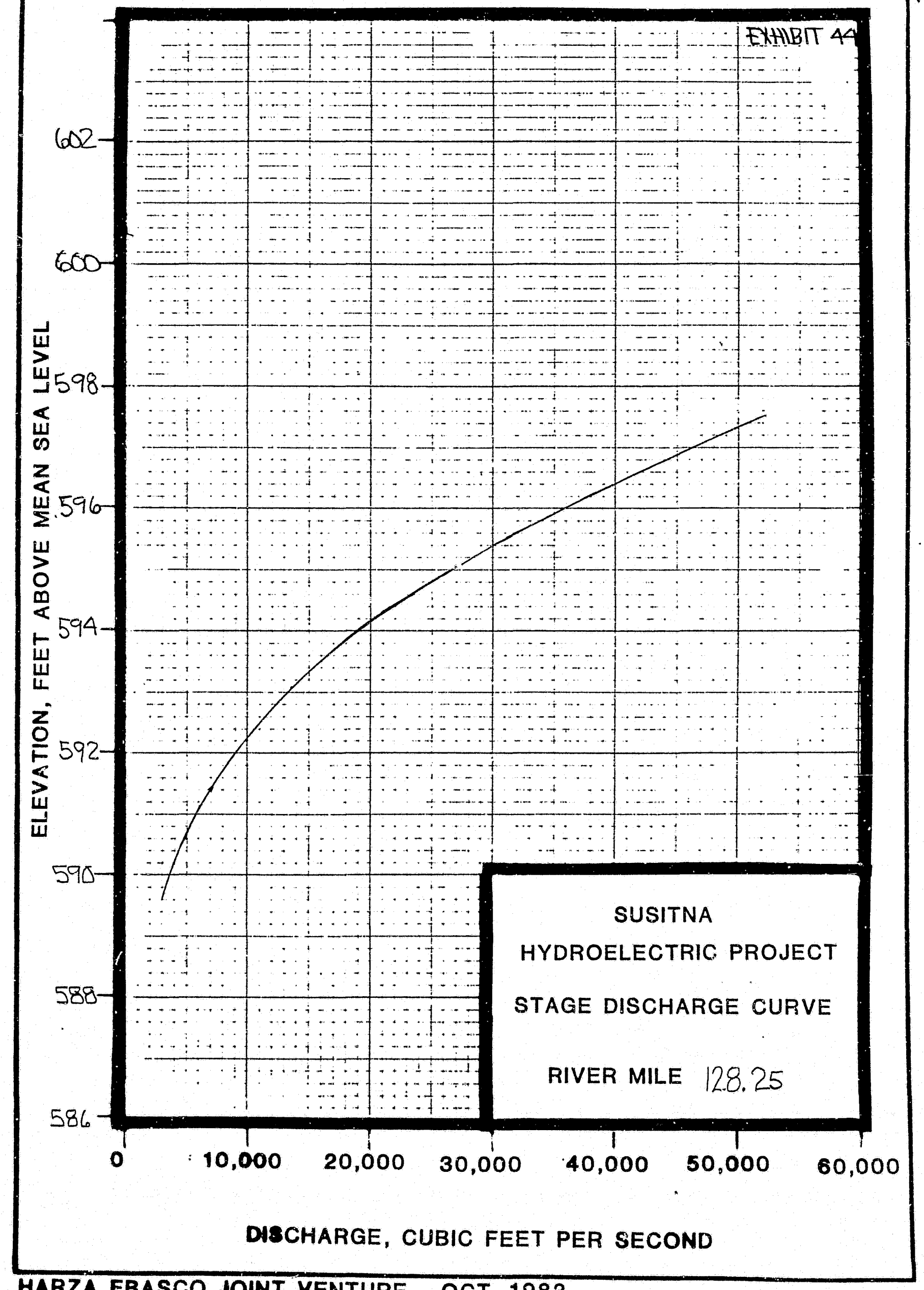
0003 6

EXHIBIT 43



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 44



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 45

ELEVATION, FEET ABOVE MEAN SEA LEVEL

602
600
598
596
594
592
590
588
586

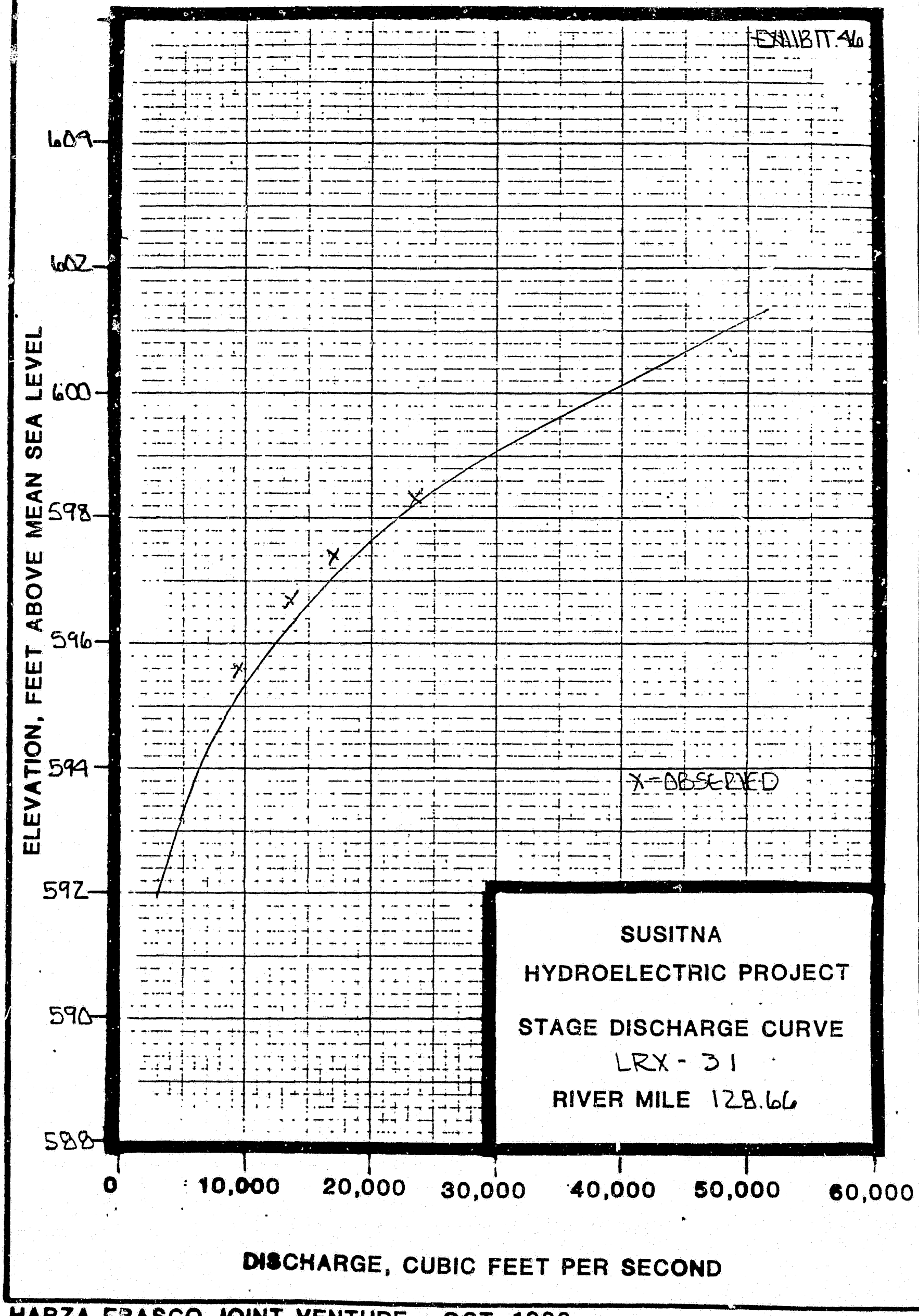
0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 128.40

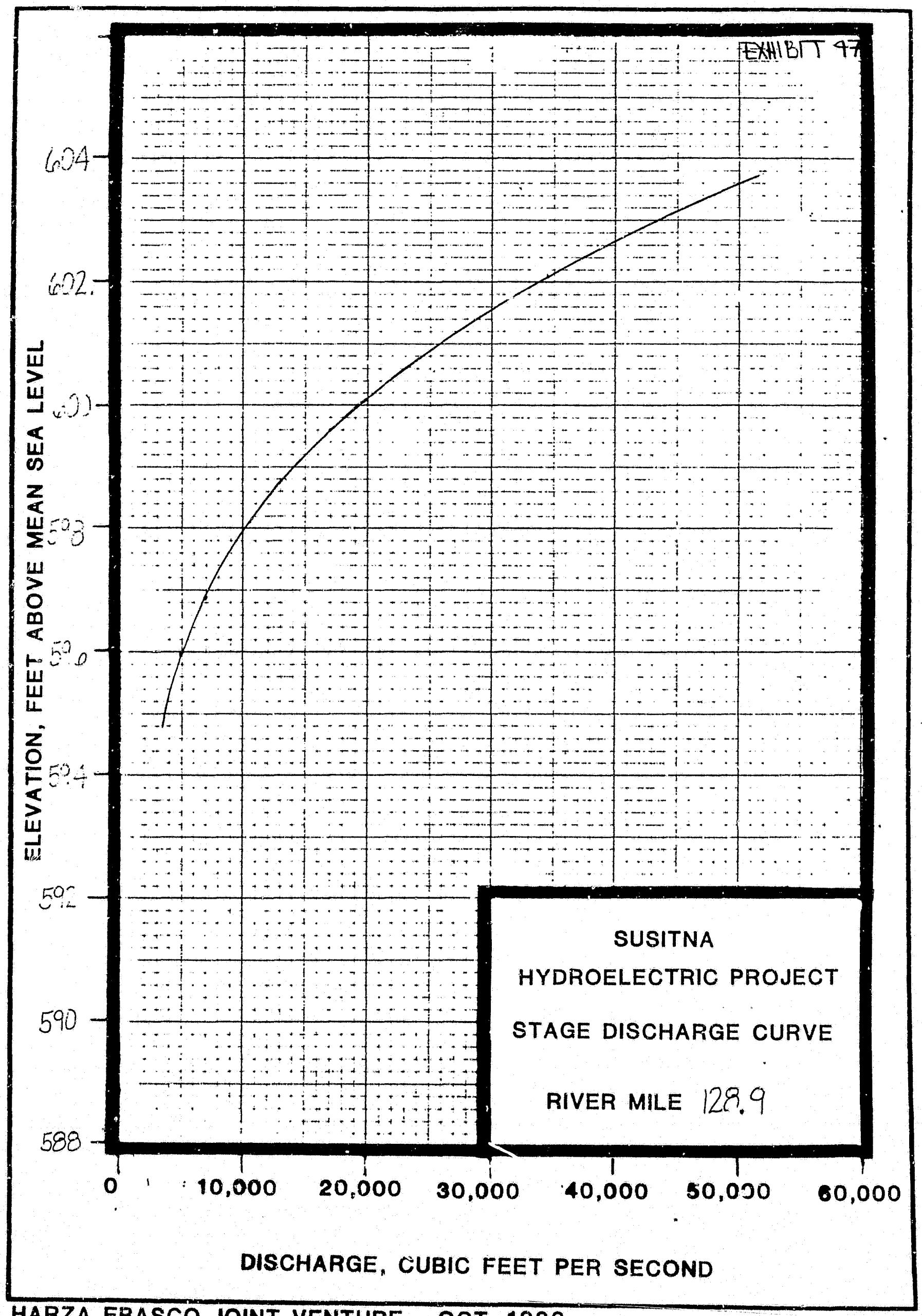
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT No



HARZA EBASCO JOINT VENTURE OCT 1983

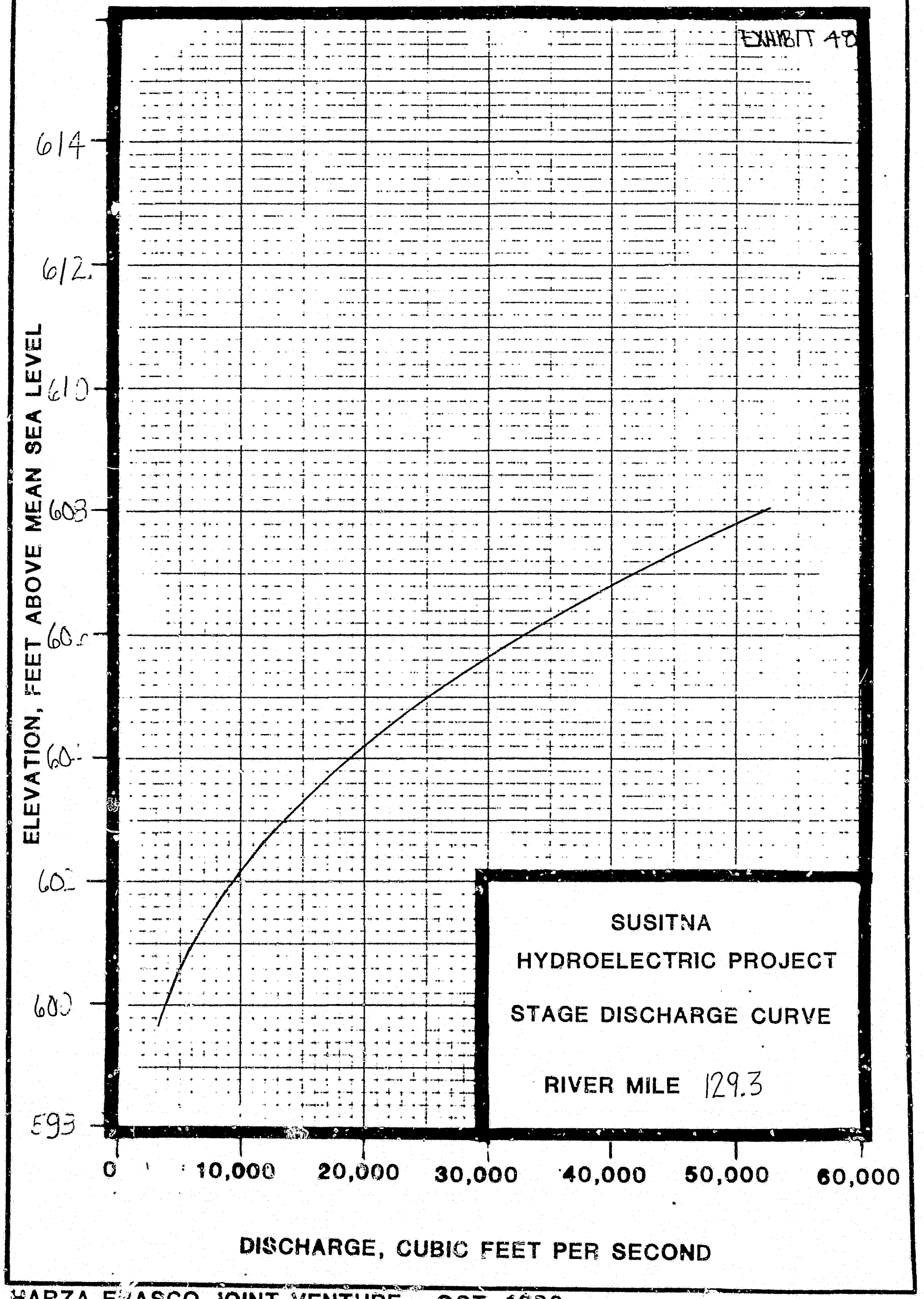
EXHIBIT 97



HARZA EBASCO JOINT VENTURE OCT 1983

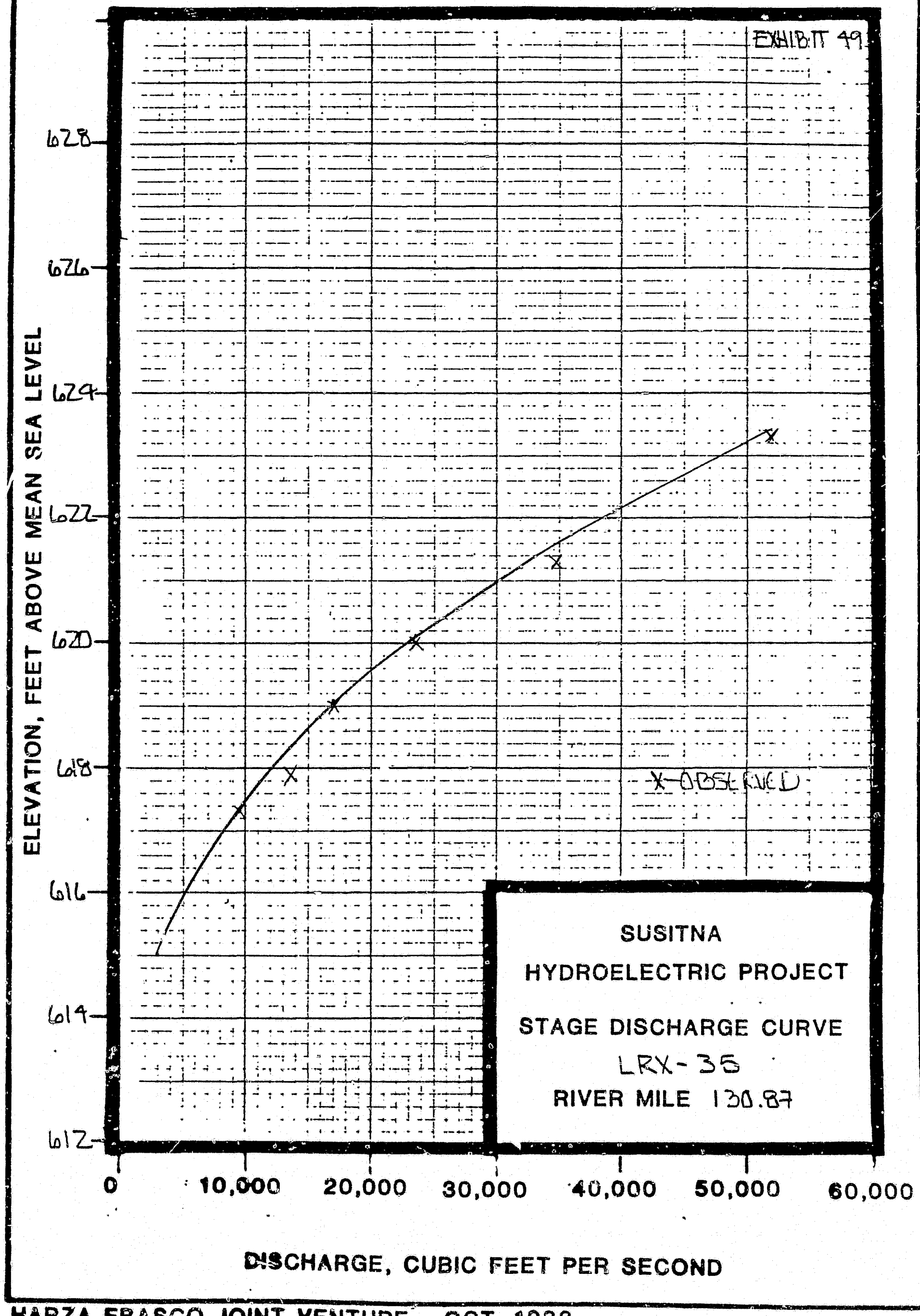
0 0 0 3 6

EXHIBIT 48



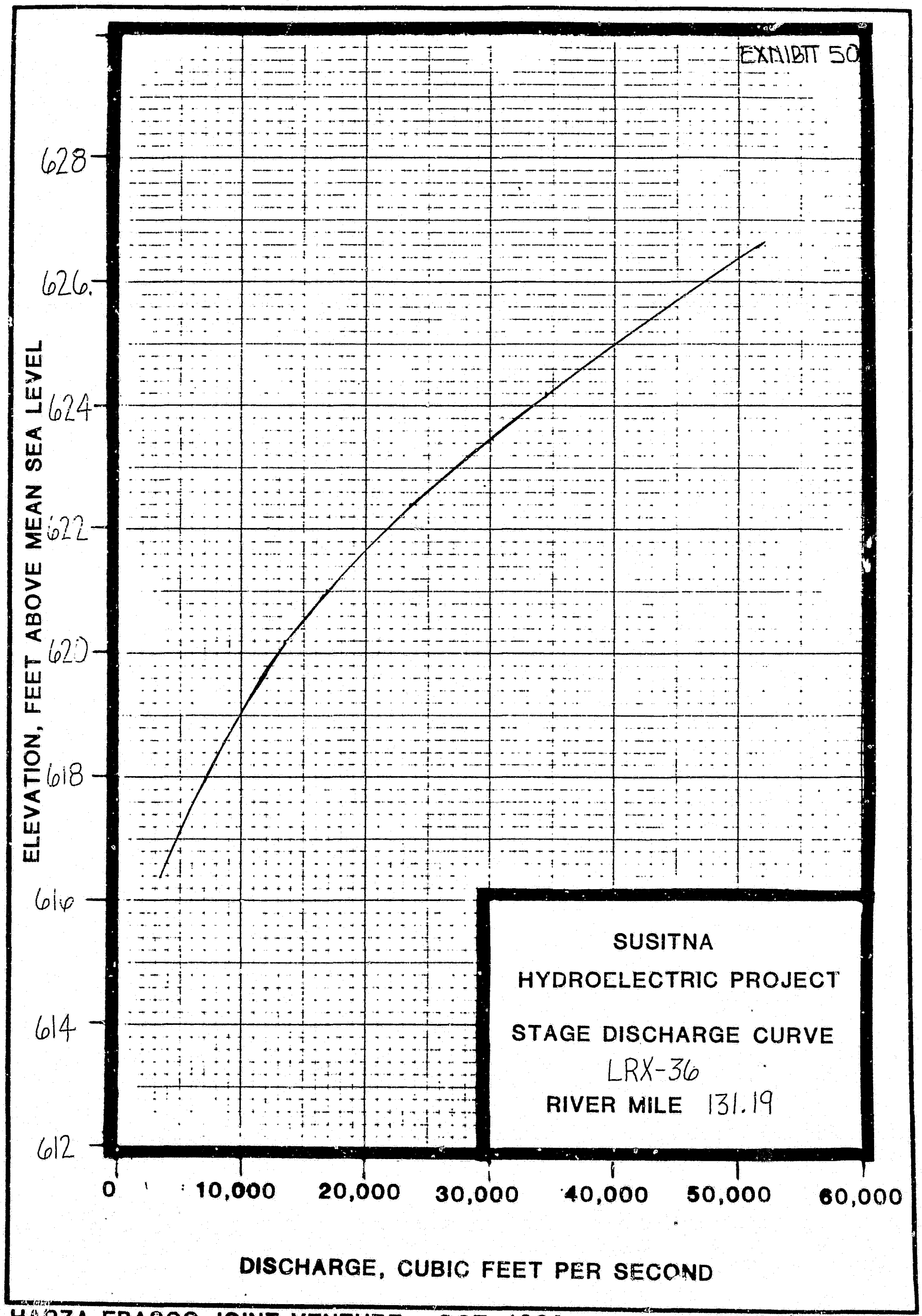
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 49



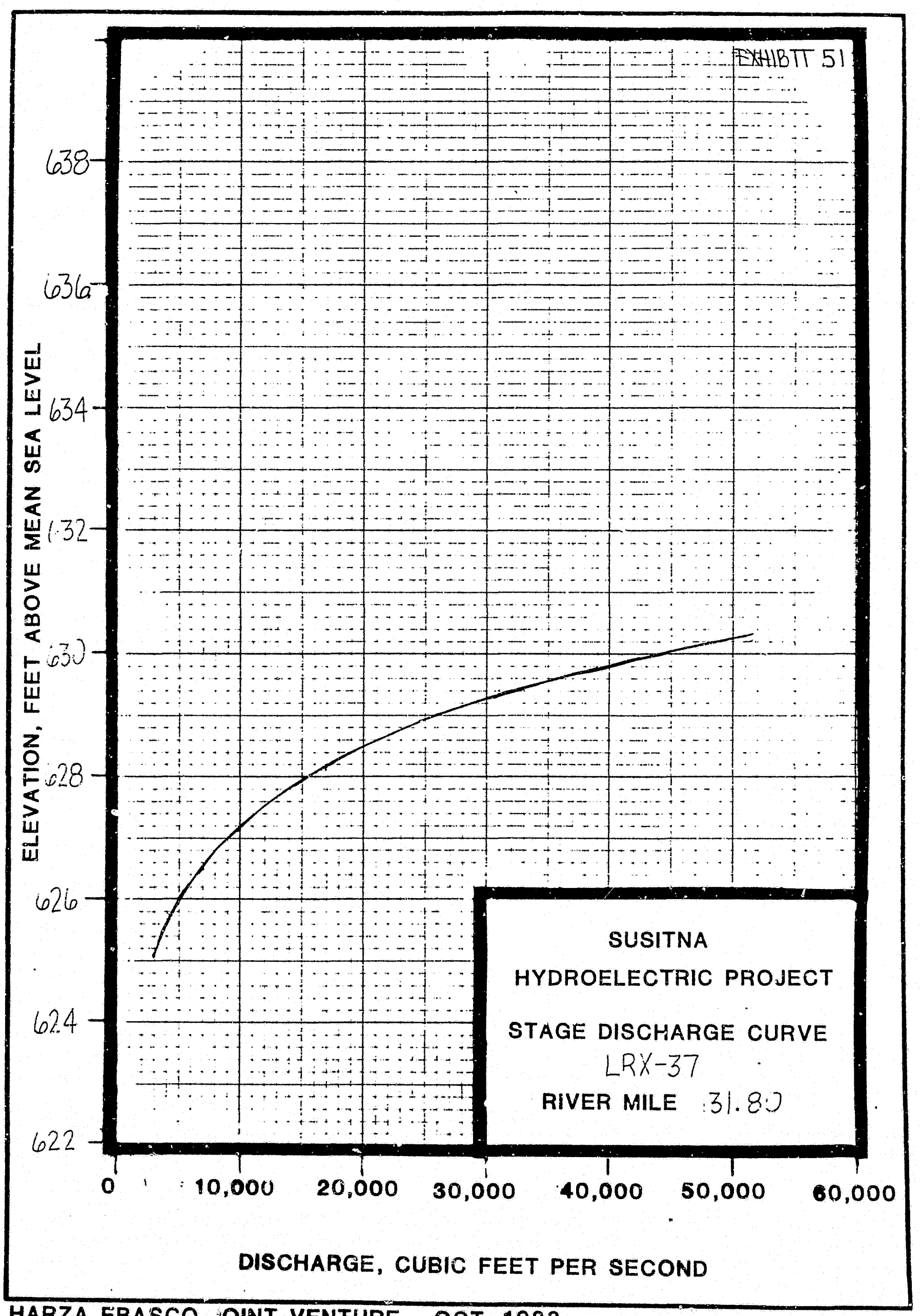
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 50



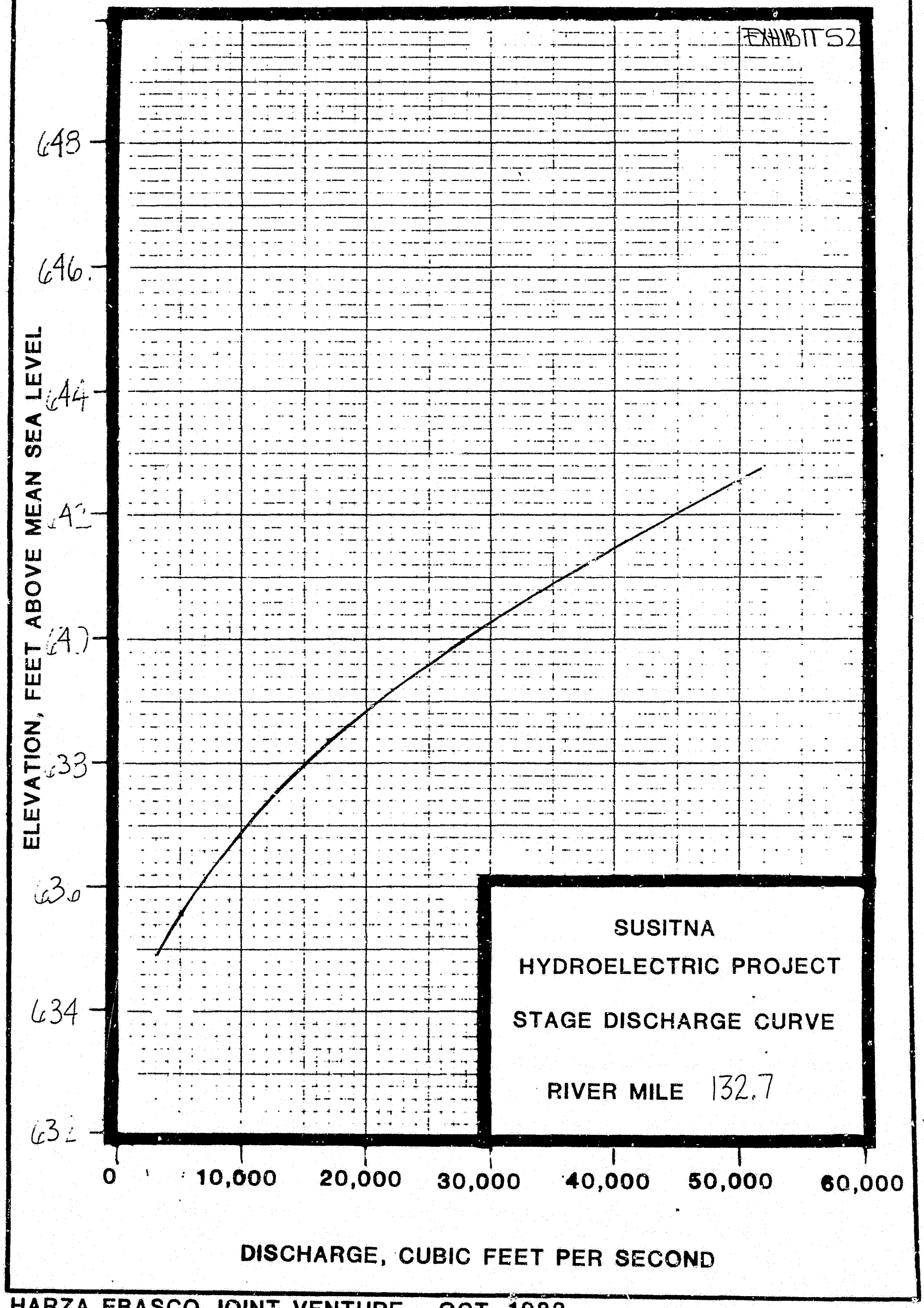
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 51



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 52



HARZA EBASCO JOINT VENTURE OCT 1983

0003

EXHIBIT 53

ELEVATION, FEET ABOVE MEAN SEA LEVEL

662
660
658
656
654
652
650
648
646

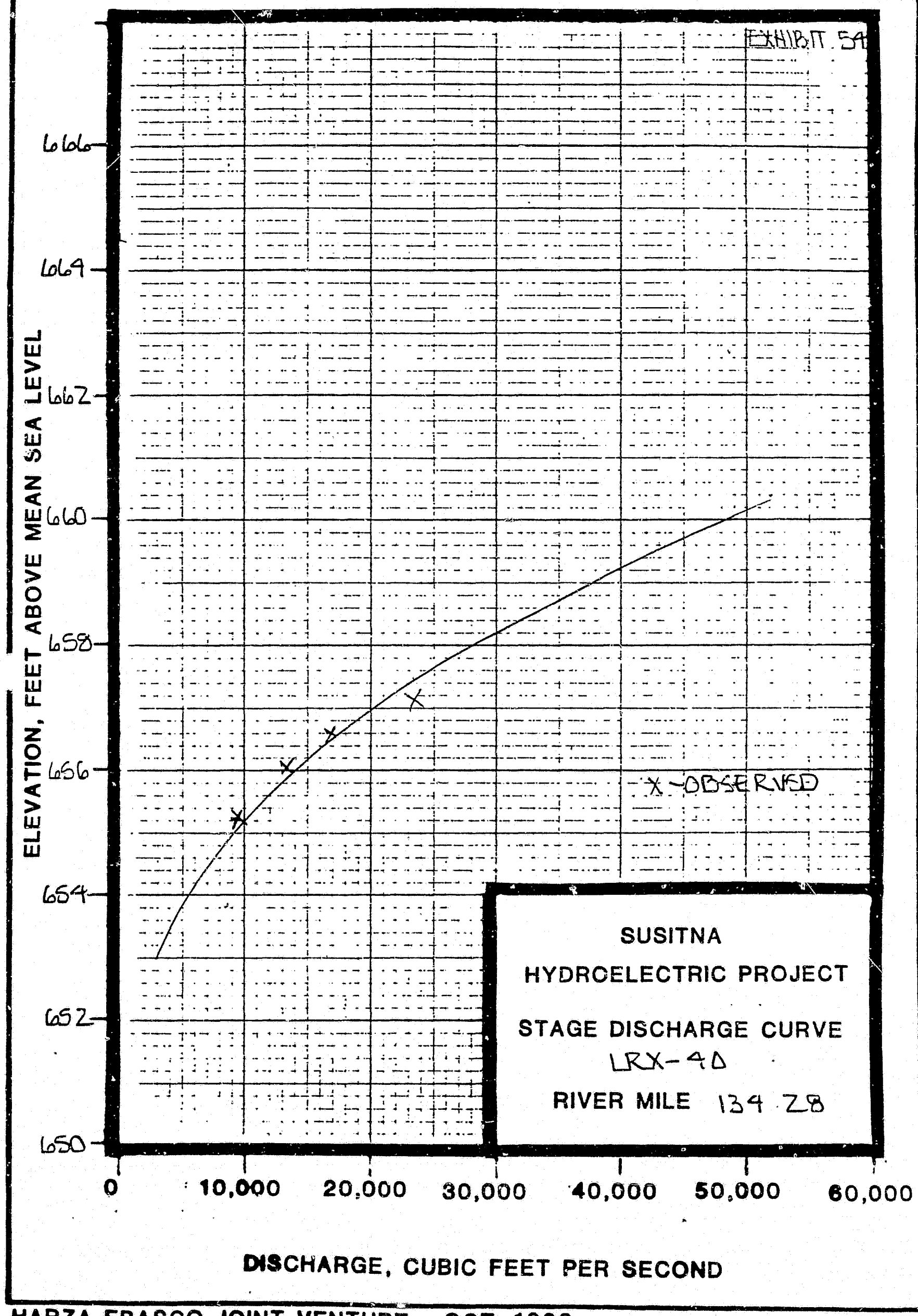
0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 133.8

HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 54



HARZA EBASCO JOINT VENTURE OCT 1983

0 0 0 3 6

EXHIBIT 55

ELEVATION, FEET ABOVE MEAN SEA LEVEL

660
654
652
650
653
650
651
652
650

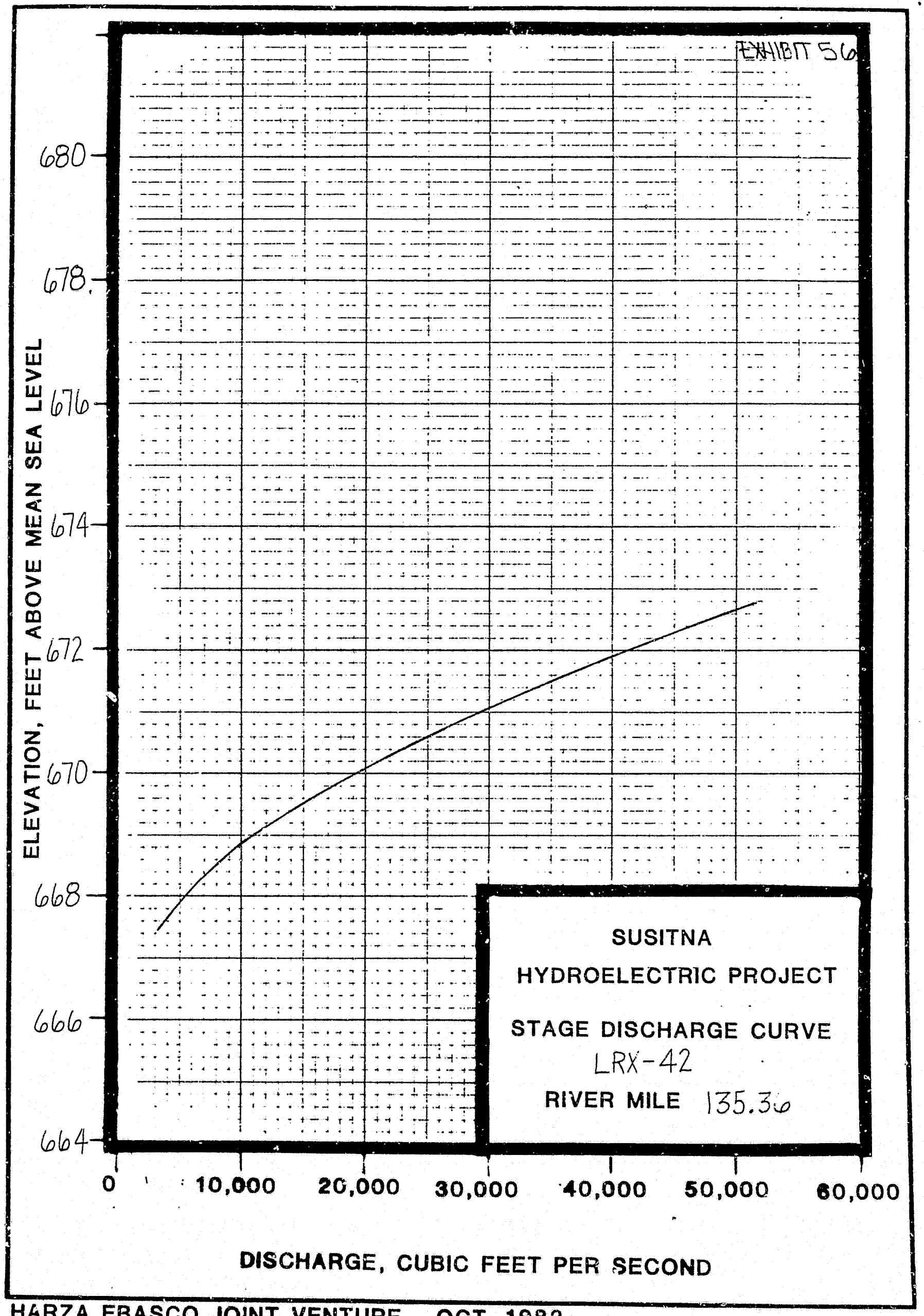
0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 134.5

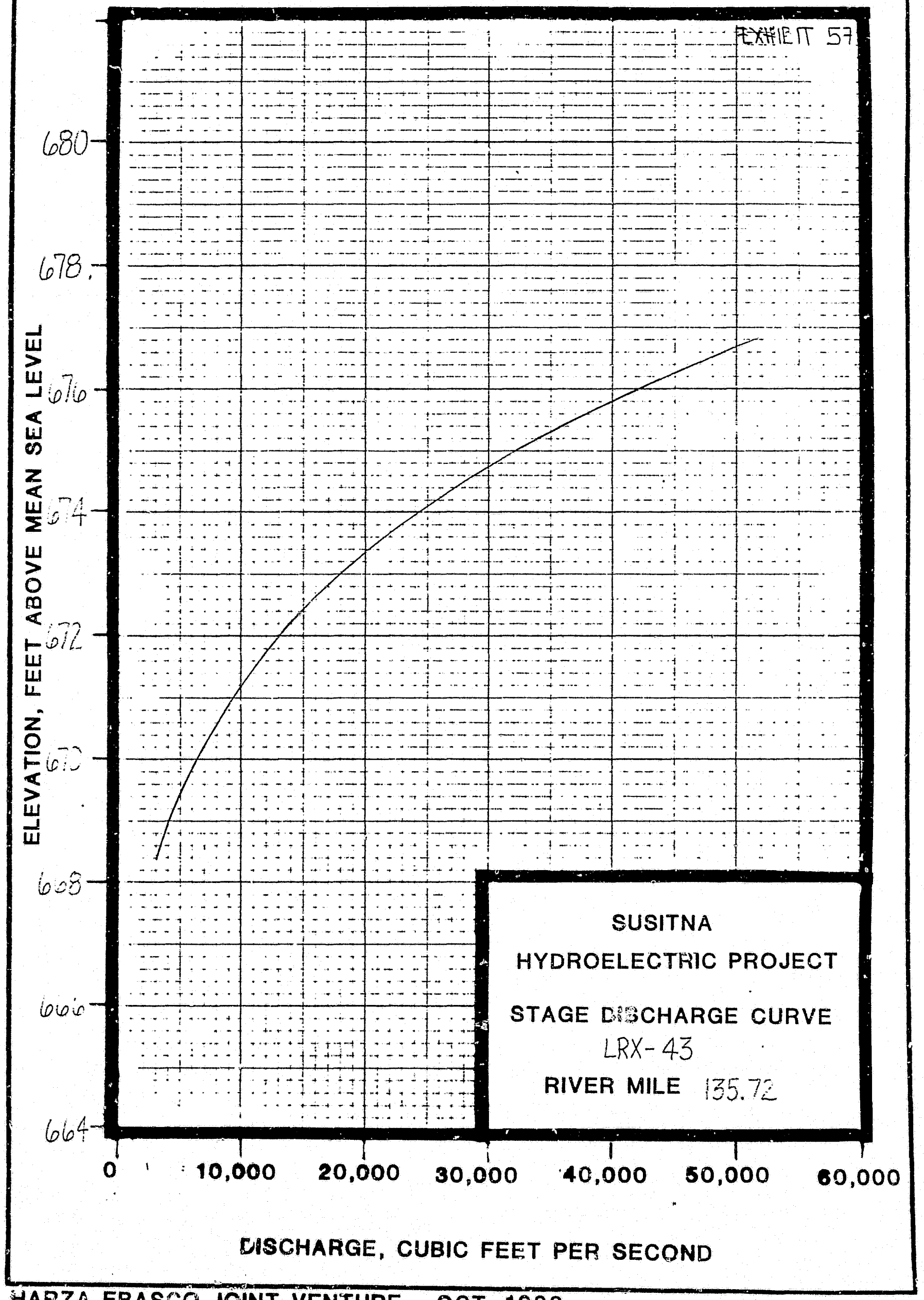
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 56



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 57



HARZA EBASCO JOINT VENTURE OCT 1983

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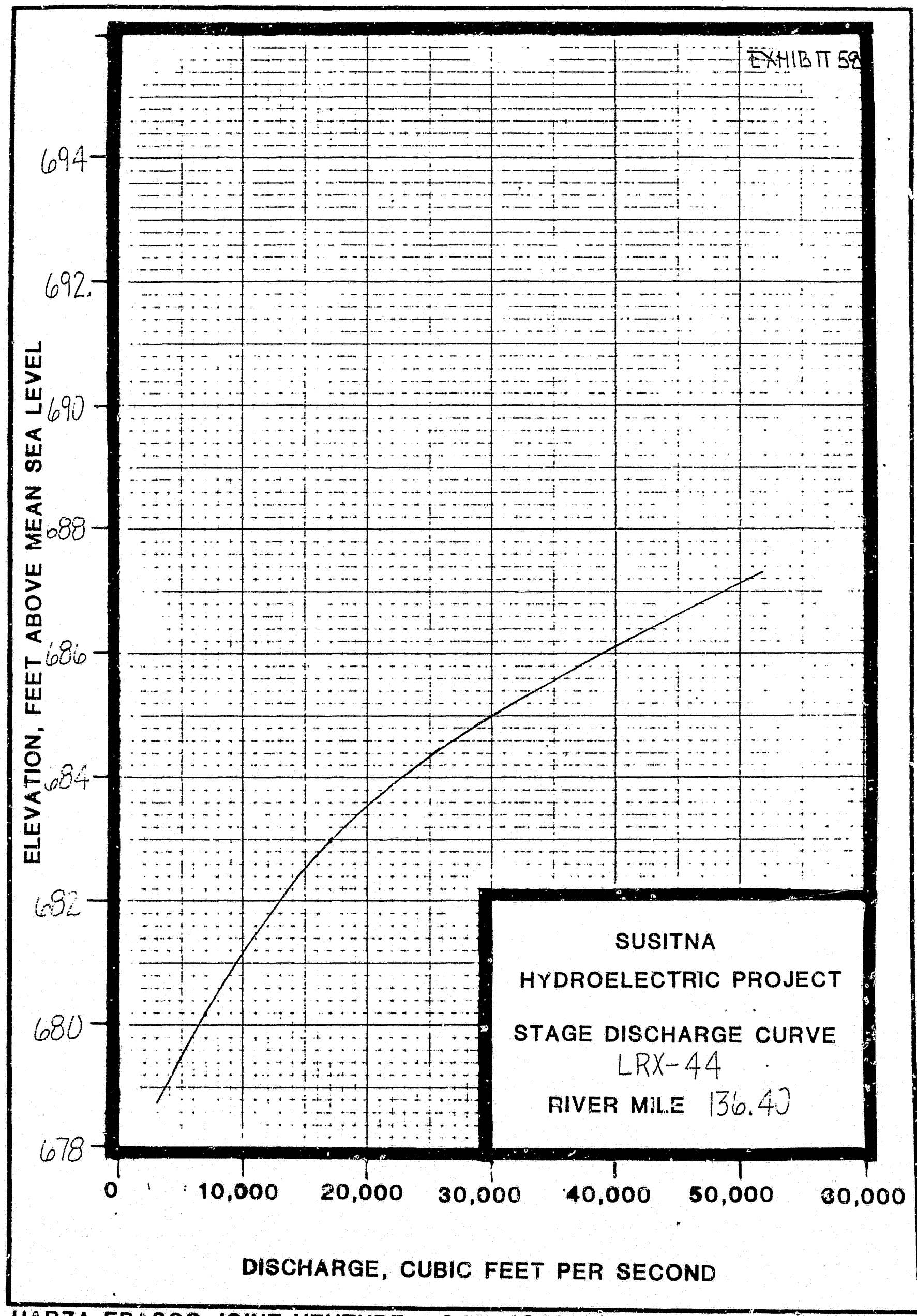
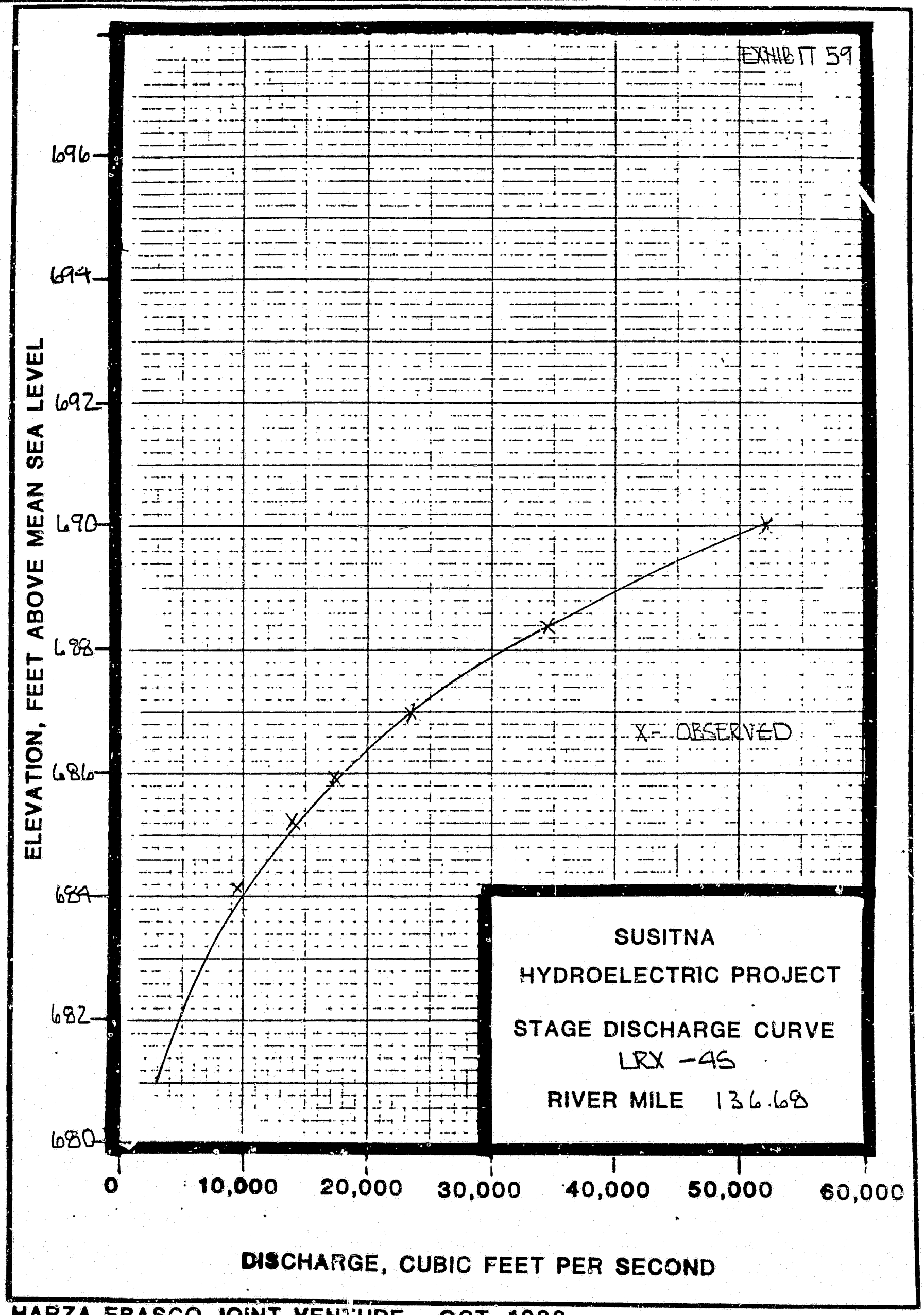


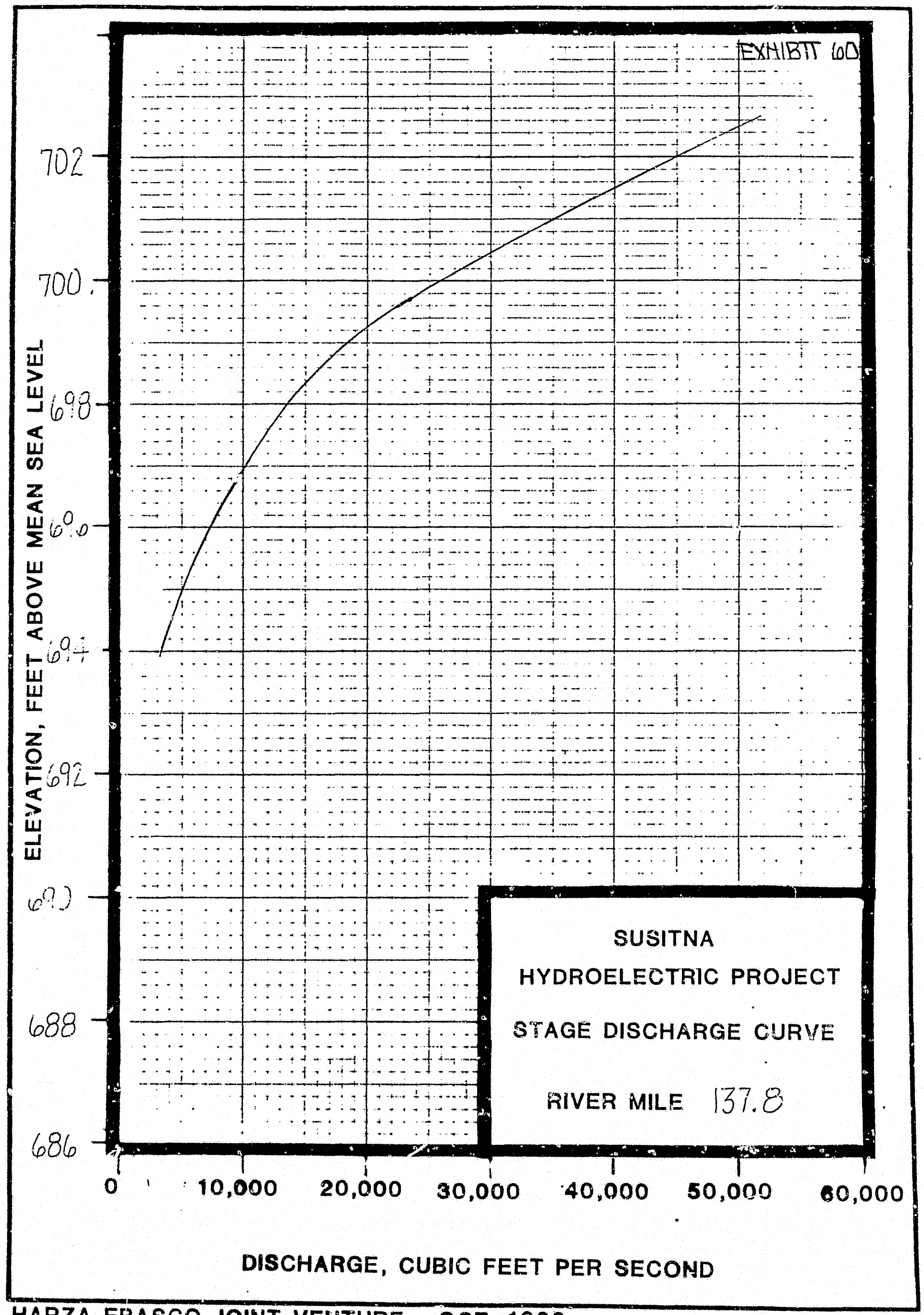
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 59



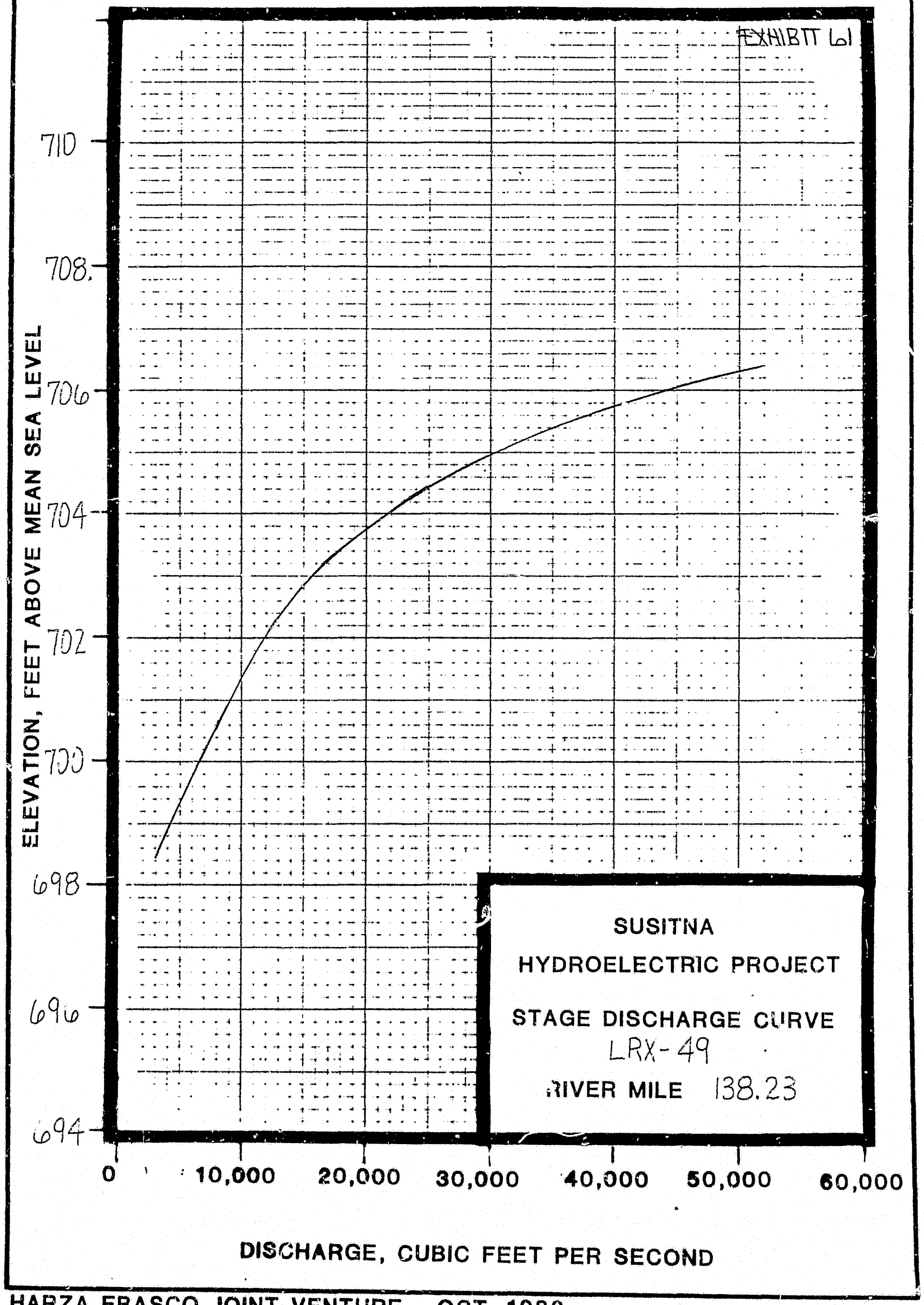
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 60



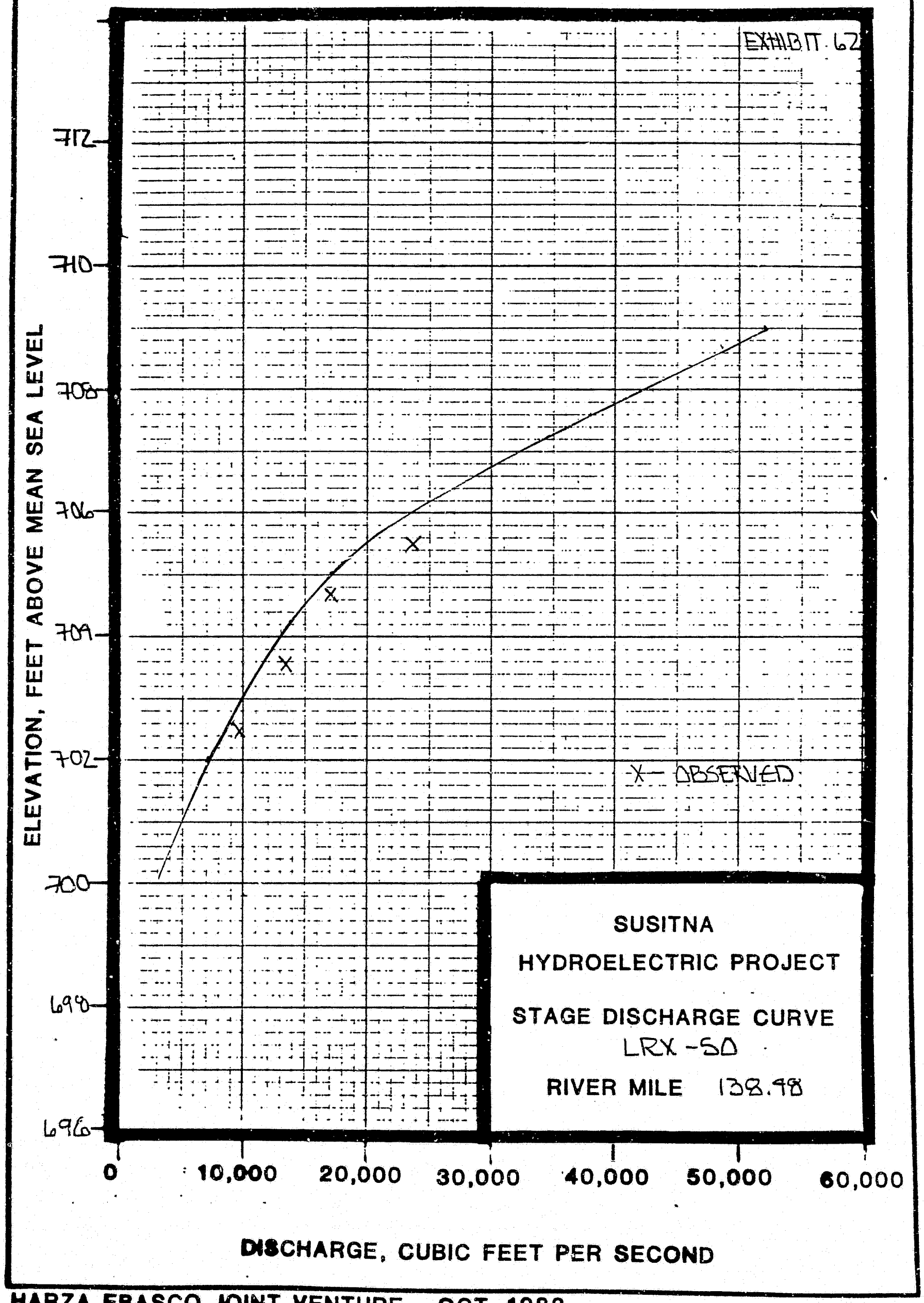
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 61



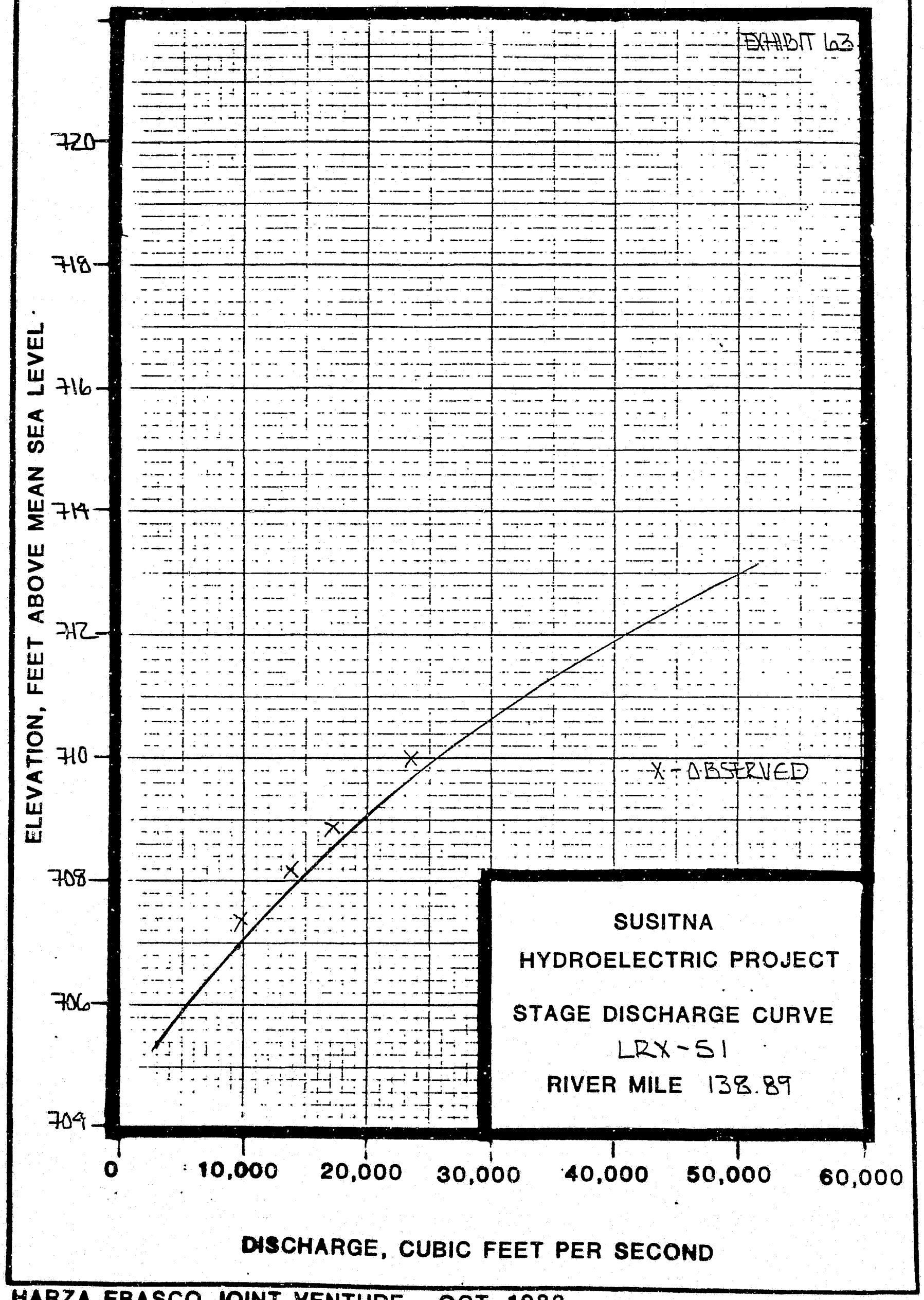
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 62



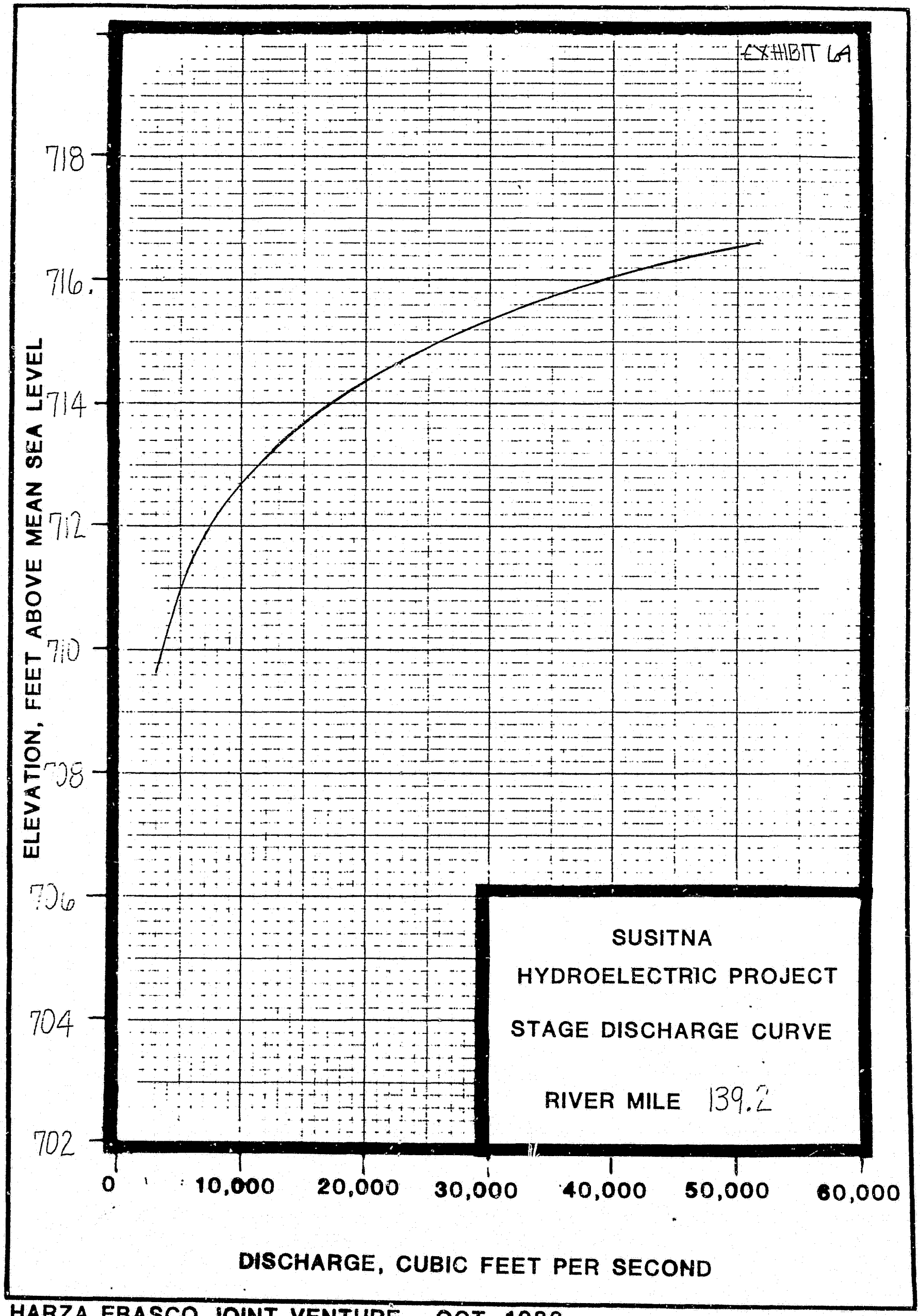
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 163



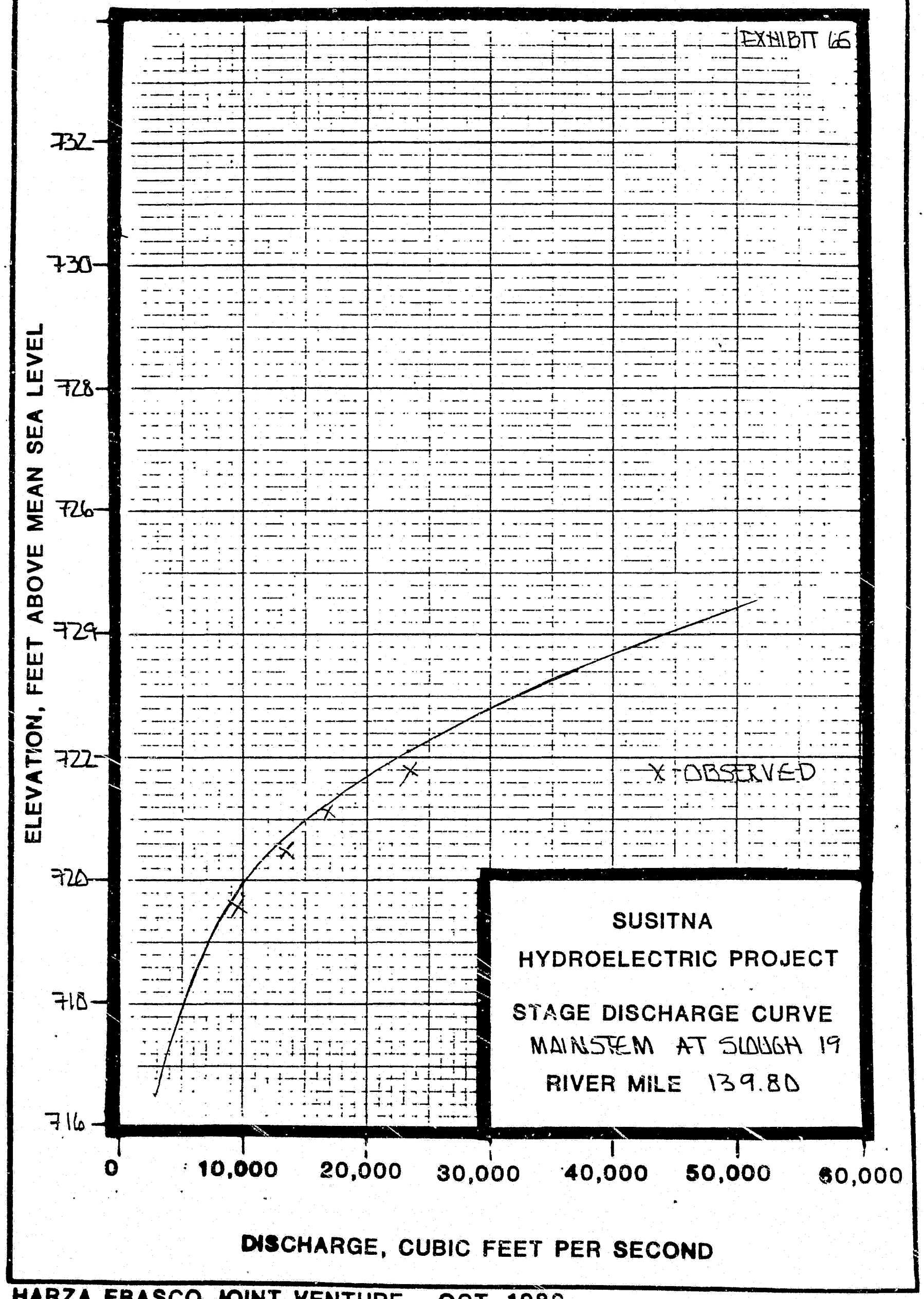
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 1A

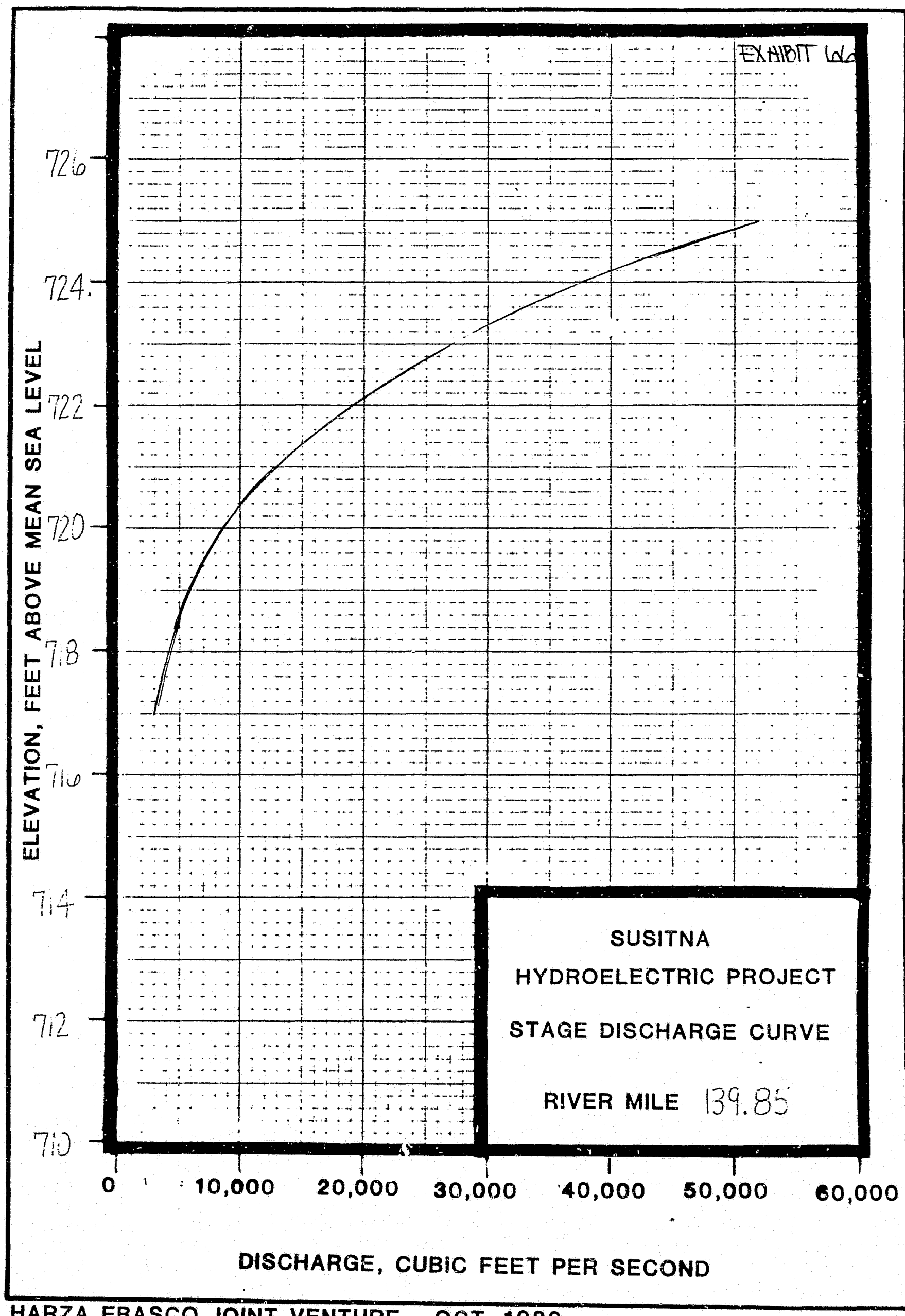


HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 66



HARZA EBASCO JOINT VENTURE OCT 1983



HARZA EBASCO JOINT VENTURE OCT 1983

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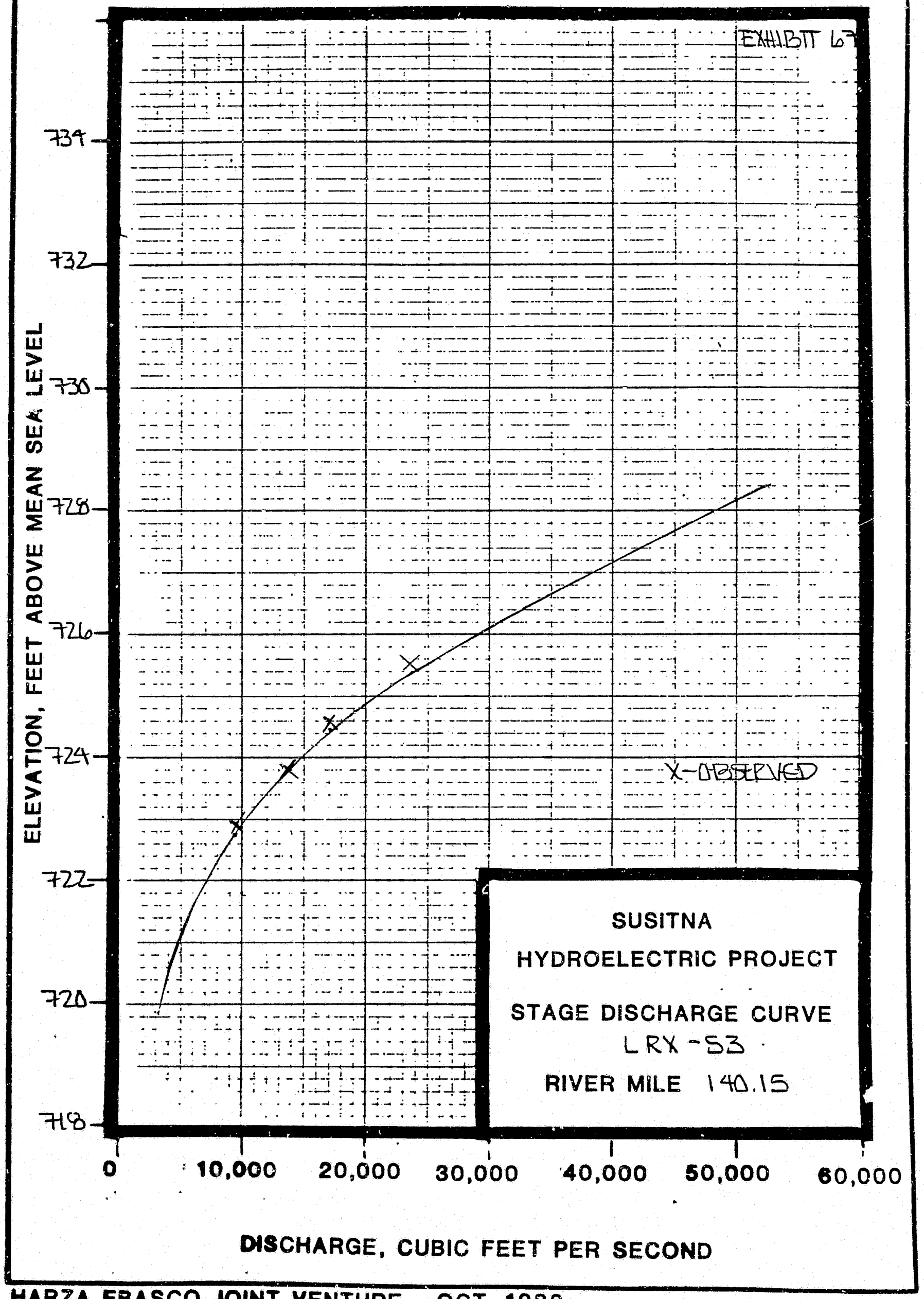
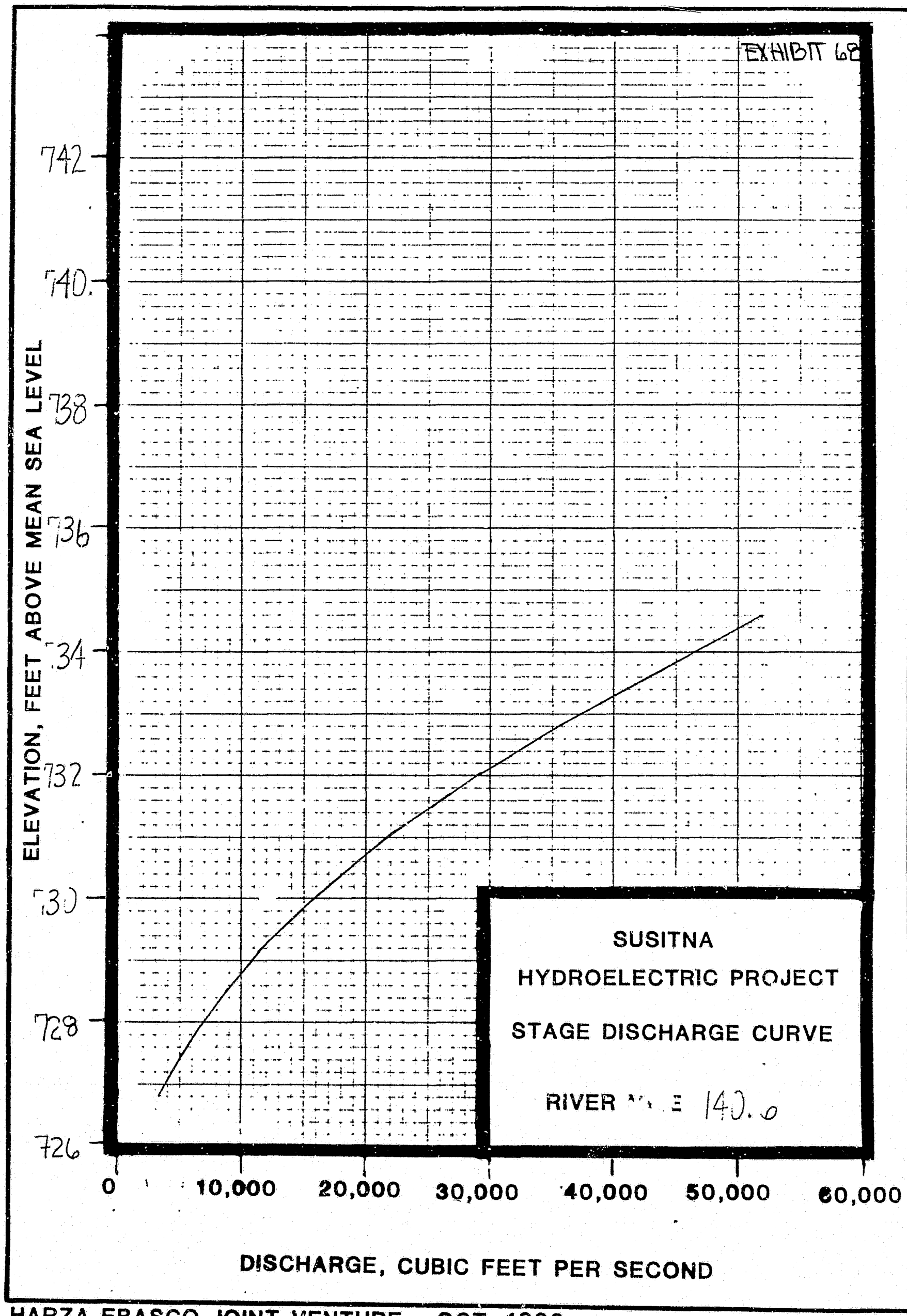


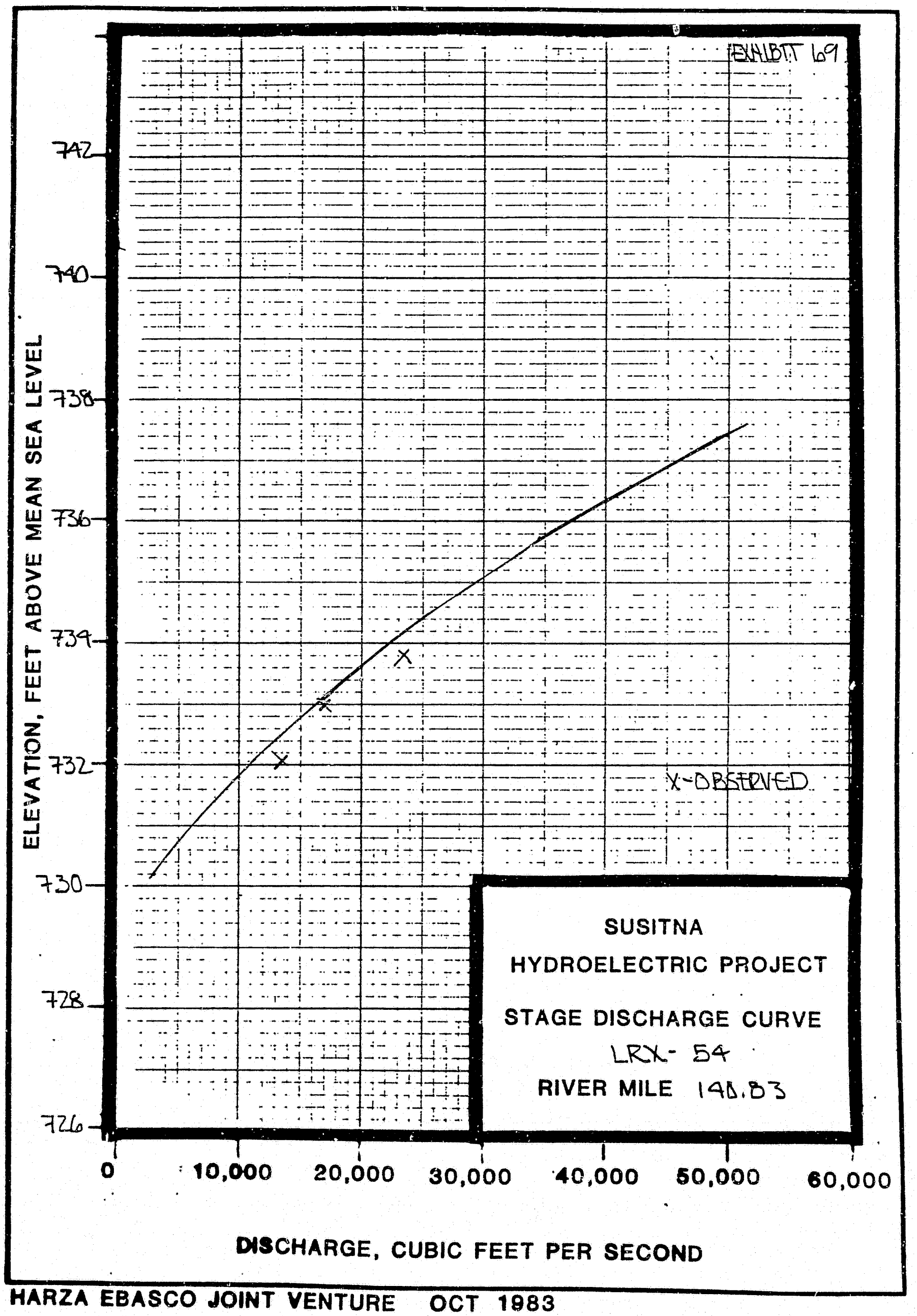
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 6B



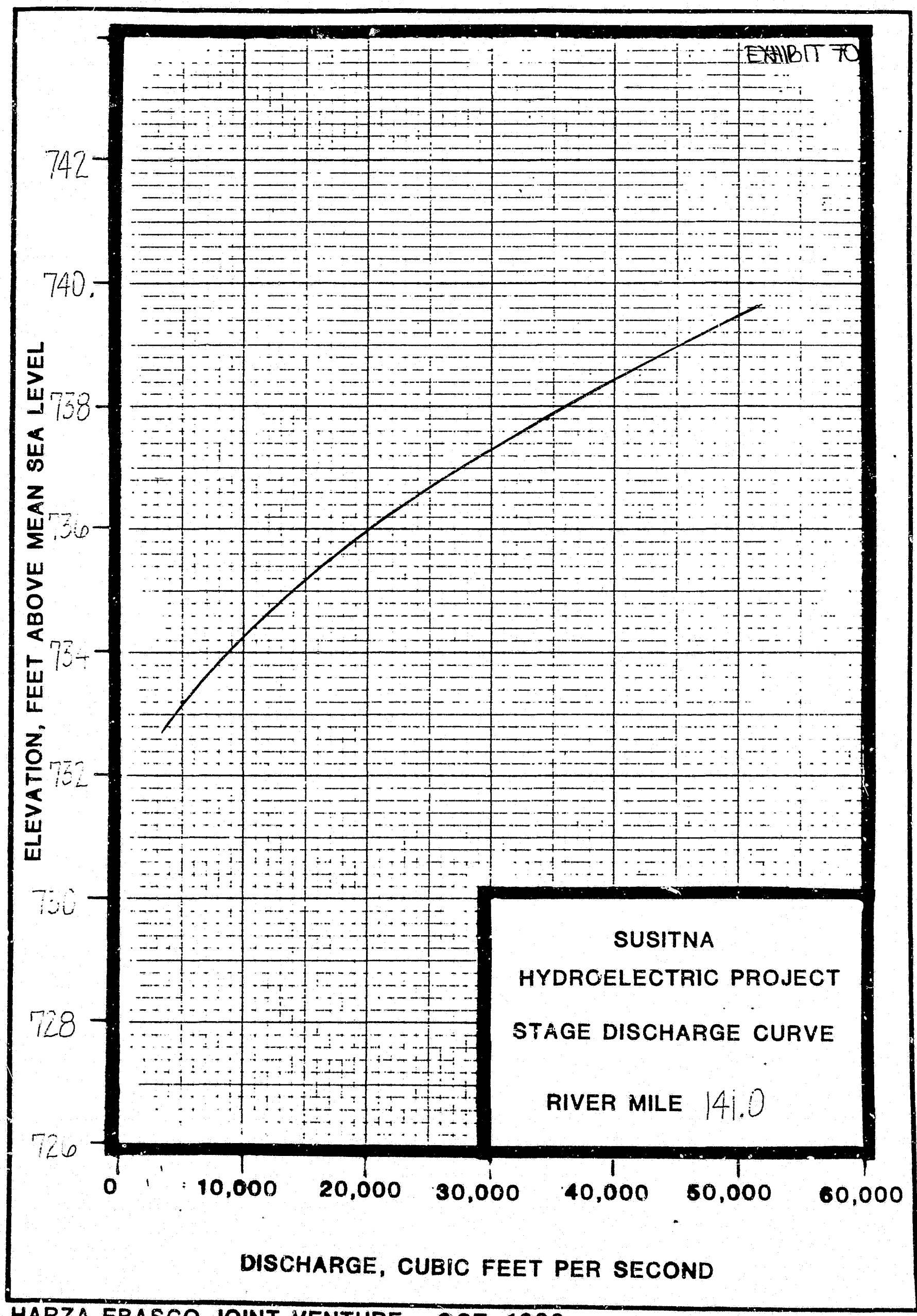
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 69



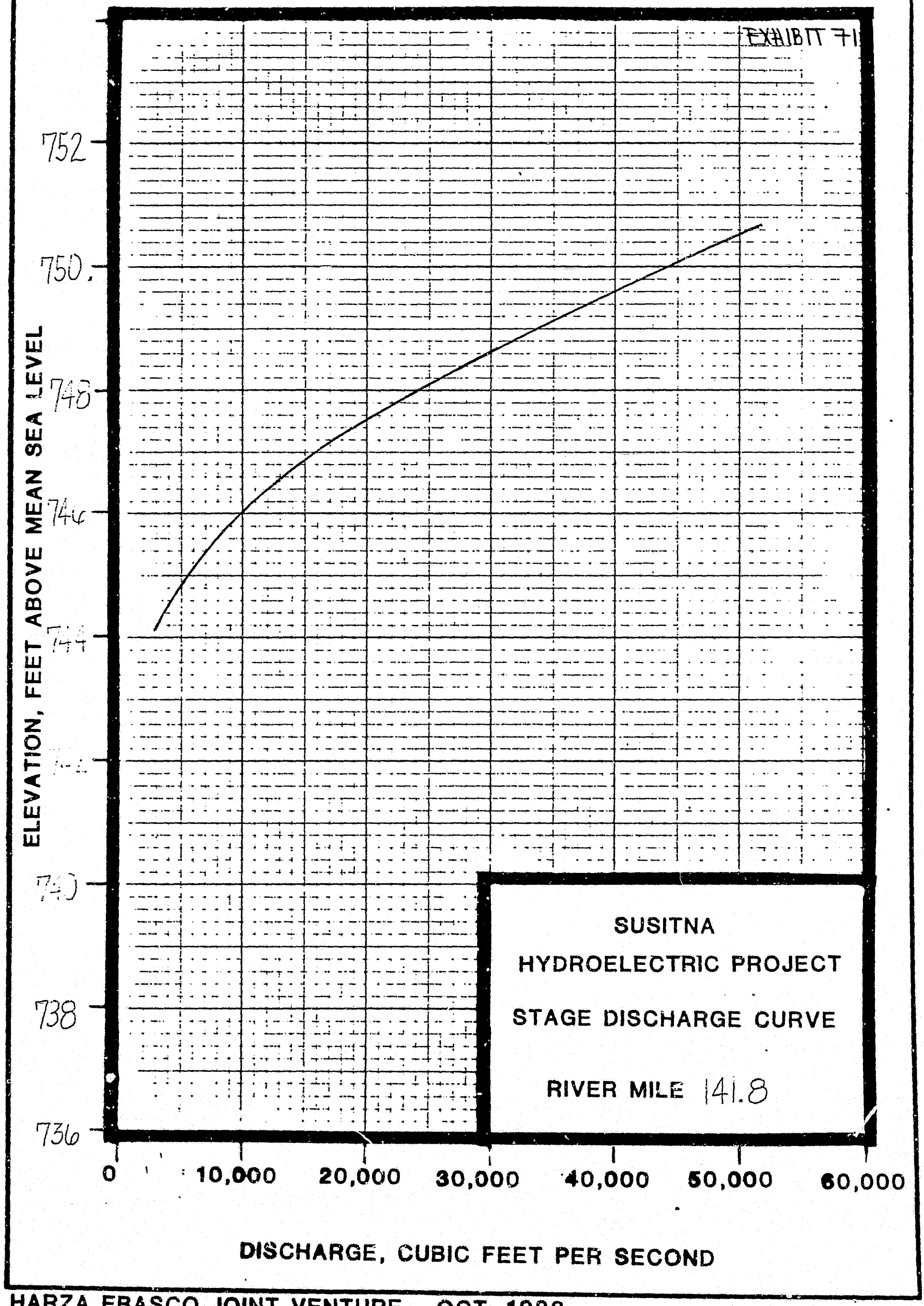
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 70



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 71



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 72

ELEVATION, FEET ABOVE MEAN SEA LEVEL

762
760
758
756
754
752
750
748
746

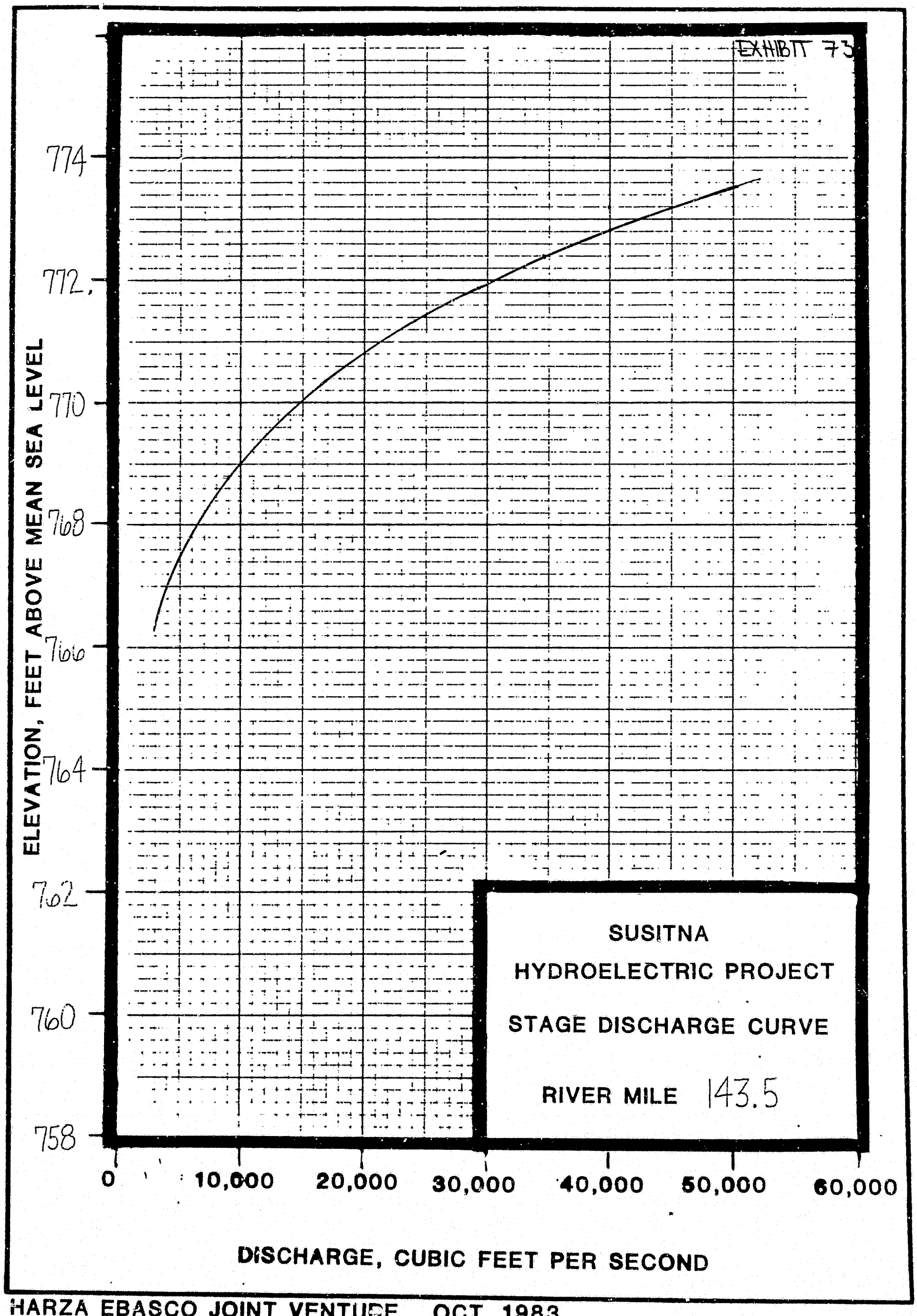
0 10,000 20,000 30,000 40,000 50,000 60,000

DISCHARGE, CUBIC FEET PER SECOND

SUSITNA
HYDROELECTRIC PROJECT
STAGE DISCHARGE CURVE
RIVER MILE 142.2

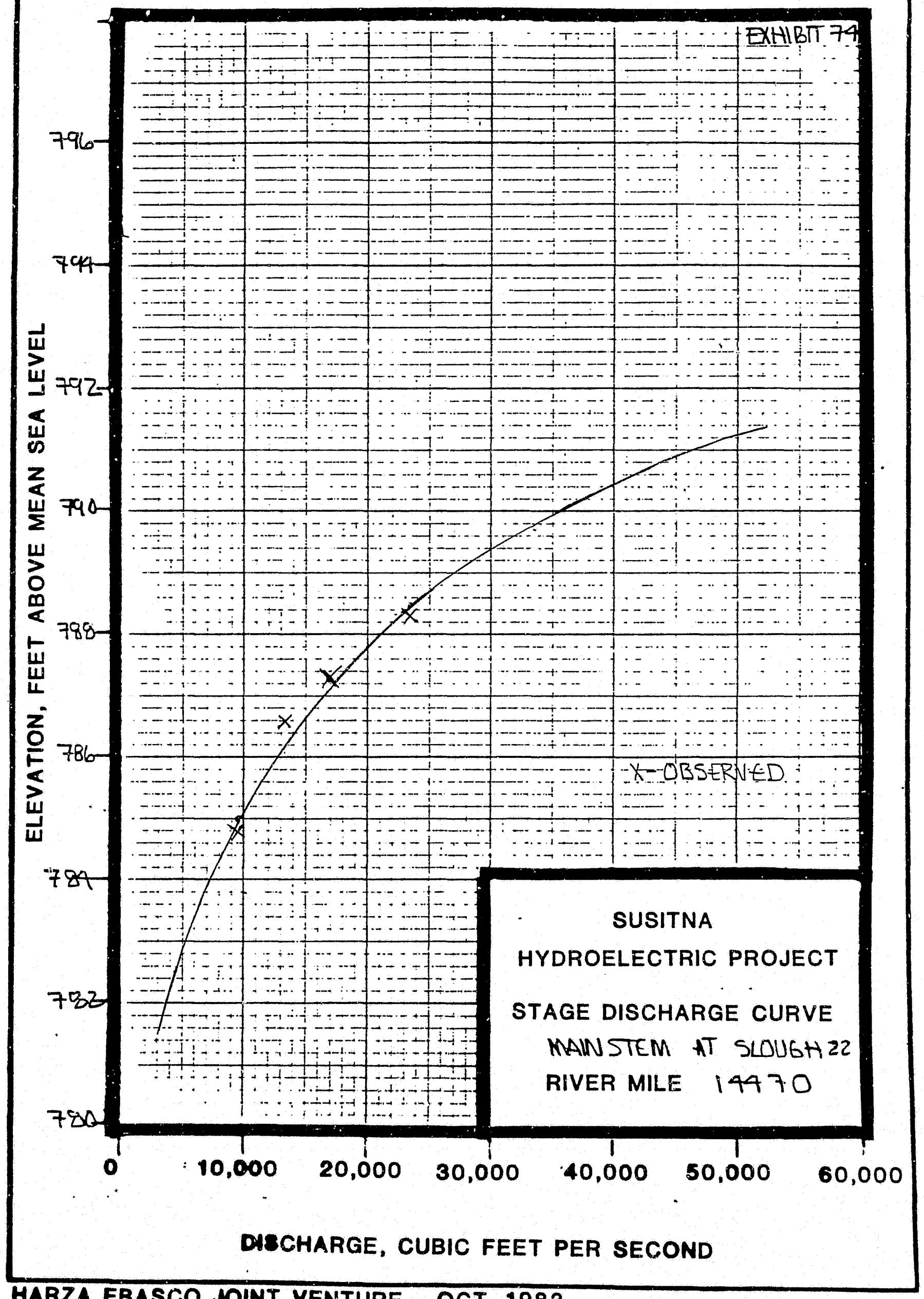
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 73



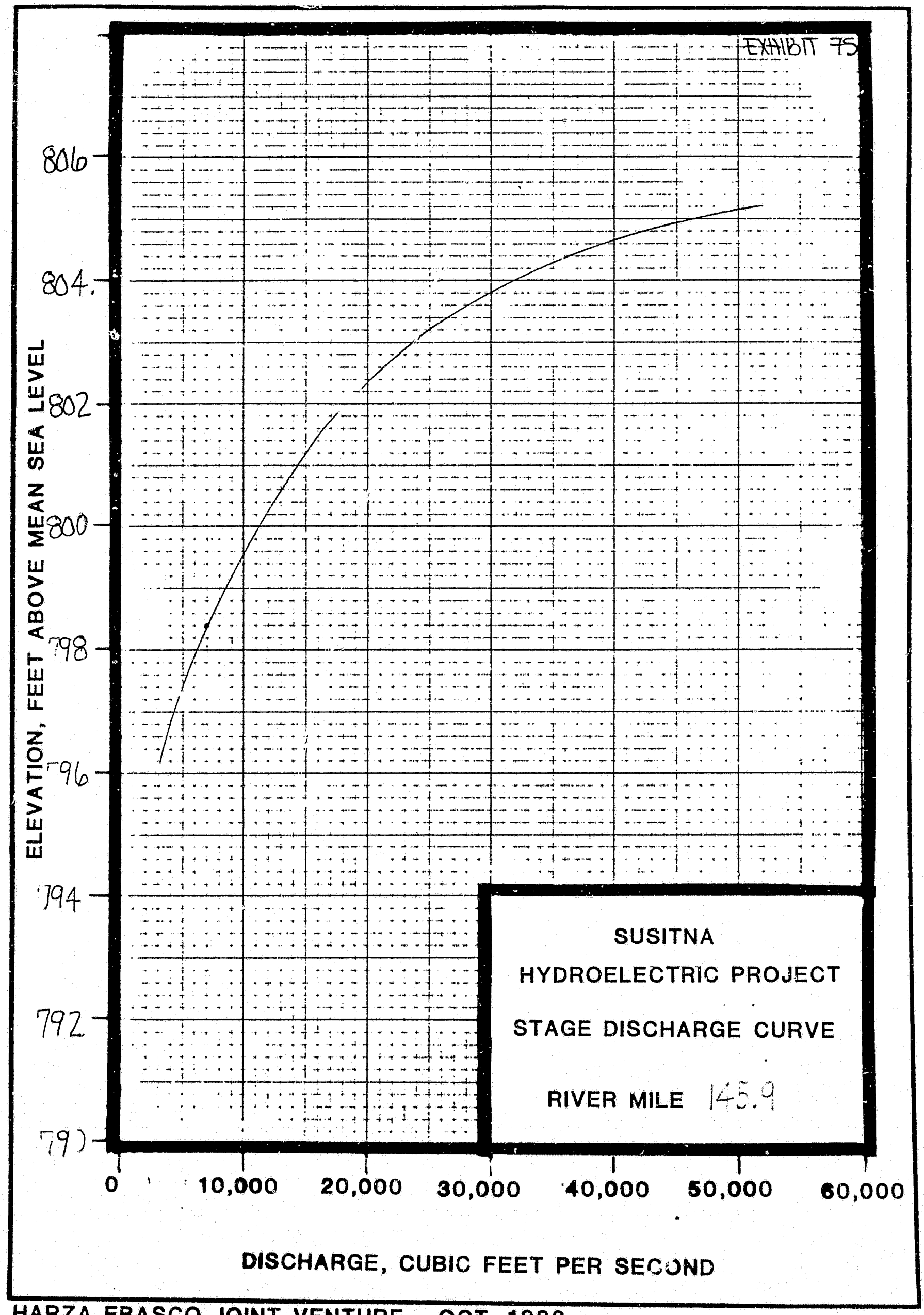
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 79



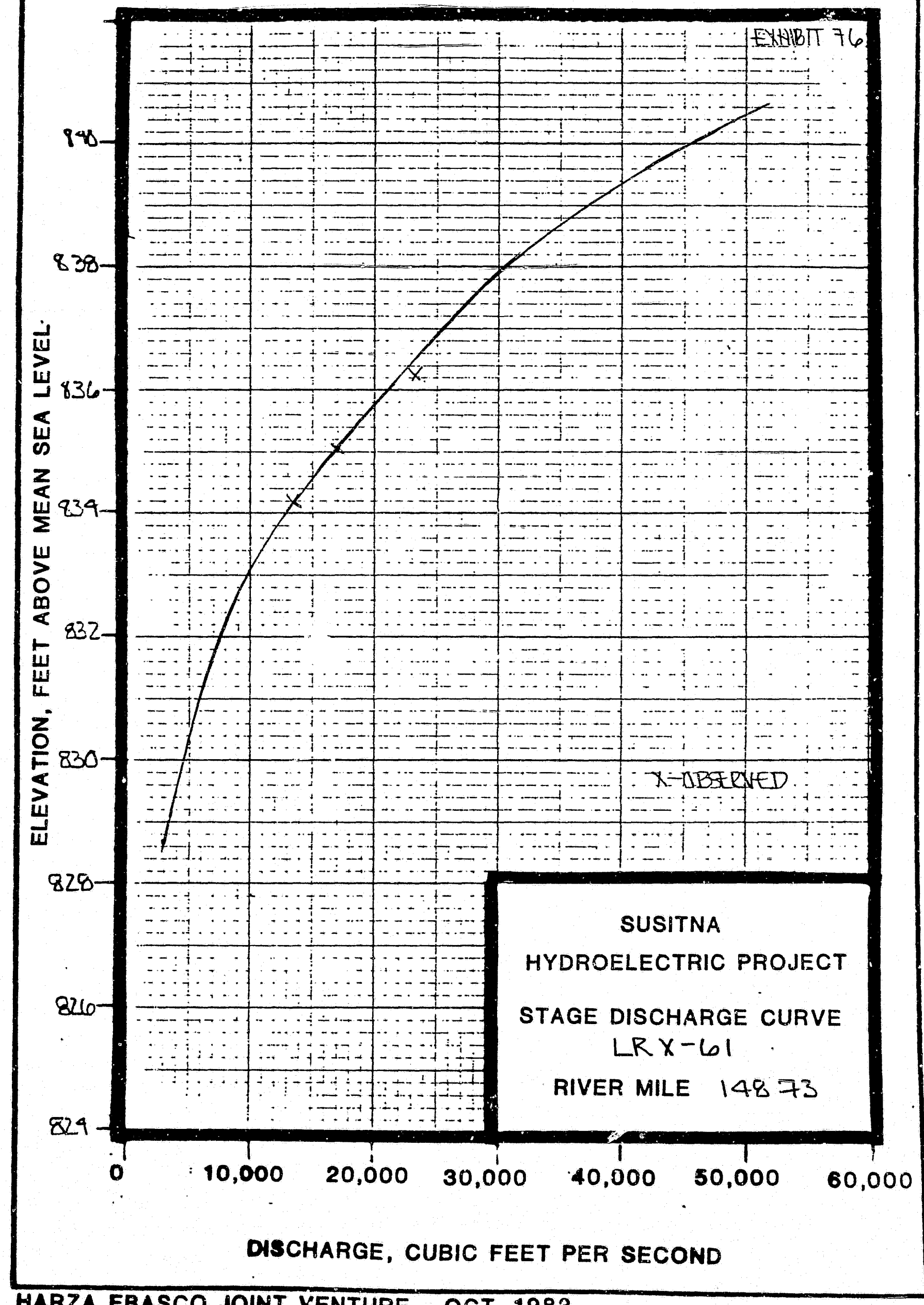
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 75



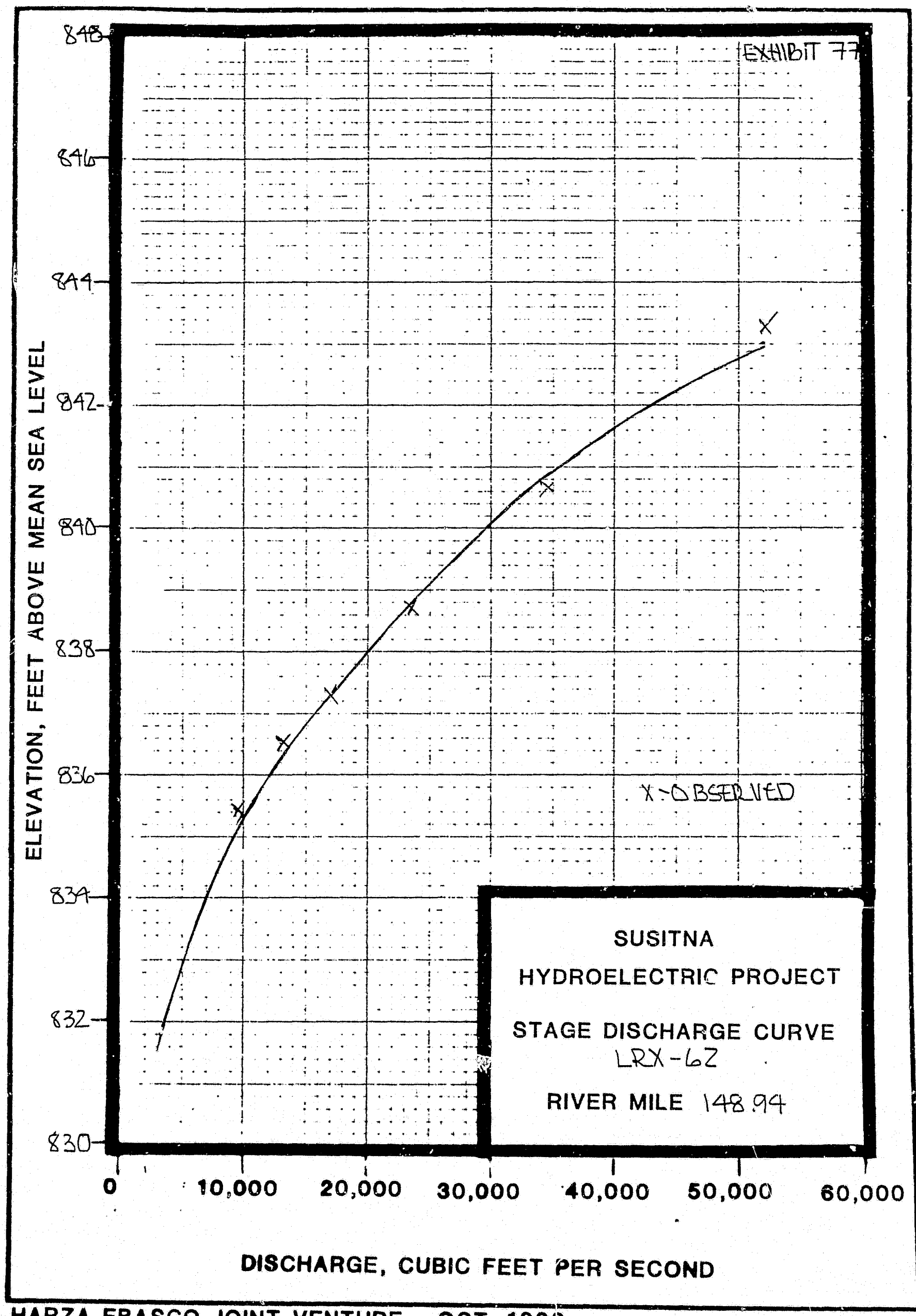
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 76



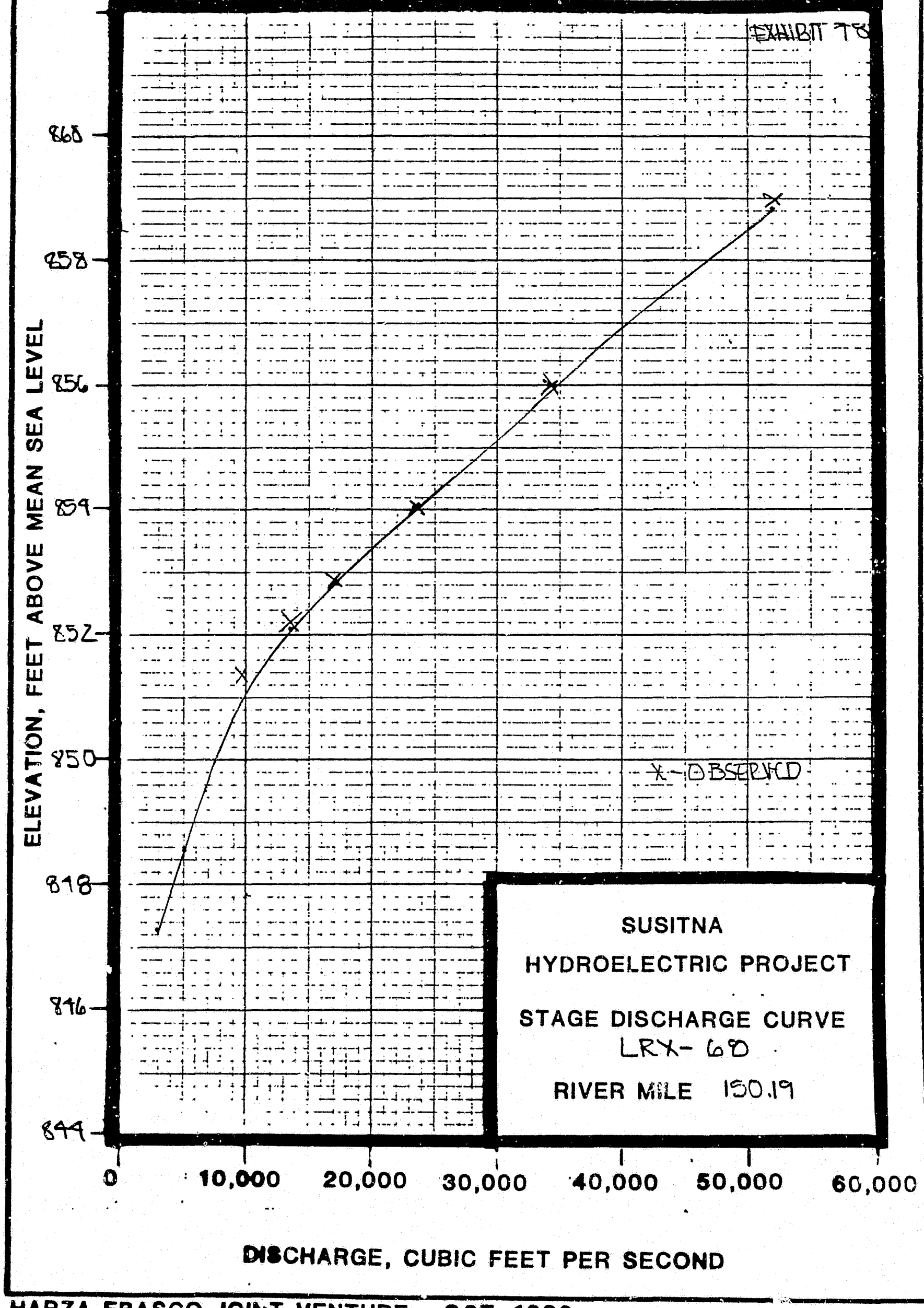
HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT 77



HARZA EBASCO JOINT VENTURE OCT 1983

EXHIBIT T8



HARZA EBASCO JOINT VENTURE OCT 1983