CARLYLE LAKE
UPPER MISSISSIPPI RIVER BASIN

KASKASKIA RIVER, ILLINOIS

REPORT OF SEDIMENTATION

1982 RESURVEY

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

REPORT ON RESURVEY OF SEDIMENTATION
CARLYLE LAKE
KASKASKIA RIVER, ILLINOIS
1982

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PERTINENT DATA SUMMARY
CARLYLE LAKE

Item	Unit	
DRAINAGE AREA	sq. mi.	2,680
INACTIVE STORAGE POOL		
Elevation	n.g.v.d.	429.5
Area	acres	6,672
Storage	acre-feet	50,368
Storage (runoff)	inches	0.35
JOINT-USE POOL		
Elevation	n.g.v.d.	429.5 - 445.0
Area	acres	24,580
Storage	acre-feet	230,227
Storage (runoff)	inches	1.63
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	58,440
Storage	acre-feet	694,050
Storage (runoff)	inches	4.89
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	65,000
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	69,400
Storage	acre-feet	304,000
Storage (runoff)	inches	2.13
Outflow (max.)	c.f.s.	160,000

PERTINENT DATA SUMMARY (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.g.v.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

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	millimetres
feet	0.3048	metres
miles (U.S. statute)	2.609344	kilometres
square miles	2.589988	square kilometres
cubic yards	0.7645549	cubic metres
acre-feet	1233.482	cubic metres
feet per second	0.3048	metres per second
cubic feet per second	0.2831685	cubic metres per second

REPORT ON RESURVEY OF SEDIMENTATION
CARLYLE LAKE
KASKASKIA RIVER, ILLINOIS

1. INTRODUCTION.

This report is prepared according to the instructions in EM 1110-2-4000, dated 15 November 1961, and by the instructions prepared by the Subcommittee on Sedimentation, entitled "Instructions for Compiling the Reservoir Sediment Data Summary Form", revised March 1966; and represents the results of the 1971, 1976 and 1982 resurveys of Carlyle Lake sedimentation ranges and downstream retrogression ranges on the Kaskaskia River. The purpose of the investigation was to analyze the 1982 resurvey data, compare the results with the 1971 and 1976 resurvey data, which were published in the Report of Sedimentation 1976 Resurvey for Carlyle Lake, and to determine the distribution of sediment depletion of storage in the lake, and trap efficiency of the reservoir. Initial operation of the lake began on 1 April 1967.

2. LOCATION OF LAKE.

Carlyle Lake 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 lake 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 LAKE.

Carlyle Lake 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 lake is operated jointly with the other projects in the Kaskaskia River Basin.

4. PERTINENT DATA - DAM AND APPURTENANT STRUCTURES.

The Pertinent Data Summary, shown on page iv, 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 lake occupies approximately 90 square miles of this area at flood control pool (elevation

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

462.5**).The watershed has a median length of about 120 miles, an extreme width of 57 miles, and an average width of 22.3 miles. The course of the river is generally tortuous with many bends. The topography of the basin is flat to gently rolling terrain. The principal occupation in the watershed is agricultural, 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. LAKE OPERATION.

Carlyle Lake was designed to operate jointly with Lake Shelbyville in a way that their design-flood outflows can be safely and economically handled by authorized levees downstream. The lake outflows are regulated during the normal December through April flood season to reduce flood peaks downstream, to affect maximum flood control benefits, and to 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 average monthly pool elevations for the period 1967 through 1982 are shown on Plate 2.

8. LAKE 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 29, a data summary of reservoir sediment, ENG Form 1787. The average monthly inflow hydrograph for the period 1966 through 1982 is shown on Plate 3.

9. ORIGINAL LAKE SURVEY.

Lake area and volume were determined from U.S. Geological Survey quadrangle sheets and River and Lakes Commission topographic survey sheets of 1908. The area and volume curves were checked from 1956 topographic survey sheets. Tabulations of lake area and storage for 5-foot intervals are shown as Tables 3, 4 and 5 for the 1971, 1976 and 1982 surveys, respectively. Area and capacity curves are shown on Plate 4.

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

10. TYPE AND SCOPE OF THE INITIAL SEDIMENT SURVEY.

There were nine sediment ranges established and surveyed by direct leveling during the period of July 1965 - January 1967 for the purpose of observing sediment distribution and the approximate rate of storage depletion. Plate 5 shows the locations of the pool sediment ranges. The cross-sections of the ranges, original, 1971, 1976 and 1982, are shown on Plates 6 through 16.

11. TYPE AND SCOPE OF SEDIMENT RESURVEY.

Detailed sediment resurveys of the nine sediment ranges by direct leveling and by a Ratheon Recording Depth Sounder, Model EE-119, were made during 1971 and 1976. The 1971 sediment resurvey was conducted from May to August 1971. The average elevation of the pool during the measurements was about 443.0. The 1976 sediment resurvey was conducted from January to March 1976. The average elevation of the pool during the measurements was about 440.5. The 1982 sediment resurvey was conducted from August to September 1982. The average elevation of the lake was about 445.6. The soundings were performed in conjunction with a Motorola Mini Ranger distance measuring unit which constantly updates the distance from the shore station. The depth recorder was placed in an 18-foot jon boat with a small horsepower outboard motor. Horizontal alignment was maintained by communication with walkie-talkies between the boat operator and a person on shore. The person on shore was located at one end of the sedimentation range with a transit sighted on the other end of the range for alignment purposes. Thus, if the boat making the soundings varied off the range, the person on shore with the transit could communicate with the boat operator by walkie-talkie as to what corrective measures to take. Two new sediment ranges (3.1A and 3.2A) were established and surveyed during the 1982 resurvey to more accurately monitor sedimentation in the future. Plate 4 shows the location of the two new ranges, and Plates 9 and 10 show the respective cross-sections.

12. METHODS OF SEDIMENT COMPUTATION.

A. The prismoidal method was used to calculate the volume of sediment deposited in the lake during the 1971, 1976 and 1982 resurveys. This method was developed specifically for calculating the amount of sediment deposited between two ranges. It was derived by the Soil Conservation Service and published as USDA Technical Bulletin No. 524, "Silting of Reservoirs," dated 1939. For method of computations see pages 158 - 161.

B. Since the prismoidal method requires accurate elevation versus area curves which are not available for the downstream channel, the average-end method was used to calculate the volume changes downstream of Carlyle Lake. This method applies best to areas with fairly uniform widths throughout the reach. This situation is typical of the downstream channel. The equation for the average-end method is expressed as:

$$V = \frac{(E_1 + E_2)}{2} \times \frac{L}{43,560}$$

where:

V = Change in sediment volume between ranges for a survey period in acre-feet,

E = Net change in cross-sectional area of the range for a survey period in square feet,

L = Distance between ranges in feet.

C. Both the 1971 and 1976 resurvey reports presented results based on the prismoidal method, and also used the average-end method and average depth method for comparison. The two previous surveys showed comparable results when these two methods were used. It should be noted that the 1982 data was analyzed not only with the prismoidal method, but also with the other two methods. The average depth method produced a total volume of 36,675 acre-feet of sediment deposited in the reservoir, and the average-end method produced a volume of 33,735 acre-feet of sediment, compared with 35,247 acre-feet computed with the prismoidal method.

13. SEDIMENT QUANTITIES AND PROJECT LIFE.

A. Summaries of the area changes of each sediment range along with the volume of sediment deposited between the ranges for the periods 1966-1971, 1966-1976 and 1966-1982 are presented in Tables 9, 10 and 11, respectively. The initial sedimentation resurvey in 1971 indicated that about 8.5% of the inactive storage and 3.3% of the joint-use storage of the lake had been filled during the period from April 1967 to August 1971. The 1976 resurvey indicated that about 8.7% of the inactive storage and 3.9% of the joint-use storage had been filled between April 1967 and March 1976. The 1982 resurvey indicates that about 66% of the inactive storage and 0% of the joint-use storage has been filled from April 1967 to August 1982.

B. The computed rates of sediment deposition are 2,960 acre-feet per year for the initial resurvey (1966-1971); 1,797 acre-feet per year for the second resurvey (1966-1976); and 2,304 acre-feet per year for the third resurvey (1966-1982). When the 1982 resurvey results are compared with the 1976 and 1971 resurveys, it shows that the sediment distribution has changed; while the overall rate of sediment distribution is lower than the first resurvey and higher than the second resurvey. The following table summarizes the change in sediment distribution:

	Initial Storage (Acre-feet)	Storage Based on 1971 Resurvey (Acre-feet)	Storage Based on 1976 Resurvey (Acre-feet)	Storage Based on 1982 Resurvey (Acre-feet)
below 430	53,739	49,206	49,066	20,478
430 to 435	47,394	46,891	46,145	18,443
435 to 440	74,164	70,327	70,016	101,938
440 to 445	105,298	102,220	101,913	106,699

The table clearly shows that between elevation 435.0 and 445.0 the storage has increased, while below 435.0 it has decreased significantly. Carlyle Lake has had extensive shoreline erosion problems, due to the wide expanses of water available for wave generation. Referring to Plate 2, it is seen that from April 1976 to February 1977 the average pool elevation was at or below elevation 441.1. Also, since February 1977, the average monthly pool elevation has been below elevation 445.0 for about 80% of the time. This has allowed almost continuous exposure of the shoreline below elevation 445.0 The above table would indicate that material between elevation 435.0 and 445.0 has been washed out by wave action and deposited below elevation 435.0. Although the surface areas developed from the 1982 resurvey data show less area than before (Tables 3, 4 & 5), Table 7 shows that the top widths for ranges 1A, 2A, 3A and 4A have increased. These four ranges are located within the main pool area and thus are exposed to wave action. All four have increased in top width, which further supports the above discussion.

C. Based on the 1982 resurvey, the rate of deposition in the inactive pool is 2,026 acre-feet per year (1965-1982). This would deplete the inactive pool storage in 23 years of operation. The 1982 resurvey also showed the joint-use pool to have its original (1965) capacity. As stated in the above paragraph, these results do not follow the trends established by the two previous resurveys. Therefore, making predictions on the expected life of the inactive and joint-use pools does not seem advisable. Results of the next resurvey will be analyzed and compared to see if the trend of the 1982 resurvey is continuing. The overall rate of deposition of 2,304 acre-feet per year is about the average of the two previous resurveys. It appears that the yearly rate since the 1976 resurvey has increased significantly, but when compared with the initial rate it is about the same (Item 37B of Plate 29). The 1976 data was rechecked to determine if the rate should be higher, but all data and calculations appear correct.

14. TRAP EFFICIENCY OF THE LAKE.

For the period of operation, Carlyle Lake has a trap efficiency of 100%. This computation was based on the method of Gunnar M. Brune, using a capacity-inflow ratio of 0.93 (Item 33 of Plate 29), presented in a transaction of the American Geophysical Union, Volume 34, Number 3, June 1953, Pages 407-417.

15. DOWNSTREAM CHANNEL AND LAKE OPERATION.

A series of nine retrogression ranges cover the reach from the U.S. Highway 50 bridge (mile 105.7) to mile 102.75 (See Plate 17). The resurvey of the retrogression ranges showed no significant scouring of the bed downstream. A thalweg profile, including the 1966, 1971, 1976 and 1982 surveys, is shown on Plate 18. Cross-sections of the downstream ranges are shown on Plates 20 through 28. The tailwater rating curve has not changed significantly during the operation of the dam. The original, 1975, and latest curves are shown on Plate 19.

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. Based on the 1982 resurvey, the capacity is almost the same as the initial capacity. Due to the very small change in storage, the existing Water Supply Contract may remain unchanged. In the future, however, decreases in joint-use storage due to sedimentation or filling of the inactive storage may necessitate modifications to the contract.

17. SUMMARY.

The rate of sedimentation computed (2,304 acre-feet per year) is much higher than the initially predicted rate of 746 acre-feet per year which was computed before the operation of the project. This predicted rate was obtained from the suspended sediment and bed load capacity of the Kaskaskia River at the nearest sedimentation station to the dam (Shelbyville, Illinois), and based on information furnished by the U.S. Department of Agriculture, Soil Conservation Service. It was anticipated that the rate of sediment deposited had stabilized as of the 1976 resurvey. However, it seems that the rate of sedimentation has increased to a greater rate than that of the 1971 resurvey. The 1982 resurvey also shows no significant degradation occurring downstream of the dam as a result of lake operation. A summary is shown on ENG Form 1787 (Plate 29).

18. RECOMMENDATION.

Due to the differing results of the 1982 resurvey as compared to the 1971 and 1976 resurveys, it is recommended that the 5- to 10- year resurvey interval be continued, with the next resurvey to be completed by FY 88.

TABLE 1

MONTHLY PRECIPITATION AND RUNOFF
FOR DRAINAGE AREA ABOVE CARLYLE GAGE
(1966-1982)

MONTH	MAXIMUM RAINFALL	MINIMUM RAINFALL	AVERAGE RAINFALL	AVERAGE RUNOFF (Inches)	(Percent)
January	5.04	0.34	2.13	1.08	50.7
February	3.58	0.82	1.87	1.65	88.2
March	7.41	1.07	3.66	2.03	55.5
April	7.73	0.96	3.82	1.70	44.5
May	7.07	1.59	3.97	0.99	24.9
June	8.56	0.48	4.08	0.96	23.5
July	7.47	0.57	4.09	0.61	14.9
August	5.25	0.52	3.14	0.48	15.3
September	6.54	0.43	3.35	0.31	9.3
October	4.71	0.77	2.58	0.43	16.7
November	7.27	0.33	2.94	0.44	15.0
December	8.65	0.42	3.23	1.17	36.2

TABLE 2

ANNUAL PRECIPITATION AND RUNOFF
FOR DRAINAGE AREA ABOVE CARLYLE GAGE
(1966-1982)

YEAR	RAINFALL (Inches)	RUNOFF (Inches)	RUNOFF (Percent)	AVERAGE DAILY RUNOFF (cfs)
1966	31.78	14.9	46.7	2942.3
1967	45.81	14.0	30.6	2771.5
1968	34.73	9.0	25.9	1776.8
1969	44.01	12.6	28.6	2482.1
1970	37.98	10.4	27.4	2052.3
1971	35.88	5.8	16.2	1137.7
1972	39.13	9.6	24.5	1898.5
1973	47.92	19.4	40.5	3840.9
1974	44.17	21.3	48.2	4211.0
1975	42.25	14.3	33.8	2829.6
1976	25.65	4.1	16.0	805.1
1977	42.15	7.4	17.6	1456.9
1978	36.38	12.3	33.8	2429.8
1979	40.86	16.2	39.6	3191.9
1980	30.62	5.5	18.0	1081.5
1981	38.44	7.3	19.0	1446.3
1982	46.67	13.6	29.1	2675.2
MAXIMUM	47.92	21.3	48.2	4211.0
MINIMUM	25.65	4.1	16.0	805.1
AVERAGE	39.08	11.6	29.1	2295.8

TABLE 3

TABULATION OF AREA AND CAPACITY
FOR CARLYLE LAKE
(1966 and 1971)

ELEVATION	1966 AREA (Acres)	1971 AREA (Acres)	1966 CAPACITY (Acre - Feet)	1971 CAPACITY (Acre - Feet) *
415	1,146	1,120	5,156	5,041
420	2,181	2,066	13,088	12,608
425	3,851	3,513	27,762	26,138
430	7,109	6,200	53,739	49,206
435	12,115	11,288	101,133	96,097
440	17,990	17,127	175,297	166,424
445	24,583	24,174	280,595	268,644
450	32,397	32,397	421,388	408,657
455	41,548	41,548	605,212	592,481
460	52,398	52,398	837,421	824,690
462.5**	58,447	58,447	974,645	961,914
465	65,113	65,113	1,127,534	1,114,803
470	84,360	84,360	1,489,630	1,476,899

*NOTE: Based on prismoidal method.

** Top of Flood Control Pool.

TABLE 4

TABULATION OF AREA AND CAPACITY
FOR CARLYLE LAKE
(1976)

ELEVATION	1976 AREA (Acres)	1976 CAPACITY (Acre - Feet) *
415	1,120	5,040
420	2,061	12,595
425	3,507	26,097
430	6,164	49,066
435	11,198	95,211
440	16,939	165,227
445	23,852	267,140
450	32,367	406,281
455	41,548	589,220
460	52,398	821,429
462.5**	58,447	958,653
465	65,113	1,111,542
470	84,360	1,473,638

* Based on prismoidal method.

** Top of Flood Control Pool.

NOTE: For original areas & capacities see TABLE 3.

TABLE 5

TABULATION OF AREA AND CAPACITY
FOR CARLYLE LAKE
(1982)

ELEVATION	1982 AREA (Acres)	1982 CAPACITY (Acre - Feet) *
415	0	0
420	639	3,896
425	2,325	17,202
430	2,592	20,478
435	4,579	38,921
440	14,521	140,859
445	22,103	247,558
450	30,687	386,654
455	41,536	570,413
460	52,398	802,557
462.5**	58,440	939,398
465	65,113	1,092,638
470	84,360	1,454,734

* Based on prismoidal method.

** Top of Flood Control Pool.

NOTE: For original areas & capacities see TABLE 3.

TABLE 6

RANGE DATA - CARLYLE LAKE

RANGE	WATER-SURFACE ELEVATION (FEET, NGVD)	DISTANCE BETWEEN RANGES (FEET)	UNILATERAL AREA-A'* (ACRES)	ACTUAL SURFACE AREA-A (ACRES)
DAM-1-A	445.0	5600	-	949.5
1-A - 2-A	445.0	10400	2753.3	3164.8
2-A - 3-A	445.0	9700	3229.9	3133.3
3-A - 4-A	445.0	27700	9831.7	10448.5
4-A - 7-A	462.0	27400	8582.3	9500.3
7-A - 9-A	462.0	27000	8623.5	8871.3
5-B	462.0	21000	1125.3	1699.5
6-B	462.0	24500	870.9	1463.9
8-B	462.0	13500	1006.2	1213.5
9-A - END	462.0	11000	2860.0	3083.6

*Area formed by connecting the points of intersection of the ranges with the crest elevation. Used with prismoidal method.

TABLE 7

CROSS SECTION RANGE DATA - CARLYLE LAKE

	1966-1971		1966-1976		1966-1982	
RANGE	CHANGE IN AREA (Sq. Ft.)	TOP WIDTH (Feet)	CHANGE IN AREA (Sq. Ft.)	TOP WIDTH (Feet)	CHANGE IN AREA (Sq. Ft.)	TOP WIDTH (Feet)
1-A	4546	11750	4044	11786	14221	11867
2-A	4895	12948	5721	12209	20134	12245
3-A	7895	17702	10842	17733	28382	17818
4-A	9749	15822	12609	15924	20894	16272
7-A	226	11300	2716	11300	5073	11037
9-A	2384	8800	71	8800	3351	8889
5-B	456	3390	25	3390	-339	3394
6-B	-415	3180	112	3180	-295	3128
8-B	-562	4110	-574	4120	-1005	4055

NOTE: Widths for 1-A, 2-A, 3-A, & 4-A are for elevation 445.0.
Widths for 7-A, 9-A, 5-B, 6-B & 8-B are for elevation 462.5.

TABLE 8

TABULATION OF COMPUTATION OF SEDIMENT DEPOSITED IN ACRE-FEET

RANGE	1966 - 1971	1966 - 1976	1966 - 1982
DAM - 1-A	351	312	1177
1-A - 2-A	1166	1188	4543
2-A - 3-A	1324	1681	5385
3-A - 4-A	5328	7000	15405
4-A - 7-A	2867	4732	4328
7-A - 9-A	1234	1132	3991
5-B	127	7	-101
6-B	-102	27	-79
8-B	-101	-103	-196
9-A - END	537	16	794
TOTAL	12731	15992	35247

NOTE: Computation by prismoidal method.

TABLE 9

TABULATION OF RANGE AREA AND VOLUME CHANGES
IN CARLYLE LAKE
(1966-1971)

RANGE CROSS SECTION	AREA CHANGE (Square Feet)	VOLUME SEDIMENT DEPOSITED * (Acre - Feet)
DAM	--	351
1-A	4546	1166
2-A	4895	1324
3-A	7895	5328
4-A	9749	2867
7-A	226	1234
9-A	2384	537
TOP OF LAKE		
5-B	456	127
6-B	-415	-102
8-B	-562	-101
TOTAL		12731

*Computed by prismoidal method.

TABLE 10

TABULATION OF RANGE AREA AND VOLUME CHANGES
IN CARLYLE LAKE
(1966-1976)

RANGE CROSS SECTION	AREA CHANGE (Square Feet)	VOLUME SEDIMENT DEPOSITED * (Acre - Feet)
DAM	--	312
1-A	4044	1188
2-A	5721	1681
3-A	10842	7000
4-A	12609	4732
7-A	2716	1132
9-A	71	16
TOP OF LAKE		
5-B	25	7
6-B	112	27
8-B	-574	-103
TOTAL		15992

*Computed by prismoidal method.

TABLE 11

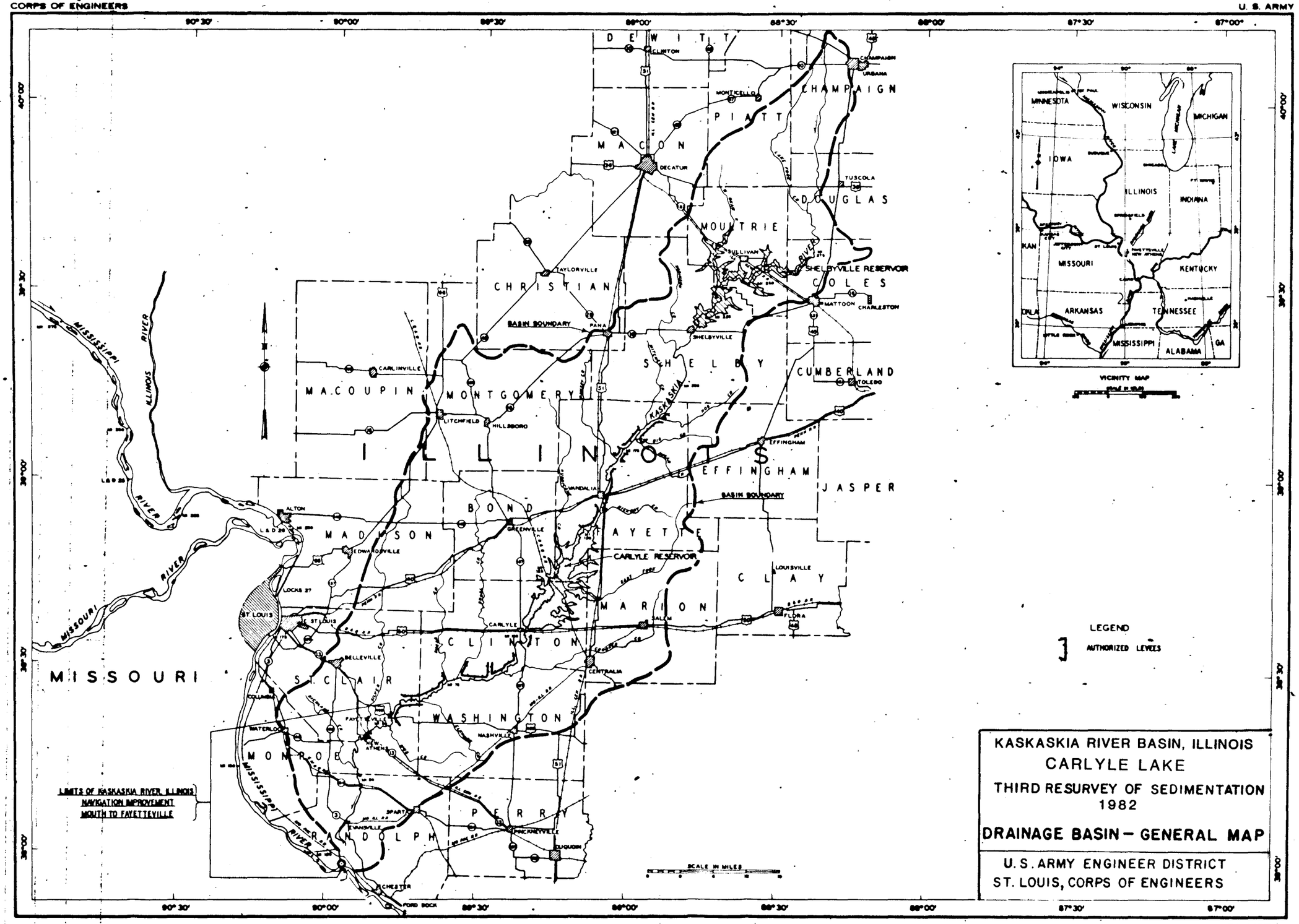
TABULATION OF RANGE AREA AND VOLUME CHANGES
IN CARLYLE LAKE
(1966-1982)

RANGE CROSS SECTION	AREA CHANGE (Square Feet)	VOLUME SEDIMENT DEPOSITED * (Acre - Feet)
DAM	--	1177
1-A	14221	4543
2-A	20134	5385
3-A	28382	15405
4-A	20894	4328
7-A	5073	3991
9-A	3351	~~-101~~ -194
TOP OF LAKE		
5-B	-339	~~-79~~ -101
6-B	-295	~~-196~~ -79
8-B	-1005	~~794~~ -196
TOTAL		35247

*Computed by prismoidal method.

CORPS OF ENGINEERS

U. S. ARMY

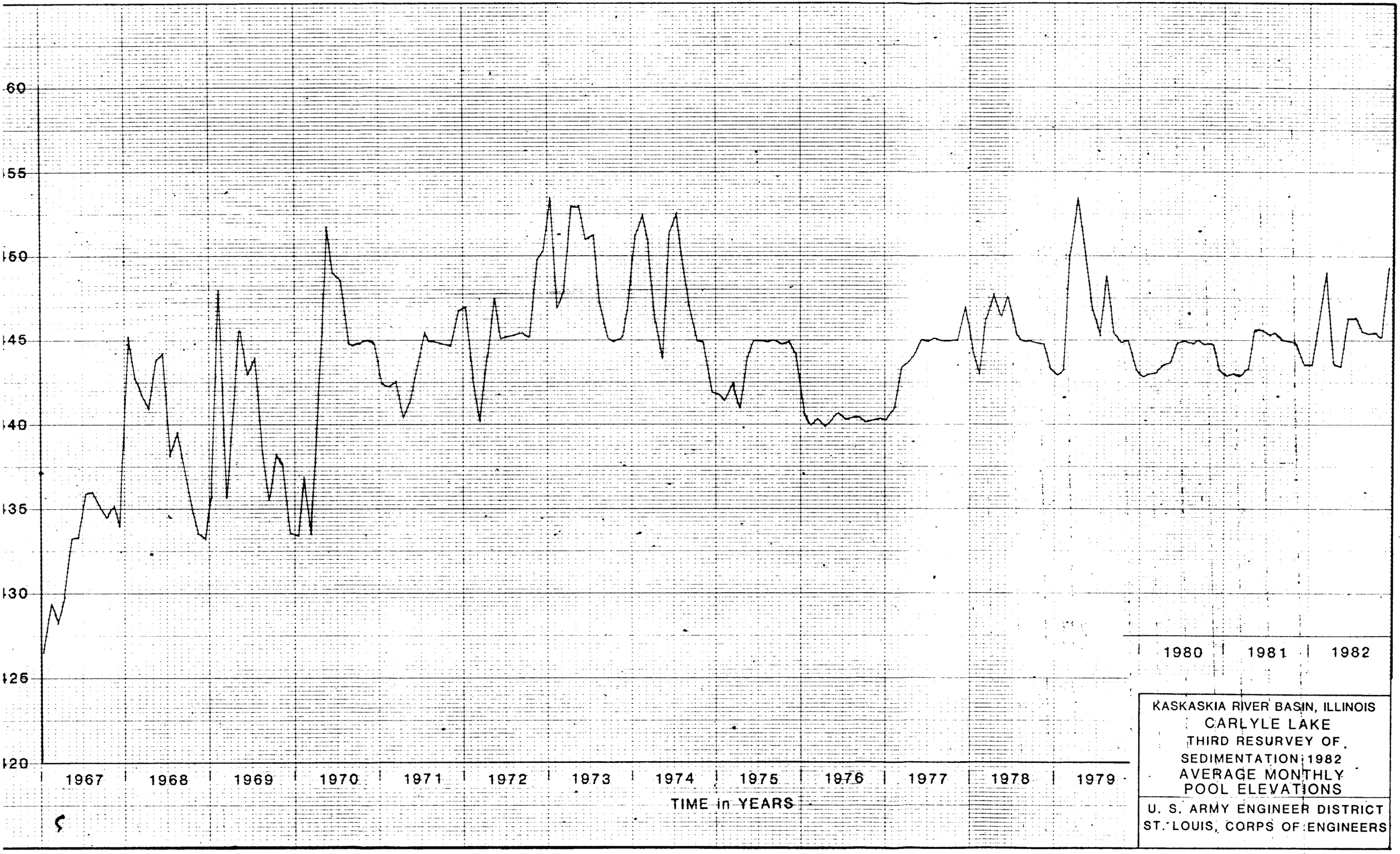


KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
THIRD RESURVEY OF SEDIMENTATION
1982

DRAINAGE BASIN – GENERAL MAP

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

PLATE 1



KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
THIRD RESURVEY OF SEDIMENTATION 1982
AVERAGE MONTHLY POOL ELEVATIONS

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

PLATE 2

PEAK INFLOW 328,254 D S F

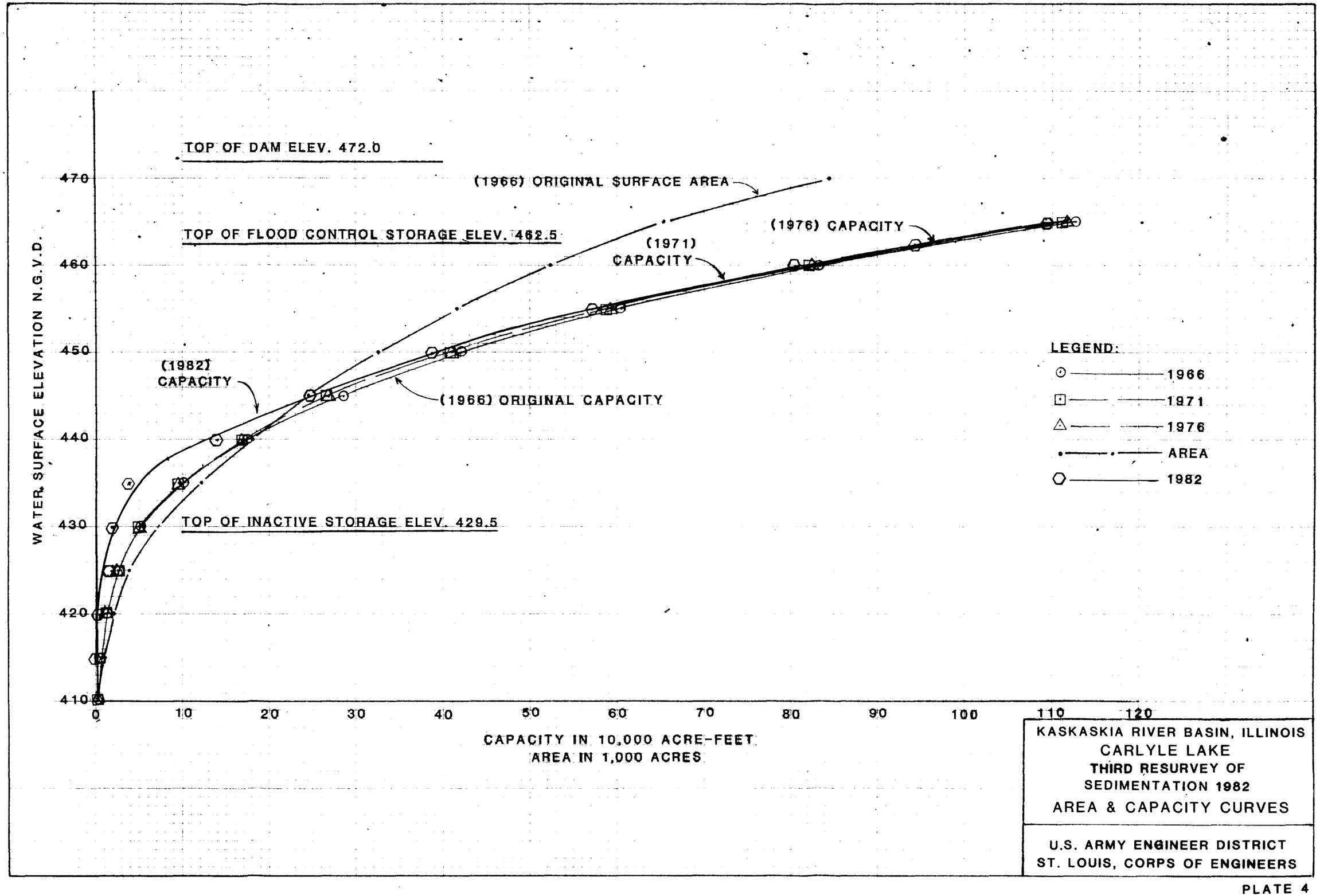
35
30
25
20
15
10
5
0

1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982

TIME In YEARS

KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
THIRD RESURVEY OF
SEDIMENTATION 1982
AVERAGE MONTHLY
INFLOW HYDROGRAPH
U. S. ARMY ENGINEER DISTRICT
ST. LOUIS, CORPS OF ENGINEERS

PLATE 3



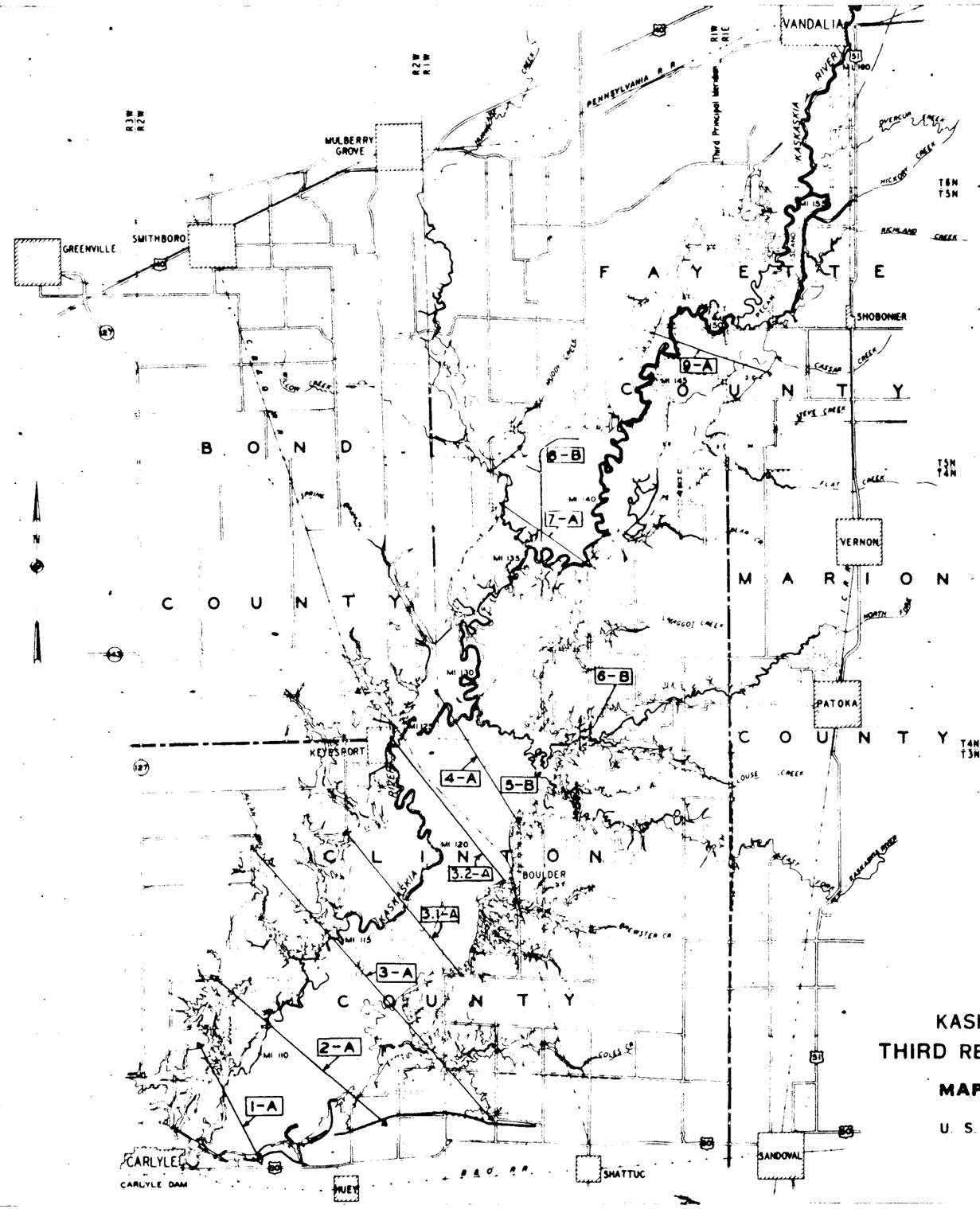
KASKASKIA RIVER BASIN, ILLINOIS
CARLYLE LAKE
THIRD RESURVEY OF
SEDIMENTATION 1982
AREA & CAPACITY CURVES

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

PLATE 4

CORPS OF ENGINEERS

U. S. ARMY



CARLYLE LAKE
KASKASKIA RIVER BASIN, ILLINOIS
THIRD RESURVEY OF SEDIMENTATION 1982
MAP, POOL SEDIMENT RANGES

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

PLATE 5

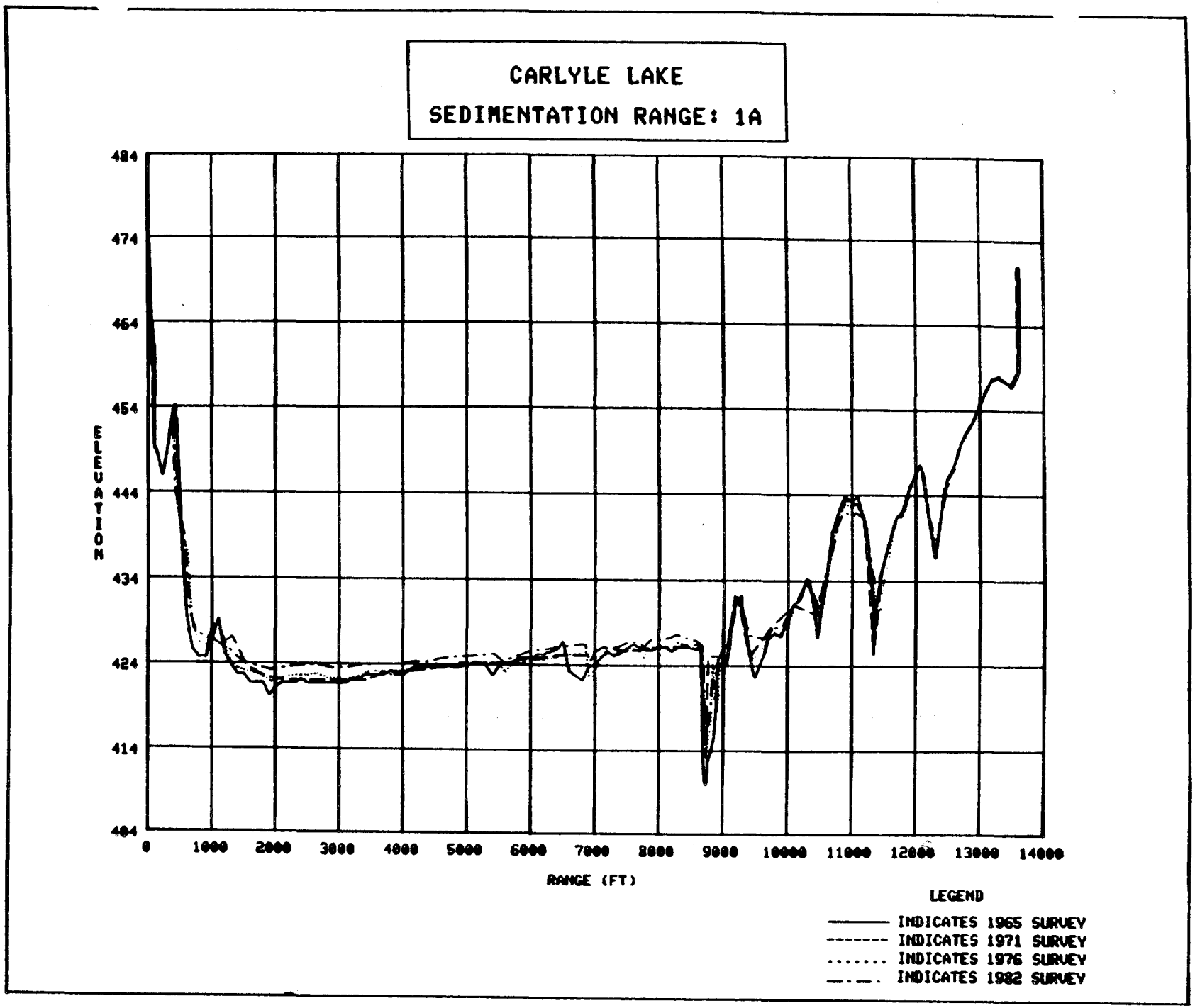

CARLYLE LAKE
SEDIMENTATION RANGE: 1A
ELEVATION
484
474
464
454
444
434
424
414
404
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 6

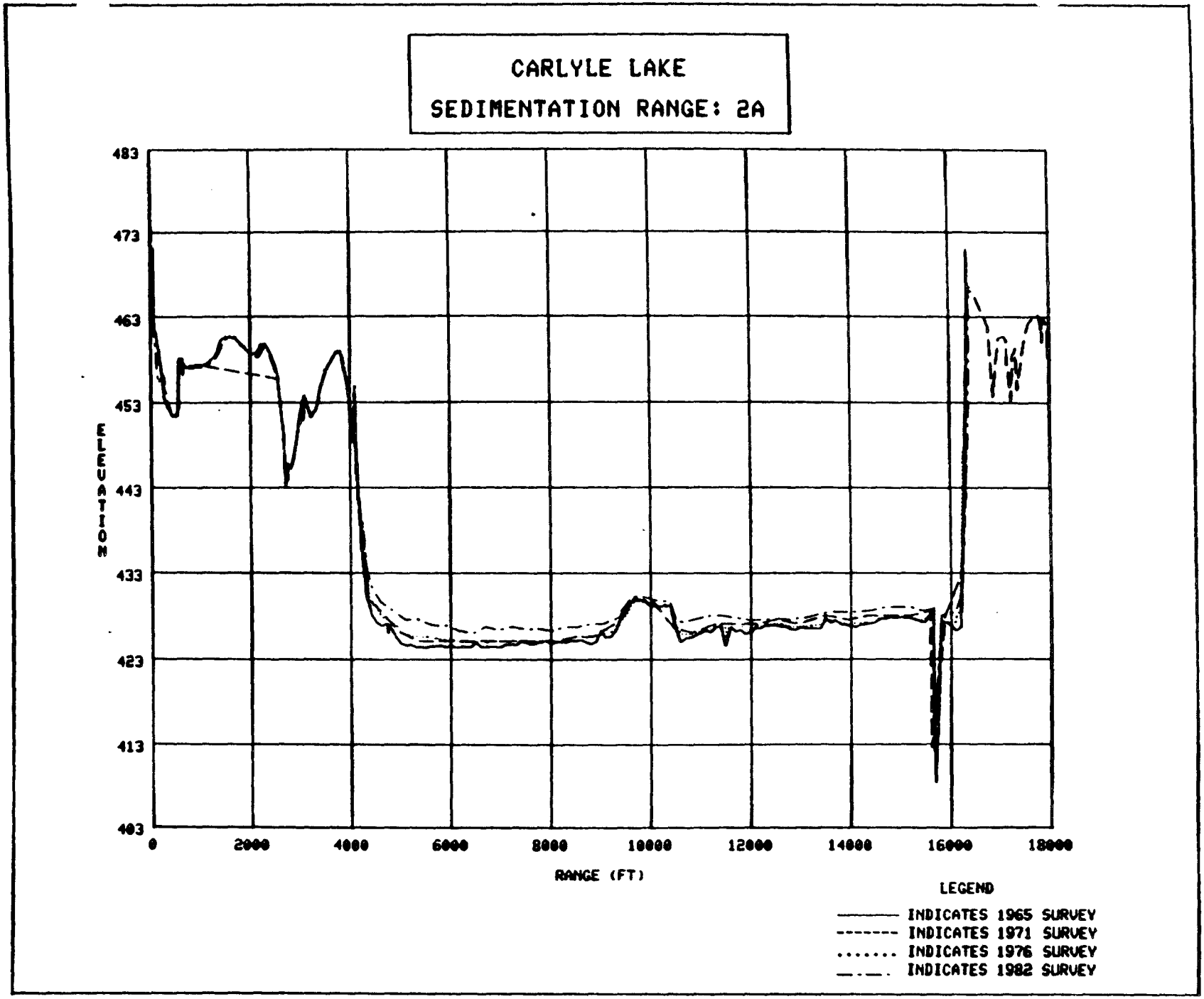

CARLYLE LAKE
SEDIMENTATION RANGE: 2A
483
473
463
453
443
433
423
413
403
ELEVATION
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 7

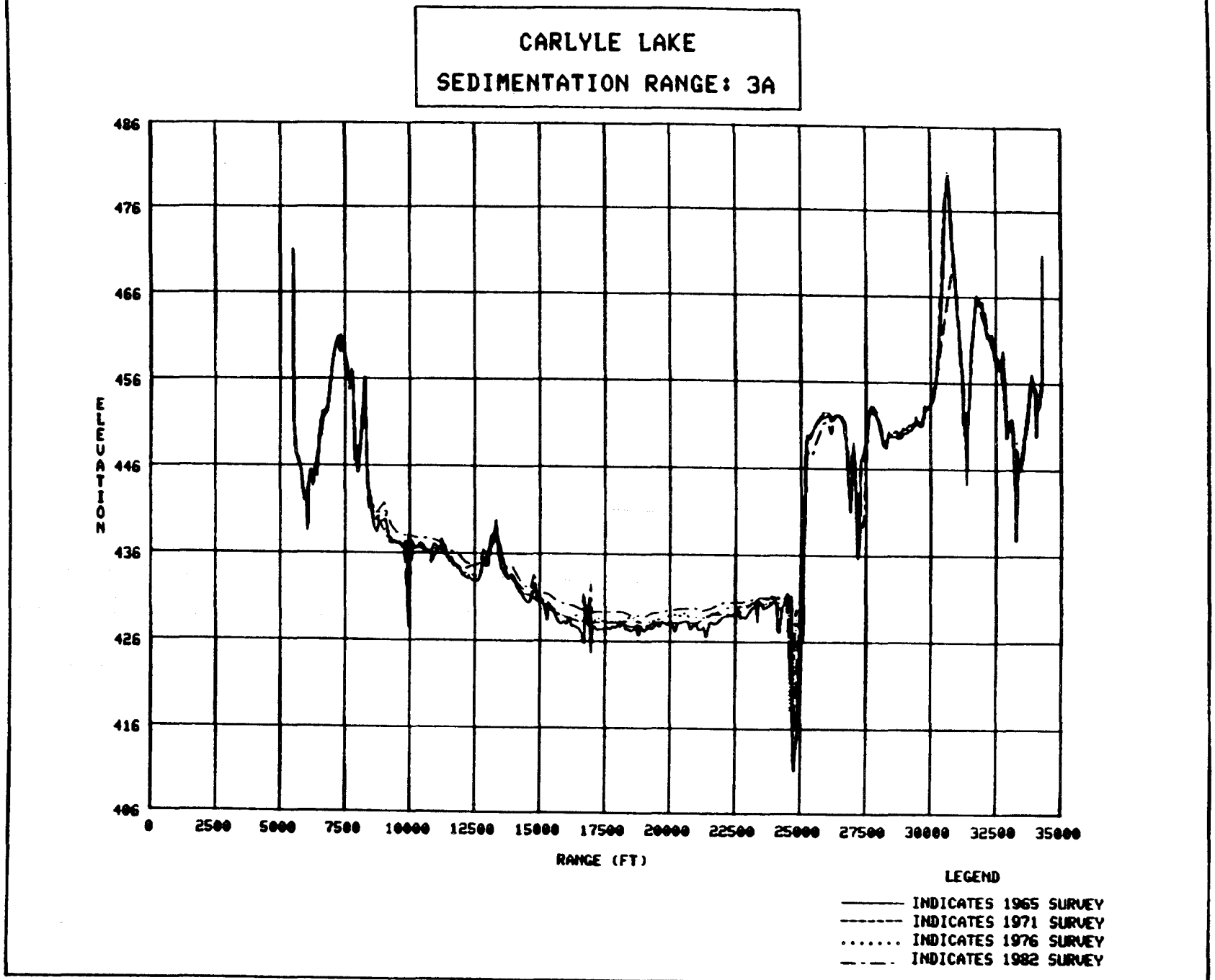

CARLYLE LAKE
SEDIMENTATION RANGE: 3A
ELEVATION
486
476
466
456
446
436
426
416
406
0
2500
5000
7500
10000
12500
15000
17500
20000
22500
25000
27500
30000
32500
35000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 8

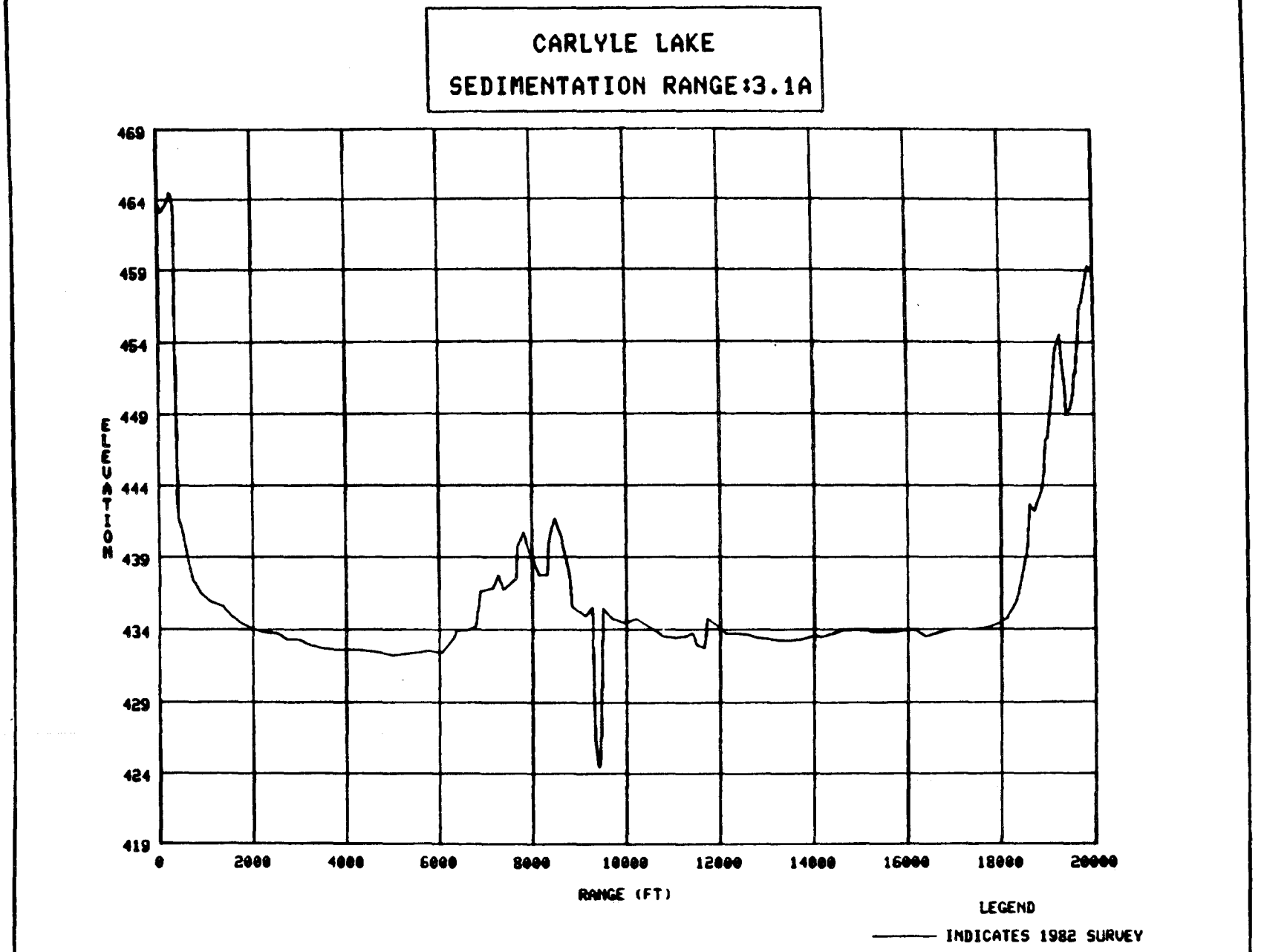

CARLYLE LAKE
SEDIMENTATION RANGE:3.1A
ELEVATION
469
464
459
454
449
444
439
434
429
424
419
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
RANGE (FT)
LEGEND
INDICATES 1982 SURVEY

PLATE 9

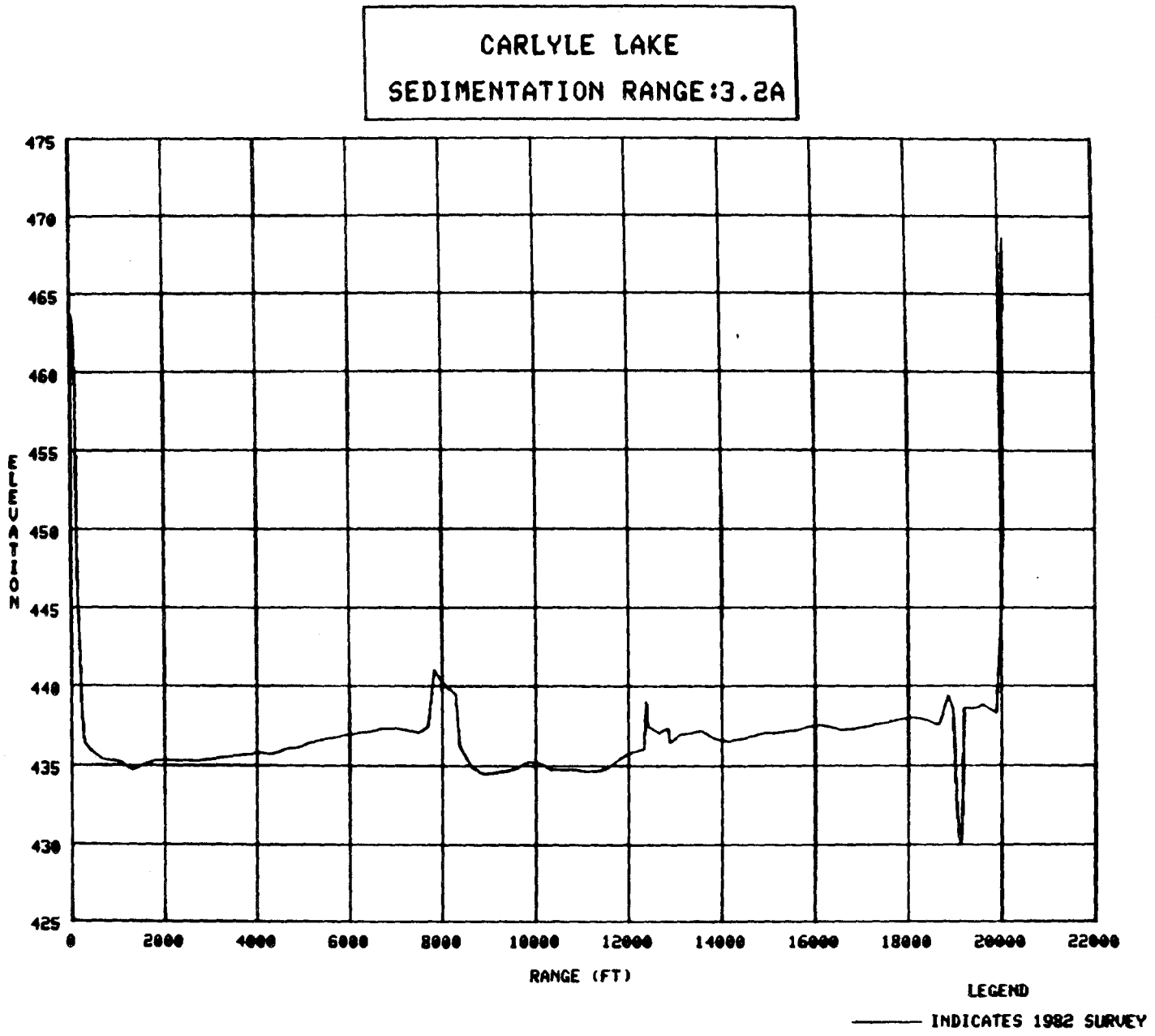

CARLYLE LAKE
SEDIMENTATION RANGE:3.2A
475
470
465
460
455
450
445
440
435
430
425
ELEVATION
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
RANGE (FT)
LEGEND
INDICATES 1982 SURVEY

PLATE 10

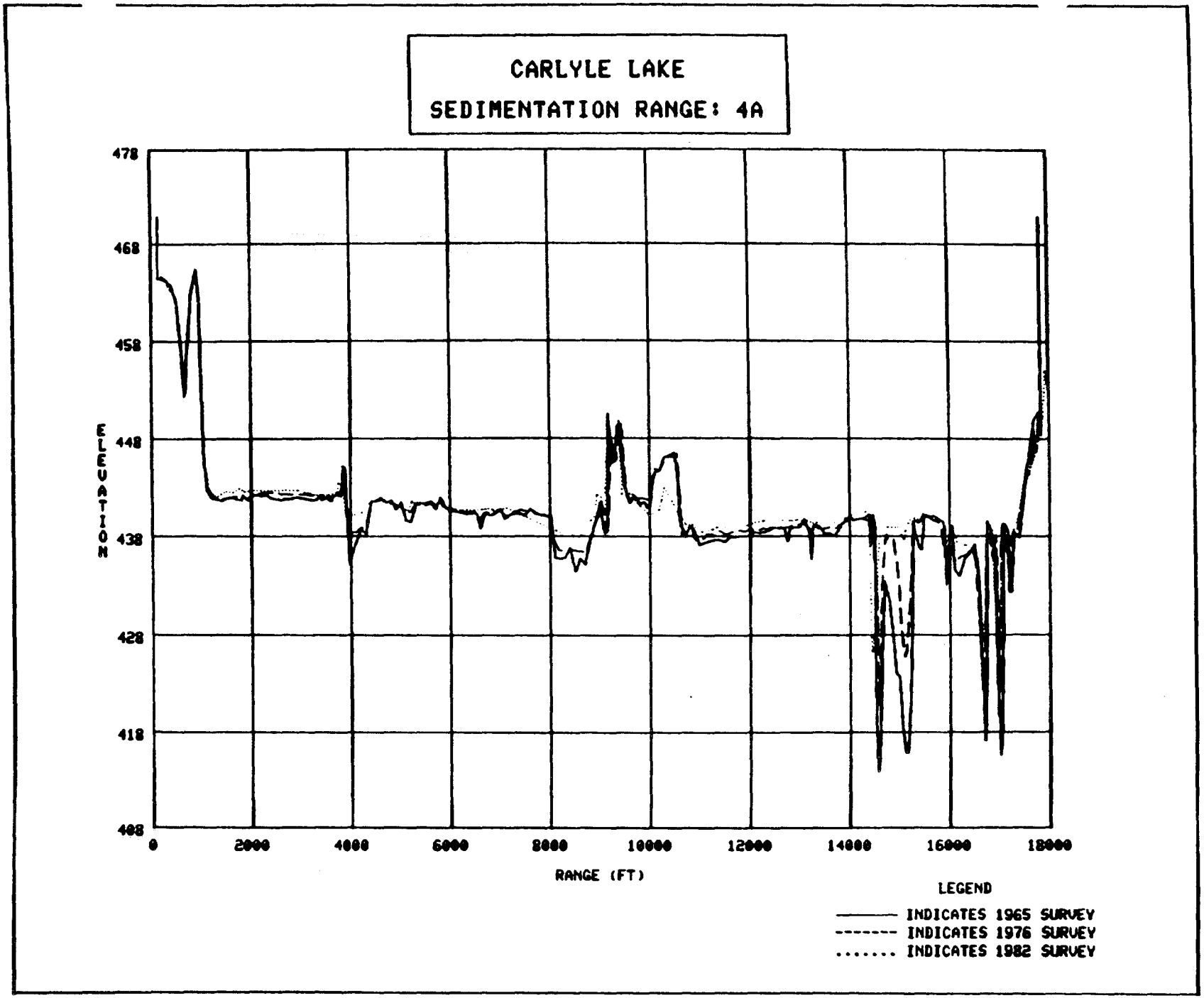

CARLYLE LAKE
SEDIMENTATION RANGE: 4A
ELEVATION
478
468
458
448
438
428
418
408
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 11

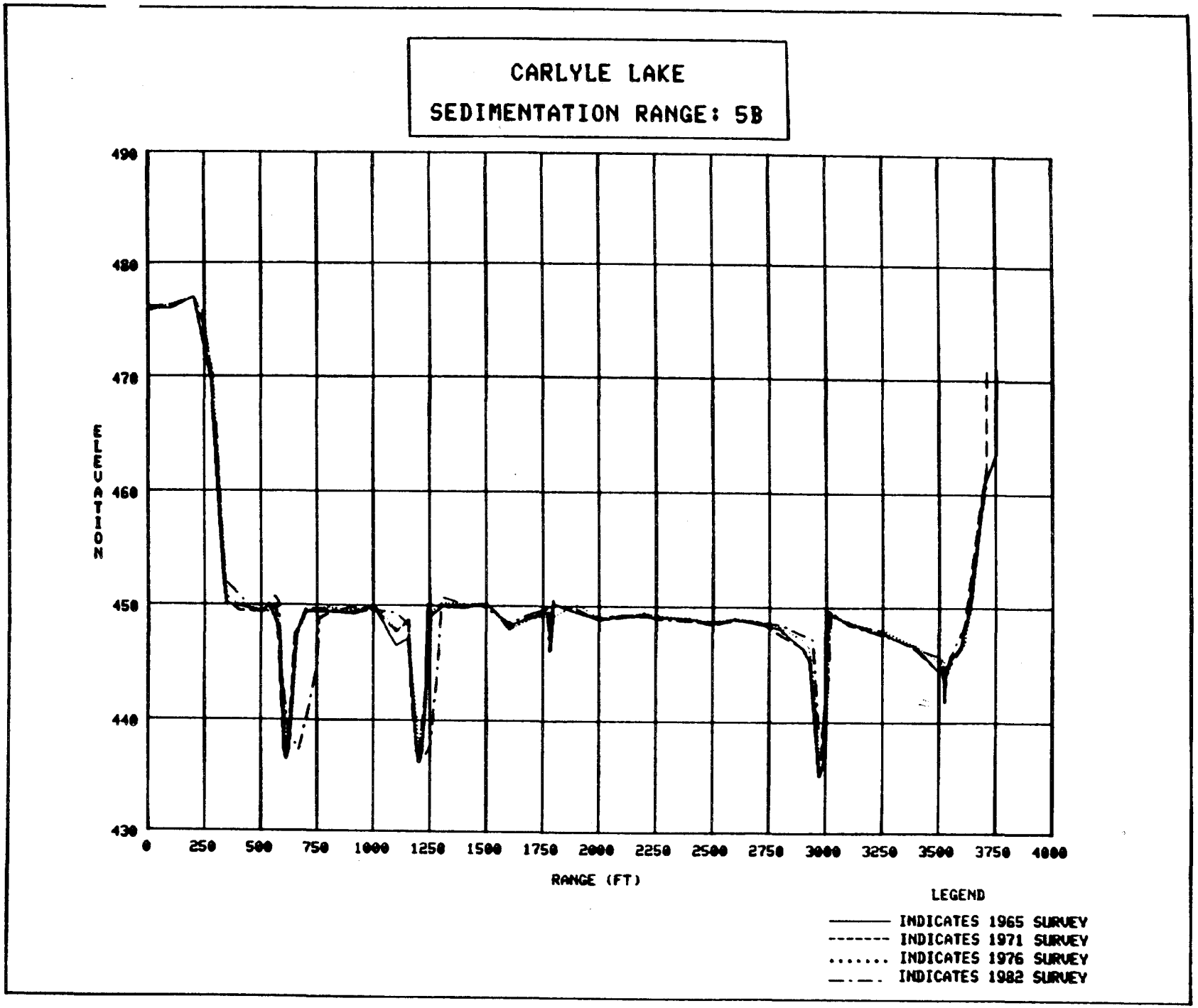

CARLYLE LAKE
SEDIMENTATION RANGE: 5B
ELEVATION
490
480
470
460
450
440
430
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
3500
3750
4000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 12

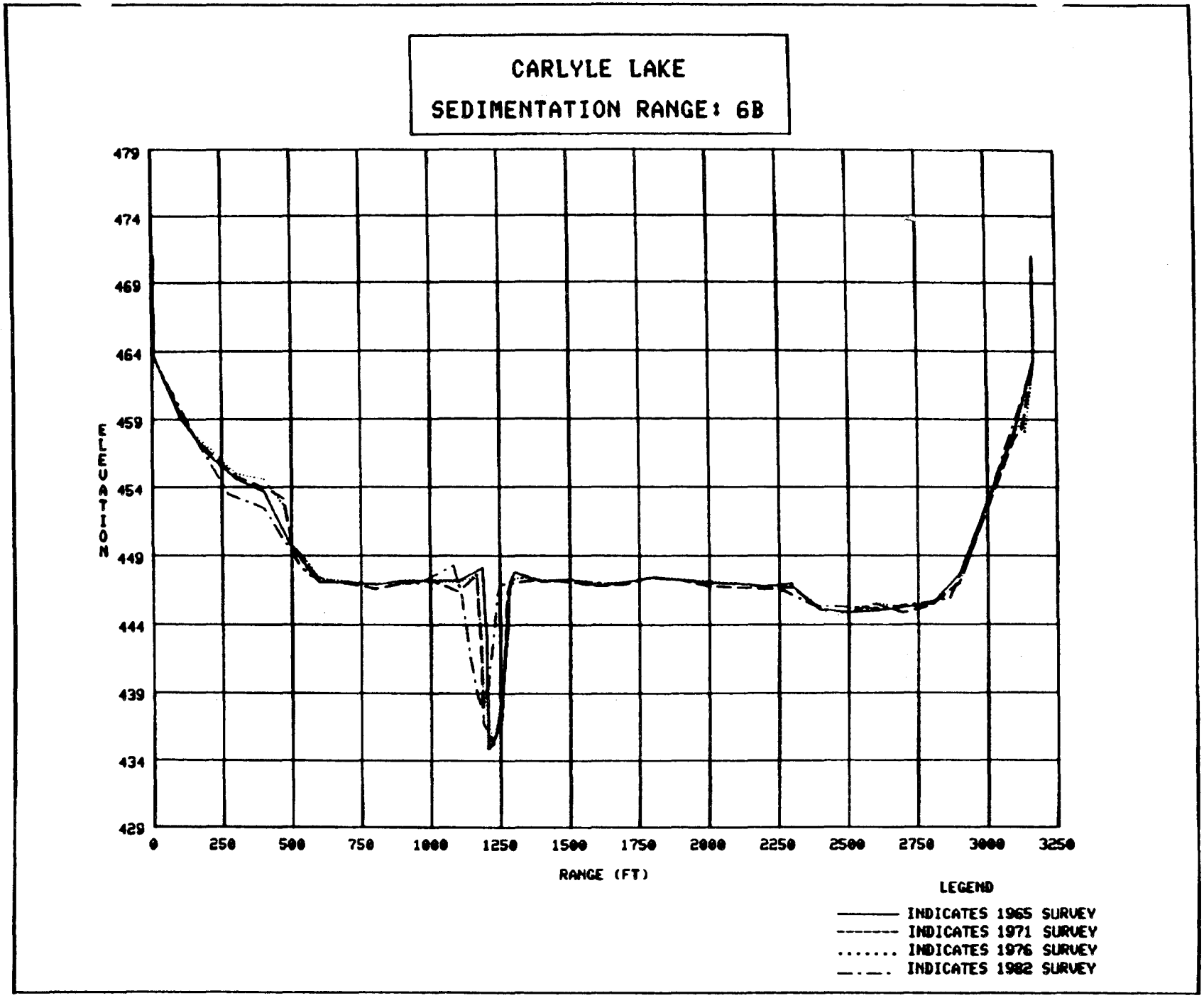

CARLYLE LAKE
SEDIMENTATION RANGE: 6B
ELEVATION
479
474
469
464
459
454
449
444
439
434
429
0
250
500
750
1000
1250
1500
1750
2000
2250
2500
2750
3000
3250
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 13

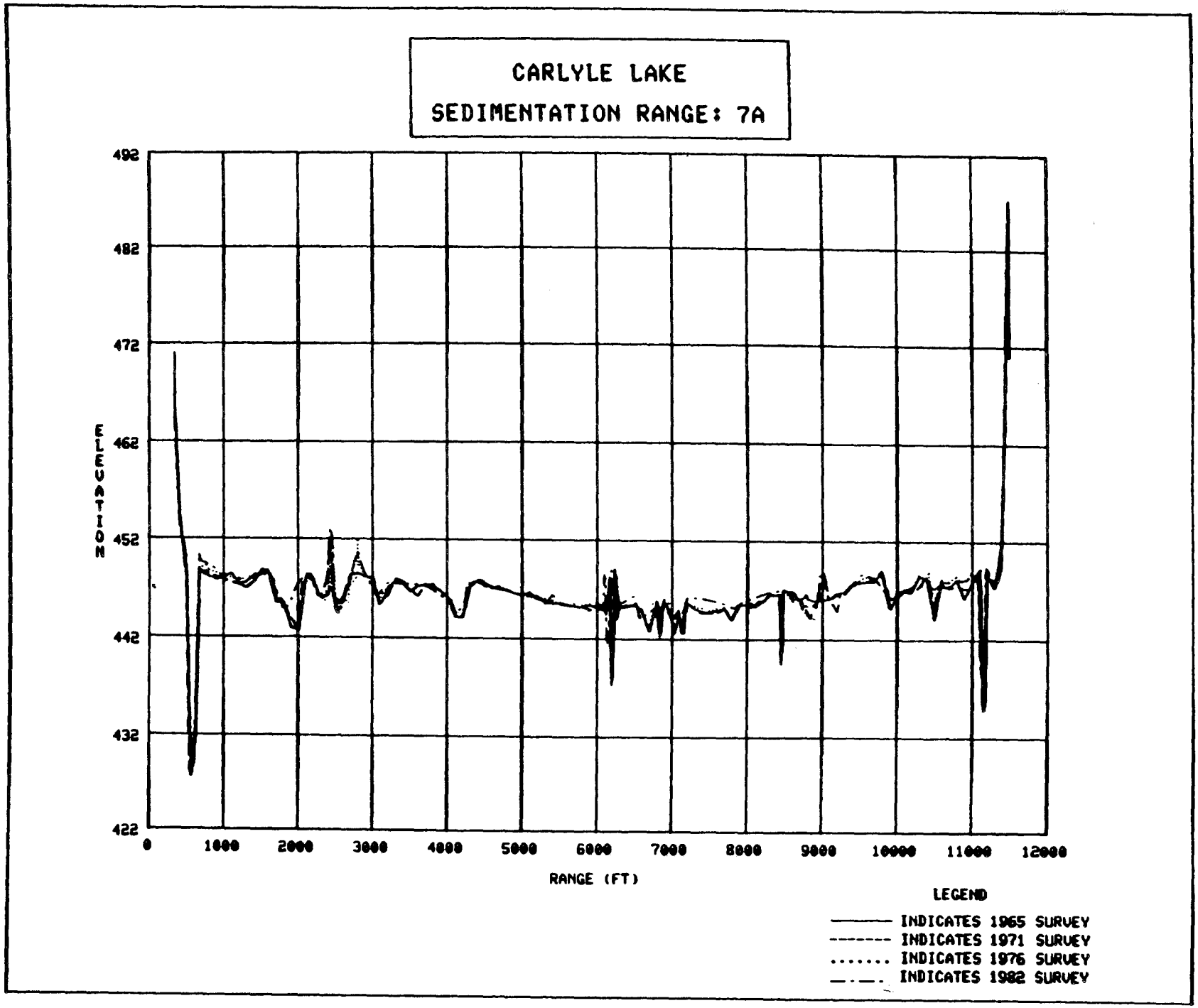

CARLYLE LAKE
SEDIMENTATION RANGE: 7A
492
482
472
462
452
442
432
422
ELEVATION
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 14

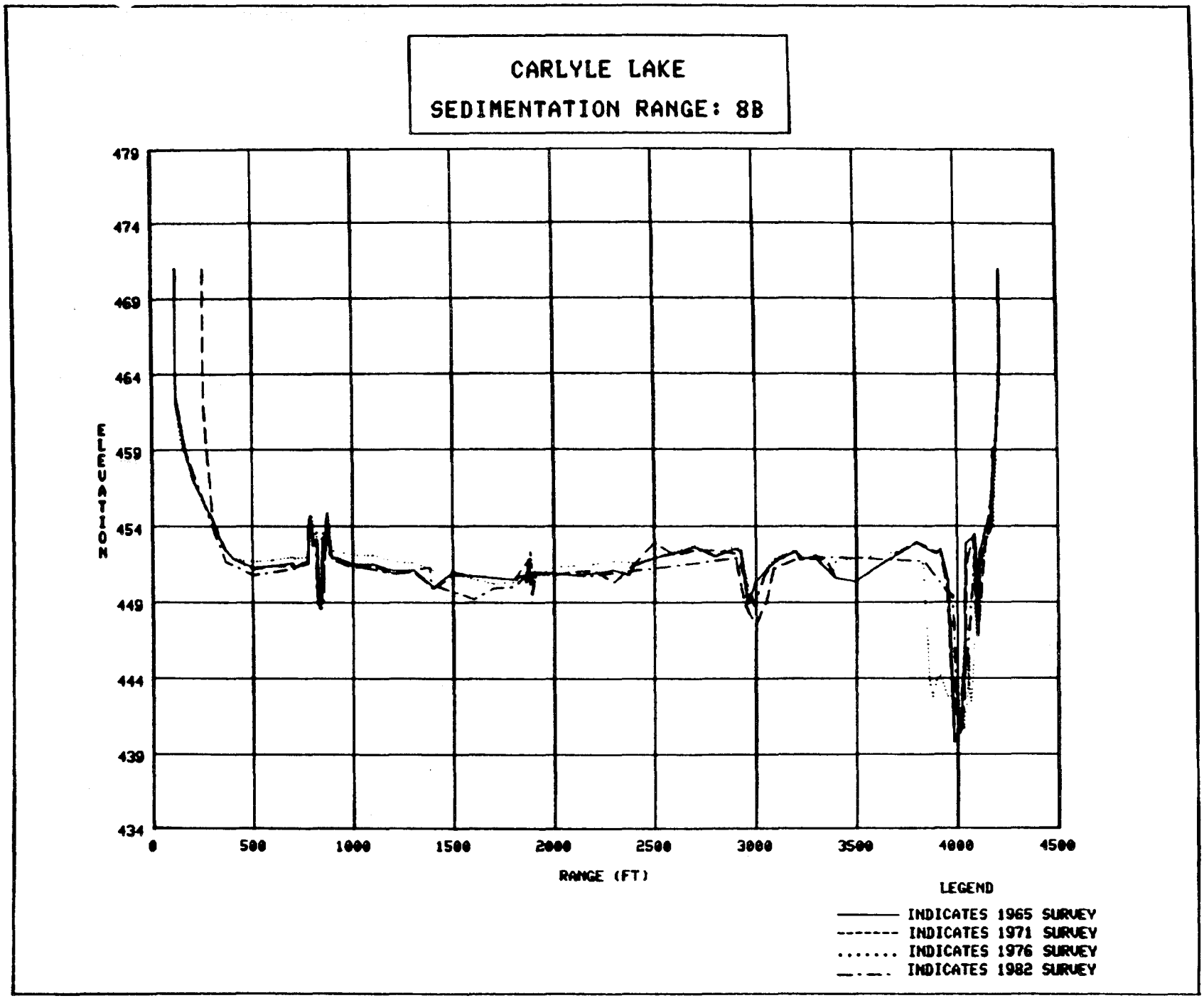

CARLYLE LAKE
SEDIMENTATION RANGE: 8B
ELEVATION
479
474
469
464
459
454
449
444
439
434
0
500
1000
1500
2000
2500
3000
3500
4000
4500
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 15

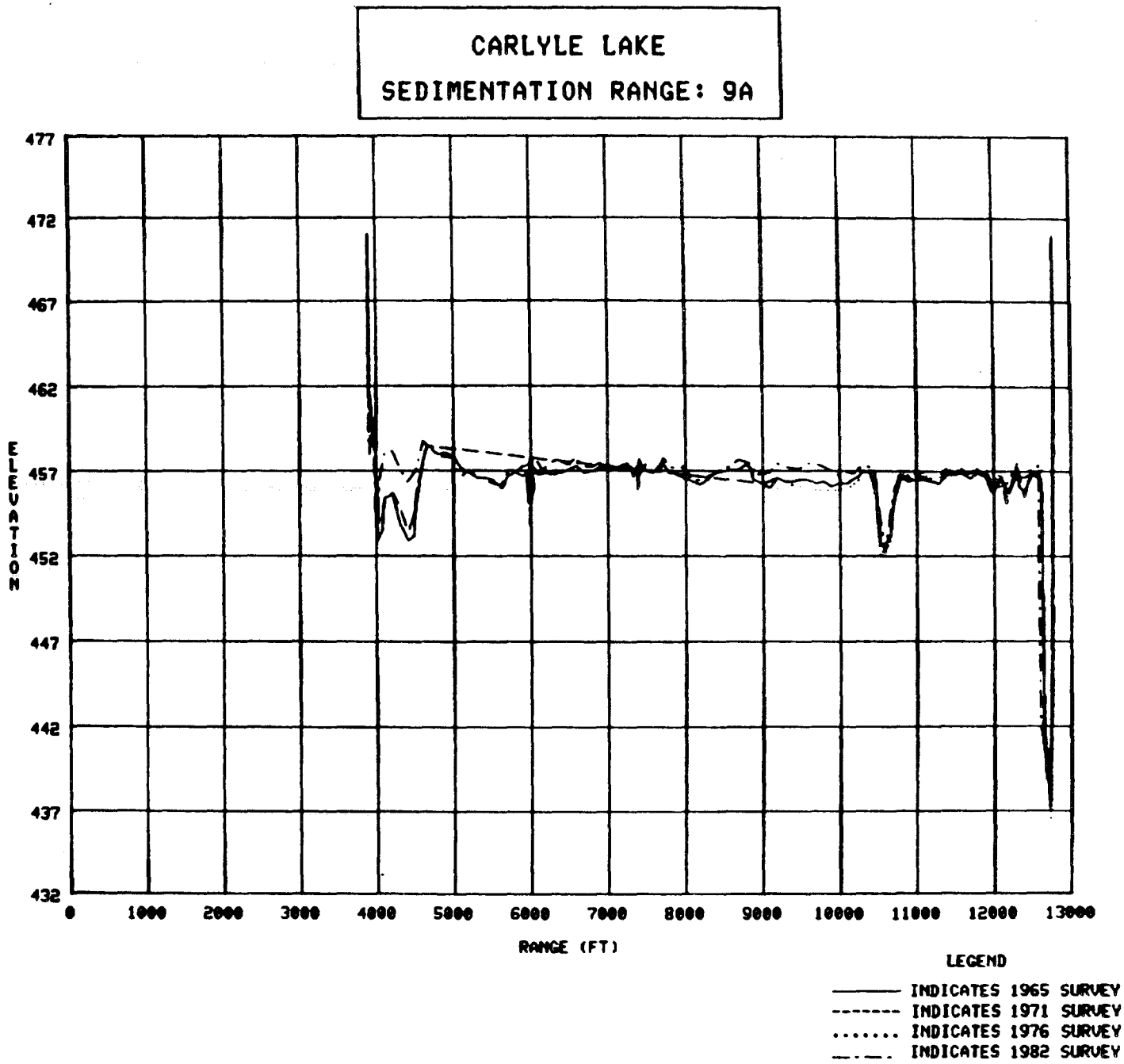
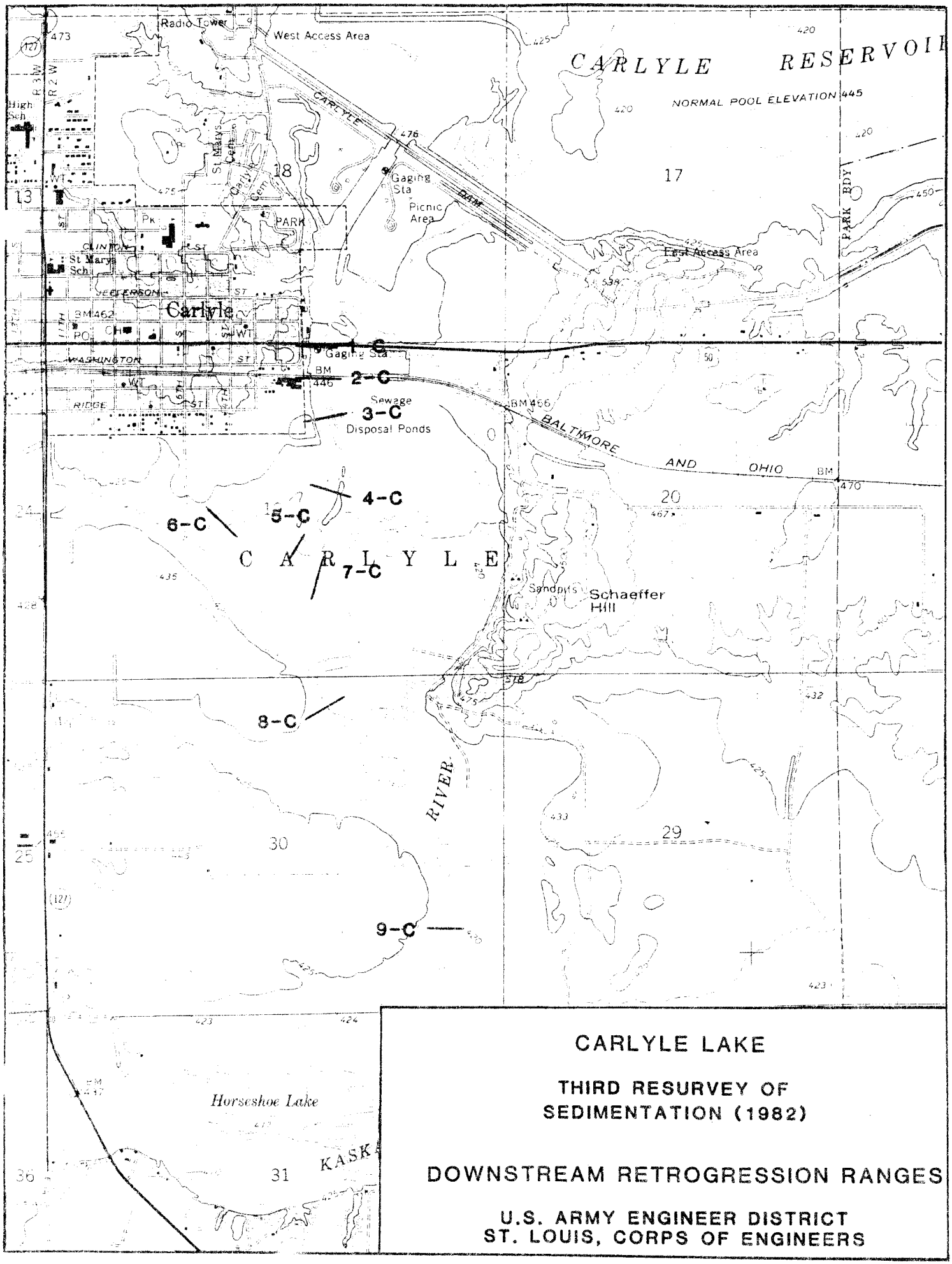

CARLYLE LAKE
SEDIMENTATION RANGE: 9A
ELEVATION
477
472
467
462
457
452
447
442
437
432
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 16



CARLYLE LAKE

THIRD RESURVEY OF SEDIMENTATION (1982)

DOWNSTREAM RETROGRESSION RANGES

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

PLATE 17

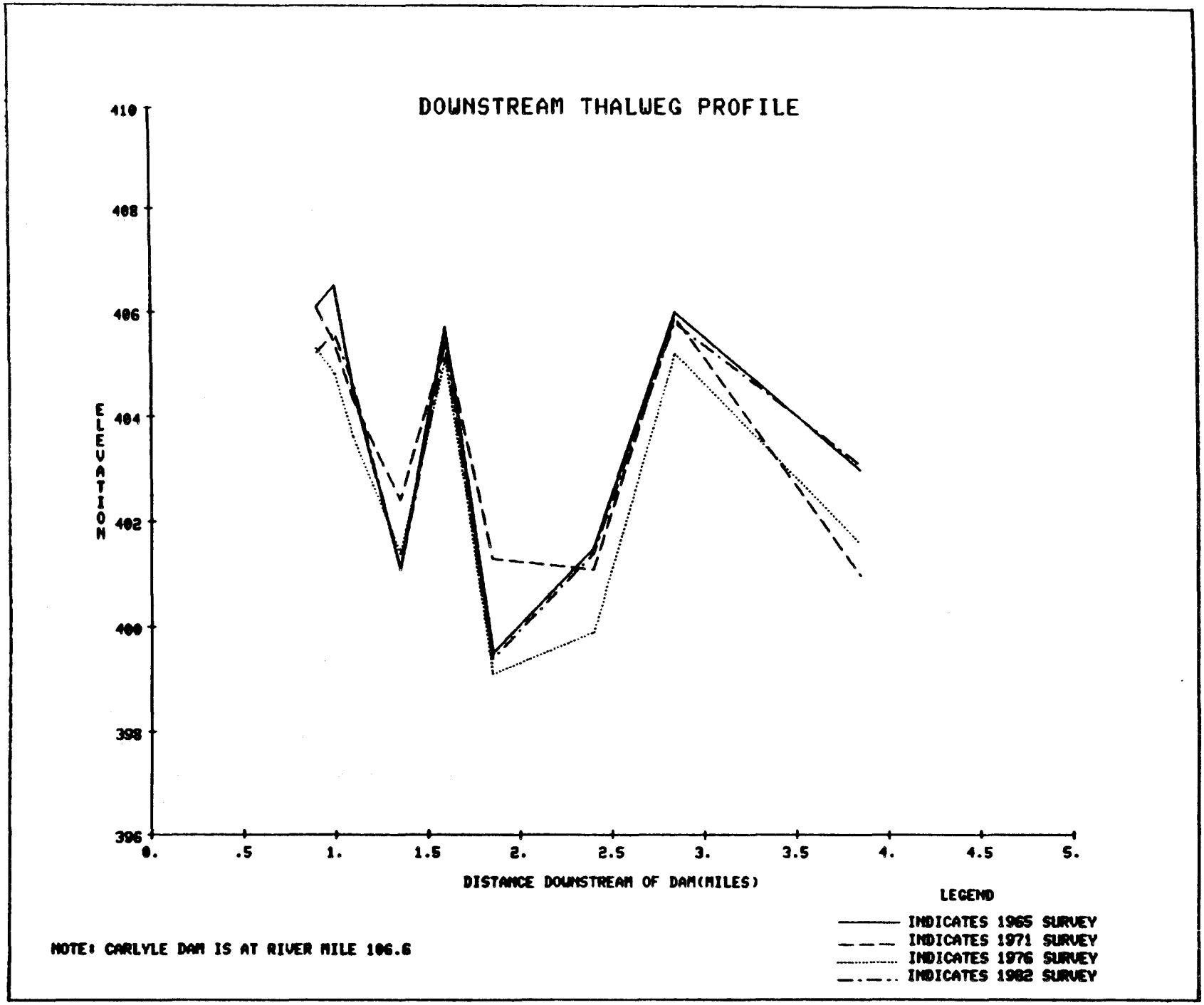

DOWNSTREAM THALWEG PROFILE
410
408
406
404
402
400
398
396
ELEVATION
0.
.5
1.
1.5
2.
2.5
3.
3.5
4.
4.5
5.
DISTANCE DOWNSTREAM OF DAM(MILES)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY
NOTE: CARLYLE DAM IS AT RIVER MILE 106.6

PLATE 18

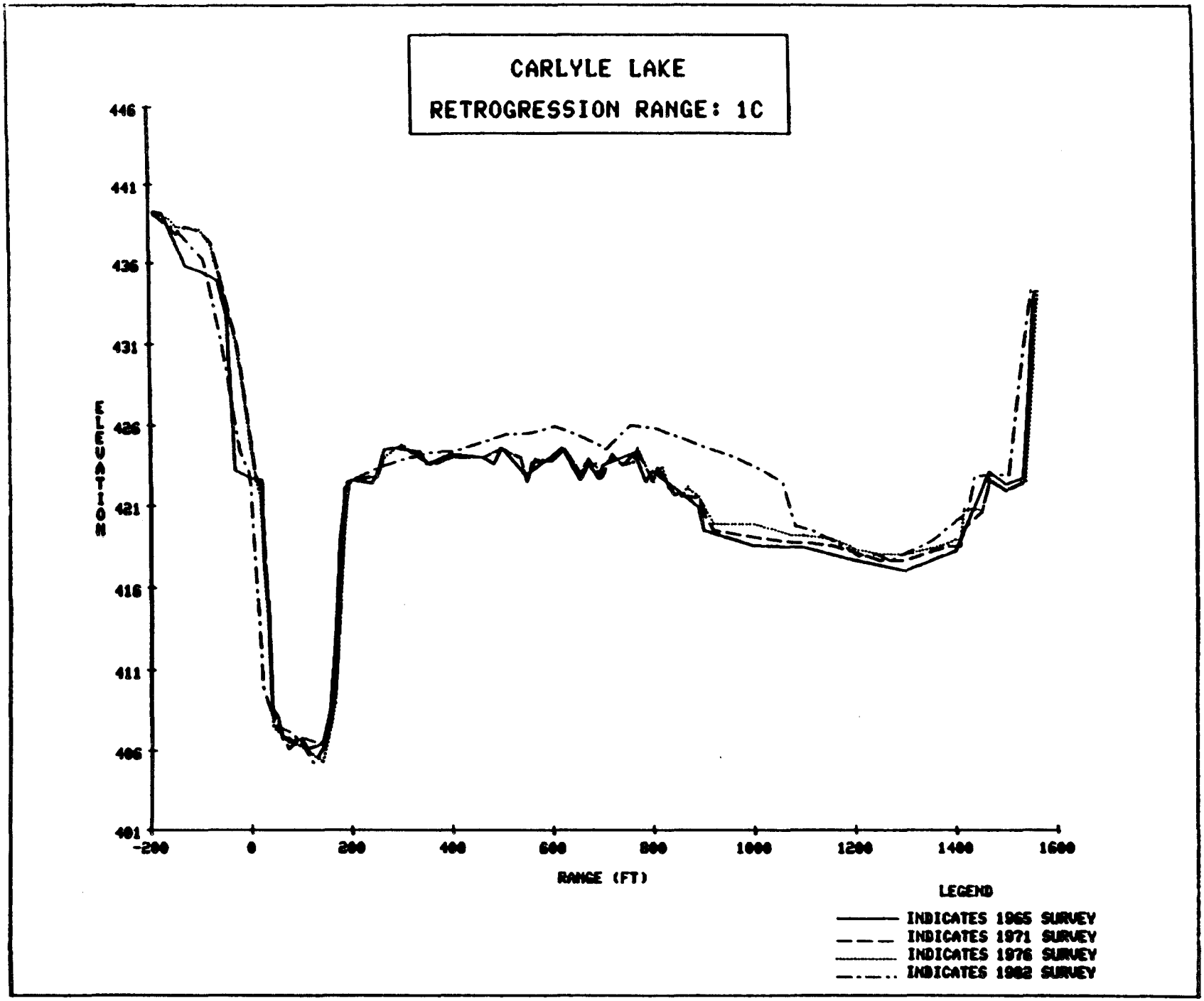

CARLYLE LAKE
RETROGRESSION RANGE: 1C
ELEVATION
446
441
436
431
426
421
416
411
406
401
-200
0
200
400
600
800
1000
1200
1400
1600
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 20

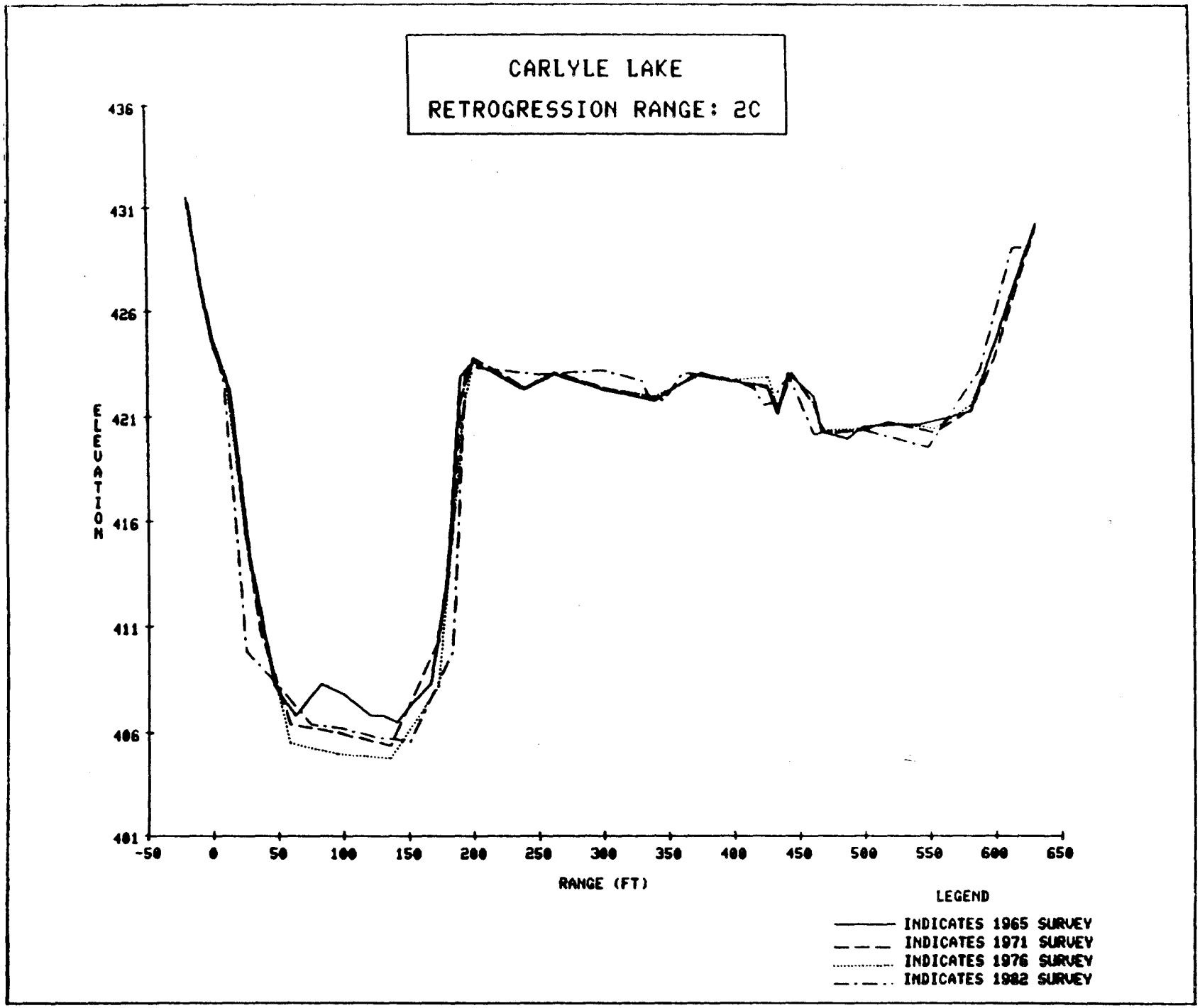

CARLYLE LAKE
RETROGRESSION RANGE: 2C
436
431
426
421
416
411
406
401
ELEVATION
-50
0
50
100
150
200
250
300
350
400
450
500
550
600
650
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 21

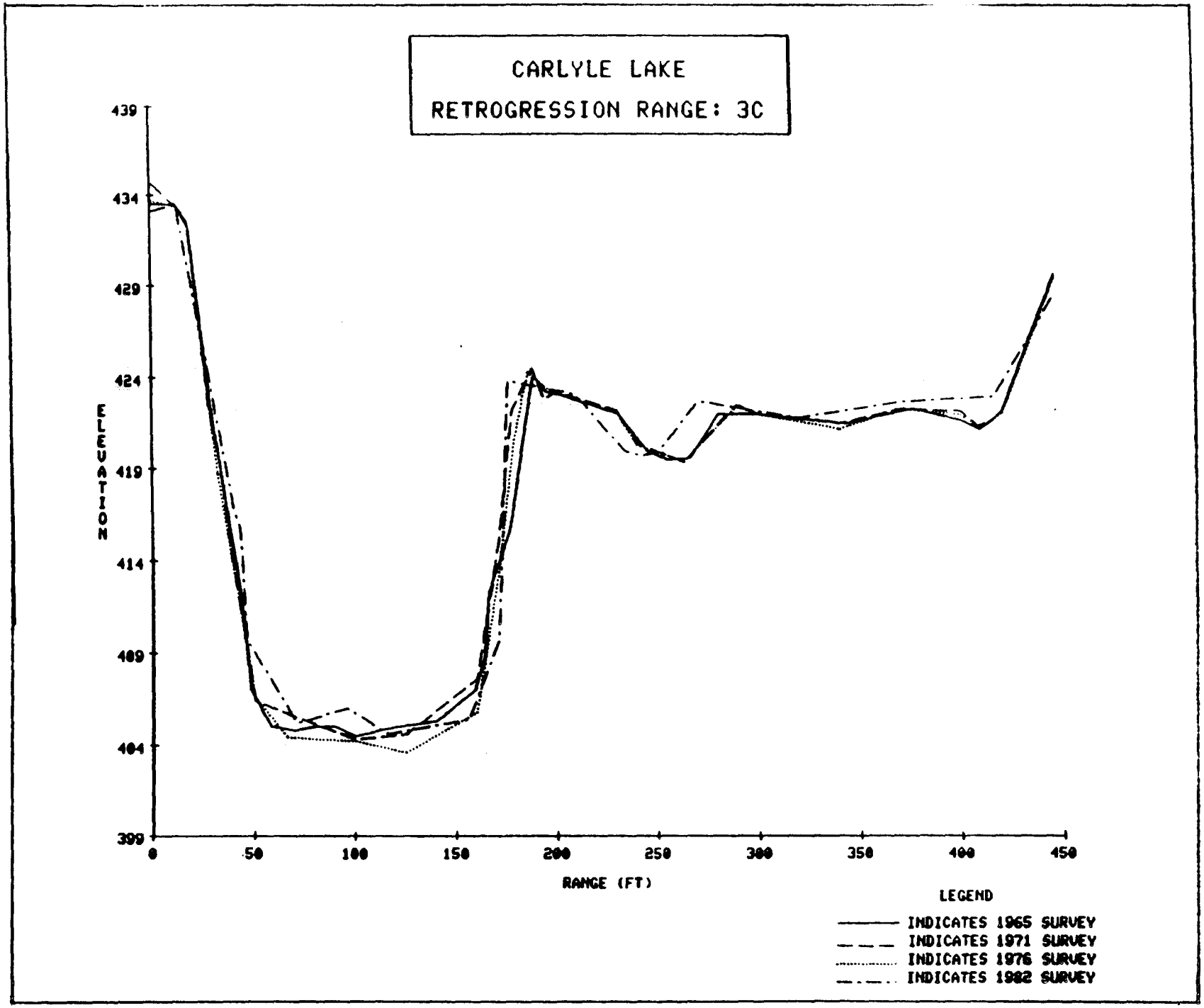

CARLYLE LAKE
RETROGRESSION RANGE: 3C
ELEVATION
439
434
429
424
419
414
409
404
399
0
50
100
150
200
250
300
350
400
450
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 22

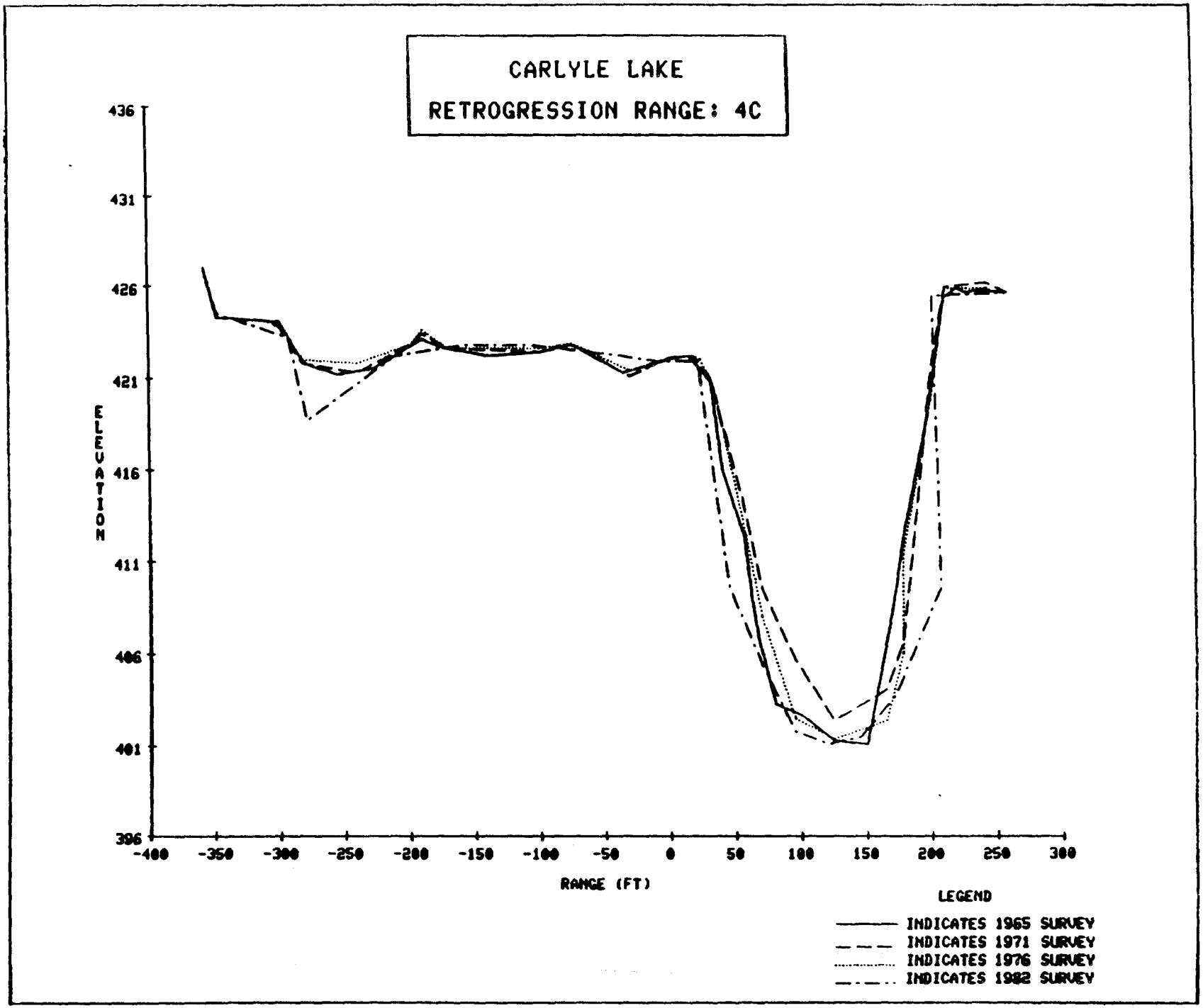
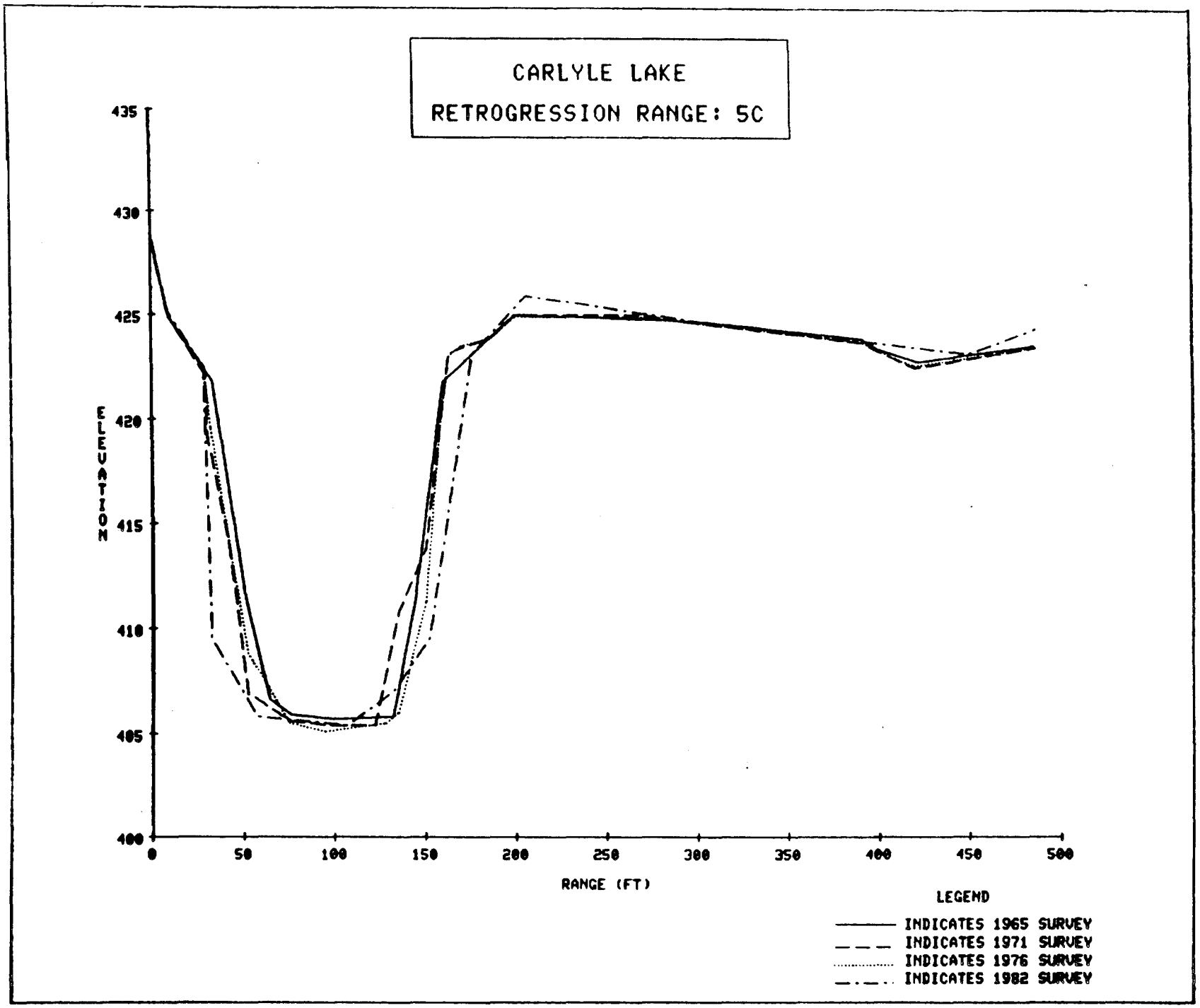

CARLYLE LAKE
RETROGRESSION RANGE: 4C
436
431
426
421
416
411
406
401
396
ELEVATION
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 22


CARLYLE LAKE
RETROGRESSION RANGE: 5C
435
430
425
420
415
410
405
400
ELEVATION
0
50
100
150
200
250
300
350
400
450
500
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

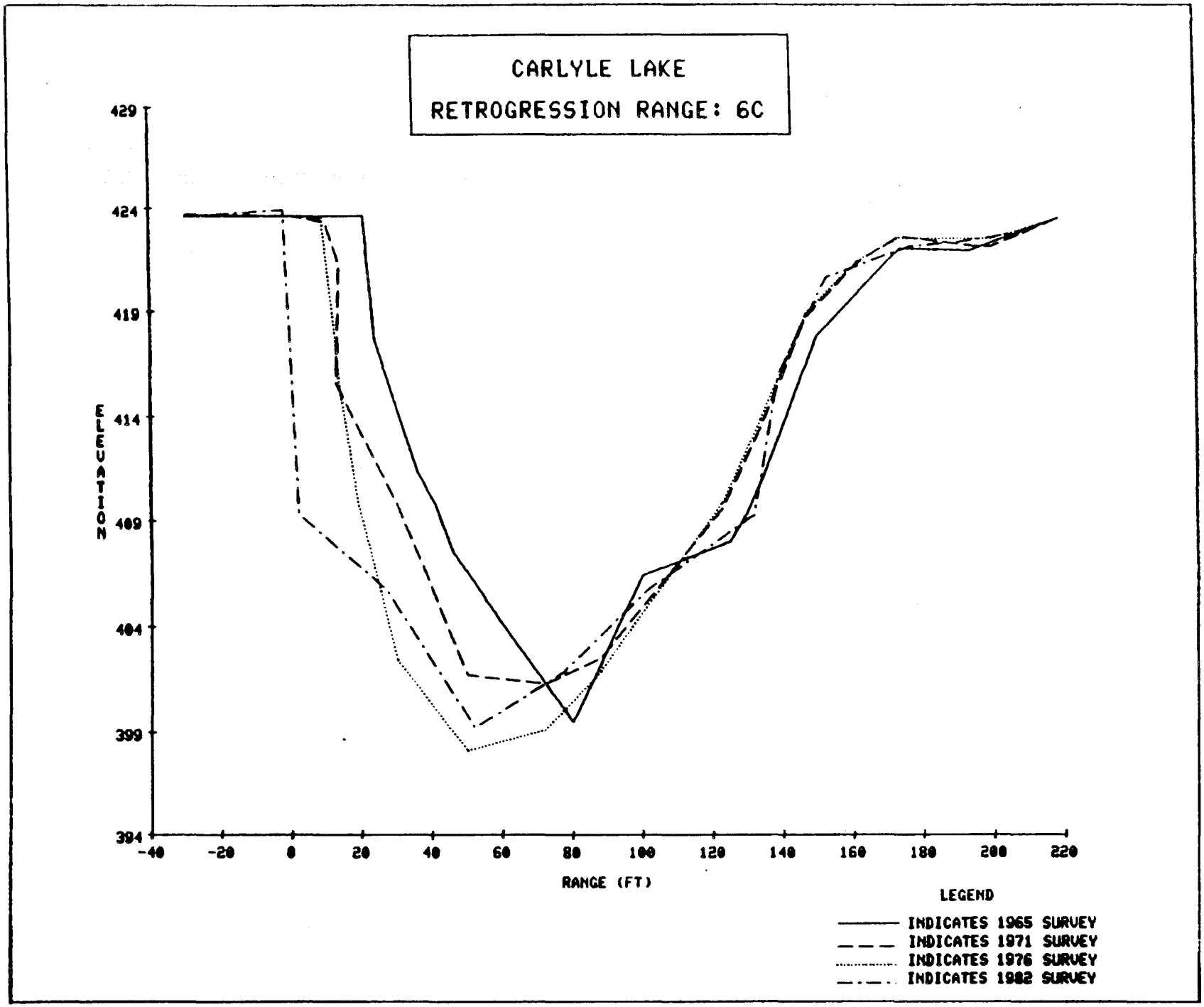

CARLYLE LAKE
RETROGRESSION RANGE: 6C
ELEVATION
429
424
419
414
409
404
399
394
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 25

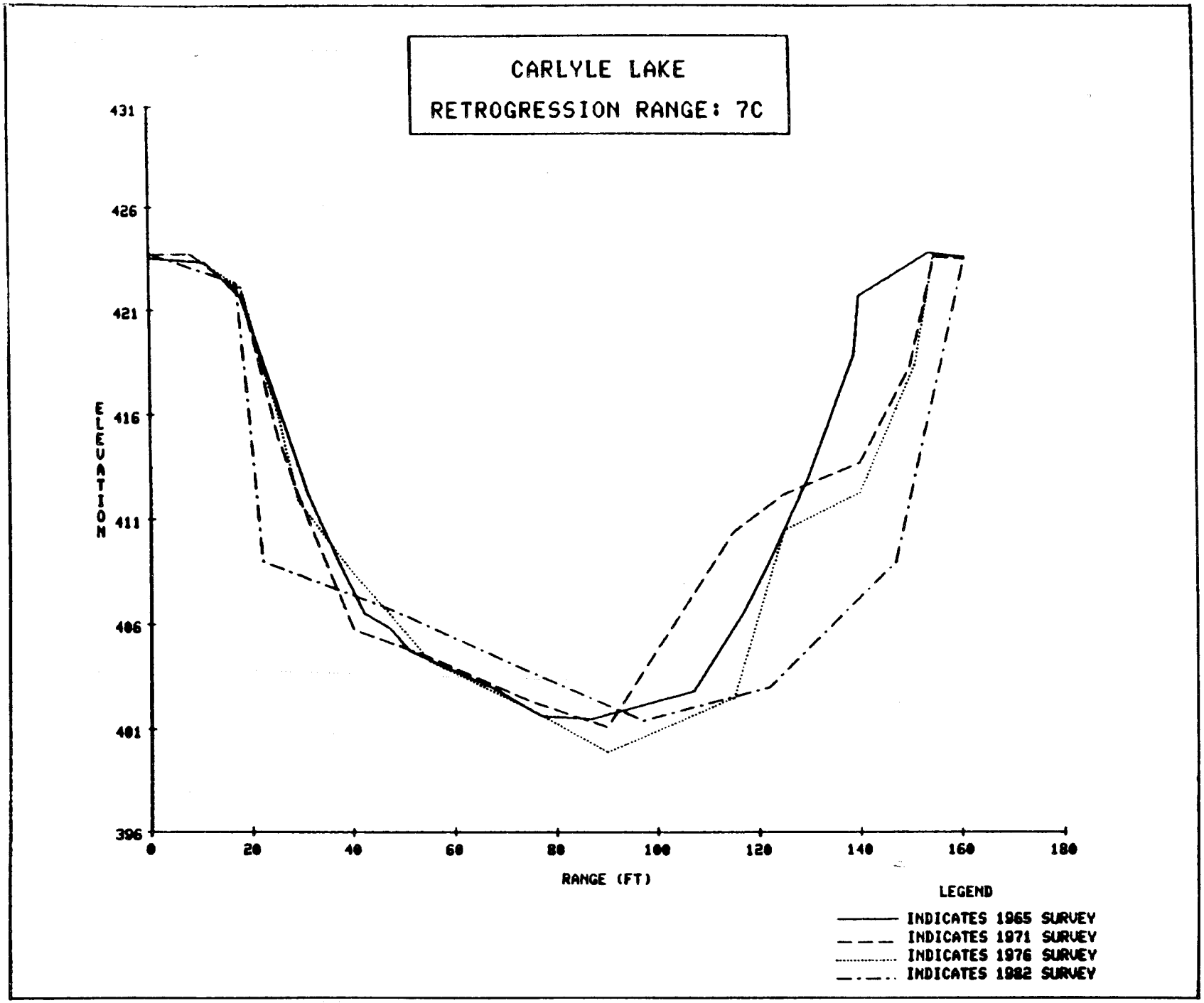

CARLYLE LAKE
RETROGRESSION RANGE: 7C
ELEVATION
431
426
421
416
411
406
401
396
0
20
40
60
80
100
120
140
160
180
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 26

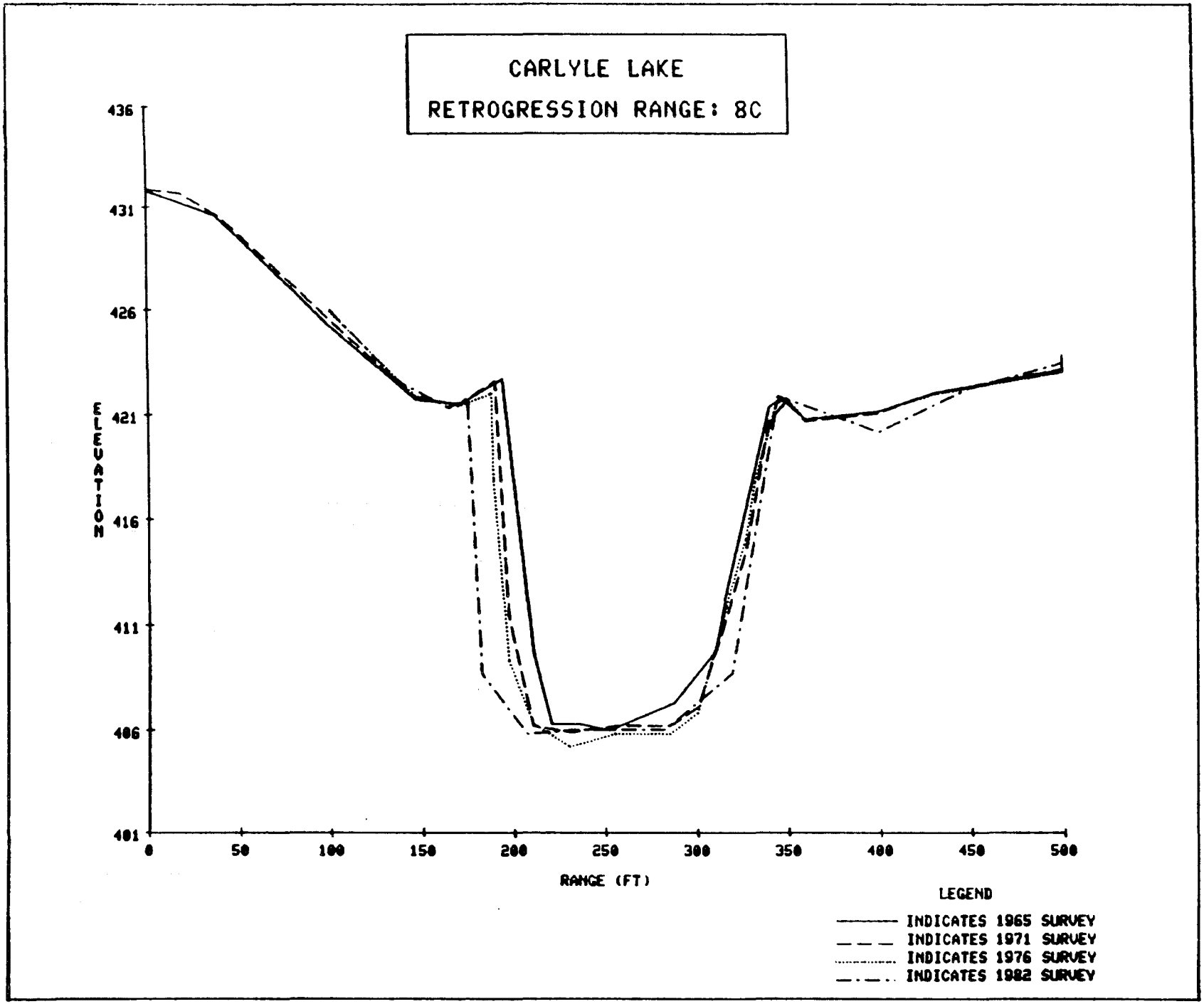

CARLYLE LAKE
RETROGRESSION RANGE: 8C
436
431
426
421
416
411
406
401
ELEVATION
0
50
100
150
200
250
300
350
400
450
500
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 27

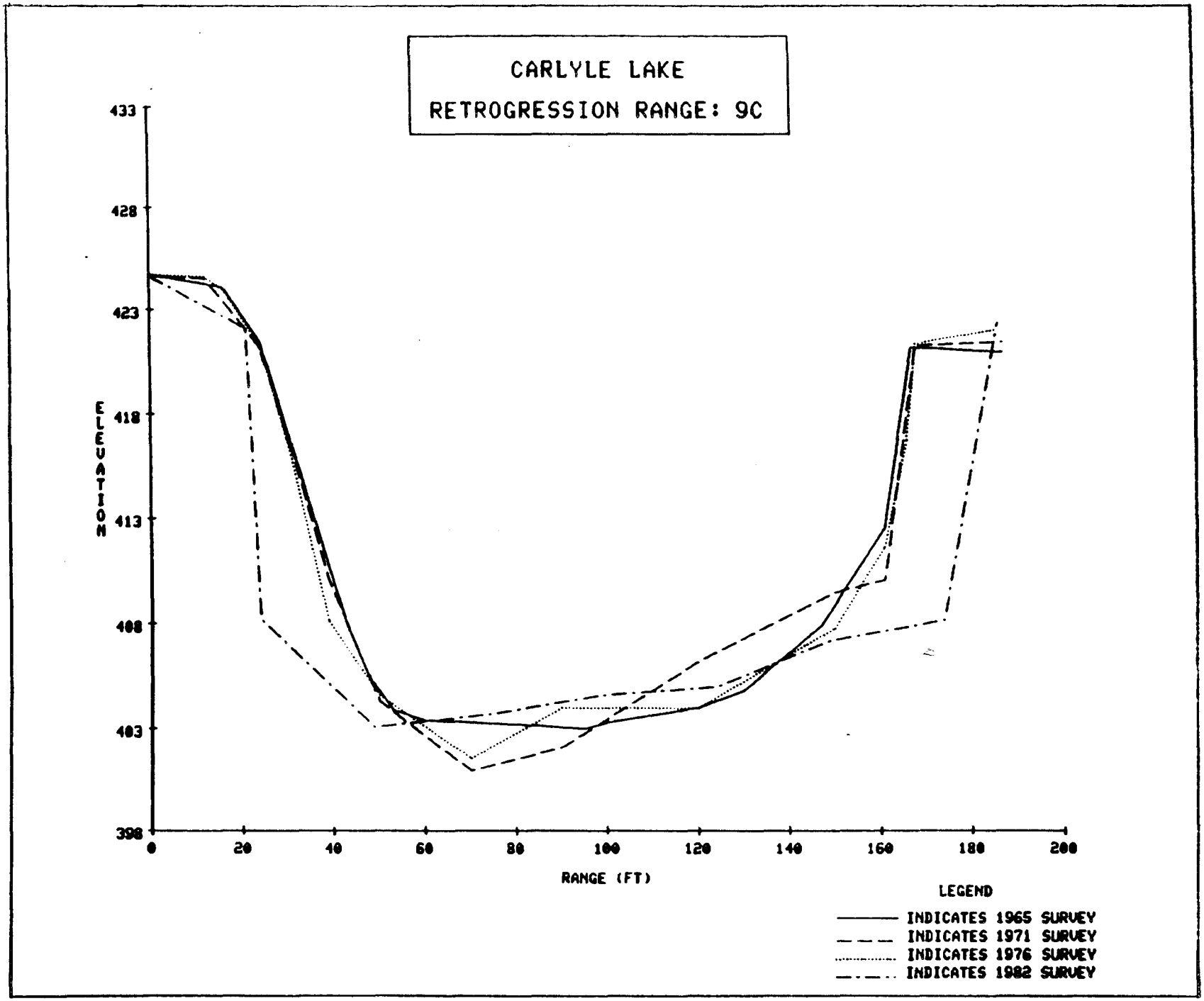

CARLYLE LAKE
RETROGRESSION RANGE: 9C
ELEVATION
433
428
423
418
413
408
403
398
0
20
40
60
80
100
120
140
160
180
200
RANGE (FT)
LEGEND
INDICATES 1965 SURVEY
INDICATES 1971 SURVEY
INDICATES 1976 SURVEY
INDICATES 1982 SURVEY

PLATE 28

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 ENGRS.	2. STREAM KASKASKIA RIVER	3. STATE ILLINOIS
4. SEC 17-18 TWP. 2N RANGE 2W	5. NEAREST P. O. CARLYLE, IL	6. COUNTY CLINTON
7. LAT. 38° 37 ' 10 " LONG. 89° 21 '15 "	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	39.08 (17)	INCHES
19. NET SEDIMENT CONTRIBUTING AREA	1,535 SQ. MI.		23. MEAN ANNUAL RUNOFF	11.6 (17)	INCHES
20. LENGTH 120 MILES	AV. WIDTH 22.3 MILES		24. MEAN ANNUAL RUNOFF	1,657,923 (17)	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.
April 1967			Range(D)	9(R)	58,447	974,645	0.91 3/
	4.3	4.3					
Aug. 1971			Range(D)	9(R)	58,447	961,914	0.90 3/
	4.6	8.9					
March 1976			Range(D)	9(R)	58,447	958,653	0.90 3/
	6.4	15.3					
Aug. 1982			Range(D)	9(R) 7/	58,447	939,398	0.93 3/

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE
April 1967	38.9	1,475,723	1,796,562	6,345,607	1,475,723	6,345,607
Aug. 1971	39.0	2,201,302	2,201 302	10,125,991	1,850,741	16,471,598
March 1976	39.1	1,402,419	2,310,823	8,975,484	1,663,208	25,447,082
Aug. 1982						

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
April 1967						
Aug. 1971	12,731	2,960	1.928	12,731	2,960	1.928
March 1976	3,261	709	0.462	15,992	1,797	1.171
Aug. 1982	19,255	3,008	1.960	35,247	2,304	1.501

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
April 1967							
Aug. 1971	4/	4/	4/	0.30	1.31	4/	4/
March 1976	4/	4/	4/	0.18	1.64	4/	4/
Aug. 1982	4/	4/	4/	0.24	3.62	4/	4/

ENG FORM 1787
NOV 66

PREVIOUS EDITIONS ARE OBSOLETE.

PLATE 29A

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											
April 1967	0.0	0.9	2.9	9.0	22.8	4.0	30.2	24.1	6.1	0.0	0.0	
Aug. 1971	0.0	0.0	0.4	0.9	3.0	22.9	9.6	9.4	26.7	27.1	0.0	
March 1976	7.3	8.5	2.6	28.8	52.7	0.0	0.0	0.0	0.0	0.1	0.0	
Aug. 1982												

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														
April 1967	9.0	12.1	17.5	18.8	18.3	9.9	3.9	3.5	3.5	3.5					
Aug. 1971	6.9	11.6	18.1	19.4	21.3	12.7	4.4	2.7	2.6	0.3					
March 1976	11.3	17.5	18.6	18.6	11.9	4.7	5.2	7.2	4.9	0.1					
Aug. 1982															

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	1979	455.4	442.8	2,310,274
1968	451.2	429.8	1,342,311	1980	445.5	442.7	782,752
1969	450.2	429.6	1,796,562	1981	447.3	442.8	1,046,850
1970	455.0	433.1	1,485,455	1982 5/	451.0	442.6	1,935,414
1971	446.1	440.3	821,865				
1972	448.9	440.0	927,602				
1973	455.5	442.2	3,021,705				
1974	455.1	442.7	3,179,291				
1975	446.4	439.9	2,090,527				
1976	455.4	439.7	802,991				
1977	448.6	440.3	1,054,504				
1978	453.0	442.8	1,046,850				

46. ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
6/								
415.0	0	0	455.0	41,536	570,413			
420.0	639	3,896	460.0	52,398	802,557			
425.0	2,325	17,202	465.0	65,113	1,092,638			
430.0	2,592	20,478	470.0	84,360	1,454,734			
435.0	4,579	38,921						
440.0	14,521	127,673						
445.0	22,103	247,558						
450.0	30,687	386,654						

47 REMARKS AND REFERENCES

1/ Top of movable gates in closed position, includes 1 ft. freeboard. Flood control pool (Elev. 442.5) used for Items 19, 31, 32, 33, 41 and 43.

2/ Includes 32,692 acre-feet for water supply, remainder for navigation.

3/ Lake Shelbyville controls 39% of watershed. C/I ratio adjusted to reflect this.

4/ No sediment samples taken.

5/ 1982 data only through August 1982, not entire year.

6/ 1982 data based on prismoidal method.
Land use in watershed: 86% farmland.

7/ Two ranges surveyed for future use (3.1A and 3.2A).

48. AGENCY MAKING SURVEY

49. AGENCY SUPPLYING DATA

50. DATE _____

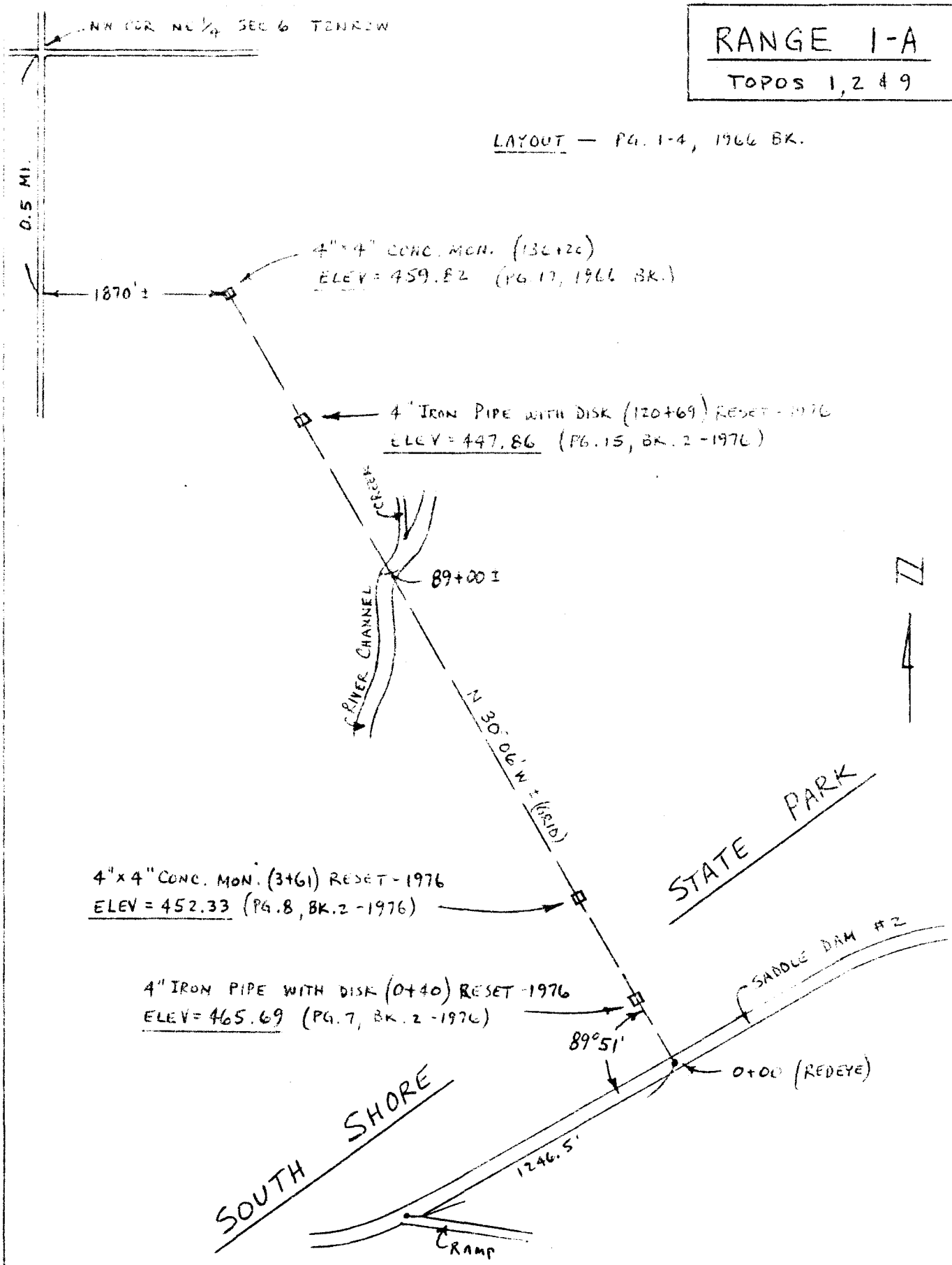
PLATE 29B

Appendix A

CARLYLE LAKE 1 WDM 3-15-82

SEDIMENTATION RANGE CONTROL

RANGE 1-A
TOPOS 1, 2 & 9



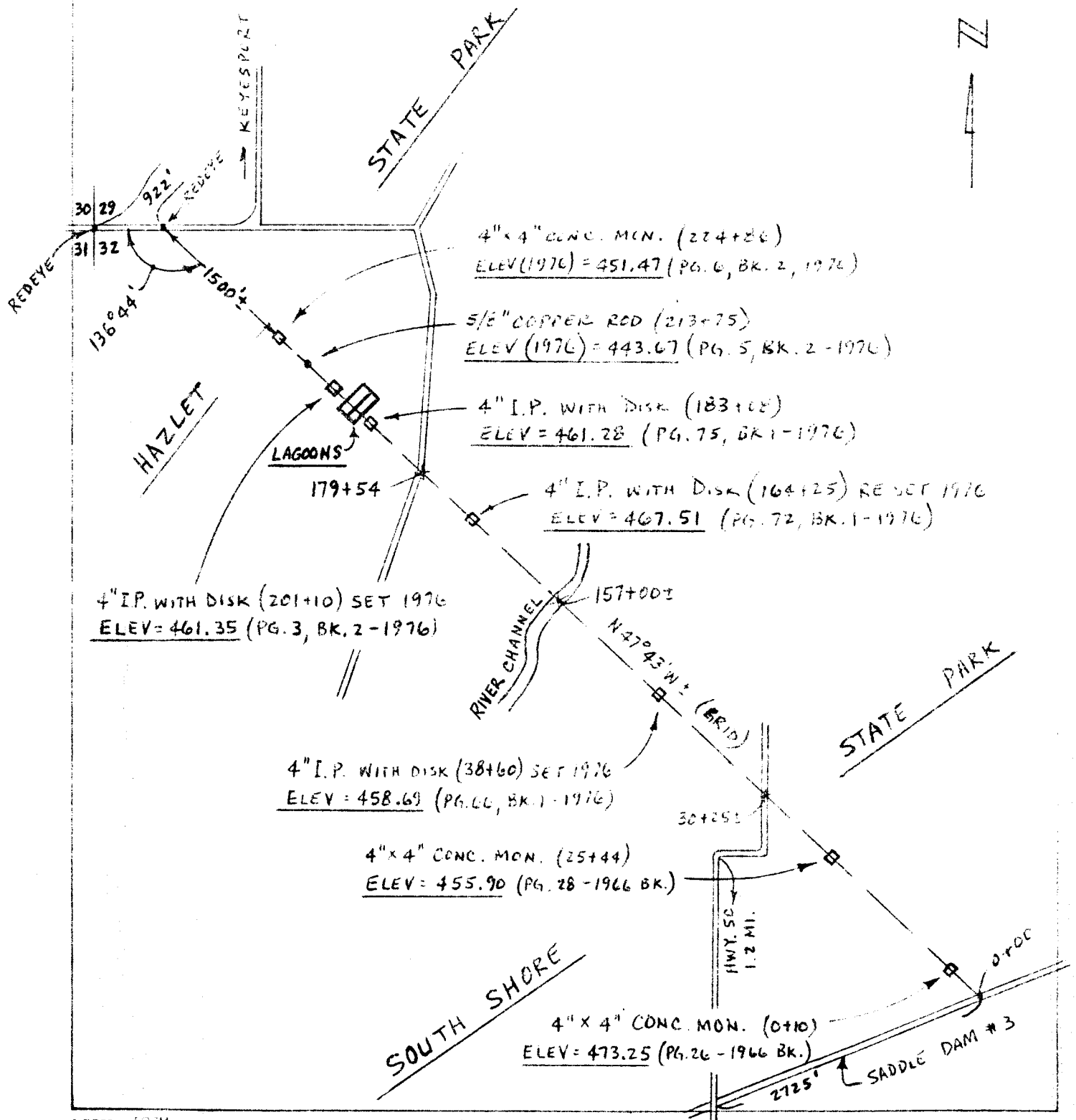
CARLYLE LAKE

SEDIMENTATION RANGE CONTROL

LAYOUT – PG. 21-24, 1966 BK.

RANGE 2-A

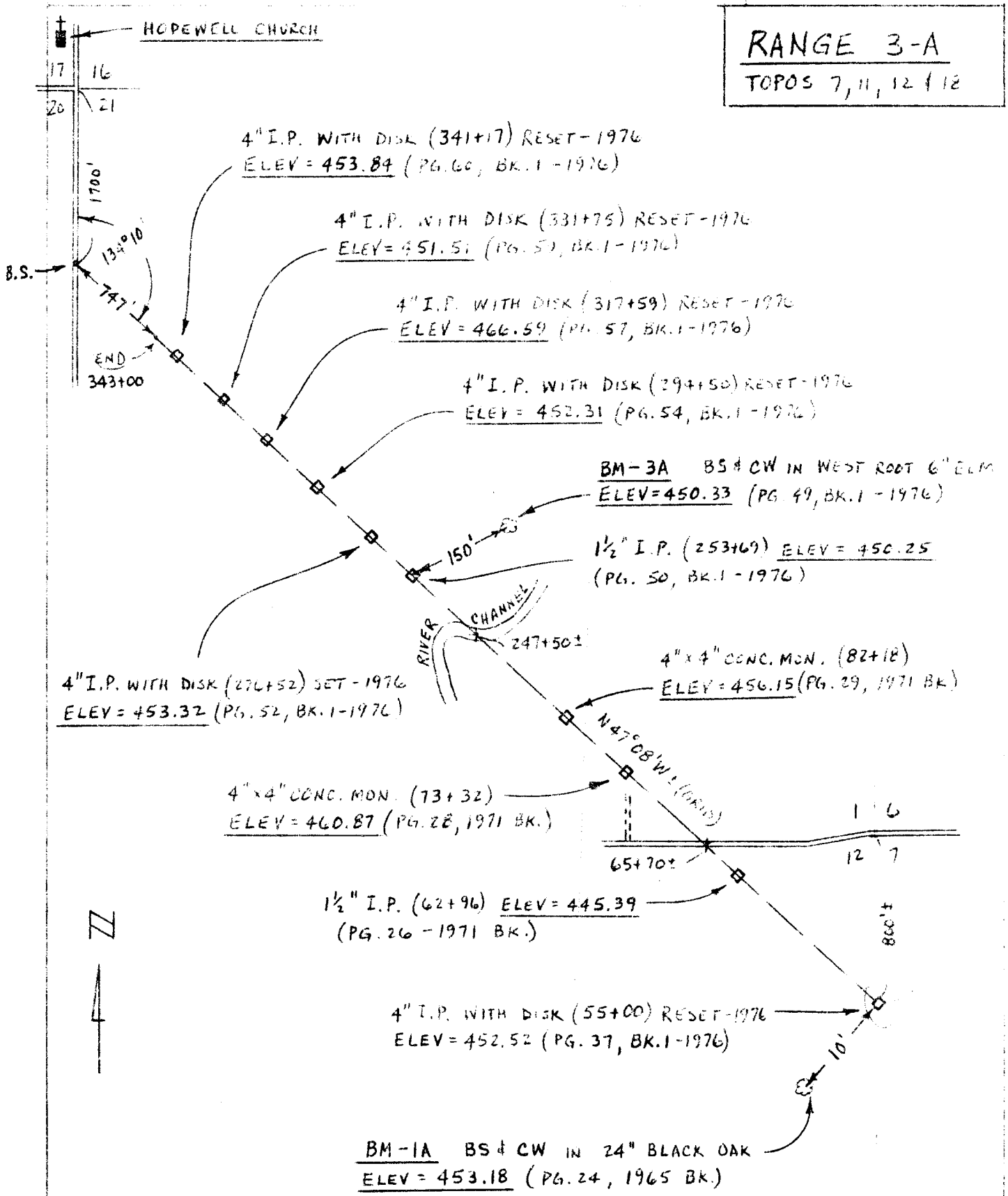
TOPOS 2, 3, 8, 10 & 11



CARLYLE LAKE 3

SEDIMENTATION RANGE CONTROL

RANGE 3-A
TOPOS 7, 11, 12 & 18



LAYOUT — PG. 2-6, 1965 BK.

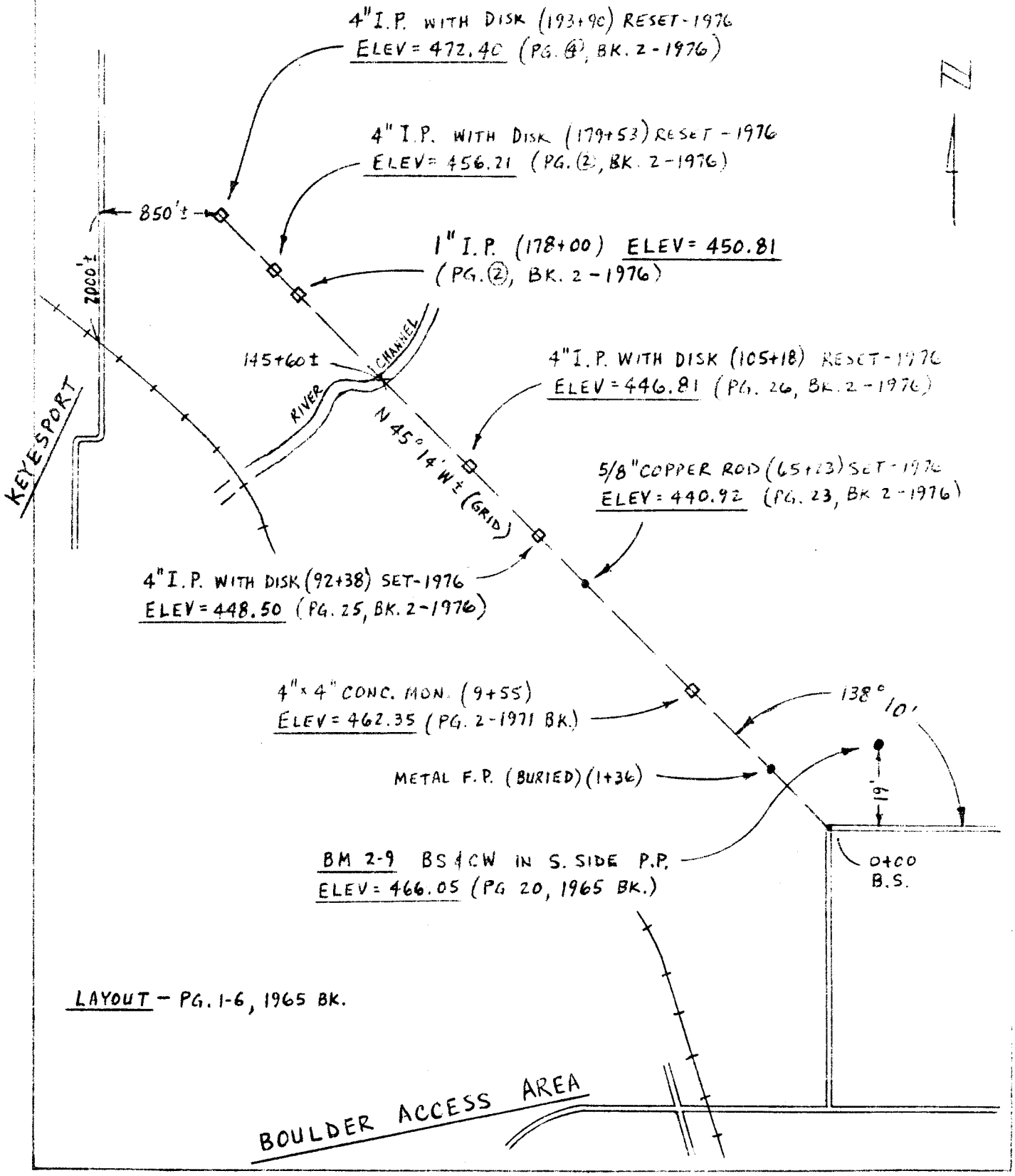
CARLYLE LAKE ... 4 103 M 3-17-82

SEDIMENTATION RANGE CONTROL

NOTE: "PG. ②" = LOOSE LEAF PAGES.

RANGE 4-A

TOPOS 21, 22 & 28

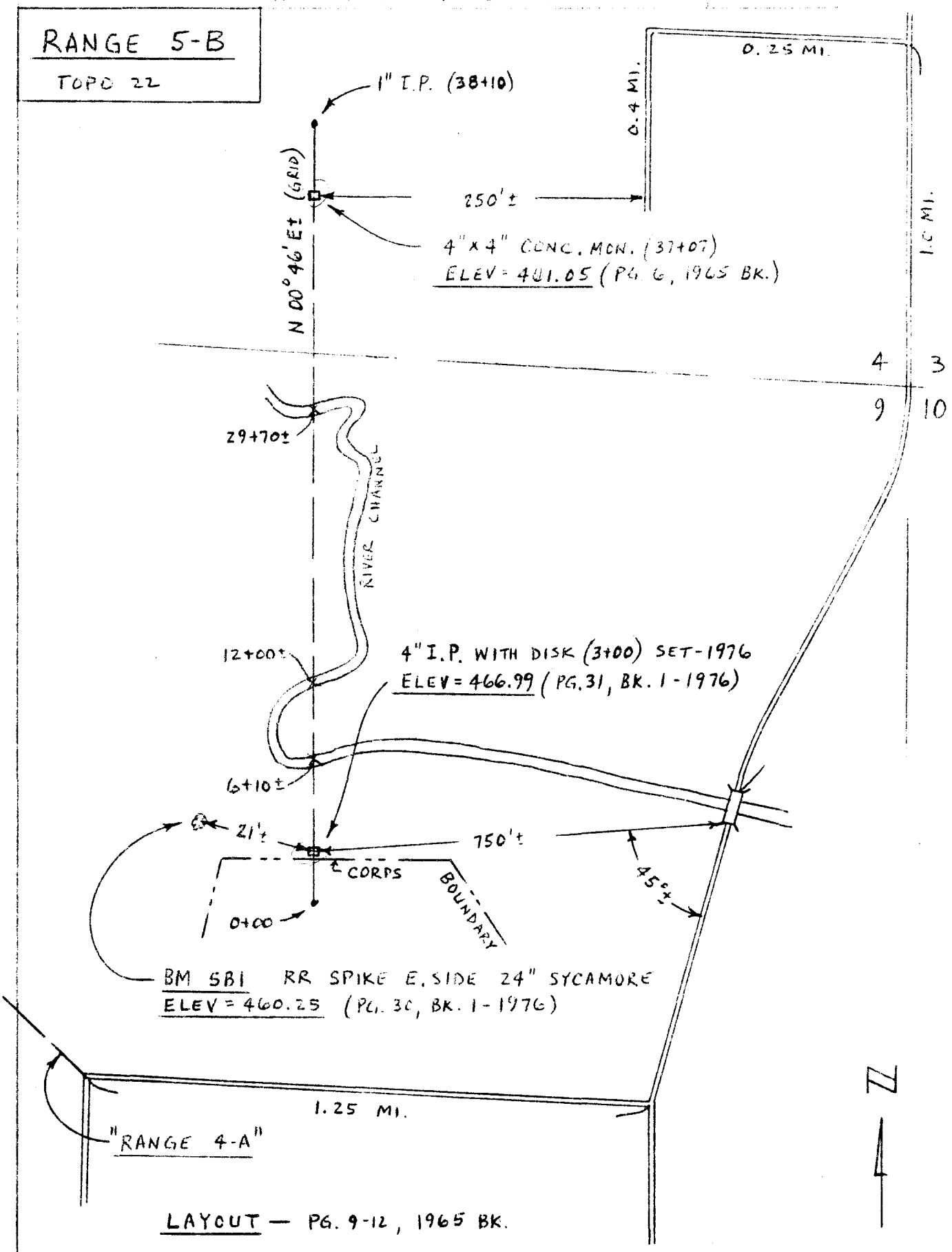


CARLYLE LAKE 5 WSM 3-18-82

SEDIMENTATION RANGE CONTROL

RANGE 5-B

TOPO 22



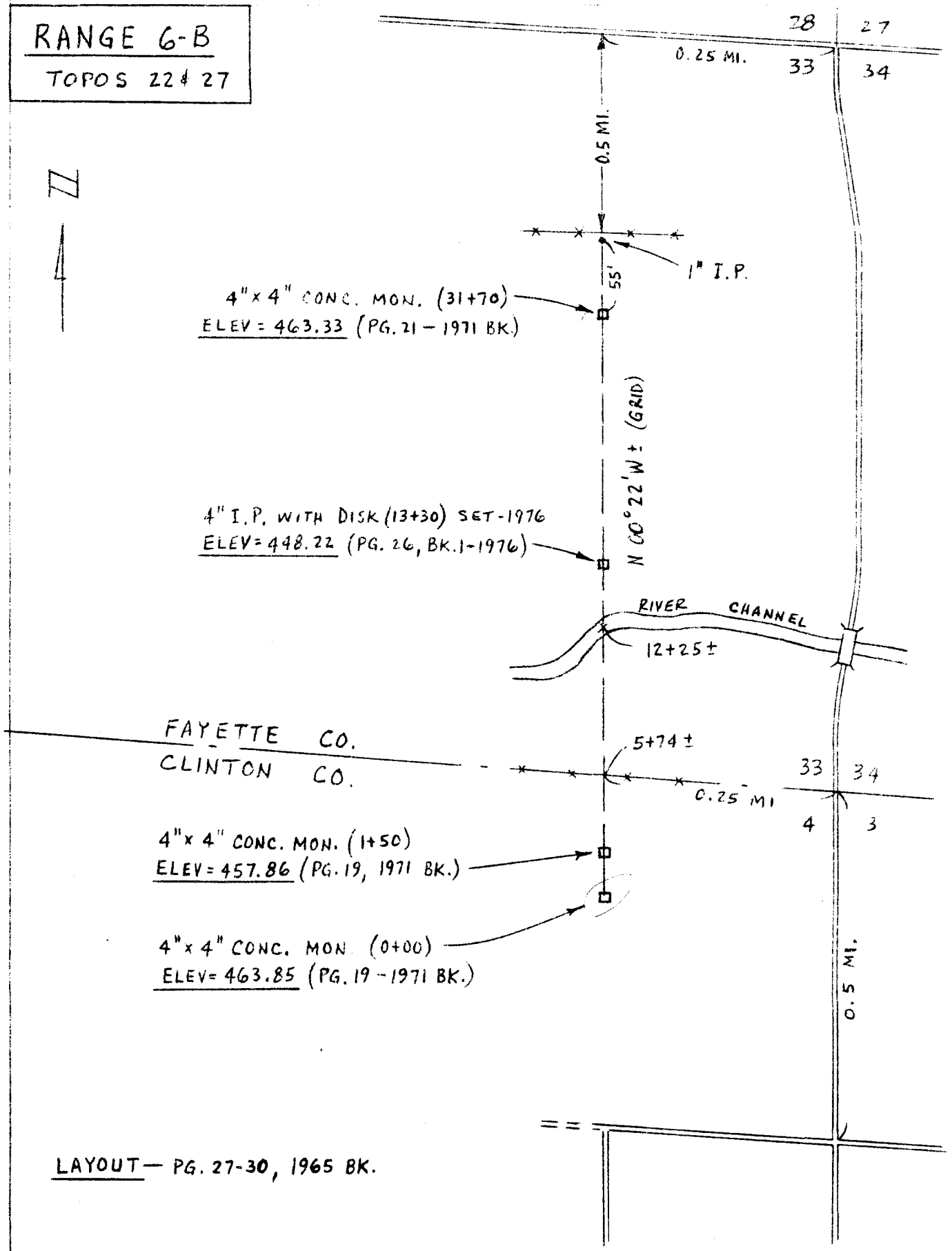
LAYOUT — PG. 9-12, 1965 BK.

CARLYLE LAKE 6 INWR 3-18 82

SEDIMENTATION RANGE CONTROL

RANGE 6-B

TOPOS 22 & 27



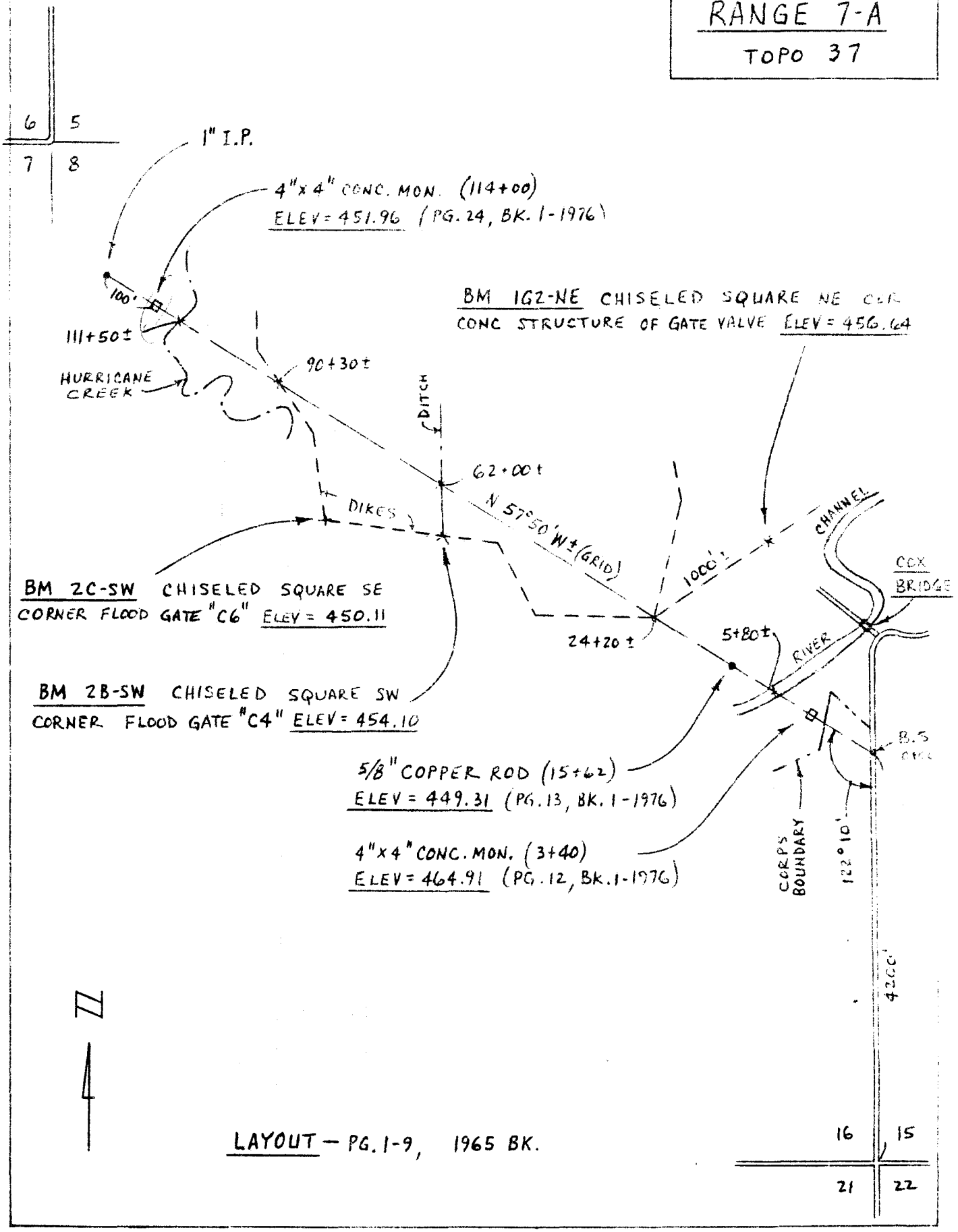
LAYOUT — PG. 27-30, 1965 BK.

CARLYLE LAKE 7 WJM 3-19-82

SEDIMENTATION RANGE CONTROL

RANGE 7-A

TOPO 37

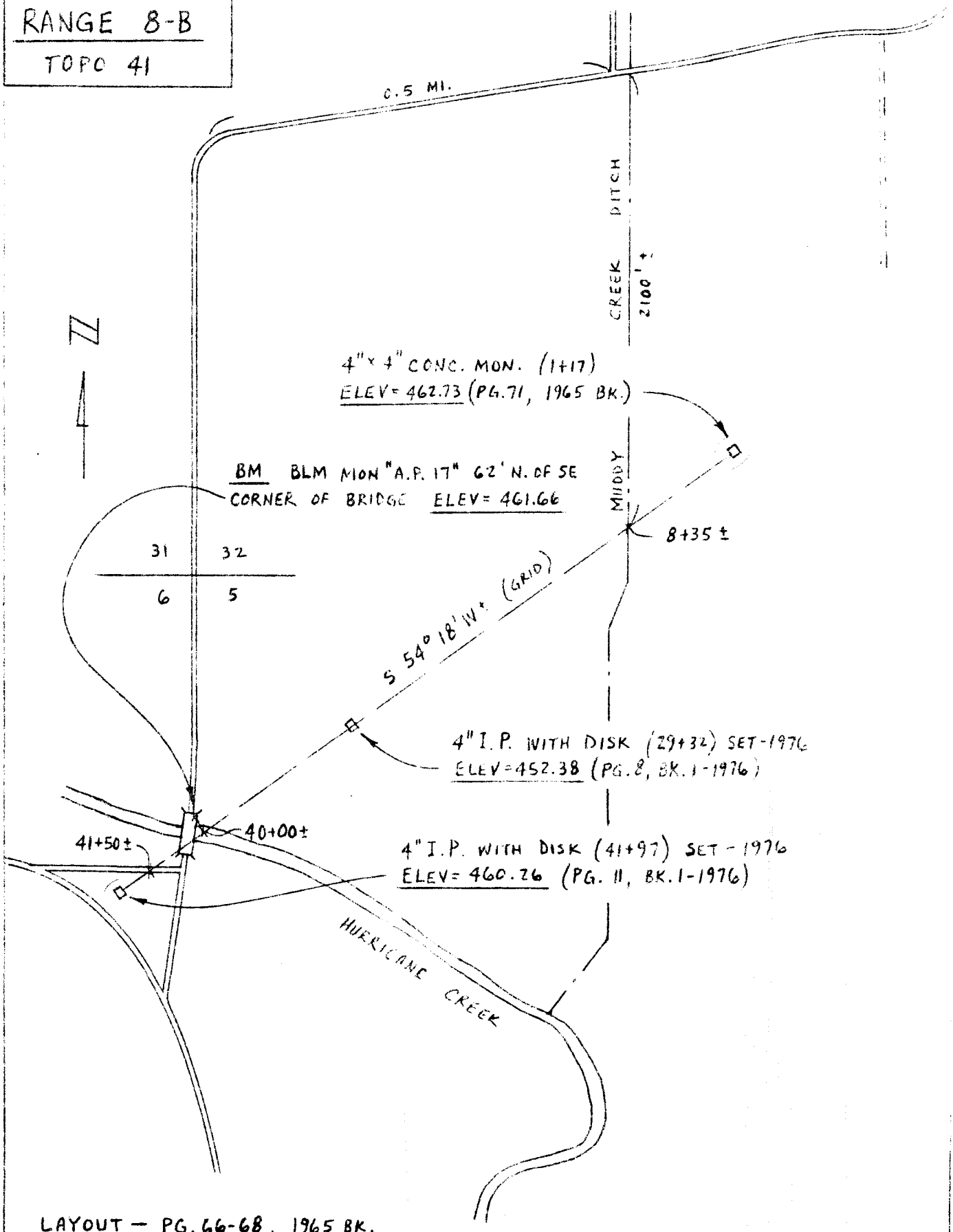


CARLYLE LAKE 8

SEDIMENTATION RANGE CONTROL

RANGE 8-B

TOPO 41

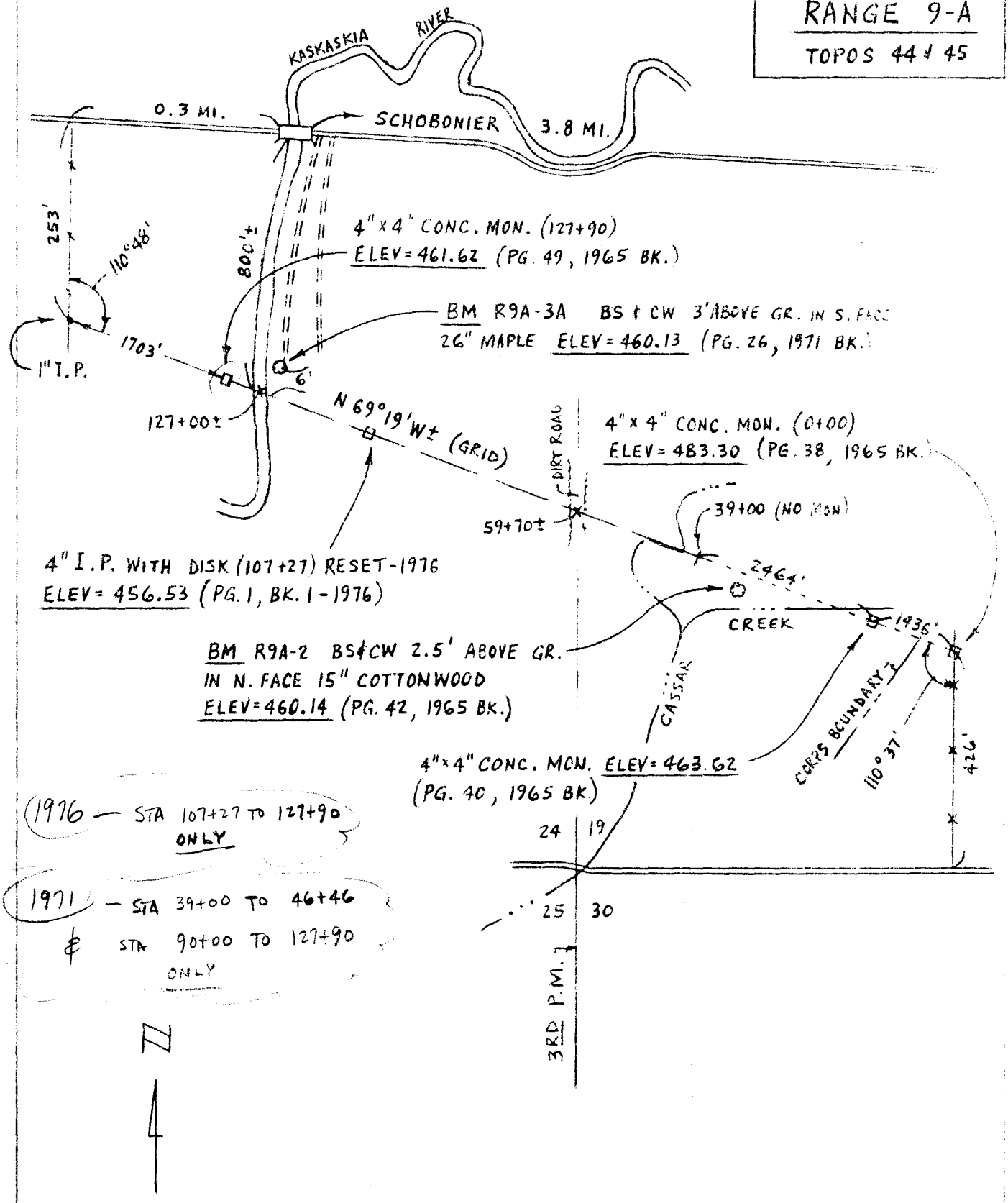


LAYOUT — PG. 66-68, 1965 BK.

CARLYLE LAKE 9 3-22-82

SEDIMENTATION RANGE CONTROL

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.