LAKE TEXANA

1991 Sedimentation Survey

Operated by
Lavaca-Navidad River Authority
Edna, Texas

United States Department of the Interior
Bureau of Reclamation

7-2090 (4-81)
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16. ABSTRACT

Lake Texana was surveyed in 1991 to compile field data needed to compute the reservoir capacity. The data were also used to compute the volume of sediments that had accumulated in the reservoir since storage began in May 1980. Sonic depth recording equipment and electronic distance measuring equipment were used to run the bathymetric survey. Reservoir capacity was computed based on surface areas determined by a width adjustment method.

The capacity of the reservoir at elevation 44.0 is now 163,506 and the surface area is 10,134 acres. Since 1980, sediments accumulated to a volume of 3,787 acre-feet, which represents 2.3-percent loss of reservoir capacity.

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LAKE TEXANA
1991 SEDIMENTATION SURVEY

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CONTENTS

Tables

Figures

CONTENTS – Continued

Page

Figures – Continued

INTRODUCTION

Palmetto Bend Dam was the first major feature constructed by the Bureau of Reclamation (Reclamation) as part of the Palmetto Bend Project. Construction of the dam began in 1976 and was essentially completed in 1980. Water storage operations were begun in May 1980. The Lavaca-Navidad River Authority (LNRA) of Edna, Texas manages and operates the dam, reservoir, and all recreational facilities on the project. Located on the Navidad River in Jackson County about 7 miles southeast of Edna and 90 miles southwest of Houston (figure 1), the dam is the first stage of the multipurpose project developed to supply water for municipal and industrial use, for conserving fish and wildlife resources, and for recreational use.

The dam extends across the Navidad River along an axis about 4 miles upstream of the confluence of the Lavaca and Navidad Rivers. The dam is a zoned embankment structure with a structural height of 93 feet. The dam crest rises to a maximum height 55 feet above sea level and 69 feet above original streambed which is 14 feet below sea level. The dam has a crest length of 7.9 miles, a maximum base width of 820 feet, a maximum crest width of 42 feet in the typical flood plain sections, and contains a total volume of 5,991,000 cubic yards of soil and rock materials. The spillway is a concrete overflow weir controlled by twelve 22.6 x 35 foot radial gates with a discharge capacity of 190,000 cubic feet per second at elevation 47.0. The general plan and sections of the dam, spillway, and outlet works are shown on figure 2.[1][1]

Since the dam is in the tidewater area of the Gulf of Mexico it is subject to high tidal surges caused by hurricanes. Special treatment on the face of the dam slopes and extra steel anchors in the concrete spillway provide additional protection during hurricane conditions.

In 1980 at the beginning of operations the reservoir at elevation 44.0 had a surface area of 10,141 acres and a total capacity of 167,293 acre-feet. The reservoir space allocations include 20,700 acre-feet allowance for 100 years of sediment deposition between the streambed and elevation 44.0, of which 15,200 acre-feet is in active storage above elevation 15.0.

Lake Texana has a length of 41.9 miles and an average width of 0.46 miles. The length is the sum of the lengths of all significant arms of the reservoir. The average width is determined by dividing the surface area by the reservoir length. The reservoir includes an 18 mile reach within the Navidad River Valley and the lower portions of the Mustang Creek and Sandy Creek valleys.

The total Navidad River drainage area above the dam is 1,404 square miles, all of which contribute sediment inflow. The drainage basin is about 71 miles in length with an average width of 19.8 miles.

[1] Numbers in the brackets refer to the bibliography.

SUMMARY AND CONCLUSIONS

This report presents the results of an investigation to monitor changes in Lake Texana after 11.1 years of reservoir sediment accumulations. It also briefly describes the field surveying procedures and equipment used in the investigation.

The primary purpose of running the 1991 survey was to gather data needed to compute the capacity of Lake Texana for operation of the reservoir. New capacity information was needed to satisfy the state water rights permit issued to LNRA and the Texas Water Development Board requiring that sediment survey data and corrected area and capacity tables for Lake Texana be submitted to the Texas Water Commission in 1992.

Standard land surveying methods were used to augment previously established horizontal control for the survey. The hydrographic survey was completed using sonic depth recording equipment together with both land based electronic distance measuring (EDM) equipment and an automated survey system with a line-of-sight electronic positioning unit. The system continuously recorded reservoir depths and horizontal distances from a fixed point as the boat was steered across the range line. Reservoir water surface elevations read on the gage at the dam were used as control in converting sonic depth measurements to true bottom elevations and to delineate the cross-sectional profiles.

The capacity of the reservoir from the 1991 survey was determined to be 163,506 acre-feet, with a surface area of 10,134 acres at the top of conservation elevation 44.0. The reservoir area and capacity tables were produced by a computer program which uses measured contour surface areas and a curve-fitting technique to compute both area and capacity at prescribed elevation increments.

A comprehensive summary of the reservoir sediment data for the 1991 survey is contained in table 1. The volume of sediments that have accumulated in the reservoir since the initial filling amounted to a total volume of 3,790 acre-feet below maximum water surface elevation 47.0 or 3,787 acre-feet below top of conservation elevation 44.0, indicating a loss in capacity of about 2.3 percent. An average annual sediment accumulation rate of 341 acre-feet was determined for the period from May 1980 to June 1991. The sediment yield rate from the drainage area was 0.243 acre-feet per square mile per year for the same period.

DESCRIPTION OF BASIN

Topography of the Navidad River drainage basin is varied. Figure 3 shows the limits of the drainage basin including Lake Texana. The basin extends upstream from sea level at the base of the dam to a maximum elevation of about 400 feet near La Grange, Texas. There are no major reservoirs in the river basin above Palmetto Bend Dam, although there are some small diversions from the river for irrigation purposes. The northern portion of the drainage basin can be characterized as rolling topography resulting in relatively high runoff peaks from the area, whereas the southern portion of the basin has very flat coastal plain topography with a considerable area devoted to rice growing which tends to dampen the runoff peaks due to water retention. Soils in the western portion of the basin are largely clay loam with relatively low retention rates. Soils in the eastern portion are quite sandy with higher retention rates. Dense tree growth in portions of the flood plain adjoining the stream channels also slow runoff during flood events. The mean annual precipitation over the basin is about 38 inches resulting in a mean annual runoff of about 411,000 acre-feet at Palmetto Bend Dam.[1] The bar graph on figure 4 shows how the annual inflow to the reservoir has varied since storage began.

SURVEYS

Survey History

The original sediment ranges were surveyed by Reclamation from 1977 to 1980. The original contour surface areas were obtained from U.S. Geological Survey 7.5 minute quadrangle maps developed from photographic data obtained in 1962. Field work for the 1991 survey began in June, 1990 and was essentially completed by June 30, 1991. A layout of the reservoir sediment range system is shown on figure 5.

Survey Methods and Equipment

The preliminary field work for the 1991 survey consisted of locating and flagging the existing sediment range end markers and relocating those which had been lost or destroyed. To prepare for the range line resurvey, a line clearing program was conducted in the reservoir area along most of the range lines to improve line of sight conditions from the range monuments to water's edge. Standard land surveying procedures and equipment were used to profile 5 range lines in the upper reach of the Navidad River and tributaries.

The hydrographic survey was completed in June, 1991 using sonic depth recording equipment to sound the underwater portion of 25 range lines. Procedures described by Blanton [2] were followed as closely as possible. For seven of the longer range lines, located in the most downstream portion of the reservoir, the surveyed range distances were obtained by the automated survey system using a single Mini-Ranger III receiver/transmitter set up at one range end. As the boat proceeded along the line range distances at selected intervals were read and recorded as marks on the sonar chart. For 18 of the shorter range lines, located in the upstream portion of the reservoir, a small boat system was used. The range distances were determined by an electronic distance measuring (EDM) instrument set up on a control point on one bank aimed at a reflector target mounted on the survey boat. Range distances were communicated by radio from shore to the boat at preselected intervals and marked on the sonar charts as the boat proceeded on line across the reservoir. For both procedures the boats were kept on line by radio communication between the shore station operator and the boat crew. Auxiliary field equipment included hand-held radios for communication between shore and boat crews and another small boat to move personnel and equipment around the reservoir.

RESERVOIR SEDIMENT DISTRIBUTION

Longitudinal distribution

The distribution of sediment throughout the length of the reservoir is illustrated in part by plots of the thalweg profiles representing the original and 1991 resurveyed profiles shown on figures 6, 7, and 8. Thalweg elevations representing original reservoir conditions are taken from the original range survey notes. Except for the possibility of some missed low point soundings during the original survey the plotted profiles should closely resemble actual channel bottom conditions during the original range survey completed in 1977 and 1978. Thalweg elevations for the 1991 profiles were derived from the sonar charts and from field notes of the ground survey. Except for some minor inaccuracies in sounding, the bottom of these profiles should closely represent channel bottom conditions along the thalweg at the time of the 1991 resurvey.

The profiles of the Navidad River (figure 6) show some lower thalweg elevations in 1991 than those measured in the original survey at Ranges 9, 10, and 14, whereas the elevations would be expected to be higher due to sediment deposits. Several plausible explanations can be given for these differences, one being that some minor river scour may have occurred in these upstream locations during high inflow events, or another being that some error in sounding or probing may have occurred in either the original or 1991 resurvey. An examination of the original and 1991 data tend to support the measured profiles indicating the possibility that some scour has occurred.

The profiles for Mustang Creek (figure 7) show the 1991 thalweg profile roughly paralleling the original profile except at Range 26 where the 1991 thalweg is below the original. This could be due to stream bed scour or an error in either the original or 1991 soundings. Future resurveys may help to explain this difference.

The profiles for Sandy Creek (figure 8) from Range 53 upstream appear normal for a reservoir with small sediment inflow operated at near full conditions most of the time. At Ranges 51 and 52, however, the 1991 thalweg elevations are lower than the original thalweg elevations. An examination of the bottom portion of the original profile data revealed range width intervals of 43 feet and 38 feet for Ranges 51 and 52 respectively where no bottom soundings occurred. This would suggest the possibility that the maximum depths of these range lines were not sounded during the original survey.

These problems with the original and 1991 thalweg profiles are confined to the very narrow river channel areas and had no significant effect on the sediment volume computations. In those locations where scour may have occurred it would be confined to the narrow stream channel and may not extend very far upstream or downstream of the sediment range where it may have occurred, unlike what appears to be the case on the thalweg profile plots.

Lateral distribution

Ground profiles for the 34 original sediment ranges are shown on figures 9 through 42. The 1991 range profile data is superimposed on these plots to indicate the changes which have occurred and to represent in general the lateral distribution of sediment within the reservoir. No resurveys were accomplished on Ranges 27 , 28, and 43 on Mustang Creek or Range 56 on Sandy Creek. These omissions have no significant impact on storage capacity computations since these ranges are all in the extreme upstream part of the reservoir where very little sediment deposition has occurred.

The comparative plots of Range 8 on figure 16 show significant differences in elevations near the right bank, the south side of the range line. The bathymetric survey of this range line in 1991 was run in two parts with the distance meter set at Station 22+33 for both parts. The main channel portion in the direction of the left bank was surveyed with little difficulty. The overbank portion toward the right bank required much maneuvering of the survey boat to avoid vegetation growth, which may have led to some data being collected considerably off-line. Assuming that the original survey through this portion was made with dry land conditions along a cleared alinement, this is the most likely explanation. These measured differences along the right bank portion were not used in the reservoir capacity computations.

Depth Distribution

Of special interest for future reservoir planning, a theoretical distribution of sediment in the reservoir was computed (table 2) using the Alternate Area-increment Method [3]. The method was used in lieu of the preferred Empirical Area-increment Method since the reservoir condition with the small quantity of sediment deposition did not lend itself to an application of the preferred method. The total 1991 sediment volume of 3,790 acre-feet was assumed in the distribution. The depth-capacity relationship plotted on figure 43, indicating the reservoir to be a Type II [3], did not apply since the Alternate Area-increment Method of distribution was used. Sediment distribution results are tabulated on columns (8), (9), and (10) of table 3. These computations indicate the sediment would reach an elevation of 2.2 feet by 1991, whereas the measured elevation of sediment at the dam was -3.6 feet mean sea level. The sediment distribution curves on figure 44 show how the measured distribution compares with the theoretical distribution by the Alternate Area-increment Method. The curves show percentage of depth plotted against percentage of sediment deposited.

SEDIMENT ANALYSES

Sediment Accumulation

Sediments have accumulated in Lake Texana to a total volume of 3,790 acre-feet at elevation 47.0, maximum water surface, and 3,787 acre-feet at elevation 44.0, top of conservation, since storage began in May 1980. An average annual accumulation rate of 341 acre-feet was computed for the 11.1 year period of operation. The net sediment accumulation rate from the contributing basin was 0.243 acre-feet per square mile per year for the same period.

The results of the sediment volume computation are shown in table 3 . Column 2 in the table gives the original measured contour areas used in the original area and capacity computation with the exception of the interpolated values at Elevation 44 and 47. In order to make a valid comparison with the 1991 computed values, these original capacity values were recomputed by current methods using the same original surface areas. Thus the capacity values in column 3 differ somewhat from those found in the original (1982) area and capacity tables [4]. The difference is due to differences between the cubic spline curve fitting technique used for producing the 1982 tables and the least squares curve fitting technique used for producing the recomputed tables. While the cubic spline technique has been used occasionally in the past, Reclamation no longer recommends use of the method since it distorts the area curve, which is the basis for the capacity computation.

The annual sediment yield from the basin during the 11.1 year period of 341 acre-feet, based on the recomputed results, is greater than the yield estimated during the project planning stage. This higher annual yield should not be used for making long term projections of storage loss. The increase is probably due to the fact that the annual inflow for five of those 11.1 years was about 1.9 times the long term mean annual inflow, and the average annual inflow for the period was 1.3 times the long term mean annual inflow (see No. 24 and No. 45 of table 1).

Reservoir sedimentation summary

A summary of the reservoir sediment data for the 1991 survey is contained in table 1. The data include a tabulation of incremental sediment inflow volume and sediment accumulation computed for the period between initial 1980 conditions and the 1991 resurvey. Also included are information on the drainage basin, records of inflow, reservoir operations and reservoir storage. These data are considered of value for practical and research studies.

RESERVOIR AREA AND CAPACITY

The 1991 reservoir surface areas were computed by the Width Adjustment Method described by Blanton [2]. Briefly the method entails computing the revised contour areas between any two ranges by applying an adjustment factor to each of the original segmental contour areas between adjacent ranges. The adjustment factor is determined as the ratio of the new average width to the original average width for both the upstream and downstream ranges at a specified contour. Computations were facilitated by subdividing the reservoir into segments using the sedimentation range lines to delineate the limit of each segmental boundary. Segmental contour areas for each elevation were determined by digitizing the segmental contours on the original topography. For any given contour elevation, the original segmental area was multiplied by the adjustment factor to obtain the 1991 surface area for that elevation. The total surface area at a given contour elevation was computed as the summation of all segmental areas at that elevation. These computations were obtained by means of the Reclamation program RESSED.

The 1991 surface areas were used as control parameters for computing the reservoir capacities by means of Reclamation's program ACAP85 [5]. The resulting surface area and storage capacity versus elevation relationships are shown graphically on figure 44. The computer program was written to include computation of 0.01 to 1.0-foot area increments by linear interpolation between measured contour areas. The respective capacities and capacity equations are then obtained by integration of the area equations. The initial capacity equation is tested over successive intervals to check whether it fits within an allowable error term. This one equation is used over the whole range that fits within this error term. At the next interval beyond, a new capacity equation (integrated from the basic area equation over that interval) begins testing the fit until it too exceeds the error term. The capacity curve thus becomes a series of curves, each fitting a certain region of data. The final area equations are obtained by differentiation of the capacity equations. Capacity equations are of the form:

$$y = a_1 + a_2x + a_3x^2$$

where: y = capacity
x = elevation above an elevation base
a_1 = intercept
a_2 and a_3 = coefficients

Results of the 1991 area and capacity computations are listed in columns (4) and (5) of table 3. Listed in columns (2) and (3) of this table are the original area and capacity values. Capacity values have been revised by using the same curve fitting technique as was used for the 1991 area and capacity computation. A special set of area and capacity tables has been published separately for the 0.01-, 0.10-, and 1-foot elevation increments[6]. Both the original and 1991 area and capacity curves are plotted on figure 44. At the top of active conservation elevation 44.0 the 1991 capacity if 163,506 acre-feet and the surface area is 10,134 acres.

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[3] "Design of Small Dams," 3rd ed., Bureau of Reclamation, Denver Office, Denver, Colorado, 1985.

[4] "Lake Texana - Area and Capacity Tables," Bureau of Reclamation, Southwest Region, Amarillo, Texas, 1982.

[5] "ACAP85 User's Manual," Bureau of Reclamation, Denver Office, Denver, Colorado, 1985.

[6] "Lake Texana - Palmetto Bend Dam - Area and Capacity Tables," Bureau of Reclamation, Great Plains Region, Billings, Montana, 1992.

RESERVOIR SEDIMENT
DATA SUMMARY

Lake Texana
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER USDI - USBR	2. STREAM Navidad River	3. STATE Texas
	4. SEC. TWP. RANGE	5. NEAREST P.O. Edna, Texas	6. COUNTY Jackson
	7. LAT 28°53'30" LONG 96°34'00"	8. TOP OF DAM ELEVATION 55.0	9. SPILLWAY CREST 44.0[1]

RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, Ac	13. ORIGINAL CAPACITY, AF	14. GROSS STORAGE ACRE-FEET	15. DATE STORAGE BEGAN
	a. FLOOD CONTROL	47.0[2]	12,364	33,110[3]	199,028	MAY, 1980
	b. MULTIPLE USE					
	c. POWER					16. DATE NORMAL OPERATION BEGAN
	d. WATER SUPPLY					4/6/82[4]
	e. IRRIGATION					
	f. CONSERVATION	44.0	9,934	157,884[3]	165,918	
	g. INACTIVE	15.0	1,639	8,034[3]	8,034	
	17. LENGTH OF RESERVOIR 41.9 MILES			AVG. WIDTH OF RESERVOIR 0.46 MILES		

BASIN	18. TOTAL DRAINAGE AREA 1,404 SQUARE MILES	22. MEAN ANNUAL PRECIPITATION 38.4[5] INCHES
	19. NET SEDIMENT CONTRIBUTING AREA 1,404 SQUARE MILES	23. MEAN ANNUAL RUNOFF 5.5[6] INCHES
	20. LENGTH 71 MILES · AV. WIDTH 19.8 MILES	24. MEAN ANNUAL RUNOFF 411,000[6] ACRE-FEET
	21. MAX. ELEVATION 400 · MIN. ELEVATION 0	25. ANNUAL TEMP. MEAN 70°F RANGE 40°F to 97°F

SURVEY DATA

26. DATE OF SURVEY	27. PER.	28. ACCL.	29. TYPE OF SURVEY	30. NO. OF RANGES OR	31. SURFACE AREA, AC.	32. CAPACITY ACRE-FEET	33. C/I RATIO AF/AF
5/30/1980			Contour(D)	5-ft	10,141[7]	167,293[7]	
6/30/1991	11.1	11.1	Range(D)	31	10,134	163,506	.398

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIP.	35. PERIOD WATER INFLOW, ACRE FEET			WATER INFLOW TO DATE, AF	
		a. MEAN ANN.	b. MAX. ANN.	c. TOTAL	a. MEAN ANN.	b. TOTAL
6/30/1991	*20-56	525,475[8]	791,571[8]	5,648,860[8]	525,475[8]	5,648,860[8]

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SEDIMENT DEPOSITS TO DATE, AF		
	a. TOTAL	b. AV. ANN.	c. /MI.²-YR.	a. TOTAL	b. AV. ANNUAL	c. /MI.²-YR.
6/30/1991	3,787 (3,790)	341 (341)	0.243 (0.243)	3,787 (3,790)	341 (341)	0.243 (0.243)

26. DATE OF SURVEY	39. AV. DRY WT. (#/FT³)	40. SED. DEP. TONS/MI.²-YR.		41. STORAGE LOSS, PCT.		42. SEDIMENT INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANNUAL	b. TOTAL TO DATE	a. PER.	b. TOT.
6/30/1991	no data		no data	0.20 (0.20)	2.26 (2.26)	no data	

* Estimated

Table 1.—Reservoir sediment summary

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW AND ABOVE CREST ELEVATION									
	44-39	39-34	34-29	29-24	24-19	19-14	14-9	9-4	4-0	0-(-6.0)
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION									
6/30/91	0.1	5.6	8.4	13.2	20.2	20.8	18.2	11.3	2.1	0.1

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR														
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-105	105-110	110-115	115-120	120-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														
6/30/91	N/A														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.[9]	MIN. ELEV.[9]	INFLOW, AF[8]	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF
1980	33.93	unavailable	unavailable	1981	41.75	31.85	778,740
1982	43.32	41.36	735,728	1983	44.00	42.16	791,571
1984	43.32	42.47	371,969	1985	43.44	42.40	716,281
1986	43.33	42.67	450,086	1987	44.21	42.59	779,903
1988	43.13	41.56	188,928	1989	43.13	41.90	241,688
1989	43.13	41.90	241,688	1990	43.13	42.04	164,600
1991[11]	43.02	41.36	429,366				

46. ELEVATION - AREA - CAPACITY DATA FOR ORIGINAL CAPACITY[7]

ELEV.	AREA	CAP.	ELEV.	AREA	CAP.	ELEV.	AREA	CAP.
0	0	0	20	3,004	19,613	40	8,348	129,719
5	178	354	25	4,151	37,565	45	10,589	176,167
10	702	2,396	30	5,396	61,343	50	15,722	241,040
15	1,639	8,034	35	6,819	91,818			

46. ELEVATION - AREA - CAPACITY DATA FOR 1991 TOTAL CAPACITY

ELEV.	AREA	CAP.	ELEV.	AREA	CAP.	ELEV.	AREA	CAP.
0	0	0	20	2,872	19,070	40	8,314	126,610
5	165	413	25	3,976	36,190	45	10,589	173,868
10	642	2,430	30	5,256	59,270	50	15,722	239,645
15	1,571	7,963	35	6,683	89,118			

47. REMARKS AND REFERENCES

1 Top of active conservation
2 Top of surcharge - maximum water surface
3 Original storage allocations
4 Date reservoir pool reached elevation 44.0
5 Annual normal precipitation for Hallettville, Texas - Climatography of the U.S. No. 81
6 Estimated flow with future upstream conservation measures - "Project Data," USDOI, WPRS, 1981
7 Original area and capacity values recomputed by current methods for comparision with 1991 values to compute sediment deposition
8 Inflow from 1980 computed by formula: Inflow = Outflow - Δ Storage
9 From GP Regional records representing end of month storage

48. AGENCY MAKING SURVEY Bureau of Reclamation
49. AGENCY SUPPLYING DATA Bureau of Reclamation | DATE July 1992

Table 1.—Reservoir sediment summary - continued

ALTERNATE AREA - INCREMENT METHOD

1991 LAKE TEXANA SEDIMENT DISTRIBUTION

SEDIMENT INFLOW 3790.00

	ORIGINAL		SEDIMENT		REVISED	
ELEV (FT)	AREA (AC)	CAPACITY (AF)	AREA (AC)	VOLUME (AF)	AREA (AC)	CAPACITY (AF)
50.0	15722.0	243435.	77.5	3790.	15644.5	239645.
47.0	12642.0	200889.	77.5	3558.	12564.5	197331.
45.0	10589.0	177657.	77.5	3403.	10511.5	174254.
44.0	10141.0	167293.	77.5	3325.	10063.5	163968.
40.0	8348.0	130315.	77.5	3015.	8270.5	127300.
35.0	6819.0	92397.	77.5	2628.	6741.5	89769.
30.0	5396.0	61860.	77.5	2240.	5318.5	59620.
25.0	4151.0	37992.	77.5	1853.	4073.5	36139.
20.0	3004.0	20105.	77.5	1465.	2926.5	18640.
15.0	1639.0	8497.	77.5	1078.	1561.5	7419.
10.0	702.0	2645.	77.5	691.	624.5	1954.
5.0	178.0	445.	77.5	303.	100.5	142.
2.2	77.5	84.	77.5	84.	.0	0.
.0	.0	0.	.0	0.	.0	0.

S U P P L E M E N T

VS	=	AO	(	H	-	HO	) +	VO
3790.0	=	77.5	(	50.00	-	2.18	) +	84.

Table 2.—Lake Texana sediment distribution

(1) Elevation (ft)	(2) 1980 Original area (acres)	(3) 1980 Original capacity (acre-feet)	(4) 1991 Revised area (acres)	(5) 1991 Revised capacity (acre-feet)	(6) Measured sediment volume (acre-feet)	(7) Percent of measured sediment	(8) 1991 Computed capacity (acre-feet)	(9) Computed sediment volume (acre-feet)	(10) Percent of computed sediment
50	15,722	243,435	15,722	239,645	3,790	100	239,645	3,790	100
47	12,642	200,889	12,642	197,099	3,790	100	197,331	3,558	93.9
45	10,589	177,657	10,589	173,868	3,789	100	174,254	3,403	89.8
44	10,141	167,293	10,134	163,506	3,787	99.9	163,968	3,325	87.7
40	8,348	130,315	8,314	126,610	3,705	97.8	127,300	3,015	79.6
35	6,819	92,397	6,683	89,118	3,279	86.5	89,769	2,628	69.3
30	5,396	61,860	5,256	59,270	2,590	68.3	59,620	2,240	59.1
25	4,151	37,992	3,976	36,190	1,802	47.5	36,139	1,853	48.9
20	3,004	20,105	2,872	19,070	1,035	27.3	18,640	1,465	38.6
15	1,639	8,497	1,571	7,963	534	14.1	7,419	1,078	28.4
10	702	2,645	642	2,430	215	5.7	1,964	691	18.2
05	178	445	165	413	32	0.1	142	303	8.0
2.2							0	84	2.2
0	0	0	0	0	0	0	0	0	0

Explanation of columns:
(1) Elevation of reservoir water surface
(2) Original reservoir water surface area surveyed in 1980, recomputed by current methods for comparison with 1991 results
(3) Original reservoir capacity from 1980 survey recomputed by current mehtods for comparison with 1991 results
(4) Reservoir surface area surveyed in 1991
(5) Reservoir capacity from the 1991 survey
(6) Measured sediment volume = column (3) minus column (5)
(7) Measured sediment expressed in percentage of total sediment (3,790 acre-feet)
(8) Computed 1991 reservoir capacity using area-increment method
(9) Computed sediment volume for period from 1980-1991 = column (3) - column (8)
(10) Computer sediment expressed in percentage of total sediment (3,790 acre-feet)

Table 3.—Summary of 1991 survey results and sediment distribution computations

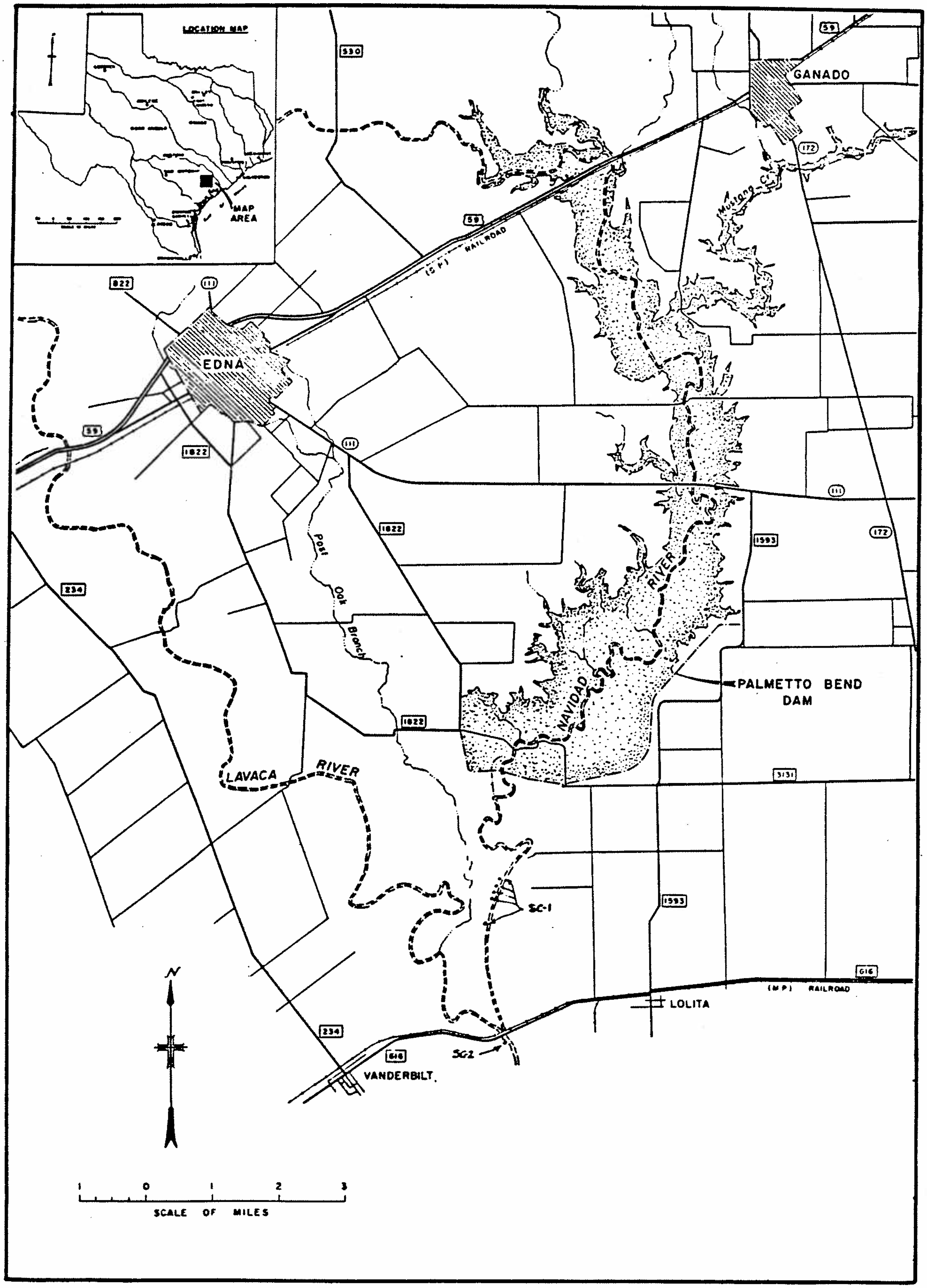

Figure 1.—Vicinity map.

Space intentionally left blank due to security concerns

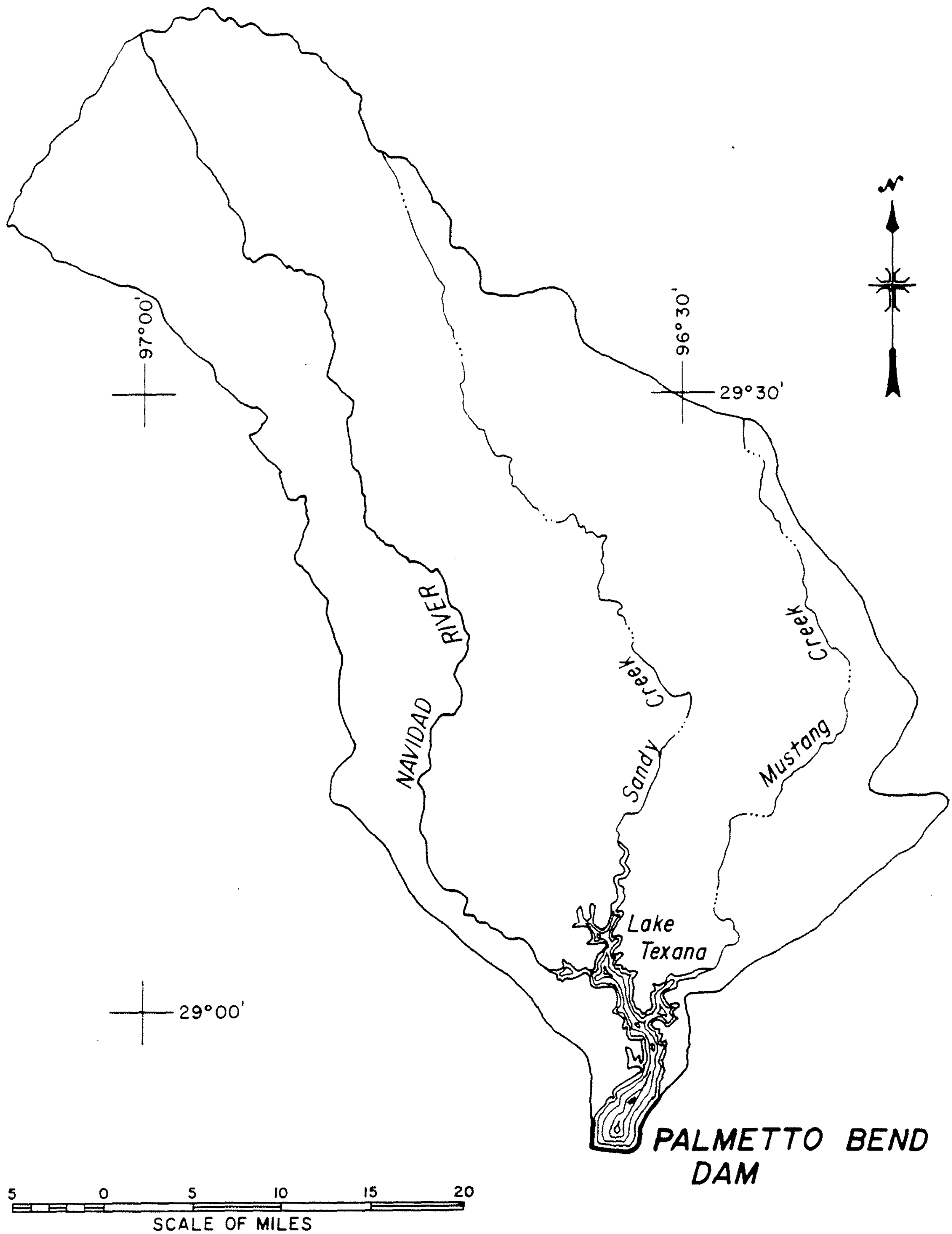

Figure 3.—Drainage area map.

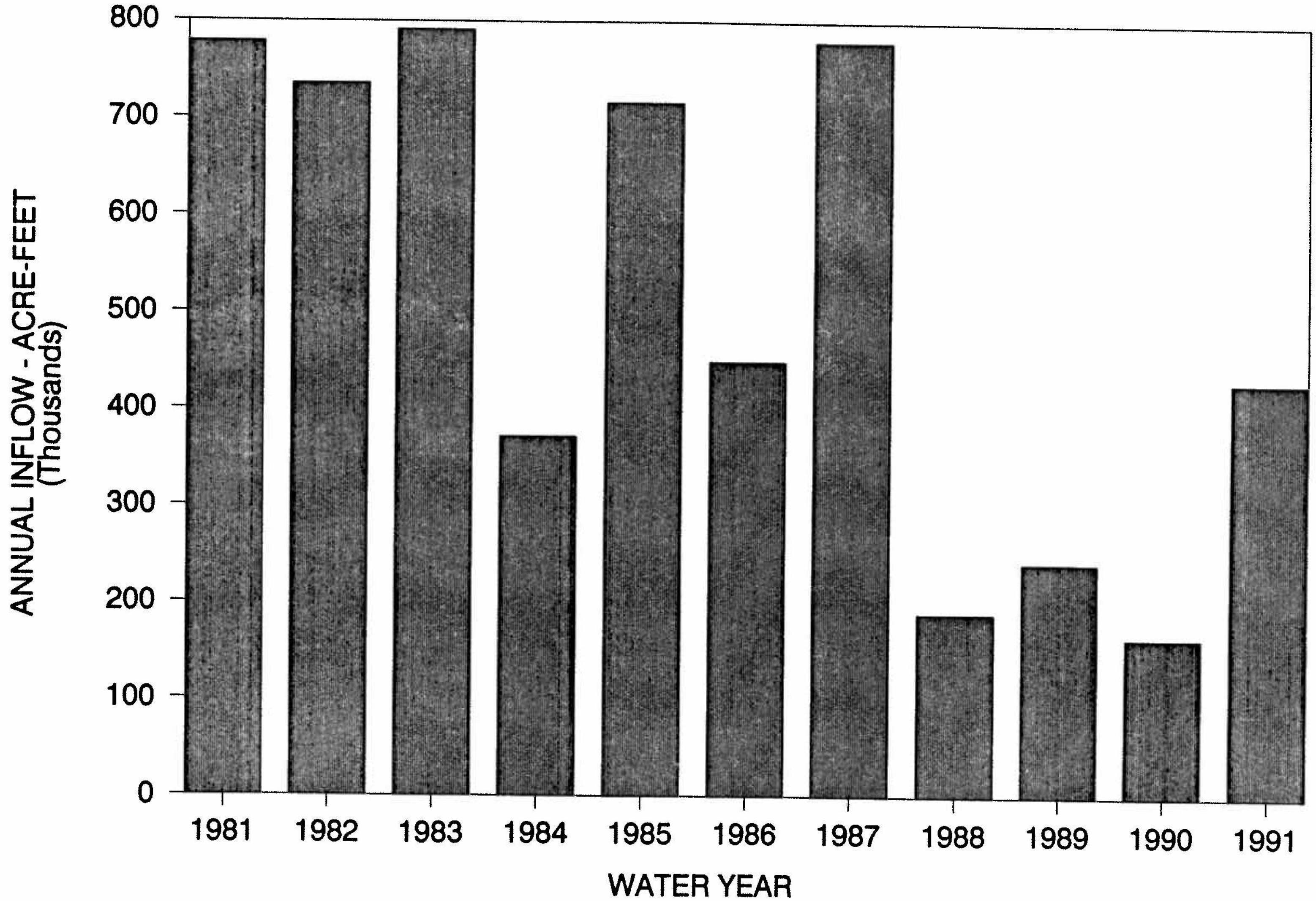

Figure 4.—Lake Texana inflows.

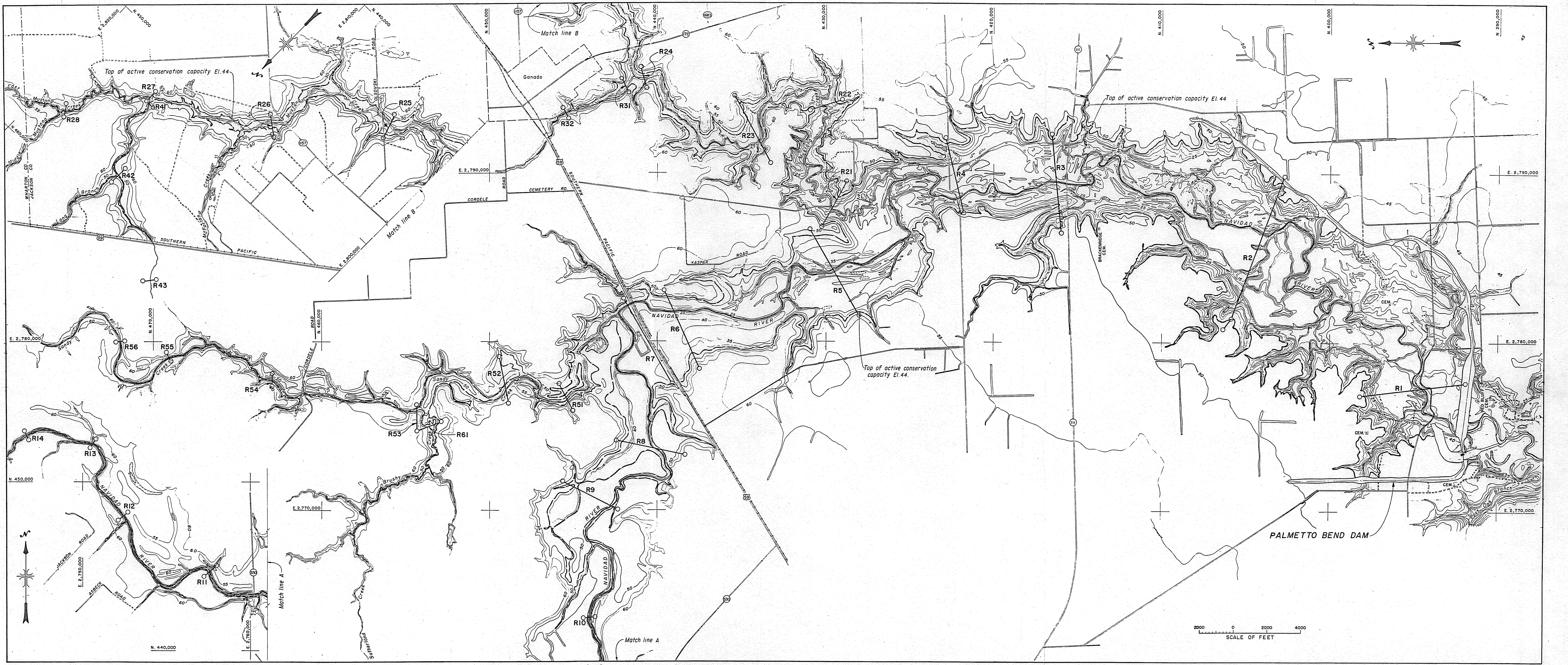

Figure 5.- Sediment Range Location Map

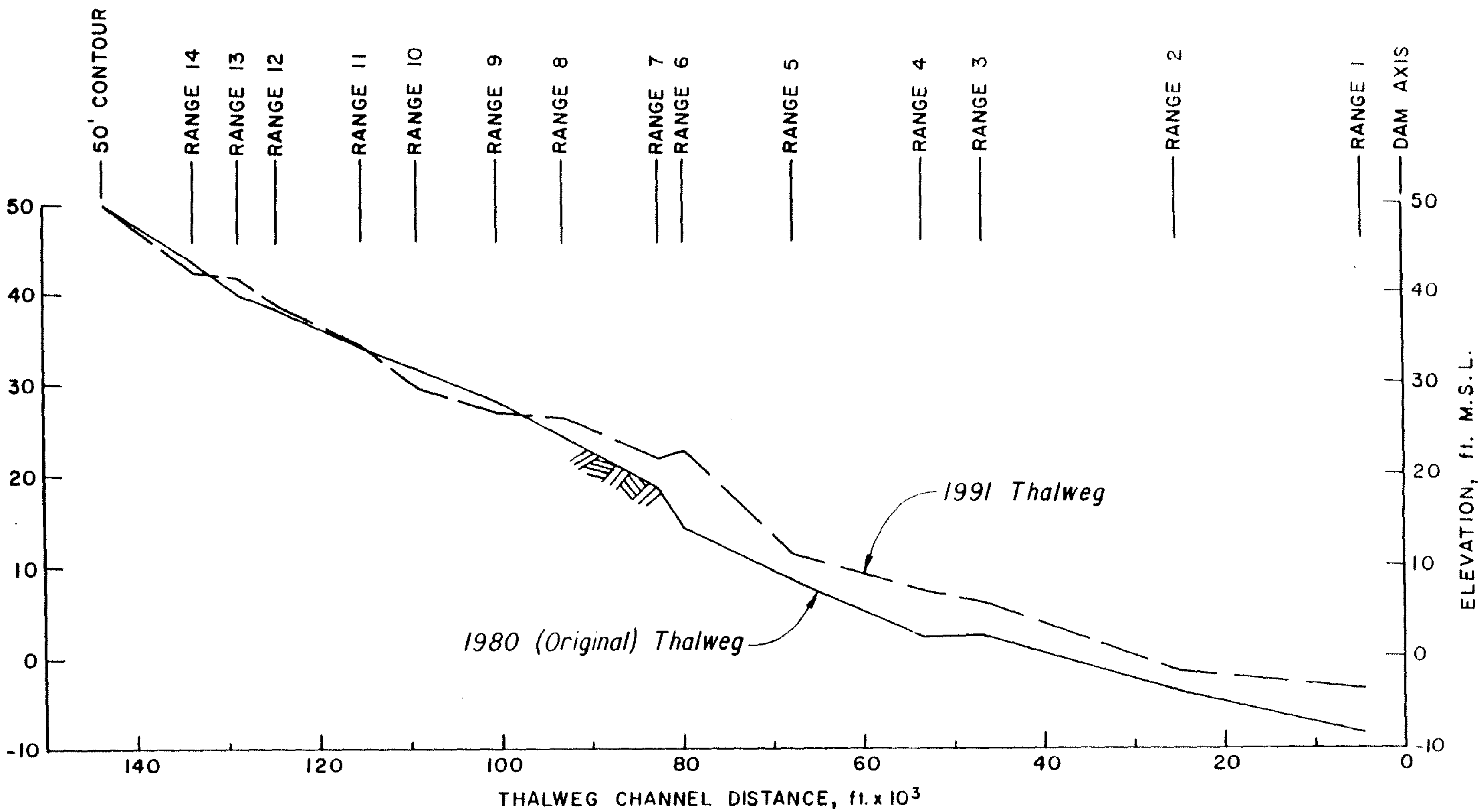

Figure 6.—Longitudinal profiles - Navidad River.

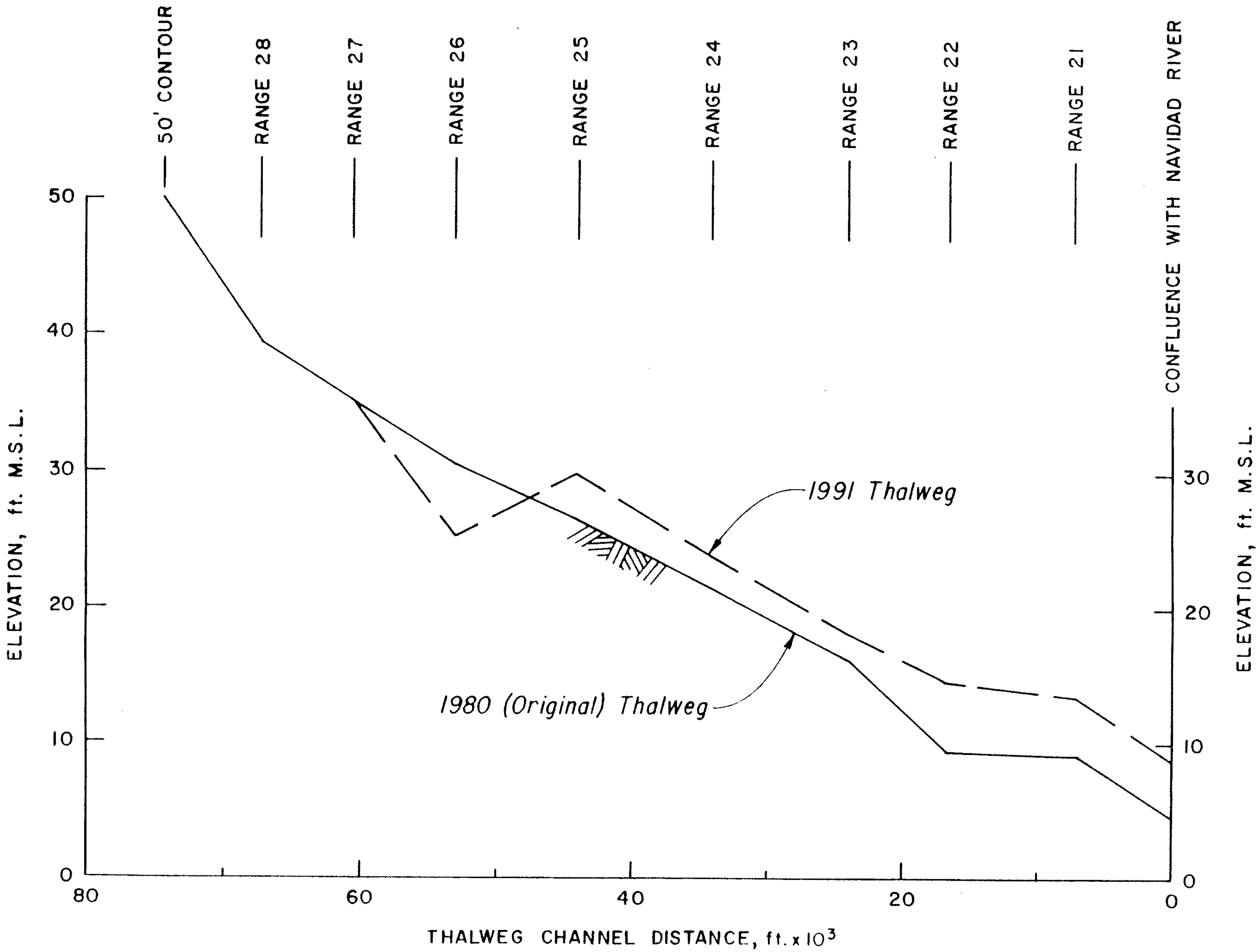

Figure 7.—Longitudinal profiles - Mustang Creek.

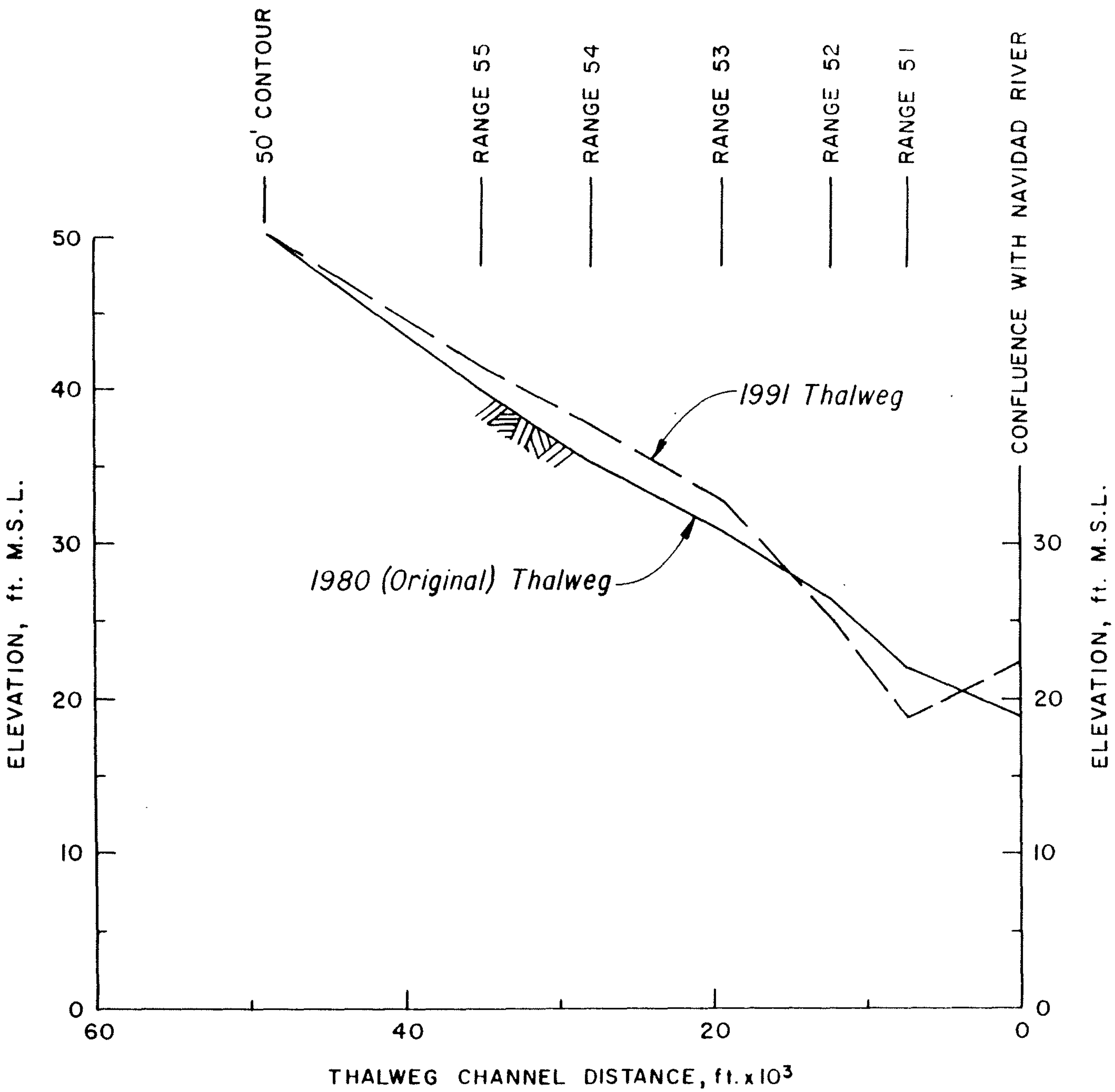

Figure 8.—Longitudinal profiles - Sandy Creek.

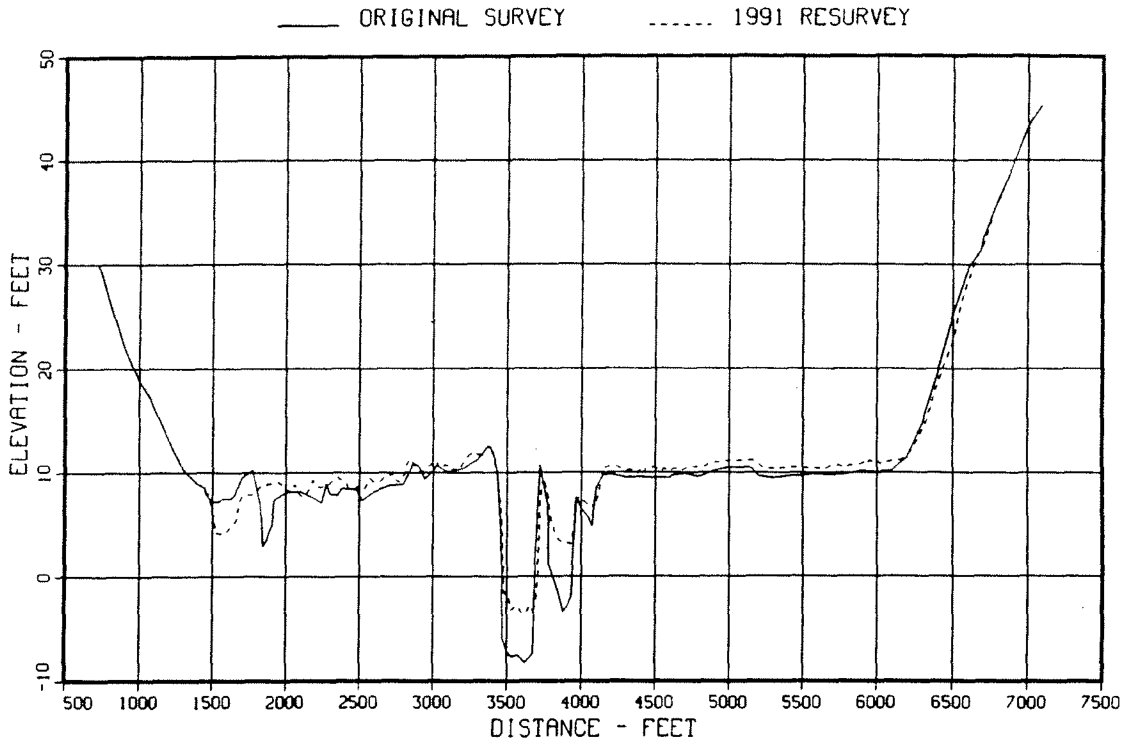

Figure 9.—Sediment Range 1 - Navidad River.

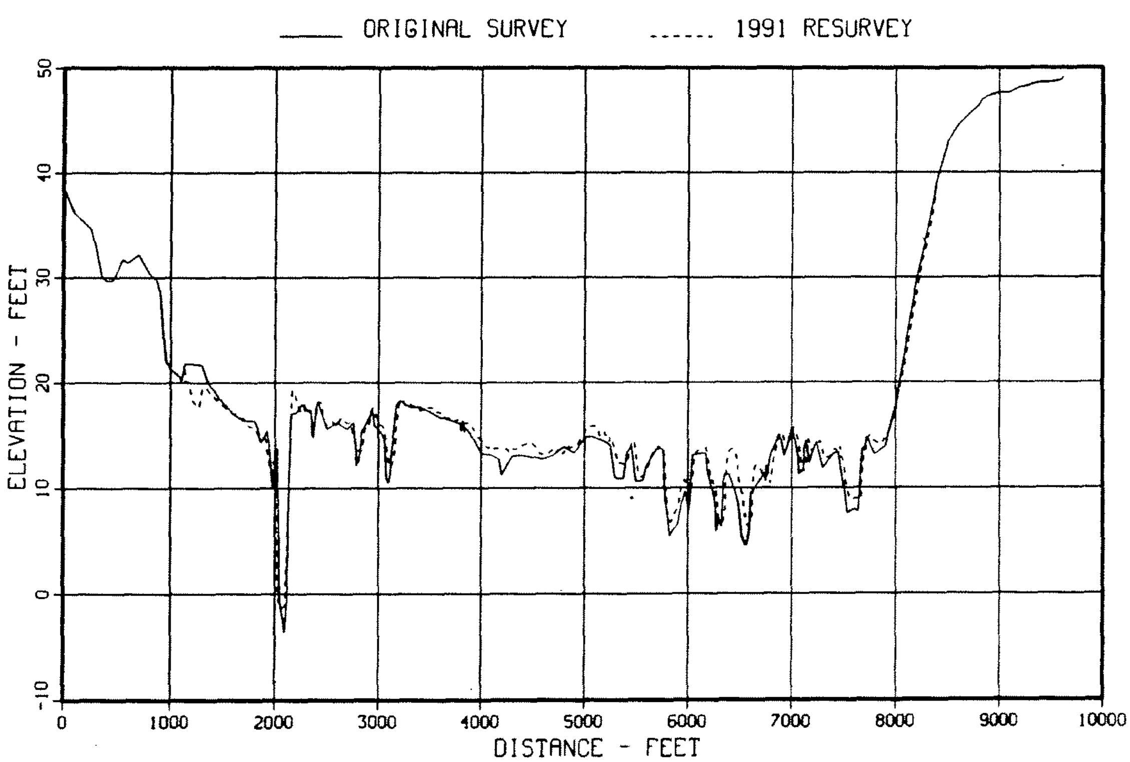

Figure 10.—Sediment Range 2 - Navidad River.

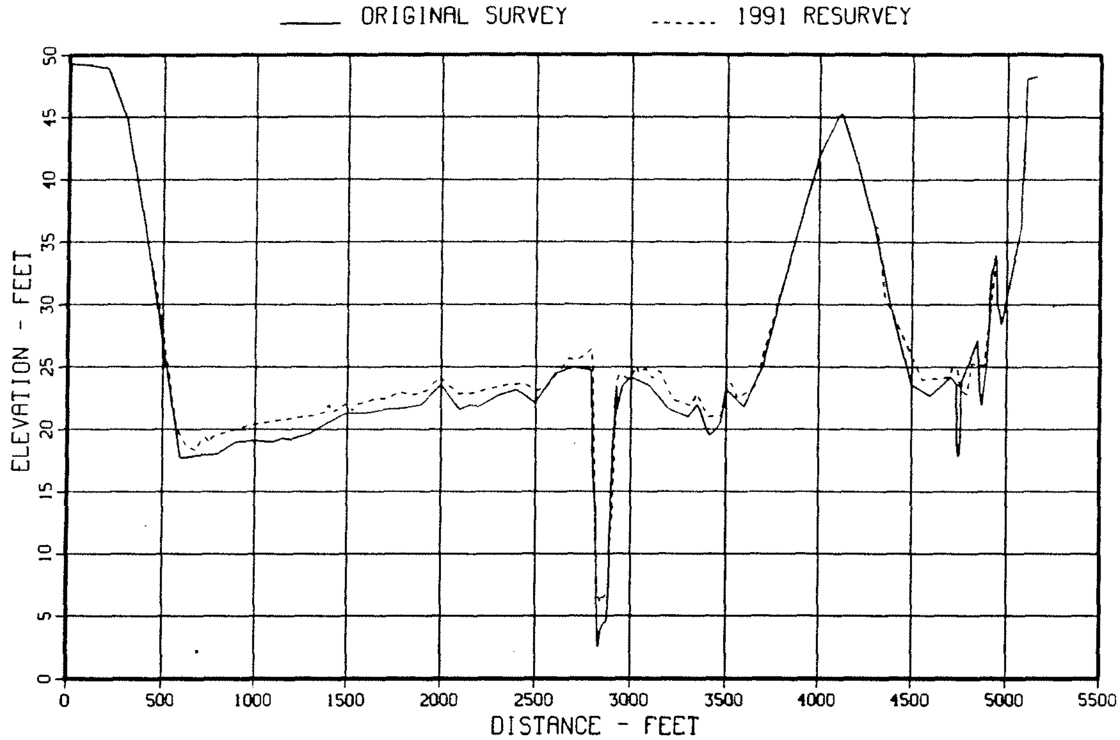

Figure 11.—Sediment Range 3 - Navidad River.

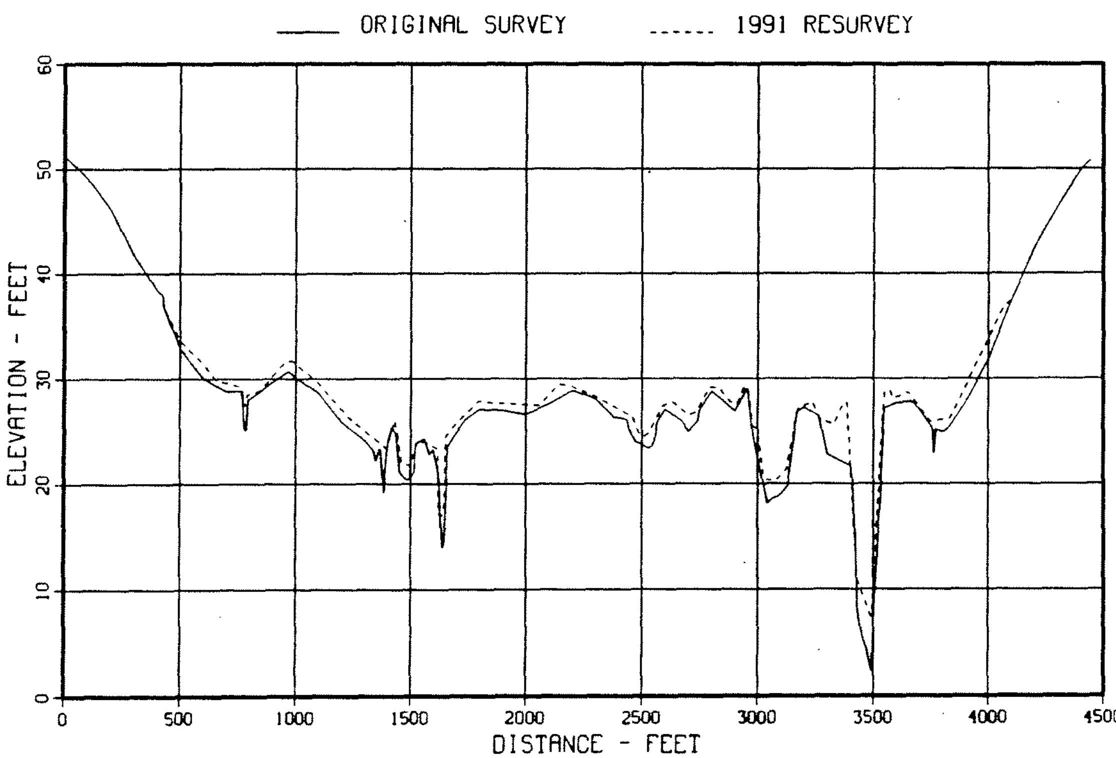

Figure12.—Sediment Range 4 - Navidad River.

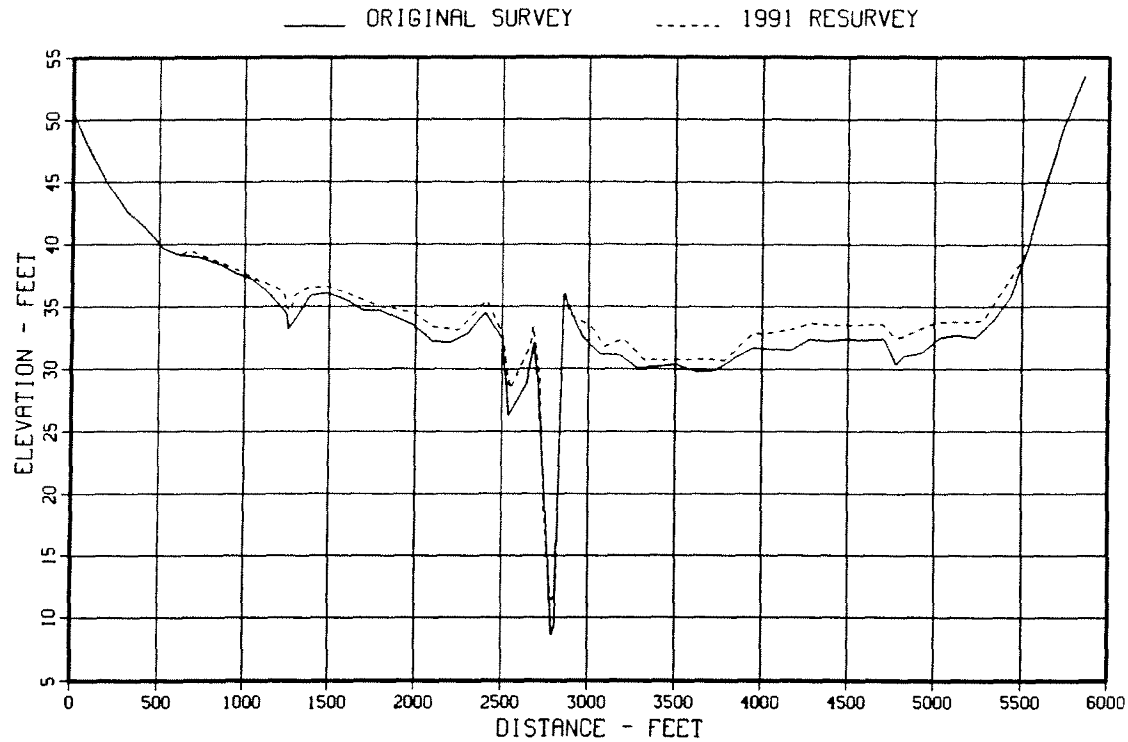

Figure 13.—Sediment Range 5 - Navidad River.

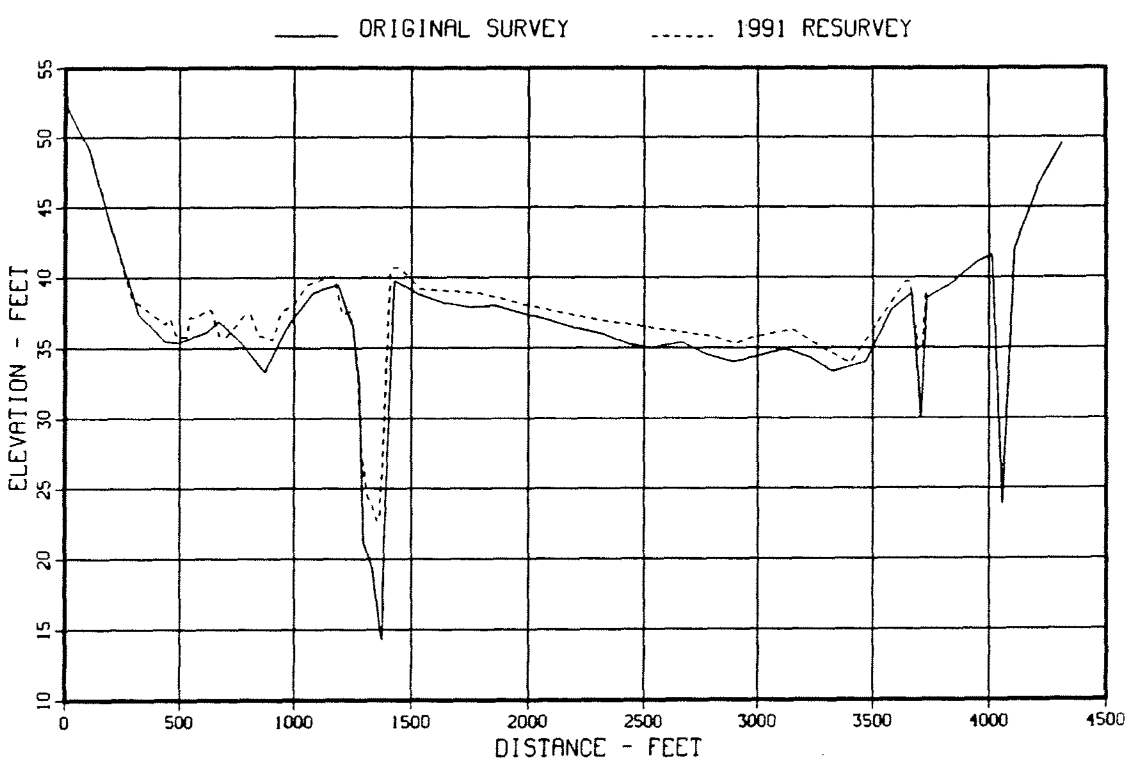

Figure 14.—Sediment Range 6 - Navidad River.

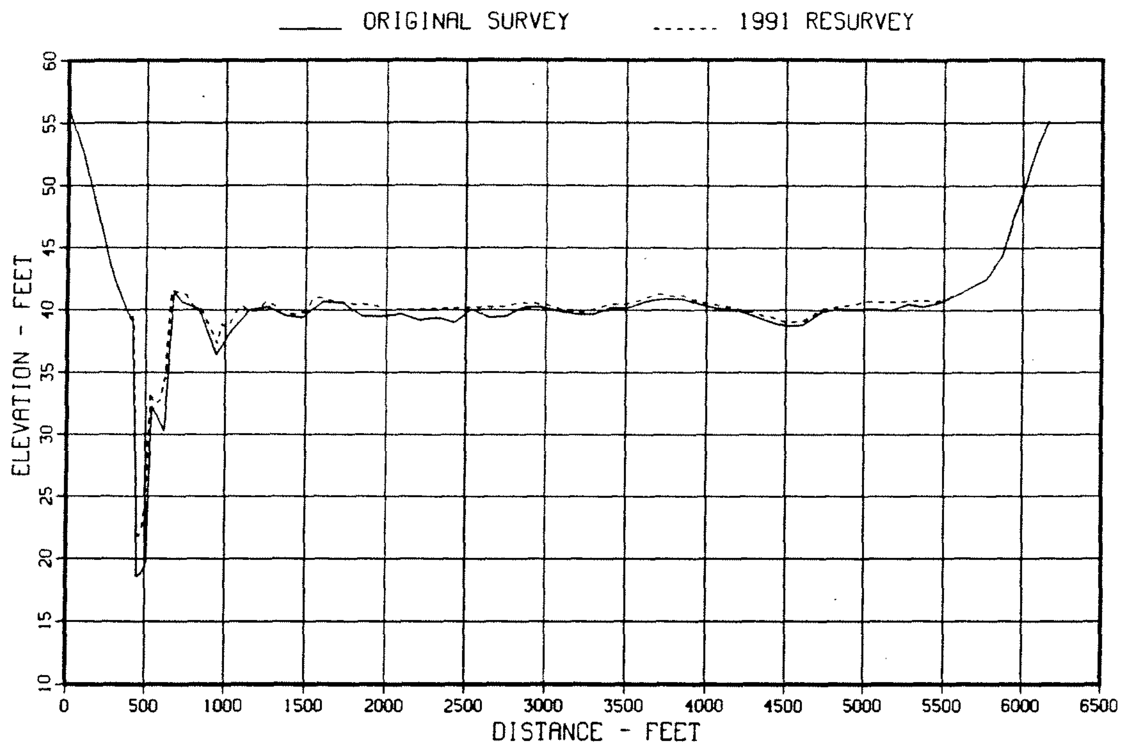

Figure 15.—Sediment Range 7 - Navidad River.

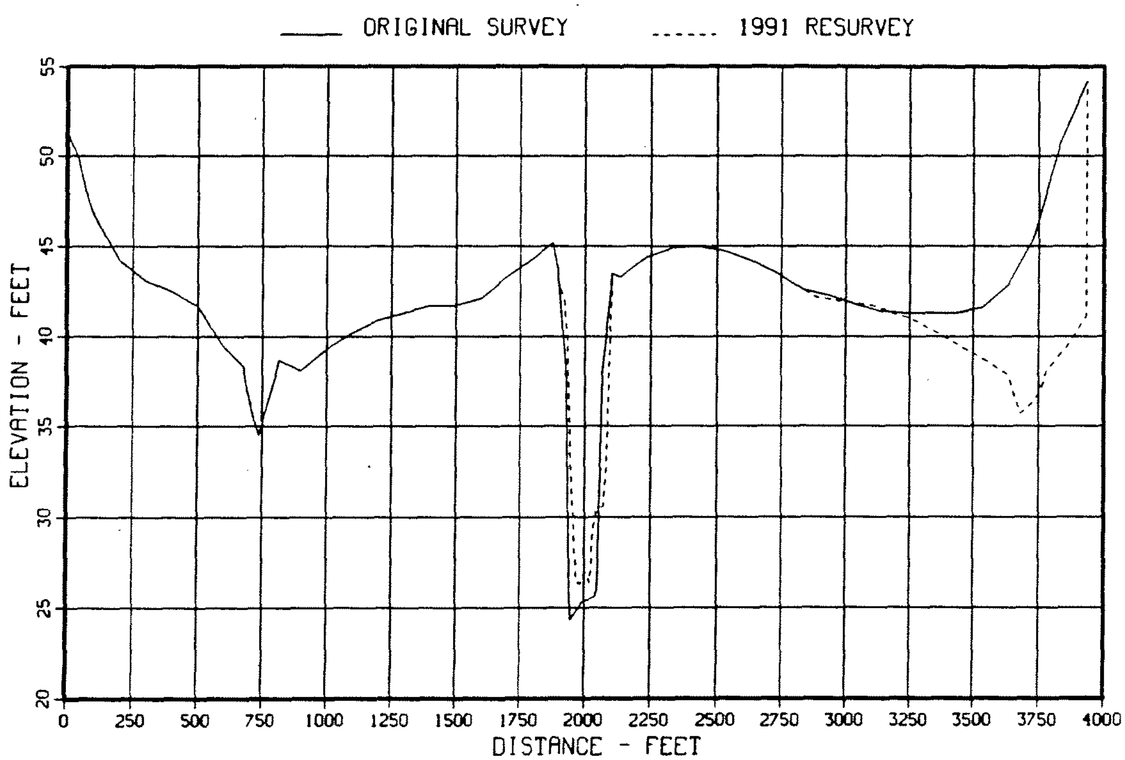

Figure 16.—Sediment Range 8 - Navidad River.

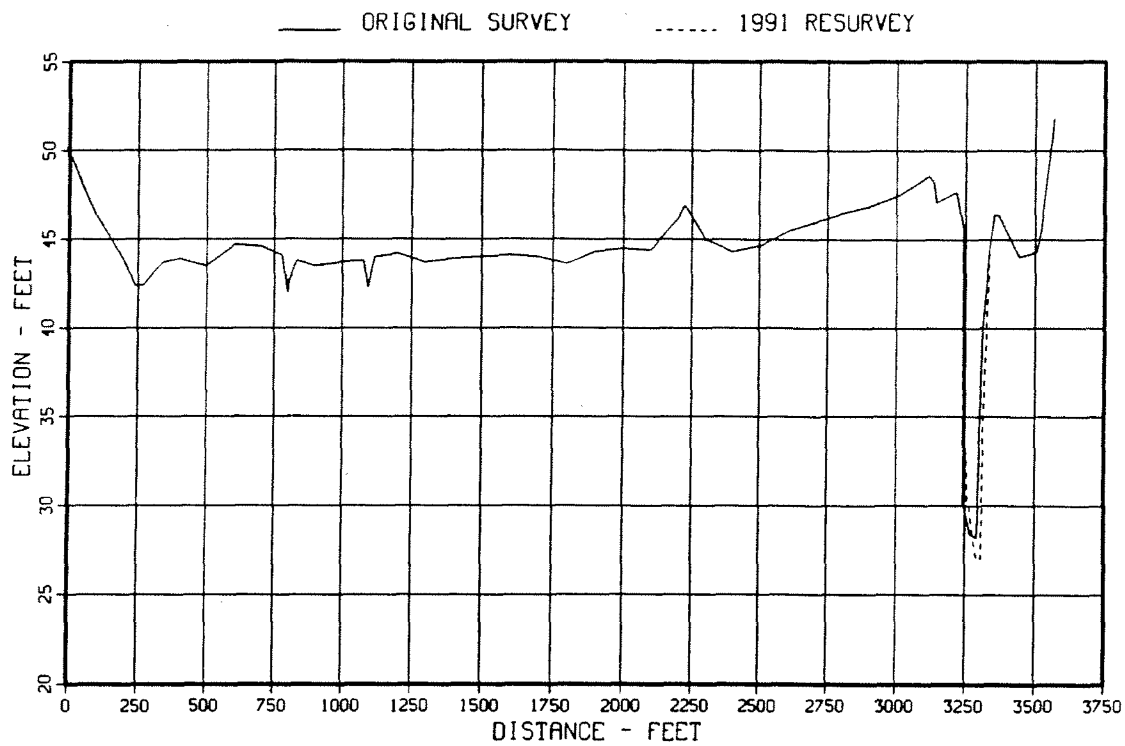

Figure 17.—Sediment Range 9 - Navidad River.

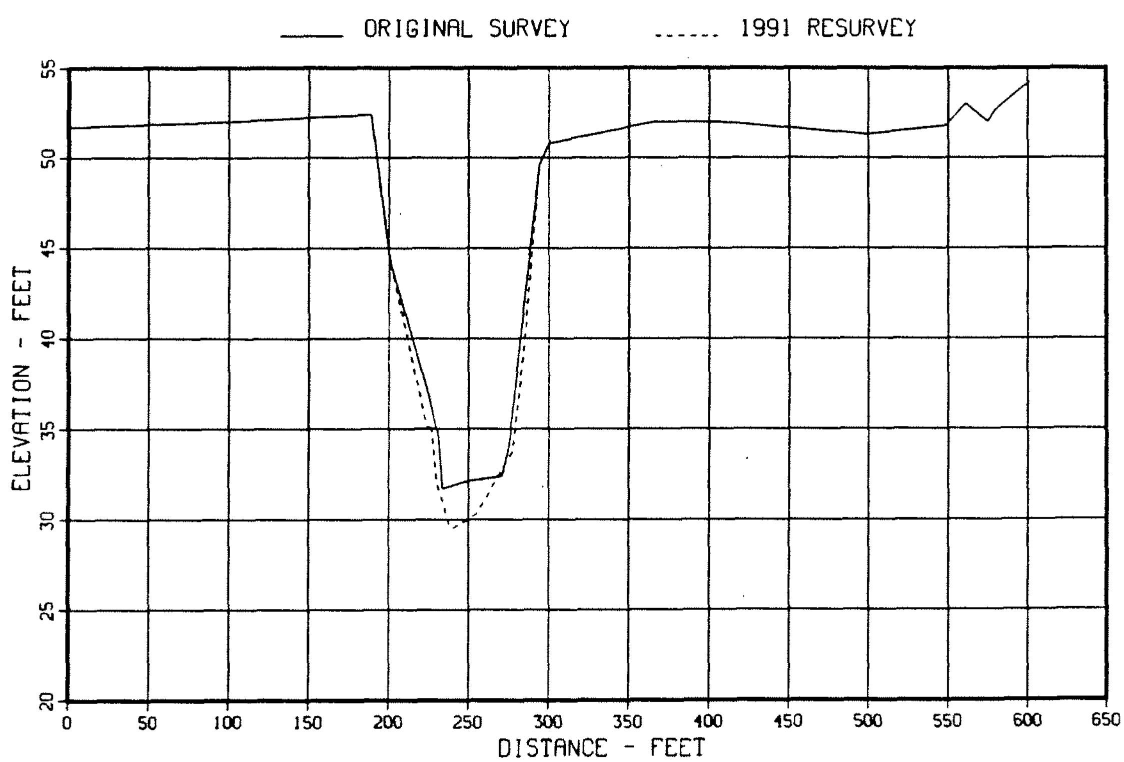

Figure 18.—Sediment Range 10 - Navidad River.

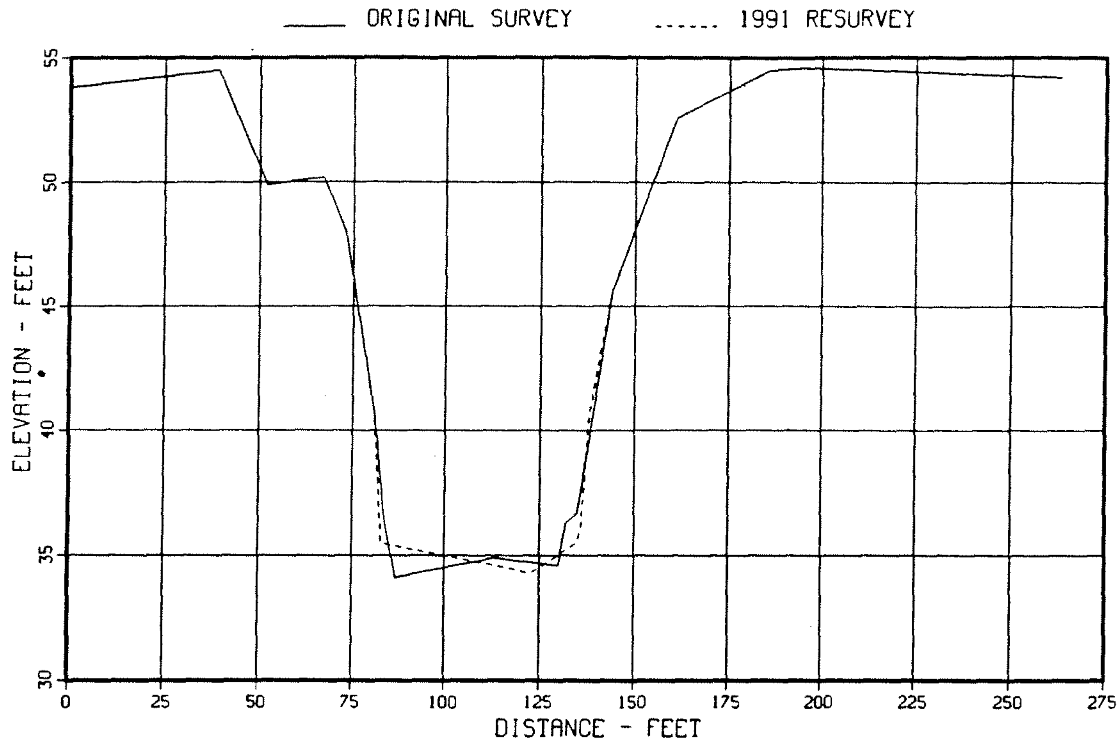

Figure 19.—Sediment Range 11 - Navidad River.

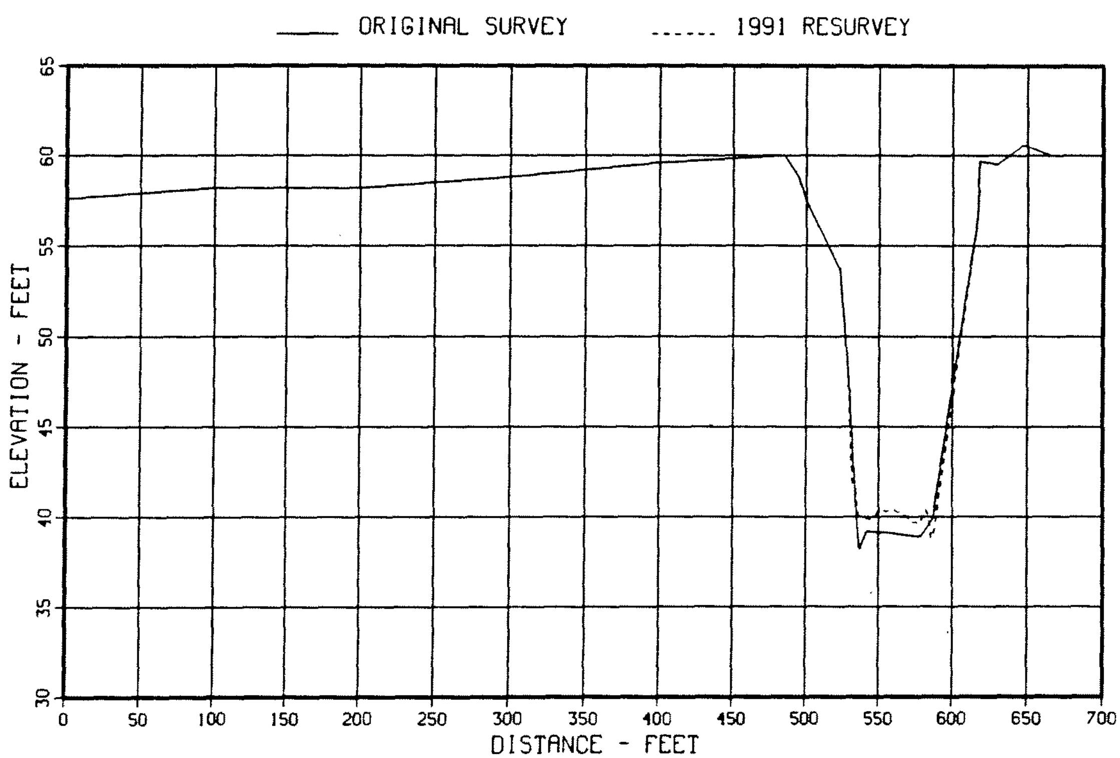

Figure 20.—Sediment Range 12 - Navidad River.

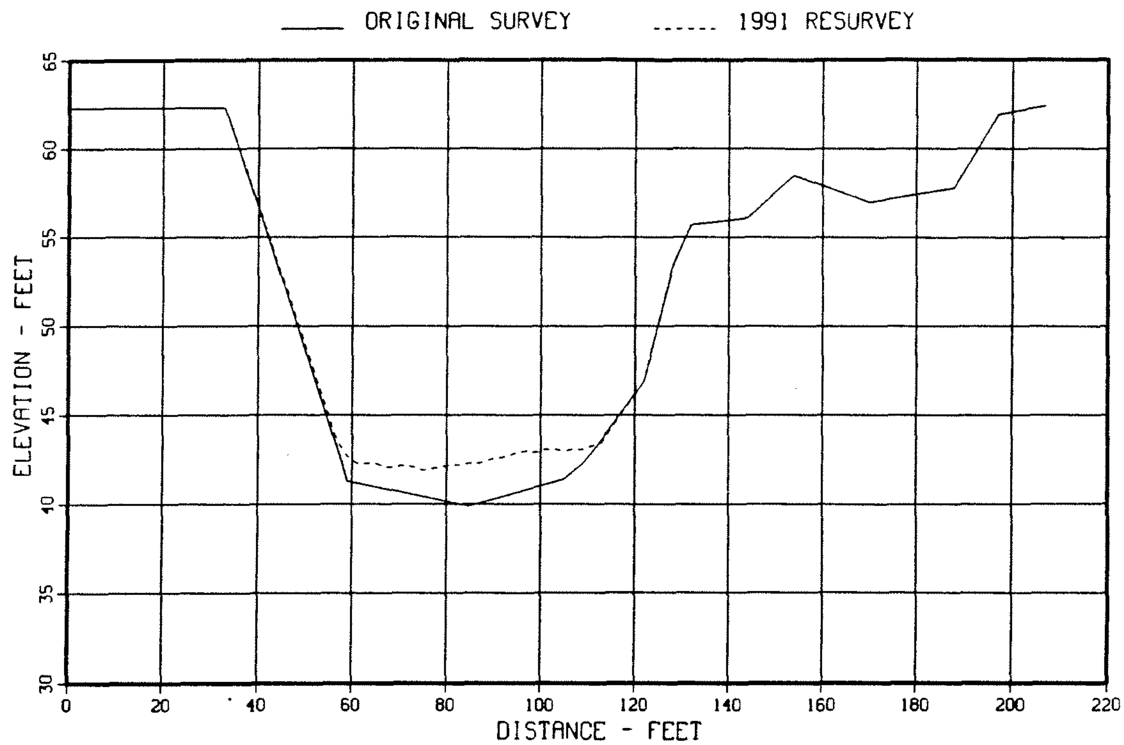

Figure 21.—Sediment Range 13 - Navidad River.

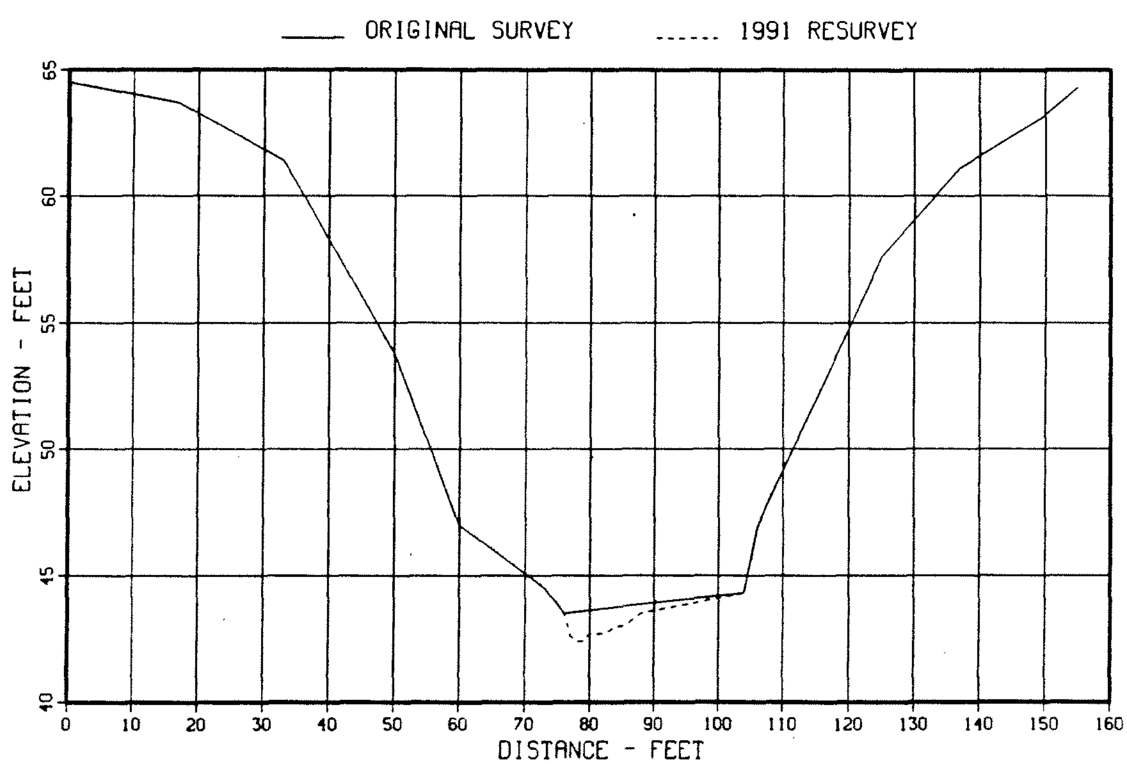

Figure 22.—Sediment Range 14 - Navidad River.

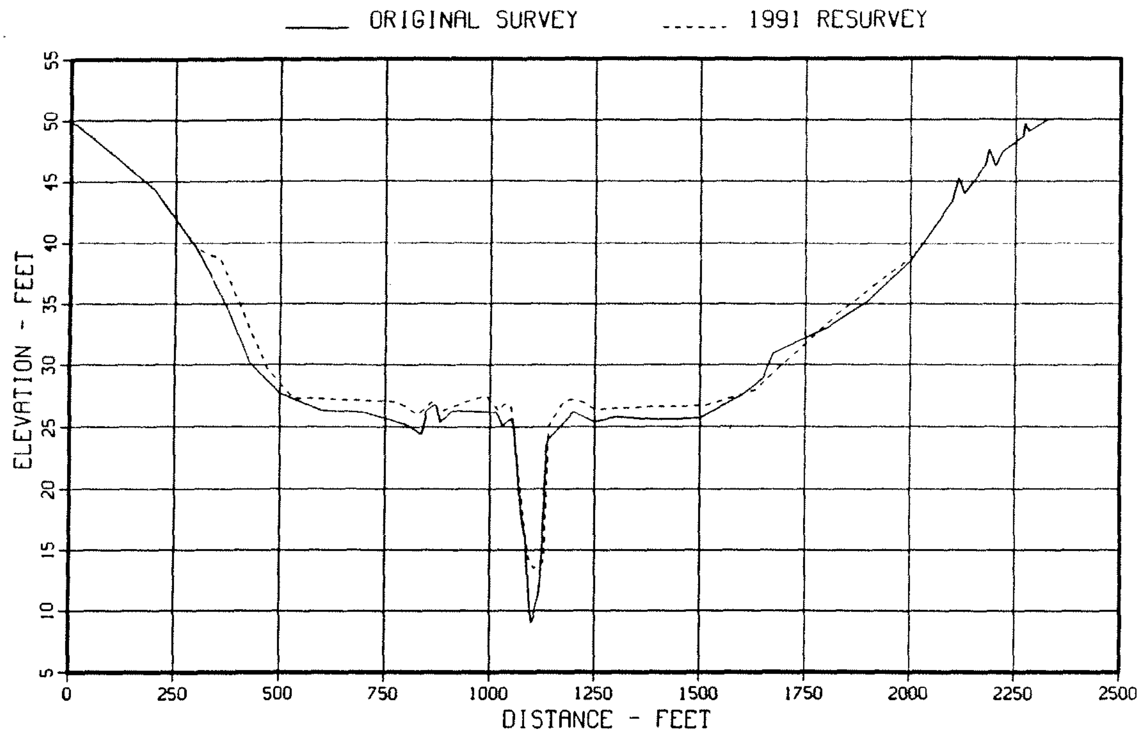

Figure 23.—Sediment Range 21 - Mustang Creek.

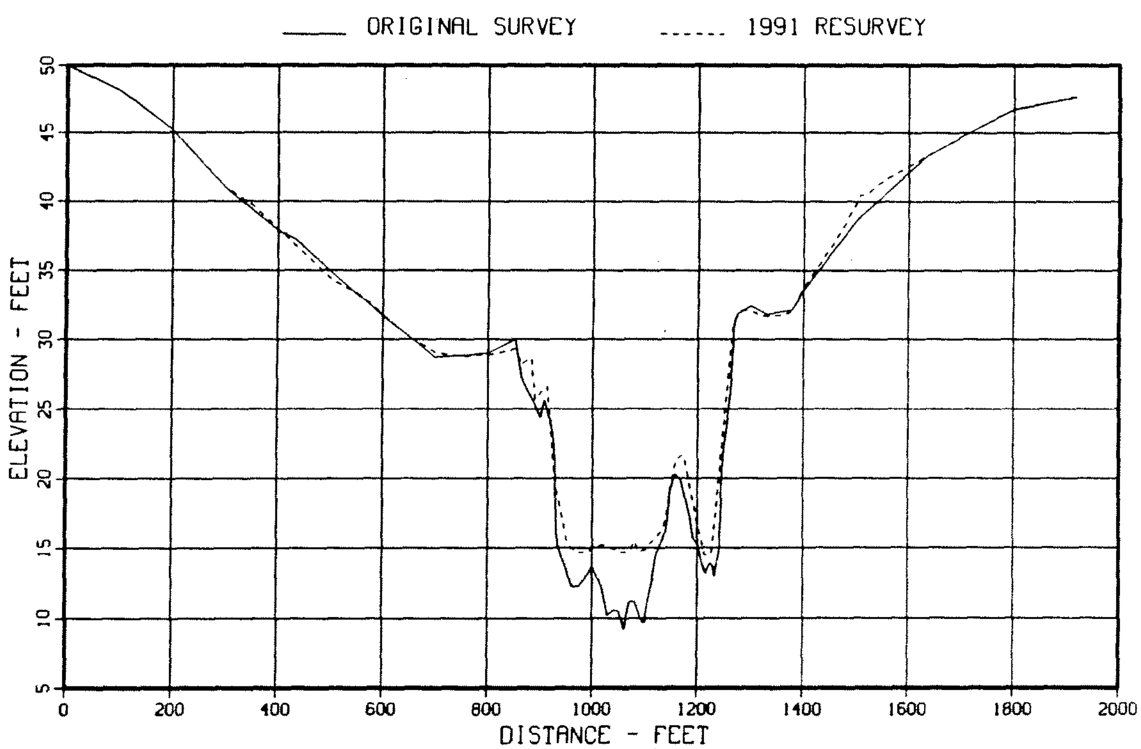

Figure 24.—Sediment Range 22 - Mustang Creek.

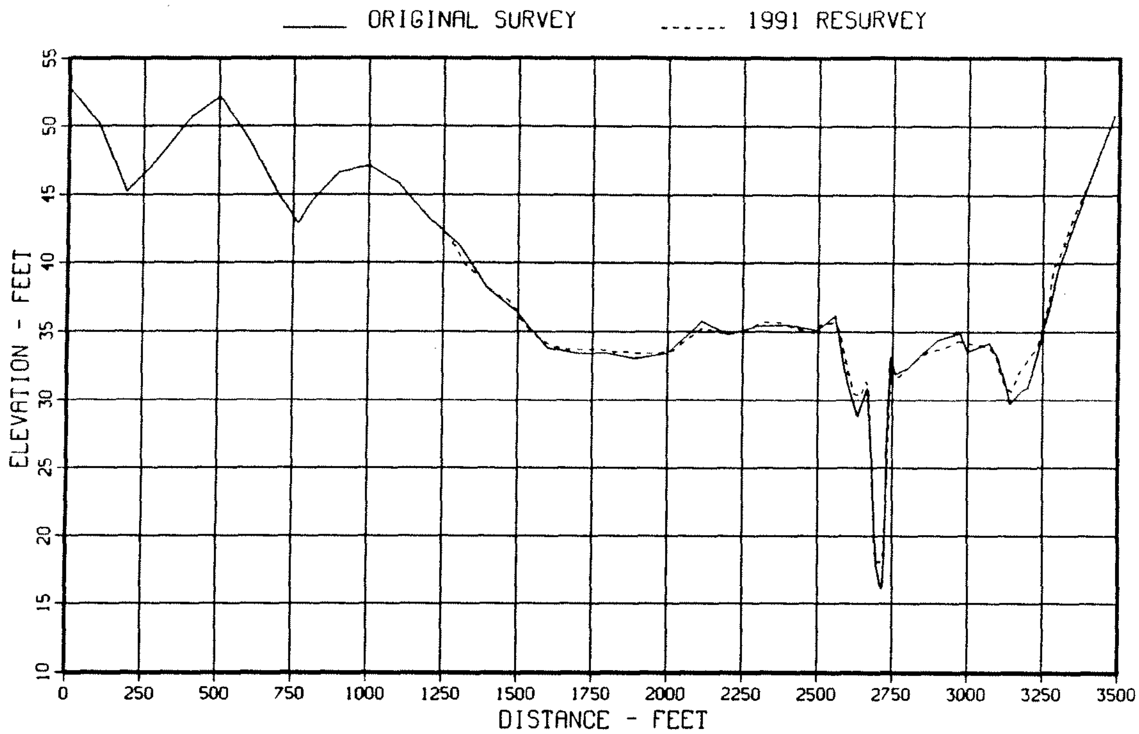

Figure 25.—Sediment Range 23 - Mustang Creek.

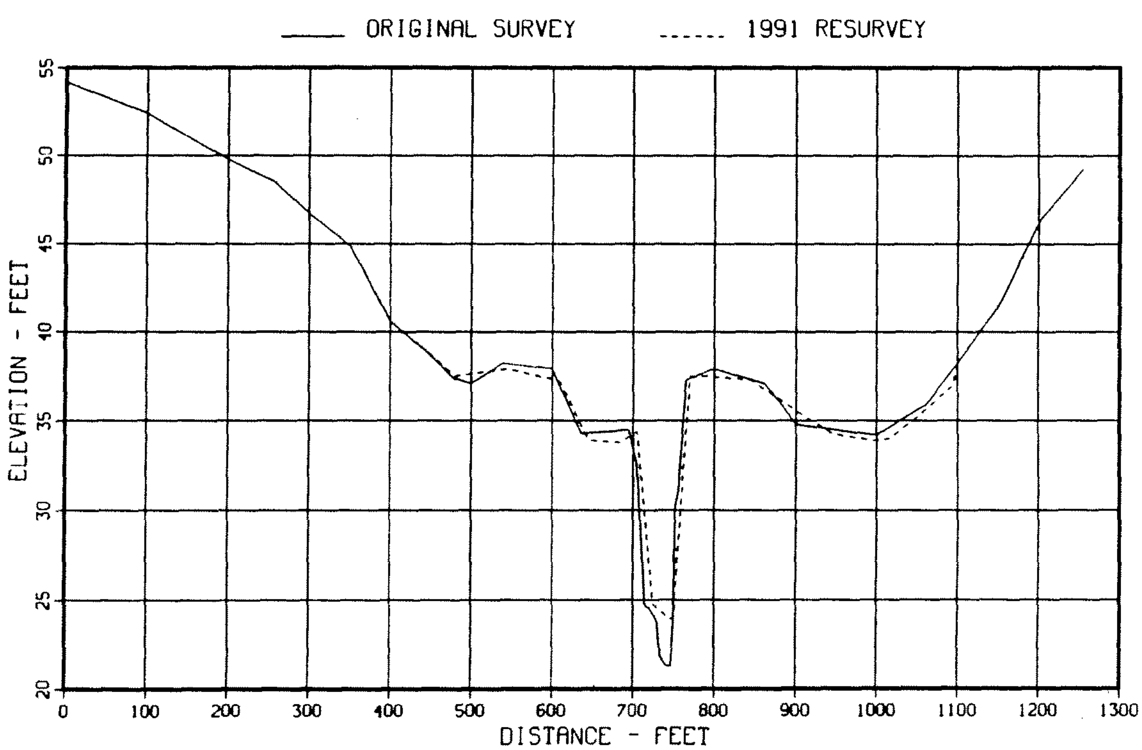

Figure 26.—Sediment Range 24 - Mustang Creek.

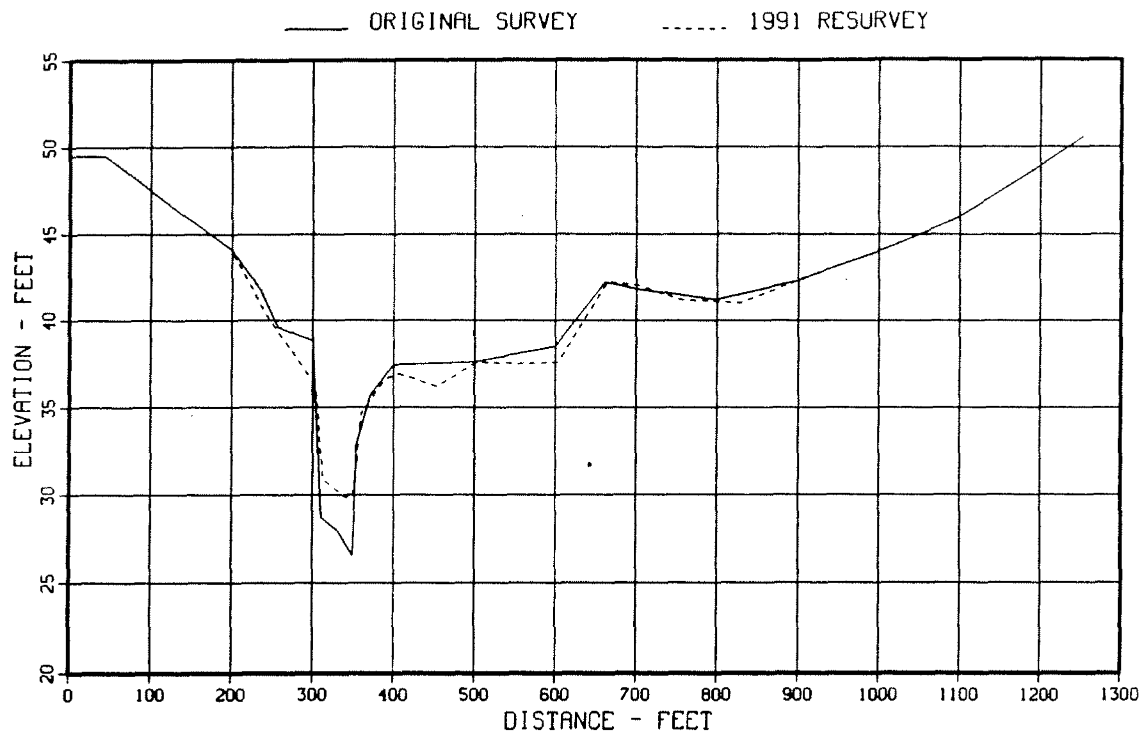

Figure 27.—Sediment Range 25 - Mustang Creek.

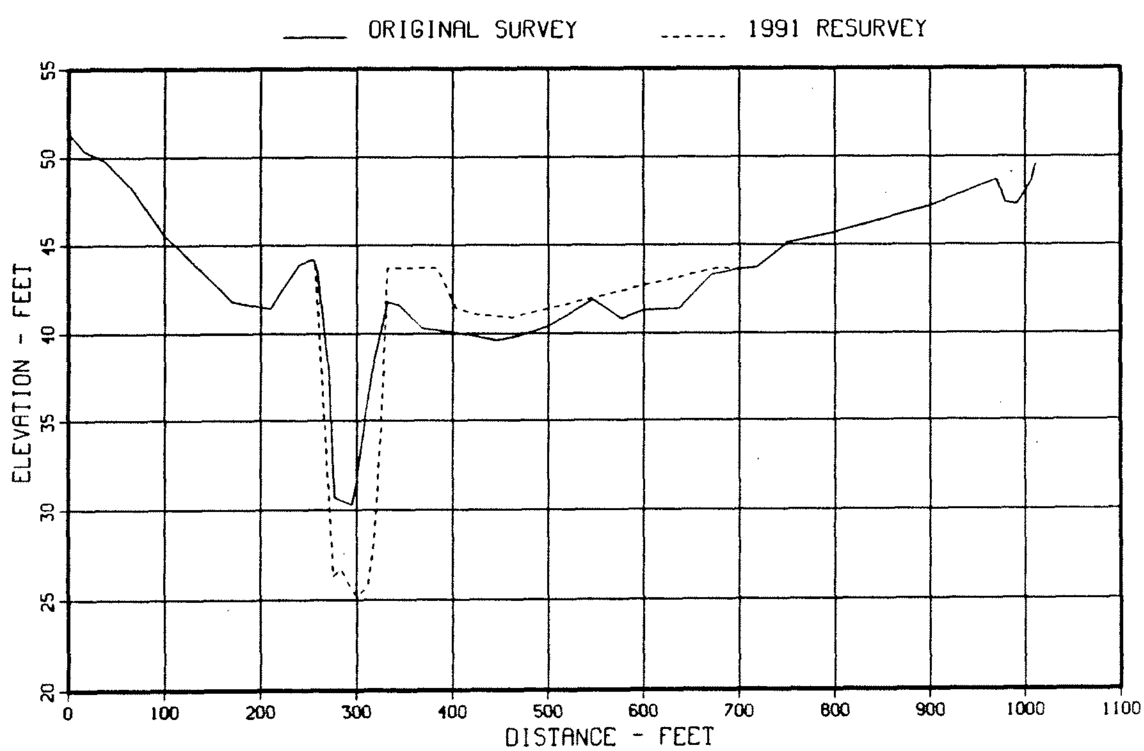

Figure 28.—Sediment Range 26 - Mustang Creek.

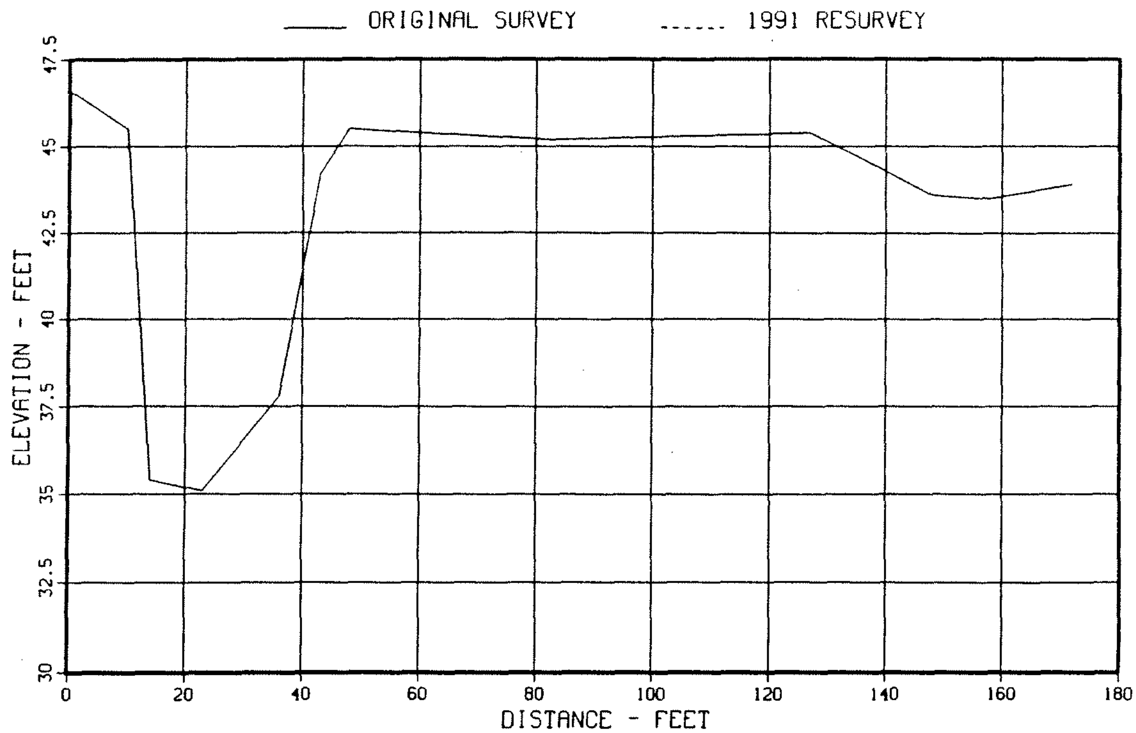

Figure 29.—Sediment Range 27 - Mustang Creek.

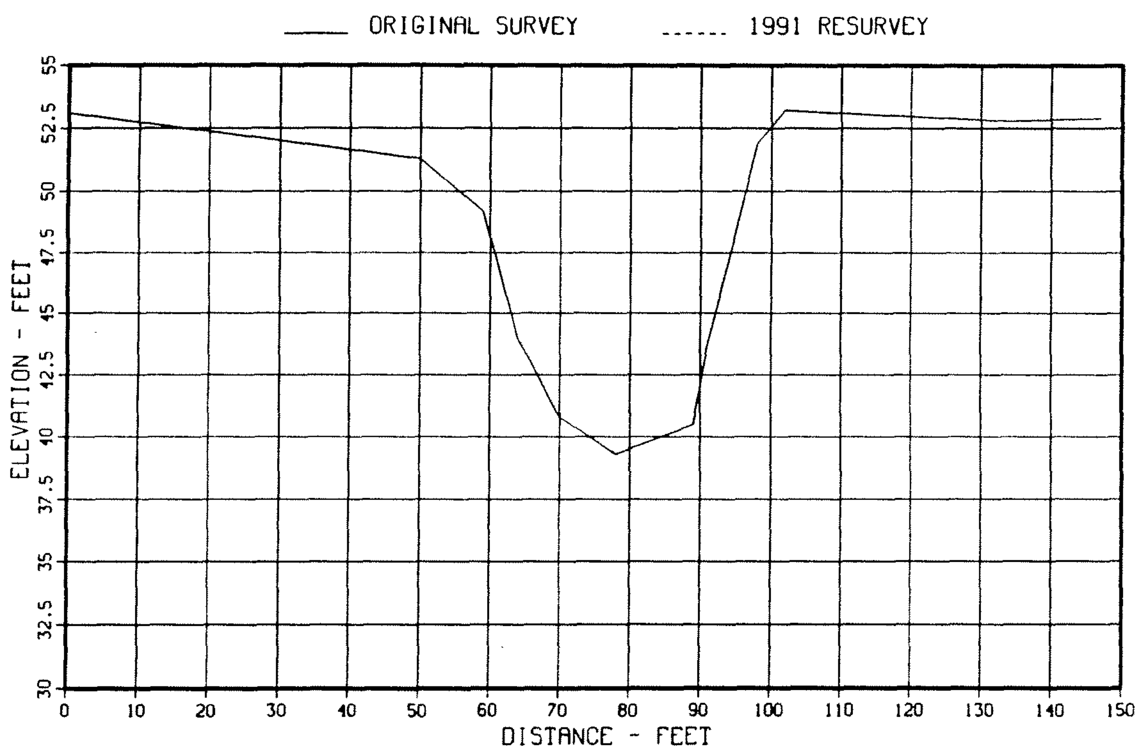

Figure 30.—Sediment Range 28 - Mustang Creek.

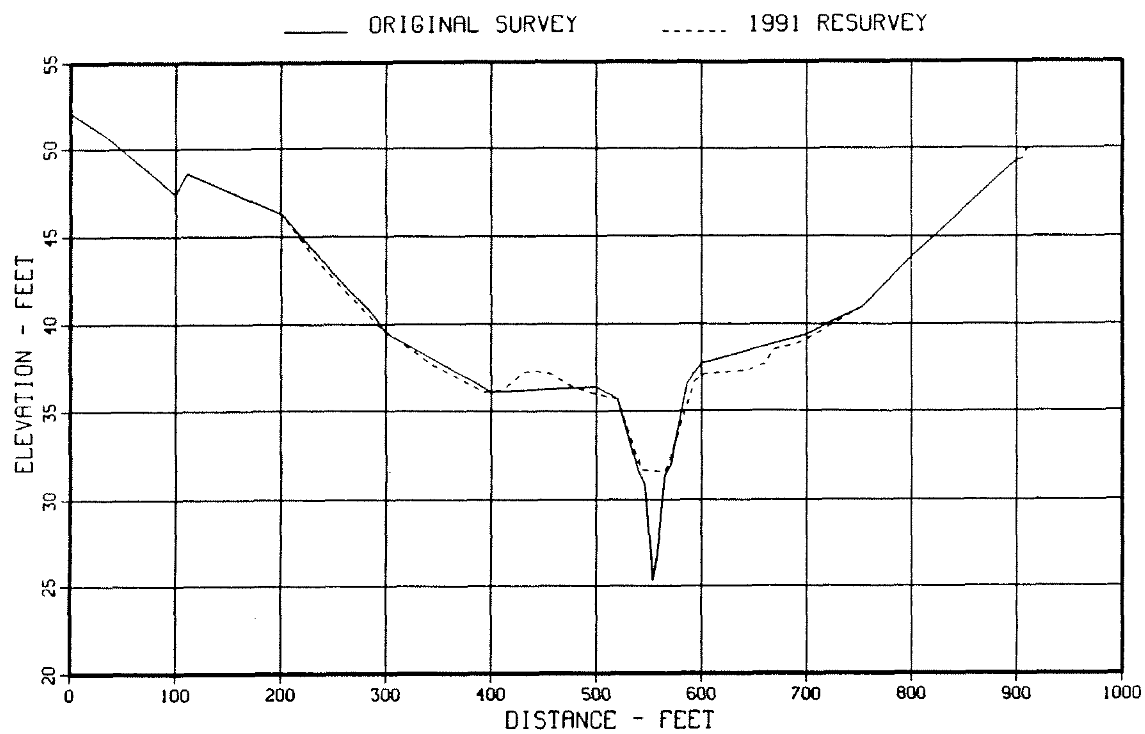

Figure 31.—Sediment Range 31 - Mustang Creek.

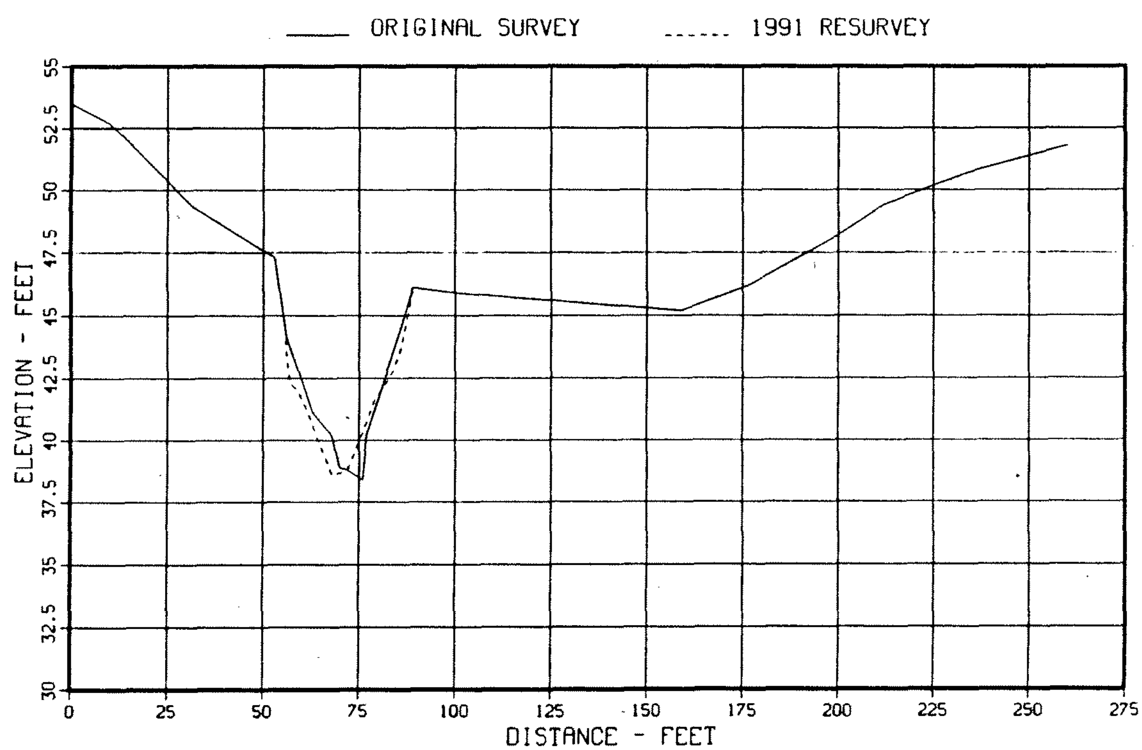

Figure 32.—Sediment Range 32 - Mustang Creek.

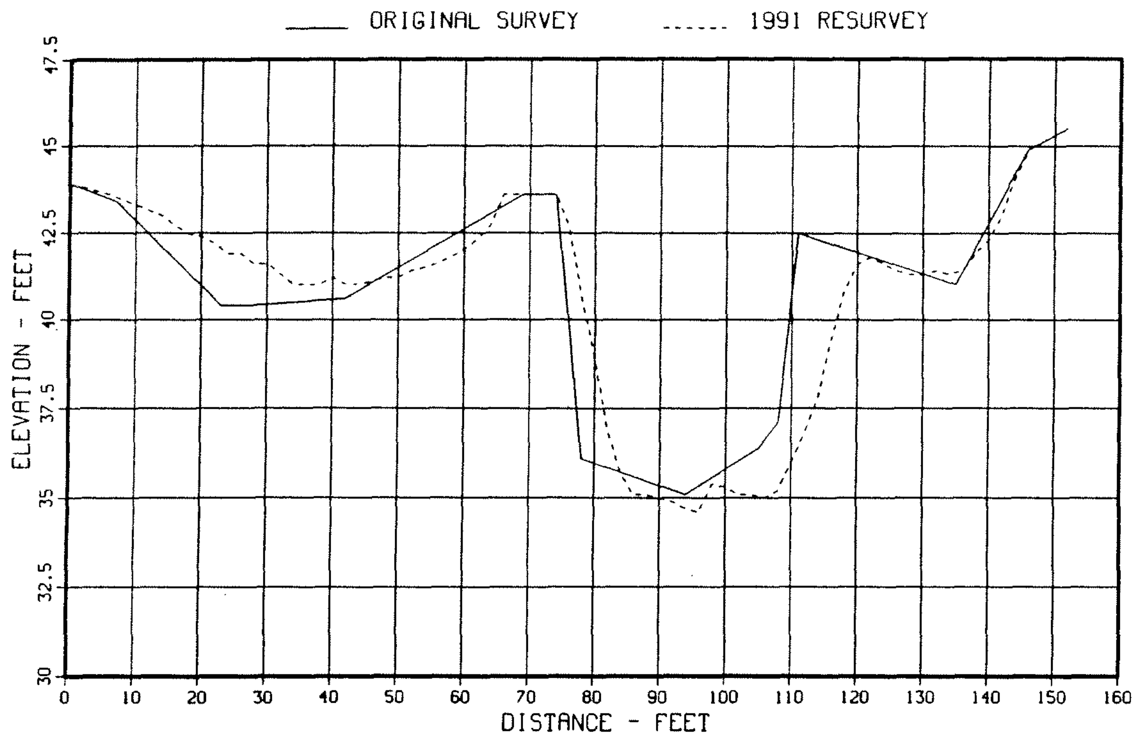

Figure 33.—Sediment Range 41 - Mustang Creek.

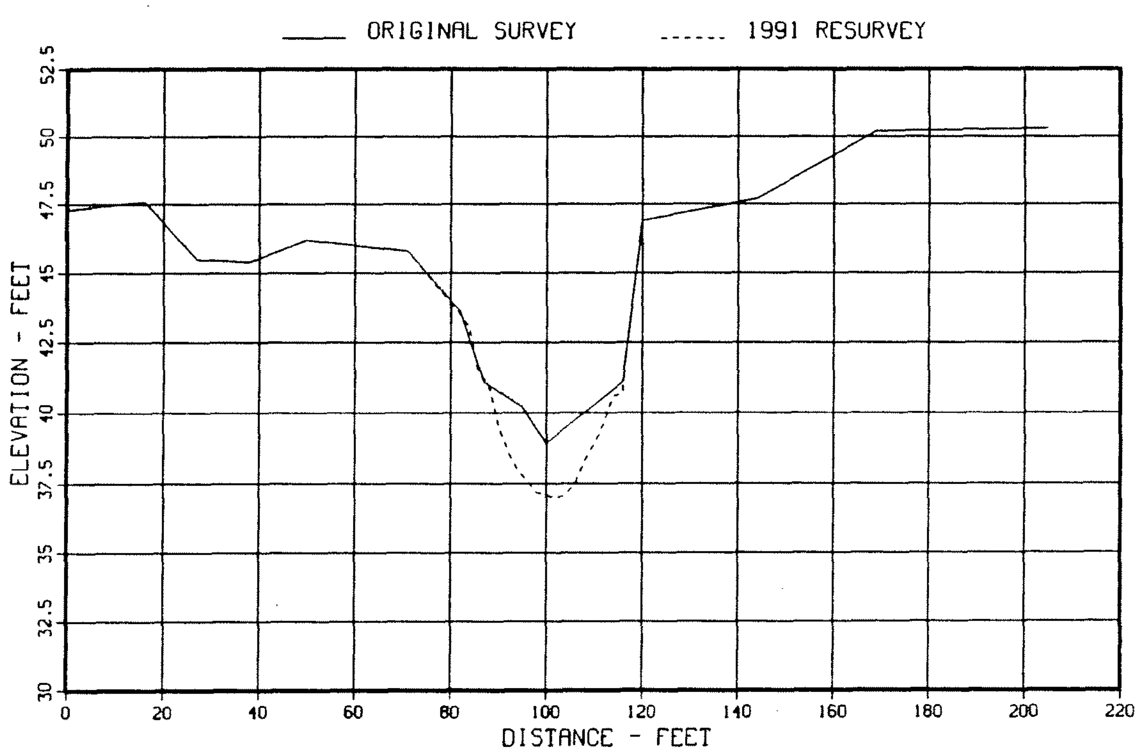

Figure 34.—Sediment Range 42 - Mustang Creek.

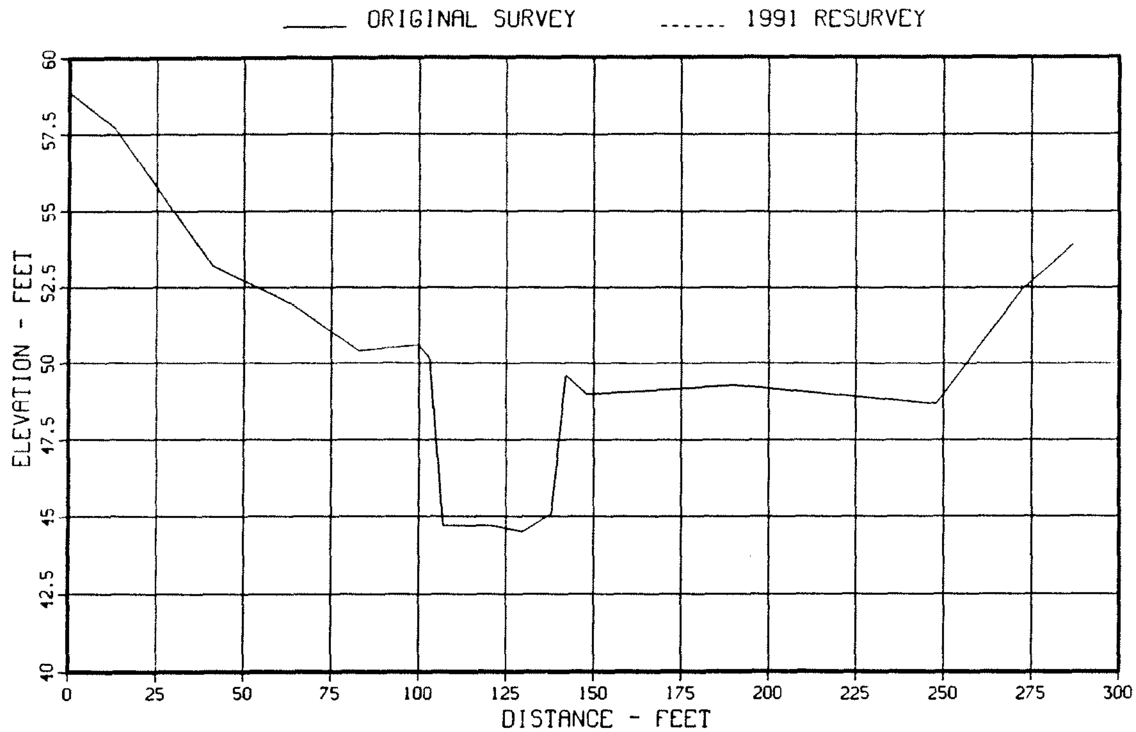

Figure 35.—Sediment Range 43 - Mustang Creek.

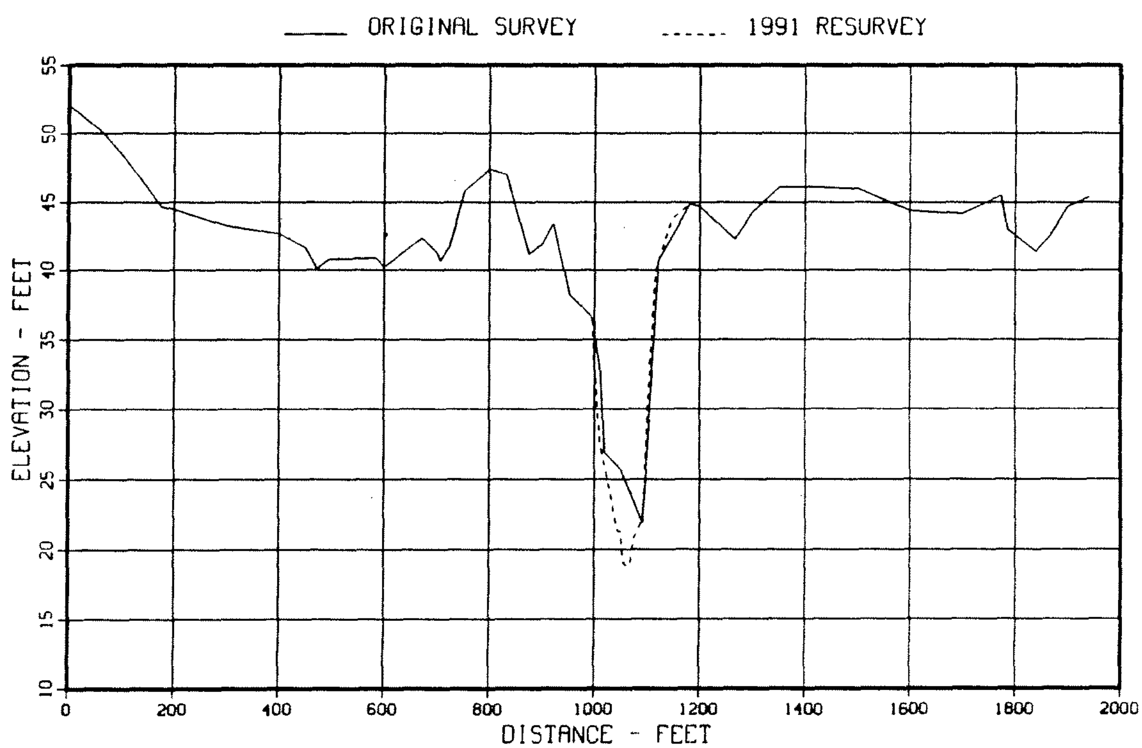

Figure 36.—Sediment Range 51 - Sandy Creek.

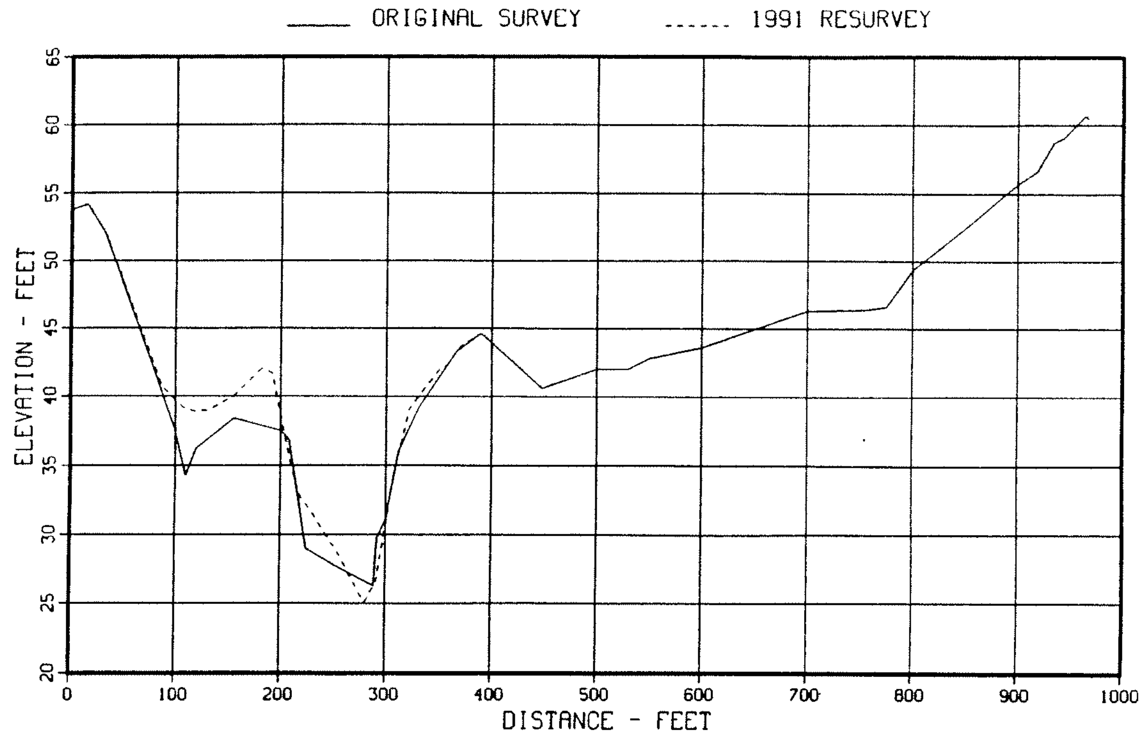

Figure 37.—Sediment Range 52 - Sandy Creek.

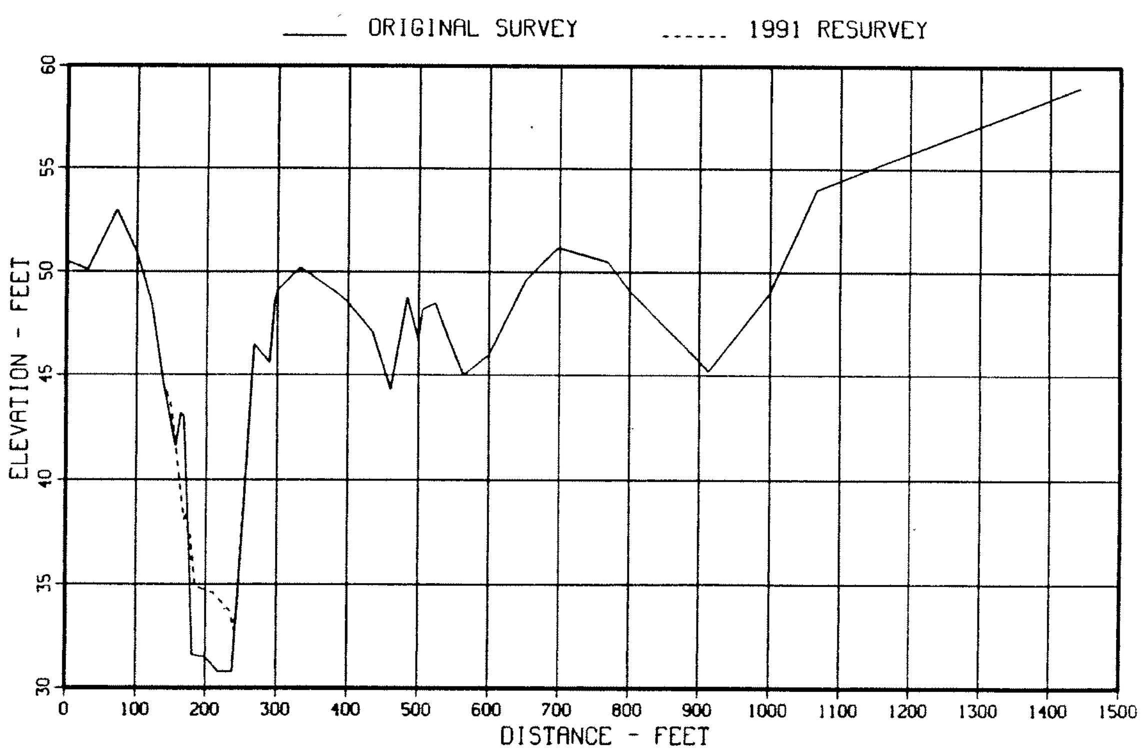

Figure 38.—Sediment Range 53 - Sandy Creek.

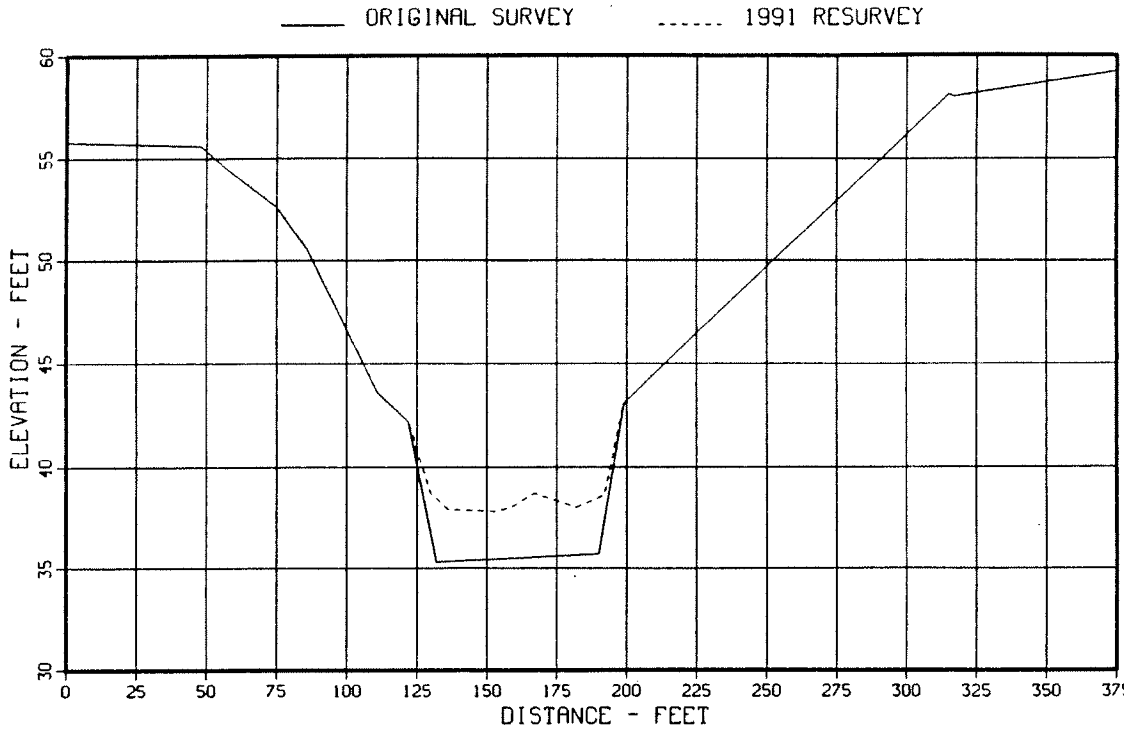

Figure 39.—Sediment Range 54 - Sandy Creek.

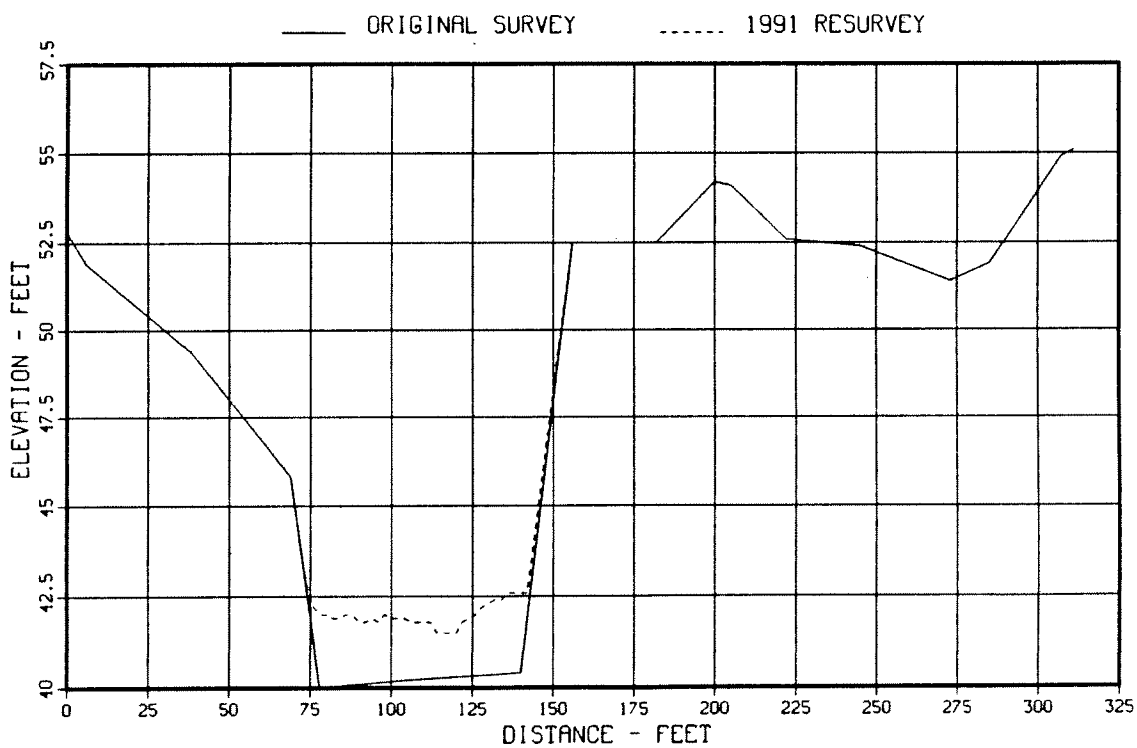

Figure 40.—Sediment Range 55 - Sandy Creek.

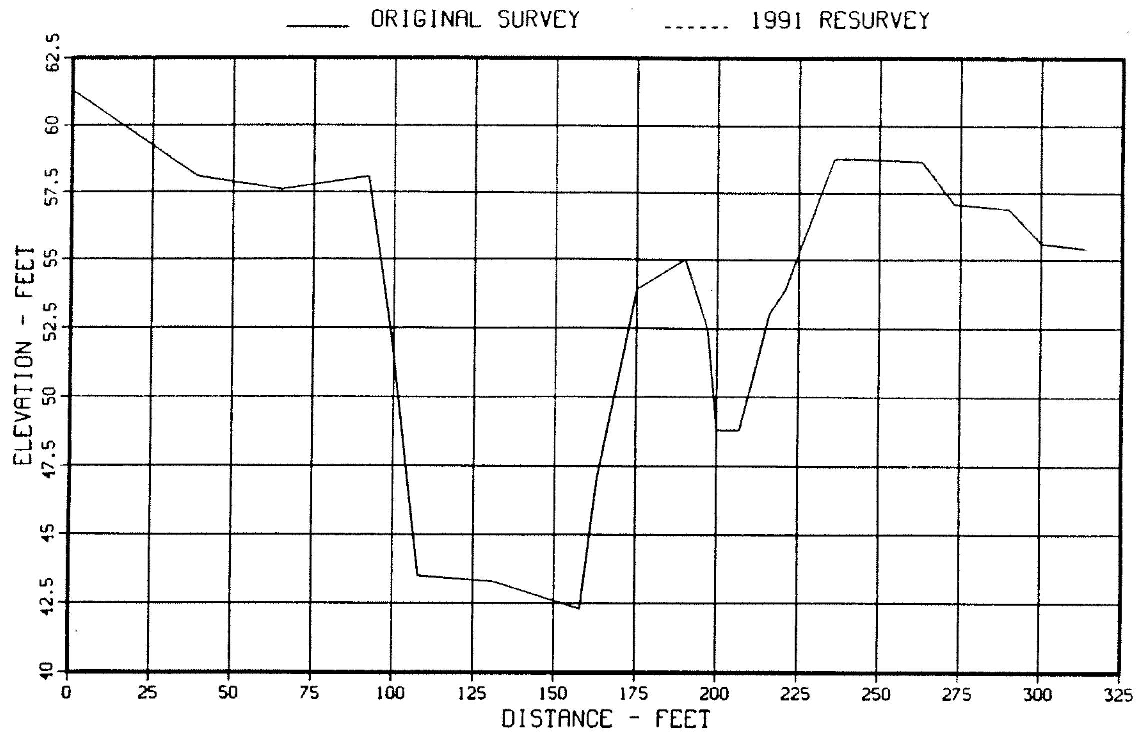

Figure 41.—Sediment Range 56 - Sandy Creek.

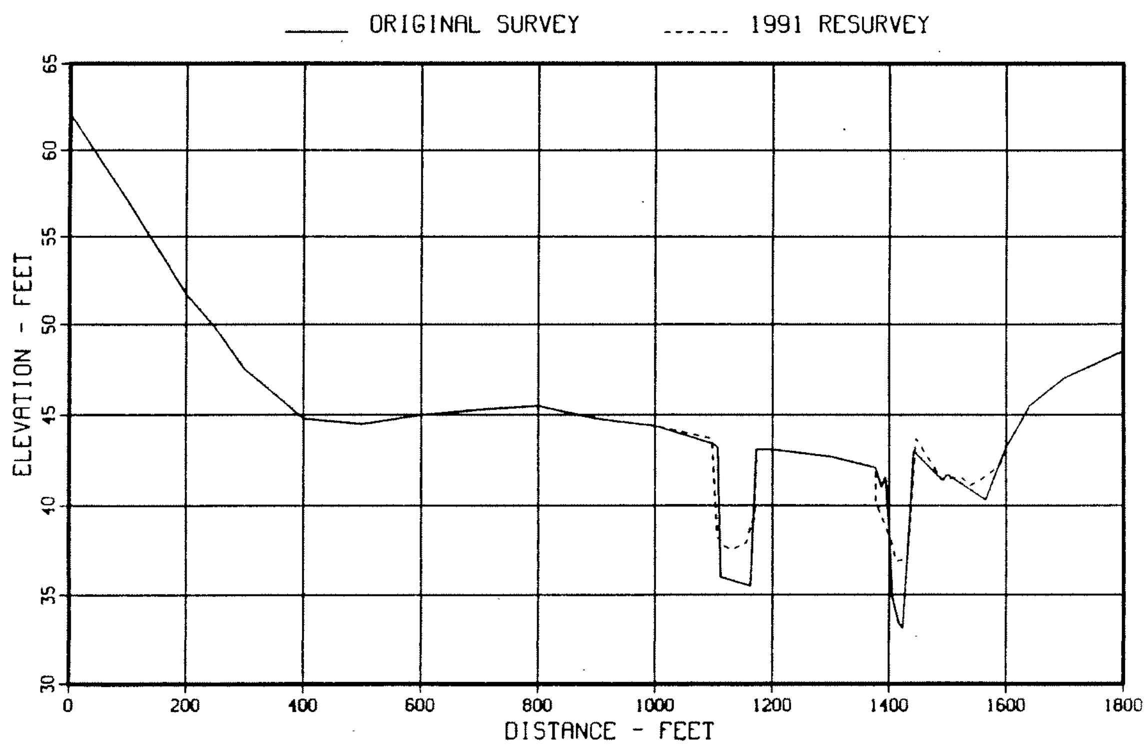

Figure 42.—Sediment Range 61 - Sandy Creek.

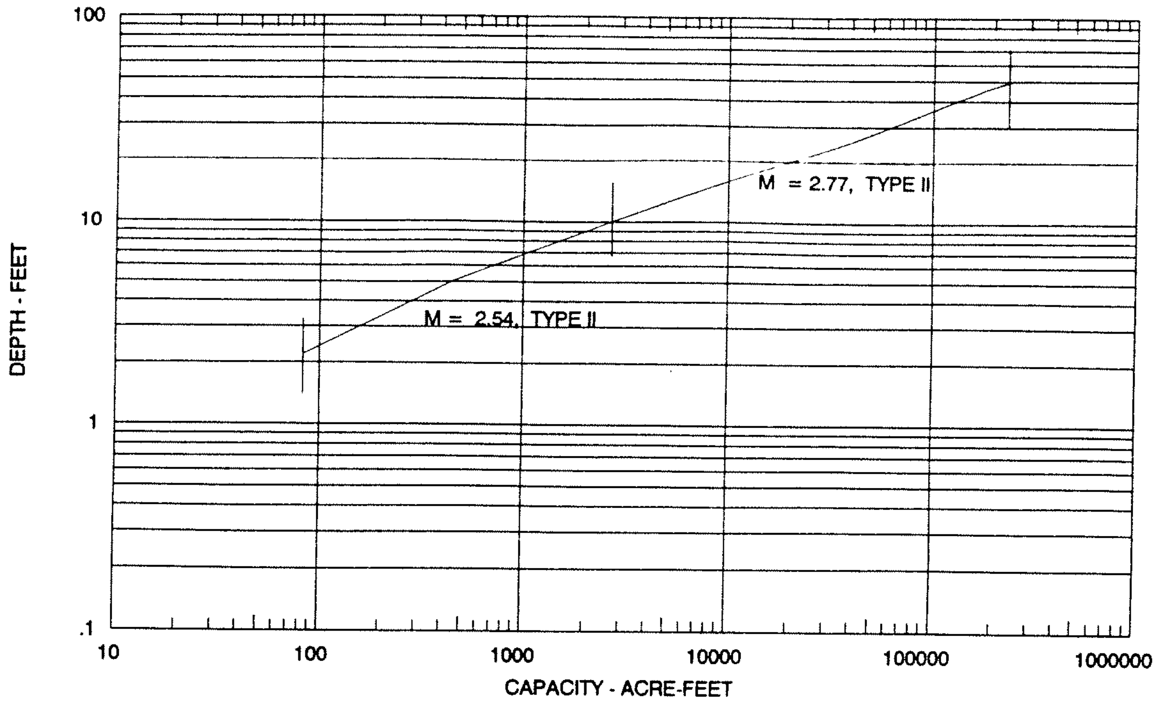

Figure 43.—Reservoir depth-capacity relationship.

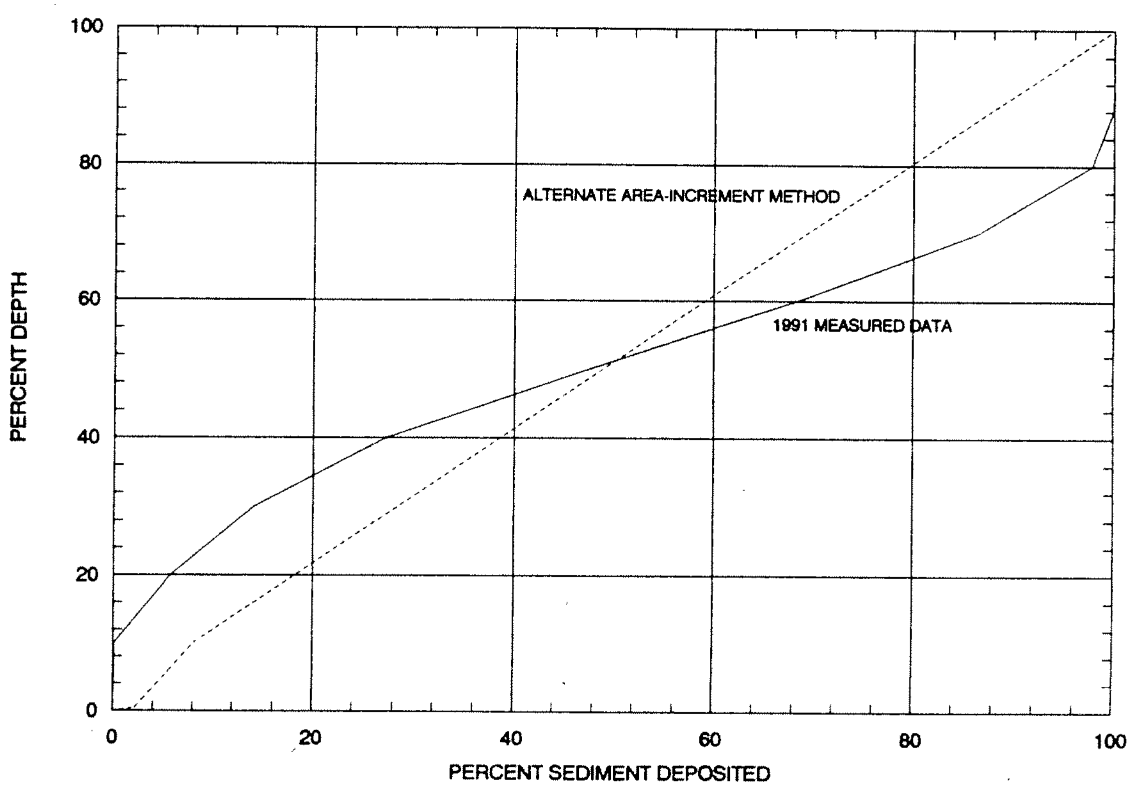

Figure 44.—Percent depth versus percent sediment deposited.

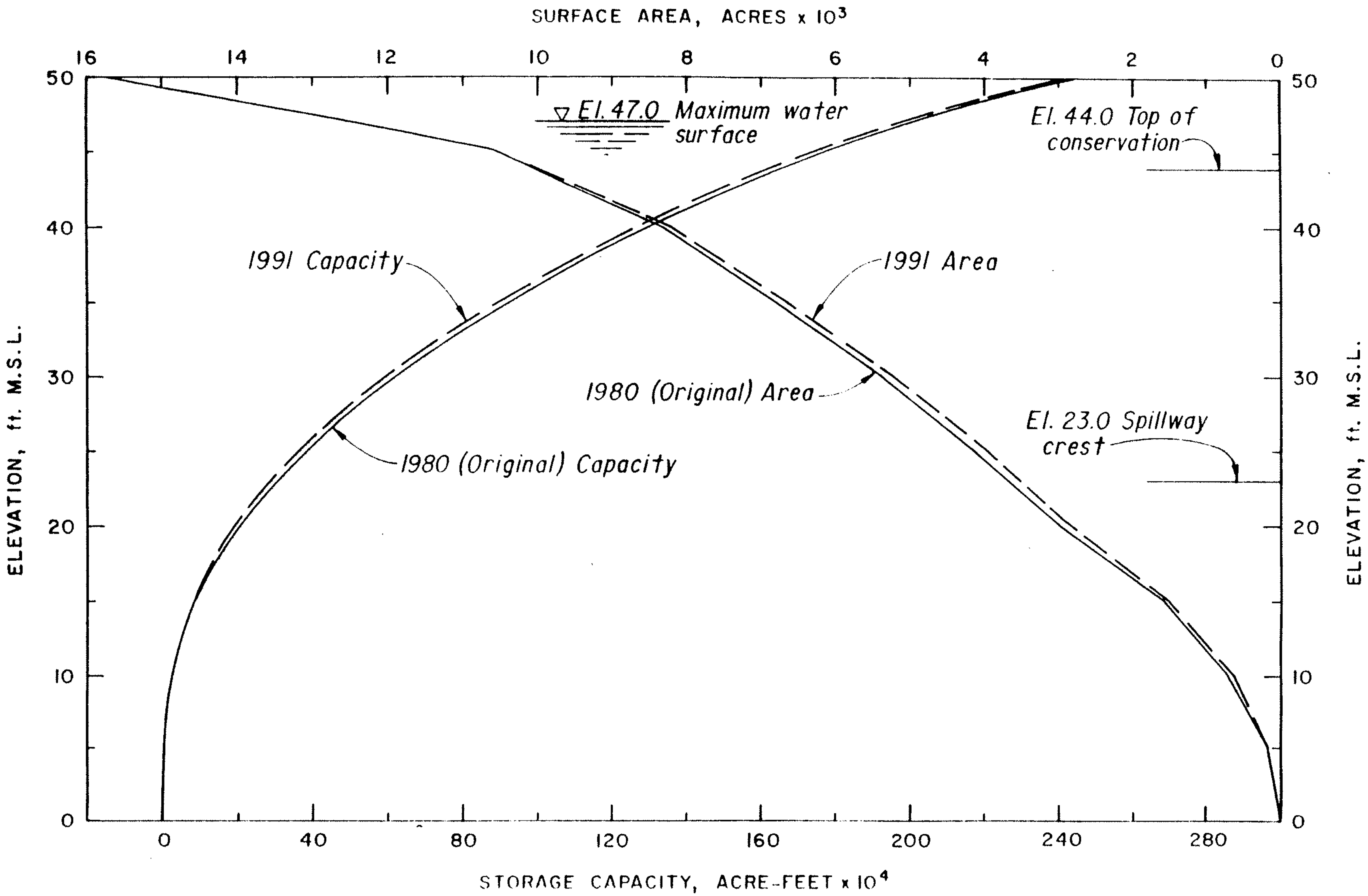

Figure 45.—Area and capacity curves - Lake Texana.