REPORT OF SEDIMENTATION
1982 and 1984 RESURVEYS
CARLYLE LAKE
UPPER MISSISSIPPI RIVER BASIN
KASKASKIA RIVER, ILLINOIS

Submitted To

U.S. Army Engineer District
St. Louis Corps of Engineers
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1984 RESURVEY

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US Army Corps
of Engineers
St. Louis District

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	25.4	millimeters
feet	0.3048	meters
miles (U.S. statute)	1.609344	kilometers
square miles	2.589988	square kilometers
cubic yards	0.7645549	cubic meters
acre-feet	1233.482	cubic meters
feet per second	0.3048	meters per second
cubic feet per second	0.02831685	cubic meters per second

PERTINENT DATA SUMMARY
CARLYLE LAKE

Reservoir storage and area values are based on the results of the 1984 sedimentation resurvey.

Item	Unit	
DRAINAGE AREA	sq. mi.	2,680
INACTIVE STORAGE POOL		
Elevation	n.g.v.d.	429.5
Area	acres	6,392
Storage	acre-feet	35,630
Storage (runoff)	inches	0.25
JOINT-USE POOL		
Elevation	n.g.v.d.	429.5 - 445.0
Area	acres	24,527
Storage	acre-feet	219,744
Storage (runoff)	inches	1.54
Regulated Outflow (min.)	c.f.s	50
Regulated Outflow (max.)	c.f.s	4,000
FLOOD CONTROL POOL		
Elevation	n.g.v.d.	445.0 - 462.5
Area	acres	58,447
Storage	acre-feet	671,739
Storage (runoff)	inches	4.70
Regulated Outflow (min.)	c.f.s.	50
Regulated Outflow (max.)	c.f.s.	10,000
INDUCED SURCHARGE		
Elevation	n.g.v.d.	462.5 - 465.5
Area	acres	67,000
Storage	acre-feet	184,000
Storage (runoff)	inches	1.29
Outflow (max.)	c.f.s.	149,000
SURCHARGE POOL (TOTAL)		
Elevation	n.g.v.d.	462.5 - 467.2
Area	acres	72,500
Storage	acre-feet	304,000
Storage (runoff)	inches	2.13
Outflow (max.)	c.f.s.	160,000

PERTINENT DATA SUMMARY
CARLYLE LAKE (continued).

Item	Unit	
FREEBOARD		
Elevation	n.g.v.d.	467.2 - 472.0
Area	acres	111,600
Storage	acre-feet	409,000
Storage (runoff)	inches	2.71
Height	feet	4.8
STANDARD PROJECT FLOOD		
Peak Inflow	c.f.s.	104,550
Peak Outflow	c.f.s.	7,000
Design Storm	inches	11.54
Runoff (includes base flow)	acre-feet	1,157,321
Runoff (includes base flow)	inches	8.10
DAM		
Elevation, Top of Dam	n.g.v.d.	472.00
Height above Streambed	feet	67
Length of Crest	feet	6,610
SPILLWAY		
Width		
Gross	feet	179
Net	feet	152
Elevation of Crest	n.v.g.d.	425
Tainter Gates		
Number	each	4
Size	feet	38 ft W. x 39 ft H.
Top Elevation, Closed	n.g.v.d.	463.5
OUTLET STRUCTURE		
Number of Sluices	each	1
Size	inches	30-in and 24-in diameter conduits joined by a Venturi tube and a regulating valve
Intake Invert Elevation	n.g.v.d.	417.0
Outlet Invert Elevation	n.g.v.d.	404.0

REPORT ON RESURVEY OF SEDIMENTATION
CARLYLE RESERVOIR
KASKASKIA RIVER, ILLINOIS, 1984

1. INTRODUCTION

This report is prepared according to instructions in EM 1110-2-4000, dated November 15, 1961, and represents the results of the 1971, 1976, 1982, and 1984 resurveys of Carlyle Reservoir sedimentation ranges and downstream retrogression ranges on the Kaskaskia River. The purpose of the investigation was to analyze the 1982 and 1984 resurvey data to determine the distribution of sediment depletion of storage in the reservoir and trap efficiency of the reservoir. Initial operation of the reservoir began on April 1, 1967.

2. LOCATION OF RESERVOIR

Carlyle Reservoir is located in Clinton County, Illinois, on the Kaskaskia River. The dam is approximately 100 miles* above the confluence of the Kaskaskia River and the Mississippi River, and approximately 1 mile upstream of the Town of Carlyle, Illinois. The watershed for the reservoir is 2,680 square miles, or about 46 percent of the total Kaskaskia River Basin. The basin is shown on Plate 1.

3. PURPOSE OF RESERVOIR

Carlyle Reservoir is part of the Kaskaskia River Basin development plan. This plan provides flood control, water supply, storage for navigation releases, recreation, and fish and wildlife conservation. The reservoir is operated jointly with the other projects in the Kaskaskia River Basin.

4. RESERVOIR PERTINENT DATA - DAM AND APPURTENANT STRUCTURES

The Pertinent Data Summary, shown on page vi, contains pertinent data concerning the dam, outlet, and spillway structures; and the elevations, areas, and capacities of the inactive, joint-use, flood-control, and surcharge pools.

5. WATERSHED CHARACTERISTICS

The watershed has a total area of 2,680 square miles. The reservoir occupies approximately 90 square miles of this area at flood-control pool (elevation 462.5**). The watershed has a median length of about 120 miles, an extreme width of 57 miles, and an average width of about 22.3 miles. The course of the river contains many bends. The topography of

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*A table of factors for converting U.S. customary units of measurement to metric (SI) units is presented on page v.

**All elevations cited herein are in feet referred to National Geodetic Vertical Datum.

the basin is flat to gently rolling terrain. The principal occupation in the watershed is agriculture with approximately 86 percent of the watershed being cultivated annually.

6. CLIMATE

The climate in the area is relatively moderate. The summers are usually mild with occasional temperatures of 100°F or higher. The winters are generally short and moderate, although temperatures below zero are not uncommon. The minimum and maximum temperatures of record are -34°F during the winter and 115°F during the summer. The average annual temperature is about 55°F. The average monthly temperature ranges from a maximum of 78°F during July to a minimum of 30°F during January. Summaries of the monthly and annual precipitation and runoff for the watershed are given in Tables 1 and 2.

7. RESERVOIR OPERATION

Carlyle Reservoir was designed to operate jointly with Shelbyville Reservoir so that their design-flood outflows can be safely and economically handled by authorized levees downstream. The reservoir outflows are regulated during the normal December through April flood season to reduce flood peaks downstream, affect maximum flood-control benefits, and empty the flood-control pool during the normal May through November low-water season. Usually, normal operational outflow does not exceed 4,000 cfs. The monthly reservoir pool hydrograph for the period 1967 through 1984 is shown on Plate 2.

8. RESERVOIR INFLOW

Summaries of the monthly and annual precipitation and runoff data for the watershed are given in Tables 1 and 2. One inch of runoff equals 142,933 acre-feet. Average annual precipitation and inflow for the sediment survey period are tabulated in Items 34 and 35 of Plate 27, a data summary of reservoir sediment, ENG Form 1787. The average monthly inflow hydrograph for the period 1966 through 1984 is shown on Plate 3.

9. ORIGINAL RESERVOIR SURVEY

Reservoir area and volume were determined from U.S. Geological Survey quandrangle sheets and River and Lakes Commission topographic survey sheets of 1908. The area and volume curves were checked from 1956 topographic reservoir survey sheets. A tabulation of the reservoir area and storage for 5-foot intervals are shown in Tables 3 and 3B. Item 46 of Plate 35, ENG Form 1787, gives area and storage (capacity) tabulation at 15-foot intervals for the original survey. Elevation versus capacity curves are shown on Plate 4.

10. TYPE AND SCOPE OF THE INITIAL SEDIMENT SURVEY

There were 9 sediment ranges established and surveyed by direct leveling during the period of July 1965 through January 1967 for the purpose of observing sediment distribution and the approximate rate of reservoir storage depletion. Plate 5 shows the location of the sediment ranges.

The cross sections of the ranges for the original survey and each of the resurveys are shown on Plates 6 through 14. Appendix A shows detailed locations of the 9 sediment ranges.

11. TYPE AND SCOPE OF SEDIMENT RESURVEYS

Detailed sediment resurveys of the 9 sediment ranges by direct leveling and by a Ratheon Recording Depth Sounder, Model EE-119 were made during 1971, 1976, 1982, and 1984. The 1971 sediment resurvey was conducted from May to August 1971. The average elevation of the reservoir pool during the measurements was about 443.0. The 1976 sediment resurvey was conducted from January to March 1976. The average elevation of the reservoir pool during the measurements was about 440.5. The 1982 resurvey was conducted from September 1982 to February 1983, with most of it being in September 1982. The average pool elevation at this time was about 445.5. The 1984 resurvey was conducted in August and September 1984. The average pool elevation was about 445.0.

Additional ranges were added in the 1982 resurvey and in the 1984 resurvey to better understand the sediment trends throughout the entire reservoir. In 1982, Ranges 3.1A and 3.2A were added, located about 7 miles and 9 miles upstream of the dam, respectively. Ranges 4.1A through 4.5A cross the Kaskaskia River channel only and were first surveyed in 1984. They are located between Ranges 4A and 7A with Range 4.1A about 1,400 feet upstream of Range 4A and Range 4.5A about 2,600 feet upstream of Range 4A. Ranges 4.1A through 4.5A cross only the river channel because of excessive brush, logs, etc. in the overbank areas, which would make surveying impossible. Plotted cross sections of these 7 ranges are shown on Plates 15 through 21. Plate 5 shows the locations of the ranges in the reservoir, and Appendix A shows their detailed locations.

Whenever future reservoir volumes are calculated with data from the additional ranges, comparison cannot be made with any survey done prior to the inclusion of the additional ranges. This is because calculations performed with the additional range data will yield a result different from that obtained without the additional data. Consistency in comparison must be maintained.

12. METHODS OF SEDIMENT COMPUTATIONS

The procedure based on the prismoidal formula for computing reservoir capacities and developed by the U.S. Soil Conservation Service (SCS) was used in the 1976 study and also in this study. The procedure was published by H.M. Eakin of the SCS as USDA Technical Bulletin No. 524, "Silting of Reservoirs," July 1936 (rev. C.B. Brown, August 1939). This paper described a range-end formula given by

$$V = \frac{A'}{3}\left(\frac{E_1 + E_2}{W_1 + W_2}\right) + \frac{A}{3}\left(\frac{E_1}{W_1} + \frac{E_2}{W_2}\right) + \frac{h_3E_3 + h_4E_4}{3\ (43{,}560)}$$

where: V = capacity, acre-feet

A' = area of the quadrilateral formed by connecting the points of intersection of the ranges with a given contour, acres

E = range cross-sectional area, square feet

W = width of the main stream range at a given elevation, feet

A = total surface area of the segment bounded the ranges, acres

h = perpendicular distance from the range on a tributary to the junction of the tributary with the main stream, or if this junction is outside the segment, to the intersection of the thalweg of the tributary with the downstream range, feet

This formula is illustrated in Figure 1 with a reservoir segment that includes two tributary arms, and is thus bounded by 4 ranges. The formula is applicable for all reservoir segments except for the one between the most downstream range and the dam. The reservoir volume in this section is given by

$$V = A\frac{E}{W} - \frac{L\ (2B - \frac{E}{W}S)\ \frac{E}{W}}{3(43{,}560)}$$

where: V, A, E, and W are the same as defined above, and

L = length of the dam, feet
B = base width of the dam, feet
S = slope of the upstream face of the dam

The length L and base width B refer to distances on the dam describing that volume of water displaced by the upstream face of the dam. Therefore, L and B almost always vary with reservoir stage.

In the study, the quadrilateral area A' was computed from USGS topographic maps of the reservoirs by scaling the appropriate distances and then summing the areas of the opposing triangles which compose the quadrilateral. The surface area, A, was computed through the application of planimetry. The values for E and W were computed based on the surveyed cross-sectional data. Values for A', A, E, and W were computed at three reservoir elevations: 430 feet, 445 feet, and 462.5 feet. These elevations correspond closely or exactly to the tops of the inactive pool (429.5 feet), the joint-use pool (445.0 feet), and the flood control pool (462.5 feet); and are also contour elevations on the USGS topographic maps.

In applying the procedure described above to the 1982 and 1984 resurvey data, results showed a very significant decrease in reservoir volume since 1976. In order to find out why this was so, the procedure was applied to the original survey data and to the 1976 resurvey data. Original volumes and 1976 volumes were obtained which were noticeably lower than those published in the previous report, "Report of Sedimentation, 1976 resurvey, Carlyle Lake," published by the U.S. Army Corps of Engineers, St. Louis District. This is most likely due to the fact that the surface areas and quadrilateral areas which were used were not identical to those used in the previous publication. Since the original values were unavailable, this resurvey analysis included calculation of quadrilateral areas and planimetering of surface areas at the three reservoir elevations. Using these new values, reservoir volumes

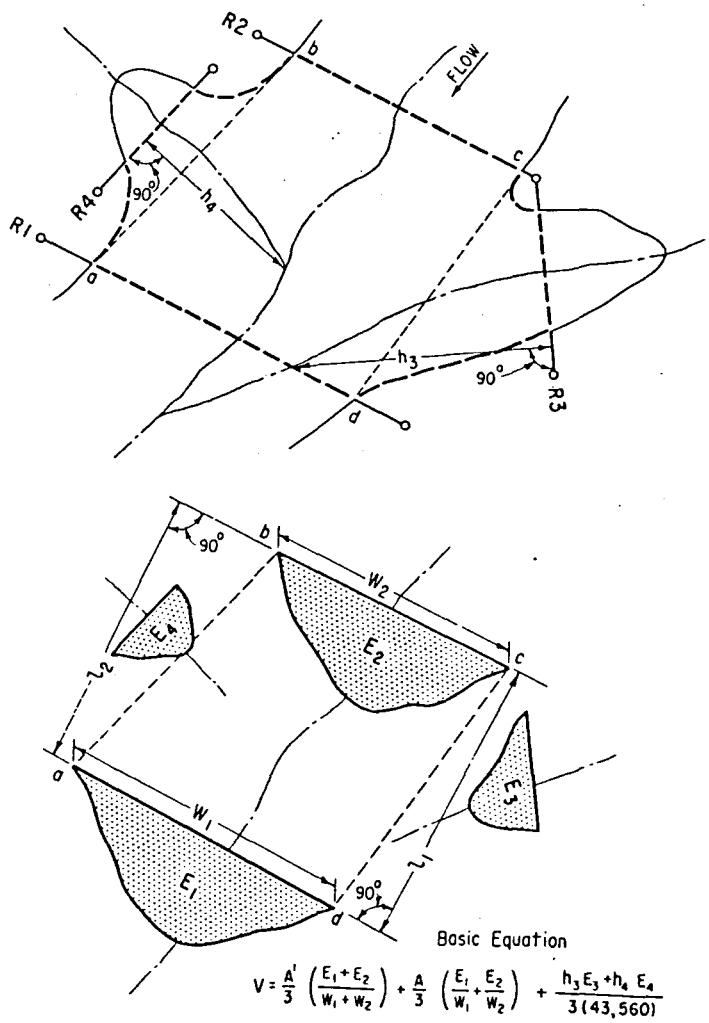


Figure 1. Terms of range-end formula for determining capacity of a reservoir. (Taken from ASCE M&R NO. 54, "Sedimentation Engineering," V.A. Vanoni, Editor, 1975, pp. 378-379).

were calculated using the same methodology for the original conditions and the 1976, 1982, and 1984 resurveys. These volumes were then consistent to one another. In order to calculate 1984 capacities which would be consistent to the original capacities which have been published, the following relationship was used:

$$V = V_0 + (V' - V_0')$$

where V = reservoir volume, consistent to original published volume

V_0 = original published volume

V' = reservoir volume based on resurvey, calculated with above methodology

V_0' = original reservoir volume, calculated with above methodology

The term, $V' - V_0'$, describes the change in volume over time. This change is then added to the original volume. This relationship was applied at the three reservoir stages which were planimetered, and other reservoir volumes were interpolated from these results. Table 3 lists the original, the 1971, and the 1976 capacities as given in the 1976 report. The changes in volume for 1967-1976, 1967-1982, 1967-1984, and 1976-1984, at the three elevations, are presented in Table 3A. Table 3B provides the original capacities, the adjusted 1976 capacities, and the 1984 capacities. In addition, Item 46 of Plate 35, ENG Form 1787, gives storage tabulation at 5-foot intervals for 1984.

In reporting reservoir volumes, or sediment volumes, values were given to the nearest acre-foot. Due to some inescapable inaccuracies in the survey data and in the application of the prismoidal formula, volumes can be accurate to three significant digits, at best. However, in order to be precise relative to previous work and in comparison of one value to another within this analysis, precision to the nearest acre-foot was maintained.

Capacities for 1982 were not listed in Table 3B. This was done because the survey data for 1984 reflects more recent conditions. Preliminary reduction of the 1982 resurvey data produced results which were not consistent with the previous data. Thus, another resurvey was conducted in 1984 to verify this fact. Further, detailed analysis of the 1982 results shows that the loss in capacity for the period 1967-1982 listed in Table 3A is significantly greater than the loss in capacity for the period 1967-1984. These losses reflect sediment deposition rates which are much greater than those of any of the other resurveys. The plotted reservoir cross sections (Plates 6-21) also illustrate that, relative to the other resurveys, the 1982 survey data is inconsistent.

Table 4 lists quadrilateral and planimetered surface areas between ranges and approximate distances between ranges. The quadrilateral areas were smaller than the surface areas because the quadrilateral areas do not reflect inlets and coves along the reservoir shore line which are included in the surface area. The areas given are areas found at elevation 462.5. Tables 5A, 5B, and 5C list the original range cross-sectional areas and the changes in cross-sectional areas during the periods 1967-1976, 1967-1982, and 1967-1984. This data is given at ele-

vation 430, elevation 445, and elevation 462.5. Again, the changes in cross-sectional area for the period 1967-1982 are quite large in comparison to the other periods.

Item 46 of Plate 35, ENG Form 1787, also lists elevation versus reservoir surface area for original conditions and for 1984. In solving for 1984 reservoir areas, the reservoir volumes computed from the 1984 resurvey were used, taking advantage of the average end area method to relate volume with surface areas. The average end area formula is given by

$$V = \frac{h}{2}(A_1 + A_2)$$

where V = volume between given reservoir elevations, acre-feet
h = distance between reservoir elevations, feet
A = surface area of the reservoir at a given elevation, acres

A normalized form of this relationship was derived to provide an expression for 1984 reservoir areas as a function of the original reservoir volumes and areas and the 1984 reservoir volumes computed with the prismoidal method. This relationship is given by

$$\frac{V_{orig} - V_{84}}{V_{orig}} = \frac{h}{2} \quad \frac{(A_1 + A_2)_{orig} - (A_1 + A_2)_{84}}{(A_1 + A_2)_{orig}}$$

It may be assumed that the surface area, as seen with the reservoir volume, does not change over time at elevations above the maximum pool elevation. Therefore, using the above expression and starting the calculations at the maximum pool elevation, the 1984 area at the lower end of the elevation interval $A_{2_{84}}$ is computed. The calculation proceeds step-wise toward the reservoir bottom in this manner. Area-elevation computations were performed at 5-foot intervals and are listed in Item 46 of Plate 35 and plotted on Plate 4.

13. SEDIMENT QUANTITIES

A summary of the volume of sediment deposited between each range in the reservoir for the periods 1967-1976, 1967-1982, 1967-1984, and 1976-1984 is presented in Tables 6A, 6B, and 6C for elevations 430, 445, and 462.5, respectively. A summation of the volume of sediment deposited in each reach indicates that during the period 1967-1976 about 1.8 percent of the total reservoir capacity was lost to sedimentation. This is a depletion rate of about 0.2 percent per year. The period 1967-1984 experienced a volume loss of about 4.9 percent, or about 0.3 percent annually.

The 1984 resurvey data show that of the 47,532 acre-feet of sediment calculated to be deposited from 1967 to 1984, about 14,900 acre-feet was deposited within the inactive pool (below elevation 429.5). This decreased the amount of storage in the inactive pool by 30 percent. In the joint-use pool (elevation 429.5 to 445.0), about 10,321 acre-feet of sediment accumulated. This reduced the joint-use pool capacity by 4.5 percent. The flood-control pool experienced a storage loss of about 22,311 acre-feet, or 3.2 percent over the same period. The following

table summarizes the sediment deposition in Carlyle Lake based on the 1976 and 1984 resurveys. A 17.4-year time period (April 1967 to September 1984) and an 8.9-year time period (April 1967 to March 1976) were used to compute the rates of sediment deposition.

Summary of Carlyle Lake Sedimentation.

Reservoir Portion	Amount of Sediment Deposited 1967-1976 (acre-feet)	Annual Rate of Deposition 1967-1984 (acre-feet/yr)	Amount of Sediment Deposited 1967-1984 (acre-feet)	Annual Rate of Deposition 1967-1984 (acre-feet/yr)
Entire Reservoir	17,355	1,950	47,532	2,730
Inactive Storage	8,289	931	14,900	860
Joint-use Storage	2,210	248	10,321	590
Flood-Control Storage	6,856	771	22,311	1,280

The 1984 resurvey also showed that, for the entire reservoir, the greatest amount of sediment was deposited between Ranges 3A and 4A. This section accounted for about 34 percent of the total sediment accumulation. The distance between Ranges 3A and 4A is approximately 5.25 miles, making it the largest section in the reservoir. This large distance between ranges made it necessary for Ranges 3.1A and 3.2A to be added for better definition in this reach. Almost three-fourths (73 percent) of the total was deposited in the upper part of the reservoir, upstream of Range 3A. The reservoir is approximately 15.1 miles long at the joint-use pool elevation and the distance to Range 3A from the dam is approximately 5 miles.

As discussed in Section 10, in 1982 and 1984, Cross Sections 3.1A and 3.2A were also surveyed. With the methodology for calculating reservoir volumes described above, the inclusion of the additional ranges in the computations yielded higher capacities. In order to compare volumes from year to year, the same cross sections must be used in the analysis. Therefore, in the above analysis, Cross Sections 3.1A and 3.2A were omitted. The effects of adding the additional cross sections are displayed in the following table.

Effects of Additional Cross Sections on Reservoir Volume Computations.

Elevation	Difference in Calculated Capacity, 1982 (acre-feet)	Difference in Calculated Capacity, 1984 (acre-feet)
430	1,567	1,864
445	14,241	13,847
462.5	40,252	40,680

14. TRAP EFFICIENCY OF THE RESERVOIR

For the period of operation from 1976 to 1984, Carlyle Lake has a trap efficiency of 96 percent. This was based on the method of Gunnar M. Brune, presented in a transaction of the American Geophysical Union, Volume 34, Number 3, June 1973, pages 407-417. A capacity-inflow ratio of 0.85 was used (Item 33, Plate 35). Plates 36-48 provide the sediment size distributions based on sediment samples collected in the 1982 resurvey.

15. DOWNSTREAM CHANNEL AND RESERVOIR OPERATION

A series of nine retrogression ranges were established downstream of Carlyle Dam to assist in monitoring downstream changes due to reservoir operation. They cover from U.S. 50 Highway Bridge at River Mile 105.7 to River Mile 102.75 (See Plate 22). A thalweg profile, illustrating the changes in river bed elevation since reservoir operation began in 1967, is shown on Plate 23. Cross sections of the retrogression ranges are shown on Plates 25 through 33. In addition, Table 7 illustrates the downstream volume increases due to the clear-water discharge from Carlyle Lake. The 1976 resurvey data indicate that an increase of 8.9 percent was experienced over the river reach between Ranges 1C and 9C. An increase of 18 percent was calculated for the period 1967-1982. The retrogression ranges were not resurveyed in 1984. In examining the cross-sectional plots on Plates 25 through 33, the 1982 data again appears as inconsistent to the other surveys at a majority of the cross sections. Examination of the cross-sectional plots reveals that most of the volume changes are due to lateral bank movement, not in bed elevation changes. This bank erosion should continue to be monitored. Plate 24 displays the 1982 tailwater rating curve in comparison to the 1969 and 1975 tailwater rating curves.

16. EFFECT ON WATER SUPPLY CONTRACT

The joint-use pool originally had 230,227 acre-feet of storage, of which 32,692 acre-feet was allocated for water supply. Of the total joint-use storage, only 10,321 acre-feet had been depleted by 1984, a reduction of 4.5 percent. Due to the small amount of storage depleted, the existing Water Supply Contract should not be changed. In the future, if sediment distribution decreases the amount of joint-use storage to the extent that any project purpose is affected, the District Engineer shall make an equitable redistribution of the storage allocations served by the project. Information concerning future sedimentation and any redistribution of storage allocations shall be made available to the Illinois Department of Transportation, Division of Water Resources.

17. SUMMARY

The computed rate of sediment deposition, 2,730 acre-feet per year is much higher than the predicted rate of 746 acre-feet per year, which was the expected yearly sedimentation rate computed before the operation of the project. This predicted rate was obtained from the suspended sediment and bed-load capacity of the river at the nearest sedimentation station to Carlyle Dam, located at Shelbyville, Illinois. It was also based upon information furnished by the U.S. Department of Agriculture, Soil Conservation Service, in a letter dated February 28, 1954. The results show that a significant amount of sedimentation is occurring in the flood-control pool. For the period 1967-1976, 40 percent of the sedimentation occurred above the joint-use pool. The period 1967-1984 reinforced this trend with 47 percent of the sedimentation occurring above the joint-use pool. For the entire period of operation, the amount of storage lost below elevation 445.0 is only about 1,450 acre-feet per year, about twice the predicted rate.

Based on the results of the 1984 resurvey, in 20 years (2004) the inactive pool will have lost approximately 32,100 acre-feet of storage to sediment accumulation, or about 64 percent of its capacity; the joint-use pool will have lost in 20 years approximately 22,100 acre-feet of capacity, or about 9.6 percent; the flood-control pool will have lost about 47,900 acre-feet of storage, or 6.9 percent. A summary of reservoir sedimentation is shown on Eng. Form 1787 (Plates 34 and 35).

18. RECOMMENDATION

Current budgeting guidance limits potential funding for future sediment surveys. Funding will be requested to conduct another resurvey in the next five to ten years. However, until the sediment deposition is anticipated to have a significant impact on project operations, funding will be unlikely. At the current rate of sedimentation, in 15 to 20 years the level of funding could justifiably be raised. The decision to do so should be based on an evaluation of the flood events that have occurred and their estimated contribution to loss of available storage.

Table 1. Monthly Precipitation and Runoff for Drainage Area Above Carlyle Gage (1966-1983).

Month	Maximum Rainfall (inches)	Minimum Rainfall (inches)	Average Rainfall (inches)	Average Runoff (inches)	Runoff (percent)
January	5.04	0.34	2.06	1.12	54.4
February	3.58	0.82	1.86	1.61	86.6
March	7.41	1.07	3.66	1.98	54.1
April	7.73	0.96	3.88	1.73	44.6
May	7.07	1.59	4.08	1.05	25.7
June	8.56	0.48	4.12	1.01	24.5
July	7.47	0.57	4.05	0.67	16.5
August	5.25	0.52	3.08	0.48	15.6
September	6.54	0.43	3.29	0.30	9.1
October	4.71	0.77	2.95	0.43	14.6
November	7.27	0.33	3.20	0.51	15.9
December	8.65	0.42	3.55	1.45	40.8

Table 2. Annual Precipitation and Runoff for Drainage Area Above Carlyle Gage (1966-1983).

Year	Rainfall (inches)	Runoff (inches)	Runoff (percent)	Average Daily Runoff (cfs)
1966	31.89	14.9	46.7	2,939.6
1967	45.81	14.0	30.6	2,771.5
1968	34.73	9.0	25.9	1,776.8
1969	44.01	12.6	28.6	2,482.1
1970	37.98	10.4	27.4	2,052.3
1971	35.88	5.8	16.2	1,137.7
1972	39.13	9.6	24.5	1,898.5
1973	47.92	19.4	40.5	3,840.9
1974	44.17	21.3	48.2	4,211.2
1975	42.25	14.3	33.8	2,829.6
1976	25.65	4.1	16.0	805.1
1977	42.15	7.4	17.6	1,456.9
1978	36.38	12.3	33.8	2,429.8
1979	40.86	16.2	39.6	3,191.9
1980	30.62	5.5	18.0	1,081.5
1981	38.44	7.3	19.0	1,446.3
1982	52.34	19.5	37.3	3,856.8
1983	46.10	16.3	35.4	3,218.8
Maximum	52.34	21.3	48.2	4,211.2
Minimum	25.65	4.1	16.0	805.1
Average	39.80	12.3	30.0	2,412.6

Table 3. Elevation Versus Capacity for Carlyle Lake.*

Elevation (feet, NGVD)	Original Capacity (acre-feet)	1971 Capacity (acre-feet)	1976 Capacity (acre-feet)
410	0	0	0
415	5,156	5,041	5,040
420	13,088	12,608	12,595
425	27,762	26,138	26,097
430	53,739	49,206	49,066
435	101,133	96,097	95,211
440	175,297	166,424	165,227
445	280,595	268,644	267,140
450	421,388	408,657	406,281
455	605,212	592,481	589,220
460	837,421	824,690	821,429
462.5	974,645	961,914	958,653
465	1,127,534	1,114,803	1,111,542

*As reported in Report on Sedimentation, 1976 Resurvey.

Table 3A. Elevation Versus Change in Capacity for Carlyle Lake.

Elevation (feet, NGVD)	Change in Capacity 1967-1976 (acre-feet)	Change in Capacity 1967-1982 (acre-feet)	Change in Capacity 1967-1984 (acre-feet)	Change in Capacity 1976-1984 (acre-feet)
430	-8,289	-16,374	-15,132	-6,843
445	-10,499	-30,460	-25,221	-14,722
462.5	-17,355	-57,628	-47,532	-30,177

Table 3B. Elevation Versus Capacity (1984) for Carlyle Lake.

Elevation (feet, NGVD)	Original Capacity (acre-feet)	Adjusted 1976 Capacity (acre-feet)[1]	1984 Capacity (acre-feet)[1]
410	0	0	0
415	5,156	4,500	2,200
420	13,088	11,000	7,000
425	27,762	23,000	17,000
430	53,739	45,450[2]	38,607[2]
435	101,133	92,000	81,000
440	175,297	163,500	151,000
445	280,595	270,096[2]	255,374[2]
450	421,388	410,000	395,000
455	605,212	591,000	578,000
460	837,421	824,000	798,000
462.5	974,645	957,290[2]	927,113[2]
465	1,127,534	1,107,000	1,072,500

[1]Interpolated from elevation - capacity curves (Plate 4).

[2]Computed values.

Table 4. Area Data by Reach for Carlyle Lake, Elevation 462.5 feet.

Reach	Distance Between Ranges (feet)	Quadrilateral Area (acres)	Surface Area (Acres)
Dam-1A	5,600	-	1,634
1A-2A	10,400	3,750	4,105
2A-3A	9,700	4,972	5,614
3A-3.1A	10,600	5,041	5,896
3.1A-3.2A	11,500	4,777	5,391
3.2A-4A	5,600	2,239	2,619
3A-4A	27,700	12,726	13,906
4A-7A	27,400	8,814	10,108
5B	15,900	716	1,344
6B	19,400	496	1,175
7A-9A	27,500	8,294	8,903
8B	15,700	698	1,193
9A	11,000	2,824	3,128

Table 5A. Range Cross Section Data for Carlyle Lake, Elevation 430 feet.

Range	Original Cross-Sectional Area (sq. ft)	Change in Cross-Sectional Area, 1967-1976 (sq. ft)	Change in Cross-Sectional Area, 1967-1982 (sq. ft)	Change in Cross-Sectional Area, 1967-1984 (sq. ft)
1A	56,747	-4,296	-13,765	-13,500
2A	45,592	-4,947	-19,250	-13,717
3A	21,134	-9,521	-16,327	-15,196
3.1A	673 (1982)	-	-	-
3.2A	0 (1982)	-	-	-
4A	7,185	-5,460	-6,626	-6,507
4.1A	0 (1984)	-	-	-
4.2A	351 (1984)	-	-	-
4.3A	158 (1984)	-	-	-
4.4A	37 (1984)	-	-	-
4.5A	14 (1984)	-	-	-
5B	0	0	0	0
6B	0	0	0	0
7A	72	-48	-70	-72
8B	0	0	0	0
9A	0	0	0	0

Table 5B. Range Cross Section Data for Carlyle Lake, Elevation 445 feet.

Range	Original Cross-Sectional Area (sq. ft)	Change in Cross-Sectional Area, 1967-1976 (sq. ft)	Change in Cross-Sectional Area, 1967-1982 (sq. ft)	Change in Cross-Sectional Area, 1967-1984 (sq. ft)
1A	214,692	-4,044	-14,200	-15,320
2A	226,452	-5,720	-20,134	-15,183
3A	239,051	-10,841	-28,325	-18,132
3.1A	194,609 (1982)	-	-	-
3.2A	169,515 (1982)	-	-	-
4A	101,359	-12,611	-20,860	-11,862
4.1A	1,624 (1984)	-	-	-
4.2A	2,078 (1984)	-	-	-
4.3A	1,760 (1984)	-	-	-
4.4A	1,578 (1984)	-	-	-
4.5A	1,290 (1984)	-	-	-
5B	1,182	-208	572	167
6B	585	89	-99	-559
7A	3,744	-782	-1,321	-1,861
8B	222	208	-135	-135
9A	532	0	157	-*

*Range 9A was not surveyed in 1984.

Table 5C. Range Cross Section Data for Carlyle Lake, Elevation 462.5 feet.

Range	Original Cross-Sectional Area (sq. ft)	Change in Cross-Sectional Area, 1967-1976 (sq. ft)	Change in Cross-Sectional Area, 1967-1982 (sq. ft)	Change in Cross-Sectional Area, 1967-1984 (sq. ft)
1A	439,008	-3,388	-13,295	-14,523
2A	466,531	-5,826	-19,301	-14,700
3A	648,790	-12,697	-27,954	-18,358
3.1A	529,758 (1982)	-	-	-
3.2A	518,364 (1982)	-	-	-
4A	395,494	-11,944	-7,688	1,138
4.1A	12,428 (1984)	-	-	-
4.2A	5,845 (1984)	-	-	-
4.3A	5,475 (1984)	-	-	-
4.4A	5,657 (1984)	-	-	-
4.5A	4,814 (1984)	-	-	-
5B	48,445	-805	375	-260
6B	43,752	-108	282	-1,339
7A	179,902	-2,719	-4,971	-2,960
8B	44,423	574	1,045	-162
9A	54,856	244	5,659	-*

*Range 9A was not surveyed in 1984.

Table 6A. Sediment Deposition by Reach for Carlyle Lake, Elevation 430 Feet.

Reach	Sediment Deposited 1967 - 1976 (acre-feet)	Sediment Deposited 1967 - 1982 (acre-feet)	Sediment Deposited 1967 - 1984 (acre-feet)	Sediment Deposited 1976 - 1984 (acre-feet)
Dam-1A	222	830	803	581
1A-2A	1,024	3,762	3,158	2,134
2A-3A	1,606	3,791	3,024	1,418
3A-4A	4,919	7,306	7,411	2,492
4A-7A	518	685	736	218
5B	0	0	0	0
6B	0	0	0	0
7A-9A	0	0	0	0
8B	0	0	0	0
9B	0	0	0	0
TOTAL	8,289	16,374	15,132	6,843

Table 6B. Sediment Deposition by Reach for Carlyle Lake, Elevation 445 Feet.

Reach	Sediment Deposited 1967 - 1976 (acre-feet)	Sediment Deposited 1967 - 1982 (acre-feet)	Sediment Deposited 1967 - 1984 (acre-feet)	Sediment Deposited 1976 - 1984 (acre-feet)
Dam-1A	701	1,336	1,389	688
1A-2A	222	4,749	4,212	3,990
2A-3A	1,708	5,187	4,123	2,415
3A-4A	5,118	15,355	10,517	5,399
4A-7A	2,727	3,808	4,766	2,039
5B	0	0	0	0
6B	0	0	0	0
7A-9A	23	25	214	191
8B	0	0	0	0
9B	0	0	0	0
TOTAL	10,499	30,460	25,221	14,722

Table 6C. Sediment Deposition by Reach for Carlyle Lake, Elevation 462.5 Feet.

Reach	Sediment Deposited 1967 - 1976 (acre-feet)	Sediment Deposited 1967 - 1982 (acre-feet)	Sediment Deposited 1967 - 1984 (acre-feet)	Sediment Deposited 1976 - 1984 (acre-feet)
Dam-1A	500	1,683	1,830	1,330
1A-2A	1,329	4,490	4,096	2,767
2A-3A	2,285	5,848	4,247	1,962
3A-4A	7,669	21,406	16,246	8,577
4A-7A	4,620	13,102	10,175	5,555
5B	134	-167*	-41*	-175*
6B	31	-56	190	159
7A-9A	932	9,154	8,434	7,502
8B	-90*	-204	-17	73
9A	-55	2,372	2,372	2,427
TOTAL	17,355	57,628	47,532	30,177

*Negative sign indicates an increase in volume.

Percentage of Storage Loss:

1967-1976: $\frac{17,355}{974,645} \times 100 = 1.8$ percent

1967-1984: $\frac{47,532}{974,645} \times 100 = 4.9$ percent

1976-1986: $\frac{30,177}{974,645} \times 100 = 3.1$ percent

Table 7. Volume Changes Downstream of Carlyle Dam, Kaskaskia River.

Section	Volume Change[1] 1967-1976 (acre-feet)	Volume Change[1] 1967-1982 (acre-feet)
1C - 2C	0.0	-3.4[2]
2C - 3C	3.0	0.7
3C - 4C	0.3	3.6
4C - 5C	1.2	12.8
5C - 6C	8.5	1.7
6C - 7C	18.5	29.5
7C - 8C	15.0	31.0
8C - 9C	20.3	60.0
TOTAL	66.8	135.9

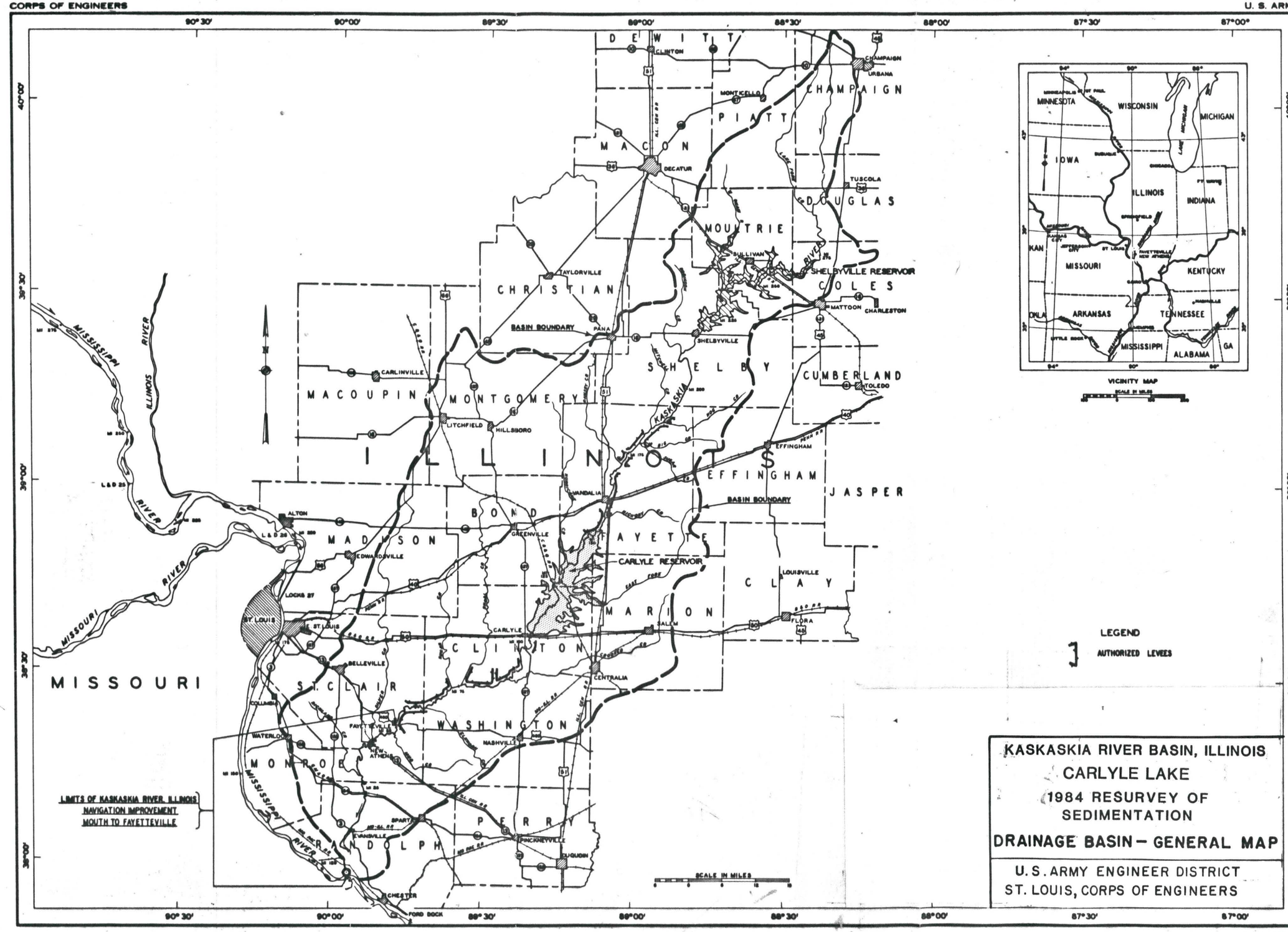
Percent Changes:

1967-1976: $\frac{66.8}{752.4} \times 100 = 8.9$ percent

(752.4 acre-feet = total volume in 1967 between ranges 1C and 9C).

[1]Calculated using average end area method.

[2]Negative indicates a decrease in volume.


KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
1984 RESURVEY OF SEDIMENTATION
DRAINAGE BASIN – GENERAL MAP
U.S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS
LEGEND
AUTHORIZED LEVEES
VICINITY MAP
SCALE IN MILES
BASIN BOUNDARY
LIMITS OF KASKASKIA RIVER, ILLINOIS NAVIGATION IMPROVEMENT MOUTH TO FAYETTEVILLE
CARLYLE RESERVOIR
SHELBYVILLE RESERVOIR
ILLINOIS
MISSOURI
DE WITT
CHAMPAIGN
PIATT
MACON
DOUGLAS
MOULTRIE
CHRISTIAN
COLES
SHELBY
CUMBERLAND
MACOUPIN
MONTGOMERY
EFFINGHAM
JASPER
BOND
FAYETTE
MADISON
CLAY
MARION
CLINTON
ST. CLAIR
WASHINGTON
MONROE
PERRY
RANDOLPH
MISSISSIPPI RIVER
ILLINOIS RIVER
MISSOURI RIVER
KASKASKIA
MINNESOTA
WISCONSIN
MICHIGAN
IOWA
INDIANA
MISSOURI
KENTUCKY
ARKANSAS
TENNESSEE
MISSISSIPPI
ALABAMA
GA
KAN
OKLA
90°30'
90°00'
89°30'
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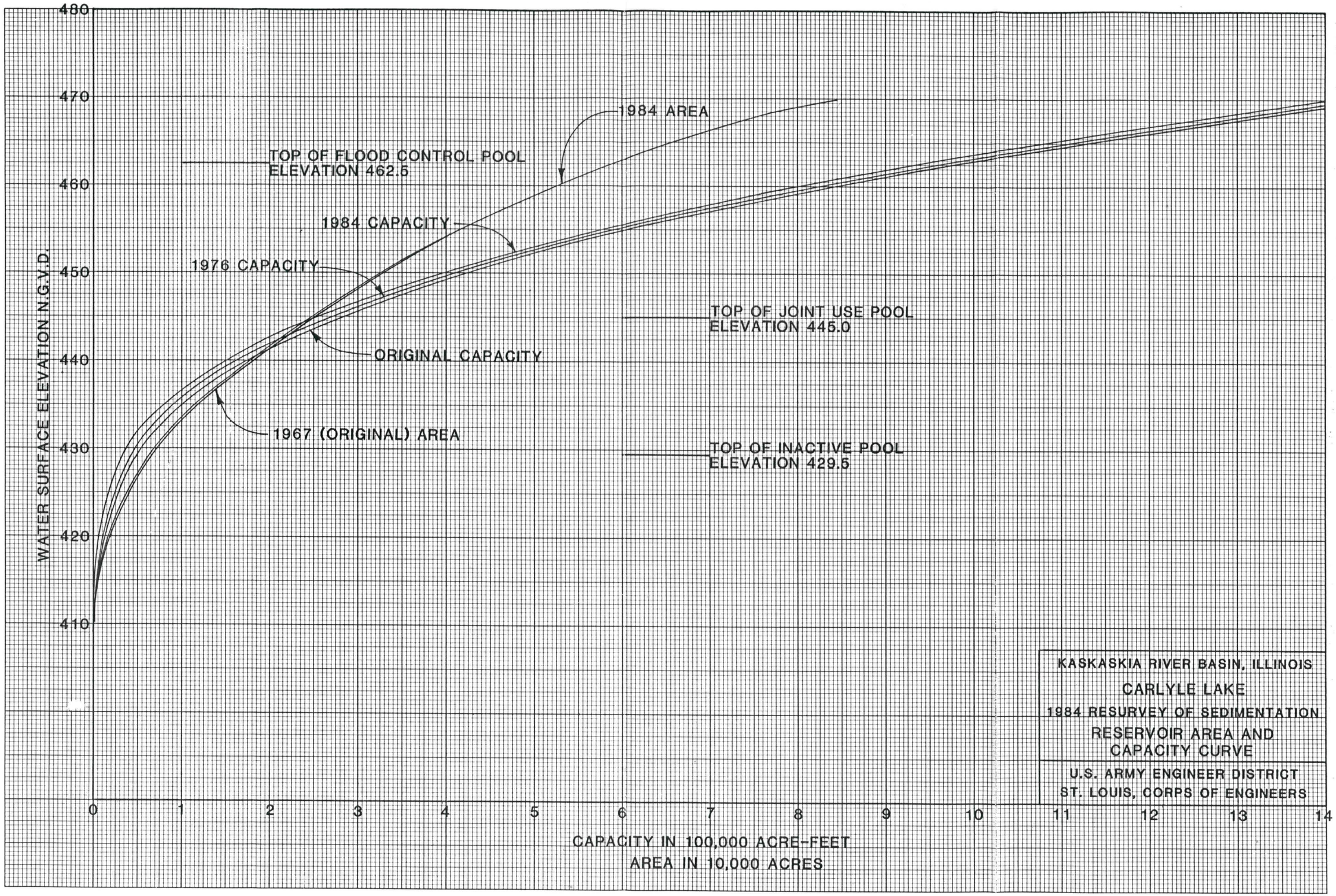
87°00'
40°00'
39°30'
39°00'
38°30'
38°00'



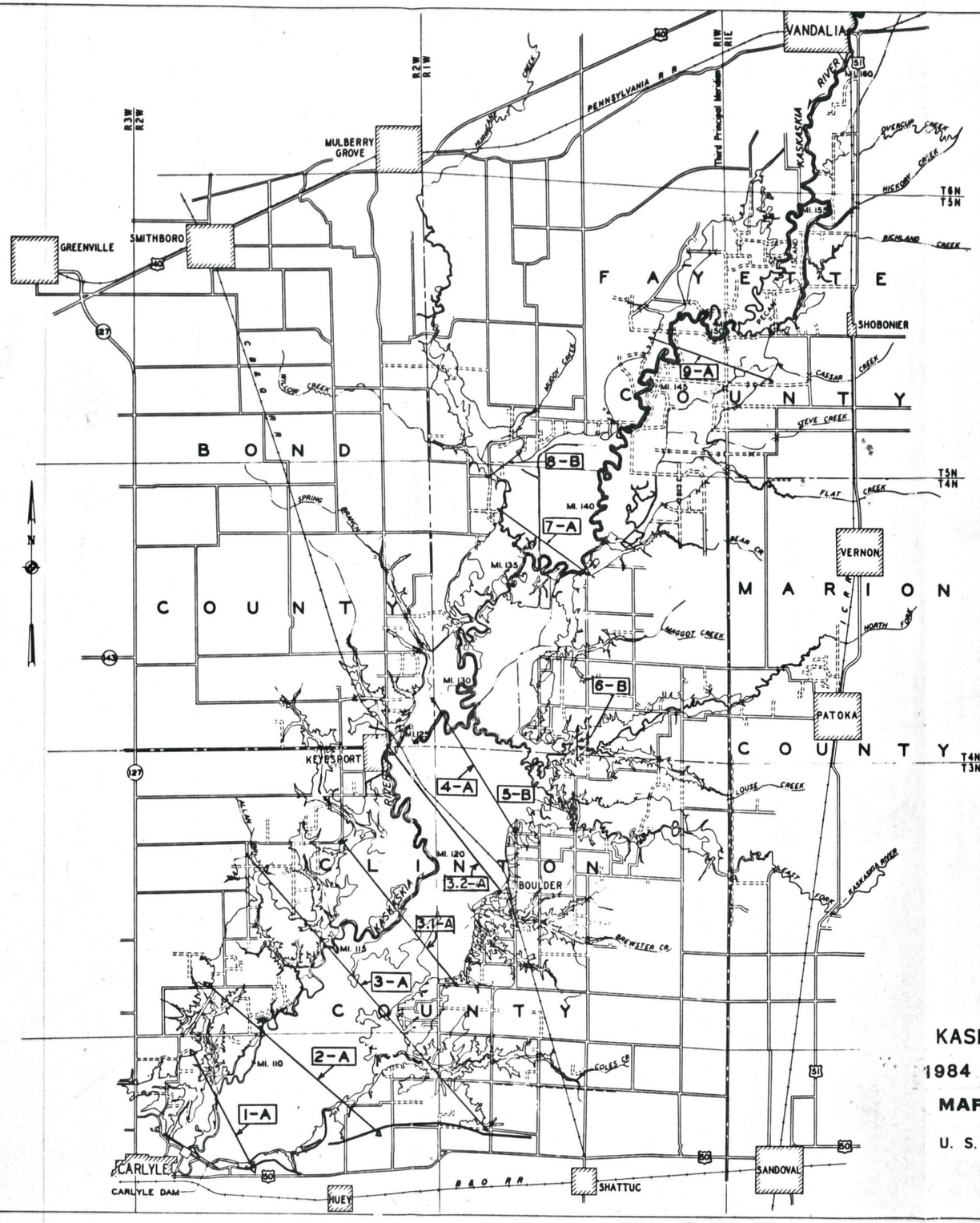
KASKASKIA RIVER BASIN, ILLINOIS

CARLYLE LAKE

1984 RESURVEY OF SEDIMENTATION

RESERVOIR AREA AND CAPACITY CURVE

U.S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS



VICINITY MAP
SCALE IN MILES
50 0 50 100

CARLYLE LAKE
KASKASKIA RIVER BASIN, ILLINOIS
1984 RESURVEY OF SEDIMENTATION
MAP, POOL SEDIMENT RANGES

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

LAKE CARLYLE

SEDIMENTATION RANGE : 1A

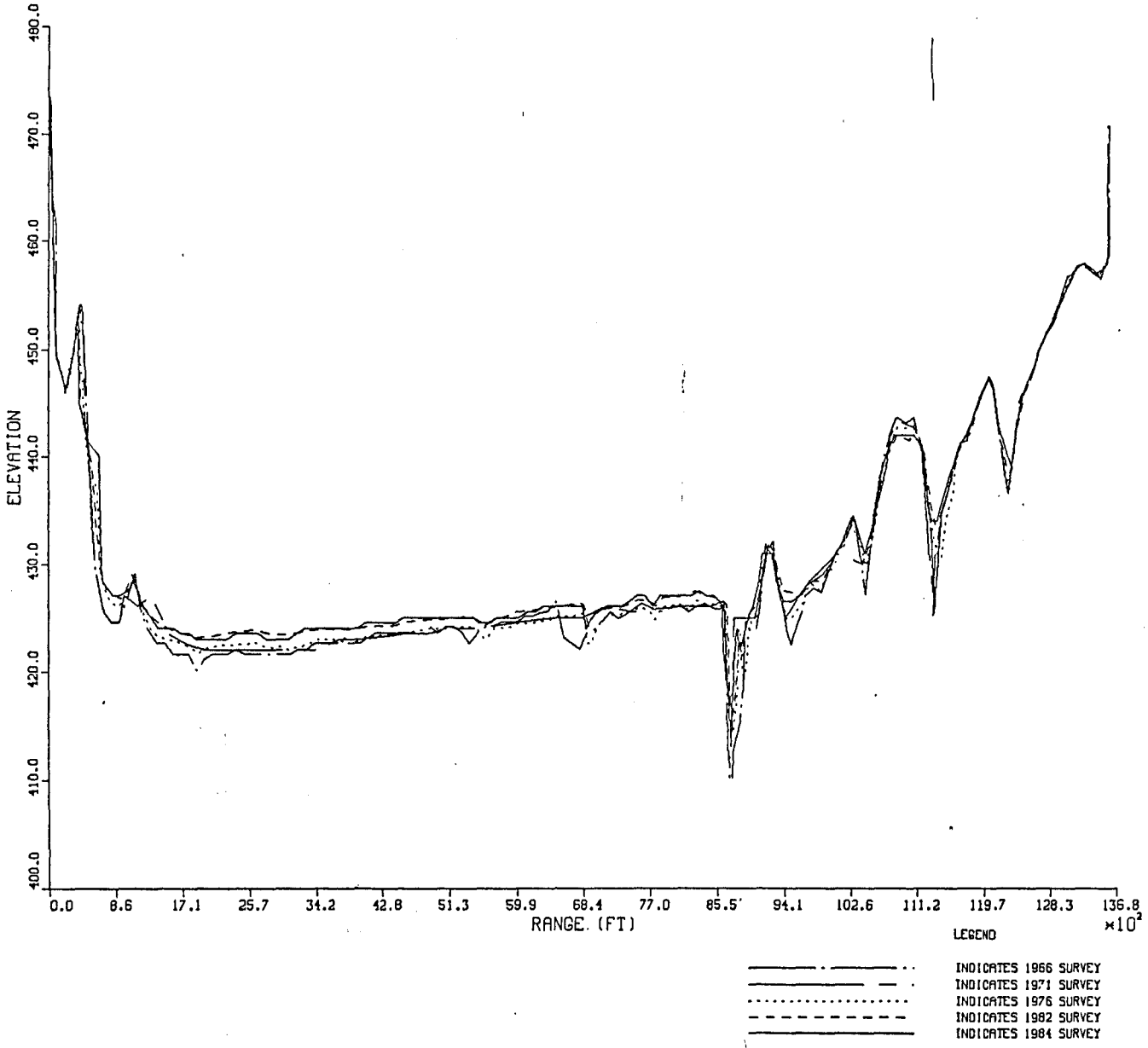


PLATE 6

LAKE CARLYLE

SEDIMENTATION RANGE : 2A

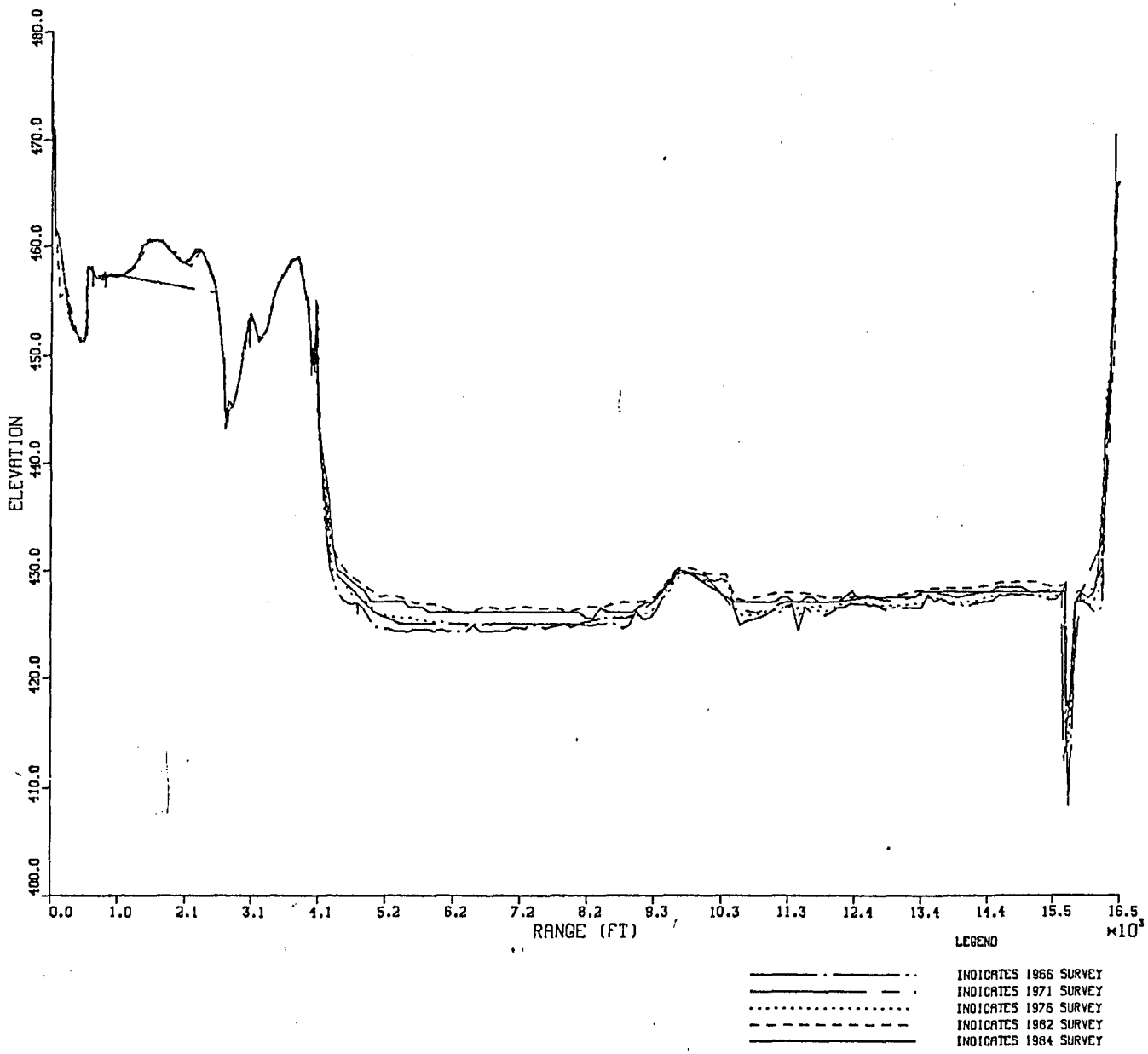


PLATE 7

LAKE CARLYLE

SEDIMENTATION RANGE : 3A

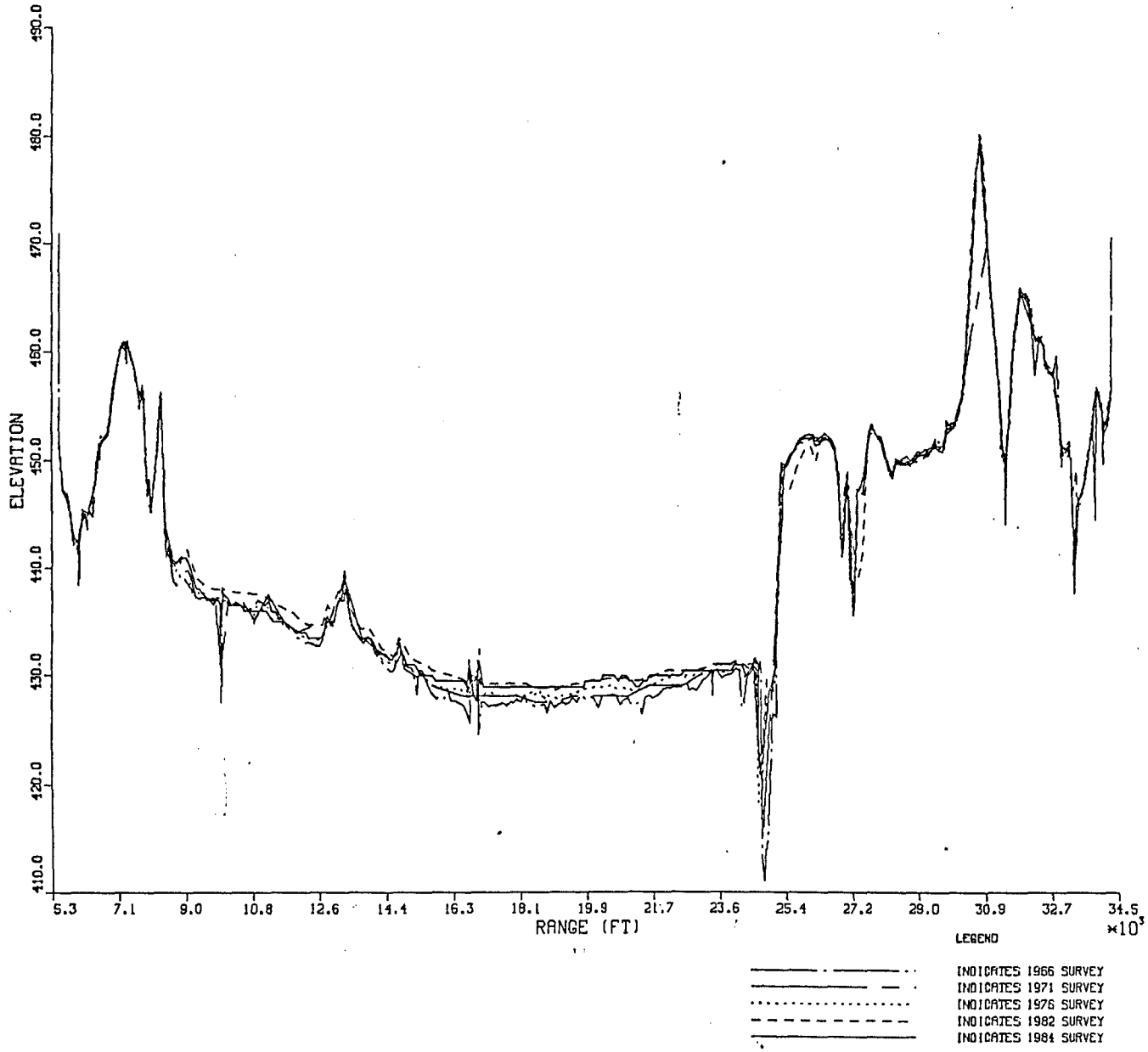


PLATE 8

LAKE CARLYLE

SEDIMENTATION RANGE : 4A

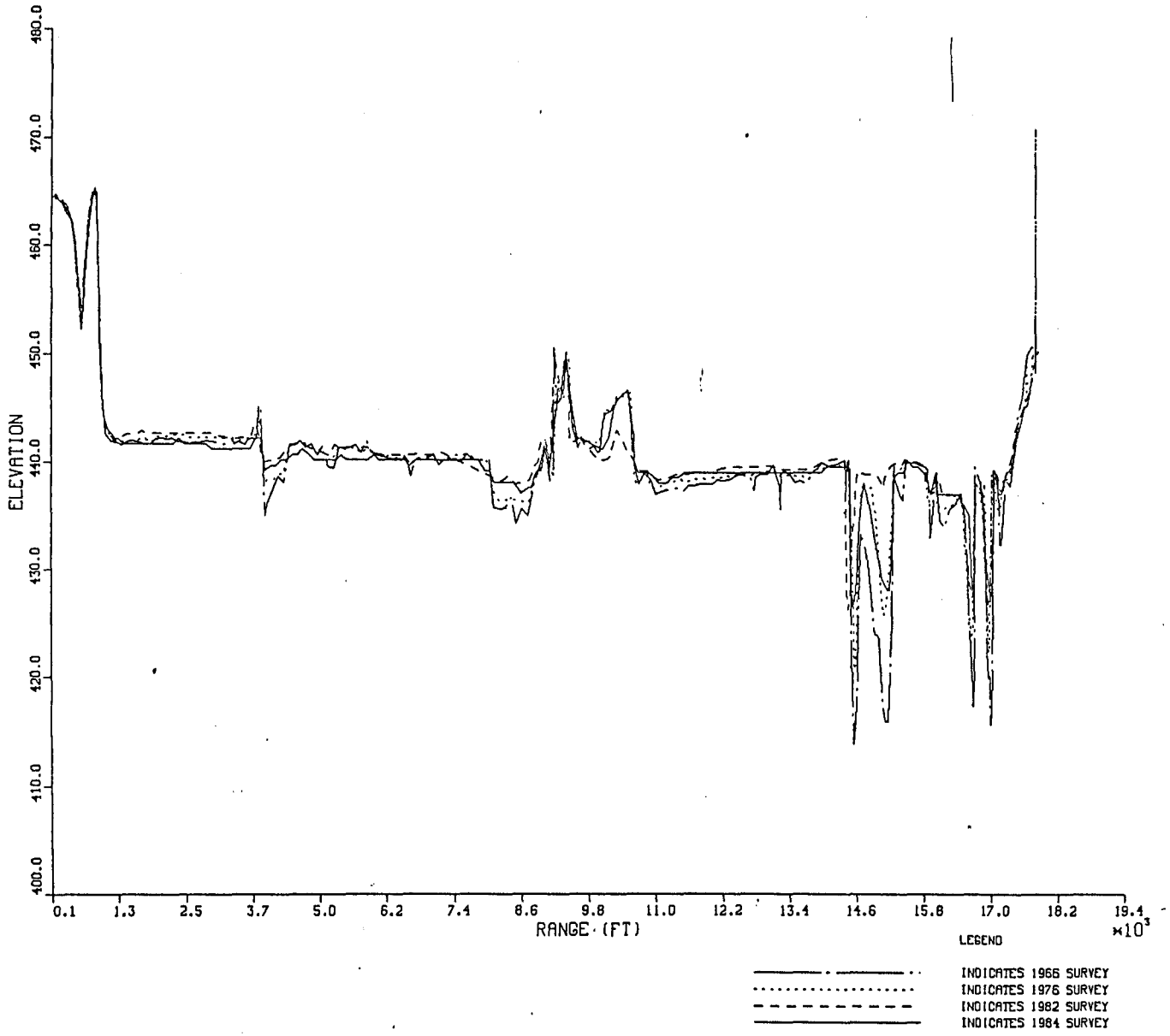


PLATE 9

LAKE CARLYLE

SEDIMENTATION RANGE : 5B

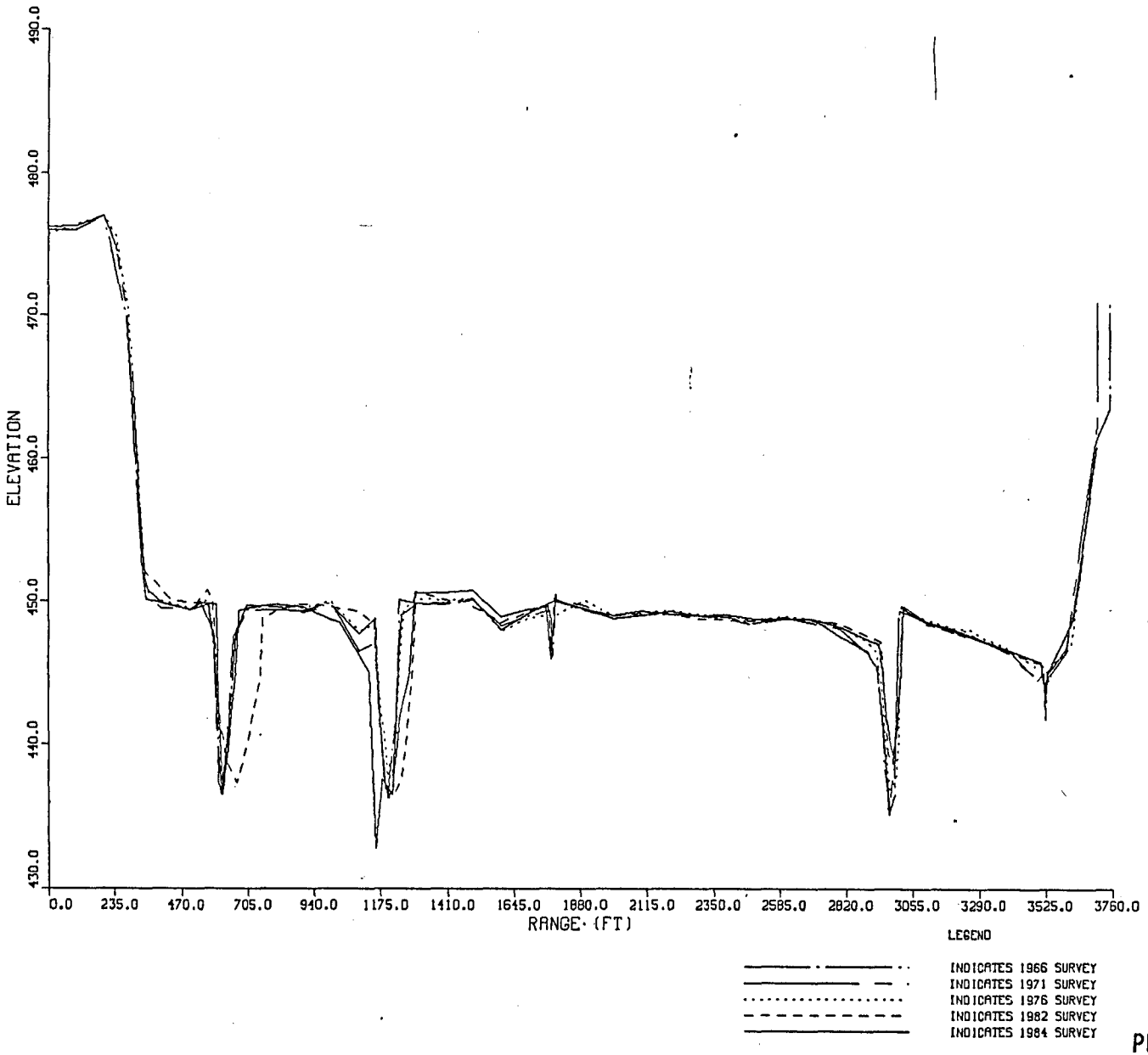


PLATE 10

LAKE CARLYLE.

SEDIMENTATION RANGE : 6B

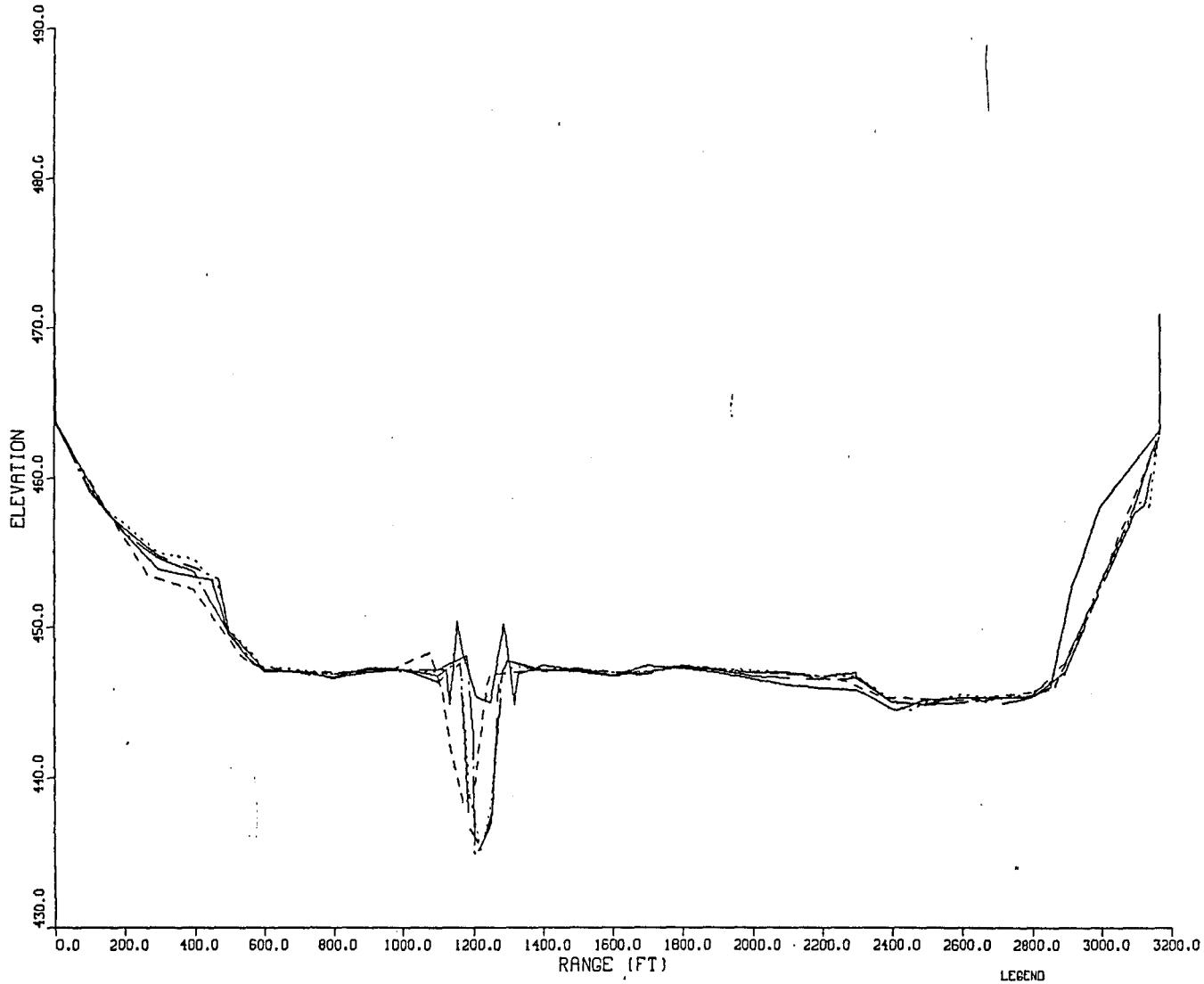


PLATE 11

LAKE CARLYLE

SEDIMENTATION RANGE : 7A

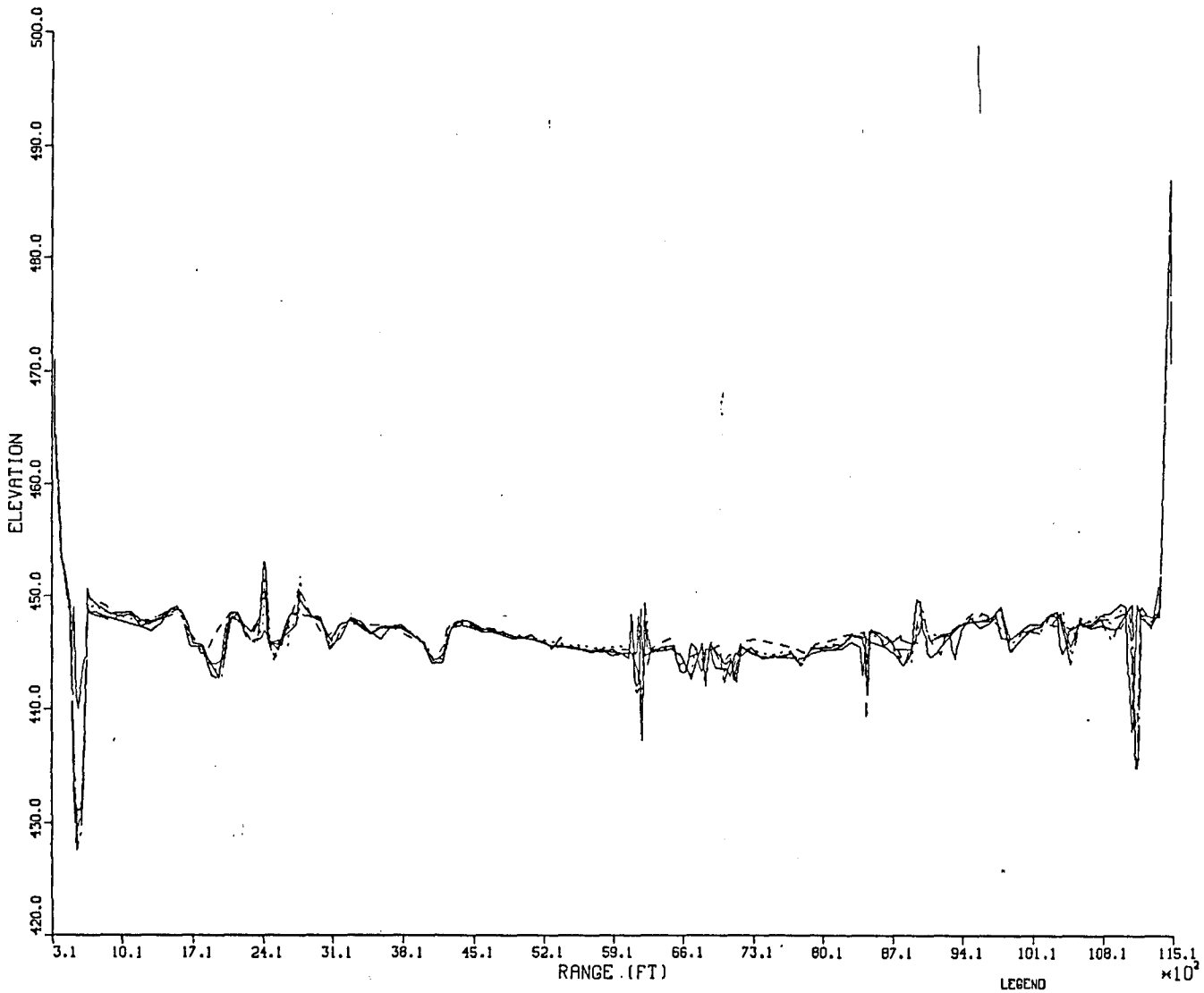


PLATE 12

LAKE CARLYLE

SEDIMENTATION RANGE : 8B

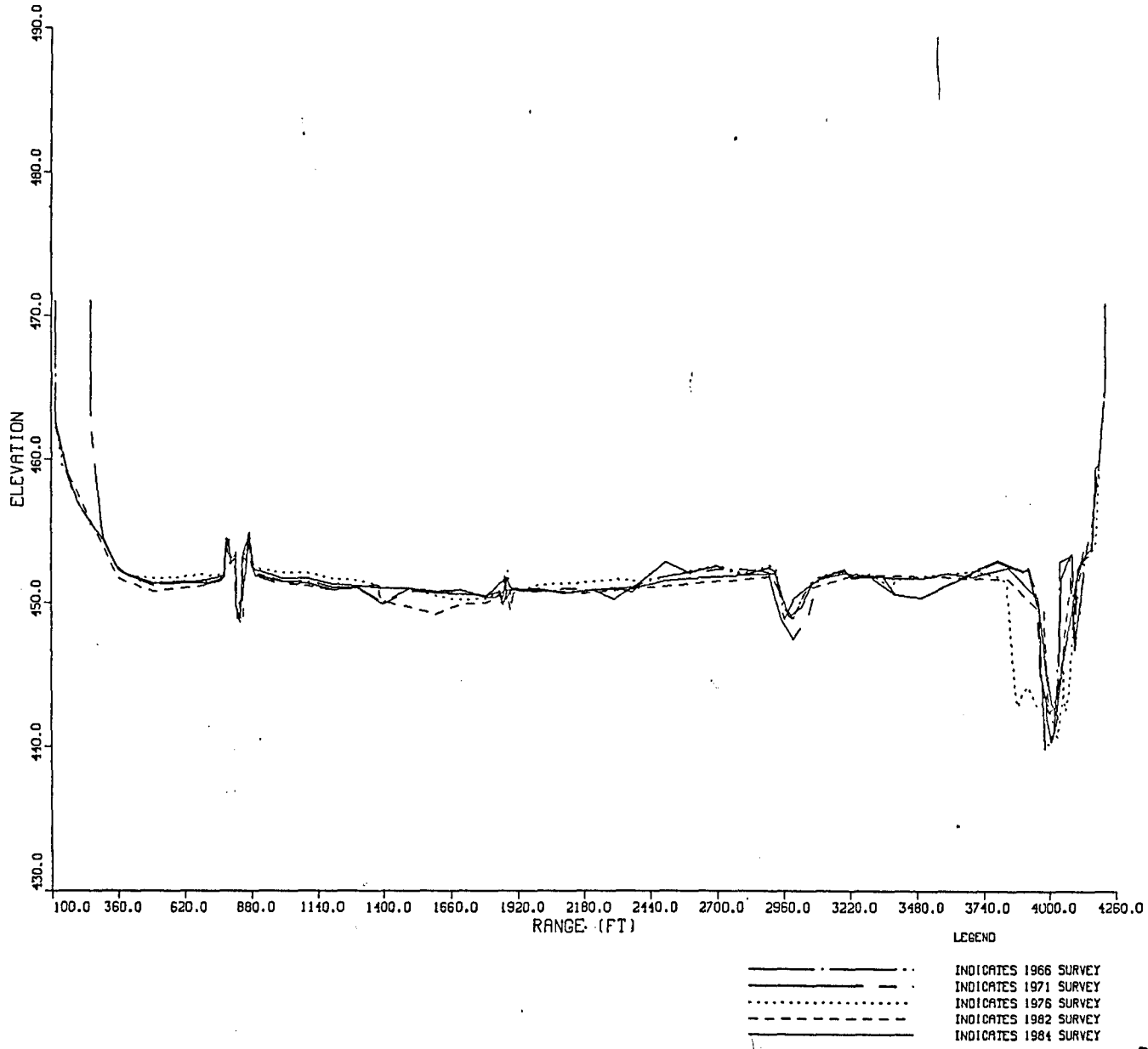


PLATE 13

LAKE CARLYLE

SEDIMENTATION RANGE : 9A

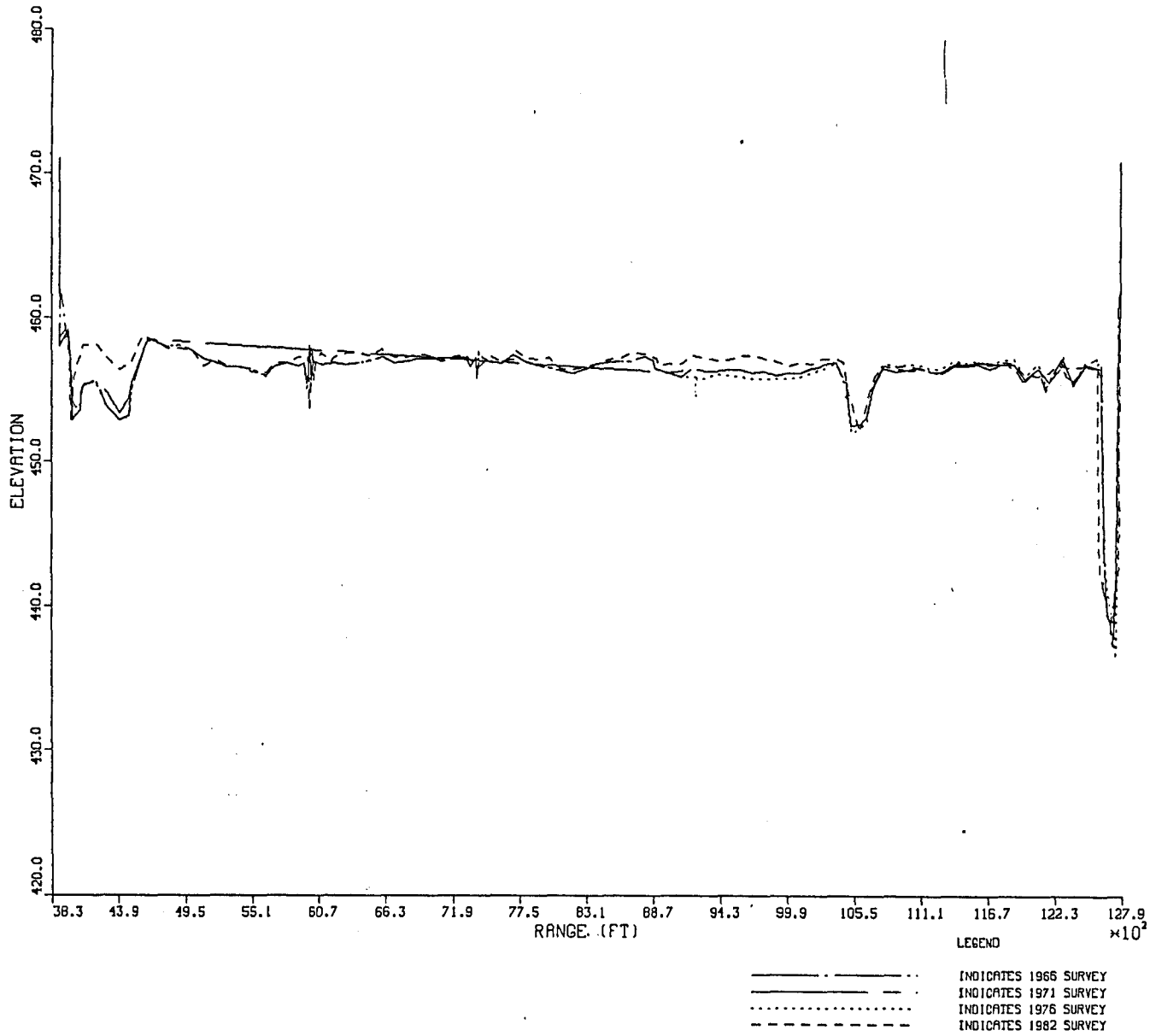


PLATE 14

LAKE CARLYLE

SEDIMENTATION RANGE : 3.1A

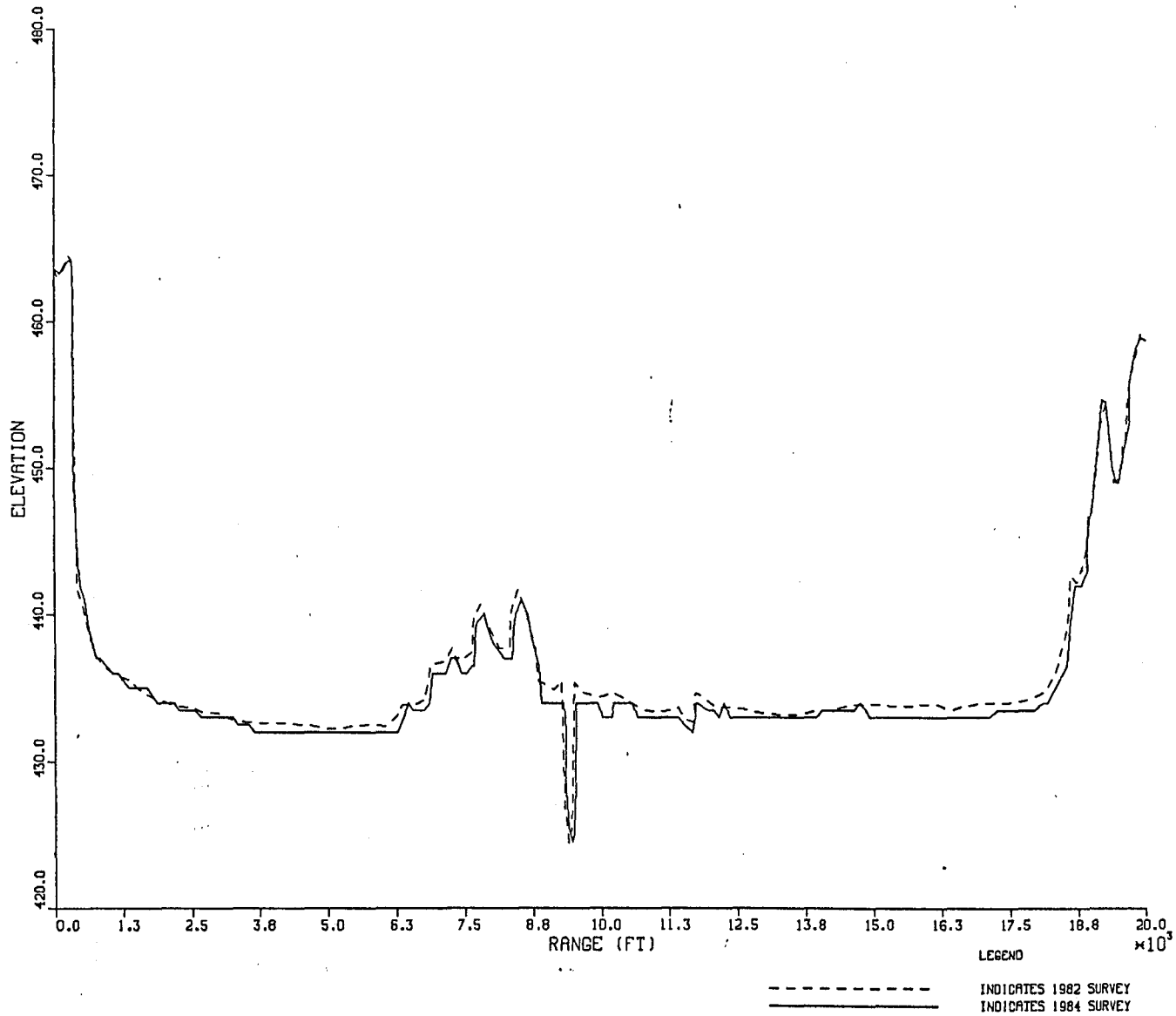


PLATE 15

LAKE CARLYLE

SEDIMENTATION RANGE : 3.2A

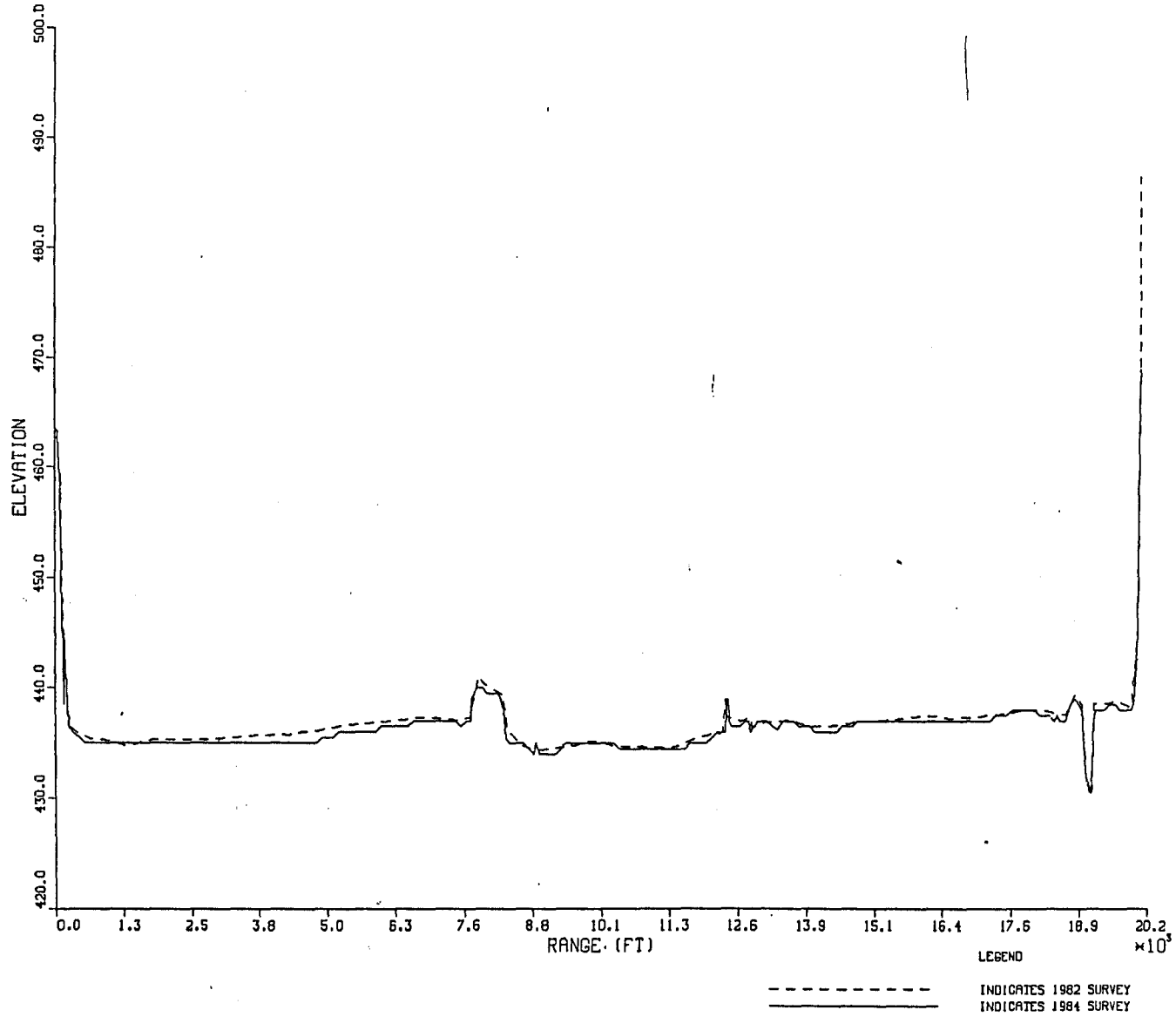


PLATE 16

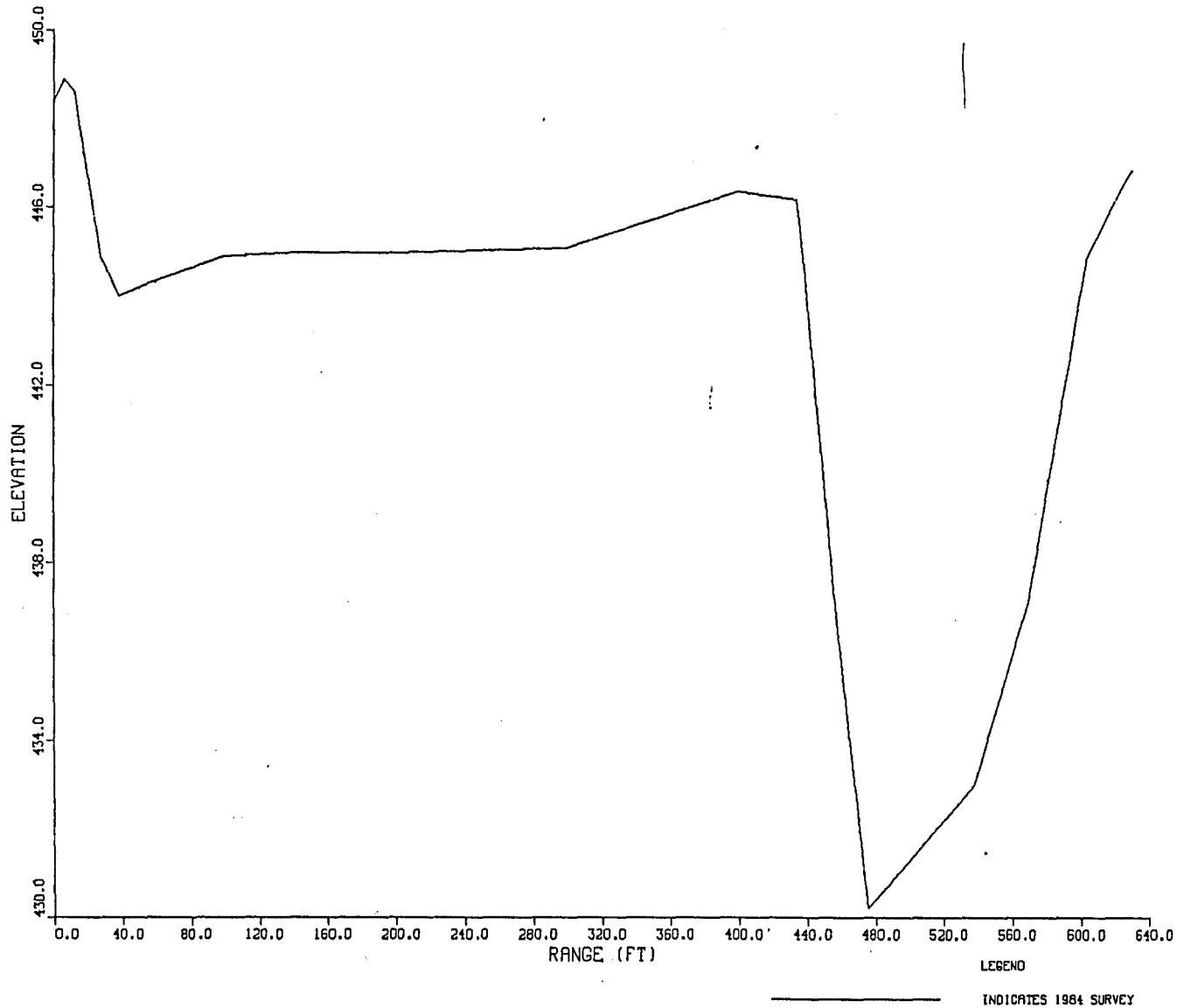

LAKE CARLYLE
SEDIMENTATION RANGE : 4.1A
ELEVATION
450.0
446.0
442.0
438.0
434.0
430.0
0.0
40.0
80.0
120.0
160.0
200.0
240.0
280.0
320.0
360.0
400.0
440.0
480.0
520.0
560.0
600.0
640.0
RANGE (FT)
LEGEND
INDICATES 1984 SURVEY

PLATE 17

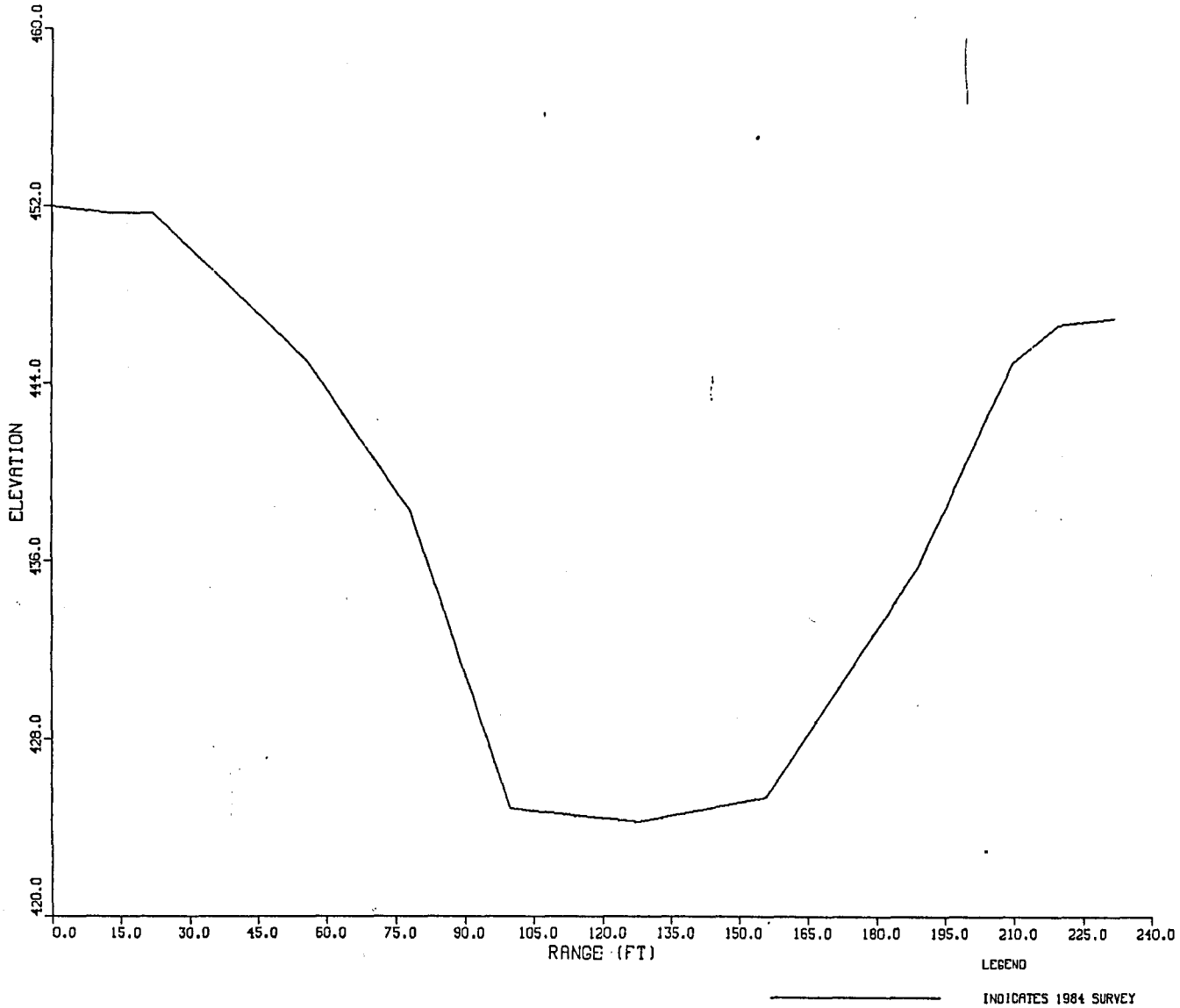

LAKE CARLYLE
SEDIMENTATION RANGE : 4.2A
ELEVATION
460.0
452.0
444.0
436.0
428.0
420.0
0.0
15.0
30.0
45.0
60.0
75.0
90.0
105.0
120.0
135.0
150.0
165.0
180.0
195.0
210.0
225.0
240.0
RANGE (FT)
LEGEND
INDICATES 1984 SURVEY

PLATE 18

LAKE CARLYLE

SEDIMENTATION RANGE : 4.3A

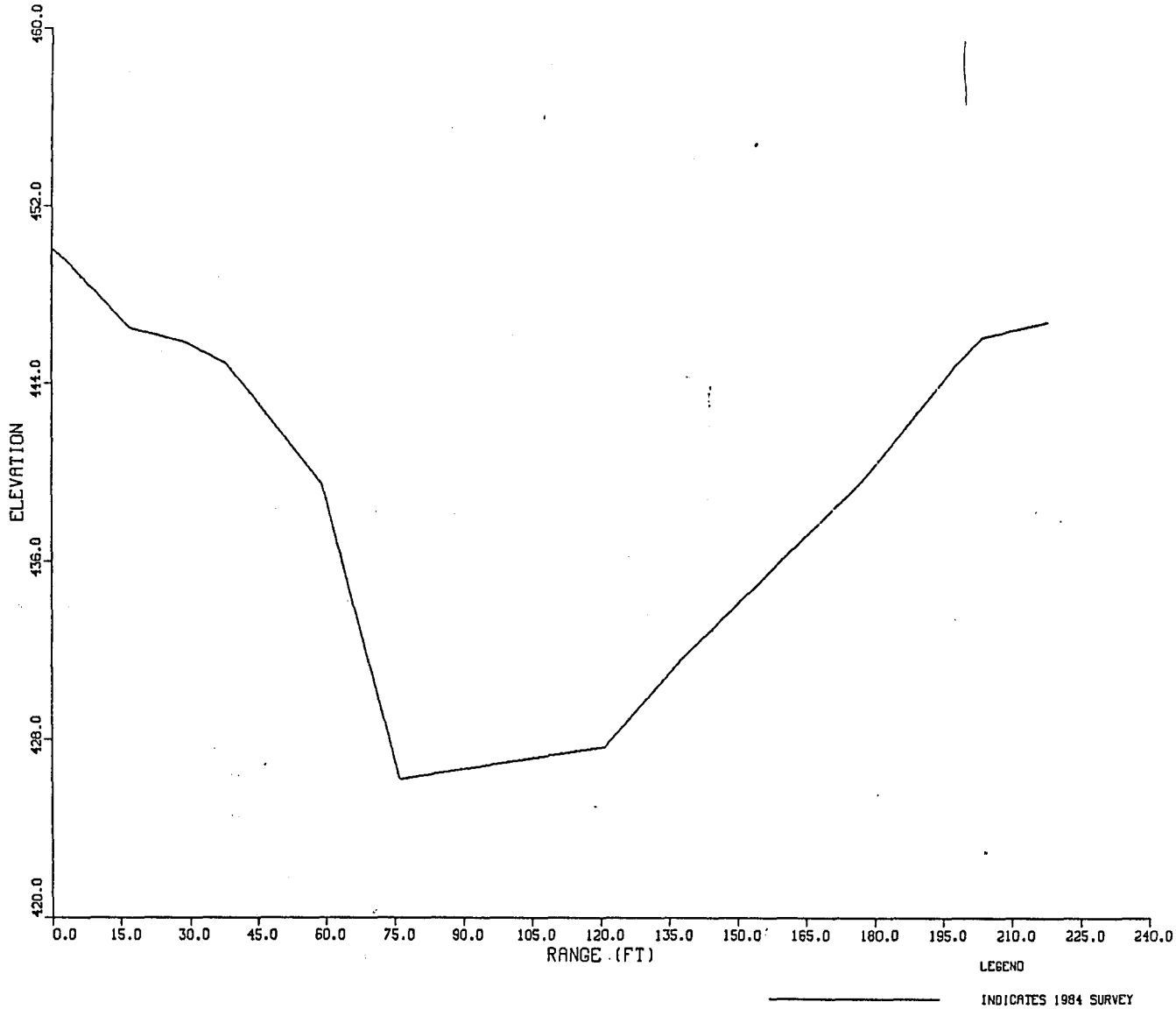


PLATE 10

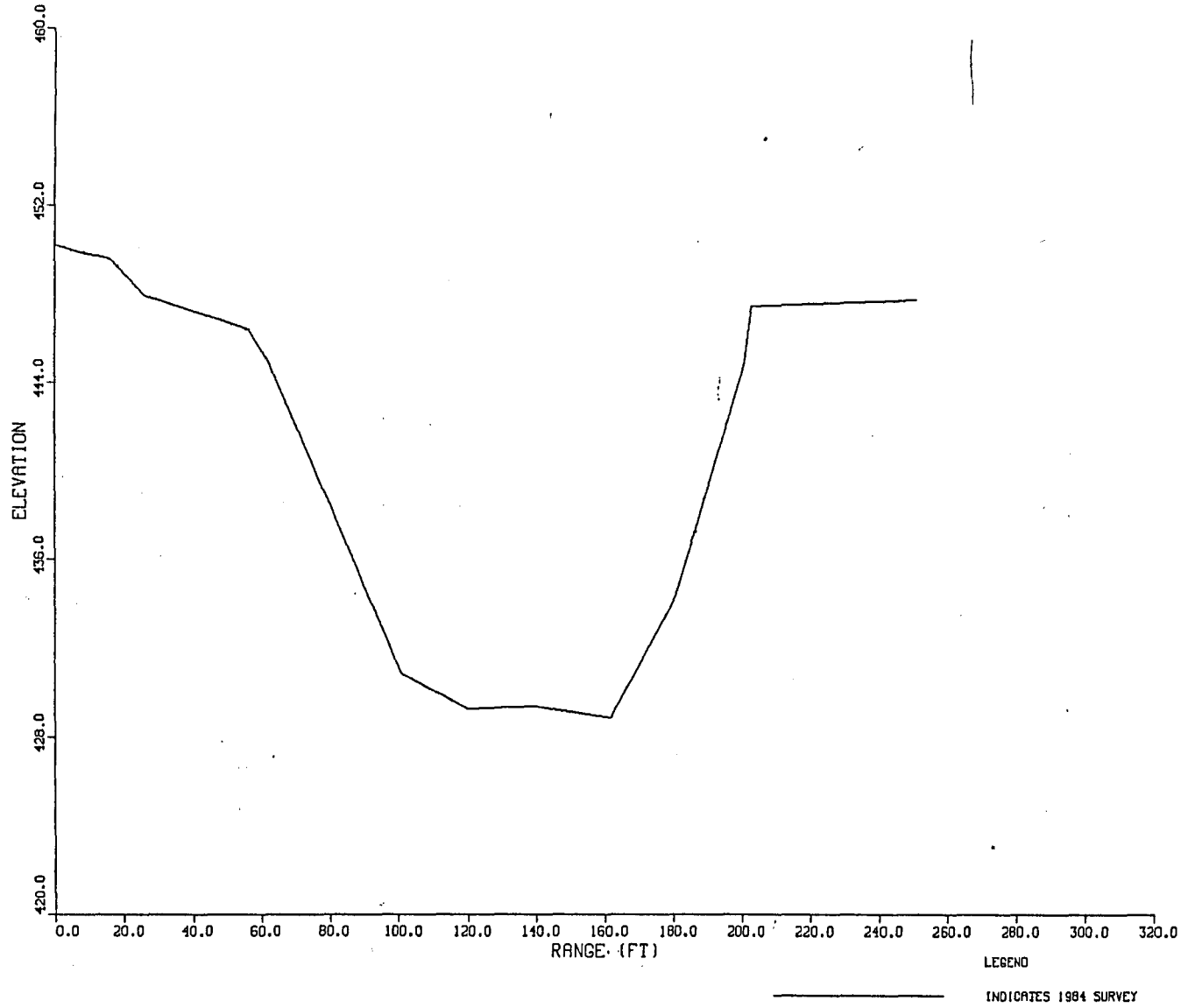

LAKE CARLYLE
SEDIMENTATION RANGE : 4.4A
ELEVATION
460.0
452.0
444.0
436.0
428.0
420.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
RANGE (FT)
LEGEND
INDICATES 1984 SURVEY

PLATE 20

LAKE CARLYLE

SEDIMENTATION RANGE : 4.5A

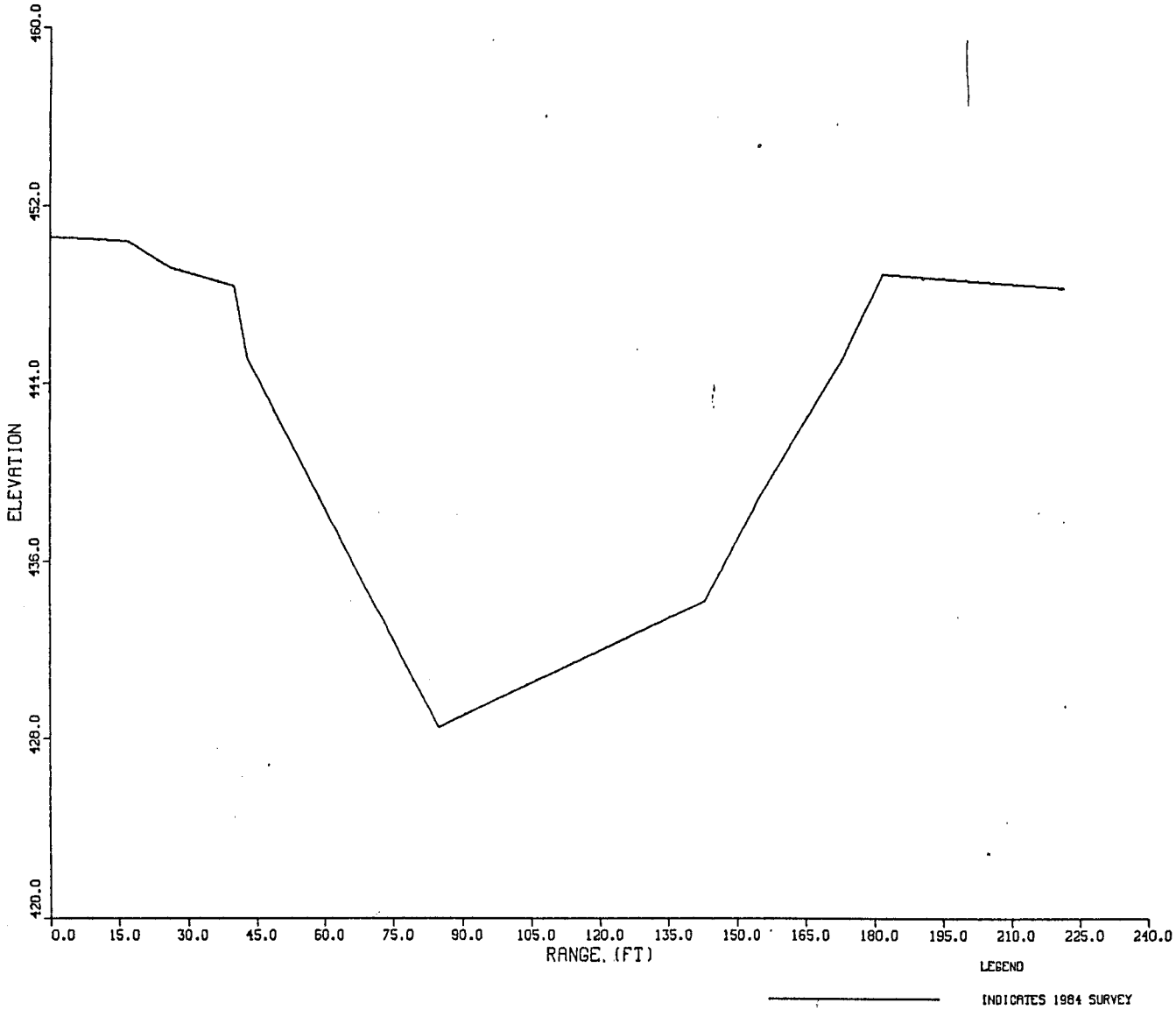
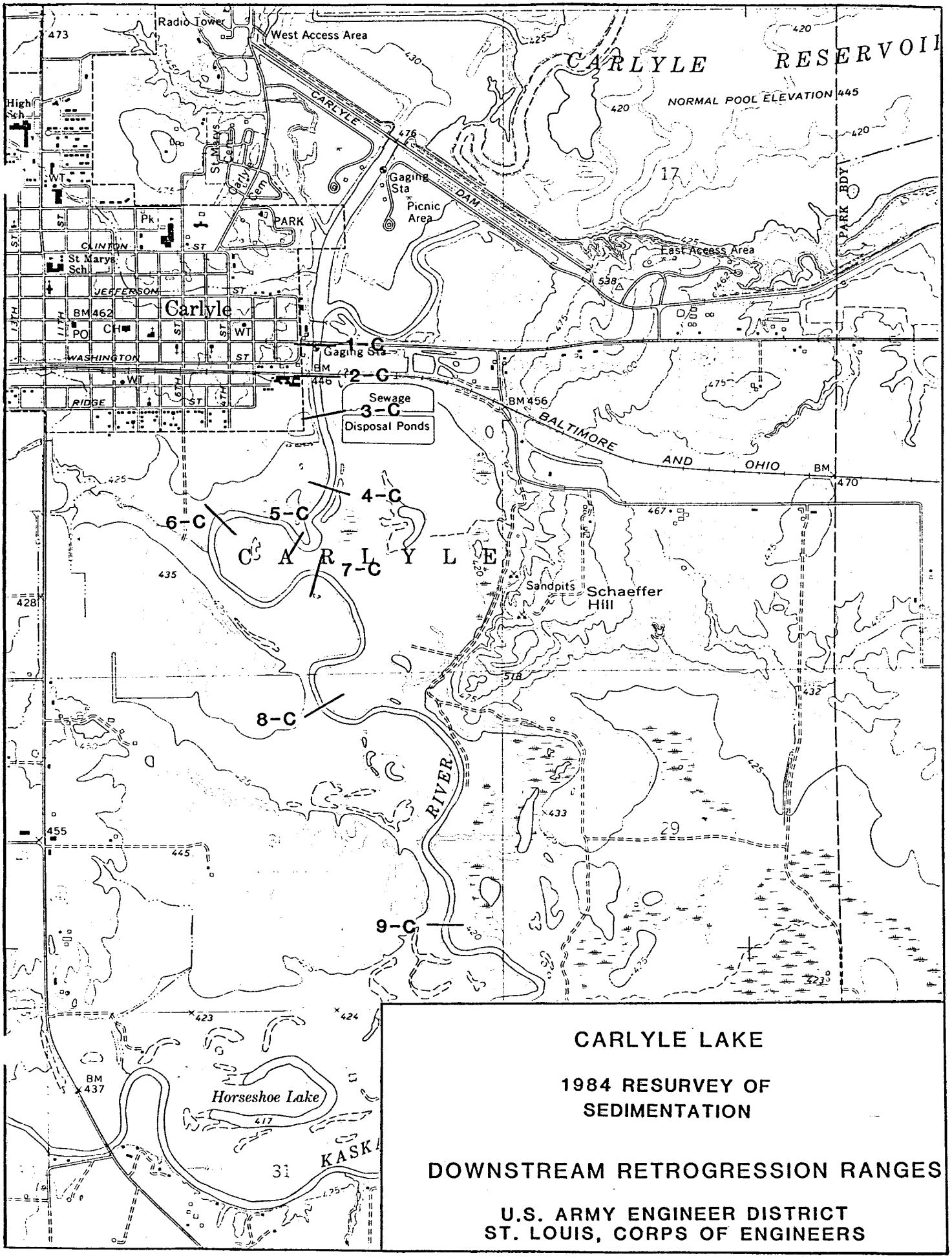


PLATE 21



CARLYLE LAKE

1984 RESURVEY OF SEDIMENTATION

DOWNSTREAM RETROGRESSION RANGES

U.S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS

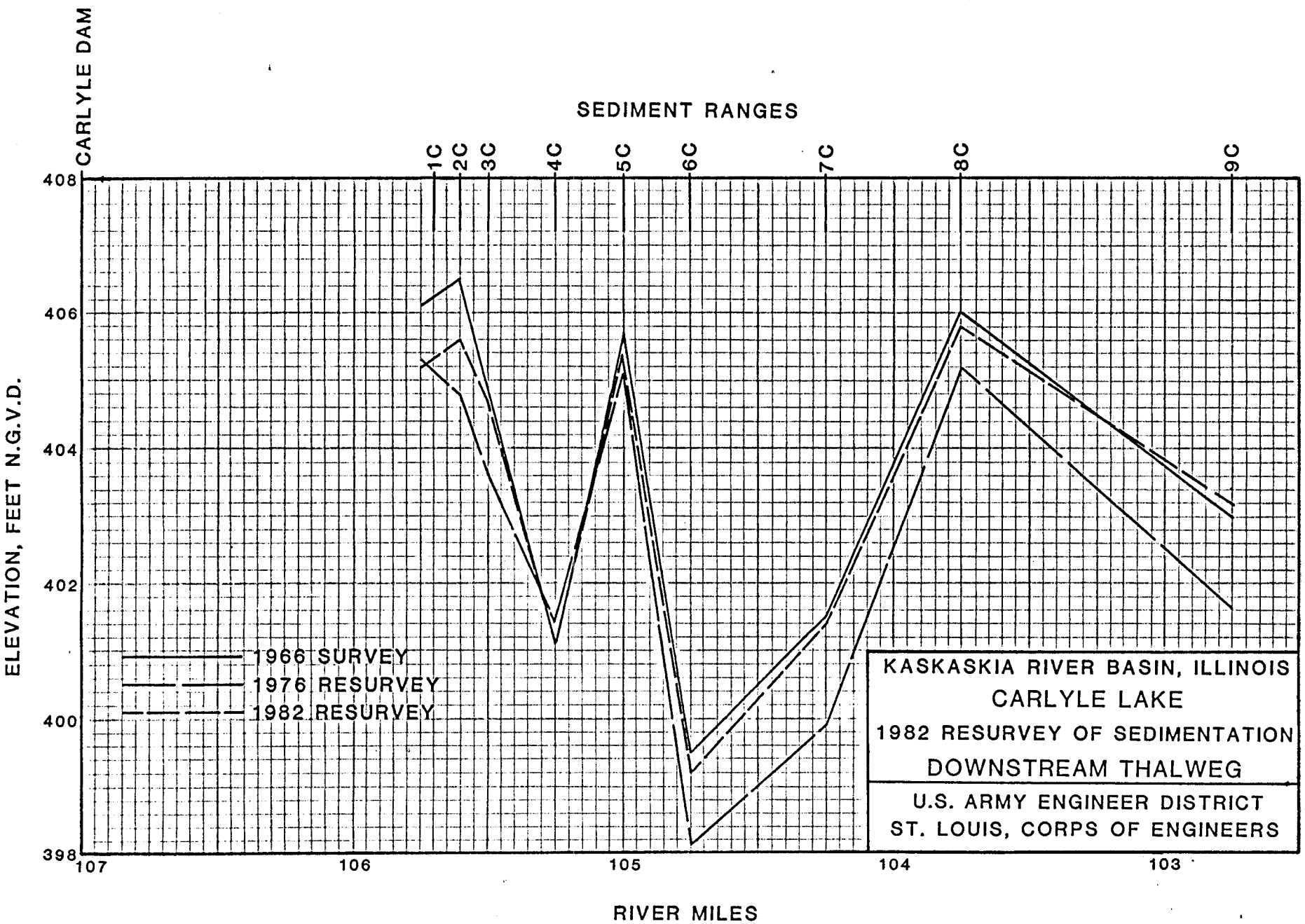
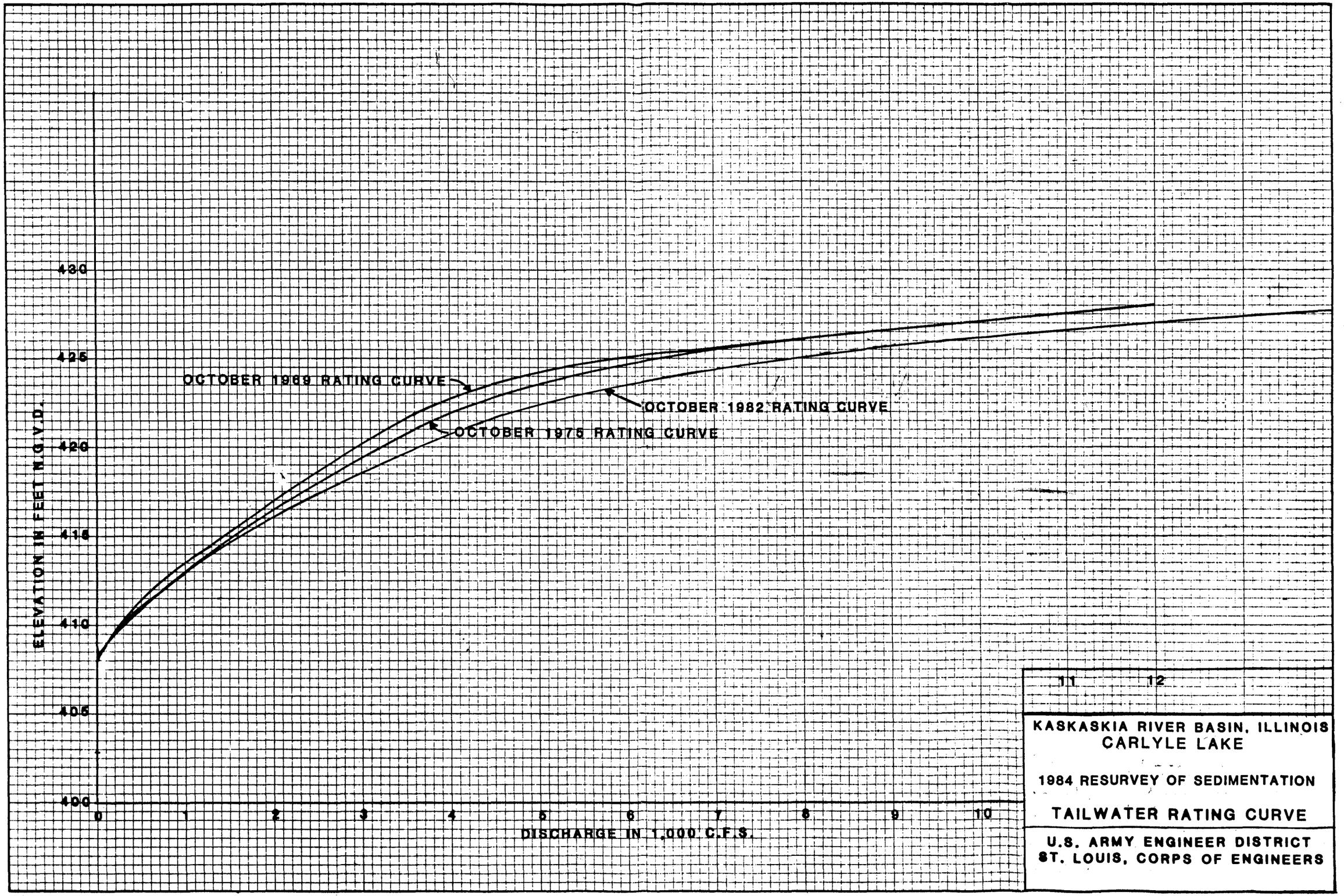

CARLYLE DAM
SEDIMENT RANGES
1C
2C
3C
4C
5C
6C
7C
8C
9C
408
406
404
402
400
398
ELEVATION, FEET N.G.V.D.
1966 SURVEY
1976 RESURVEY
1982 RESURVEY
107
106
105
104
103
RIVER MILES
KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
1982 RESURVEY OF SEDIMENTATION
DOWNSTREAM THALWEG
U.S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS

PLATE 23



KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE

1984 RESURVEY OF SEDIMENTATION

TAILWATER RATING CURVE

U.S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS

LAKE CARLYLE

RETROGRESSION RANGE : 1C

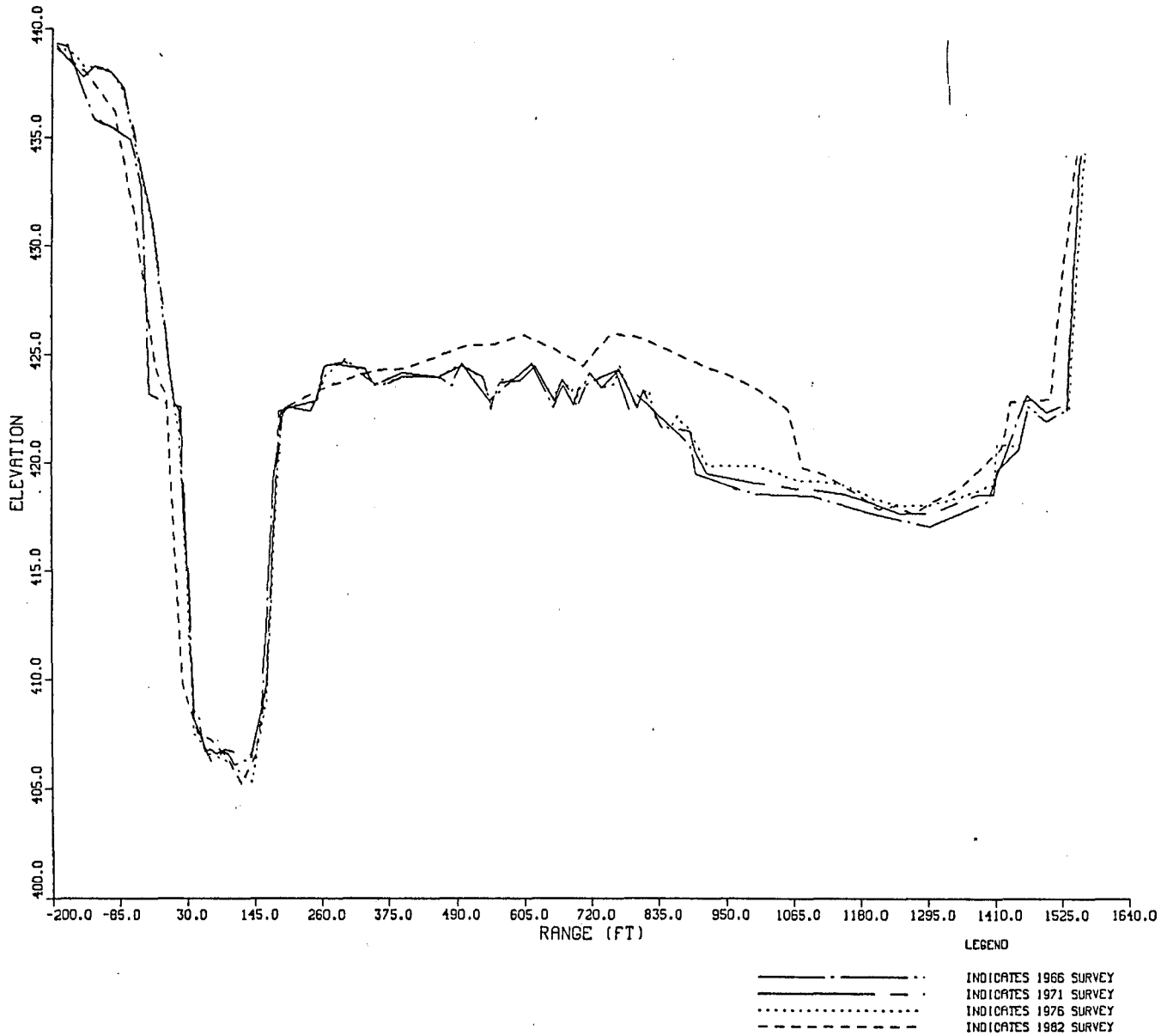


PLATE 25

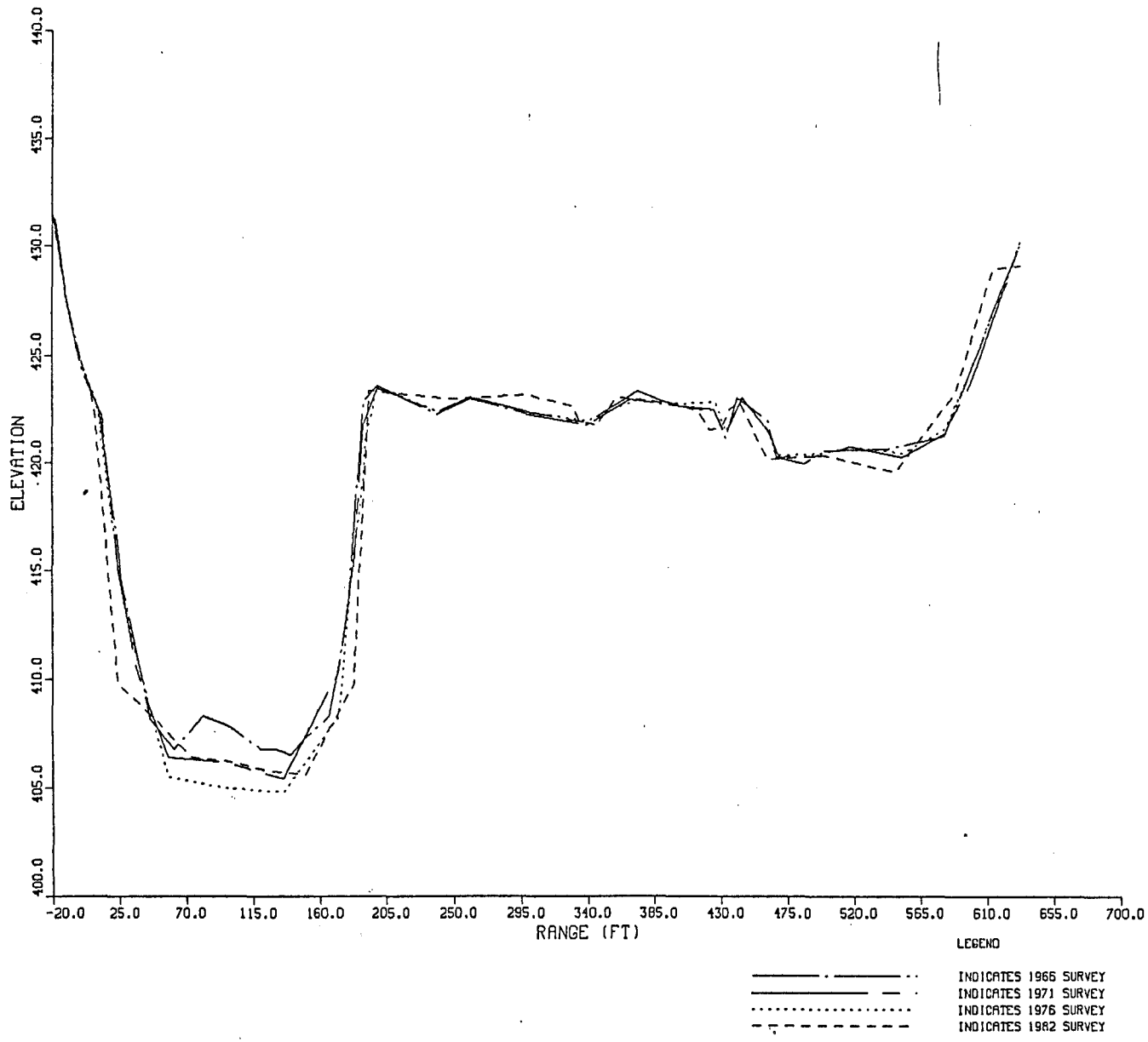

LAKE CARLYLE
RETROGRESSION RANGE : 20
ELEVATION
400.0
405.0
410.0
415.0
420.0
425.0
430.0
435.0
440.0
-20.0
25.0
70.0
115.0
160.0
205.0
250.0
295.0
340.0
385.0
430.0
475.0
520.0
565.0
610.0
655.0
700.0
RANGE (FT)
LEGEND
INDICATES 1966 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 26

LAKE CARLYLE

RETROGRESSION RANGE : 3C

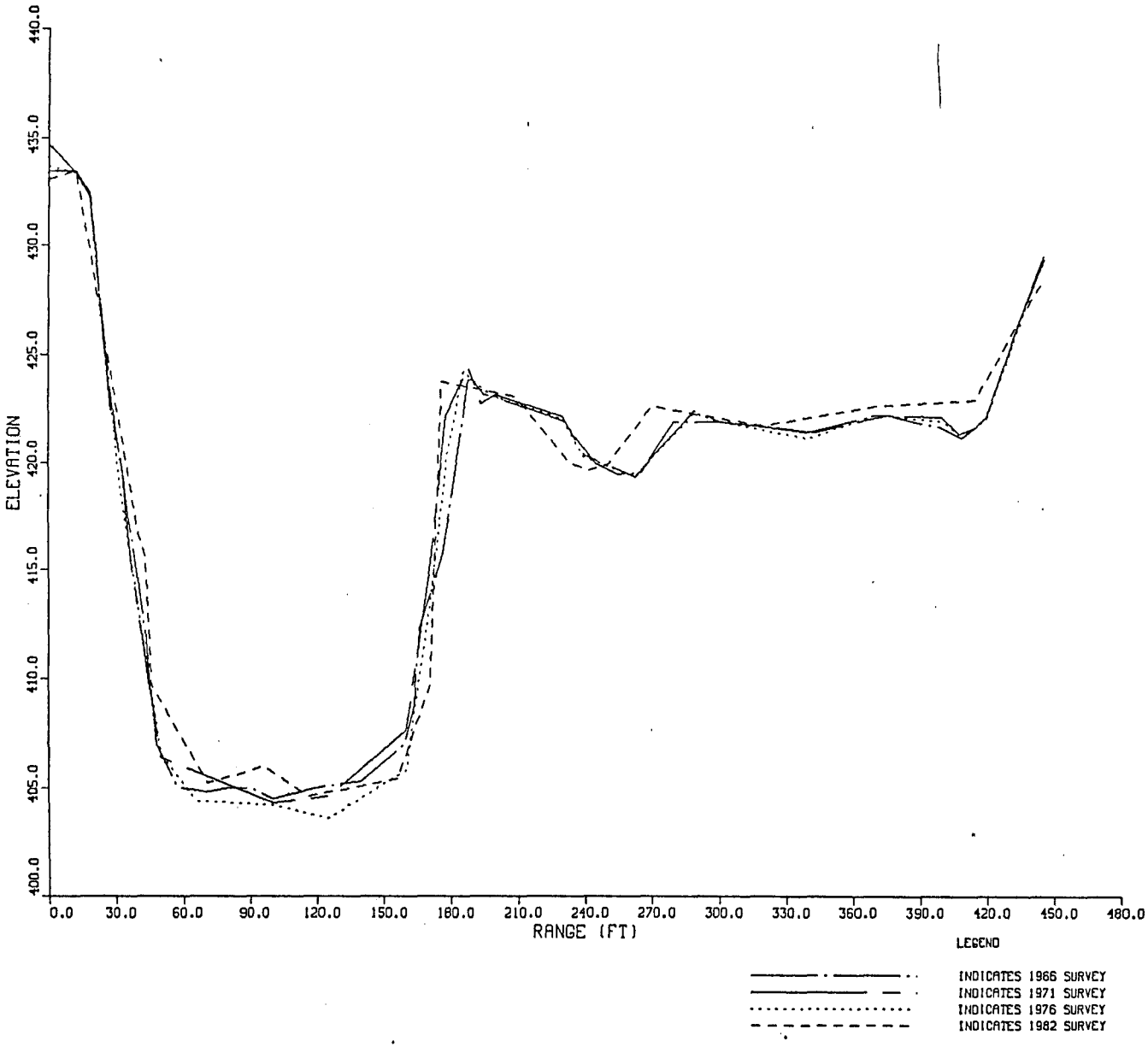


PLATE 27

LAKE CARLYLE

RETROGRESSION RANGE : 4C

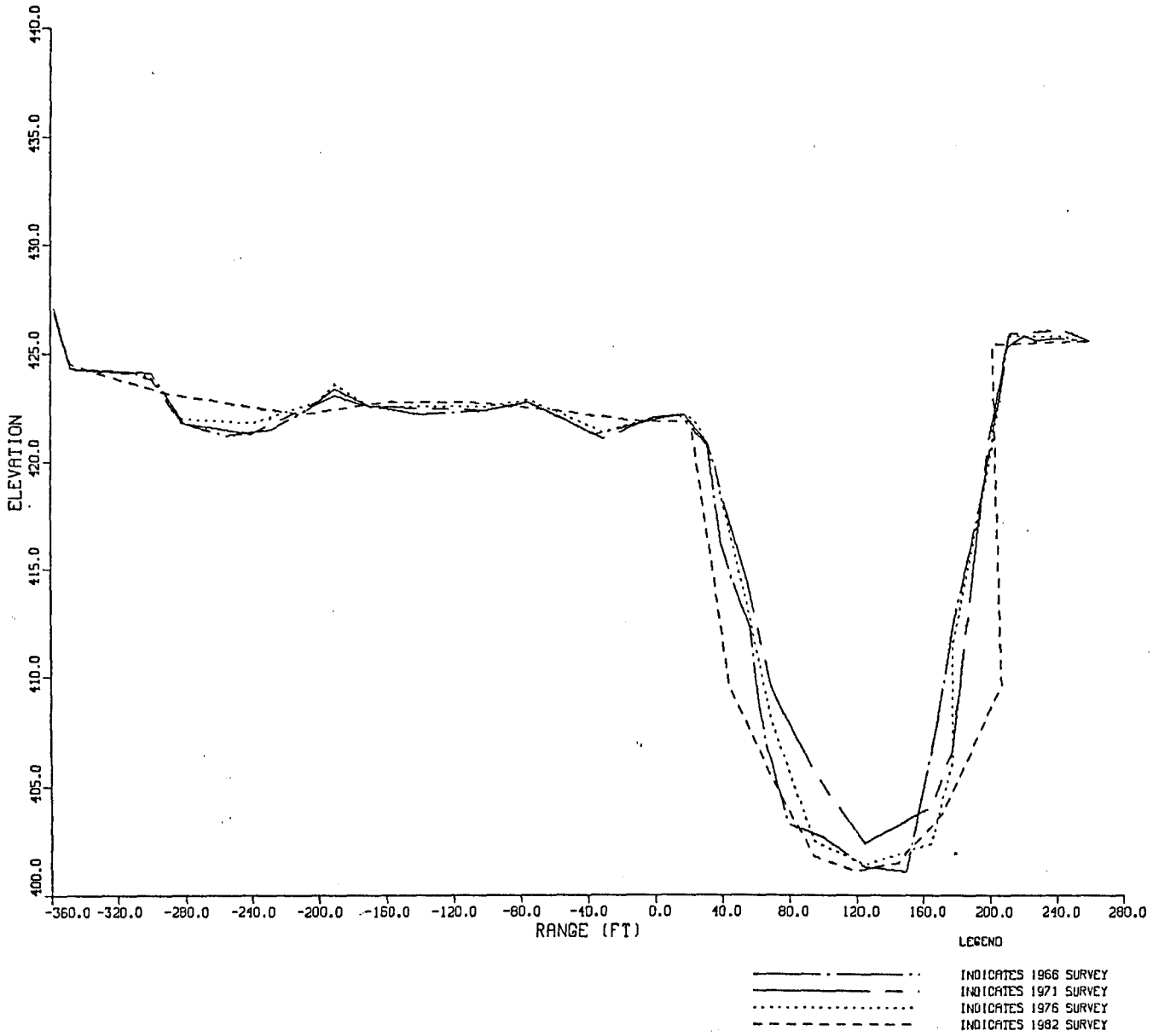


PLATE 28

LAKE CARLYLE

RETROGRESSION RANGE : 5C

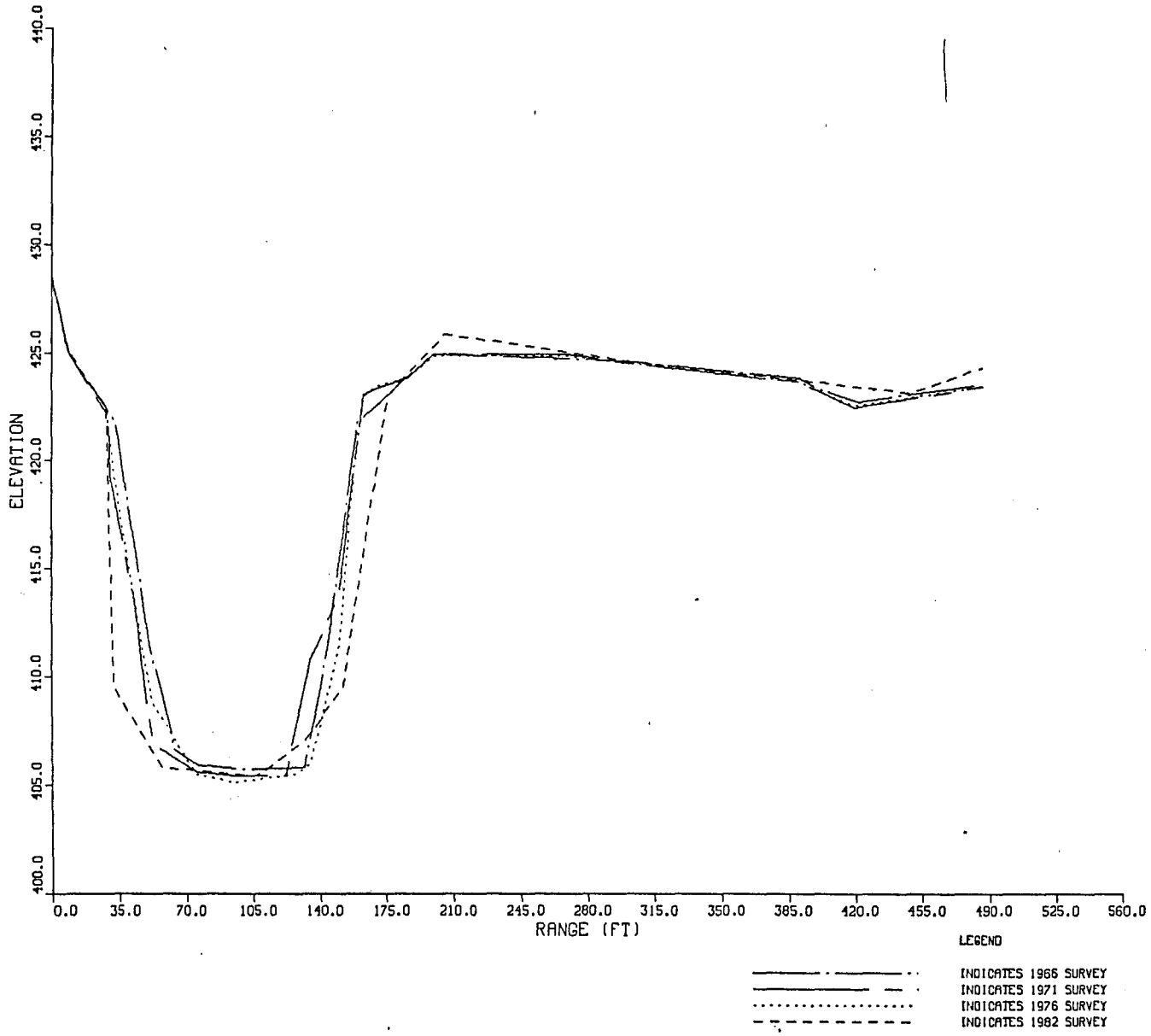


PLATE 29

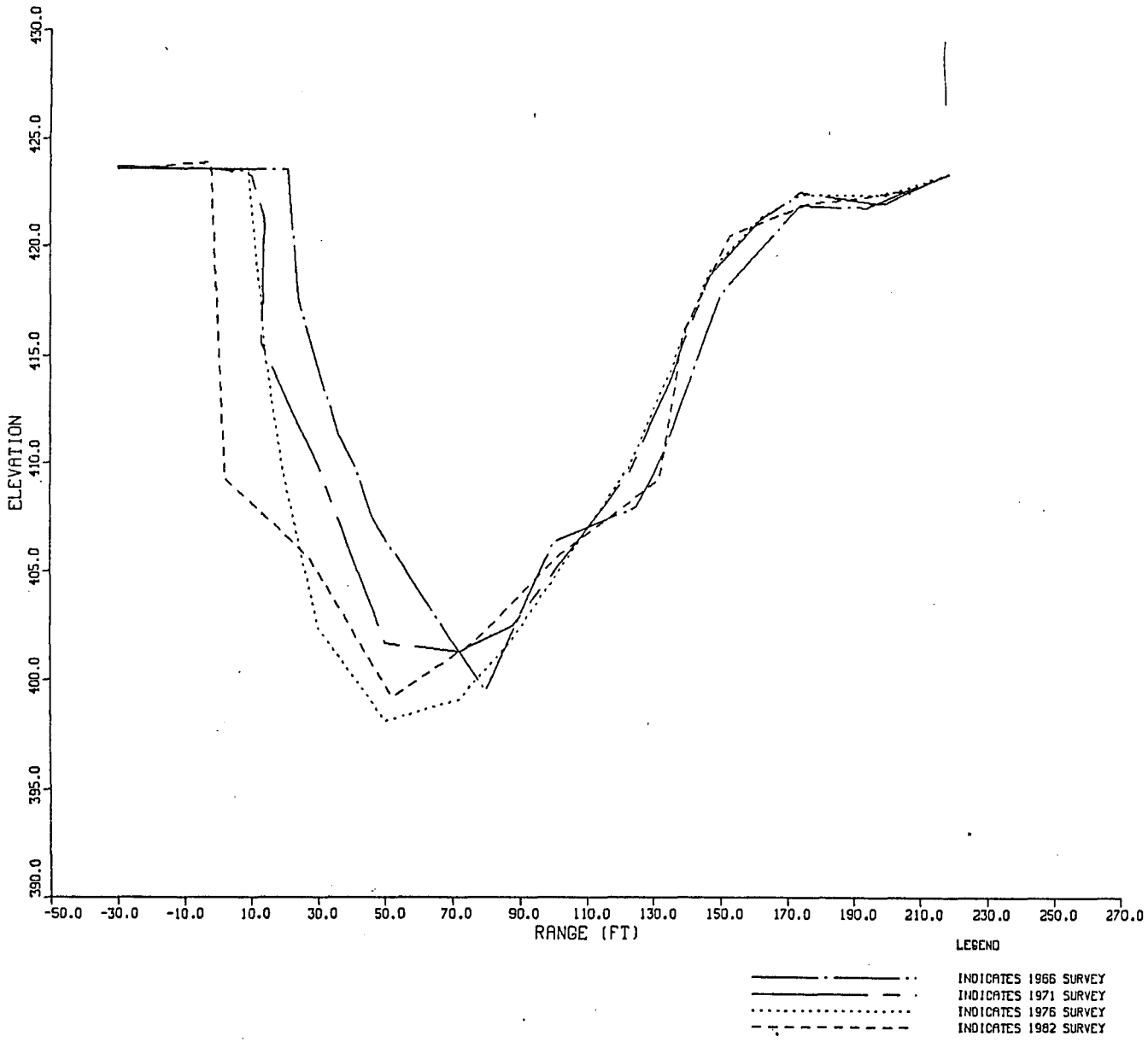

LAKE CARLYLE.
RETROGRESSION RANGE : 60
ELEVATION
390.0
395.0
400.0
405.0
410.0
415.0
420.0
425.0
430.0
-50.0
-30.0
-10.0
10.0
30.0
50.0
70.0
90.0
110.0
130.0
150.0
170.0
190.0
210.0
230.0
250.0
270.0
RANGE (FT)
LEGEND
INDICATES 1966 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 30

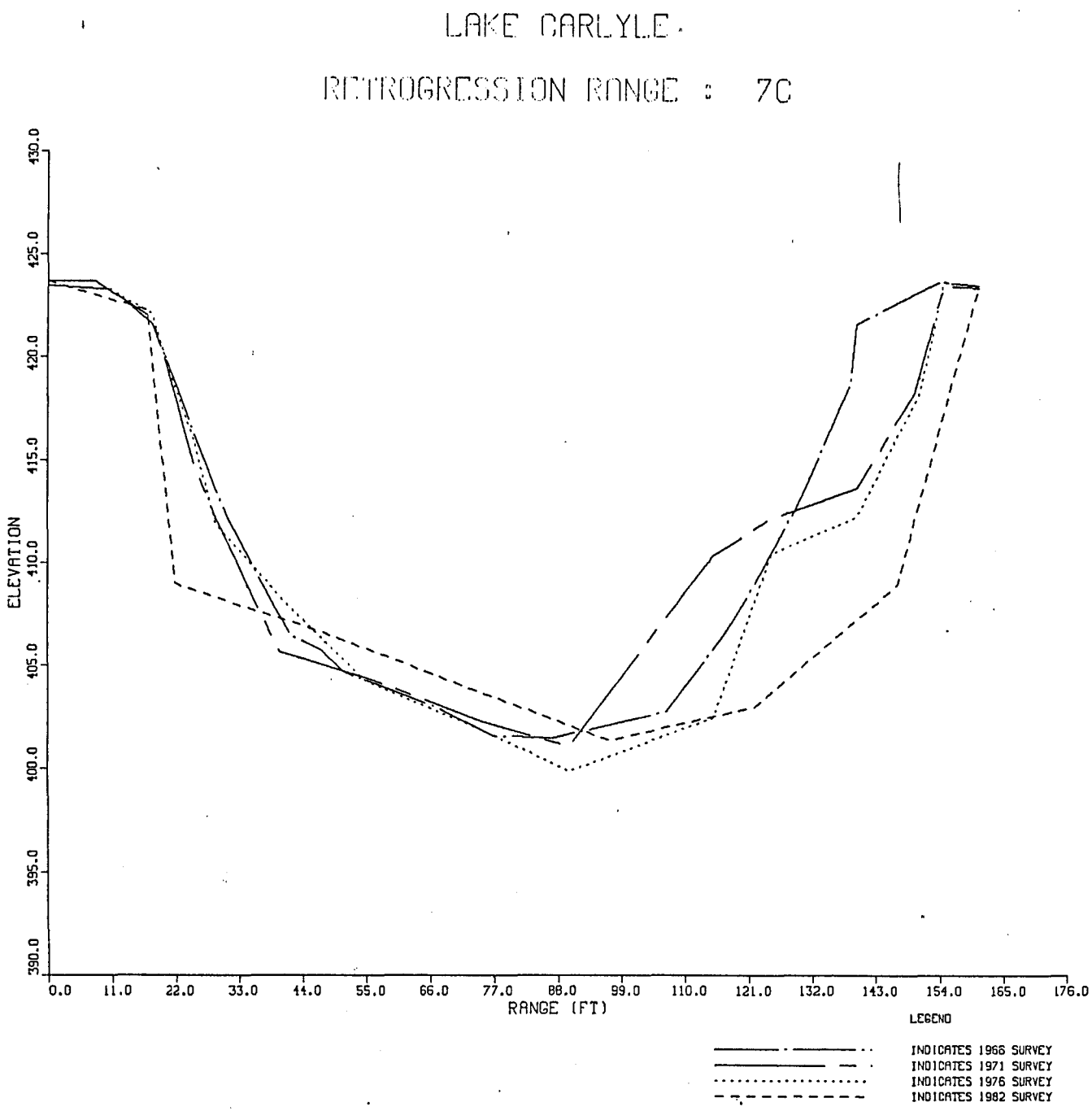

LAKE CARLYLE
RETROGRESSION RANGE : 7C
ELEVATION
430.0
425.0
420.0
415.0
410.0
405.0
400.0
395.0
390.0
0.0
11.0
22.0
33.0
44.0
55.0
66.0
77.0
88.0
99.0
110.0
121.0
132.0
143.0
154.0
165.0
176.0
RANGE (FT)
LEGEND
INDICATES 1966 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 31

LAKE CARLYLE

RETROGRESSION RANGE : 8C

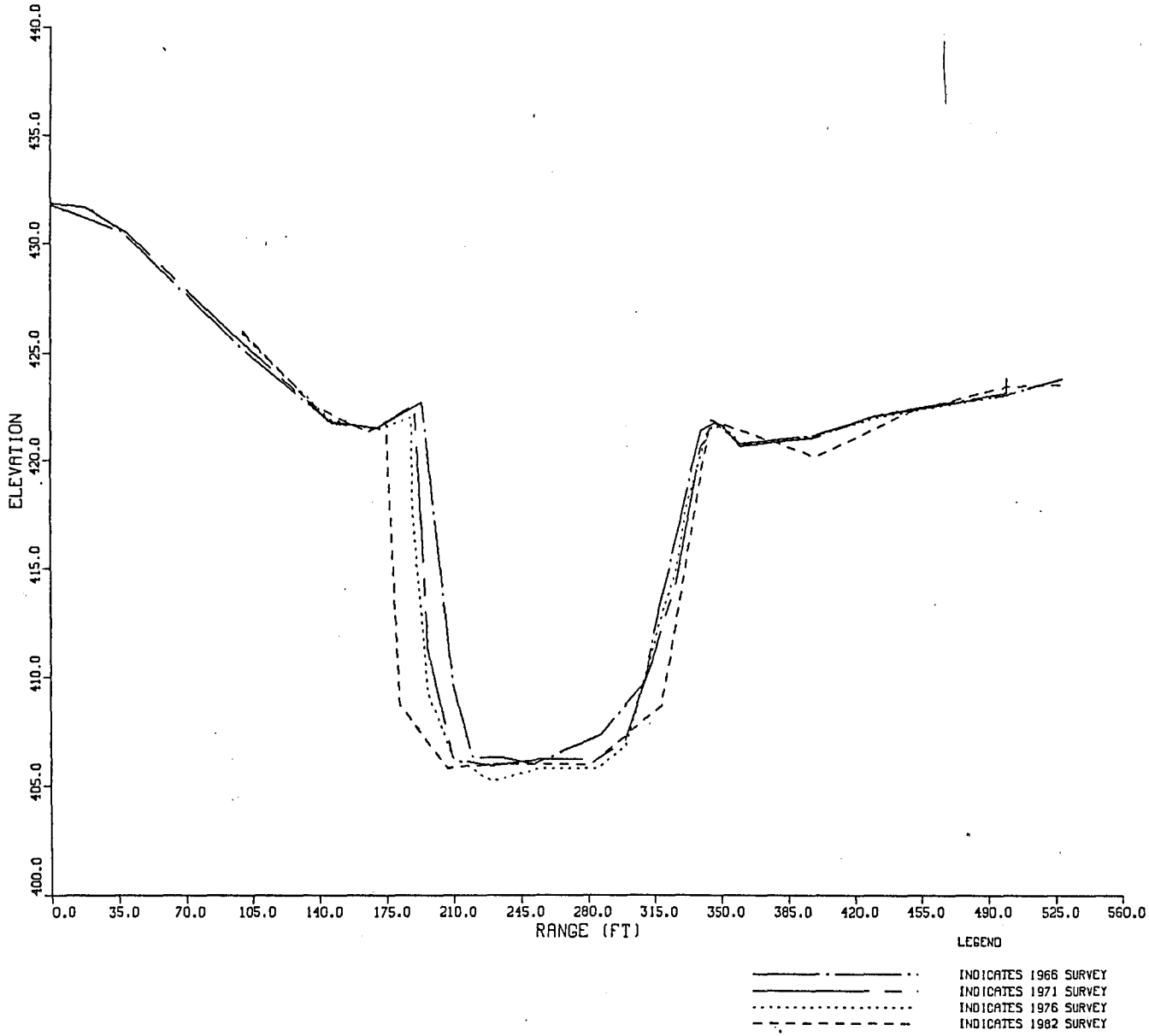


PLATE 32

LAKE CARLYLE

RETROGRESSION RANGE : 9C

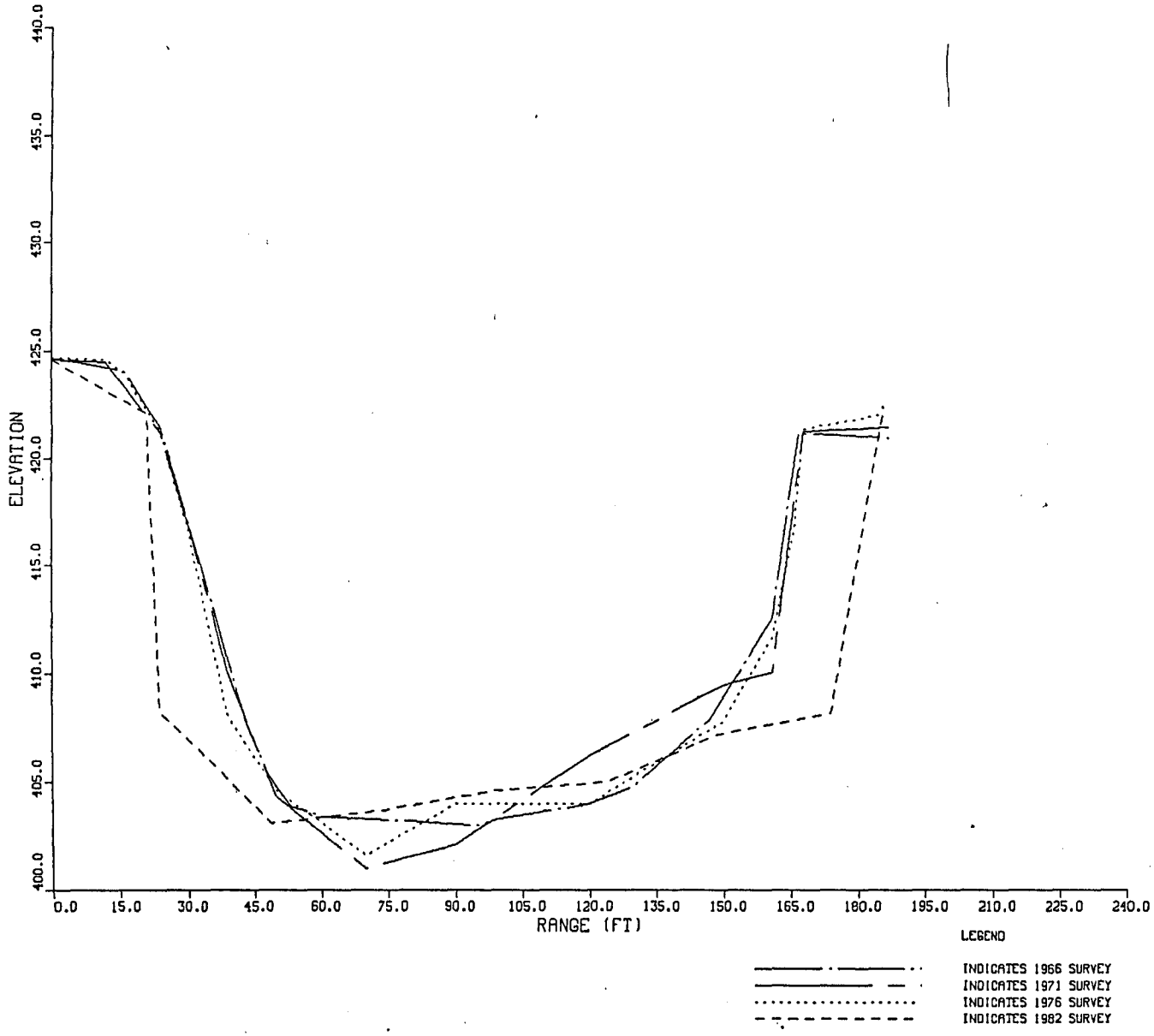


PLATE 33

RESERVOIR SEDIMENT
DATA SUMMARY

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

Carlyle Lake
NAME OF RESERVOIR

DATA SHEET NO.

DAM

1. OWNER DA. Corps of Engineers	2. STREAM Kaskaskia River	3. STATE Illinois
4. SEC. 17-18 TWP. 2N RANGE 2W	5. NEAREST P.O. Carlyle, Ill.	6. COUNTY Clinton
7. LAT. ° ′ ″ LONG. ° ′ ″	8. TOP OF DAM ELEVATION 472.0	9. SPILLWAY CREST ELEV. 463.5 1/

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL	462.5	58,447	694,050	974,645	1 Apr. 1967
b. MULTIPLE USE	445.0	24,583	230,227 2/	280,595	
c. POWER					16. DATE NORMAL OPER. BEGAN
d. WATER SUPPLY					
e. IRRIGATION					
f. CONSERVATION					1 Aug. 1970
g. INACTIVE	429.5	6,672	50,368	50,368	

17. LENGTH OF RESERVOIR Joint-use Pool: 15.1 MILES | AV. WIDTH OF RESERVOIR 2.5 MILES

WATERSHED

18. TOTAL DRAINAGE AREA 2,680 SQ. MI.	22. MEAN ANNUAL PRECIPITATION 39.8 (18) INCHES
19. NET SEDIMENT CONTRIBUTING AREA 1,535 SQ. MI.	23. MEAN ANNUAL RUNOFF 12.5 (18) INCHES
20. LENGTH 120 MILES; AV. WIDTH 22.3 MILES	24. MEAN ANNUAL RUNOFF 1,781,660 AC.-FT.
21. MAX. ELEV. 725; MIN. ELEV. 405	25. ANNUAL TEMP.: MEAN 55° RANGE -34° to 115°

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
Apr. 1967			Range (D)	9 (R)	58,447	974,645	0.90 3/
	8.9	8.9					
Mar. 1976			Range (D)	9 (R)	58,447	957,290	0.89
	8.5	17.4					
Sep. 1984			Range (D)	16 (R)	58,447	927,113	0.85

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	36. WATER INFL. TO DATE, AC.-FT. a. MEAN ANNUAL	b. TOTAL TO DATE
Apr. 1967	41.1	1,805,630	3,048,744	16,100,200	1,805,630	16,100,200
Mar. 1976	39.6 4/	1,665,220	2,792,218	14,154,363	1,737,104	30,254,563
Sep. 1984						

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
Apr. 1967	17,355 5/	1,946	1.268	17,355	1,946	1.268
Mar. 1976	30,177	3,550	2.313	47,532	2,729	1.778
Sep. 1984						

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR. a. PERIOD	b. TOTAL TO DATE	41. STORAGE LOSS, PCT. a. AV. ANN.	b. TOT. TO DATE	42. SED. INFLOW, PPM a. PERIOD	b. TOT. TO DATE
Apr. 1967	6/	6/		0.20		6/	
Mar. 1976	36.8	1854	6/	0.28	1.78	1257	6/
Sep. 1984			1425		4.88		927

ENG FORM NOV 66 1787 PREVIOUS EDITIONS ARE OBSOLETE.

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION										
	55-50	50-45	45-40	40-35	35-30	30-25	25-20	20-15	15-10	10-5	5-Crest
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION										
Apr. 1967	12.1	13.8	10.9	8.6	6.3	4.0	3.5	6.9	27.0	6.9	0.0
Mar. 1976	4.0	5.3	5.6	6.0	6.3	8.0	9.9	15.2	36.4	3.3	0.0
Sep. 1984											

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	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														
Apr. 1967	7.2	14.4	18.6	18.9	15.0	11.5	9.8	2.3	2.3	0.0					
Mar. 1976	10.3	8.9	11.6	12.6	9.9	8.1	8.9	10.6	10.9	8.2					
Sep. 1984															

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.
1967	435.9	425.2	2,005,901	1976	445.4	439.7	802,991
1968	451.2	429.8	1,342,311	1977	445.2	440.3	595,482
1969	450.2	429.6	1,796,562	1978	448.7	443.0	2,097,059
1970	455.0	433.1	1,485,455	1979	453.5	443.1	2,369,944
1971	446.1	440.3	821,865	1980	445.1	443.0	801,213
1972	448.9	440.0	927,602	1981	445.8	443.0	908,162
1973	455.5	442.2	3,021,705	1982	449.2	443.5	2,181,586
1974	455.1	442.7	3,179,291	1983	449.9	443.4	2,450,410
1975	446.4	439.9	2,090,527	1984	451.3	444.0	2,478,474

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
Original Capacity - 1967			450	32,397	421,388	430	6,881	38,607
415	1,146	5,156	455	41,548	605,212	435	11,532	81,000
420	2,181	13,088	460	52,398	837,421	440	17,897	151,000
425	3,851	27,762	465	65,113	1,127,534	445	24,527	255,374
430	7,109	53,739	1984 Capacity			450	32,264	395,000
435	12,115	101,133	415	880	2,200	455	41,548	578,000
440	17,990	175,297	420	1,922	7,000	460	52,398	798,000
445	24,583	280,595	425	3,342	17,000	465	65,113	1,072,500

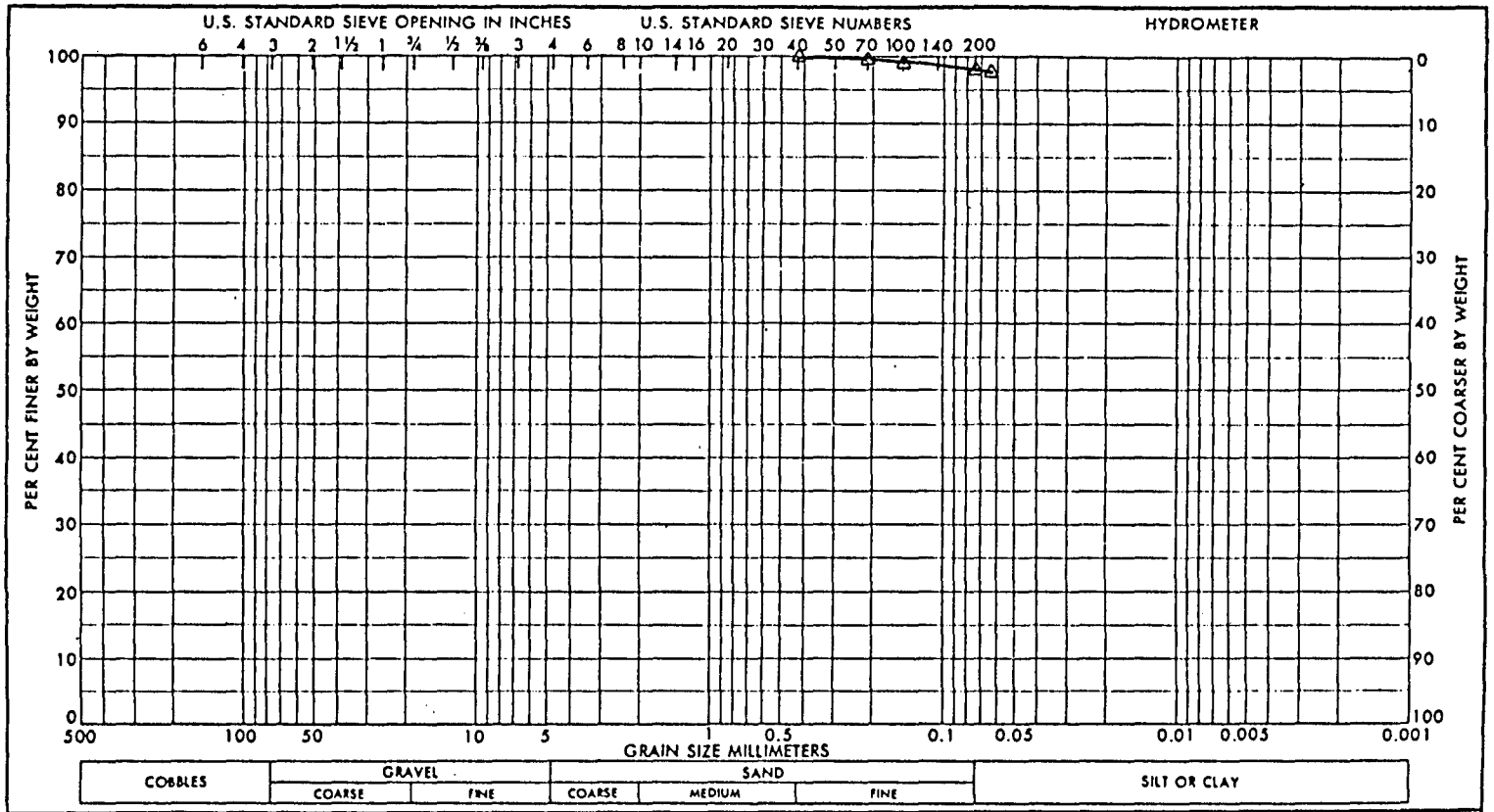
47. REMARKS AND REFERENCES

1/ Top of movable gates in closed position, includes 1 ft. freeboard. Flood control pool (el. 462.5) used for items 19,31,32,33,41,43.
2/ Includes 32,692 acre-feet for water supply, remainder for navigation.
3/ Adjusted to reflect that Lake Shelbyville controls 39% of the watershed.
4/ Precipitation data for period extends through Dec., 1983.
5/ 1971 resurvey results were presented in the Report of Sedimentation, 1976 resurvey, and are not shown here due to space limitations.
6/ No sediment samples taken is 1976.

Reference: "Report of Sedimentation, 1976 Resurvey, Carlyle Lake," U.S. Army Corps of Engineers, St. Louis District, St. Louis, Missouri.

48. AGENCY MAKING SURVEY

49. AGENCY SUPPLYING DATA U.S. Corps of Engineers, St. Louis Dist. 50. DATE 12/85



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

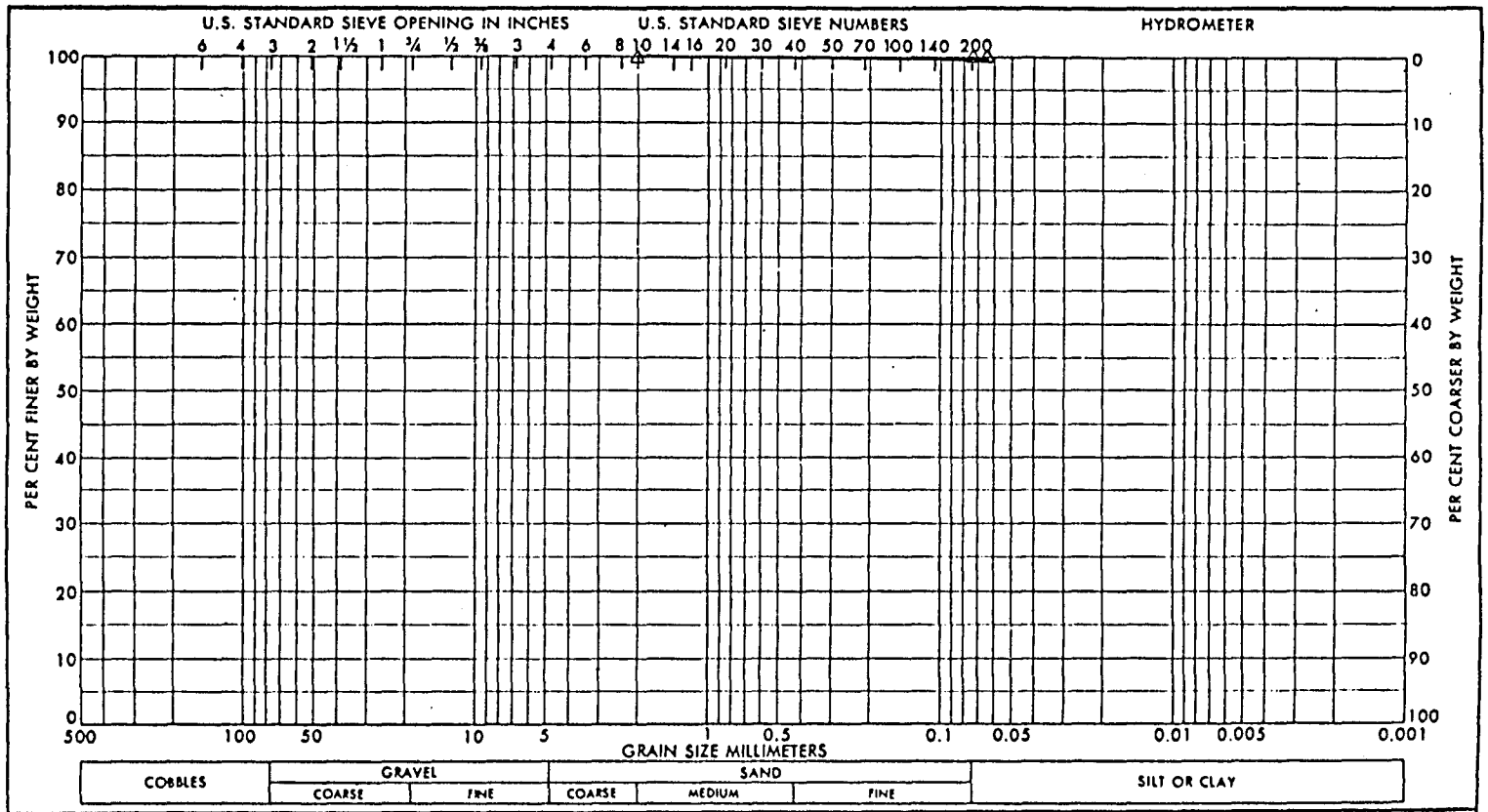
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 1A, (East), 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

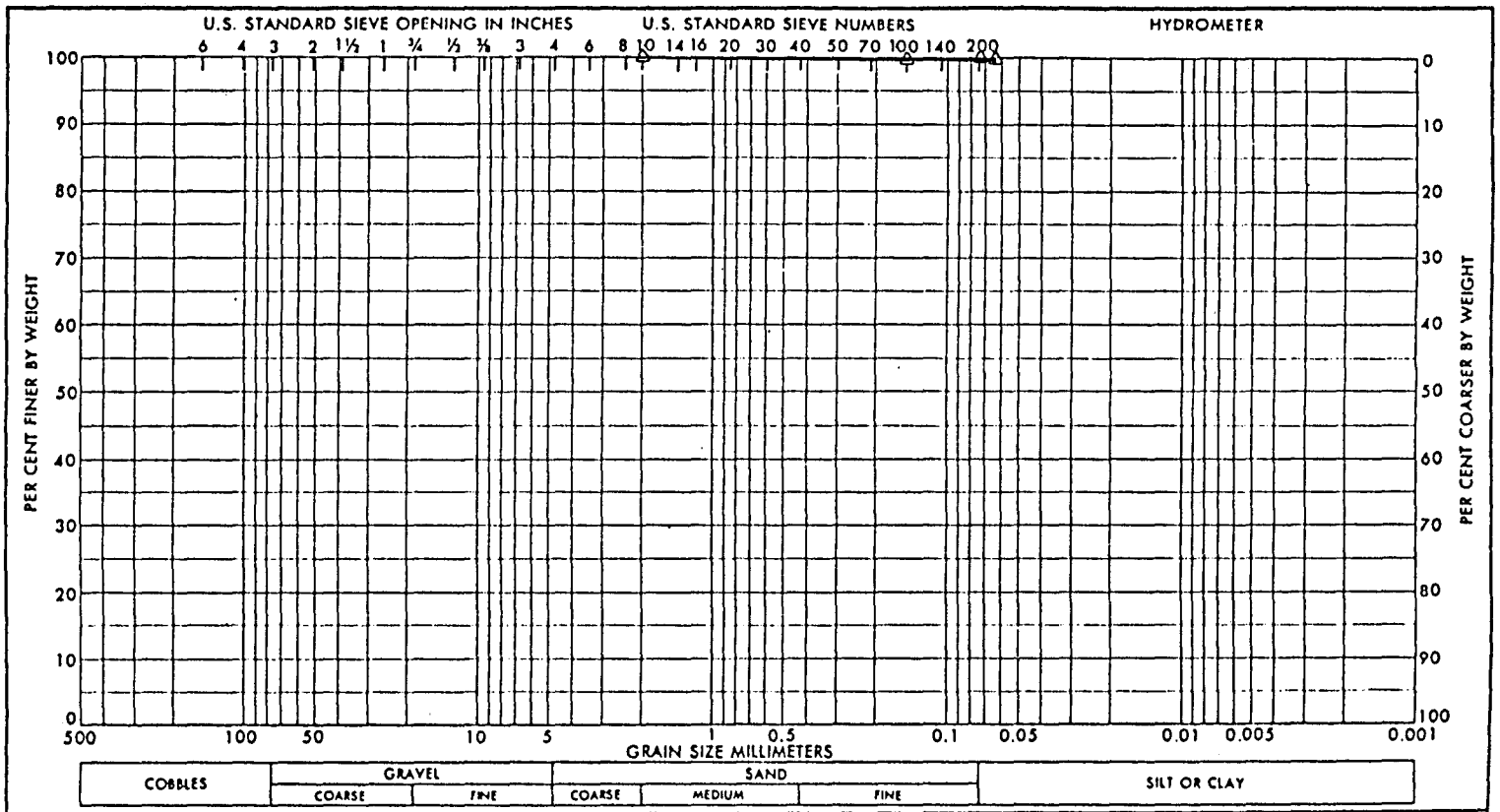
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 1A (West), 1982 RESURVEY



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

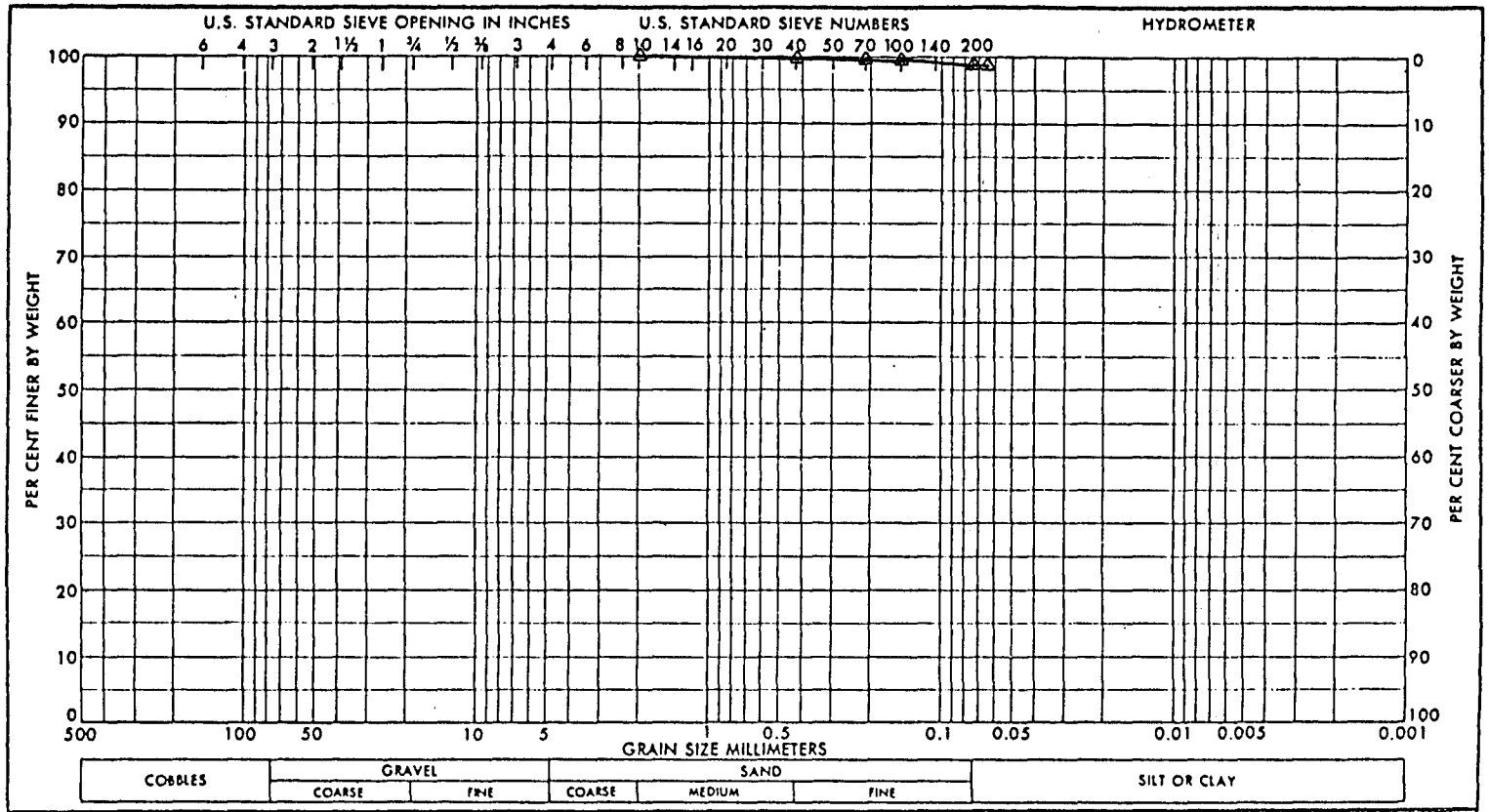
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 2A, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

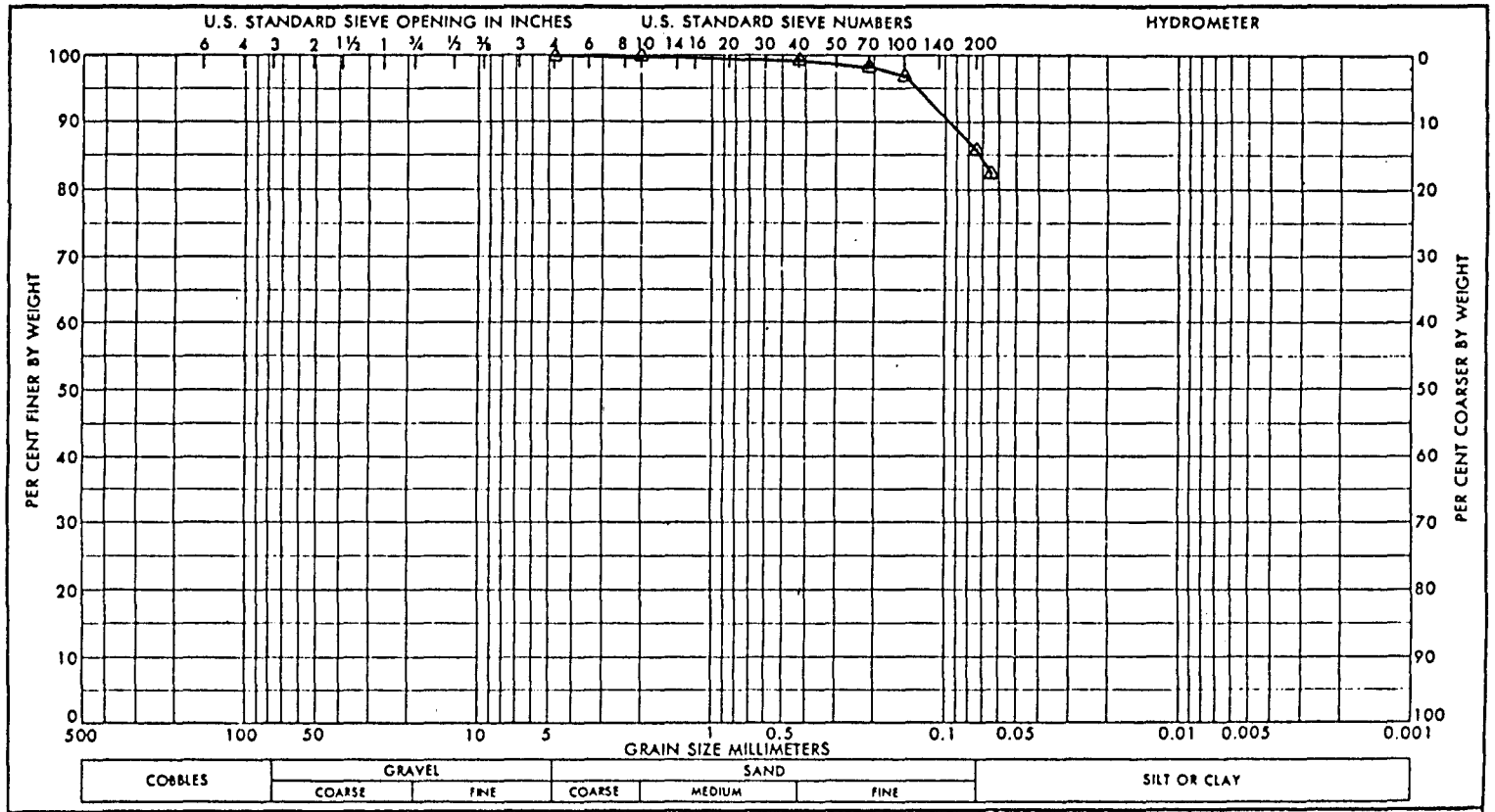
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 3A (East), 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

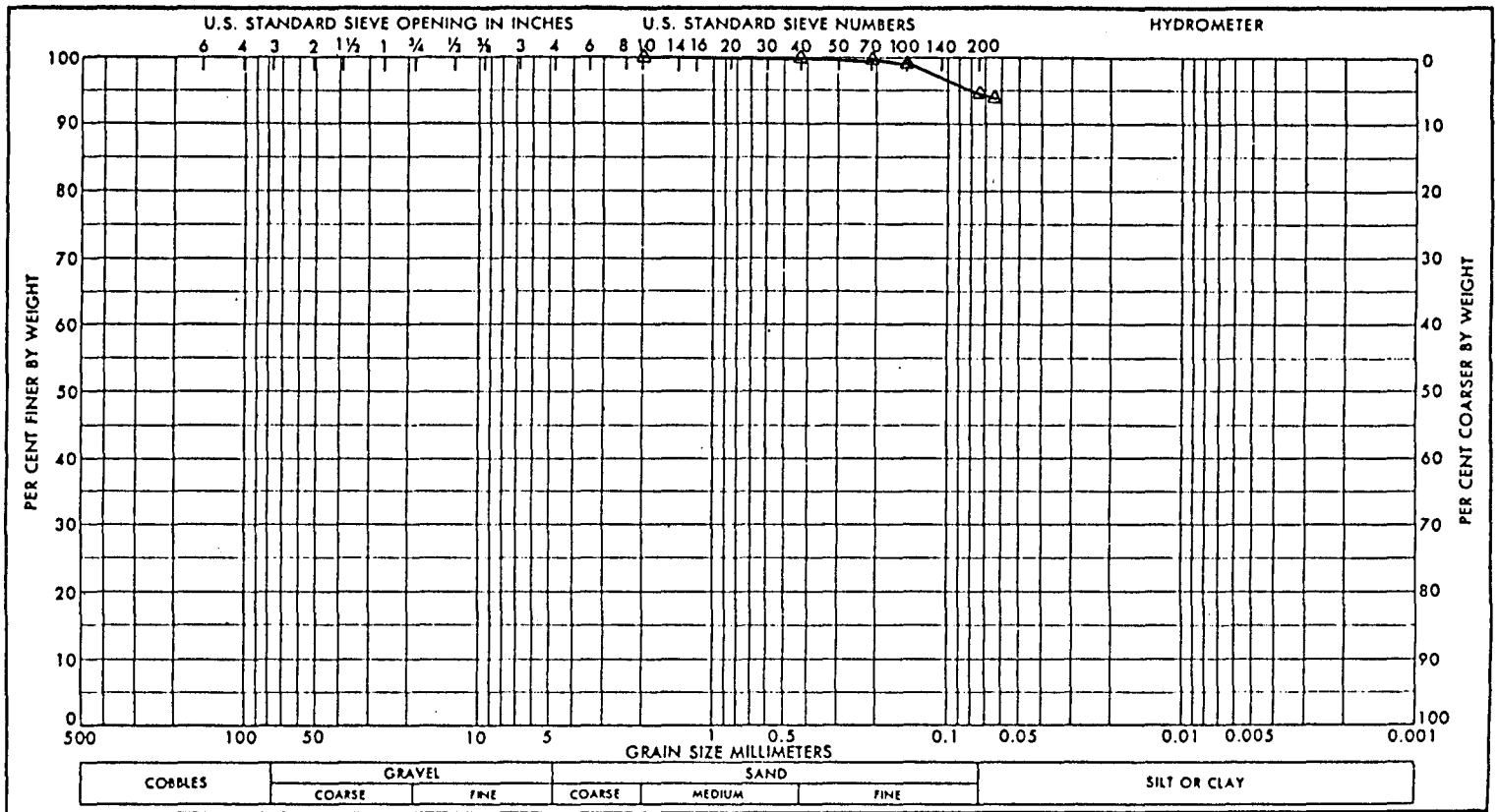
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 3A (West), 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

PROJECT

AREA

BORING NO.

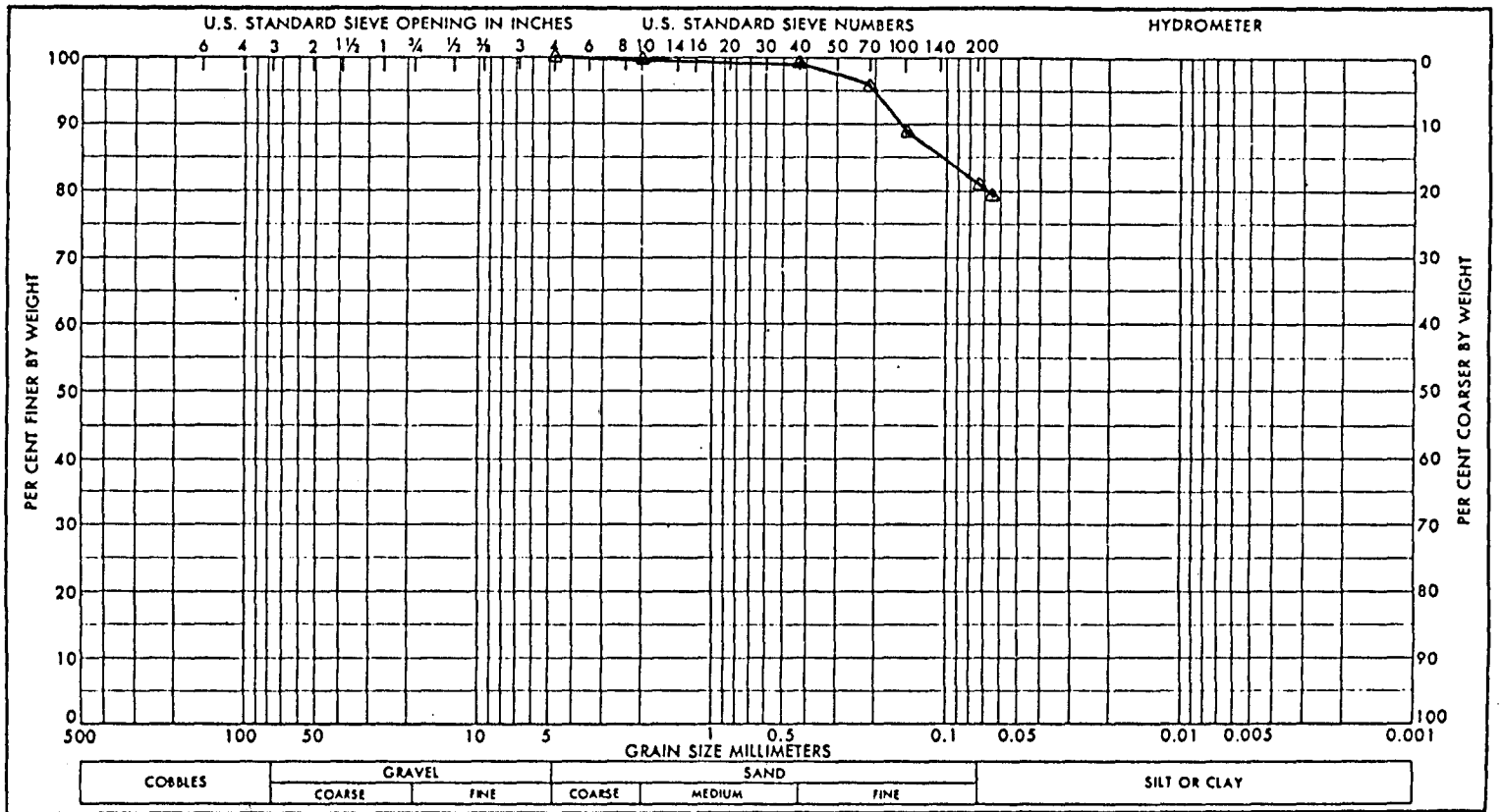
DATE

GRADATION CURVES

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 3.1A, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

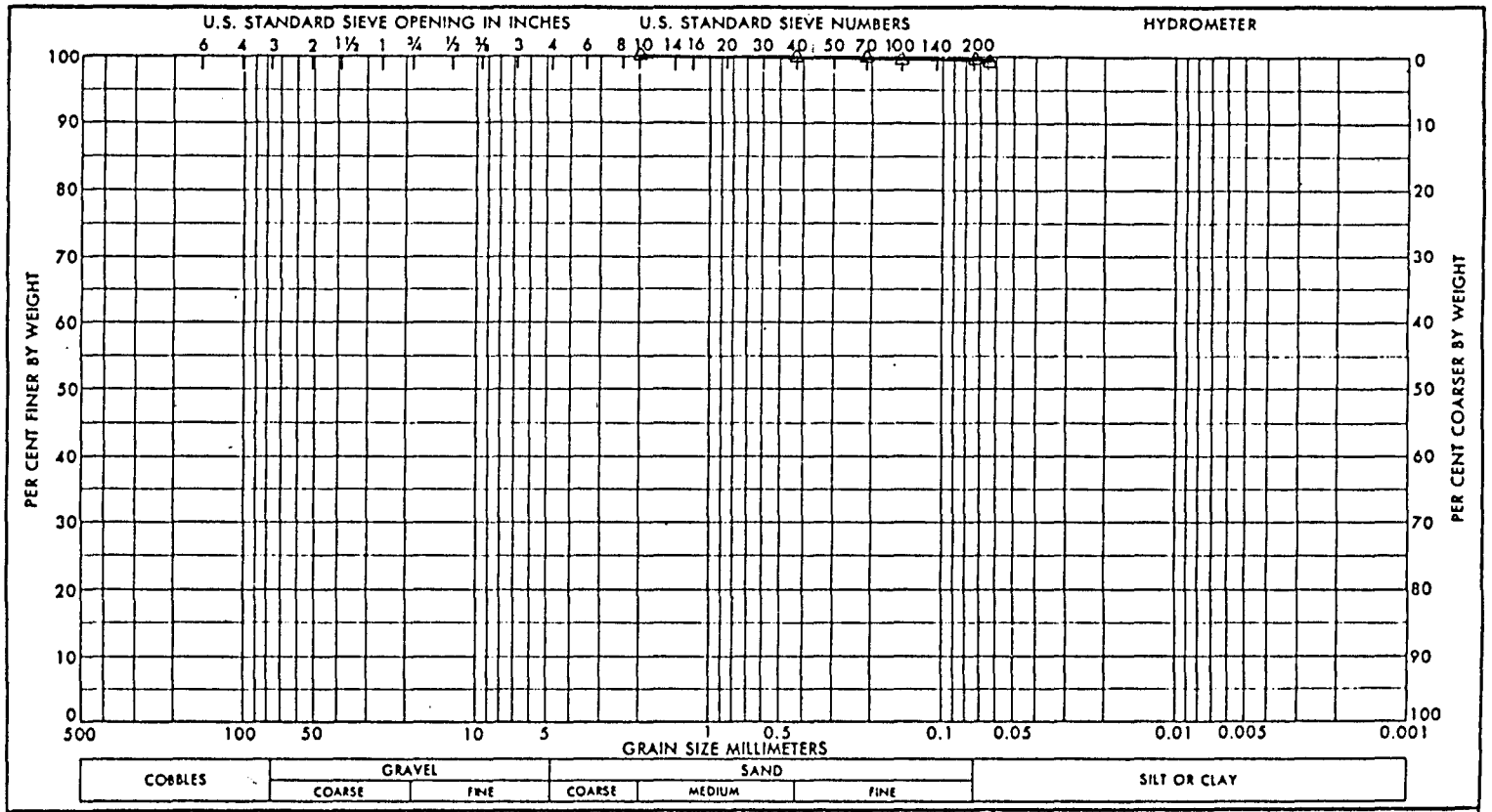
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 3.2A, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

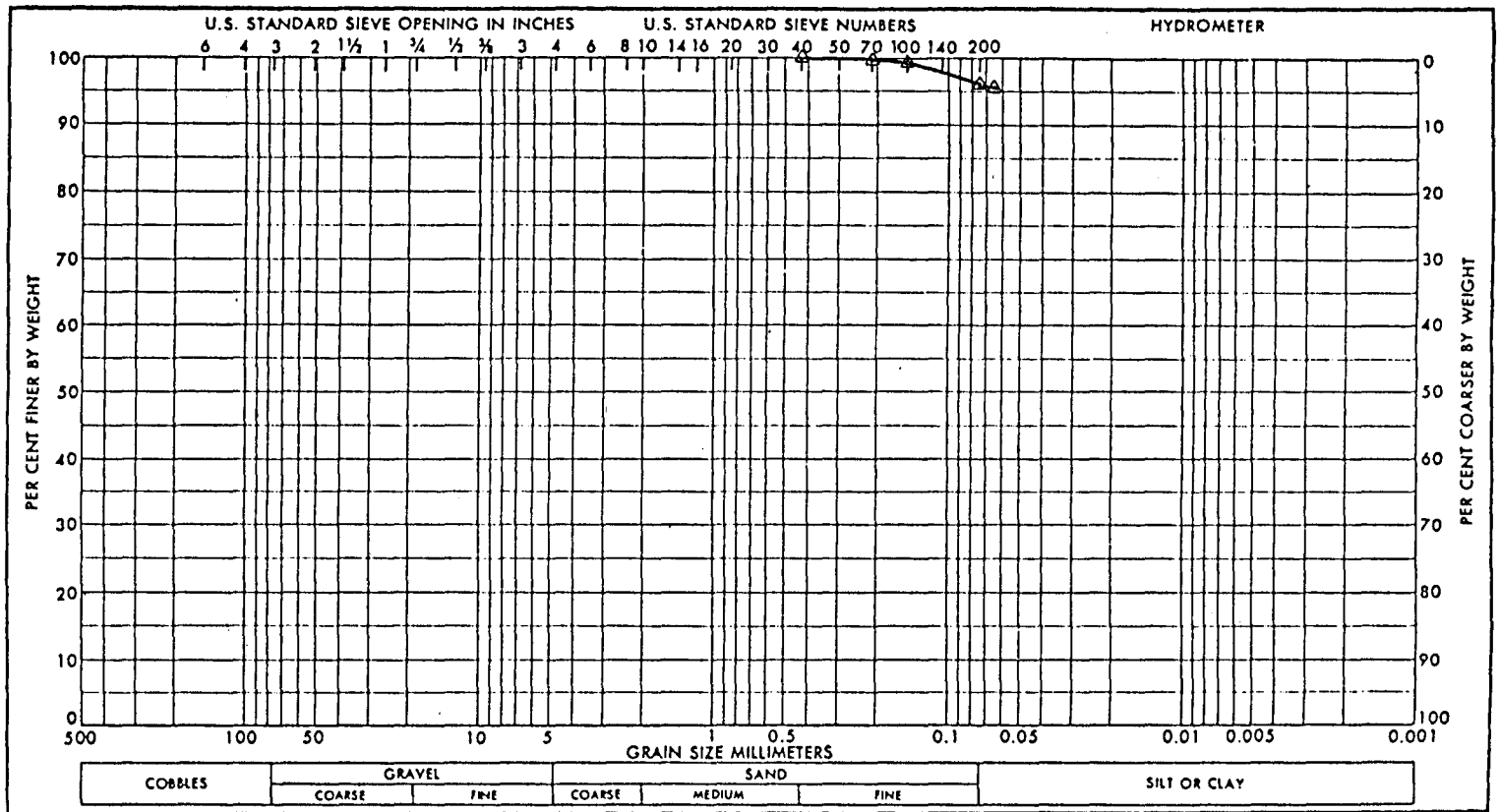
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 4A, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

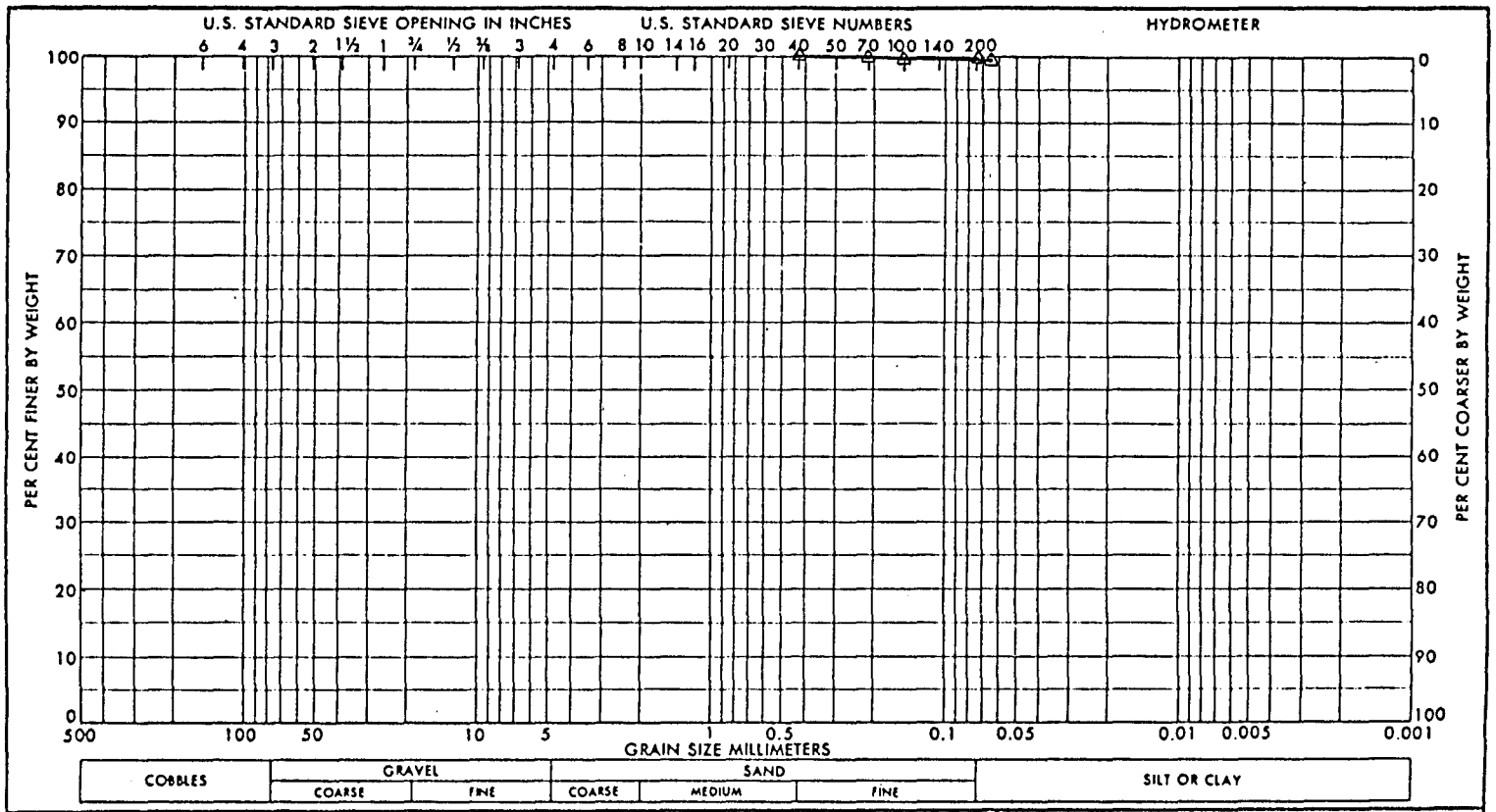
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 5B, 1982 RESURVEY



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

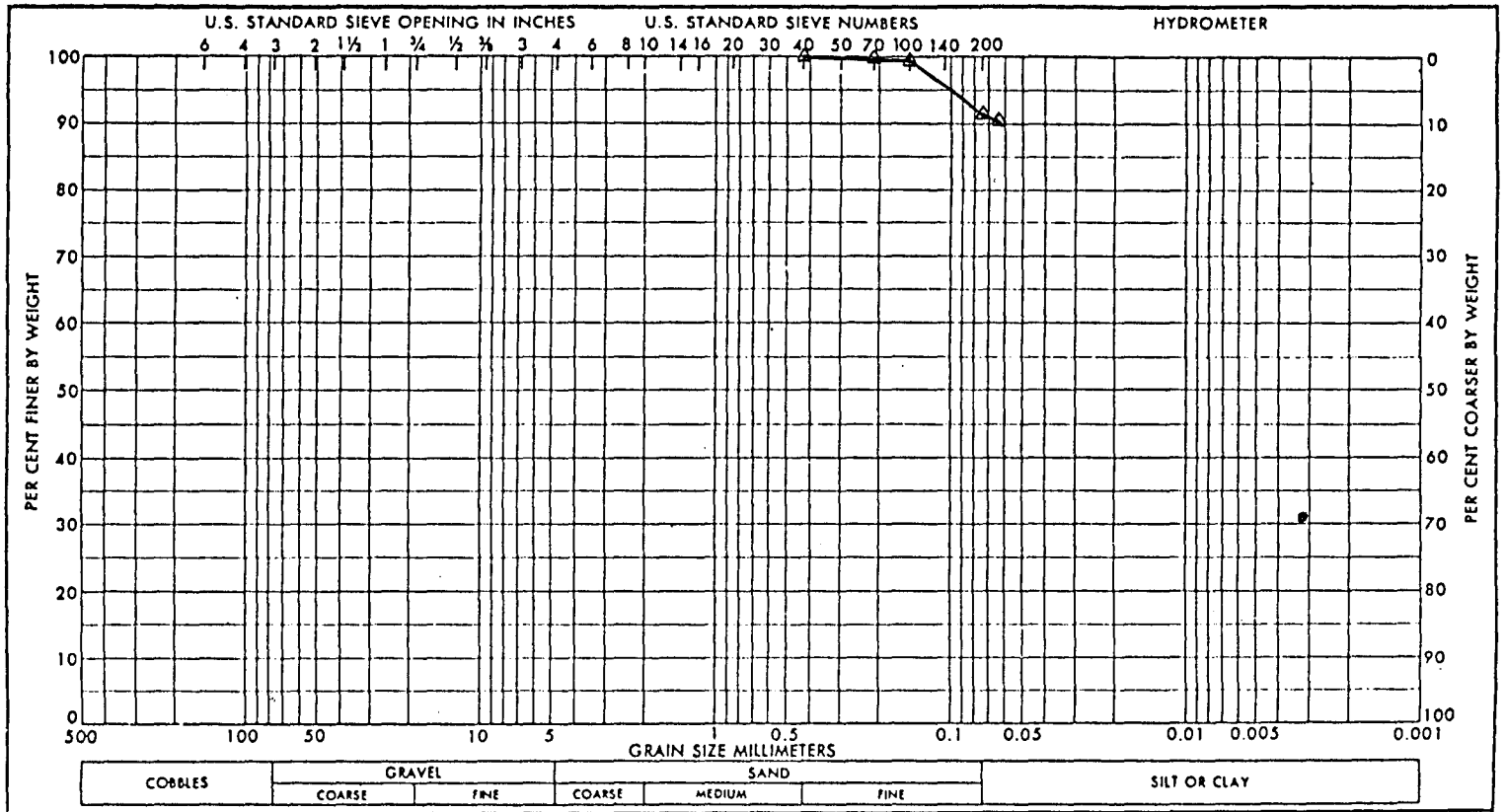
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 6B, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

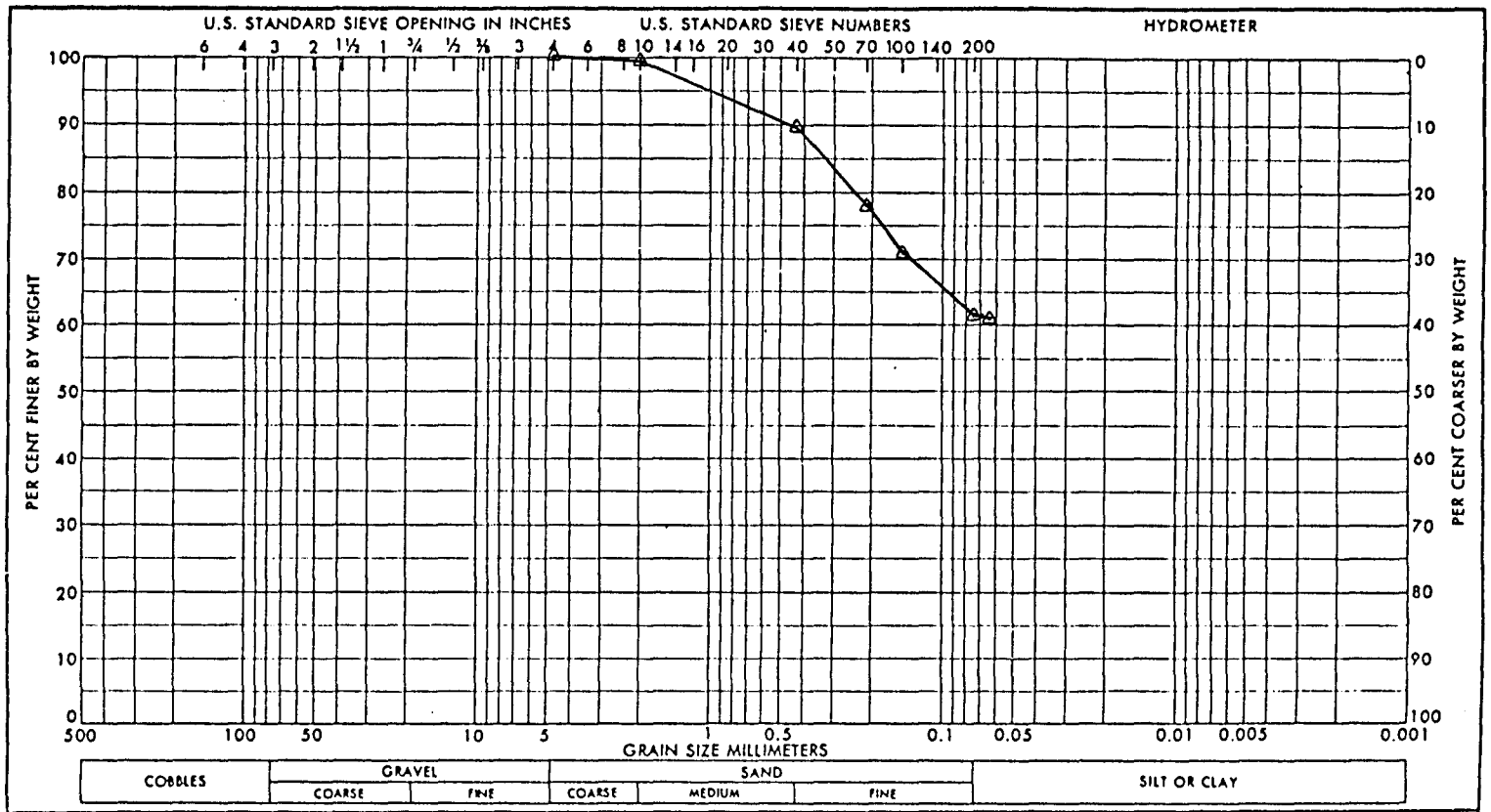
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 7A, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

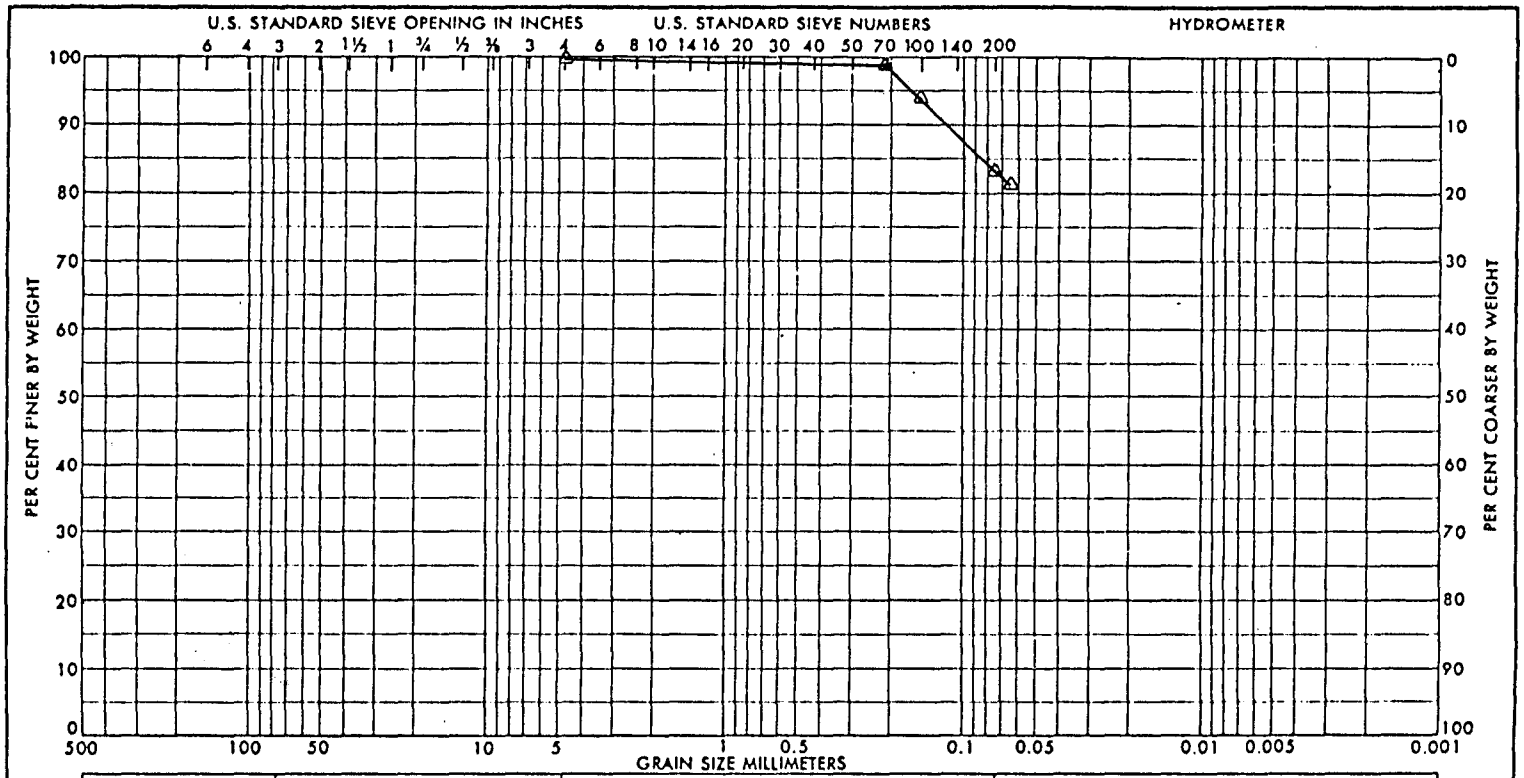
BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 8B, 1982 RESURVEY



SAMPLE NO.	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI

GRADATION CURVES

PROJECT

AREA

BORING NO.

DATE

PLATE V-2

ENG FORM 1 MAY 63 2087

LAKE CARLYLE
SEDIMENT SIZE DISTRIBUTION
SAMPLE 9A, 1982 RESURVEY

APPENDIX A

SEDIMENT RANGE CONTROL

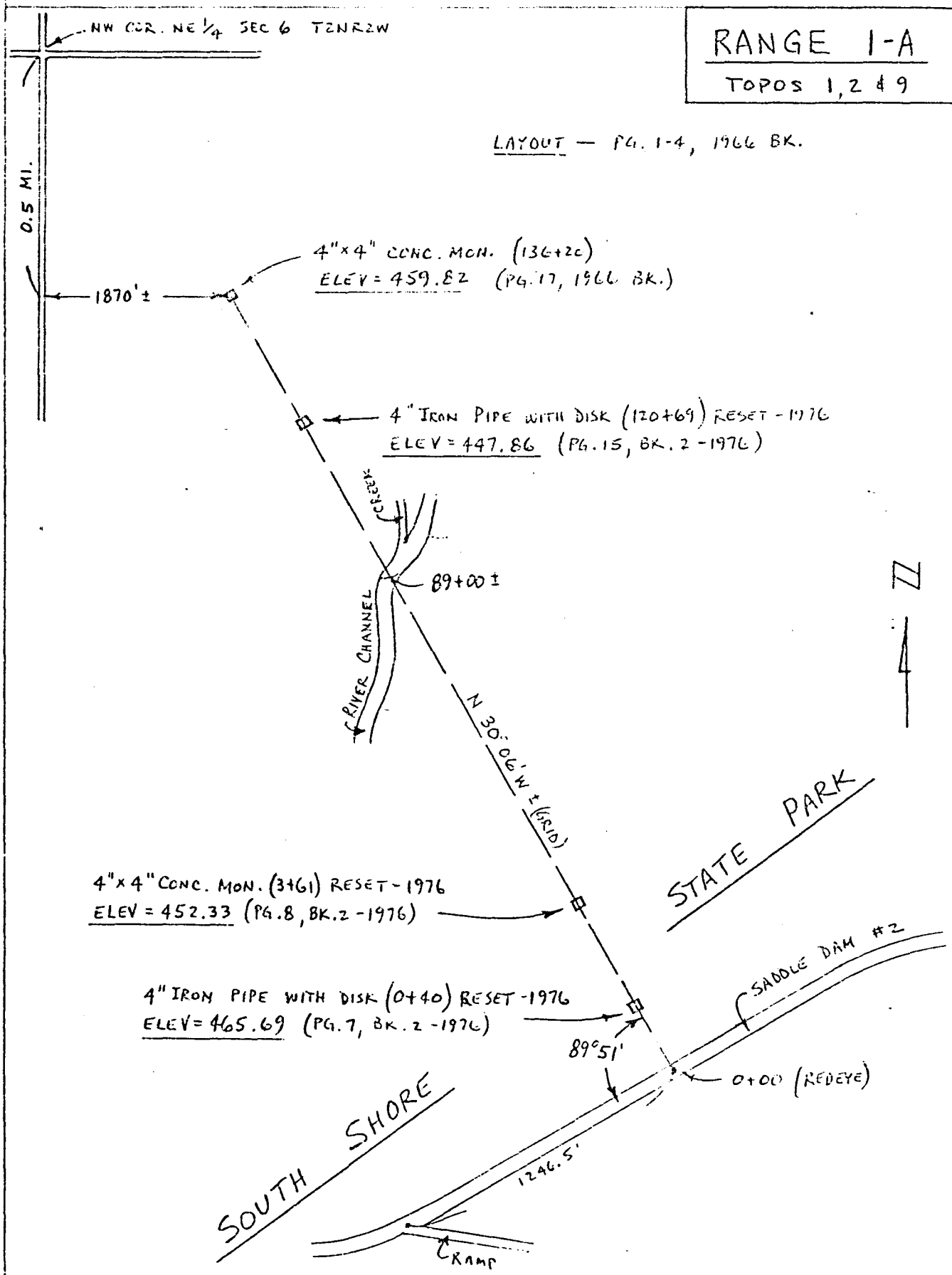
PROJECT CARLYLE LAKE | SHEET 1 | COMPUTED WJM | 3-15-82

SUBJECT SEDIMENTATION RANGE CONTROL | CHECKED

RANGE 1-A

TOPOS 1, 2 & 9

LAYOUT — PG. 1-4, 1966 BK.



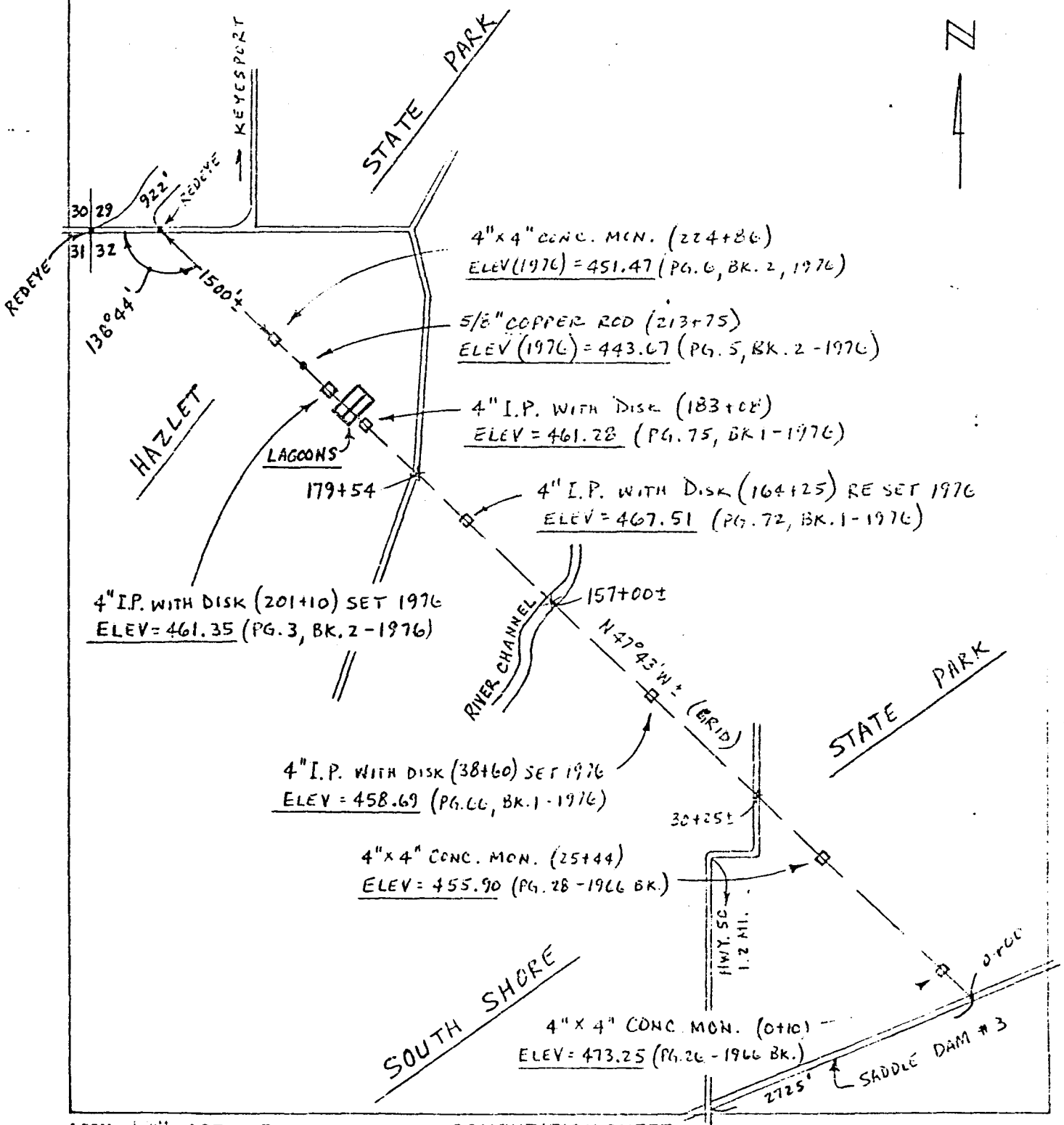
PROJECT: CARLYLE LAKE — Page 2 — 3-16-82

SUBJECT: SEDIMENTATION RANGE CONTROL

LAYOUT — PG. 21-24, 1966 BK.

RANGE 2-A

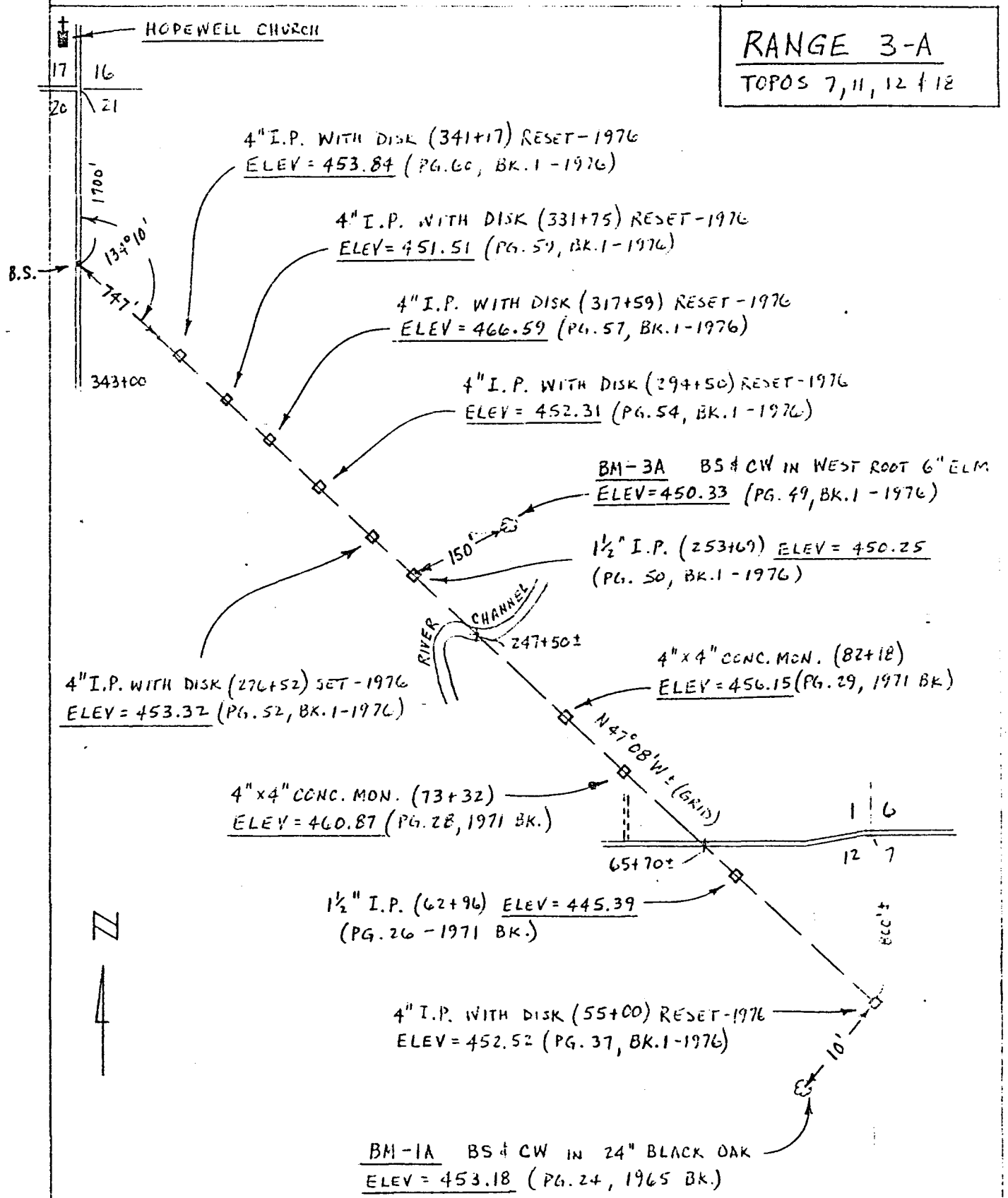
TOPOS 2, 3, 8, 10 & 11



PROJECT	CARLYLE LAKE	3	COMPUTED	3-16-00
SUBJECT	SEDIMENTATION RANGE CONTROL		CHECKED	

RANGE 3-A

TOPOS 7, 11, 12 & 18



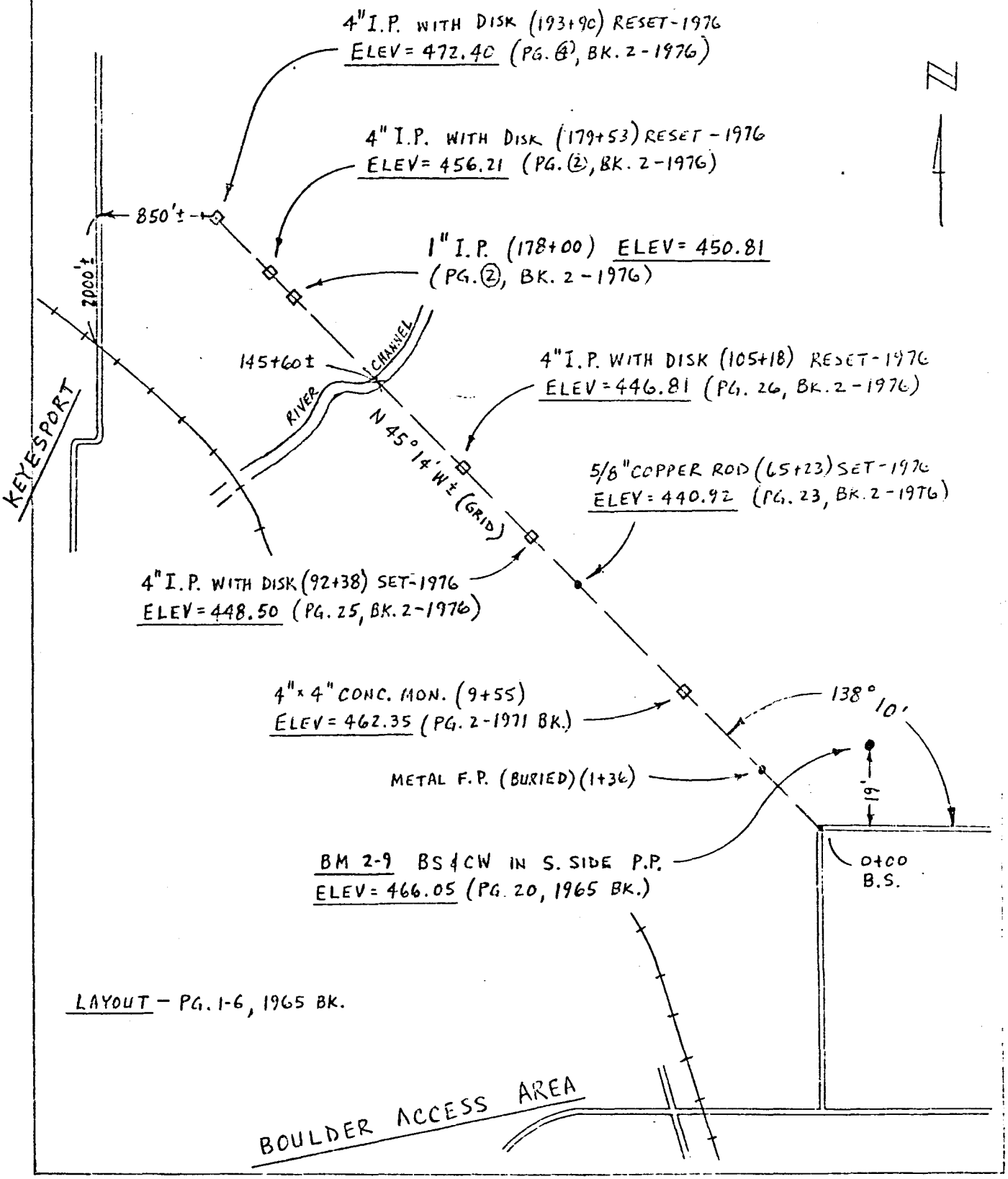
LAYOUT — PG. 2-6, 1965 BK.

PROJECT CARLYLE LAKE PAGE 4 COMPUTED LWS M 3-17-82

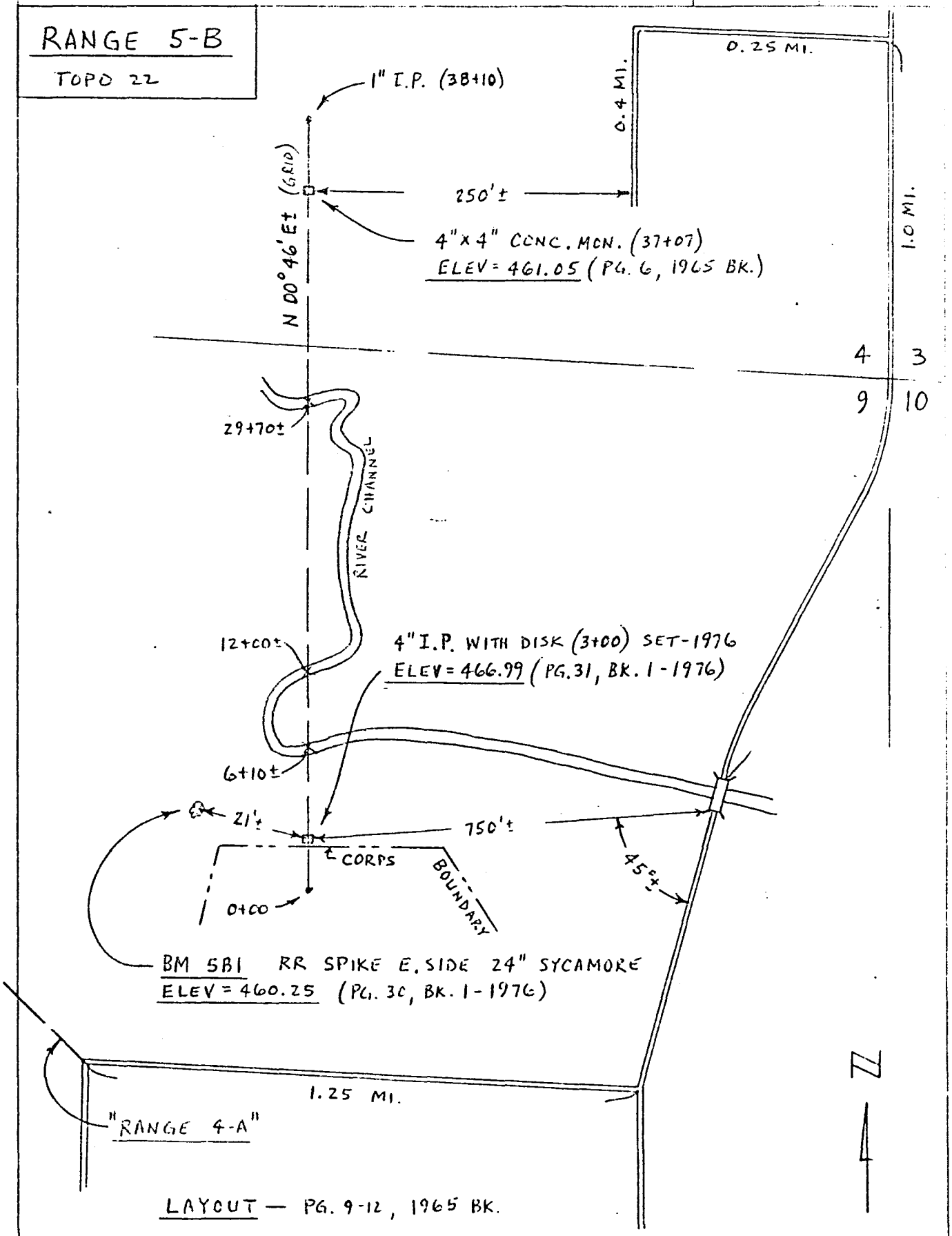
SUBJECT SEDIMENTATION RANGE CONTROL CHECKED

NOTE: "PG. ②" = LOOSE LEAF PAGES.

RANGE 4-A
TOPOS 21, 22 & 28



PROJECT	CARLYLE LAKE	Page 5	COMPUTED BY WJM	3-18-82
SUBJECT	SEDIMENTATION RANGE CONTROL		CHECKED BY	DATE

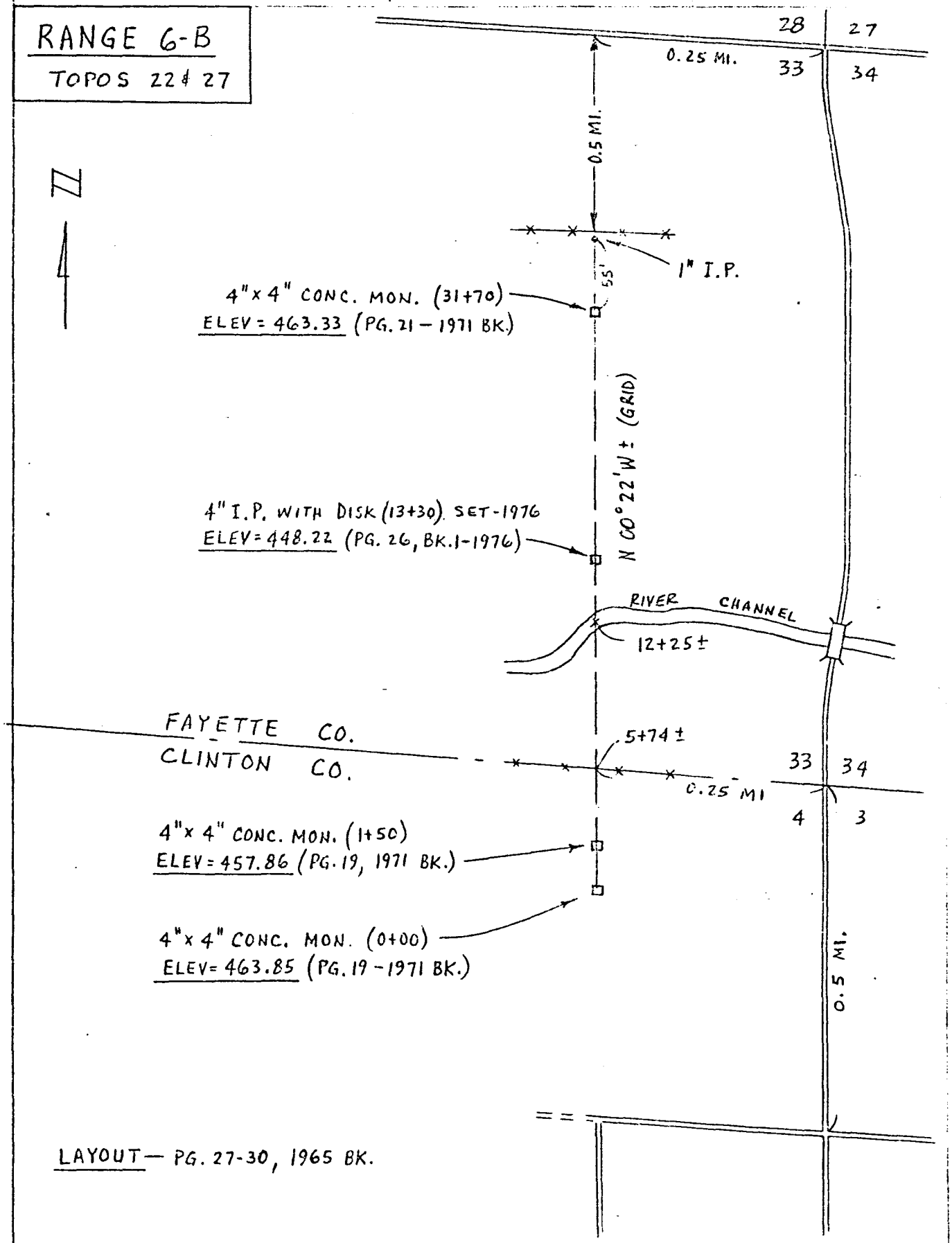


PROJECT CARLYLE LAKE 6 WKH 3-18-82

SUBJECT SEDIMENTATION RANGE CONTROL

RANGE 6-B

TOPOS 22 & 27



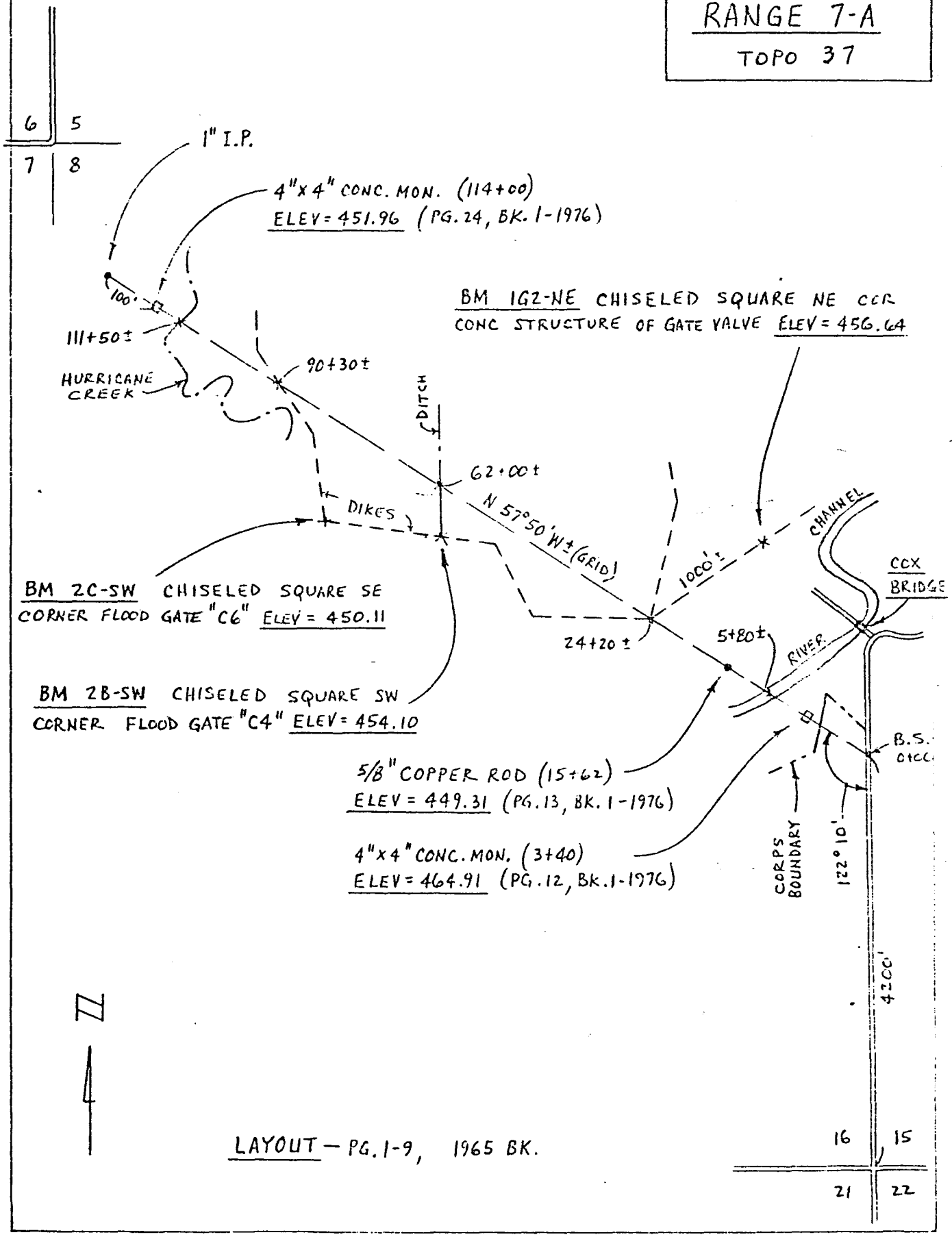
LAYOUT — PG. 27-30, 1965 BK.

PROJECT CARLYLE LAKE PAGE 7 COMPUTED WDM 3-19-82

SUBJECT SEDIMENTATION RANGE CONTROL CHECKED

RANGE 7-A

TOPO 37

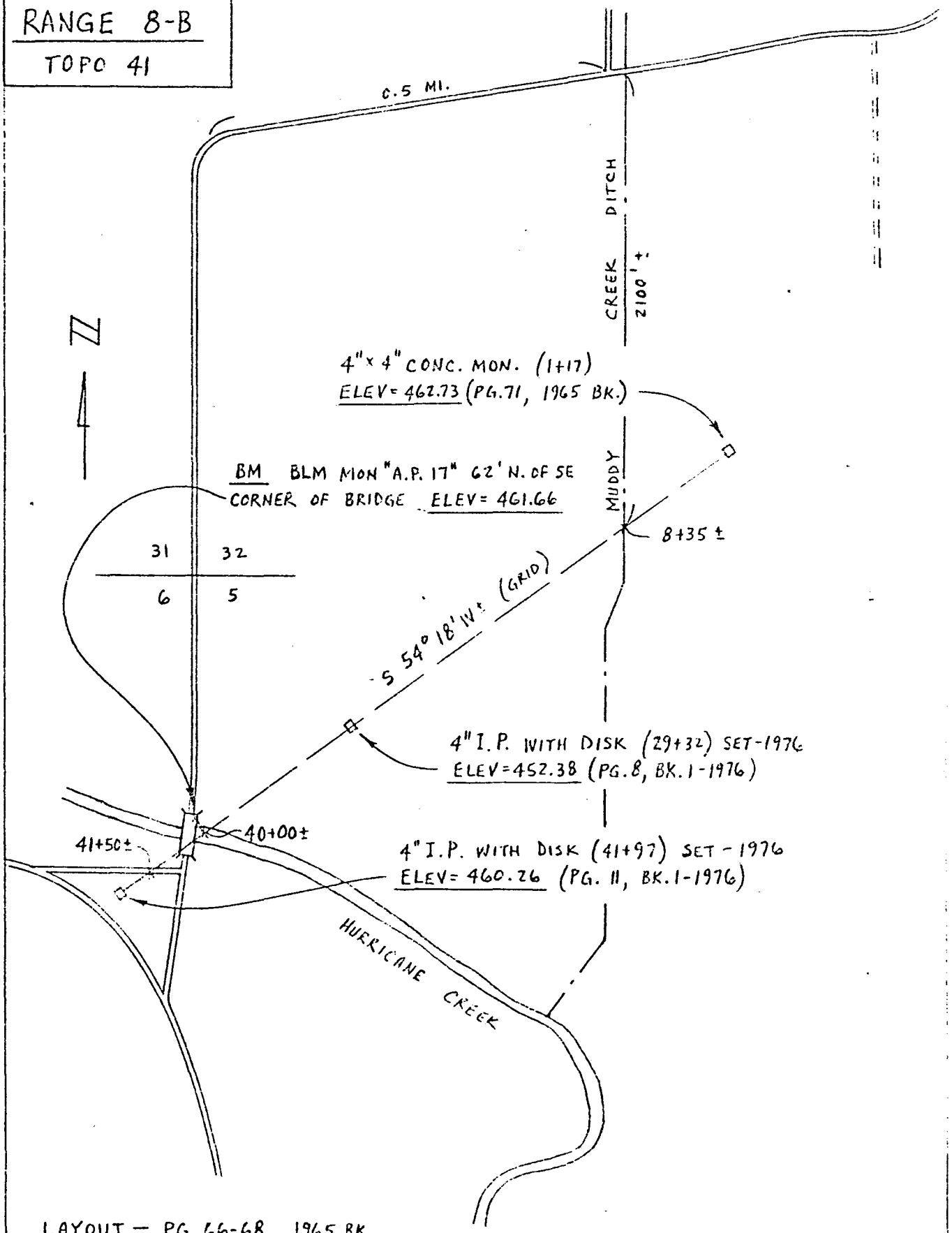


PROJECT CARLYLE LAKE 8 WJM 3-19-82

SUBJECT SEDIMENTATION RANGE CONTROL

RANGE 8-B

TOPO 41

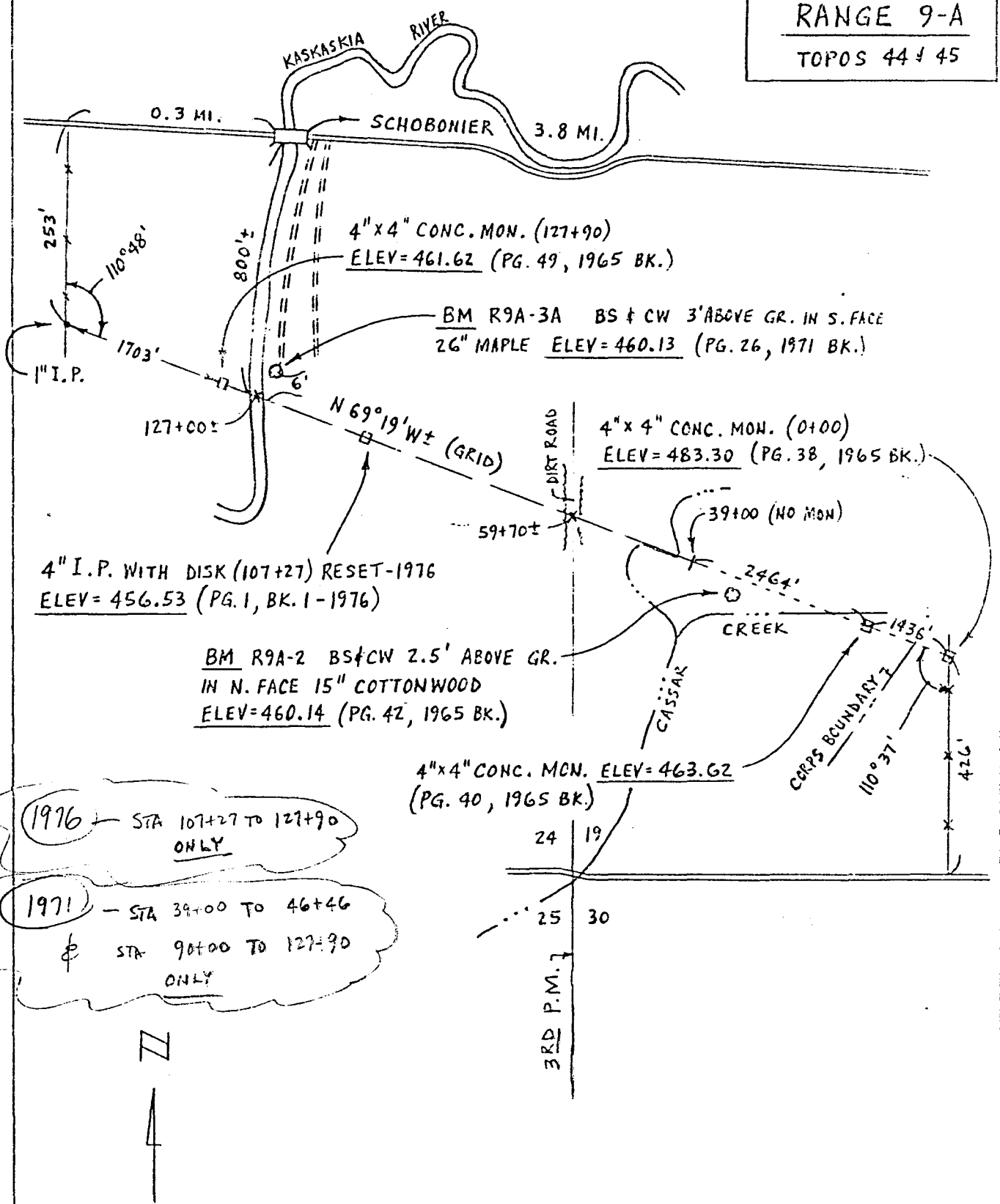


LAYOUT — PG.66-68, 1965 BK.

PROJECT CARLYLE LAKE | 9 | COMPUTED 3-22-82

SUBJECT SEDIMENTATION RANGE CONTROL | CHECKED

RANGE 9-A
TOPOS 44 & 45



1976 — STA 107+27 TO 127+90 ONLY

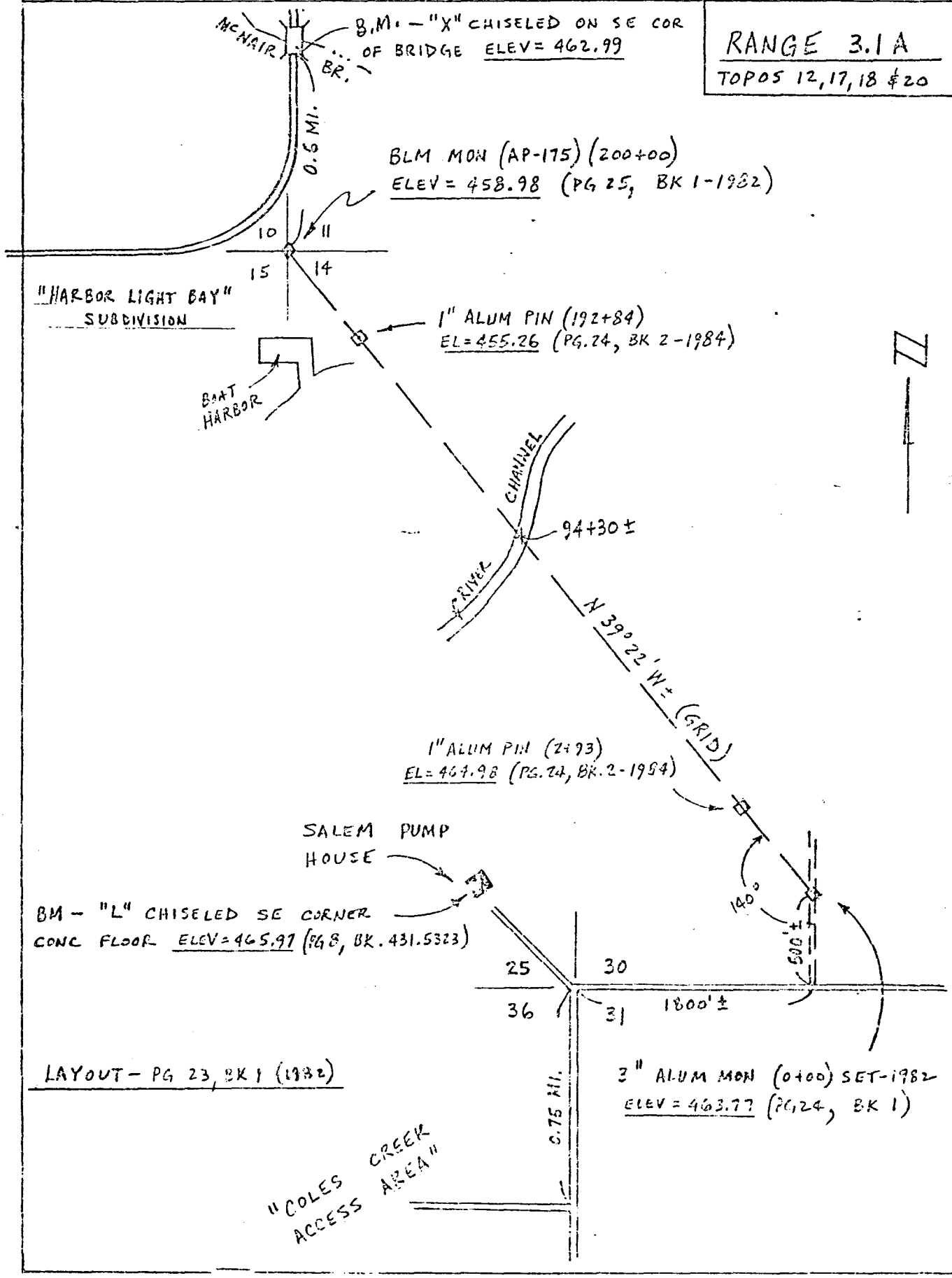
1971 — STA 39+00 TO 46+46 & STA 90+00 TO 127+90 ONLY

LAYOUT — PG. 57-64, 1965 BK.

PROJECT			COMPUTED BY	DATE
CARLYLE LAKE		Page 10 of 13		6-30-82
SUBJECT			CHECKED BY	DATE
SEDIMENTATION RANGE CONTROL				

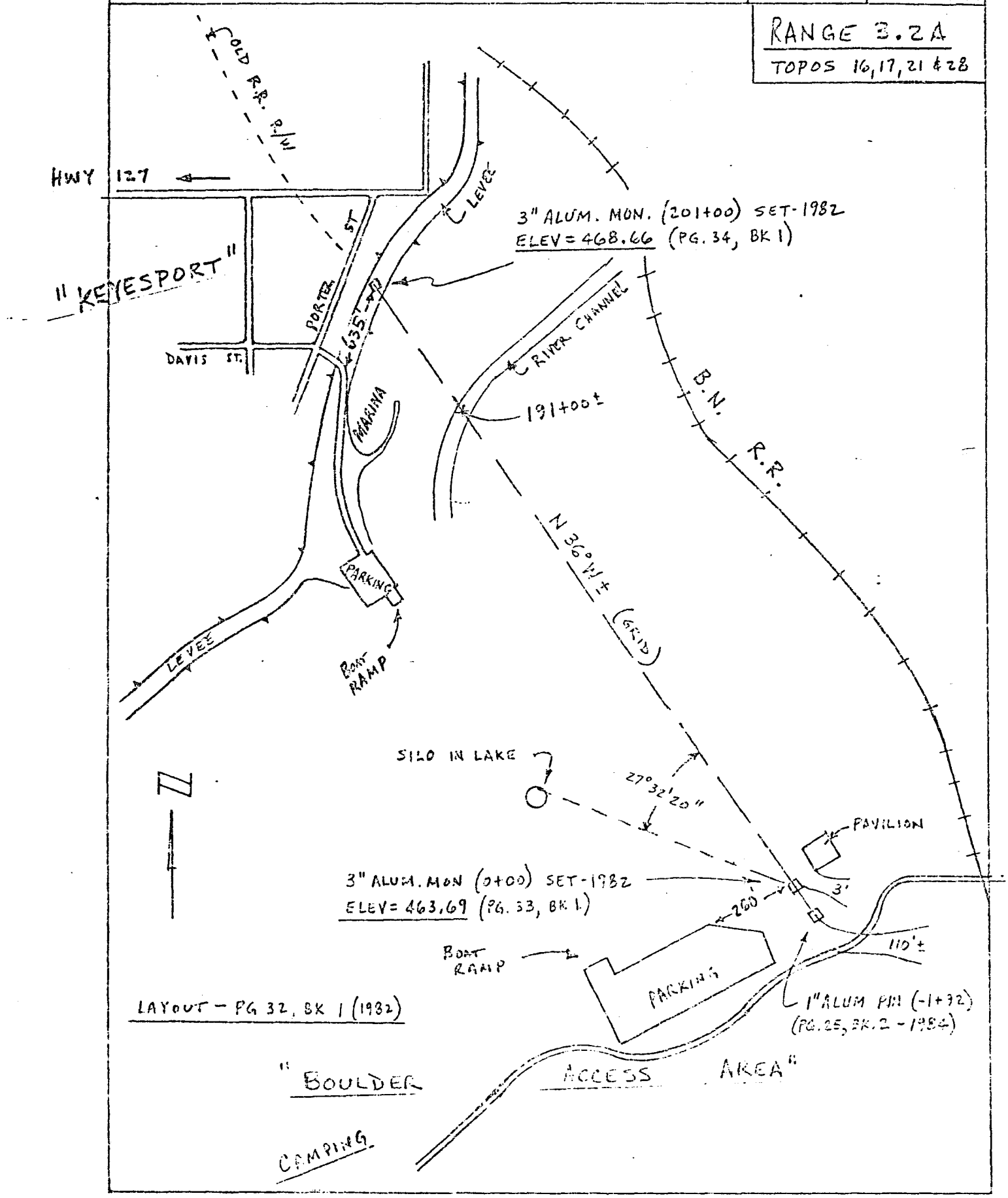
RANGE 3.1 A

TOPOS 12, 17, 18 & 20



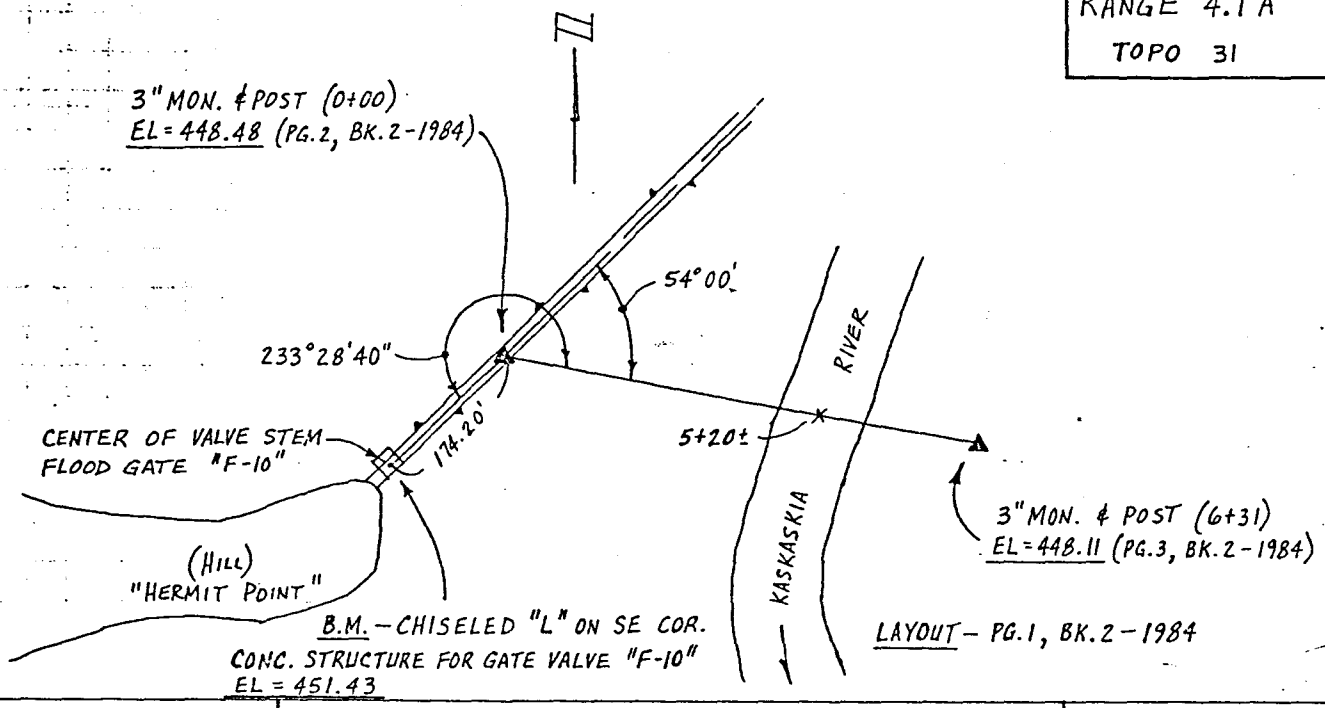
PROJECT CARLYLE LAKE	Page 11 of 13	COMPUTED BY	DATE 6-29-82
SUBJECT SEDIMENTATION RANGE CONTROL		CHECKED BY	DATE

RANGE 3.2A
TOPOS 16, 17, 21 & 28



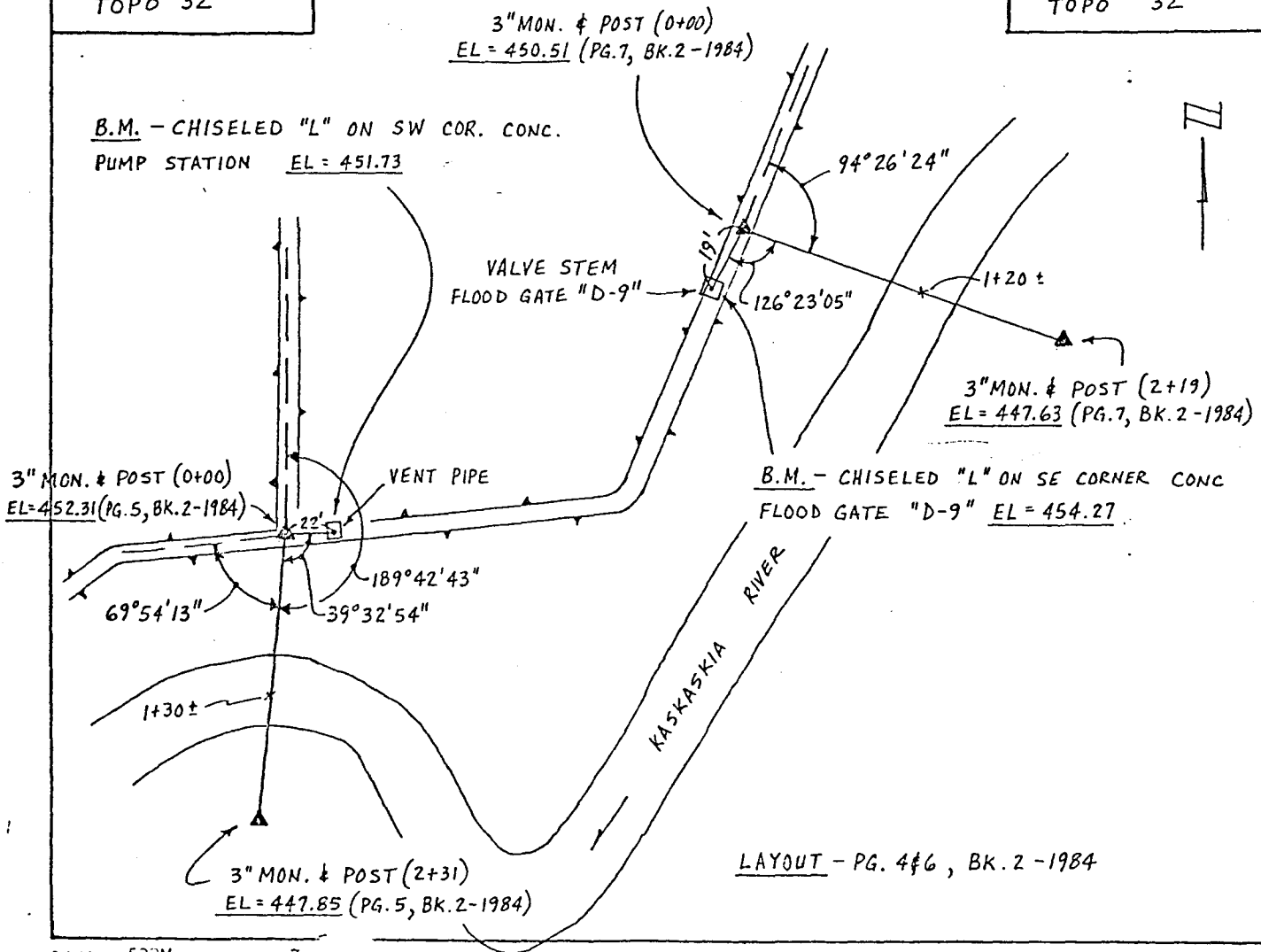
PROJECT			COMPUTED BY	DATE
CARLYLE LAKE	Page 12 of 13		WBM	10-02-84
SUBJECT			CHECKED BY	DATE
SEDIMENTATION RANGE CONTROL				

RANGE 4.1 A
TOPO 31



RANGE 4.2A
TOPO 32

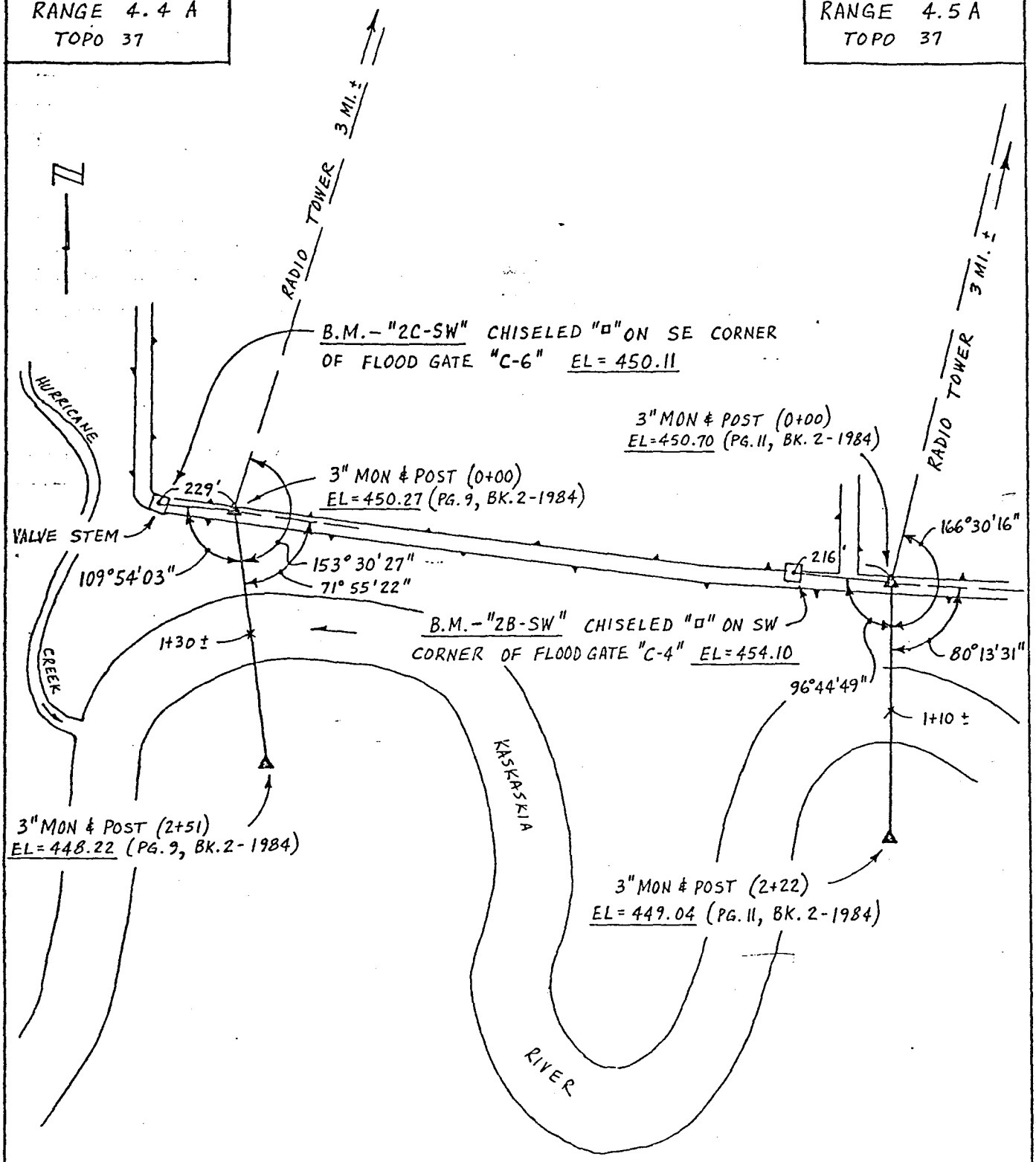
RANGE 4.3A
TOPO 32



PROJECT CARLYLE LAKE	Page 13 of 13	COMPUTED BY WJM	DATE 10-03-84
SUBJECT SEDIMENTATION RANGE CONTROL		CHECKED BY	DATE

RANGE 4.4 A
TOPO 37

RANGE 4.5 A
TOPO 37



LAYOUT — PG. 8 & 10, BK. 2-1984