YAZOO RIVER

SEDIMENTATION STUDY OF THE YAZOO RIVER BASIN

GREENWOOD BENDWAY STUDY

CONTRACT NO. DACW 38-76-C-0193

Prepared for

U. S. ARMY CORPS OF ENGINEERS

VICKSBURG DISTRICT

Vicksburg, Mississippi

Prepared by

Civil Engineering Department
Engineering Research Center
Colorado State University
Fort Collins, Colorado

D. B. Simons
R. M. Li
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ACKNOWLEDGMENTS

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In addition, the authors wish to thank Tim Ward for preparing the temporal design, and Jurgen Garbrecht for aiding in the analysis of the Greenwood Bendway.

AUTHORIZATION

This study was performed for the U.S. Army Corps of Engineers, Vicksburg District, Lower Mississippi Divison, Under Contract No. DACW38-76-C-0193. Larry Banks was the authorized Project Manager for the Vicksburg District, and Daryl B. Simons and Ruh-Ming Li were the Principal Investigators for Colorado State University. The primary purpose of the Phase I study was to evaluate the overall river basin response in both the main stem and its major tributaries associated with the Upper Yazoo Project. In accordance with the letter dated March 30, 1978 from U.S. Army Corps of Engineers, Colorado State University was requested to conduct an additional study on the Greenwood Bendway. The purpose of this additional study is to study flood control and sedimentation problems associated with the Greenwood Bendway in the Yazoo River Basin, Mississippi.

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I. Introduction

General

The Sedimentation Study of the Yazoo River Basin is a system analysis of the water and sediment movement in the basin (Figure 1). The study evaluated various design alternatives for flood control and maintenance of the proposed flood control project (upper Yazoo Project) outlined by the U.S. Army Corps of Engineers. Phase I of this study emphasizes the evaluation of the overall river basin response in both the mainstem and its major tributaries associated with the Upper Yazoo Project. The additional study on the Greenwood Bendway examines in detail the river and tributary response in the Greenwood Bendway area.

The Greenwood Bendway extends for 11.5 miles (river miles 162.5 to 174.0) on the Yazoo and Tallahatchie Rivers (Figure 2). Because the city of Greenwood is located along the Bendway there has been considerable interest in maintaining the Bendway in the best possible manner. Flood control, water quality, navigation, and aesthetics all must be considered when evaluating project designs. Levees and floodwalls have been built to protect the city of Greenwood and the adjacent farm lands. Big Sand Creek which originally flowed into the Bendway, has been diverted to flow into the Yalobusha. The most important work has been the construction of the Ft. Pemberton cutoff (or Greenwood cutoff). The cutoff lowered stages at Greenwood and along the upstream reaches by reducing the length of the river, but when opened for prolonged periods, the cutoff has caused large amounts of deposition in the Bendway. When the cutoff is open most of the mainstem flow passes through it. This causes a significant reduction in the Bendway discharge. With the decreased flow the sediment supplied by the Yalobusha River cannot be

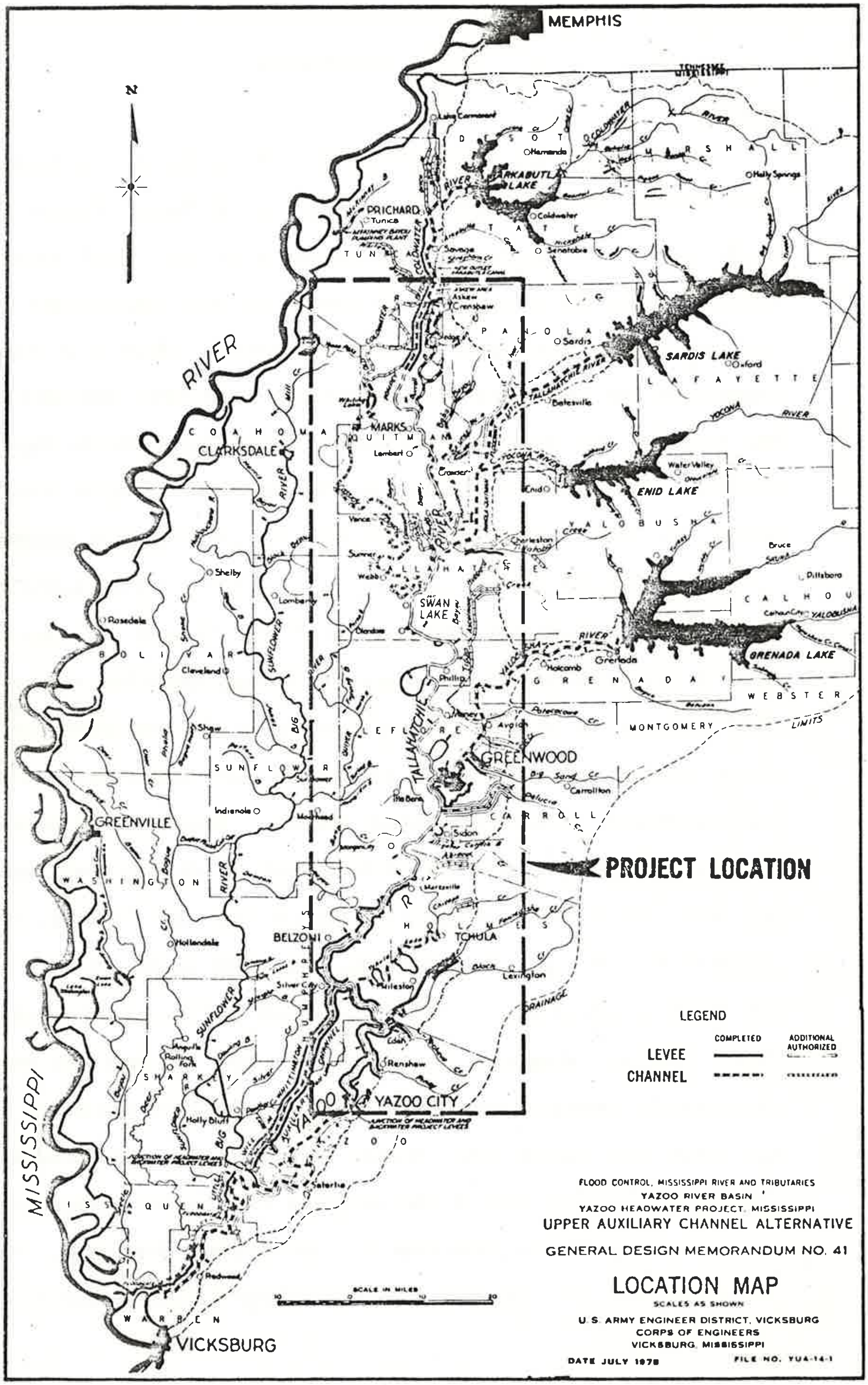

Figure 1. Project location map.

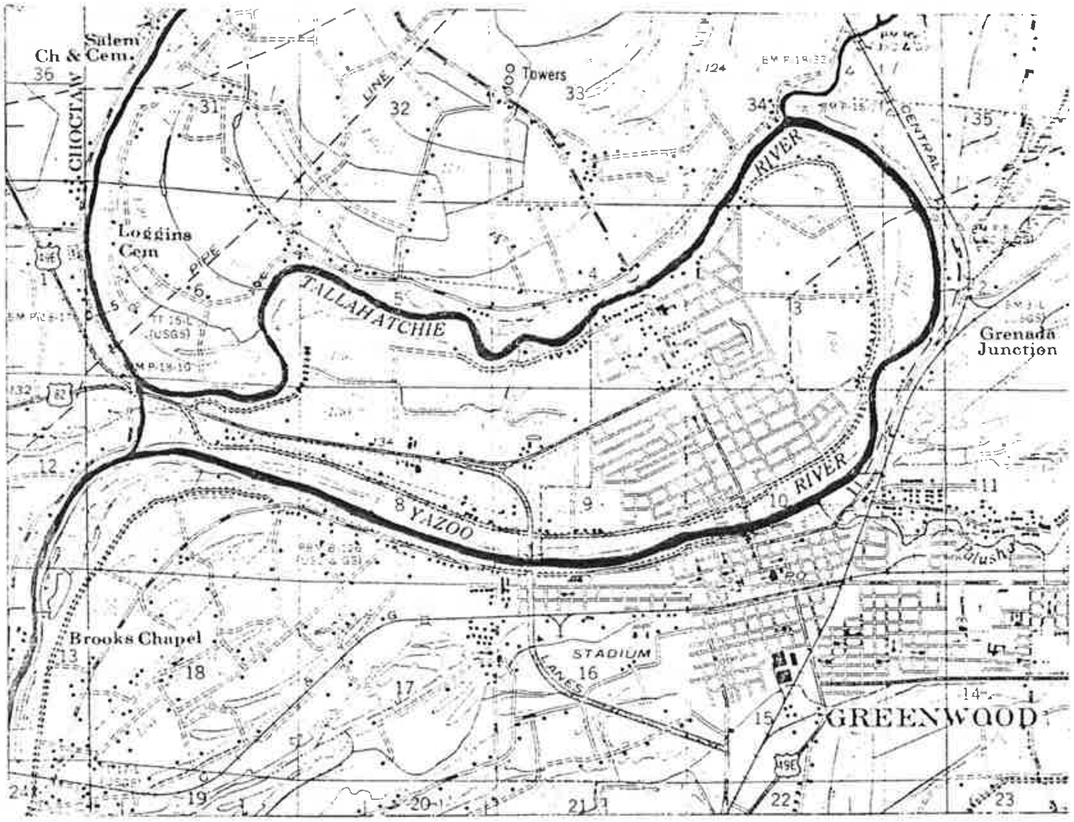

Figure 2. Map of Greenwood Bendway.

adequately transported and the Bendway aggrades. Because of this aggradation, the U.S. Army Corps of Engineers operated the cutoff with an earth plug. The plug was removed during high flow periods to reduce river stage, and rebuilt during low flow periods, so the increased discharge would scour out the Bendway and keep it open. This study examines in detail the river and tributary response to several alternative solutions of both design and operation associated with the Bendway flood and sedimentation problems.

Alternative Runs

To identify the extent of sedimentation problems related to the Greenwood Bendway area, seven alternative runs were proposed. The alternative study runs were conducted by routing water and sediment through the Yalobusha, Yazoo and Tallahatchie Rivers, in the vicinity of the Greenwood Bendway, for a 50-year hydrograph utilizing various alternative plans. Run 1 from the Phase I Sedimentation Study of the Yazoo River Basin is used as the baseline condition (Simons, Li, Brown, Chen, Ward, Duong, and Ponce, 1978).

Five alternative runs of the Yazoo Basin Sedimentation Model for the Greenwood Bendway study were identified by the U.S. Army Corps of Engineers in their letter dated March 30, 1978. Two additional runs were identified by the Corps of Engineers after reviewing the Progress Report of February 1979 which contained the results of the first five alternative runs. All runs used a 50-year weekly hydrograph for 11 years of observed data and 39 years of generated flows. All runs used the known discharge sediment routing model developed in Phase I. Run 1 and runs A through G are listed below.

Run 1--Baseline Conditions. Run 1 from Phase I of the Sedimentation Study of the Yazoo River is used to represent baseline conditions. In this run the channel is unaltered and the Ft. Pemberton cutoff is only opened for mainstem flows exceeding 25,000 cfs. These conditions closely model the present circumstances in the Bendway area. The earthen plug in the cutoff is removed when mainstem discharge approaches 25,000 cfs (mean weekly flow) and is replaced as soon as possible after the flood event passes.

Run A--Existing Conditions with Cutoff Open. This run models existing conditions in the Bendway, except that the Ft. Pemberton cutoff is assumed open and unregulated.

Run B--Plan E Conditions with Cutoff Open. This run models conditions when Plan E of the Upper Yazoo Project is implemented upstream and downstream of the Bendway. The cutoff is assumed open and unregulated. While the modeling of Plan E conditions will reflect larger channel size, it also includes the downstream effects of the closure of the Marksville overflow and increased sediment inflow from Abiaca Creek assuming future channelization and levee plans are implemented. Upstream changes modeled include the Craigside Cutoff.

Run C--Regulated Cutoff. This run is identical to Run B except the cutoff is regulated by a control structure. The cutoff will be closed for all mainstem flows less than 25,000 cfs. For flows above 25,000 cfs the cutoff will be open.

Run D--Tallahatchie River Lake Plan. This run is the same as Run B except the portion of the Tallahatchie River from above the confluence of the Yalobusha to below the inlet of the Ft. Pemberton cutoff becomes a lake by the placement of dams at both ends. This, of course, implies that all mainstem flow passes through the cutoff and the Yalobusha flows into the lower Bendway.

Run E--Yazoo River Lake Plan. This run is the same as Run B except two dams will turn the Yazoo River portion of the Bendway into a lake. The Yalobusha flows into the Tallahatchie and the combined mainstem and Yalobusha flows pass through the cutoff.

Run F--Regulated Cutoff Modified. This run is identical to Run C except the cutoff is closed for all mainstem flows less than 15,000 cfs. For flows above 15,000 cfs the cutoff is open.

Run G--Yazoo Lake Plan Modified. This run is identical to Run E except the sediment inflow from Abiaca Creek is reduced by 50 percent of Plan E conditions and the crest elevation of the weir in the Ft. Pemberton cutoff is lowered to 100 ft M.S.L.

II. System Design

Overall System Design

The overall system design used in the Greenwood Bendway study is very similar to the design used in the Phase I study. The same temporal design was used for the generation of the 50-year hydrograph. The calibration did require a different temporal design because of data limitations and is described in the following section. Because this study is concerned with the Bendway area, the spatial design was modified to give a better resolution in the Bendway. To save computer costs the rest of the system was shortened by eliminating reaches above Swan Lake on the Tallahatchie and above Whaley on the Yalobusha. Figure 3 shows the spatial representation of the river system that was modeled in this study. While the Bendway and Phase I designs are different, it is believed their results will be comparable.

Temporal Design

As noted above, the temporal design for the 50-year hydrograph is the same as for the Phase I study (Simons, Li, Ward, and Duong, 1978). Since not all the data required by the Phase I design were available for the calibration period, a separate design was developed.

A set of average daily discharges was developed for the calibration period using 8:00 AM stages and stage-discharge relationships representative of 1977 conditions. Ninety average daily discharges were computed for days from January 1, 1977 through March 31, 1977. Discharges for the calibration period were then extracted from this set of 90 daily values.

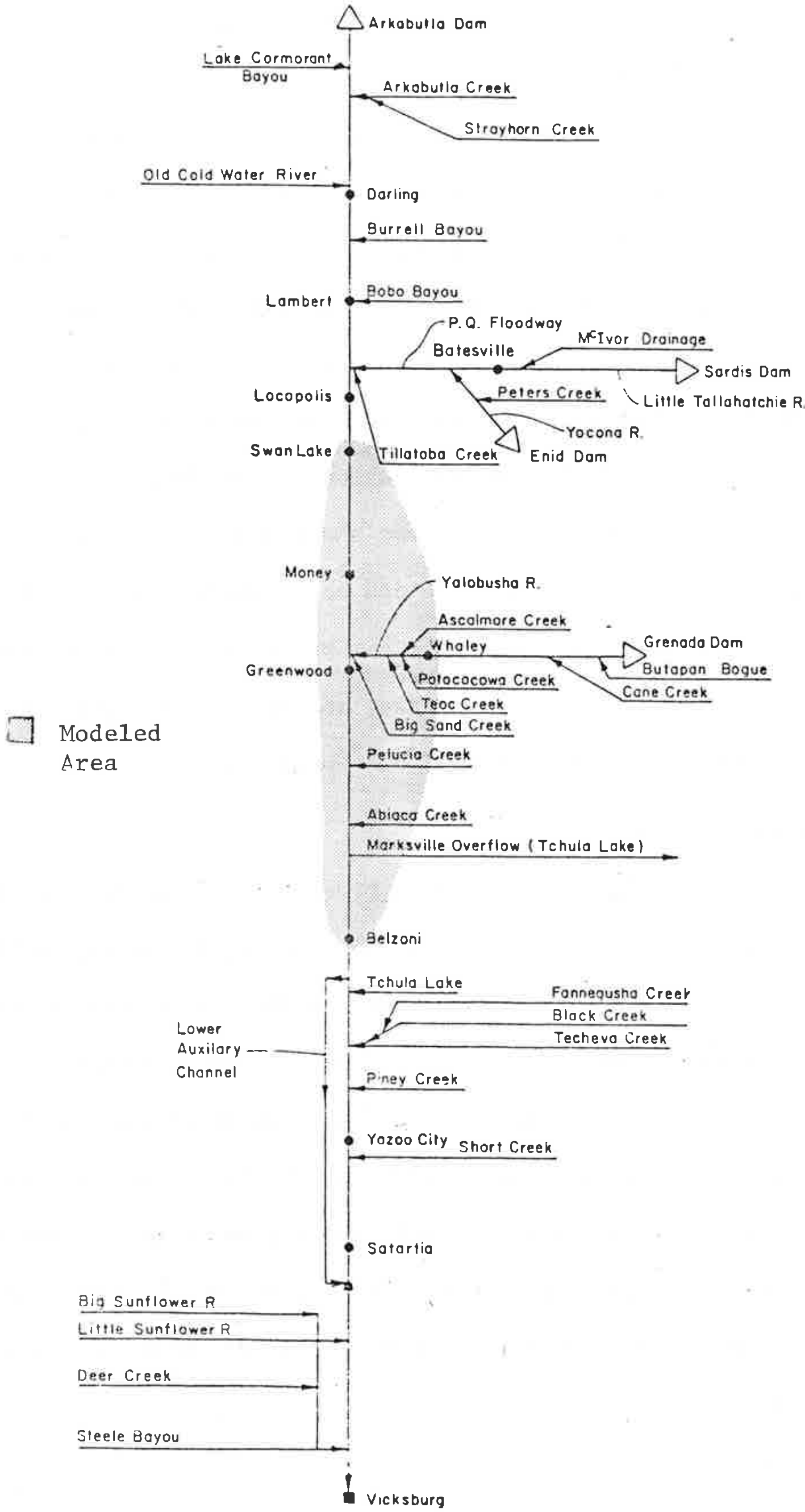

Figure 3. Spatial design of the Greenwood Bendway study.

Stage readings for key stations in this study were provided by the U.S. Army Corps of Engineers. Some records were missing a few values that were estimated by interpolation and/or by comparison with other stations. Missing stages for Ascalmore Creek were estimated using a linear relationship between Ascalmore Creek and Big Sand Creek stages. The Yalobusha River at Whaley stages correlated well with the Yazoo River at Greenwood stages. The correlation was much better than with the Yalobusha River at Grenada (Highway 51) stages. In this case the former relationship was used to estimate stages.

The 8:00 AM stages were converted to discharge using stage-discharge equations developed specifically for this study. Because the calibration period was in 1977, only measured stages and discharges for that year were used to develop relationships at the various stations, if the number of measurements was sufficient. In only three cases were the data sufficient to warrant a new stage-discharge equation. In other cases an updated equation was developed by incorporating all available data from 1964 to 1977. Addition of this data yielded an updated equation previously used in the Yazoo River Sedimentation Study (Simons, Li, Ward, and Duong, 1978). Four equations remained unchanged since they were obtained from Corps of Engineers curves. The stage-discharge equations used in development of 8:00 AM discharges are listed in Table 1. This table indicates that the stage-discharge relationship at some stations can be represented by a power curve of the form $Q = a(S+c)^b$, a linear type of the form $Q = MS+K$ or a combination of both. Comparison of the updated equations for Whaley and Money show that the parameters used here are similar to those in the previous study (Simons, Li, Brown, Chen, Ward, Duong and Ponce, 1978).

Table 1. Stage-discharge relationships used for generating calibration flows--Q is discharge, S is stage

Station	Stage-discharge relationship	Remarks
Yazoo River at Balzoni	$Q = 46.188\ S^{1.822}$	1977 only
Abiaca Creek[1]	$Q_1 = 30.59\ (S-4)^{2.120}$	$S \leq 16.40$
	$Q_2 = 2433.33\ (S) - 33533.33$	$S > 16.40$
Pelucia Creek[1]	$Q_1 = 58.843\ (S-7.5)^{2.3736}$	$S \leq 14.12$
	$Q_2 = 2485.71\ S-29885.71$	$S > 14.12$
Yazoo River at Greenwood	$Q = 2.321\ S^{2.755}$	1977 only
Ascalmore Creek[1]	$Q_1 - 8.492\ (S-1)^{2.615}$	$S \leq 7.17$
	$Q_2 = 1161.564\ S - 7339.465$	$S > 7.17$
Big Sand Creek[1]	$Q_1 = 30.478\ (S-1.5)^{2.64}$	$S \leq 5.64$
	$Q_2 = 1928.575\ S-9571.43$	$S > 5.64$
Yalobusha River at Whaley[2]	$Q_1 = 0.297\ S^{3.233}$	$S \leq 25.46$
	$Q_2 = 11892.28\ S-292533.85$	$S > 25.46$
Tallahatchie River at Greenwood	$Q = 737.68\ S-10739.12$	$S > 14.56$
Tallahatchie River at Money[2]	$Q = 48.013\ (S-3)^{1.760}$	
Tallahatchie River near Swan Lake	$Q = 47.486\ S^{1.743}$	1977 only

[1]COE Rating Curve

[2]Updated equation

Flows for ungaged point sources of Teoc and Potococowa Creeks were computed from values of Ascalmore and Big Sand Creeks based on discharge per unit area. Discharge values for ungaged point sources were computed from

$$Q_{UG} = \frac{A_{UG}}{N} \sum_{J=1}^{N} \left[\frac{Q_G^J}{A_G^J} \right] \tag{1}$$

where Q_{UG} is the discharge from the ungaged point source, A_{UG} is the area of ungaged watershed contributing to the site, Q_G^J is the discharge at the gaged site J, A_G^J is the watershed area contributing to gaged site J, and N is the number of sites used. In this study two gaged sites were used.

Non-point sources were computed for three reaches: Belzoni to Greenwood, Greenwood to Money (including Yalobusha up to Whaley), and Money to Swan Lake. Non-point source flows were computed by flow continuity or

$$Q_{NPS} = Q_{OUT} - \sum_{i=1}^{n} Q_{IN_i} \tag{2}$$

where Q_{NPS} is the daily discharge for the non-point sources, Q_{OUT} is the outflow station of the reach being processed, Q_{IN_i} is the individual inflow to the reach and n is the number of inflows. Statistics of the measured and synthesized discharges are presented in Table 2. Gaged, ungaged, and non-point sources computed for the above 90-day period were used as the base from which the calibration period was selected.

Because of high losses for the non-point source between Greenwood, Money, and Whaley, that non-point source was divided into two. One of

Table 2. Statistics of ninety calibration discharges--January 1, 1977 to March 31, 1977

Station	Mean (cfs)	Standard deviation (cfs)
Belzoni	8176	5313
Abiaca Creek	433	506
Pelucia Creek	986	1148
Yazoo at Greenwood	7810	6975
Big Sand Creek	349	1859
Teoc Creek	112	359
Potococowa Creek	218	699
Ascalamore Creek	64	279
Yalobusha at Whaley	1856	1523
Tallahatchie at Greenwood	4681	3377
Money	6029	4190
Swan Lake	4534	3179

these was the difference in flow between Money and the Tallahatchie River at Greenwood, and the second was the difference between Greenwood, Whaley, and the Tallahatchie River at Greenwood.

Spatial Design

The spatial design utilized is very similar to the Phase I design (Simons, Li, Brown, Chen, Ward, Duong, and Ponce, 1978). There are basically two differences between the Bendway and Phase I designs. First, the resolution was increased in the Bendway by the addition of more cross sections. These additional sections reduce the cross-section spacing in the Bendway to an average of 1/2 mile, the minimum possible spacing for the present model since the model cannot simulate sediment diffusion and other processes particular to a small simulation space interval. Figure 4 shows the location of cross section measurements in the area. The second change was the elimination of reaches far from the Bendway. Calculations were performed from Belzoni to Swan Lake on the Tallahatchie and just above Whaley on the Yalobusha. Swan Lake and Whaley were chosen as boundary points for this study since the Phase I analysis showed these locations to be fairly stable.

One minor change from Phase I is that instead of using a sediment rating curve, backwater calculations were carried a short distance up Big Sand Creek to obtain a more accurate estimate of its sediment discharge. No sediment routing was done since the Big Sand has a large number of check dams on its lower end; and its bed is fairly stable except for the migration of bed forms.

Appendix A contains schematics that show the location of all cross sections, major tributaries, point source tributaries, and non-point sources. Appendix B lists the identification number for each cross section used by the model in each alternative run.

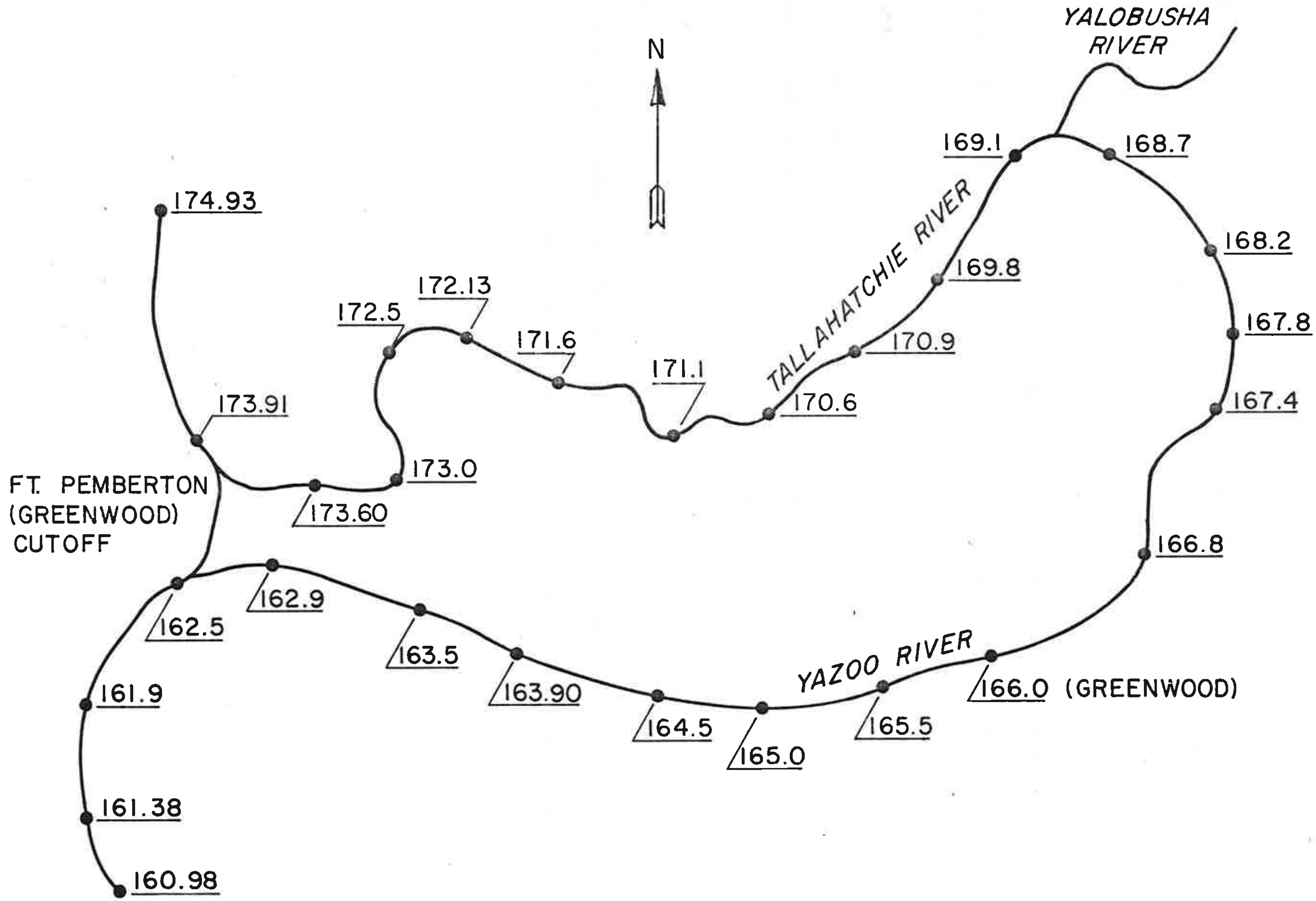

Figure 4. Cross-section locations for the Greenwood Bendway.

III. Calibration

General

The Greenwood Bendway Model was calibrated for Manning's n only. The sediment transport equations for the mainstem and tributaries utilized in the Phase I study were directly applied. No calibrations on sediment transport rates were made because of the short period of record. The point-source tributary sediment transport rates were calibrated in Phase I by adjusting the sediment discharge power functions until the mainstem bed at the tributary confluences became stable in Run 1. The mainstem sediment transport was calculated by a transport equation derived from Yazoo River sediment discharge measurements.

During the first week in 1977, the Ft. Pemberton cutoff was closed by an earthen plug for the first time in years, and the entire mainstream flow was forced through the Bendway. For ten weeks following the closure of the cutoff the U.S. Army Corps of Engineers conducted detailed cross-sectional surveys in the Bendway, cutoff, and Yalobusha Rivers approximately every two weeks. During these ten weeks, a large amount of aggradation and degradation was observed. It was determined to use this period to calibrate and verify the model.

For the calibration and verification period, flow records at all stations required by the Phase I temporal design were not available. Consequently, a new temporal design was formulated for the calibration and verification period to generate the missing data. Furthermore, during this period, a keyway was dredged in the Bendway. The exact location and volume of dredging would be required for calibration. Appendix C contains the dredging records of the two dredges operating in the Bendway.

The importance of dredging to river response cannot be underestimated. Figure 5 shows the thalweg elevation with respect to time at one cross section, P.R. 169.4. The cross section was dredged on approximately January 10. Within one week the section had filled to its original elevation. This rapid response can drastically affect sediment transport up and downstream of the dredged area. Because of the dredging activity, the Manning's n-value calibration period was reduced to 31 days, the period from February 15 to March 18 when no dredging was recorded. Since the Phase I sediment calibration result was used, once the Manning's n-value was calibrated it was possible to verify the sediment transport during the same time period of February 15 to March 18.

Results

The Greenwood Bendway Model was calibrated by adjusting Manning's n so that observed and computed stages at Greenwood, Tallahatchie at Greenwood, and Swan Lake matched as closely as possible. Manning's n was considered to be both a function of discharge and of river reach; the results are shown in Table 3. Considering the wide range of flows

Table 3. Error Computed and Measured Stage

	Error in Stage in Feet		
	Minimum	Mean	Maximum
Yazoo at Greenwood	0.04	0.55	0.98
Tallahatchie at Greenwood	0.01	0.35	0.76
Swan Lake	0.01	0.44	1.76

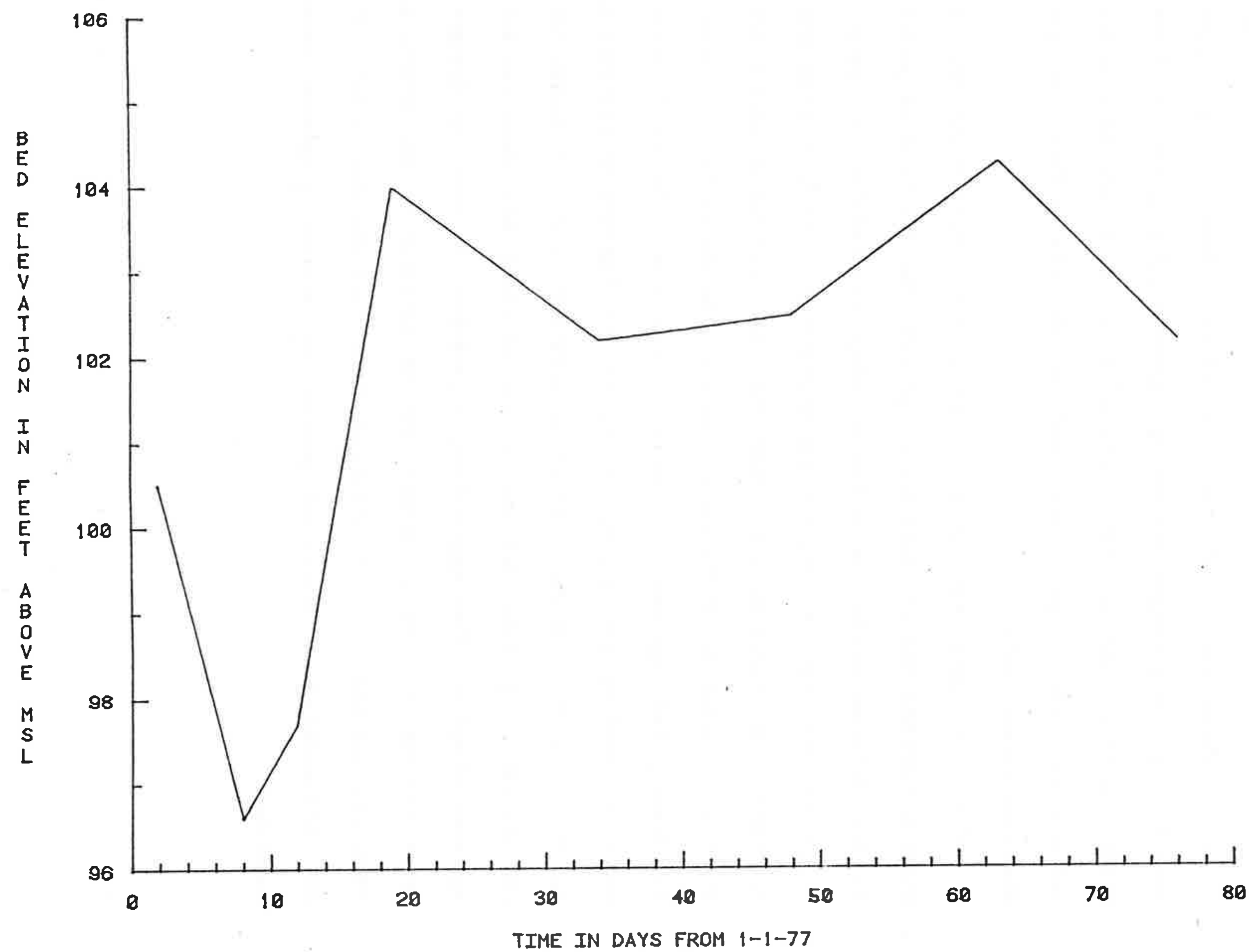

Figure 5. Thalweg elevation at P.R. 169.4.

during the simulation (3,500 to 25,000 cfs at Greenwood) the average error of approximately 0.45 feet is excellent. Manning's n varied from 0.023 to 0.026 between Belzoni at Greenwood and from 0.030 to 0.031 between Greenwood and Swan Lake. Figures 6, 7, and 8 show the computed and observed river stage at Greenwood, Tallahatchie at Greenwood, and Swan Lake respectively.

Figure 9 shows the computed and observed bed elevations in Greenwood Bendway for the verification period. The verification period for bed elevation is the same as the calibration period for river stage. It can be seen that the computed and observed profiles have reasonable agreement. It should be remembered that the verification period was started six weeks after the cutoff closure. In the initial six weeks the Bendway had experienced a general degradation. In one location below the mouth of the Yalobusha River the bed degraded from elevation 125 MSL to 95 MSL. By the start of the verification period, though the bed had generally stabilized most of the observed data shows the bed aggraded slightly. This aggradation is probably the result of dredged areas filling in. As a further test of validity of the model, a comparison was made of the locations of degradation and aggradation. It was determined that sixty-five percent of correct responses were simulated.

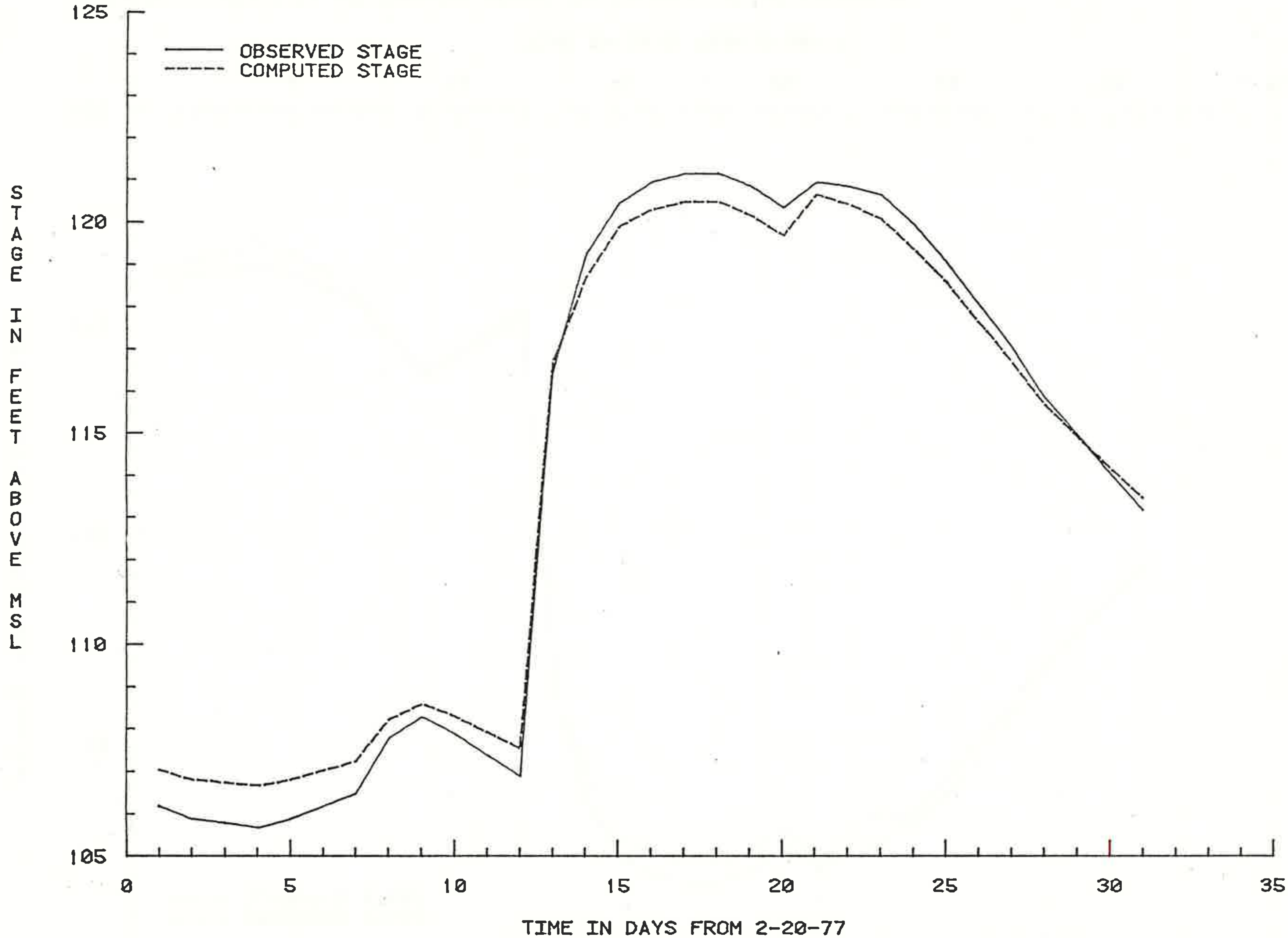

Figure 6. Observed and computed stages for Greenwood Bendway.

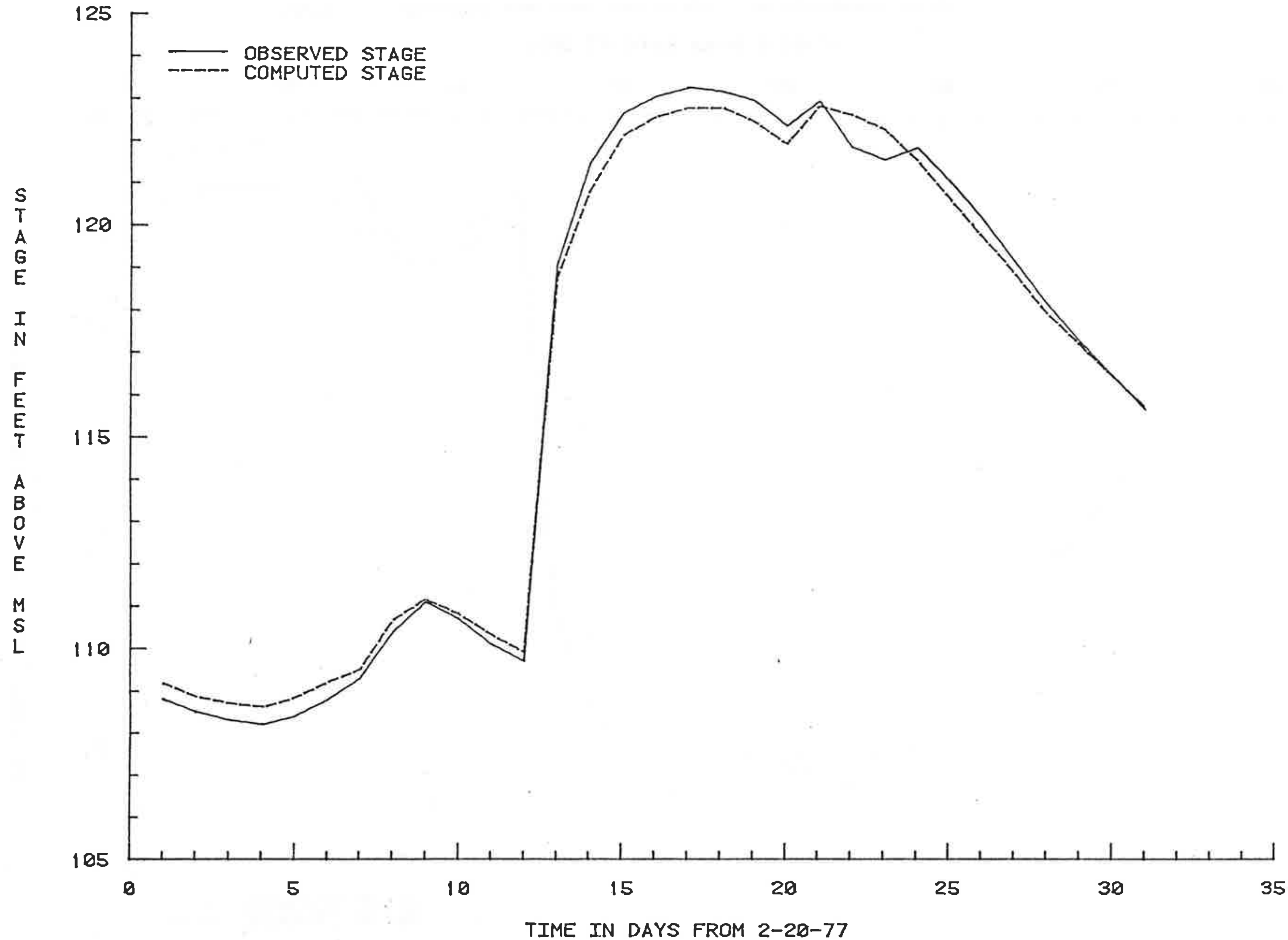

Figure 7. Observed and computed stages for Tallahatchie at Greenwood.

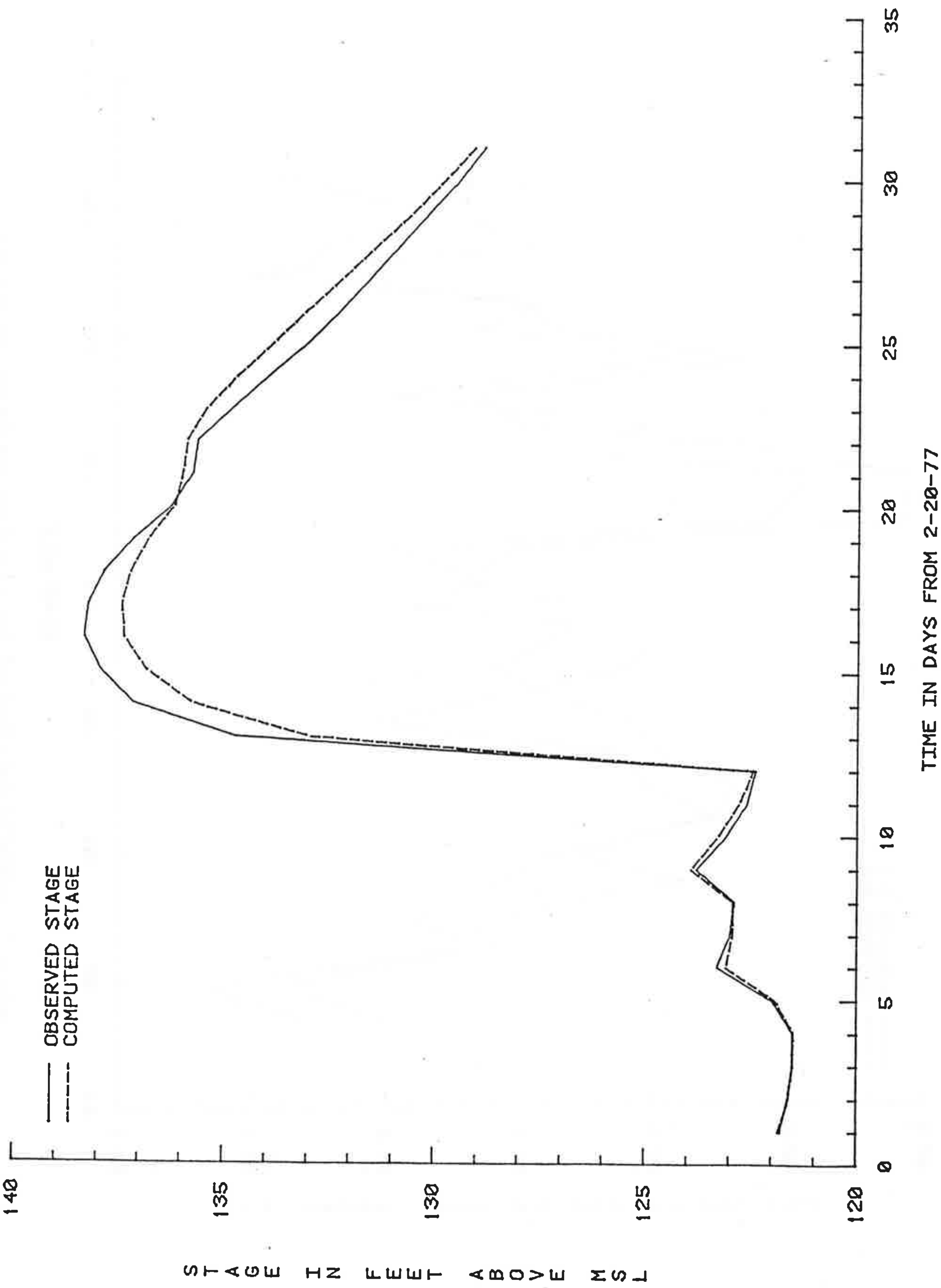

Figure 8. Observed and computed stages for Swan Lake.

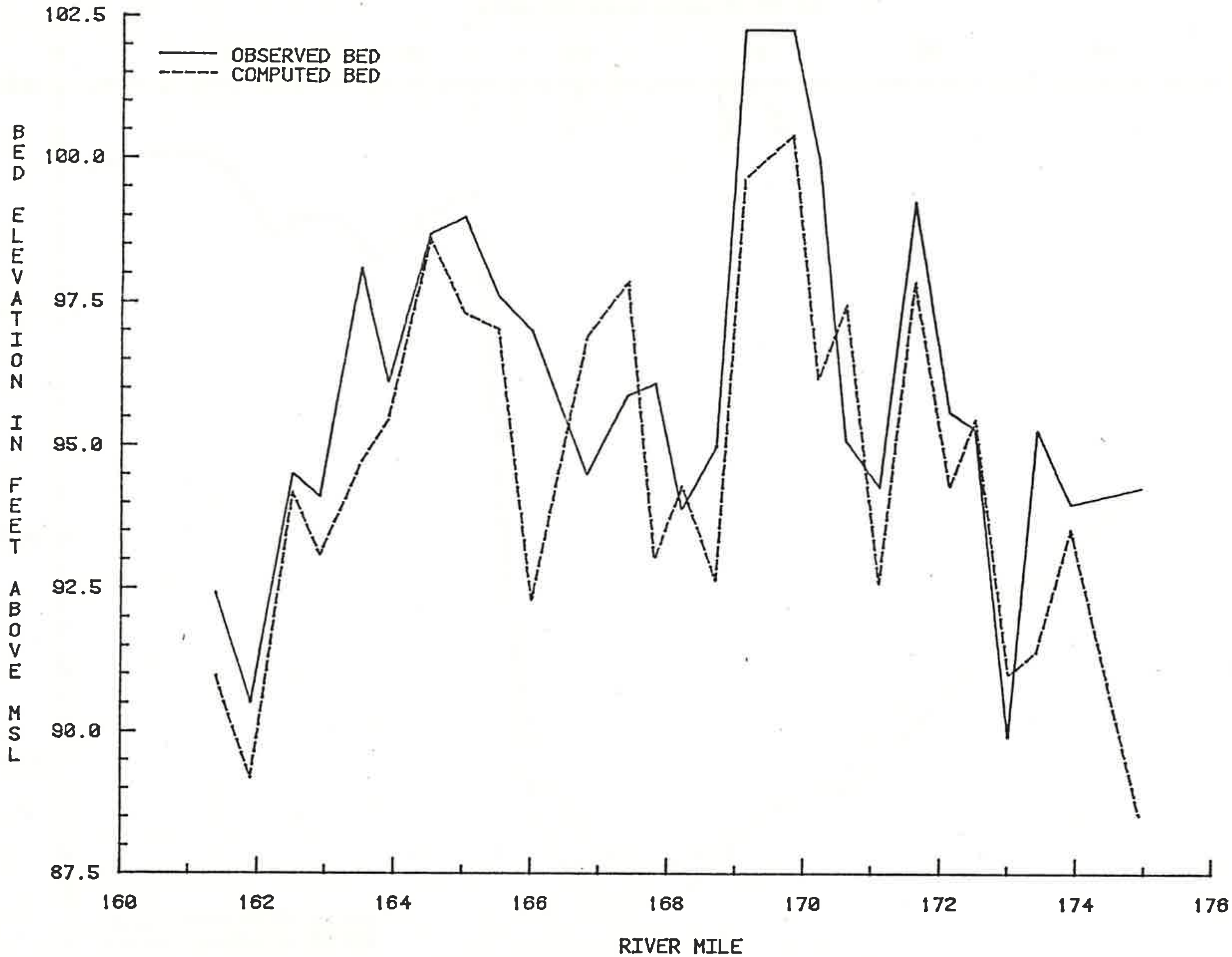

Figure 9. Computed and observed bed elevation for Greenwood Bendway.

IV. Alternative Evaluation

General

As mentioned in Section II the spatial representation used in the Greenwood Bendway study is similar to the design used in Phase I, Yazoo River Basin Sedimentation study. Water and sediment calculations started at Belzoni on the Yazoo River, and extended up to Swan Lake on the Tallahatchie River and to Whaley on the Yalobusha River.

The actual spatial designs differ slightly between the different alternatives. Nevertheless, the river segments were identified by the same designation system in each run. Referring back to Figure 2, River Segment No. 1 extends on the Yazoo from Belzoni to just below the Bendway. River Segment No. 2 is the Yazoo River in the Bendway and extends from the confluence with the Greenwood cutoff to the confluence of the Yalobusha River. River Segment No. 3 is the Tallahatchie River in the Bendway and extends from the confluence of the Yalobusha to the inlet of the cutoff. River Segment No. 4 extends on the Tallahatchie River from the inlet of the cutoff to Swan Lake. The Yalobusha River from its confluence with the Yazoo to Whaley is River Segment No. 5 and the Ft. Pemberton cutoff (Greenwood cutoff) is River Segment No. 6.

Baseline Conditions

Run 1 of the Phase I Sedimentation Study of the Yazoo River Basin is used as the baseline conditions, since it closely reflects existing conditions. In this run the cutoff is opened for flows exceeding 25,000 cfs and closed for flows less than that amount. The channel is unaltered. Table 4 lists the aggradation (positive) and degradation (negative) in each reach for each run. There were small amounts of

Table 4. Net Aggradation and Degradation under Different Design Conditions (aggradation positive, degradation negative)

	River Segment Volume in thousand cubic yards					
Alternative	1	2	3	4	5	6
1. Existing conditions	1941	598	-153	4713	24	-48
A. Existing conditions with cut-off open	-5262	2273	1819	666	592	21
B. Plan E	19902	2949	2104	2387	1114	252
C. Regulated cutoff (25,000)	25215	-1572	-492	5357	941	27
D. Tallahatchie Lake	20320	2828	Lake	3622	974	410
E. Yazoo Lake	20036	Lake	1590	2331	949	136
F. Regulated cutoff (15,000)	24119	-2072	-404	5451	1354	276
G. Yazoo Lake Modified	14145	Lake	1342	1408	689	114

aggradation in reaches 1, 2, 4, and 5, while reaches 3 and 6 experienced small degradation. Overall the bed is fairly stable during the 50 years of simulation. Figure 10 shows the original and final bed profiles and the maximum water surface elevations for the run. As can be seen the bed was fairly stable during the simulation.

The water surface elevations plotted in Figure 10 are maximum values at each cross section during the 50 years of simulation. These values do not necessarily occur at the same time at all locations and may not have taken place during the period of maximum discharge. The downstream water surface and the long-term sediment movement in the system will dictate local water surface elevations.

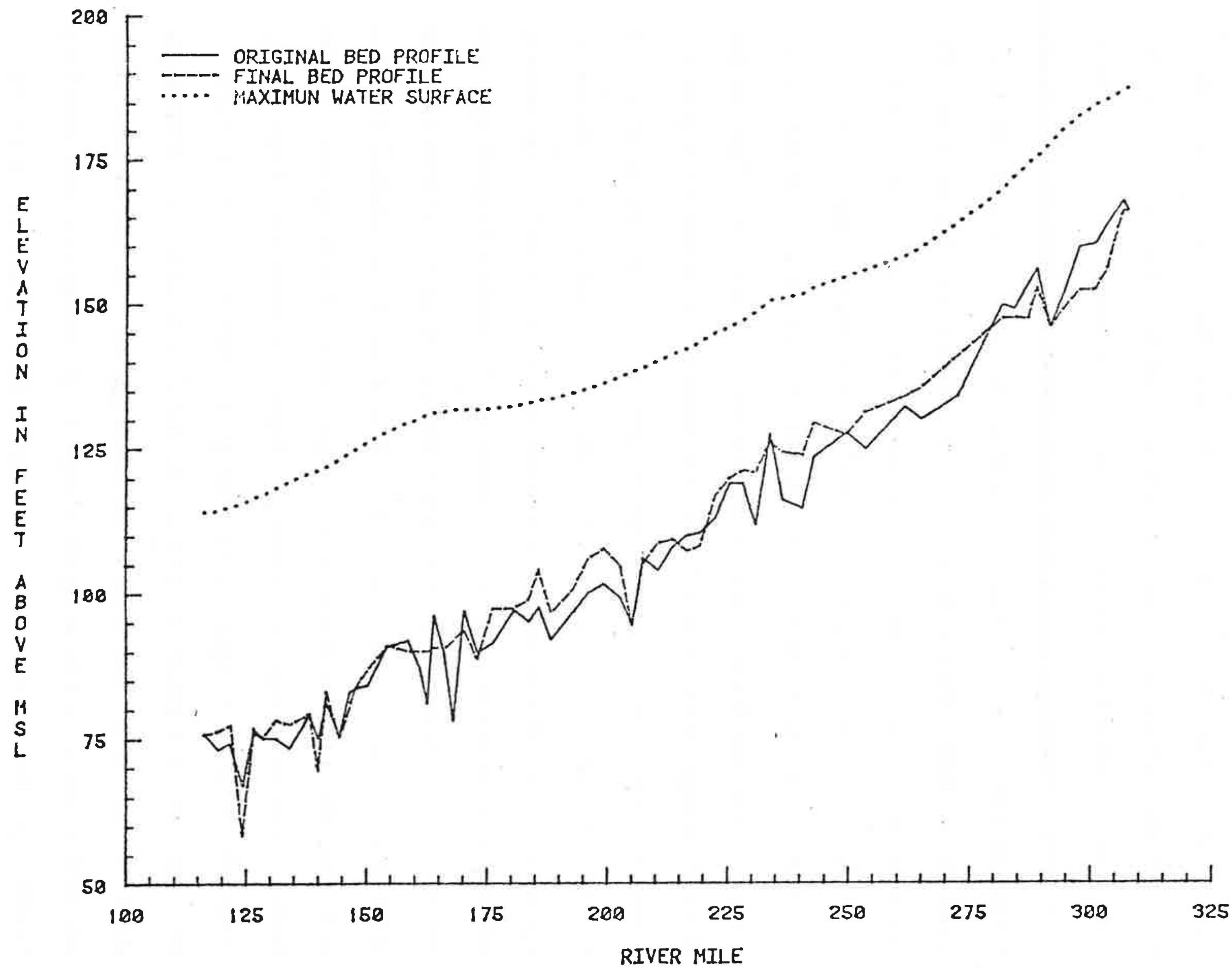

Figure 10. Beginning and final bed profiles and maximum surface elevations for natural conditions (Run No. 1).

Run A--Existing Conditions with Cutoff Open

Run A is an evaluation of existing conditions in the Bendway with the exception that the cutoff is assumed open during the entire simulation. Figure 11 shows the net aggradation and degradation with time for each segment under Run A conditions. As can be seen in the figure there is a small amount of aggradation in the Bendway, Tallahatchie River, Yalobusha River, and the cutoff (segments 2, 3, 4, 5, and 6), while the lower Yazoo River (River Segment No. 1) experiences degradation. The aggradation on the Yalobusha is caused by the large sediment inflows from Big Sand, Teoc, Ascalmore and Potococowa Creeks. The scour on the Yazoo River (River Segment No. 1) is the response to the Bendway trapping sediment upstream. This scour produced a slight reduction in the stage-discharge relationship below the Bendway, as shown in Figure 12. Figure 13 shows the change in time of the Yazoo River bed profile from Belzoni to just below the Bendway. As can be seen, the trapping of sediments upstream causes a degradation which starts below the Bendway and moves downstream. While the amounts of sediment trapped upstream are small, they appeared to have moved the system past a threshold value which started the degradation. The aggradation in the Bendway combined with the degradation downstream brought about little change in the Bendway stage-discharge relationship. Figure 14 shows the change in the stage-discharge relationship with time at Greenwood. It is important to note that the discharge plotted is the total discharge past Greenwood, which is the sum of the Bendway and cutoff flows. As can be seen there are some changes in the stage-discharge relationship for flow less than 15,000 cfs during the period of simulation. However, there is no noticeable change for the high flows. There are large bed changes in

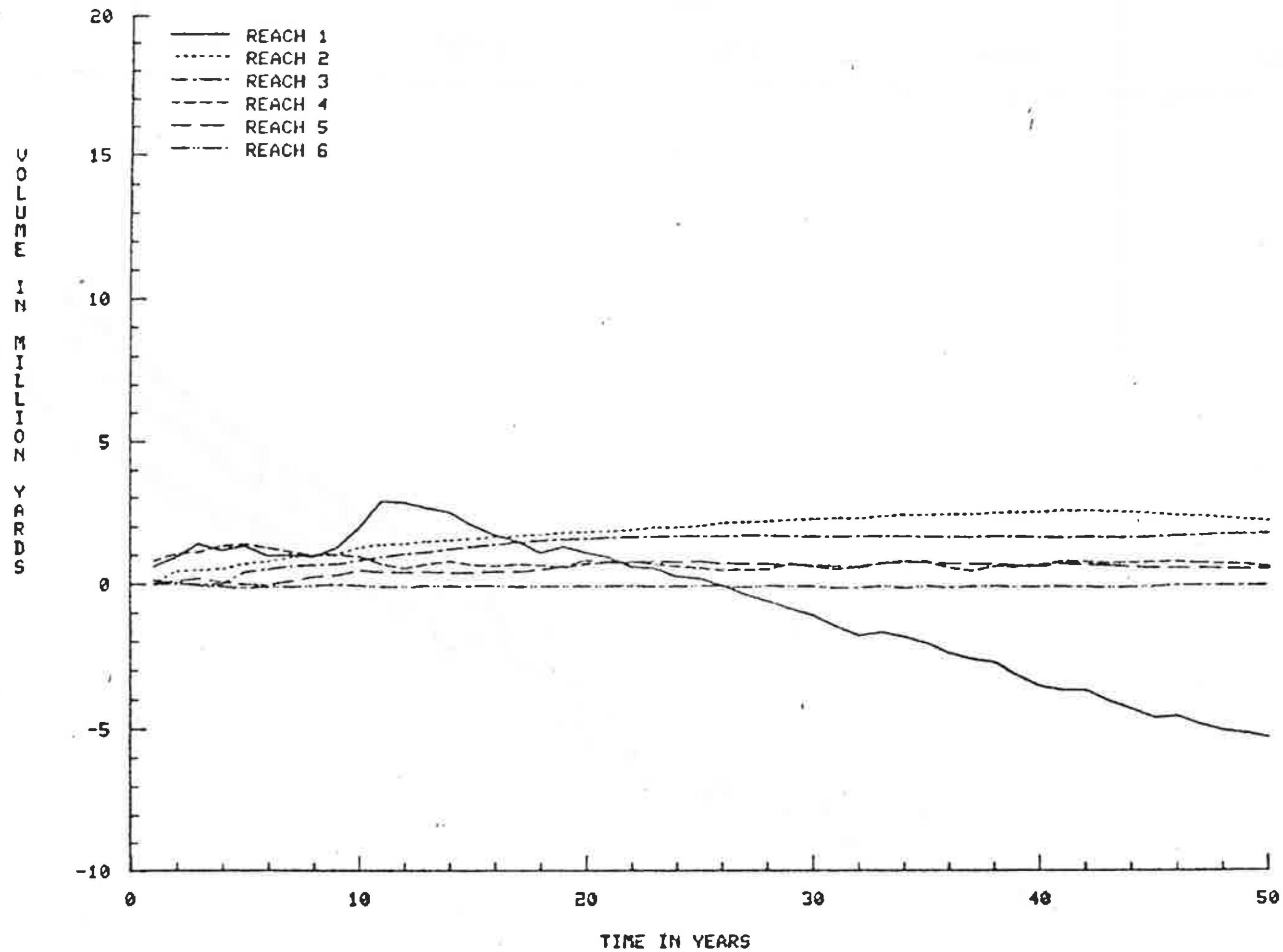

Figure 11. Aggradation (positive) and degradation (negative) in each reach for Run A.

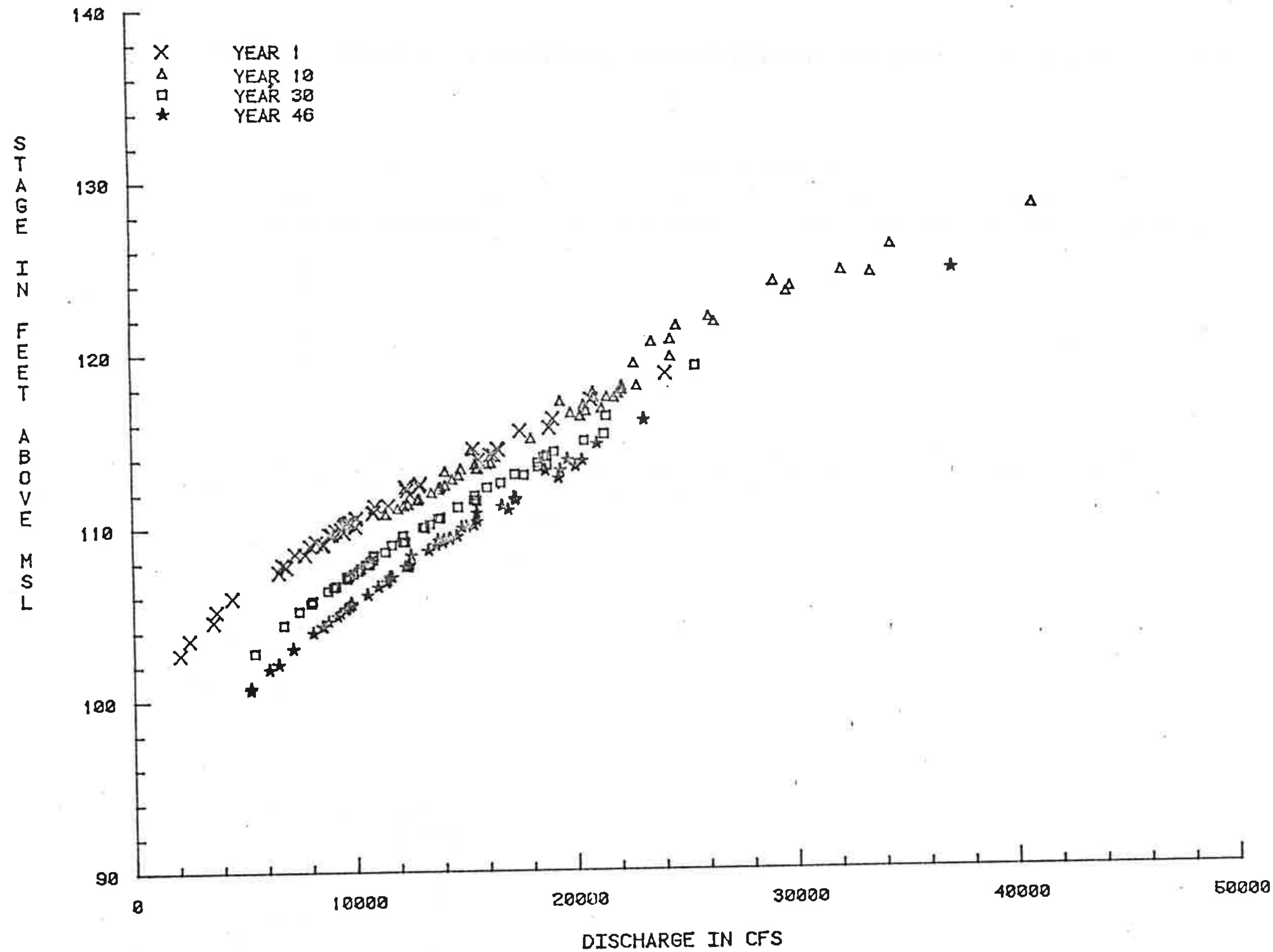

Figure 12. Stage-discharge relationship at River Mile 162.5 for Alternative A.

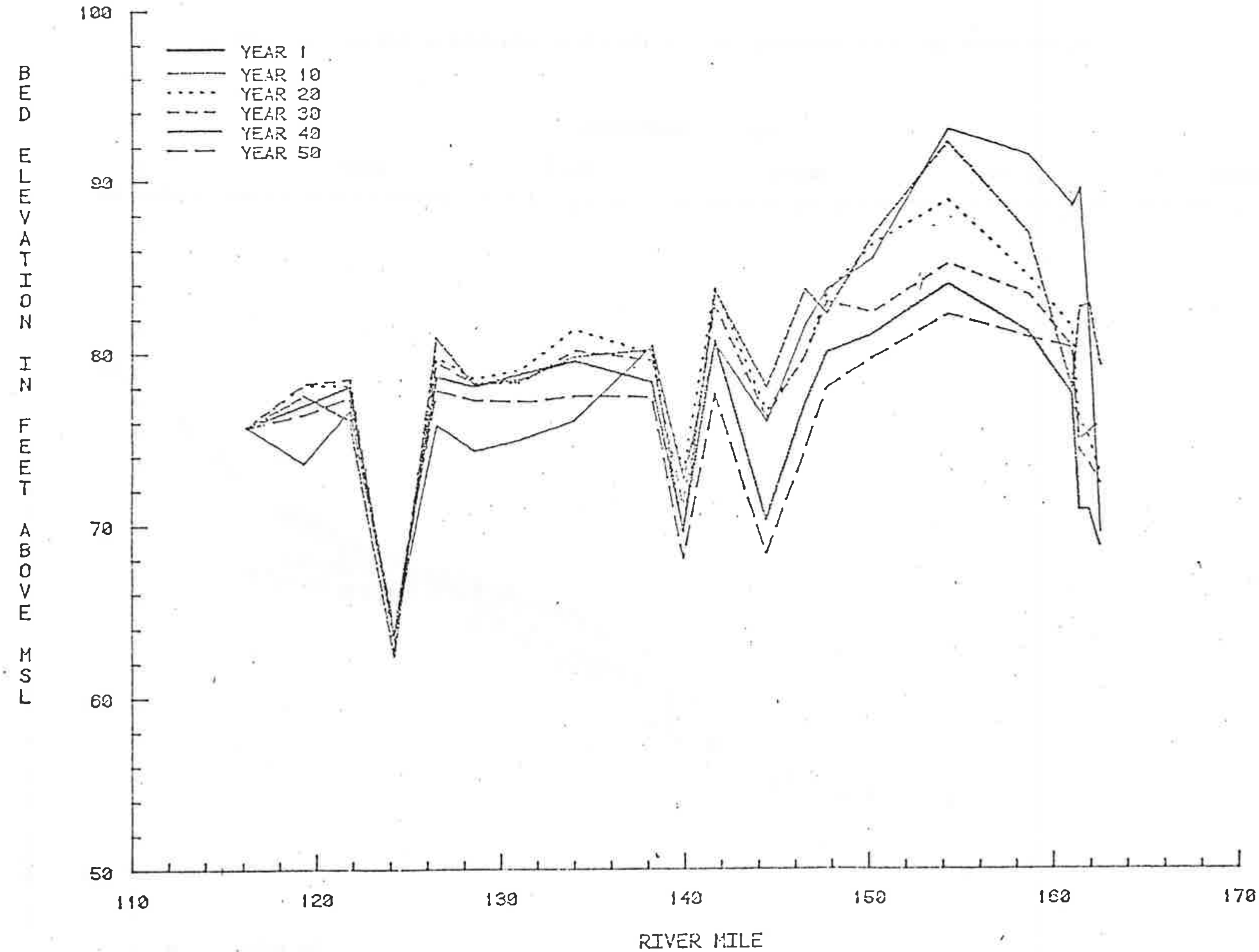

Figure 13. Yazoo River bed profile.

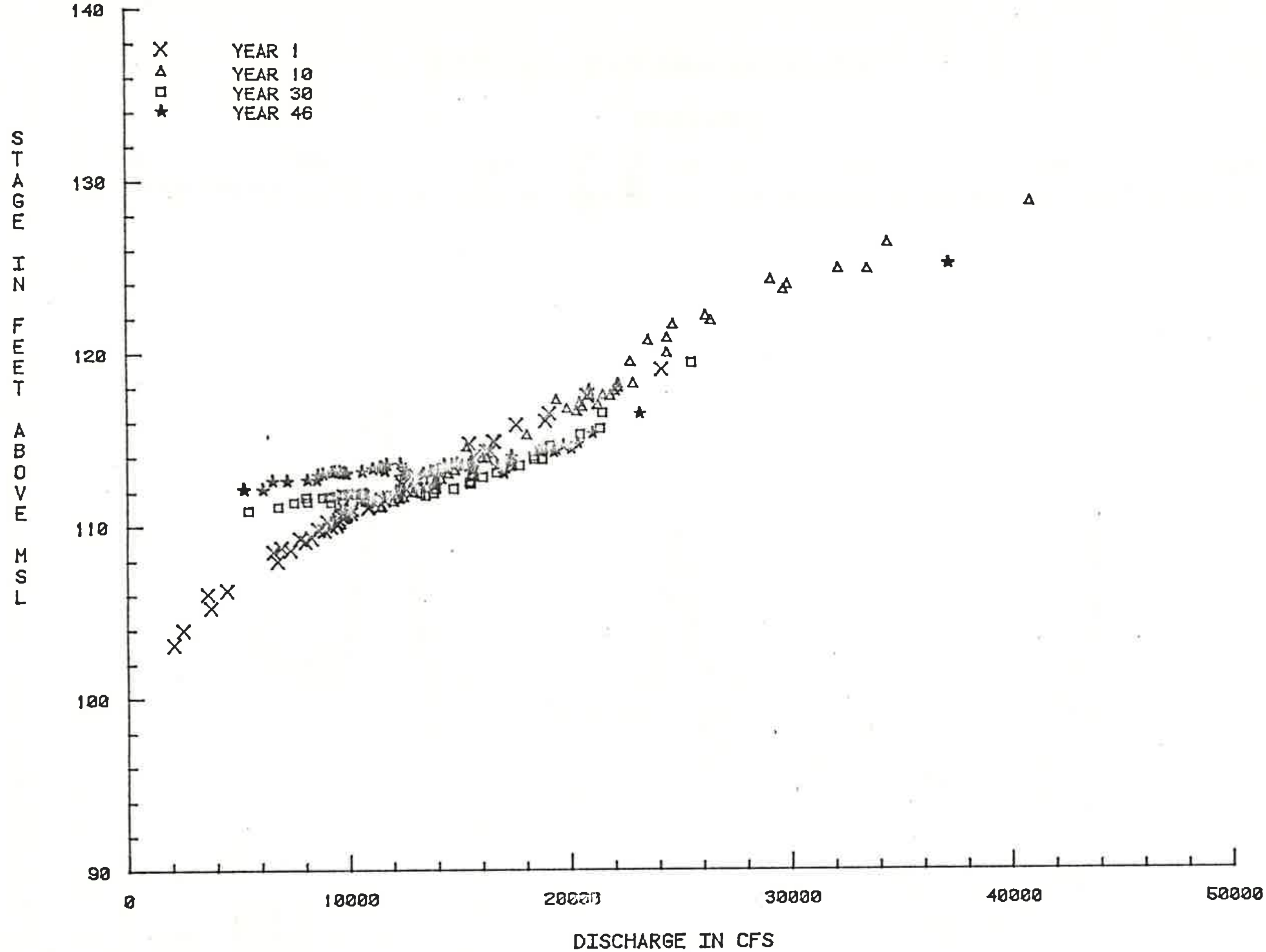

Figure 14. Stage discharge relationship at Greenwood for Alternative A.

the Bendway though, caused by the average 81,800 cubic yards per year deposited. The large difference between Run A results and those of Run No. 1 of the Phase I study is due to the assumption of the cutoff being open and unregulated in Run A of this study. Figure 15 shows initial and final bed elevation for the mainstem along with the maximum water surface profile. The Bendway aggrades up to 15 feet at some locations. While this aggradation has little effect on mainstem water surface elevations above the Bendway, it will cause increased stages on the Yalobusha and it can have serious water quality problems since it could clog sewage outfalls and drastically change the character of the Bendway during low flows.

Run B--Plan E Condition with Cutoff Open

Run B Considers Plan E conditions with the cutoff open and unregulated. The Yazoo River from Belzoni to below the Bendway changes from degradation to deposition. This is comparable to the results in the Phase I study. This deposition is caused in part by the larger channel size, but is mainly due to an increase in sediment supply of 500 percent from Abiaca Creek. The increase in sediment from Abiaca Creek was assumed to result from its proposed channelization and levee construction. Figure 16 shows the net aggradation in each reach for Run B. As can be seen all river segments have steady but decreasing deposition.

Figure 17 shows the beginning and final bed profiles as well as the maximum water surface elevations along the mainstem for Run B. This figure clearly indicates the impact of the increased sediment supply from Abiaca Creek. Figure 18 shows the maximum water surface elevation for Runs A through E. The water surface levels are generally higher than those for natural conditions for the reaches downstream of Money.

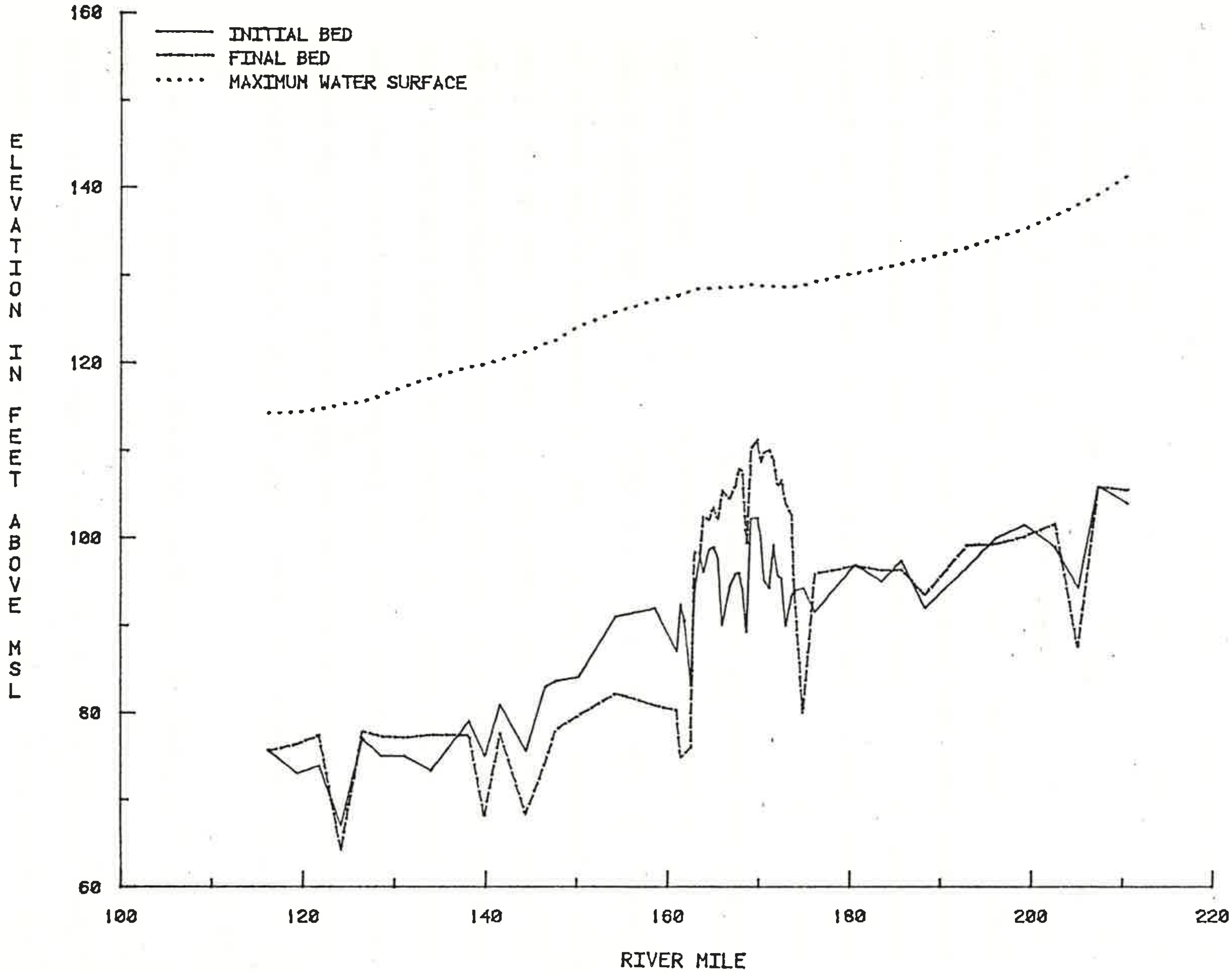

Figure 15. Initial and final bed elevation and maximum water surface elevation for Run A.

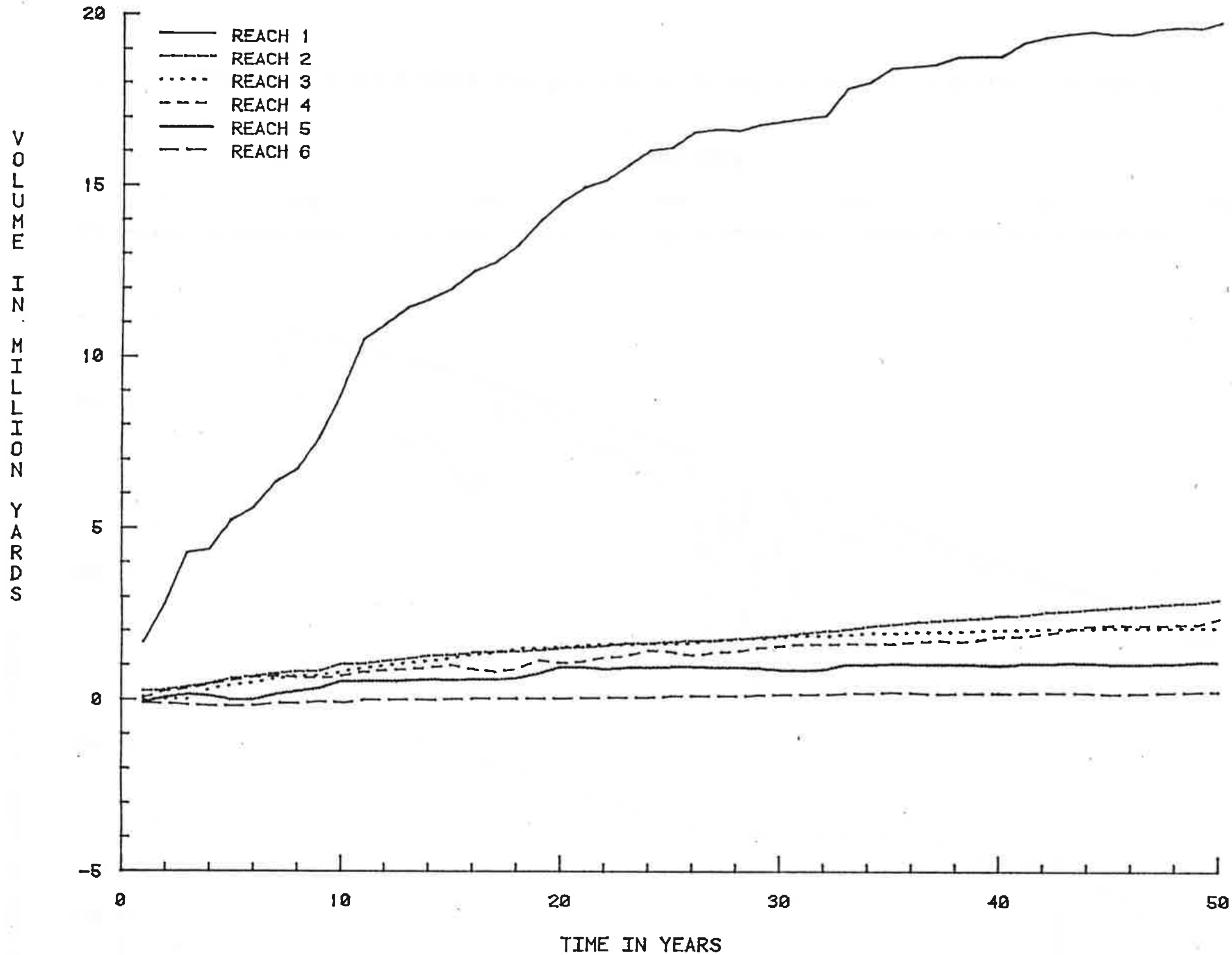

Figure 16. Aggradation (positive) and degradation (negative) in each reach for Run B.

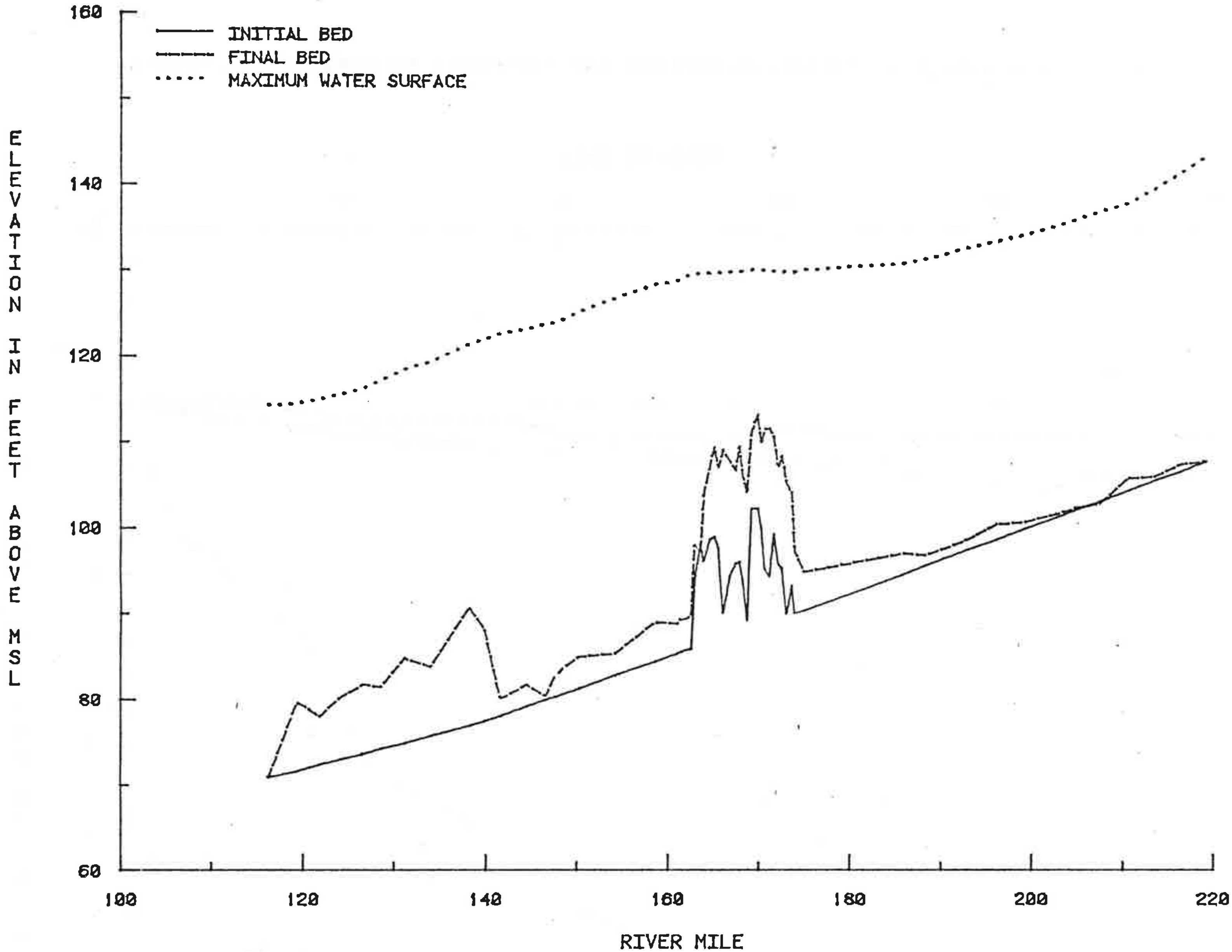

Figure 17. Initial and final bed elevation and maximum water surface for Run B.

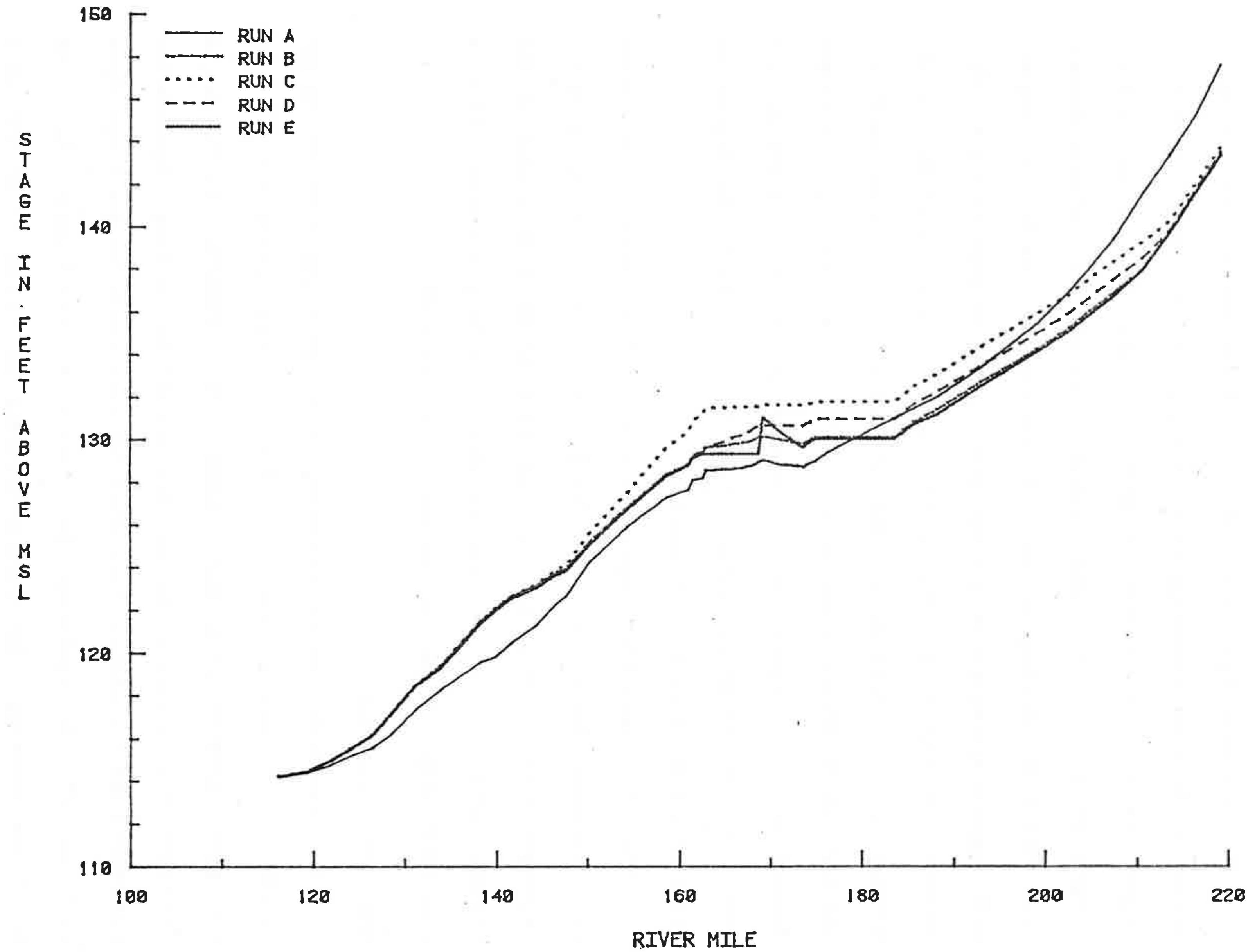

Figure 18. Maximum water surface elevations for each run.

The lowering of water surface level upstream of Money is primarily a result of the Craigside cutoff.

The increased deposition downstream of the Bendway causes a steady rising of the stage-discharge relationship in the Bendway as is shown in Figure 19. This illustrates the need for channel maintenance in River Segment No. 1 in order to make Plan E effective. The sediment deposition within the Bendway increases 23 percent over Run A. The Bendway will aggrade approximately 101,000 cubic yards per year in Run B. This increase in aggradation would, of course, increase problems in the Bendway as stated previously. The Tallahatchie River, Yalobusha River, and the cutoff (River Segments No. 4, 5, and 6) experience increased deposition. This deposition is caused by the increase in the average water surface elevation brought about by the significant deposition below Abiaca Creek in River Segment No. 1.

Figure 20 shows the computed flow at the Tallahatchie at Greenwood Gage (Permanent Range 171.1) for Run B. Reverse flow, or flow from the Yalobusha toward the cutoff, is signified by negative values in the figure. After a year the flow is always slightly reversed. This is consistent with the Corps of Engineers' observations.

Run C--Regulated Cutoff

This run tests the effectiveness of a regulating structure in the cutoff. The cutoff is closed for flows less than 25,000 cfs and open for flows greater than that amount. The seven-day discharge at Greenwood exceeds 25,000 cfs only 1.8 percent of the time. Aggradation (positive) and degradation (negative) for each reach for Run C are shown in Figure 21. By regulating the cutoff both River Segments No. 2 and No. 3 are scouring. The Bendway degrades an average of 41,300 cubic

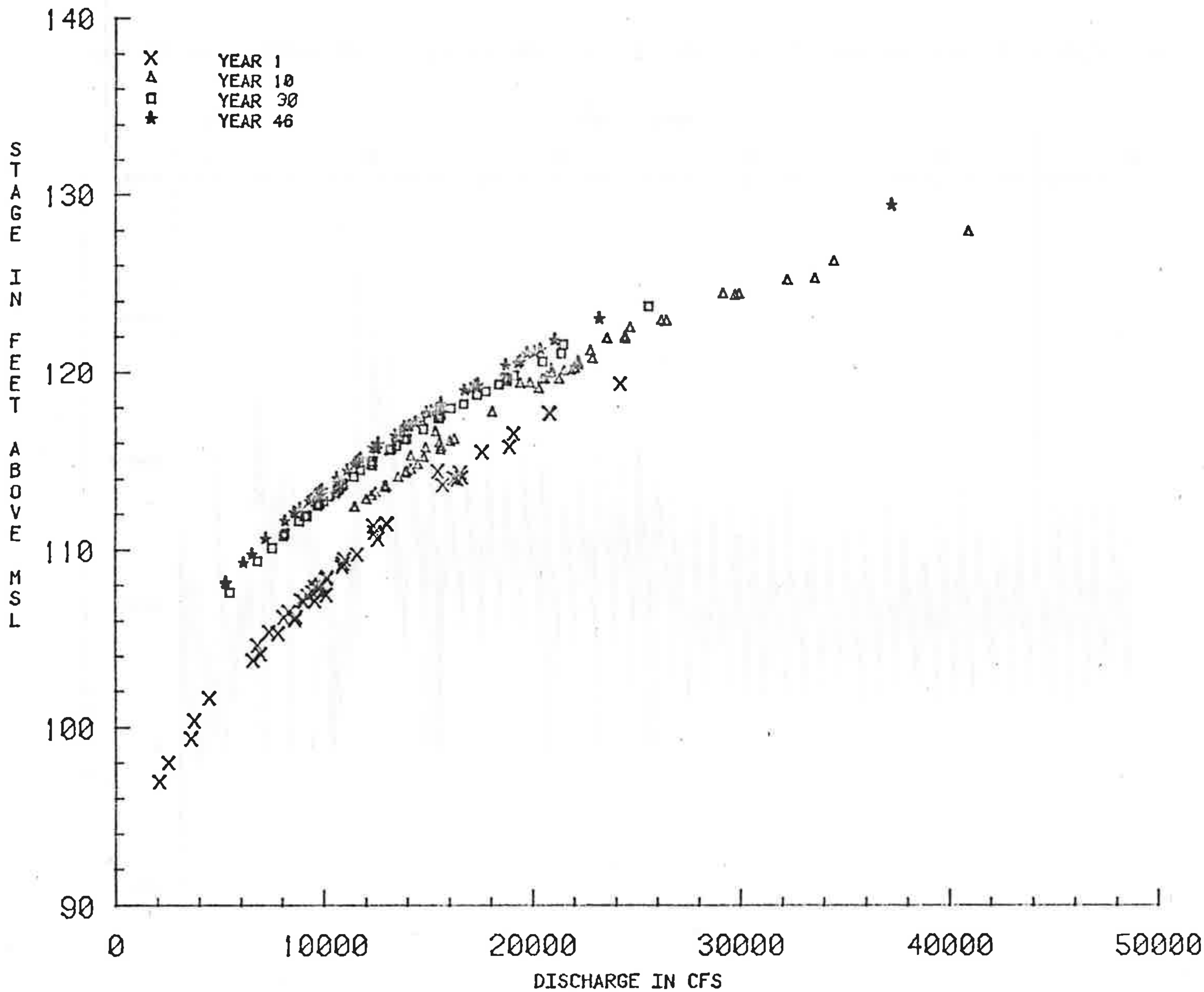

Figure 19. Stage-discharge relationship at Greenwood for Alternative B

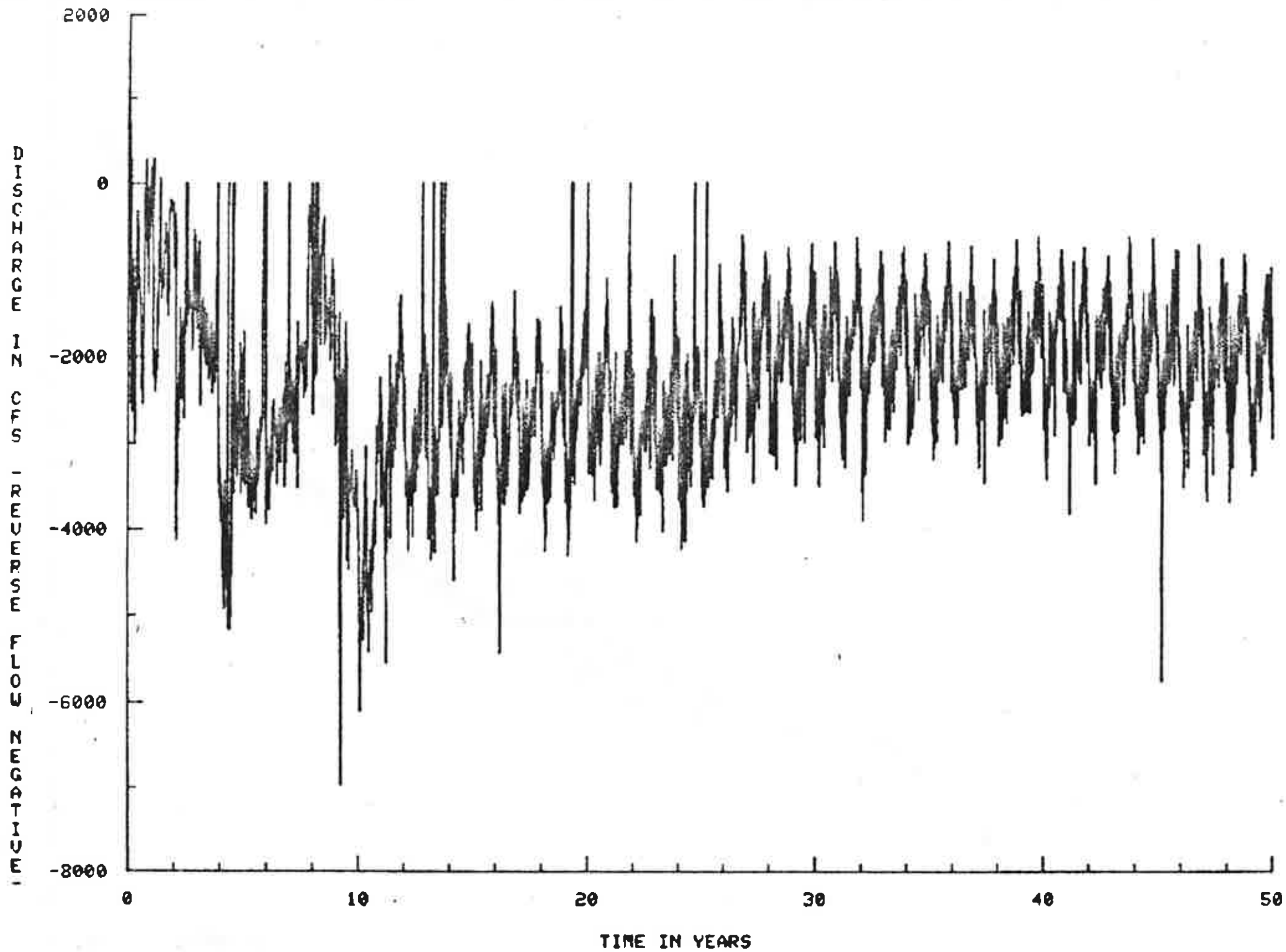

Figure 20. Discharge in the Tallahatchie River at Greenwood (reverse flow negative).

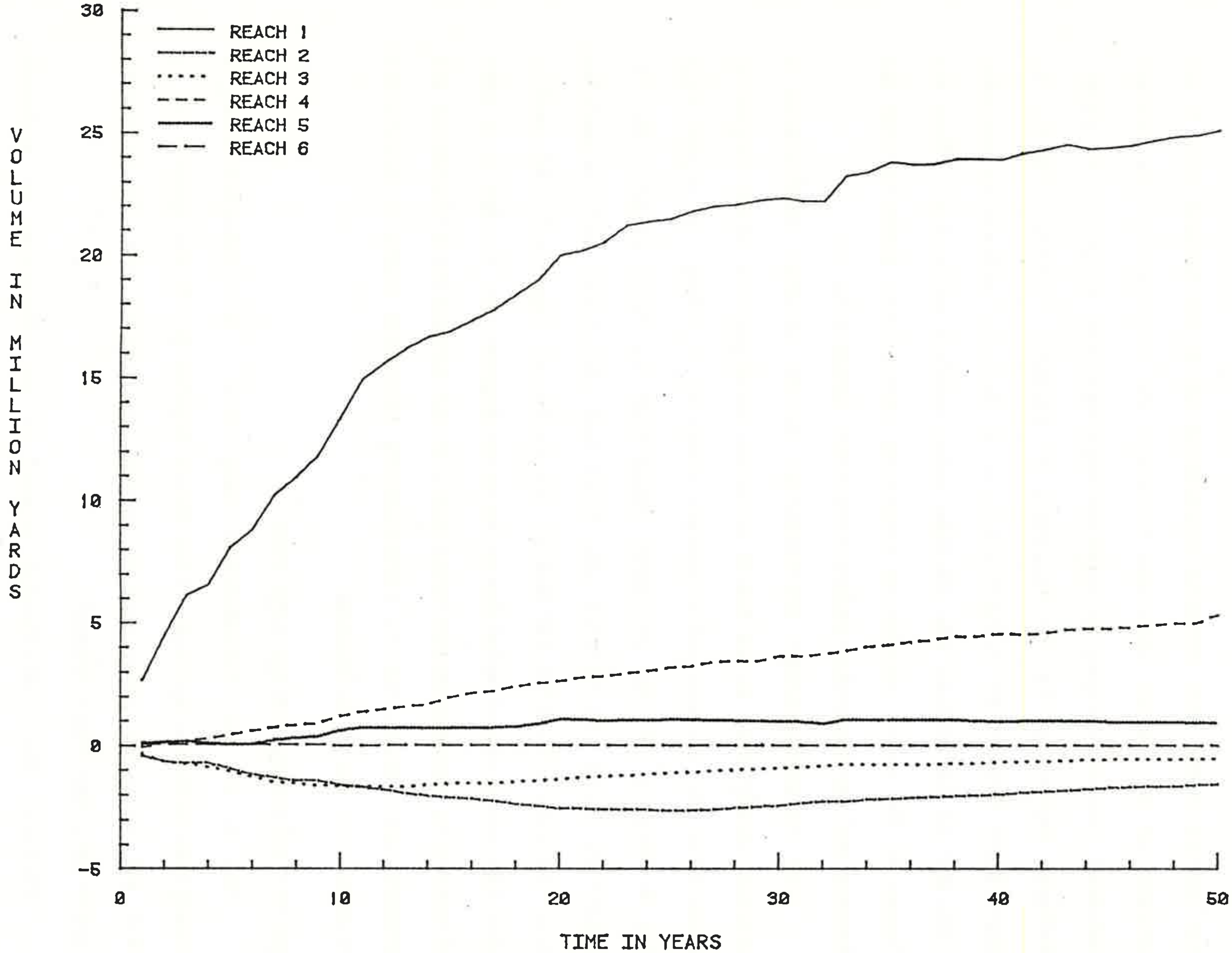

Figure 21. Aggradation (positive) and degradation (negative) in each reach for Run C.

yards per year. The cutoff aggradation is also reduced since it is open to only very high flows. This alternative would keep both the Bendway and cutoff open, but sediment deposition in River Segment No. 1 increases by 26 percent over Run B, since the increase in the Bendway sediment transport capacity supplies more sediment to the lower reach. Sediment deposition in the Yalobusha is slightly reduced from Run B, while River Segment No. 4 experiences a 124 percent increase in aggradation due to increasing the average water surface elevation. This increase in the water surface is caused by forcing low flows through the Bendway and the backwater effect from River Segment No. 1.

The stage-discharge relationship in the Bendway experiences a similar steady rise as in Run B as shown in Figure 23, while Figure 15 shows that the maximum water surface elevation for Run C is higher than Run B because of the increased deposition in River Segment No. 1. Figure 20 shows the initial and final bed elevations and the maximum water surface elevation for Run C. As in Run B, Figures 21, 22, and 23 show the necessity of maintenance in River Segment No. 1. Run C is more effective in minimizing the water quality and navigation problems in the Bendway and cutoff, but it significantly increases sediment deposition elsewhere in the river system.

Run D--Tallahatchie River Lake Plan

Run D is the Tallahatchie Lake Plan. It evaluated Plan E conditions with the exception that River Segment No. 3 was dammed off so that all mainstem flows passed through the cutoff and the Yalobusha flowed into the lower Bendway.

Overall, this alternative caused a net increase in sediment deposition over Run B. Figure 24 is a graph of the aggradation and degradation in each reach for Run D. River Segments No. 1, No. 4, and

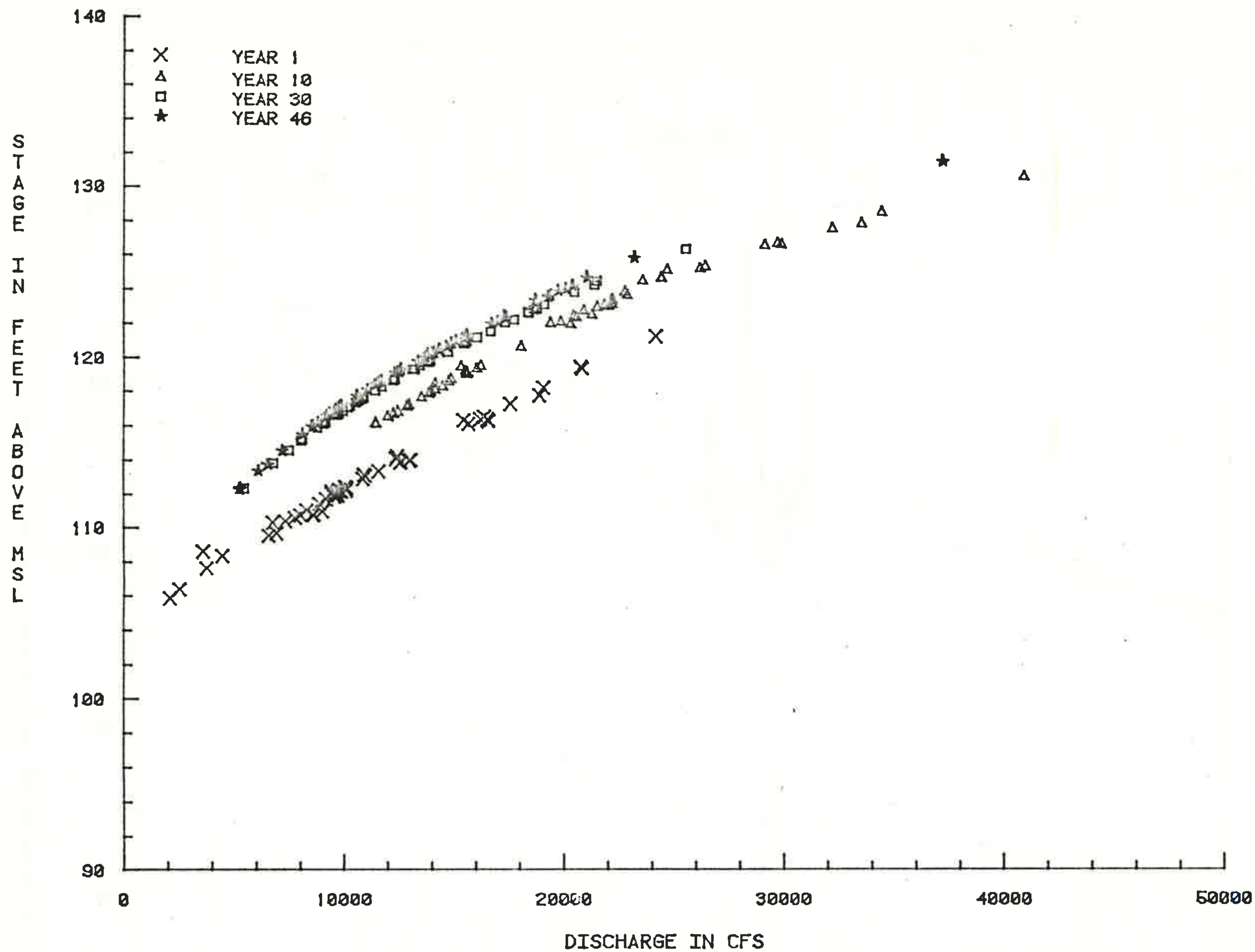

Figure 22. Stage-discharge relationship at Greenwood for Alternative C.

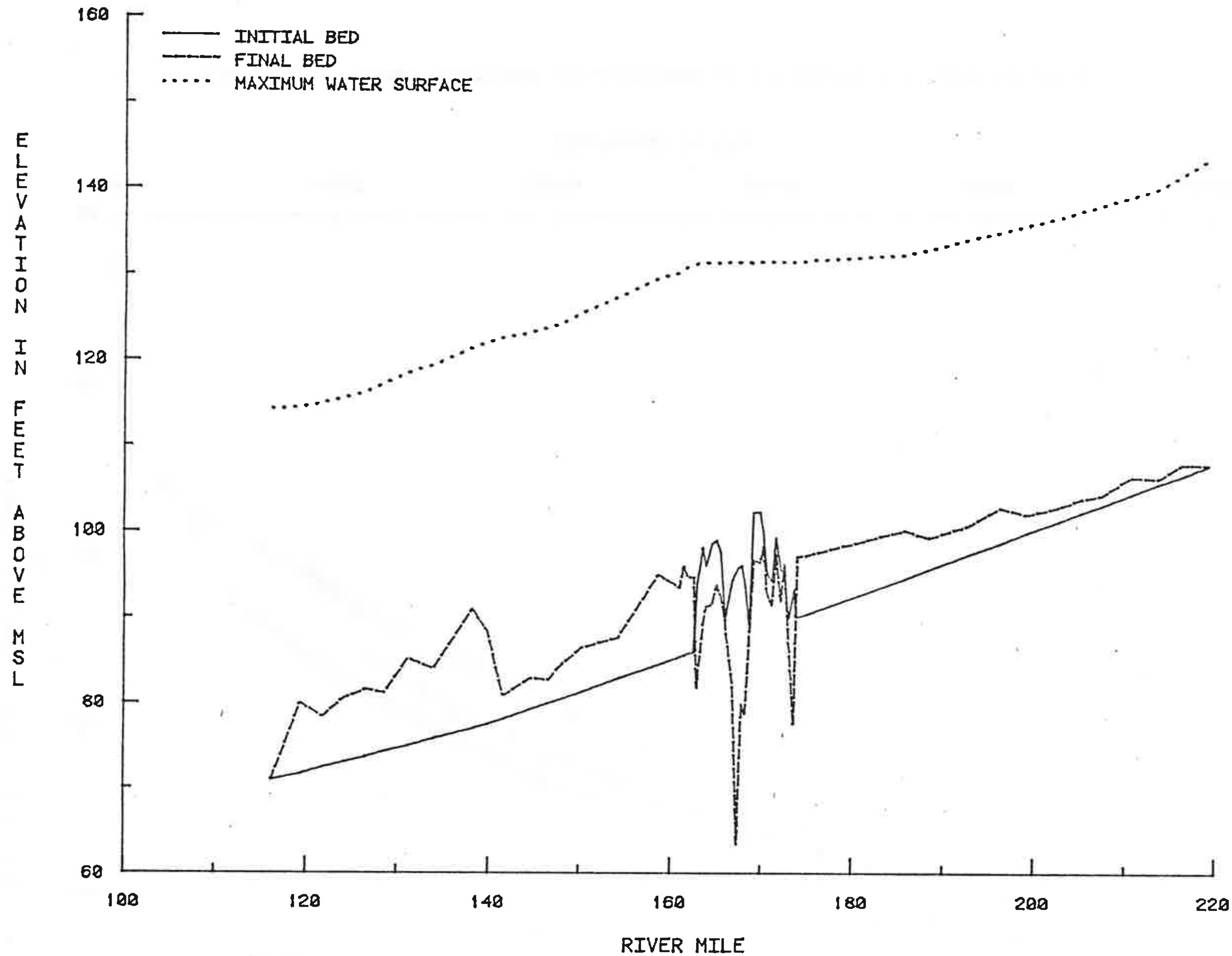

Figure 23. Initial and final bed elevation and maximum water surface for Run C.

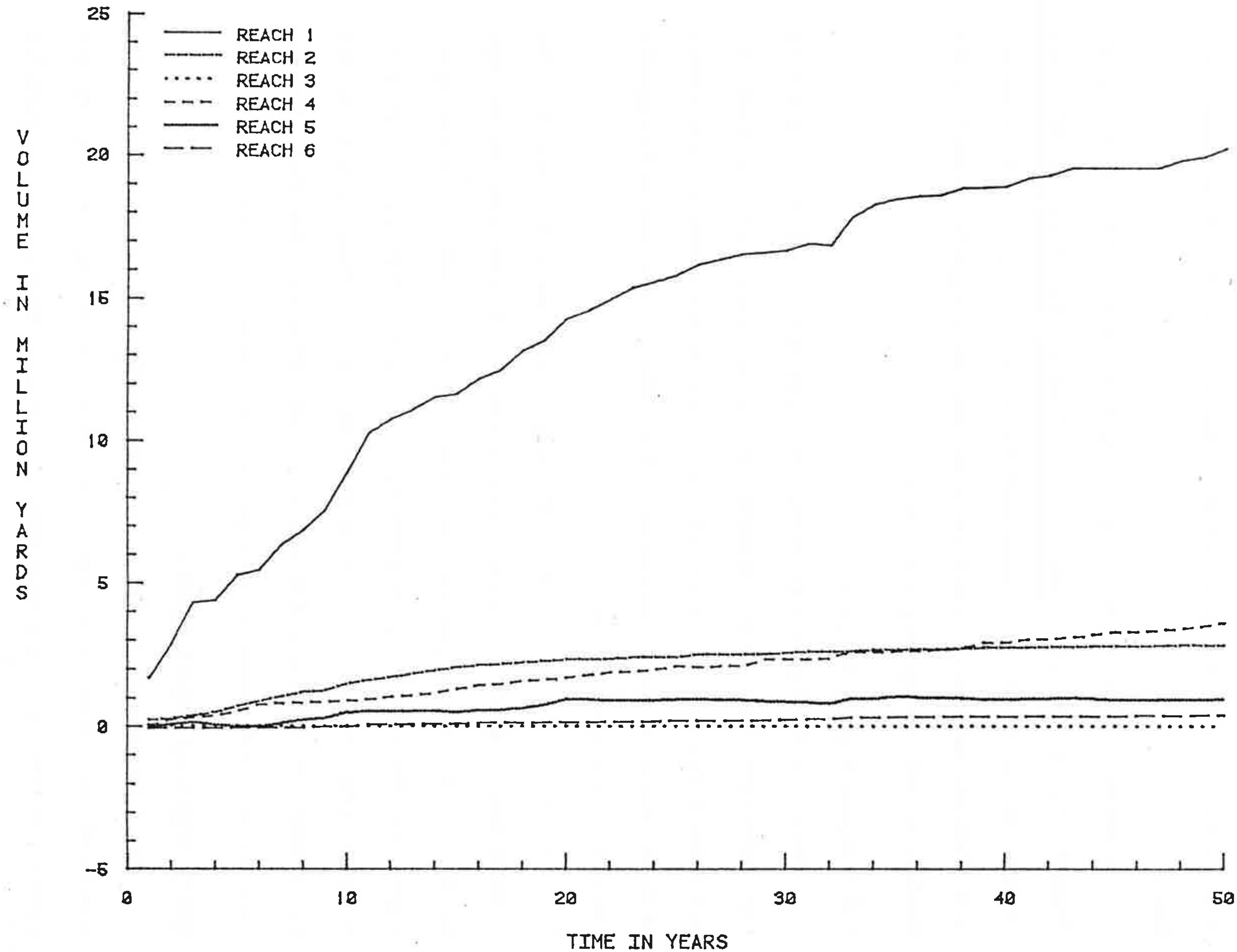

Figure 24. Aggradation (positive) and degradation (negative) in each reach for Run D.

No. 6 experience a 2, 52, and 63 percent, respectively, increase in aggradation over Run B. Figure 18 also shows that the maximum water surface profile for Run D is slightly higher than Run B and lower than Run C.

Alternative Run D was unable to maintain the lower Bendway (River Segment No. 2) with the relatively small Yalobusha flows. Twenty feet of aggradation occurred at Greenwood (river mile 166.0). This alternative does not maintain channel capacity and the navigable channel in the Bendway as well as Alternative Run B.

Run E--Yazoo River Lake Plan

Run E is the Yazoo Lake Plan. It evaluates Plan E conditions with the exception that River Segment No. 2 is dammed off so that the Yalobusha flows into River Sigment No. 3, and hence moves its confluence with the mainstem above the cutoff. The combined mainstem and Yalobusha then flows through the cutoff.

Figure 25 shows the aggradation in each reach for Run E. The aggradation is generally lower than in Run B. Aggradation was reduced by 28, 2, 15, and 46 percent in reaches 3, 4, 5, and 6, respectively. Figure 18 shows that the maximum water surface elevation for Run E is slightly lower than Run B. From the comparison of Runs A, B, C, D, and E, it must be concluded that the Yazoo Lake Plan is a feasible alternative from flood control, navigation, and aesthetic points of view.

Run F--Regulated Cutoff Modified

Run F is similar to Run C, the only difference being the cutoff is regulated such that it is open for flows greater than 15,000 cfs and closed for flow less than that amount. Fifteen thousand cfs is exceeded

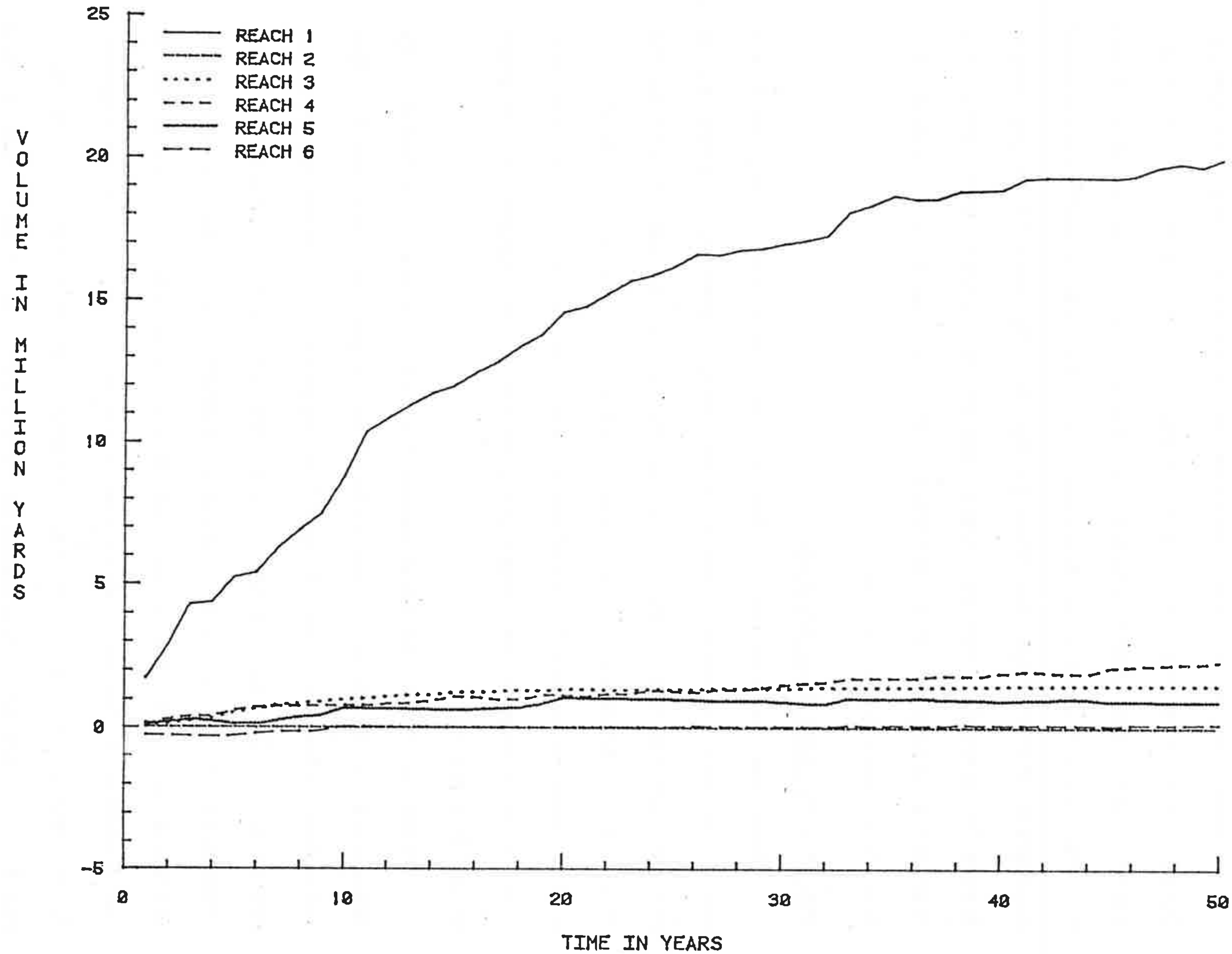

Figure 25. Aggradation (positive) and degradation (negative) in each reach for Run E.

30 percent of the time for seven-day flows. This alternative, when compared to Run C, tests the sensitivity of cutoff regulation.

Figure 26 shows the aggradation (positive) and degradation (negative) in each reach for Run F. Comparison of Figures 20 and 26 and Table 4 shows that Run F results are very similar to the results of Run C. The only significant difference is that the cutoff experienced deposition slightly greater than in Run B. The overall system sensitivity is generally low for regulation of the cutoff; therefore, if a regulating structure were constructed it would need to be opened at a flow level well below 15,000 cfs.

Run G--Yazoo Lake Plan Modified

This run is similar to Run E, the Yazoo Lake Plan, with the exception that sediment inflow from Abiaca Creek is reduced by 50 percent and the weir crest elevation in the cutoff was lowered to 100 feet M.S.L. Reduction of the Abiaca sediment will evaluate the effects on the mainstem caused by tributary control and the lowering of the weir crest will determine the sensitivity of the river channel to the level of grade control.

Figure 27 shows the total aggradation in each reach for Run G. The deposition in reach No. 1 was reduced by 20 percent from Run E. This indicated tributary control will be effective in reducing mainstem aggradation. The deposition in river reaches 3, 4, 5, and 6 were also reduced by 11, 39, 27, and 16 percent, respectively. While some of this reduction is due to the control of Abiaca Creek, the majority is due to the lowering of the weir which lowers the base level for River Segments 3, 4, and 5 and increases the sediment transport rate out of these reaches. It may be advantageous to reduce the weir crest elevation even

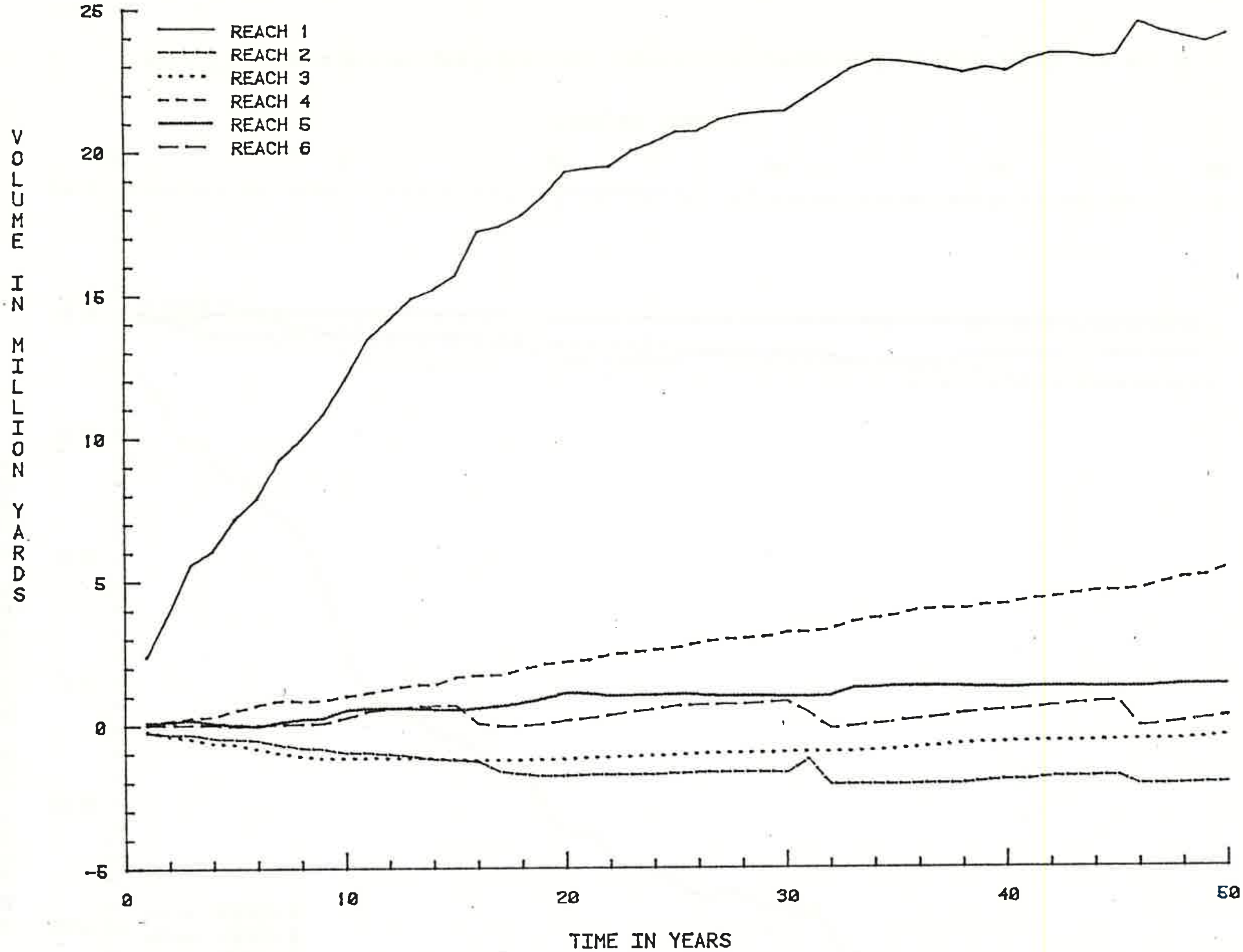

Figure 26. Aggradation (positive) and degradation (negative) in each reach for Run F.

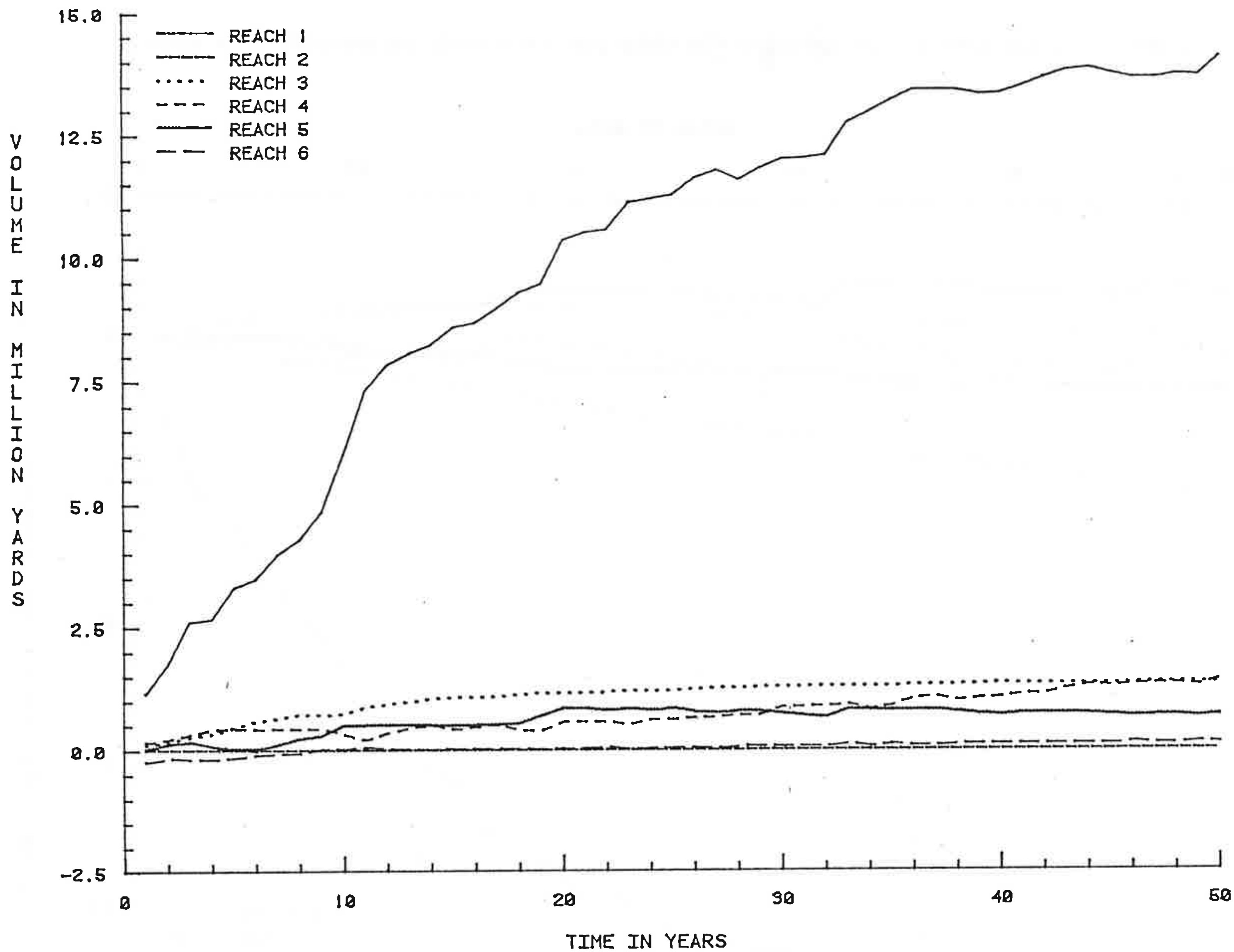

Figure 27. Aggradation (positive) and degradation (negative) in each reach for Run G.

more or remove the weir entirely, but additional studies would be required to determine the exact effects of such action.

Figure 28 shows the maximum water surface elevations for Runs A, B, E, and G. Run G has the lowest maximum water surface profile of any alternative evaluated with Plan E conditions and is only slightly higher than Run A. With channel maintenance the profile for Alternative G would undoubtedly be significantly lower than Run A. The continued need for channel maintenance is shown by Figure 29, the stage-discharge relationship at River Mile 162.5 for Run G.

Bendway deposition may be further reduced by sediment controls on the Yalobusha tributaries, Big Sand Creek, Teoc Creek, Potococowa Creek, and Ascalmore Creek. These creeks supplied a total of 3,620,000 cubic yards of sediment during the 50 years of simulation. Further studies would be required to determine the effectiveness of controlling the sediment on these creeks.

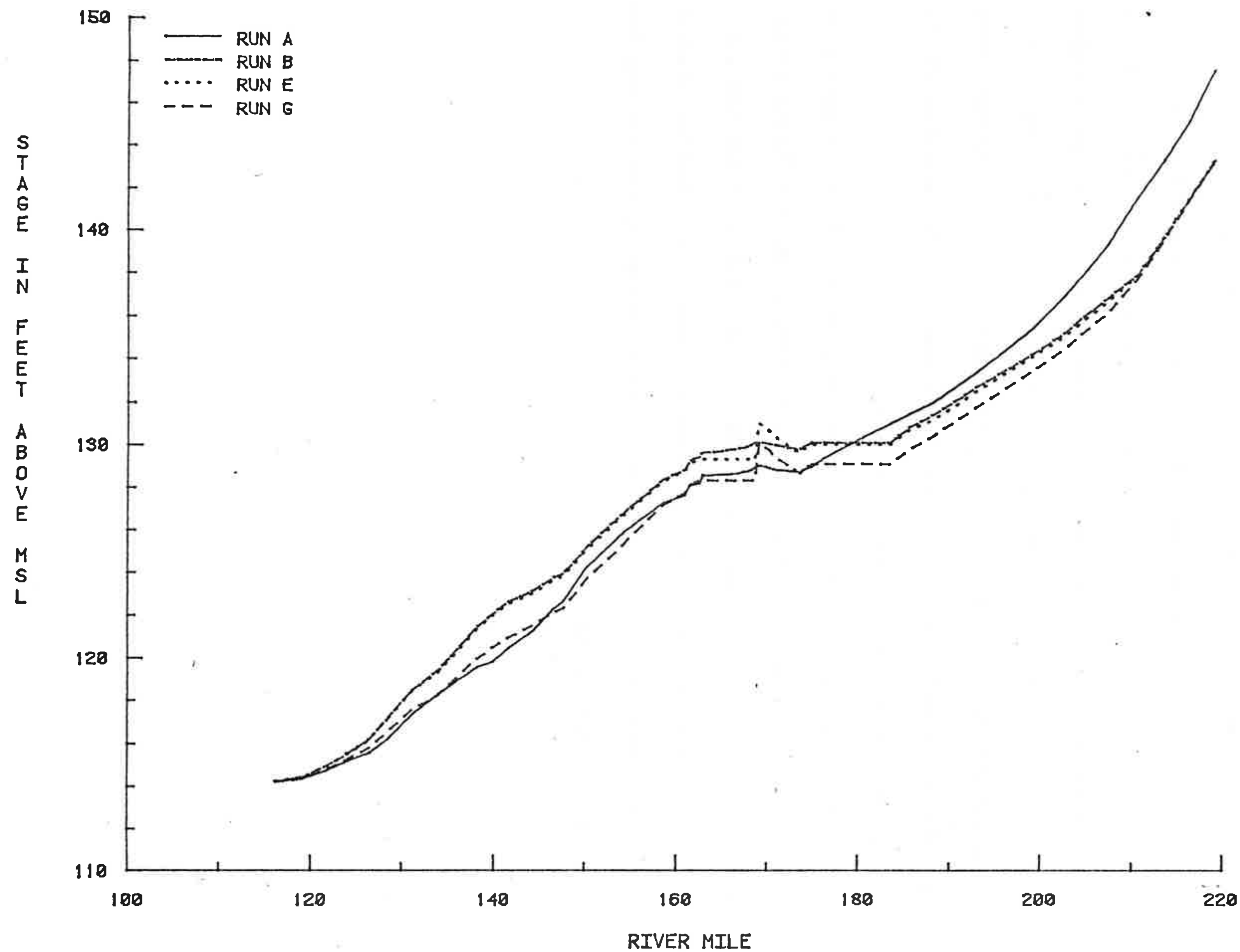

Figure 28. Maximum water surface elevations for Runs A, B, E, and G.

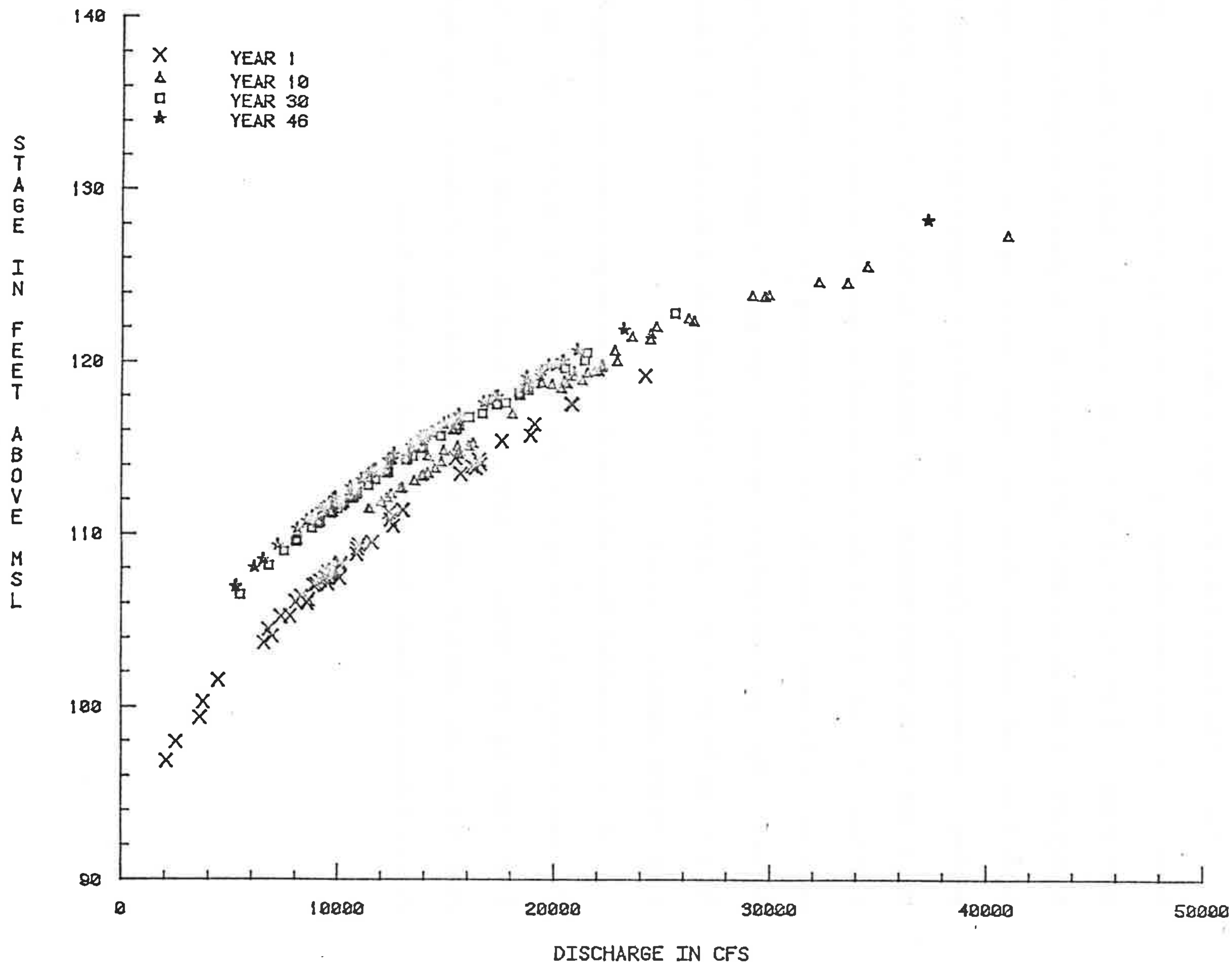

Figure 29. Stage-discharge relationship at River Mile 162.5 for Run G.

V. Conclusions and Recommendations

Run G, the Yazoo Lake Plan with reduction of sediment from Abiaca Creek and a lower weir elevation was the best alternative evaluated in this study. If the Plan E channel is maintained by channel dredging and tributary control as designed, Alternative G will provide adequate flood protection and reduced dredging requirements in the mainstem and Bendway. In addition, the study indicated that regulation of the Bendway by a gated dam would maintain the Bendway channel better than other alternatives, but it will increase mainstem deposition dramatically--so much so as to make it unattractive considering the entire Upper Yazoo Project. The open unregulated Bendway and the Tallahatchie Lake plan (Run B and D) are both inferior to the Yazoo Lake plan because of their high Bendway deposition rates.

It is recommended that additional studies be performed to determine the best elevation for the weir in the Ft. Pemberton cutoff if the Yazoo Lake Plan is implemented. Also, consideration should be given to controlling the sediment input from the Yalobusha tributaries, Big Sand Creek, Potococowa Creek, Teoc Creek, and Ascalmore Creek.

REFERENCES

Simons, D. B., R. M. Li, G. O. Brown, Y. H. Chen, T. J. Ward, N. Duong, and V. M. Ponce, "Sedimentation Study of the Yazoo River Basin--Phase I, General Report." Prepared for U.S. Army Corps of Engineers, Vicksburg District, June 1978.

Simons, D. B., R. M. Li, T. J. Ward, and N. Duong, "Sedimentation Study of the Yazoo River Basin--Phase I, Temporal Design." Prepared for U.S. Army Corps of Engineers, Vicksburg District, June 1978.

APPENDIX A

Schematic Cross-Section Locations of
Greenwood Bendway on Yazoo

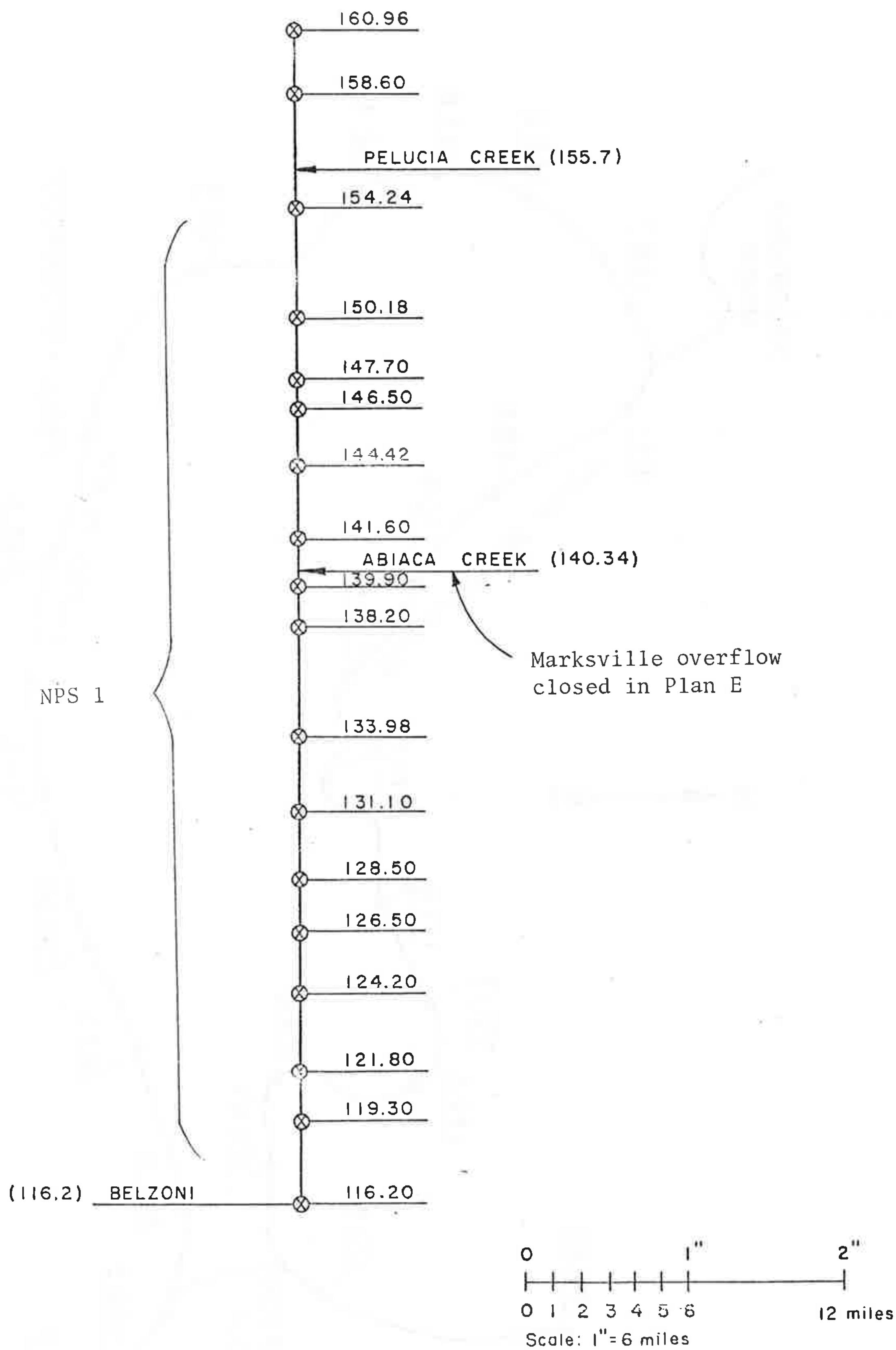

Figure A-1. Yazoo River Belzoni to Greenwood.

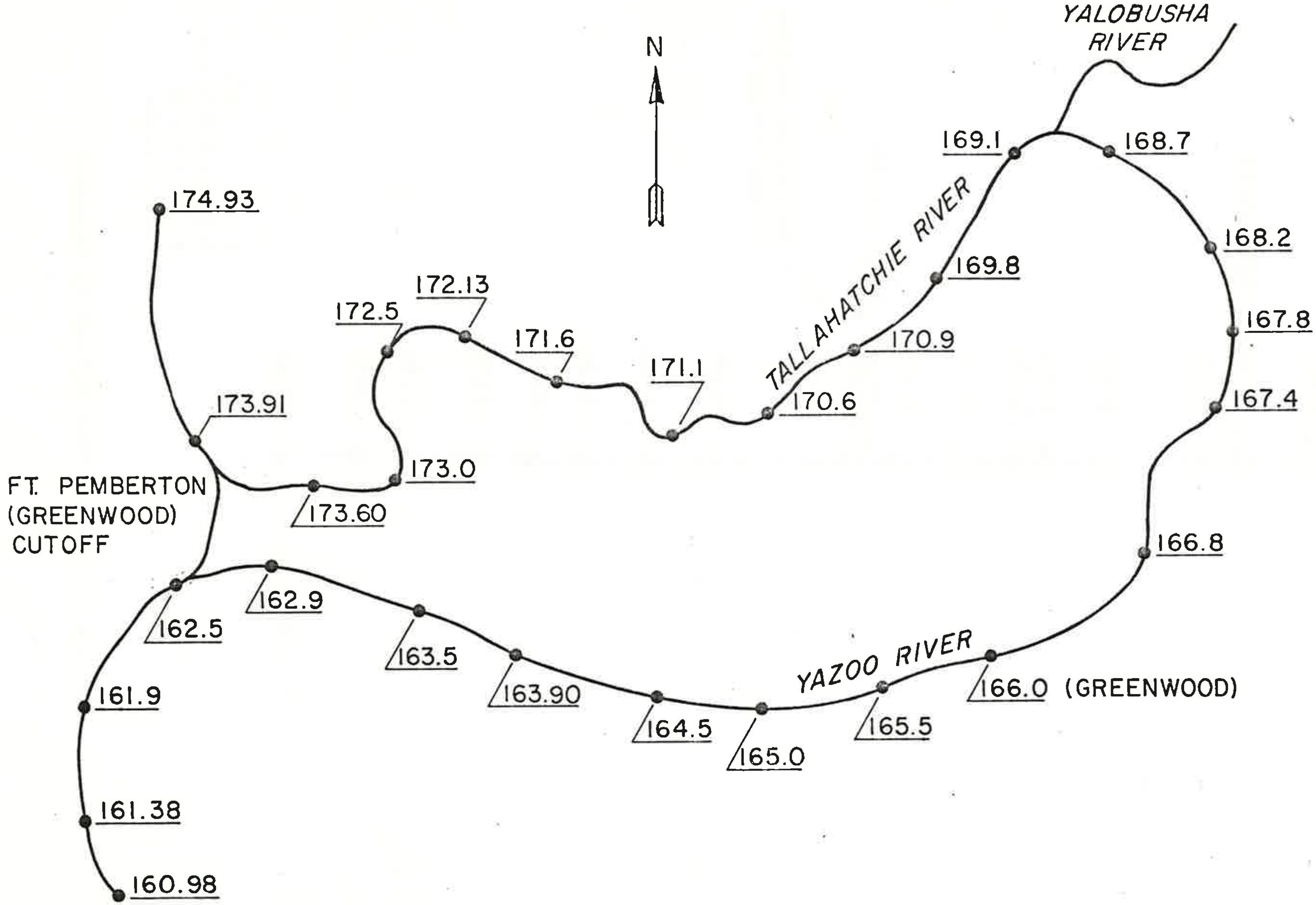

Figure A-2. Greenwood Bendway area.

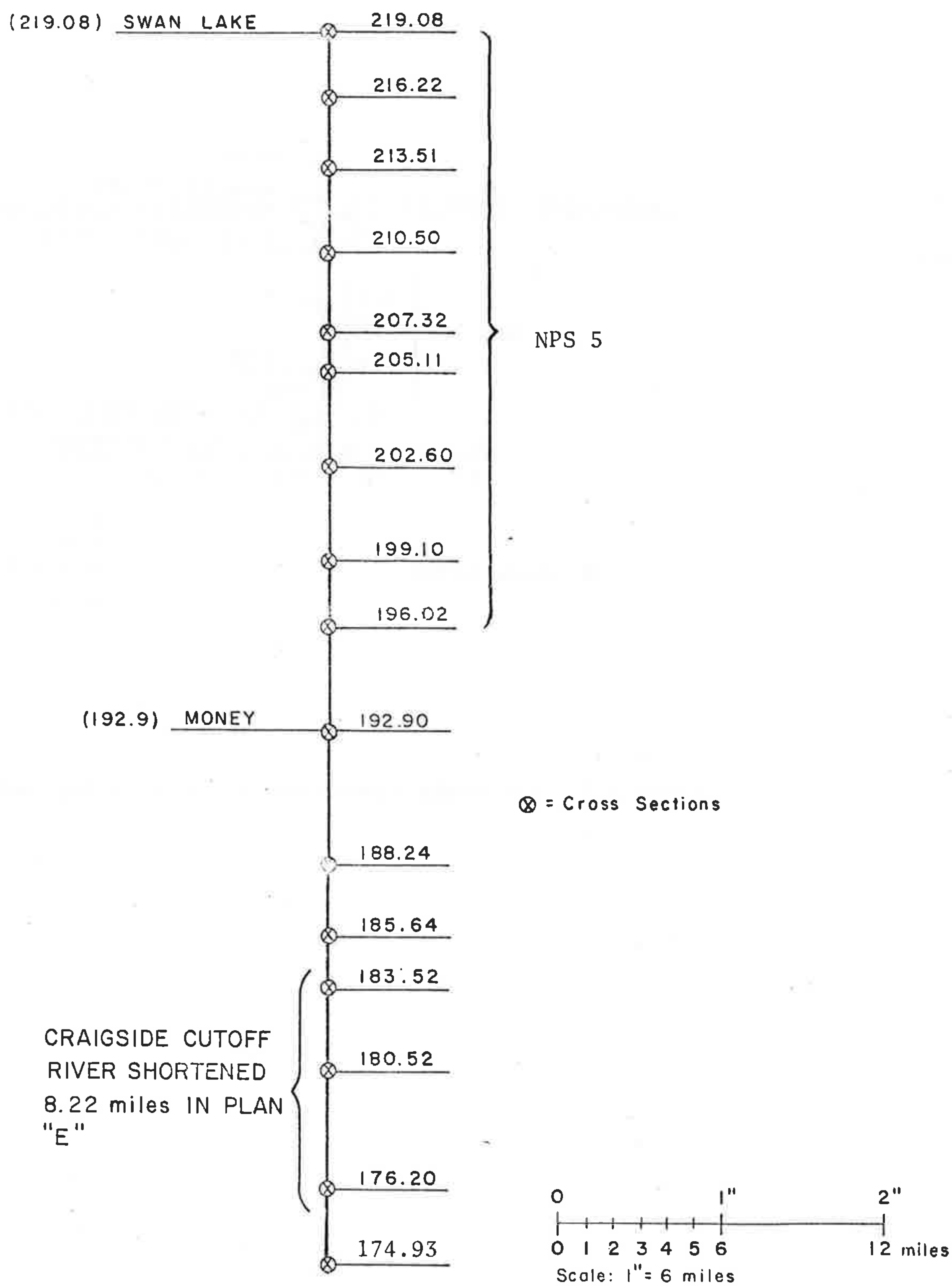

Figure A-3. Tallahatchie River above Greenwood Bendway.

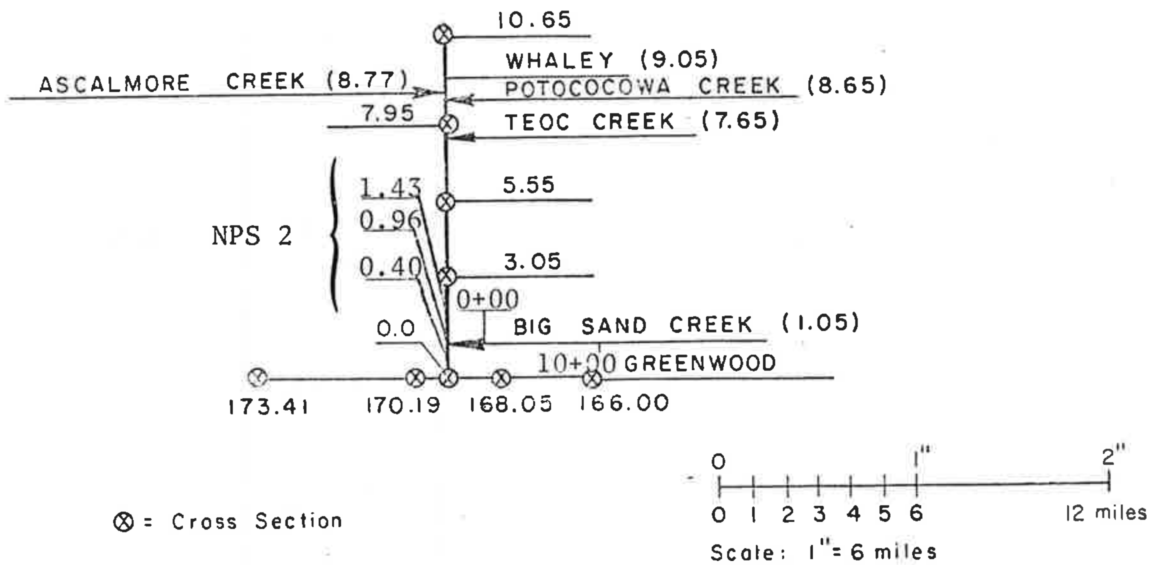

Figure A-4. Yalobusha River confluence to Whaley and Big Sand Creek.

APPENDIX B

Cross-Section Numbers

CROSS-SECTION NUMBERS

	River Miles	Alternative Runs A	Alternative Runs B, C, D, E, F, G
River Segment 1	116.2	1	1
	119.3	2	2
	121.8	3	3
	124.2	4	4
	126.5	5	5
	128.5	6	6
	131.1	7	7
	133.98	8	8
	138.20	9	9
	139.90	10	10
	141.60	11	11
	144.42	12	12
	146.50	13	13
	147.70	14	14
	150.18	15	15
	154.24	16	16
	158.60	17	17
	160.96	18	18
	161.38	19	19
	161.9	20	20
River Segment 2	162.5	21	21
	162.9	22	22
	163.5	23	23
	163.9	24	24
	164.5	25	25
	165.0	26	26
	165.5	27	27
	166.0	28	28
	166.8	29	29
	167.4	30	30
	167.8	31	31
River Segment 3	168.2	32	32
	168.7	33	33
	169.1	34	34
	169.8	35	35
	170.19	36	36
	170.6	37	37
	171.1	38	38
	171.6	39	39
	172.13	40	40
	172.5	41	41
	173.0	42	42
River Segment 4	173.60	43	43
	173.91	44	44
	174.93	45	45

	River Miles	Alternative Runs A	Alternative Runs B, C, D, E, F, G
	176.20	46	-
Craigside	180.52	47	-
Cutoff	183.52	48	-
	185.64	49	46
	188.24	50	47
	192.90	51	48
	196.02	52	49
	199.10	53	50
	202.60	54	51
	205.11	55	52
	207.32	56	53
	210.50	57	54
	213.51	58	55
	216.22	59	56
	219.08	60	57
Yalobusha			
River	0.0	61	58
Segment 5	0.40	62	59
	0.96	63	60
	1.43	64	61
	3.05	65	62
	5.55	66	63
	7.95	67	64
	10.65	68	65
Ft. Pemberton			
River	162.5 (0.00)	69	66
Segment 6	16+50 (0.16)	70	67
	10+40	71	68
	4+90 (0.38)	72	69
	Weir (0.50)	73	70
	Weir (0.50)	74	71
Big Sand			
River	0+00 (0.00)	75	72
Segment 7	20+00 (0.38)	76	73

APPENDIX C

Dredging Records

Date	12" Dredge Station From	12" Dredge Station To	=	12" Dredge Mile From	12" Dredge Mile To	14" Dredge Station From	14" Dredge Station To	=	14" Dredge Mile From	14" Dredge Mile To
10/24/76	13+00	12+25		185.35	185.33					
10/30/76	7+25	6+25		185.24	185.22					
11/5/76	2+25	2+00		185.14	185.14					
11/6/76	2+00	1+00		185.14	185.14	63+25	63+50		186.50	186.30
11/7/76	1+00	0+00		185.12	185.1	63+50	65+00		186.30	186.33
11/8/76	13+50	14+00		185.36	185.38	Down				
11/10/76	Down					66+00	68+50		186.35	186.40
11/15/76	Down					73+00	74+00		186.48	186.50
11/20/76	Down					77+50	79+10		186.57	186.60
11/23/76	247+39	247+00		1.7	1.68	82+00	83+10		186.65	186.67
11/24/76	Down					83+10	84+00		186.67	186.69
11/25/76	247+00	244+50		1.68	1.63	84+00	85+50		186.69	186.72
11/29/76	236+50	234+00		1.48	1.43	88+50	89+00		186.78	186.79
11/30/76	Down					89+00	90+75		186.79	186.82
12/2/76	Down					91+00	91+25		186.82	186.83
12/3/76	Down					Down				
12/9/76	Down					91+25	91+50		186.83	186.83
12/15/76	177+15	174+00		0.36	0.30	97+00	98+00		186.94	186.96
12/20/76	166+00	163+75		0.14	0.10	102+50	104+25		187.04	187.07
12/21/76	Down					104+25	104+50		187.07	187.08
12/22/76	163+75	163+50		0.10	0.10	104+50	105+50		187.08	187.10
12/24/76	163+40	161+50		0.09	0.06	106+50	107+75		187.12	187.14
12/25/76	Down					Down				
12/26/76	161+50	160+75		0.06	0.04	107+75	108+75		187.14	187.16
12/30/76	155+50	154+25		188.05	188.02	111+50	112+50		187.21	187.23

Date	12" Dredge Station From	= To	12" Dredge Mile From	To	14" Dredge Station From	= To	14" Dredge Mile From	To
1/1/77	154+00	153+00	188.02	188.00	113+50	115+50	187.35	187.29
1/2/77	Down				115+50	116+00	187.29	187.30
1/3/77	Down				Down			
1/7/77	Down				Down			
1/8/77	176+00	177+50	0.33	0.36	Down			
1/10/77	179+75	180+50	0.40	0.42	Down			
1/15/77	187+75	188+75	0.56	0.57	Down			
1/20/77	191+75	194+75	0.63	0.69	Down			
1/22/77	196+00	196+75	0.71	0.73	Down			
1/23/77	Down				Down			
1/24/77	196+75	199+00	0.73	0.77	Down			
1/30/77	208+00	210+00	0.94	0.98	Down			
2/4/77	214+25	215+00	1.06	1.07	Down			
2/5/77	Down				Down			
2/6/77	215+00	216+50	1.07	1.10	Down			
2/9/77	222+00	223+00	1.20	1.22	Down			
2/10/77	223+00	224+00	1.22	1.24	Down			
	Dredge moved back							
2/10/77	201+85	202+18	0.82	0.83	Down			
2/11/77	Down				Down			
2/12/77	Down				Down			
2/13/77	203+59	203+80	0.86	0.86	Down			
2/15/77	204+75	204+85	0.88	0.88	Down			
2/16/77	Down				Down			
2/20/77	Down				Down			
2/25/77	Down				Down			

Date	12" Dredge Station From	To	= 12" Dredge Mile From	To	14" Dredge Station From	To	= 14" Dredge Mile From	To
3/1/77	Down				Down			
3/5/77	Down				Down			
3/10/77	Down				Down			
3/15/77	Down				Down			
3/20/77	Down				Down			
3/21/77	36+41.5	36+10	185.79	185.78	Down			
3/22/77	36+10	35+20	185.78	185.77	Down			
3/24/77			4.75	300' down-stream	Down			
3/26/77				4.62	Down			
3/27/77	Down				Down			
4/1/77	Down				Down			
4/5/77	Down				Down			
4/10/77	Down				Down			
4/15/77	Down				Down			
4/20/77	Down				Down			
4/25/77	Down				Down			
4/29/77	Down				Down			
4/30/77	Down				Started hourly -10+00	@ 2000 hrs.	184.91	
5/1/77	Down				-10+00	-6+00	184.91	184.99
5/3/77	Down				- 4+00	-1+25	185.02	185.08
5/4/77	Down				21+00		185.50	
5/10/77	Down				34+50	36+00	185.75	185.78
5/15/77	Down				40+70	41+50	185.87	185.89

Date	12" Dredge Station From	To	= 12" Dredge Mile From	To	14" Dredge Station From	To	= 14" Dredge Mile From	To
5/20/77	Down				46+80	48+40	185.99	186.02
5/23/77	Down				52+20	53+00	186.09	186.10
5/24/77	Down				Dredged in Yazoo River at Fort Pemberton Cutoff			
5/25/77	Completed Job				Completed Job			

APPENDIX D

Stage-Discharge Relationships

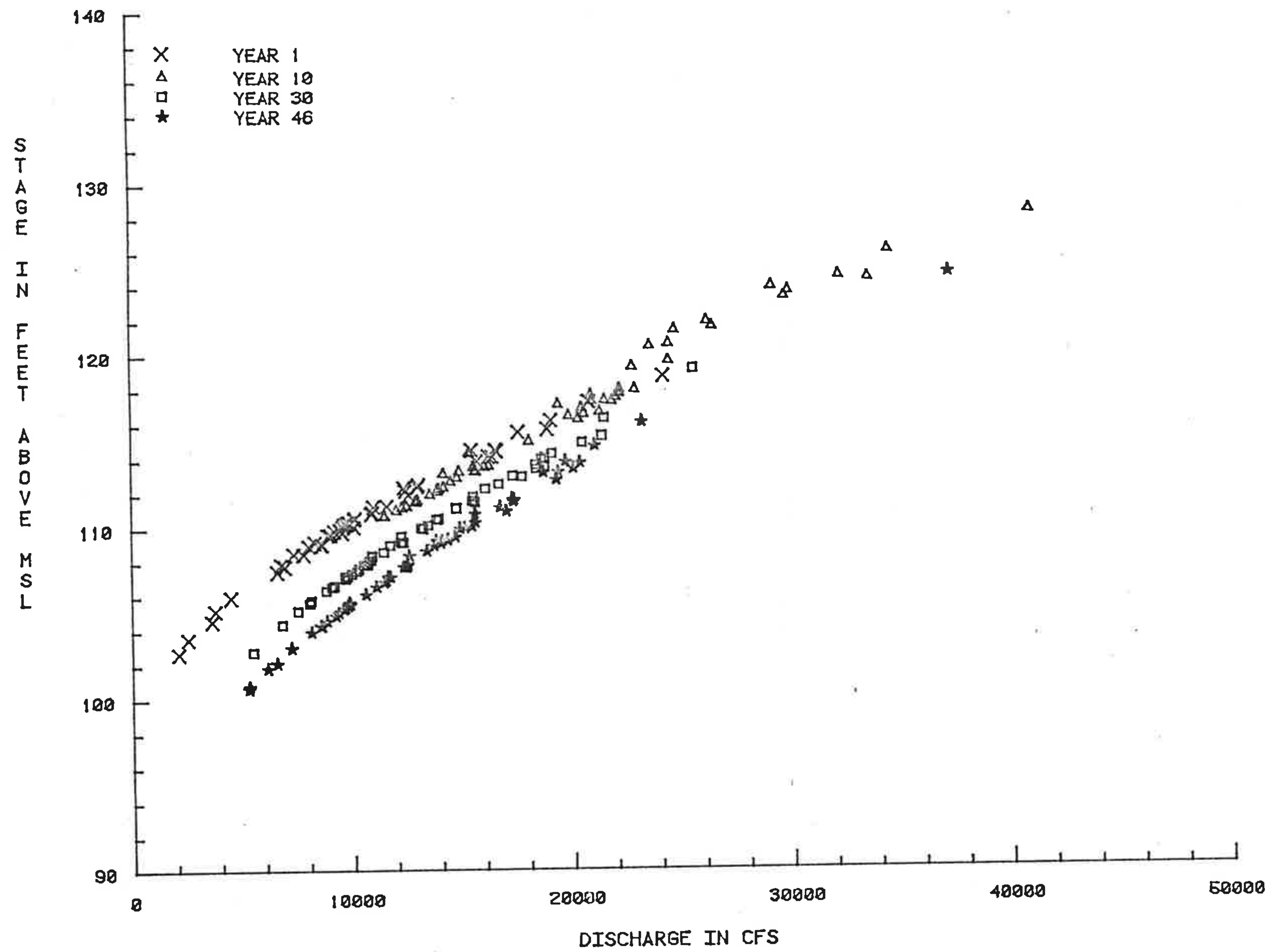

Figure D-1. Stage-discharge relationship at River Mile 162.5 for Alternative A.

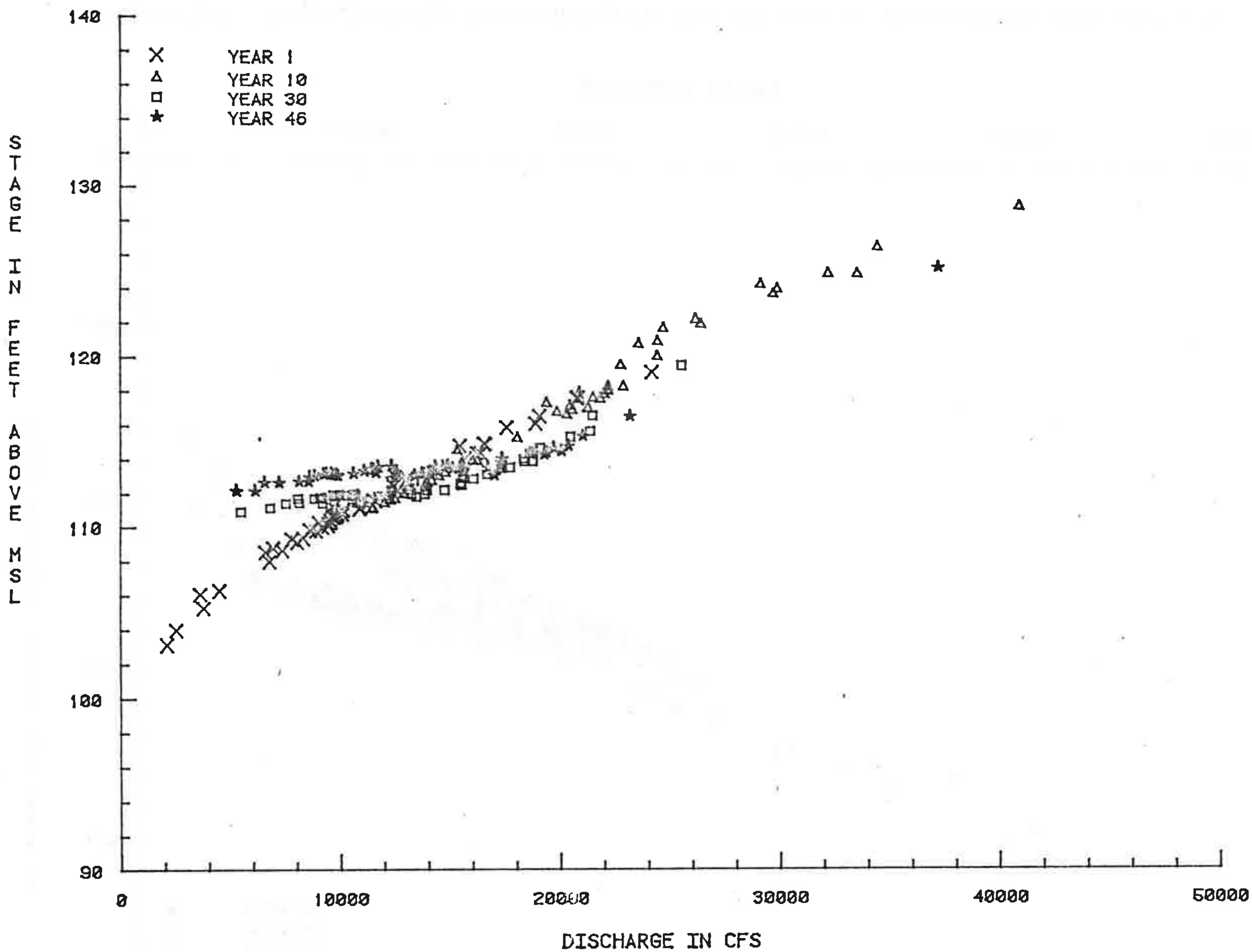

Figure D-2. Stage-discharge relationship at Greenwood for Alternative A.

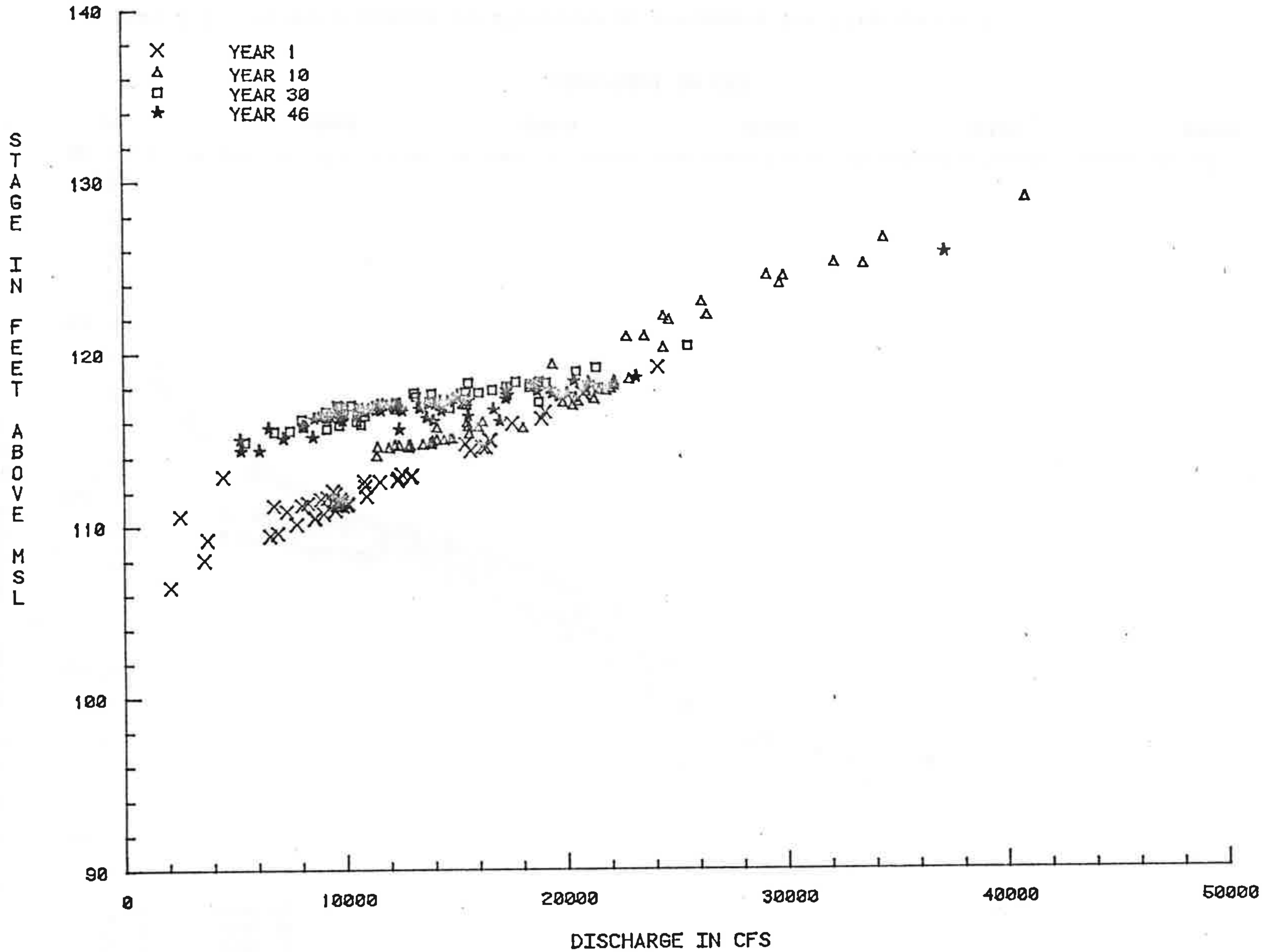

Figure D-3. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative B.

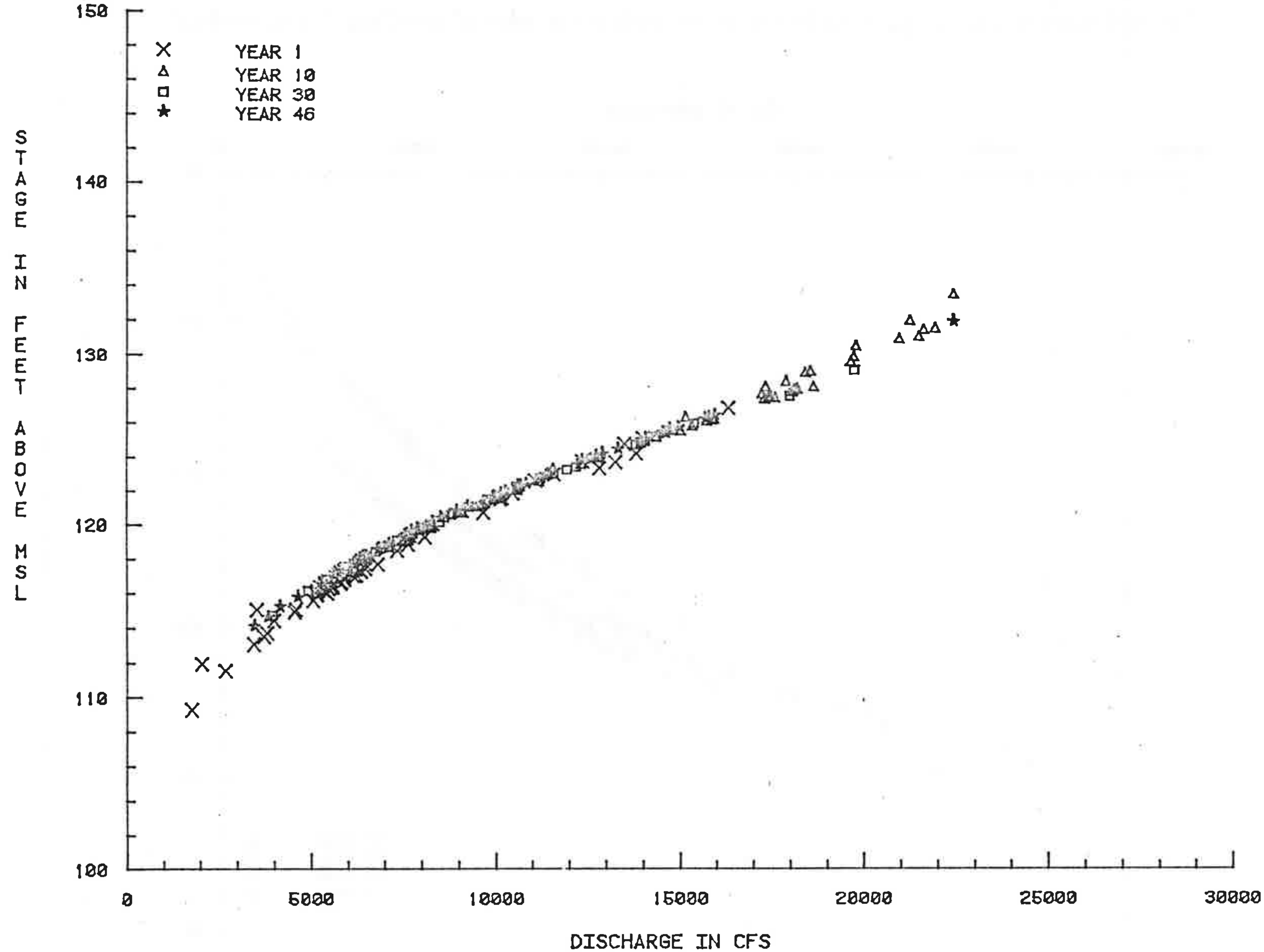

Figure D-4. Stage-discharge relationship at Money for Alternative A.

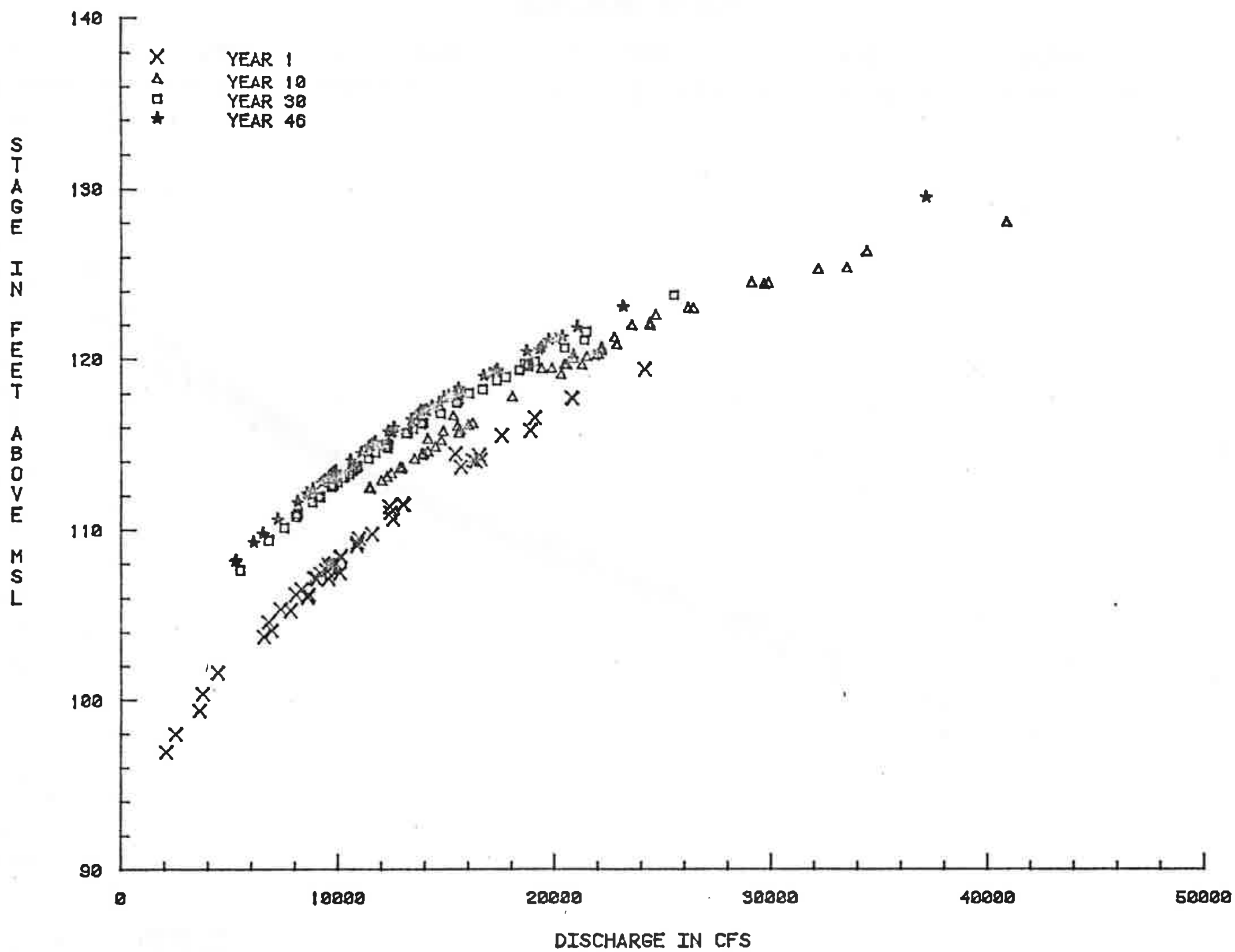

Figure D-5. Stage-discharge relationship at River Mile 162.5 for Alternative B.

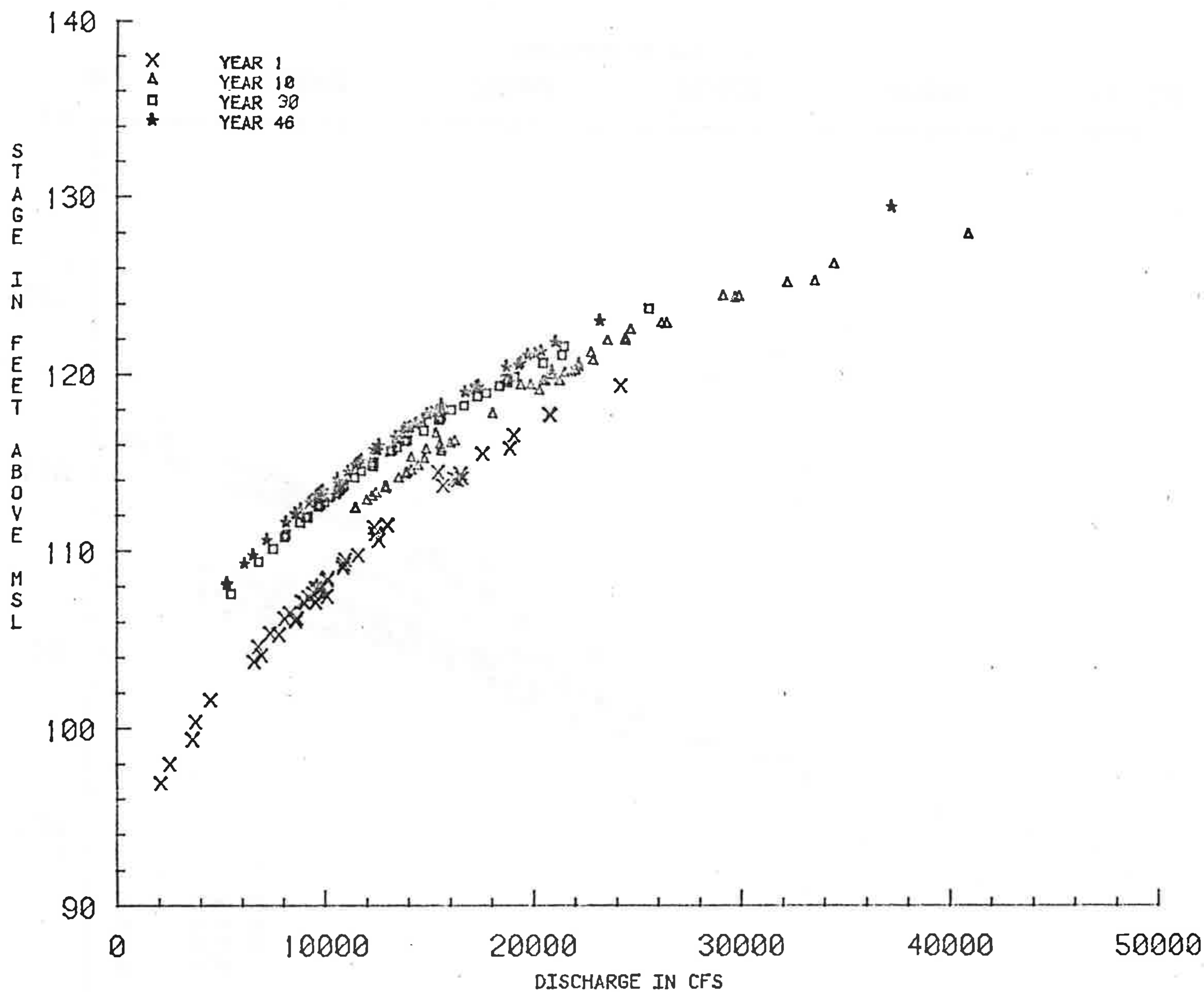

Figure D-6. Stage-discharge relationship at Greenwood for Alternative B.

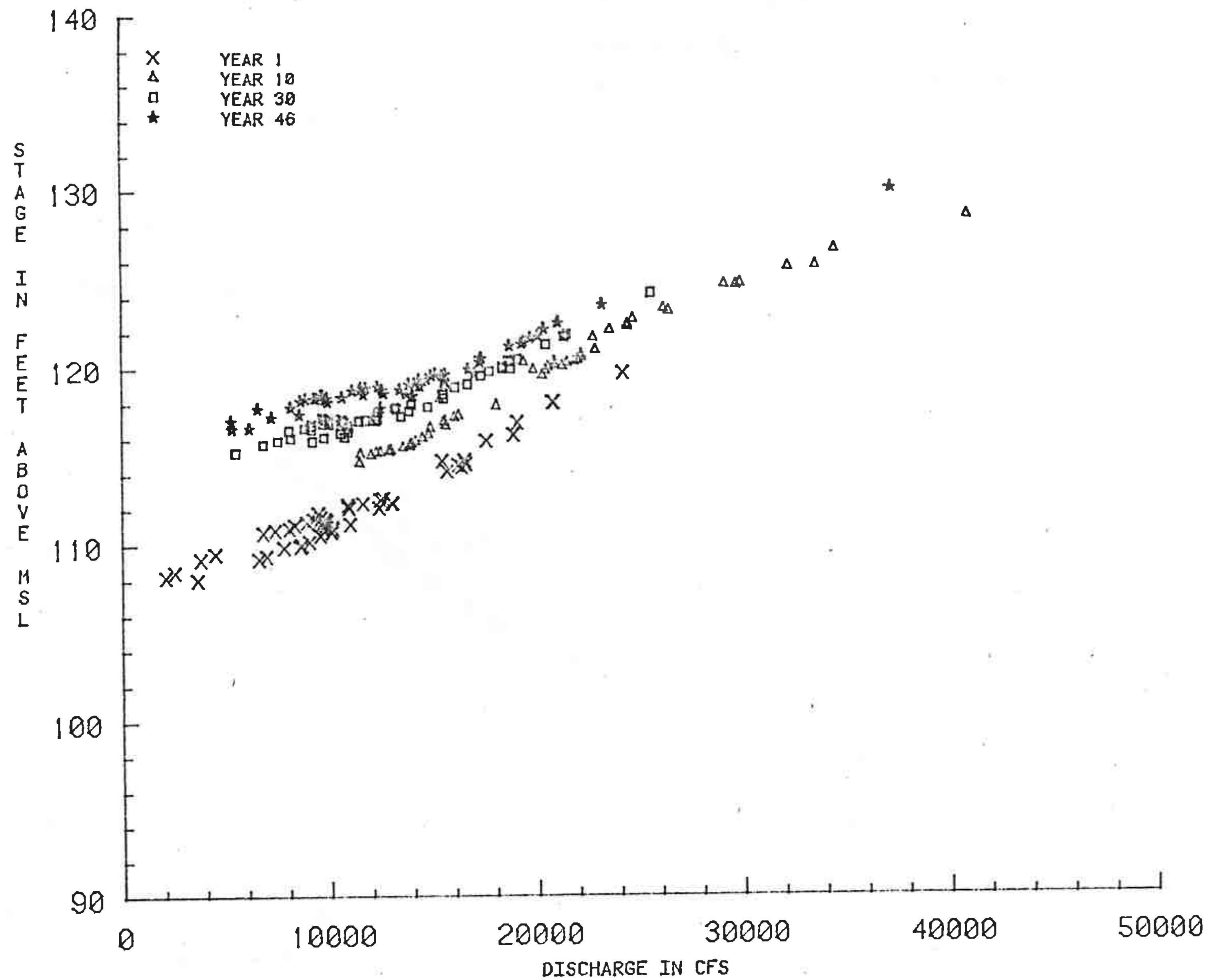

Figure D-7. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative B.

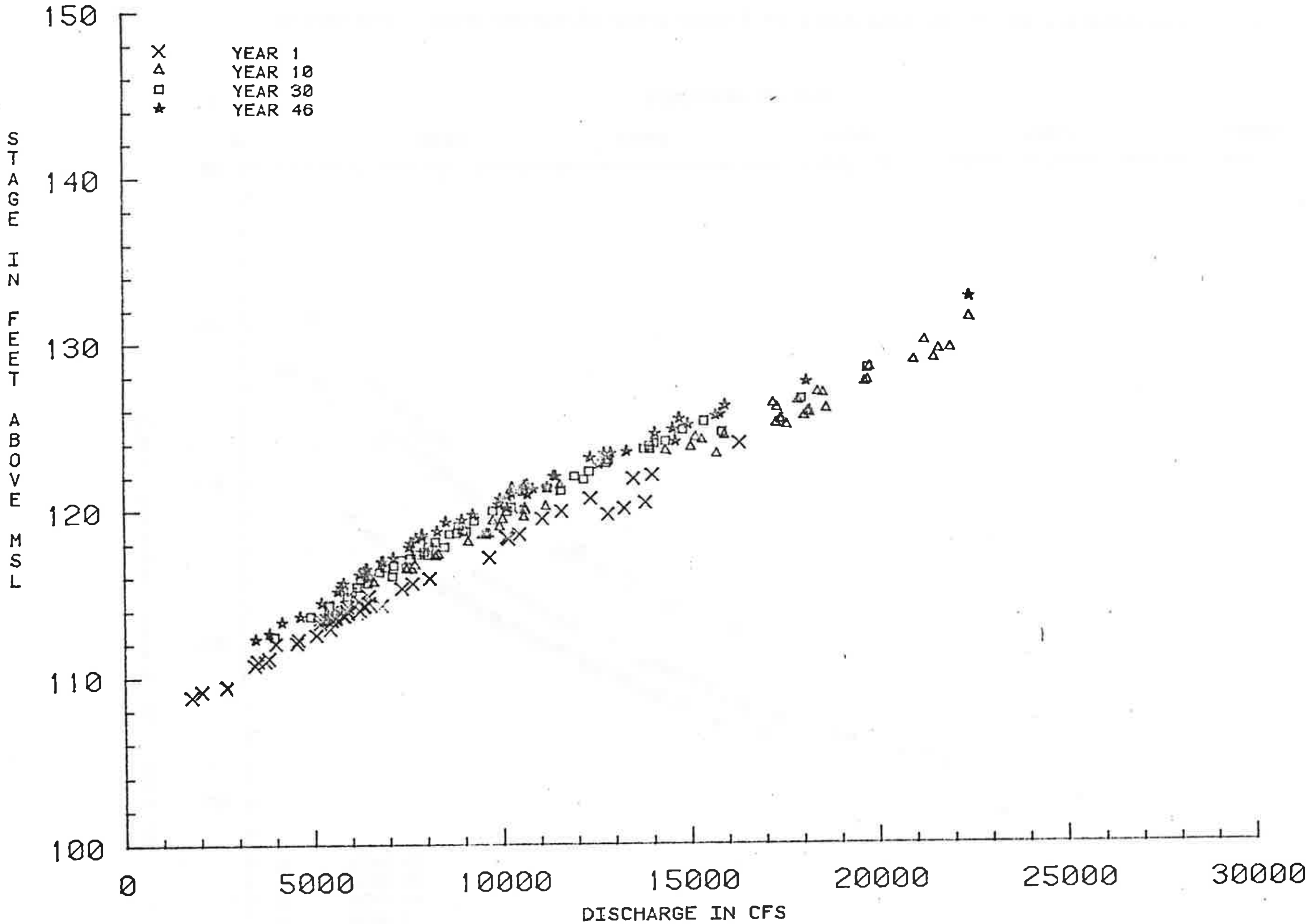

Figure D-8. Stage-discharge relationship at Money for Alternative B.

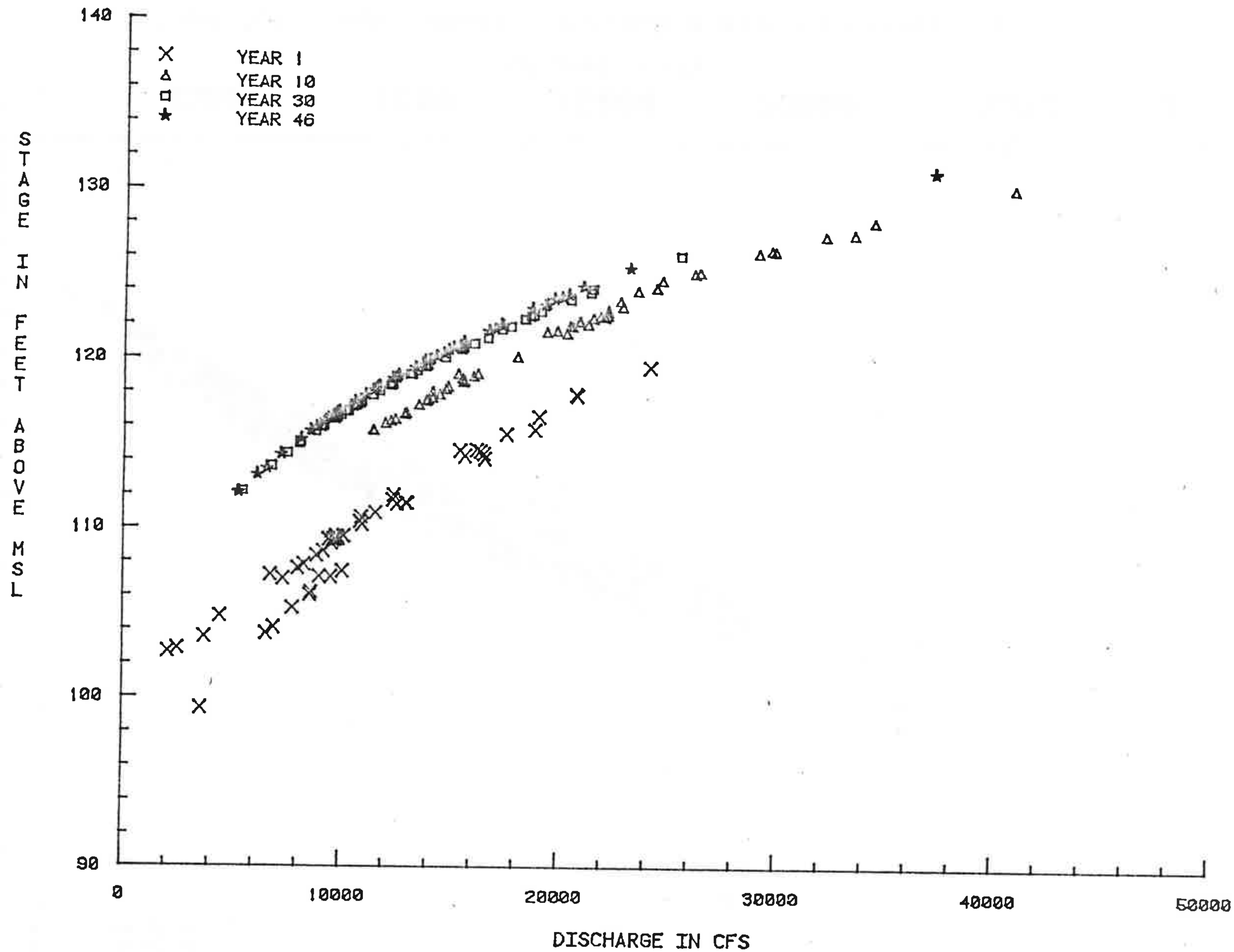

Figure D-9. Stage-discharge relationship at River Mile 162.5 for Alternative C.

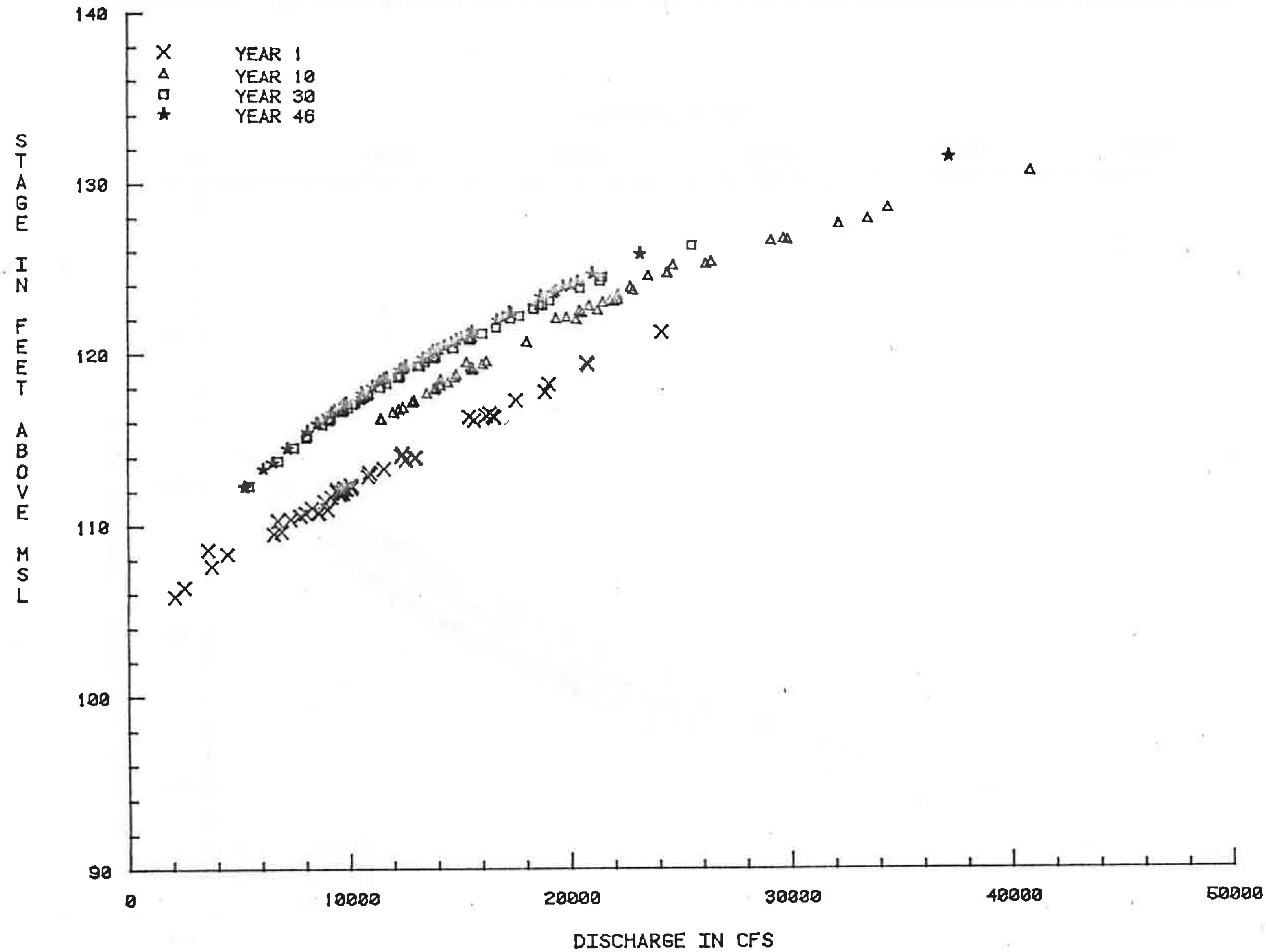

Figure D-10. Stage-discharge relationship at Greenwood for Alternative C.

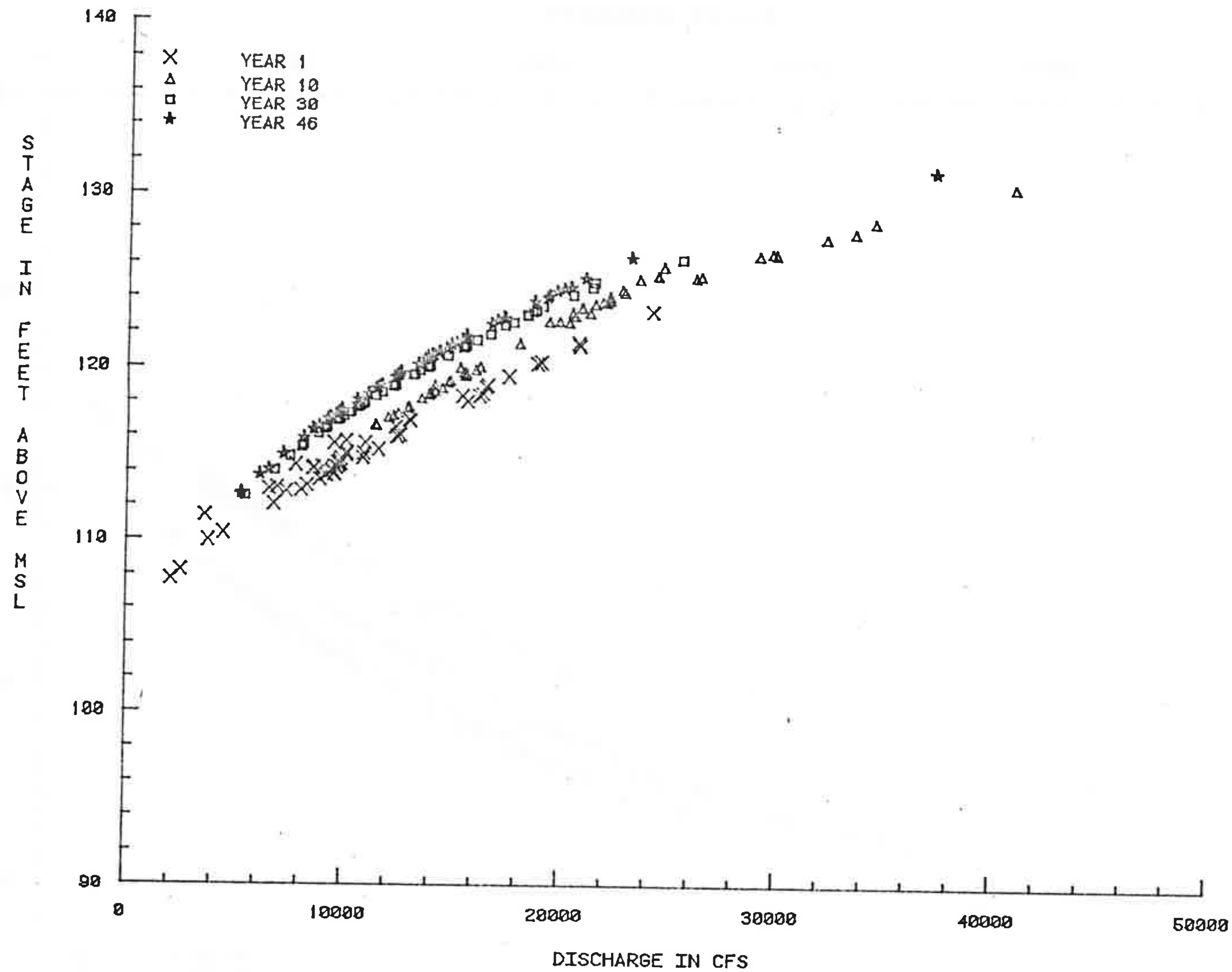

Figure D-11. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative C.

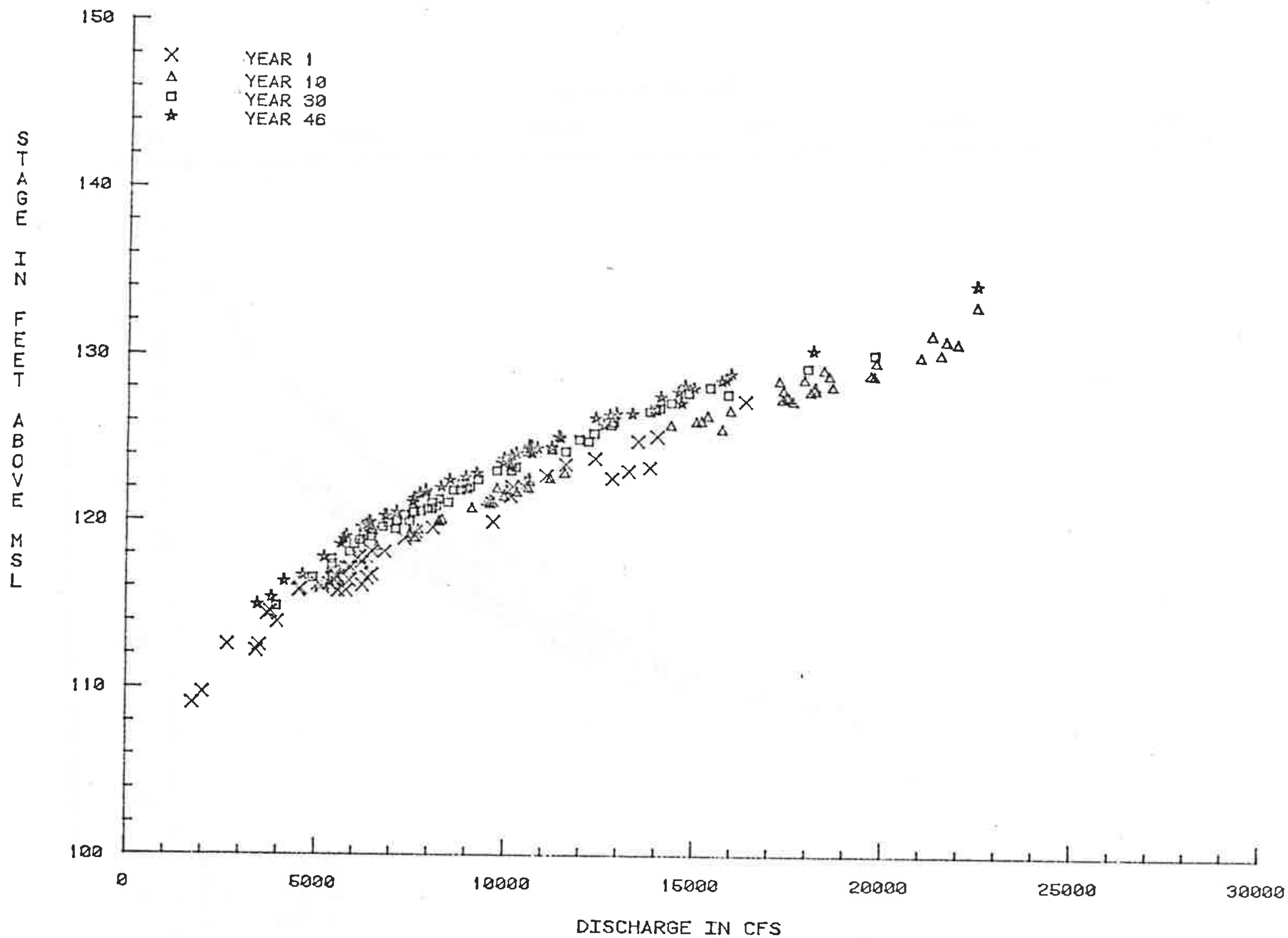

Figure D-12. Stage-discharge relationship at Money for Alternative C.

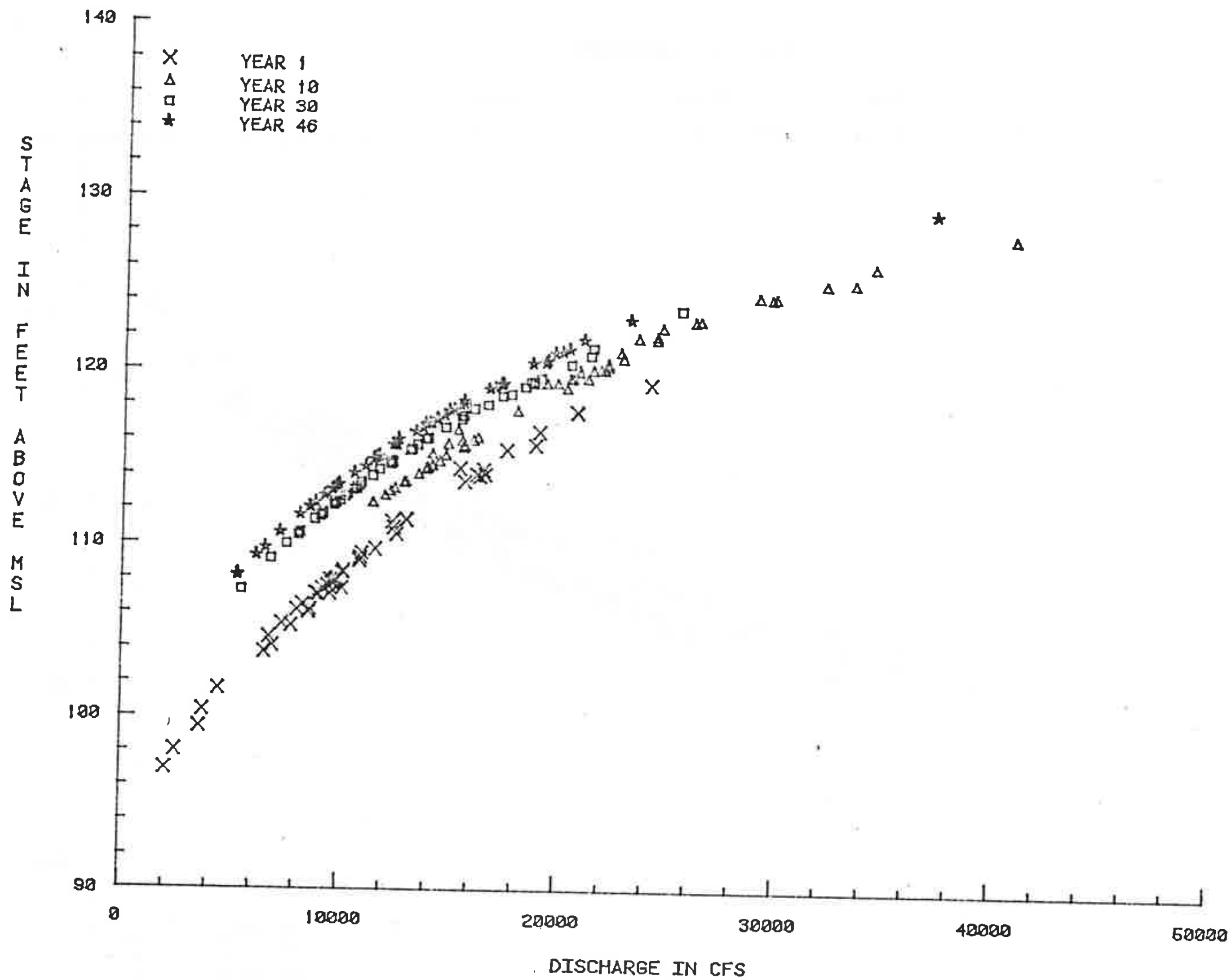

Figure D-13. Stage-discharge relationship at River Mile 162.5 for Alternative D.

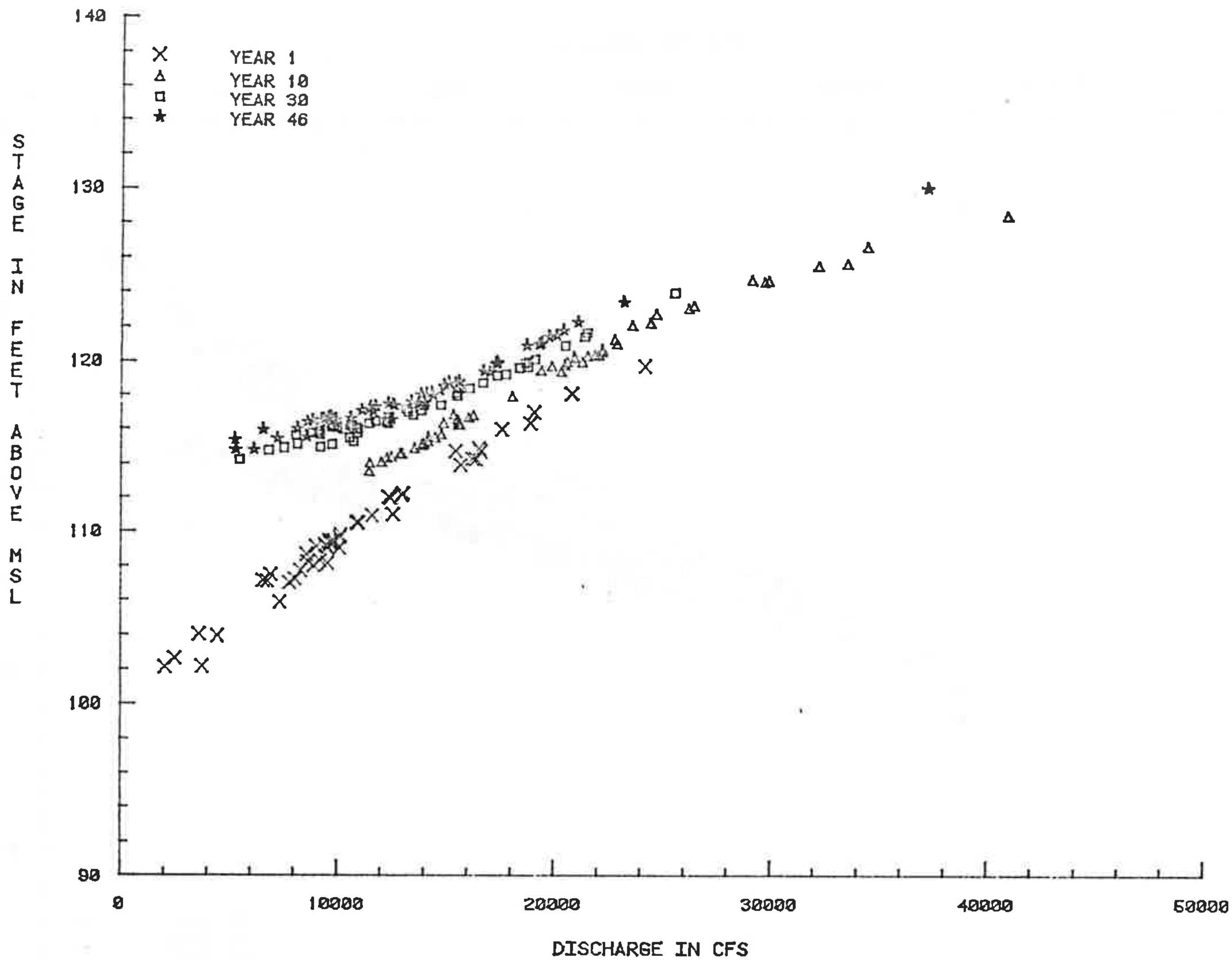

Figure D-14. Stage-discharge relationship at Greenwood for Alternative D_3.

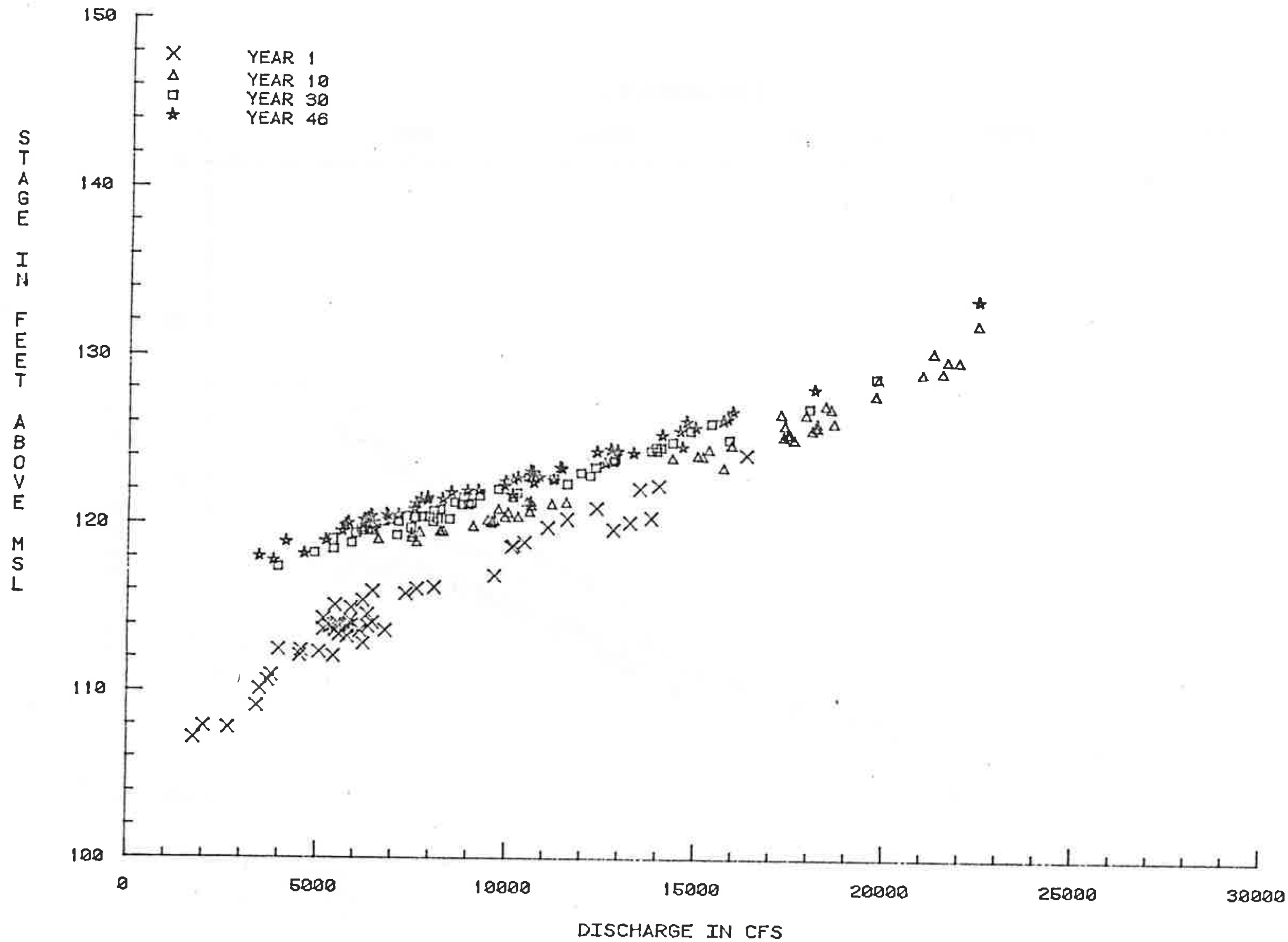

Figure D-15. Stage-discharge relationship at Money for Alternative D.

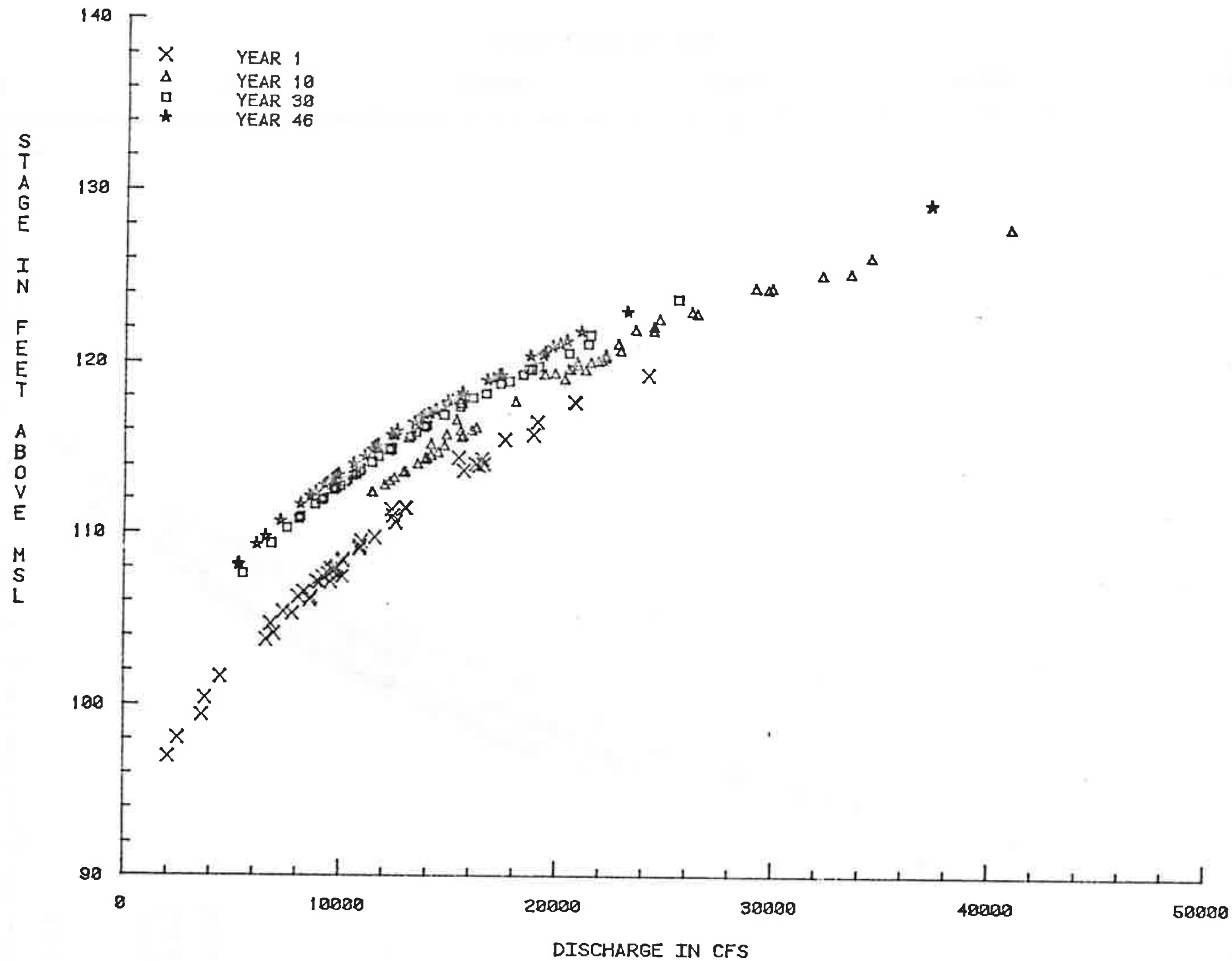

Figure D-16. Stage-discharge relationship at River Mile 162.5 for Alternative E.

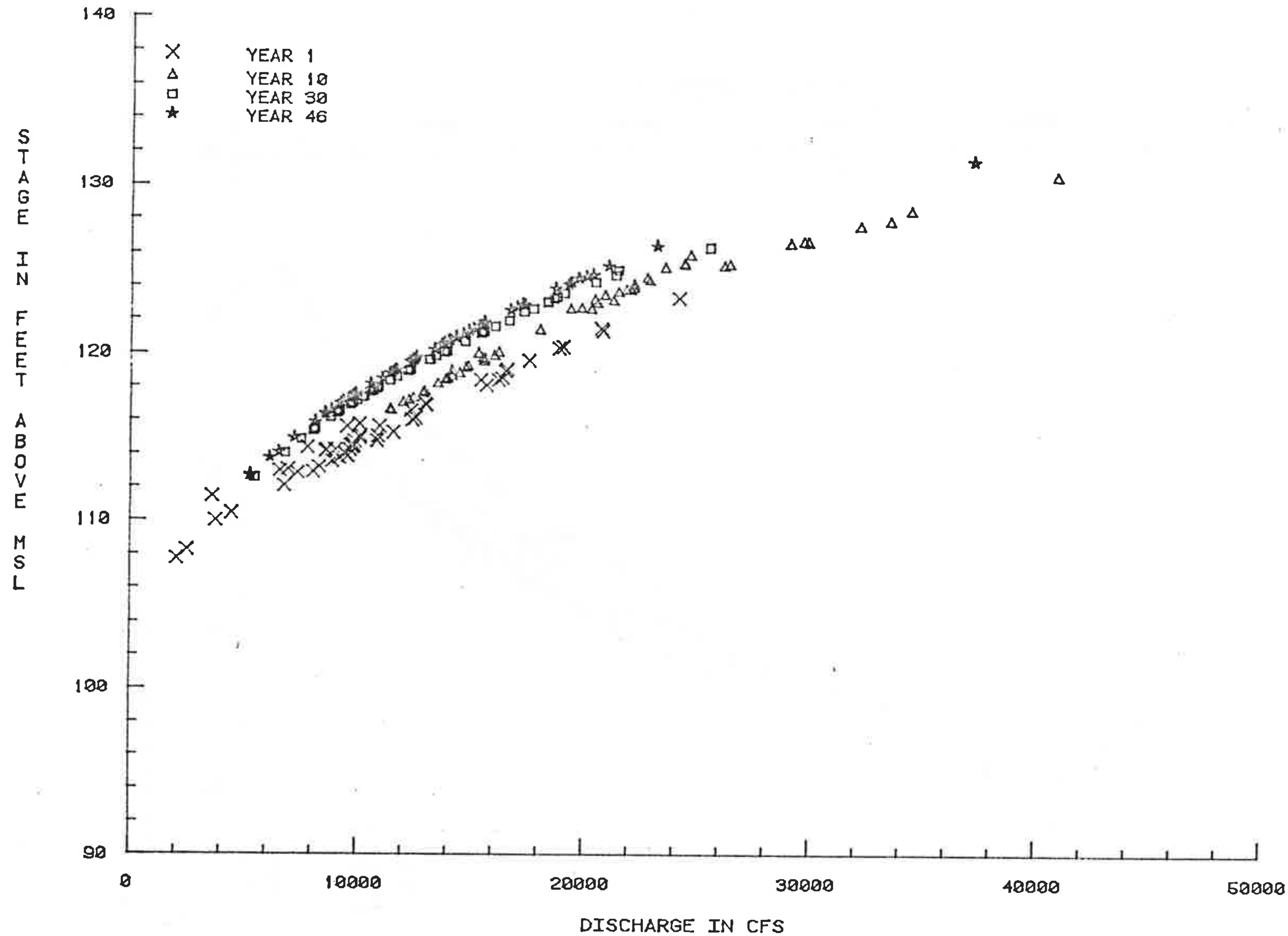

Figure D-17. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative E.

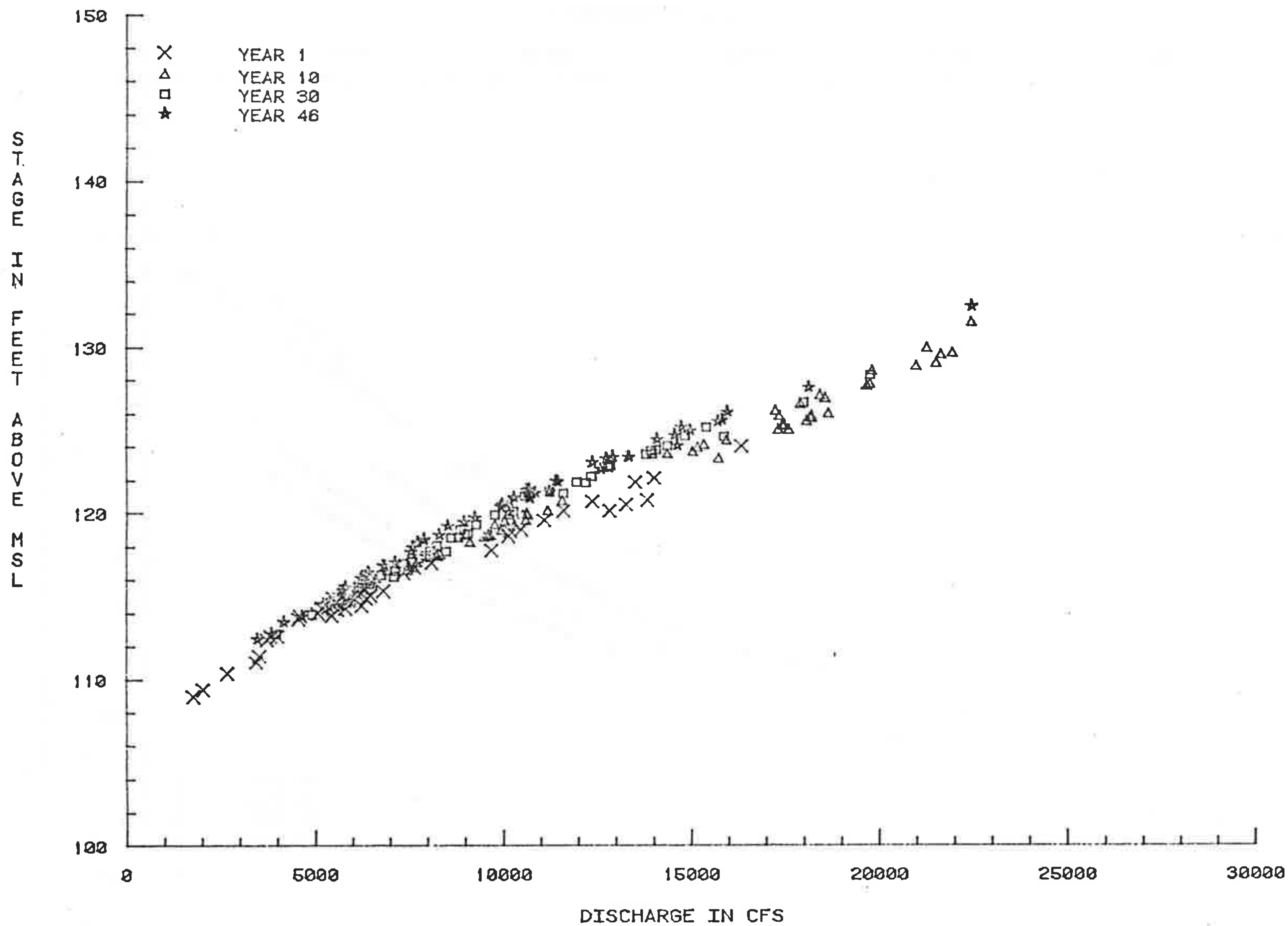

Figure D-18. Stage-discharge relationship at Money for Alternative E.

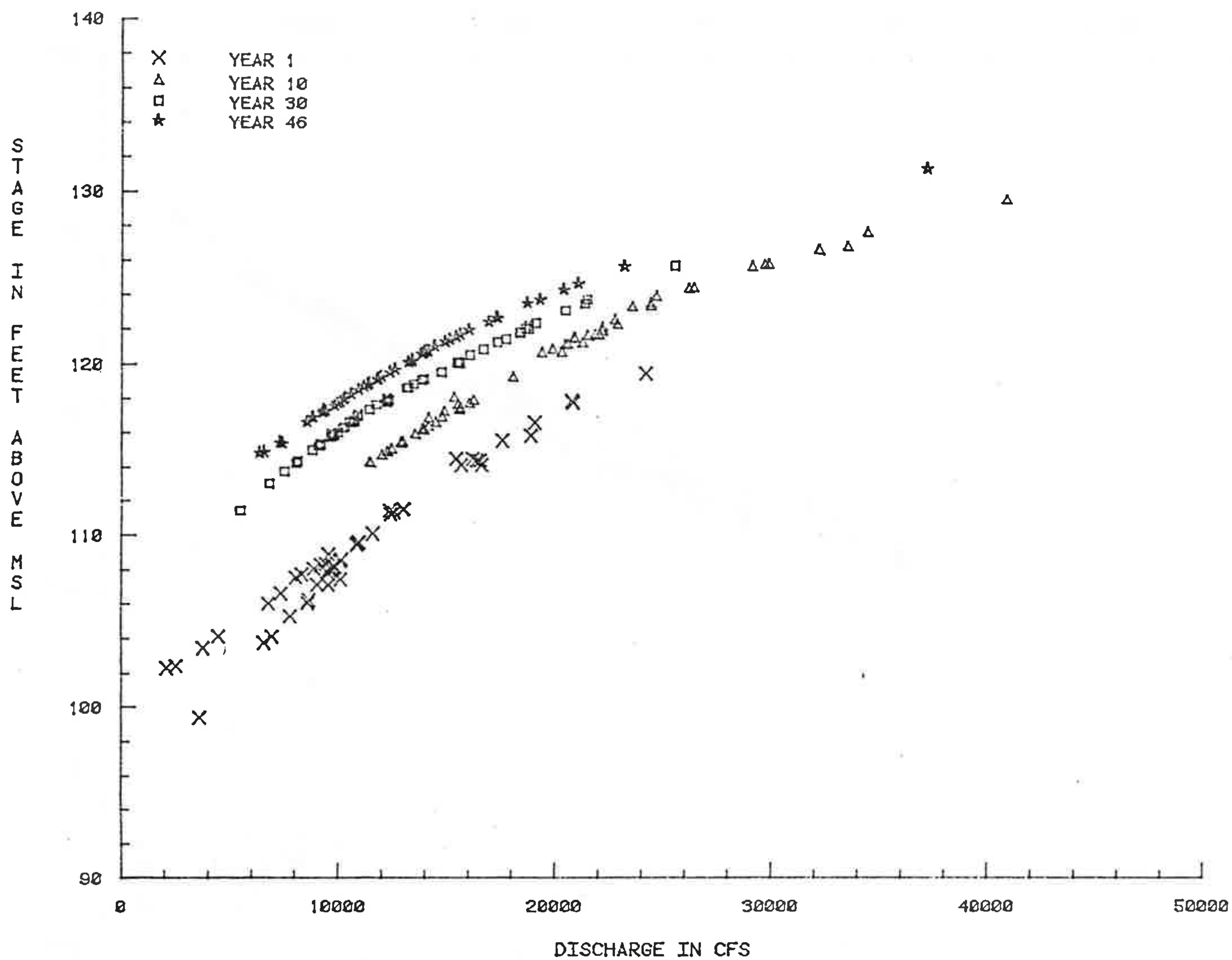

Figure D-19. Stage-discharge relationship at River Mile 162.5 for Alternative F.

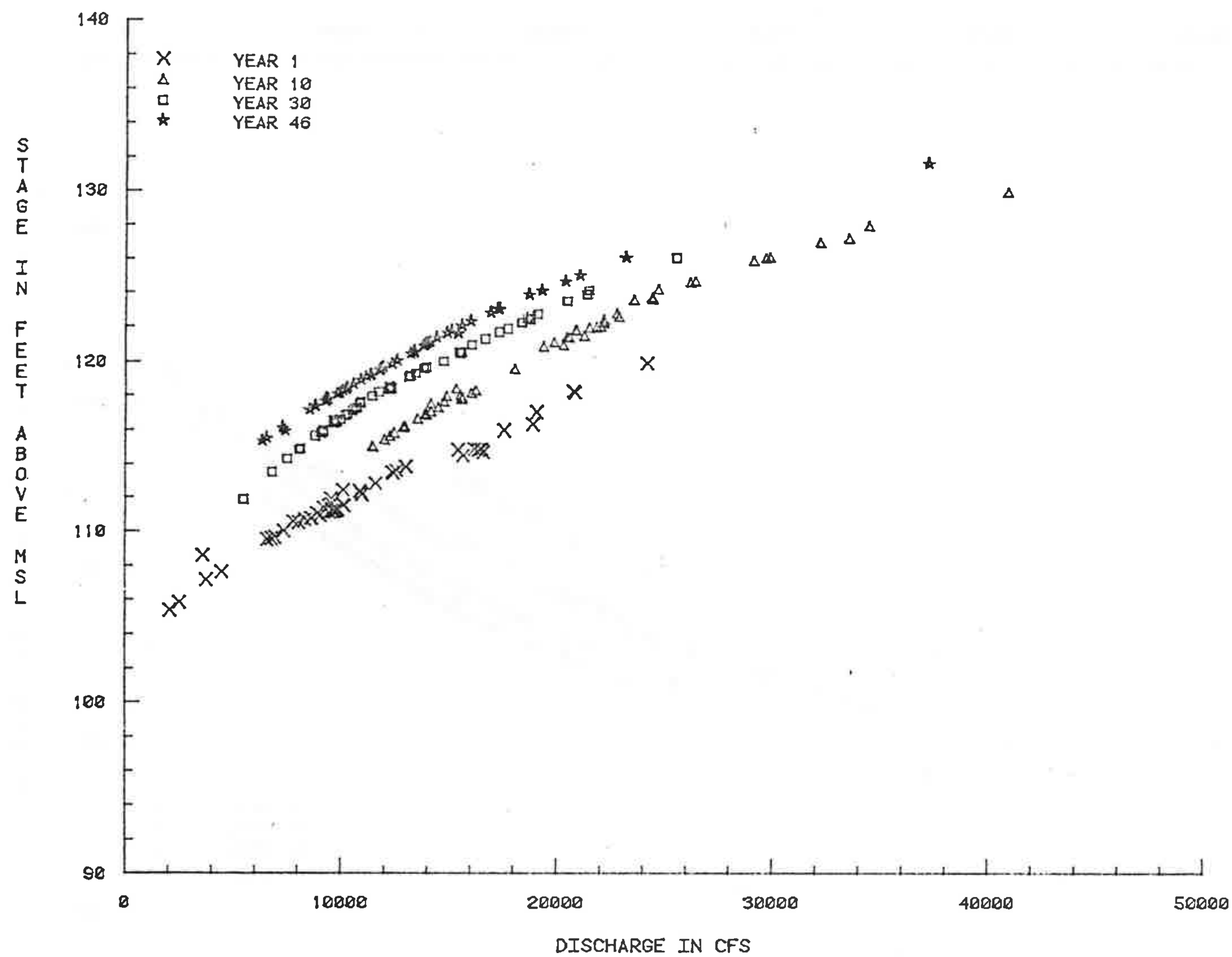

Figure D-20. Stage-discharge relationship at Greenwood for Alternative F.

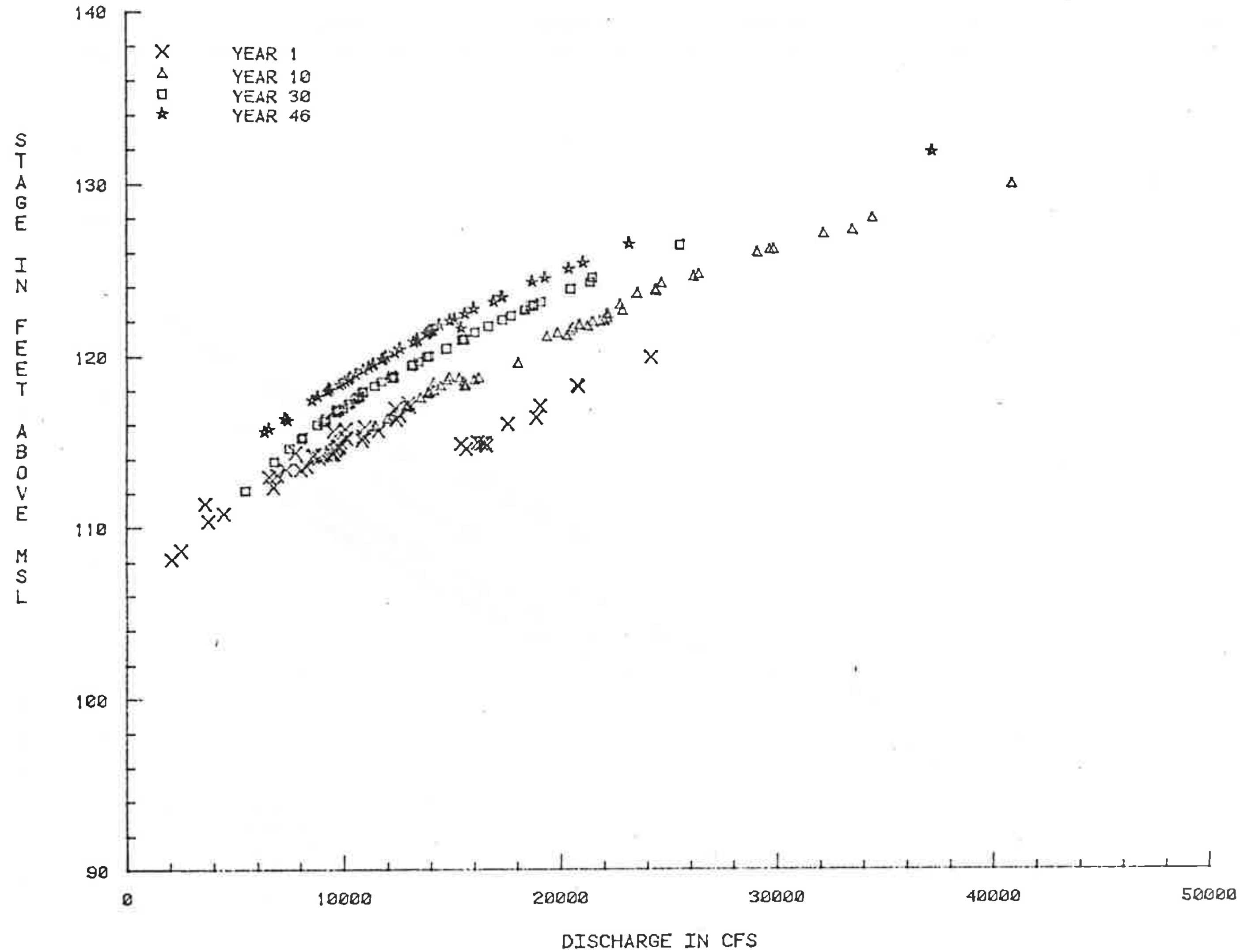

Figure D-21. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative F.

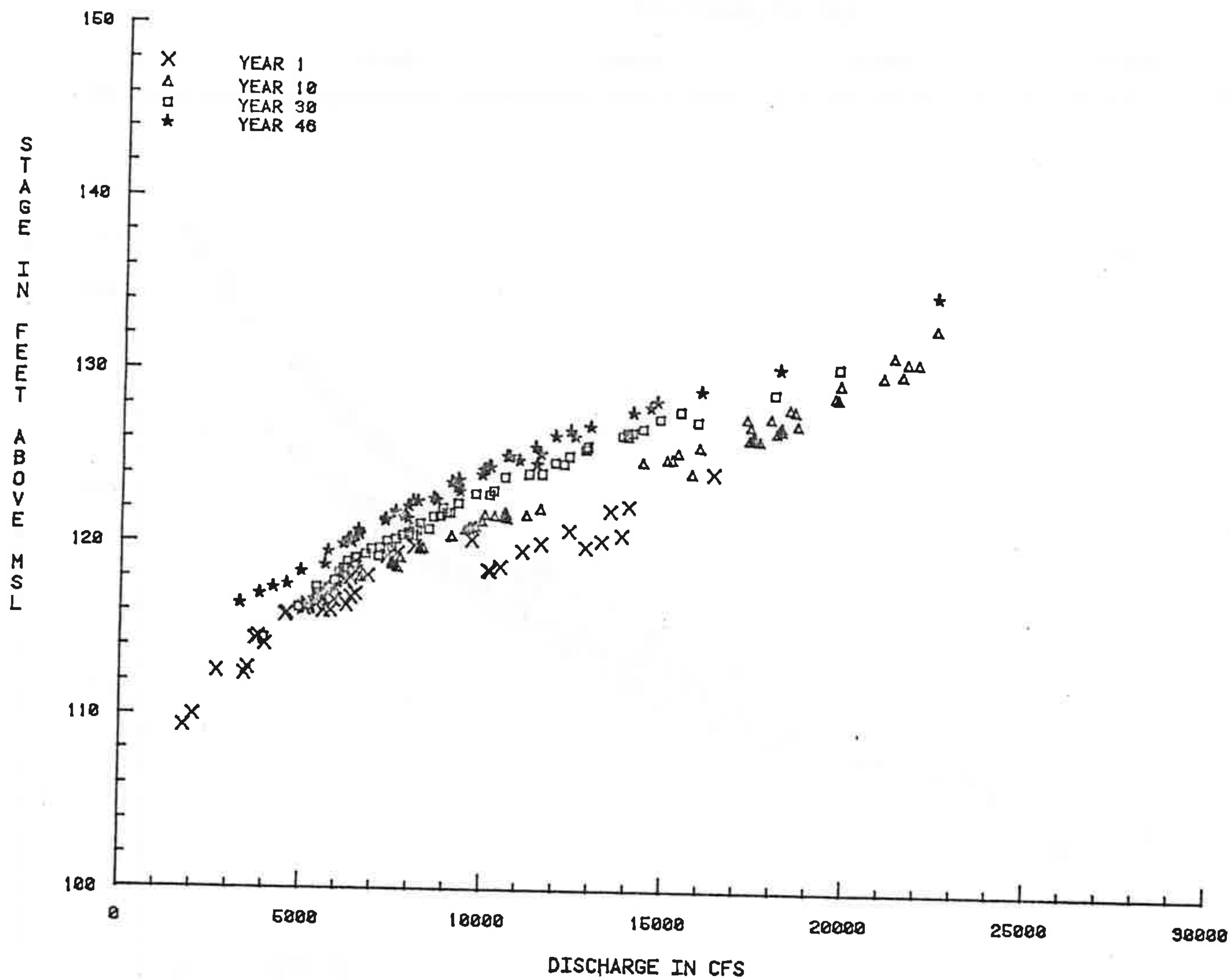

Figure D-22. Stage-discharge relationship at Money for Alternative F.

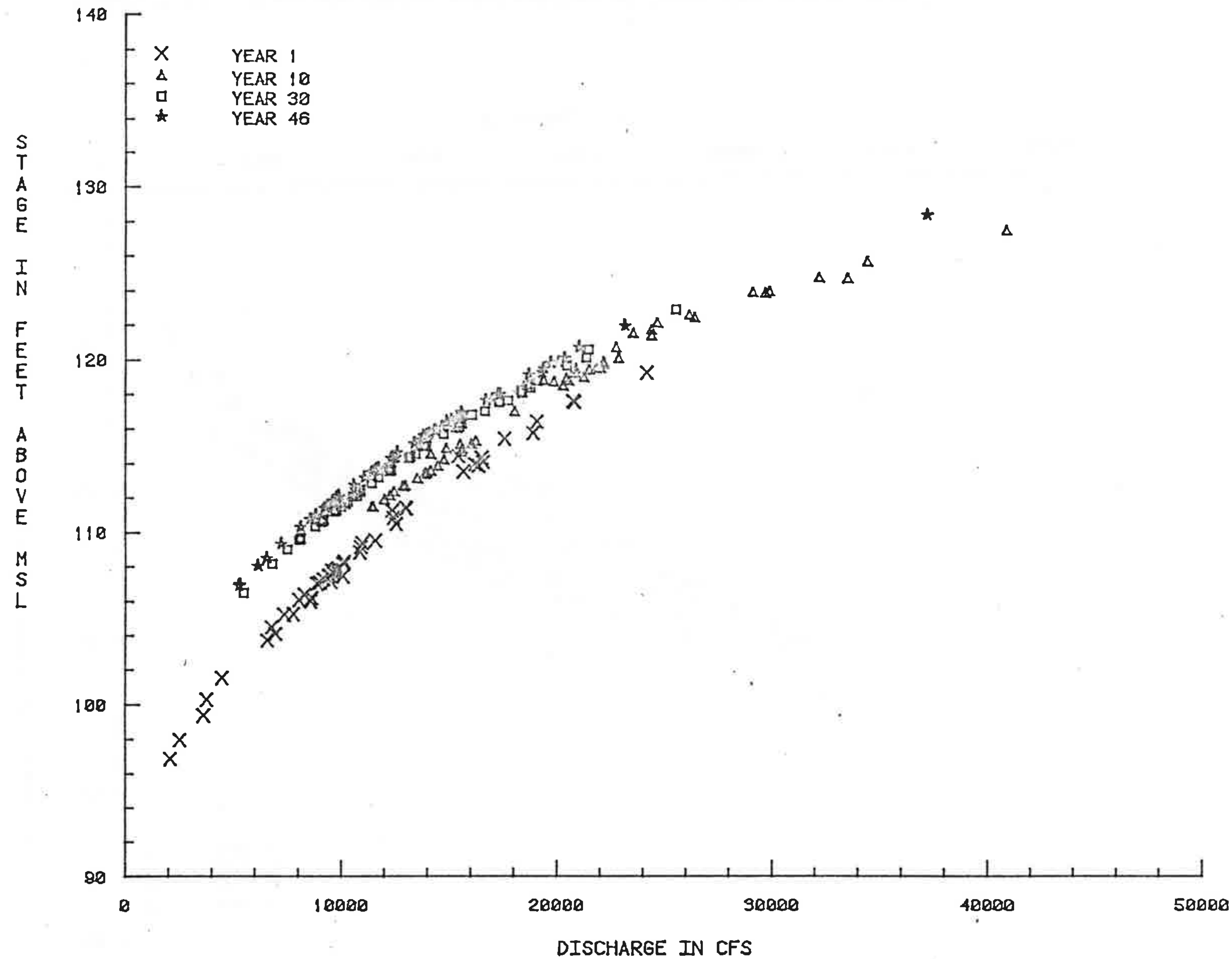

Figure D-23. Stage-discharge relationship at River Mile 162.5 for Alternative G.

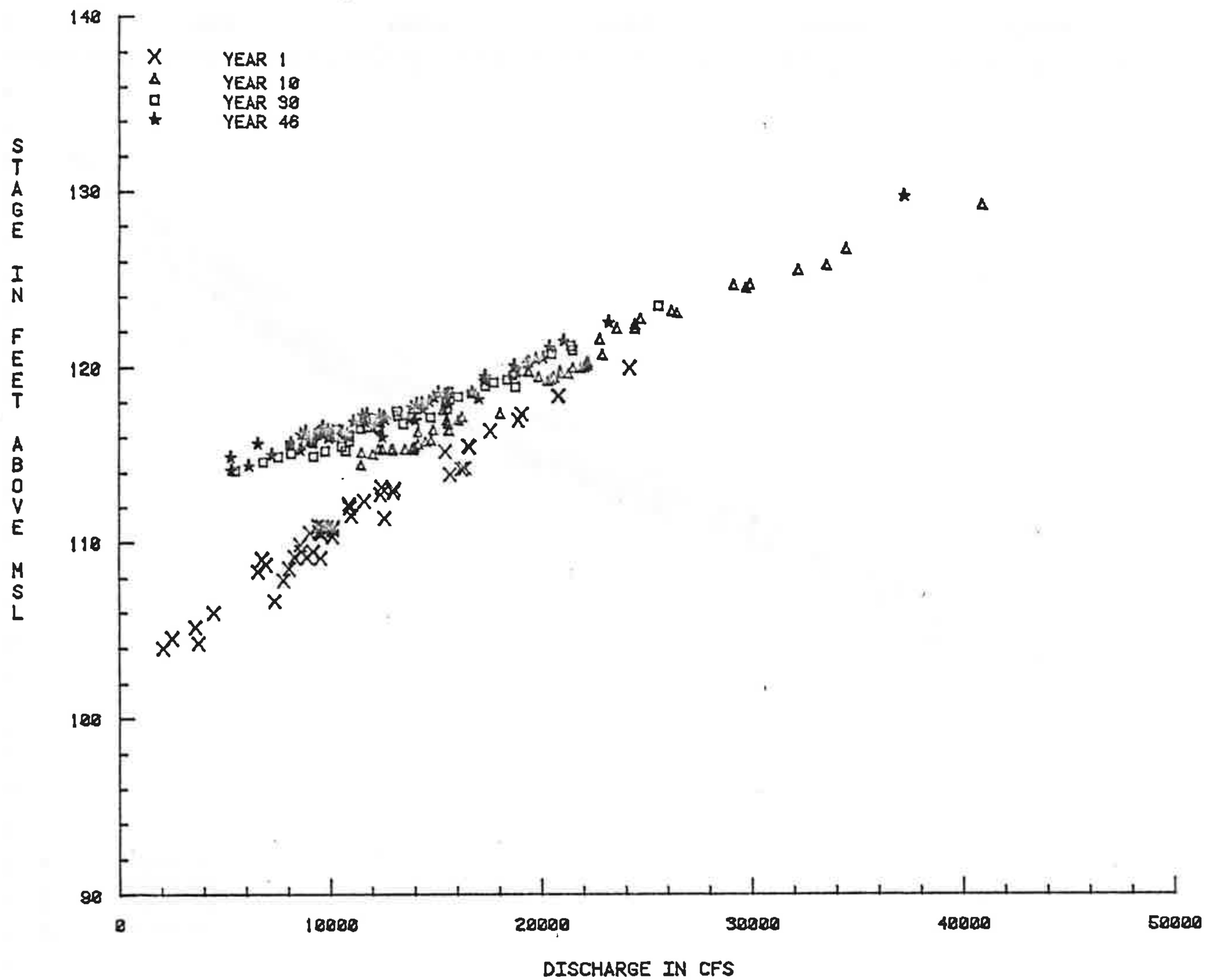

Figure D-24. Stage-discharge relationship for Tallahatchie at Greenwood for Alternative G.

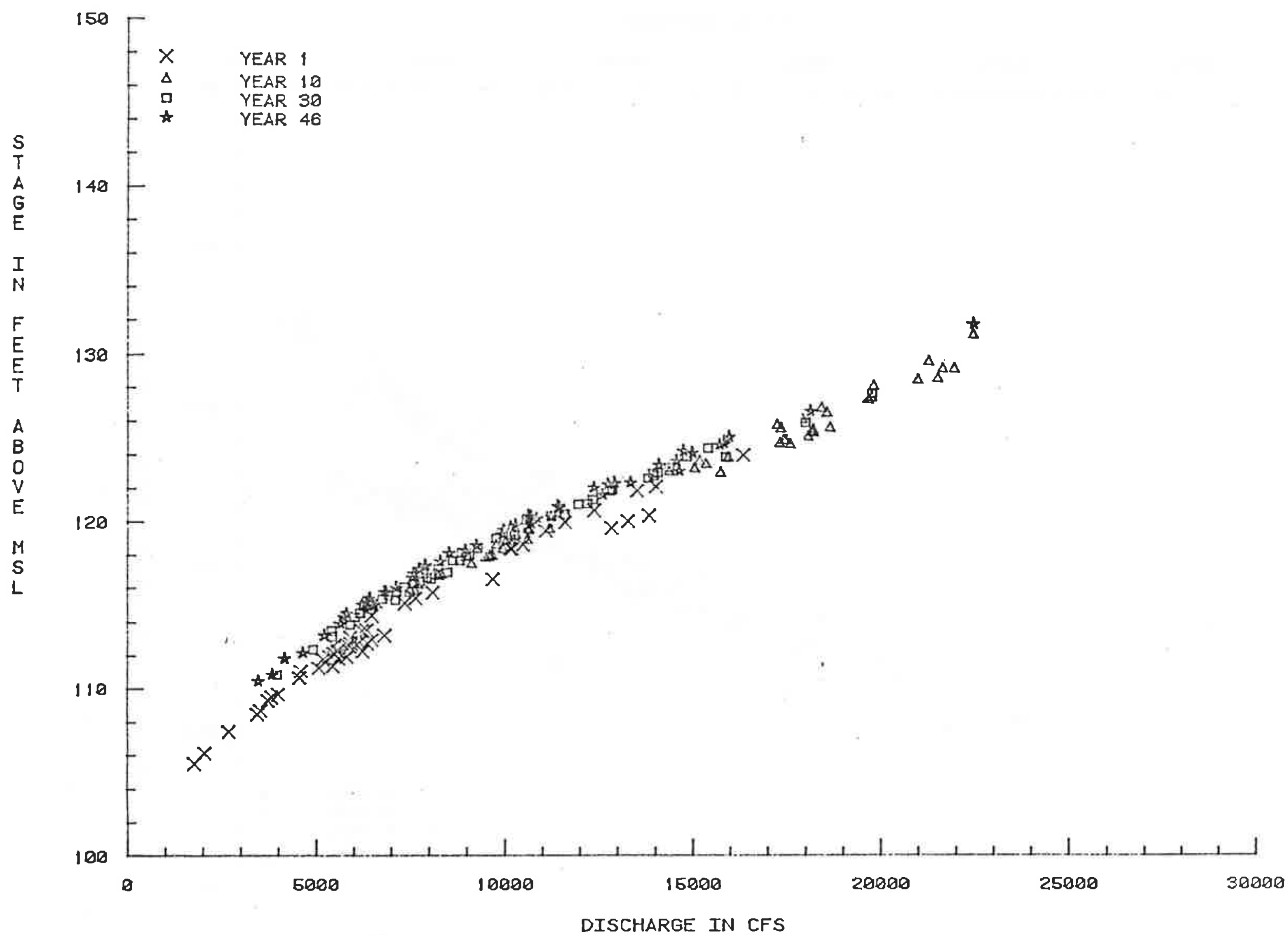

Figure D-25. Stage-discharge relationship at Money for Alternative G.