REPORT OF INVESTIGATION NO. 7 1951

STATE OF ILLINOIS

ADLAI E. STEVENSON, Governor

THE SILTING OF RIDGE LAKE

Fox Ridge State Park

Charleston, Illinois

J. B. Stall, L. C. Gottschalk, A. A. Klingebiel, E. L. Sauer
and S. W. Melsted

Illinois State Water Survey Division, Soil Conservation Service
United States Department of Agriculture, and Illinois
Agricultural Experiment Station, Cooperating

DEPARTMENT OF REGISTRATION AND EDUCATION

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(PRINTED BY AUTHORITY OF STATE OF ILLINOIS)

DATE DUE

Stall, J. B.
THE SILTING OF RIDGE LAKE, FOX RIDGE STATE PARK, CHARLESTON, ILLINOIS.

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Ridge Lake and Watershed

CONTENTS

RESULTS

SUMMARY

1. Ridge Lake, a small recreation lake built in 1941, is located in Fox Ridge State Park near Charleston, Illinois. The lake has a drainage area of 902 acres; original lake area was 18. 1 acres and original volume was 187 acre-feet.

2. The 1947 sedimentation survey shows a capacity loss of 1. 29 per cent per year. In the 6.4-year life of the lake, sediment has destroyed 8. 3 per cent of the original capacity.

3. The sediment deposited in Ridge Lake represents an average annual loss of 120 cubic feet, or 4. 4 tons of sediment per acre from the watershed.

4. Chemical analyses of the lake sediment show a high general level of available potassium and phosphorus indicating a relatively high fertility of the eroding soils.

5. Chemical and physical analyses of the sediment suggest that a large part of the sediment originates on the Hennepin gravelly loam which covers 33. 5 per cent of the watershed area. This occurs on the steep, heavily eroded side slopes of the main valley and tributaries.

6. The watershed conservation survey shows that 65 per cent of the area is in land-capability classes I, II, and III, which are considered safe for continuous cultivation. Class VII land covers 33.2 per cent of the watershed. This is not recommended for cultivation at anytime and is best suited for woodland.

7. One unusual feature of the watershed area is the scarcity of medium slopes. On 64.6 per cent of the area, slopes are less than 4. 0 per cent, while slopes in excess of 30 per cent occur on 33. 2 per cent of the area.

8. Calculations show that 58 per cent of the material eroded from this watershed originates in woodland areas, mostly on "G" slopes (over 30 per cent). On the average, erosion is proceeding nearly three times faster on the steep woodland than on the level upland.

9. The high rate of storage loss in the reservoir is due to excessive rates of erosion on the watershed.

10. The permanent solution to this silting problem is the establishment of a complete watershed treatment program, which includes land treatment measures and gully control measures. At this early date in the life of the lake, such a program would materially extend the life of the lake.

11. It is estimated that a land treatment program on this watershed, as outlined in this report, would reduce the rate of sedimentation in the reservoir by 14 per cent. Control of major gullies would give an additional 29 per cent reduction, for a total reduction of 43 per cent. A reduction in sedimentation greater than 43 per cent could be achieved through more complete control of gullies or the construction of sedimentation basins.

12. The adoption of soil conservation practices means increased net income to the farmer. A study of 76 farms in central Illinois for 1940-1945, showed that farms following a conservation program averaged $6. 65 more net income per acre per year than non-conservation farms.

13. It is recommended that a watershed treatment program be undertaken on this watershed immediately.

THE SILTING OF RIDGE LAKE

Fox Ridge State Park

Charleston, Illinois

by

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INTRODUCTION

OBJECTIVES OF STATE-WIDE SEDIMENTATION PROGRAM

Need for Data

About 500 artificial impounding reservoirs have been constructed within the State of Illinois to date. These represent an investment of both public and private money, and were built for both industrial and public water supplies, as well as for beauty and general recreation purposes. A study of the State of Illinois has been made[1] which shows that only approximately 600 sites remain within the boundaries of the State on which future reservoirs could economically be constructed. Consequently, the development of the remaining one-half of the State's reservoirs must be carried out only with a clear understanding of the forces which tend to destroy as well as to elongate the life of a reservoir.

The menace of sedimentation, which depletes the capacity of a reservoir, is not generally well understood. That soil erosion takes place in every part of Illinois, is evidenced by the turbid water carried by each stream. Whenever a dam is built to impound the waters of such a stream, it immediately begins to store the turbid water and the sediment immediately begins to settle out. This lowers the capacity of the impounding reservoir. The destruction of a storage reservoir begins immediately upon its completion. There is a need for better understanding of the whole sedimentation problem within Illinois; by the public who in the future will be investing money in the construction of dams, by the farmer who loses the soil from his farm, and by the engineer who will be designing new dams.

Public water supply users would be quick to object to turbidity or muddiness of the water in the drinking glass on their dining table. Modern filtration and purification methods, however, completely remove the silt content of the water before it is delivered to this consumer. The muddy flowing waters of the stream, which carries silt into the storage reservoir, thus can go completely unnoticed by water users. Residents in the vicinity of the lake may notice that it becomes muddy after a rain, but the water quickly clears up again and the public is not reminded that the silt load of the water has settled put and now rests on the bottom of the lake where it occupies space originally designed to store water. This state-wide destruction of reservoir capacity

1. Preliminary Data on Surface Water Resources. Illinois State Water Survey Division Bulletin No. 31, 157 pp., Urbana, Illinois, 1937.

is a destruction of the water resources of the State. The halting of this destruction and the conservation of the remaining reservoir sites within the State is a matter that must be given attention within this generation.[2]

Illinois Program

The seriousness of erosion in Illinois and the consequent rapid reservoir sedimentation led the Illinois State Water Survey Division, the Illinois Agricultural Experiment Station, and the Soil Conservation Service, in 1936, to join in a cooperative study to determine the effects of different reservoir, watershed, and climatic factors on the rate of sedimentation of reservoirs. Up to the present time, sedimentation data in some form are available on 33 reservoirs within the State. Thirteen of these reservoirs have been subject to detailed sedimentation surveys. By this method, it is possible to determine accurately the original and present volume of the reservoir, as well as the rate of storage loss per year. In four cases it has been possible to resurvey a reservoir after an elapsed period of ten years to determine the change in rate of sedimentation where this occurs.

The State-wide program has been oriented toward determining sediment production indices in those areas of the State in which future reservoir development for water supply is likely to be greatest. Approximately two-thirds of the State of Illinois depends predominantly on surface water reservoirs as a means of public water supply. Within this area there are 110 communities which now exceed 1,000 in population, and probably within the next few decades will be in need of an increased public water supply. The natural boundaries of soils and physiography within this portion of the State have determined the specific study areas in which sedimentation work will be concentrated.[3]

The specific objectives of the State-wide program as well as the survey outlined herein are: (1) to establish information on factors affecting sedimentation; (2) to furnish factual data for future reservoir development; (3) to provide data for estimating sedimentation damages to existing and proposed reservoirs; and (4) for developing methods of sedimentation control.

Need for This Report

As part of the State-wide program, Ridge Lake was chosen to be representative of a rather small watershed of rough, wooded topography, and a moderate Capacity-Watershed ratio. This reservoir was also chosen for survey because of the fact that in less than seven years the sediment beds in the lake have become noticeable. At this early date in the life of the reservoir, it is believed that with complete knowledge of the sedimentation to date within the reservoir, a program of sediment control at this stage might very materially lengthen the life of this lake.

Also of importance in the study of the silting of Ridge Lake, is the opportunity to observe the effect of sedimentation and the presence of silt beds on the bottom of the lake upon the raising of fish and aquatic plants.

SCOPE OF INVESTIGATIONS

Lake Survey

A detailed survey of Ridge Lake was made from September 9 to 23, 1947, by a field party of the State Water Survey Division. In this survey the original and present shoreline of the reservoir were mapped and a series of six silt cross-sections were taken on the lake. By this means the original and present capacity of the lake were determined, as well as the volume of sediment deposited within the lake since its construction. In carrying out the survey, a permanent monument system was installed so that in future years resurveys may be made to measure the sediment accumulation.

Watershed Survey

In an effort to determine the watershed sources from which the sediment originates, the Soil Conservation Service in 1947 conducted a detailed conservation survey of this watershed. These data on soils, slopes, land use, erosion, and conservation practices give a very complete picture of the agricultural use of the farm lands of the watershed. An analysis of these data has been made to show specific problem areas where the soil losses from erosion are particularly great, and where conservation measures would be very effective. By means of these data, it is possible to point out definite land treatment measures needed on this watershed to effectively reduce the soil losses and the accumulation of sediment in the reservoir.

Watershed History

An additional study has been made by the Soil Conservation Service and Agricultural Experiment Station cooperating, of the land use

2. Hudson, H. E., Jr. Do Water Resources Need Conserving? Illinois Wildlife. Vol. 4, No. 3, June 1949.

3. Unpublished memorandum, "Illinois Sedimentation Program," State Water Survey, August 30, 1949, 8 p.

history of the watershed farms during the past twenty years. This analysis shows the trend in land use on the watershed for this period. Its interpretation in light of the measured rate of sedimentation in the reservoir aids in developing recommendations for land use changes which would be most effective in reducing soil losses.

Sediment Samples

During the course of the survey, a series of six sediment samples were taken from various parts of the reservoir by means of a- special sampler. Chemical and physical analyses of these samples have been made by the Illinois Agricultural Experiment Station. These analyses report the texture, colloidal content, volume-weight, and presence of plant food constituents in the sediment of the lake. These data give significant indications as to the watershed sources of the sediment in the reservoir.

Interpretation of Results

The final interpretation of the silting problem at Ridge Lake has been made by the three cooperating agencies. This was done on the basis of the complete reservoir and watershed survey data, plus the analytical data available on the sediment samples. Results are presented so as to be most useful to reservoir owners and operators. Several remedial measures are discussed, including the application of a watershed protective program.

ACKNOWLEDGEMENTS

Lake Operator

The agencies conducting this survey wish to acknowledge the generous cooperation of the State Natural History Survey Division, Department of Registration and Education, in authorizing and expediting the reservoir survey. This Division made available to the field party, two boats for use in the survey of the reservoir, and office space during the period of the field work.

State Water Survey Division

The survey of Ridge Lake was made by a field party of the Engineering Sub-Division, consisting of the following men: B. O. Larson, Chief of the Party; John B. Stall, Assistant Engineer; Leslie Jones, and Douglas Rucker. This Divison made the computations on the results of the reservoir survey, including the water and sediment volumes. The engineering section of this report was prepared by J. B. Stall. The entire report was prepared and edited by Mr. Stall under the supervision of Mr. H. E. Hudson, Jr., Head of the Engineering Sub-Division.

Soil Conservation Service

The Soil Conservation Service of the United States Department of Agriculture has participated in the Illinois sedimentation program in many different ways.

The Sedimentation Section of the Office of Research in Washington furnished the specialized field equipment for survey work. Mr. L. C. Gottschalk, Head of the Sedimentation Section, gave technical assistance to the field party during the conduct of the survey, and compiled the watershed section of this report.

Mr. B. B. Clark, State Conservationist, cooperated by authorizing the conservation survey of this watershed by Soil Conservation Service personnel, and was helpful in many ways to the authors in the compilation of the report. The field work of the watershed survey was carried out by Mr. H. M. Smith, Soil Scientist, during 1947. Mr. A. A. Klingebiel, State Soil Scientist, analyzed the survey data on the watershed and prepared for this report the proposed detailed conservation program needed on the watershed.

The Illinois State Soil Conservation Districts Board, Mr. R. C. Hay, Executive Secretary, cooperated in this study by financing the laboratory work in making the sediment analyses. This work was carried out in the laboratories of the Illinois Agricultural Experiment Station.

Dr. E. L. Sauer, Project Supervisor, Research, Economics of Soil Conservation, Soil Conservation Service, and Illinois Agricultural Experiment Station cooperating, carried out the study of land use and conservation history of the watershed. This study entailed both field visits and study of public records and their interpretation. Dr. Sauer also prepared the data in this report concerning the costs and benefits of conservation.

Illinois Agricultural Experiment Station

Samples of the sediment in the lake were procured by the field party. Under the supervision of E. E. DeTurk, Professor of Soil Fertility, these samples were analyzed in detail in the laboratory of the Agricultural Experiment Station. The interpretation of these analyses and their comparison to watershed soils has been carried out by S. W. Melsted, Associate Professor of Soil Analysis.

RESERVOIR

GENERAL INFORMATION

Dam

The dam which forms Ridge Lake is 450 feet in length and extends in a north-south direction with a 70-foot concrete flood spillway at the north end. The top of the dam is 20 feet wide and is at elevation 603 feet above mean sea level. Both upstream and downstream faces of the dam have a 3 to 1 slope, and there is concrete facing several feet in width on the upstream face to protect the dam from wave erosion.

Spillway

The primary overflow structure in this lake consists of a tower spillway, designed in such a manner that it removes water from the lower part of the lake rather than the top. This tends to increase the average oxygen content of the lake water. The spillway lip in this tower is 8 feet long and is at elevation 595 mean sea level. The outflow pipe is a rectangular 5x7 foot conduit through the dam. At the bottom of the tower spillway is a de-watering valve utilized to drain the reservoir on certain occasions.

In addition to the tower spillway which has a capacity of 25 cubic feet per second, there is a flood spillway on the north end of the dam as mentioned previously. This flood spillway is 70 feet in length and has a crest elevation of approximately 1 foot above the lip of the tower spillway. It is thus effective in removing flood waters in excess of the capacity of the tower spillway.

Reservoir

Ridge Lake is located six miles south of the city of Charleston in Fox Ridge State Park, Coles County, as shown in Figure 1. The lake is in the extreme northwest corner of Section 13, extending slightly into Section 12 of Township UN., Range 9 E. The lake is impounded on Dry Run Creek, a small tributary of the Embarrass River, the dam being located just off the Embarrass Valley. The lake extends slightly less than one-half mile in a northeasterly direction from the dam.

Ridge Lake was completed and water first impounded in April, 1941. The lake was constructed by the Division of Parks of the Department of Public Works and Buildings of the State of Illinois. Construction work was carried out with Civilian Conservation Corps labor. The hydraulic design of Ridge Lake was carried out by the State Water Survey Division and the National Park Service.

The reservoir is utilized by the State Natural History Survey Division for studies of aquatic life and for fish propagation. No water is pumped from this reservoir. Ridge Lake was incorporated into the design of Fox Ridge State Park as an integral part of this recreational development. One of the principal values of the lake is the beauty it affords the visitors of the State Park. Fishing is very popular on this lake and the natural setting of the lake makes it a worthwhile addition to the other built-up recreation areas of the State Park.

At a water level elevation of 595, the elevation of the lip of the tower spillway, the lake proper is about 2, 500 feet in length. The main body of the lake varies in width from about 400 feet at the dam to 200 feet at the upper end. The water depth at the dam is about 20 feet. The steep sidewalls of the lake basin tend to make the lake comparatively deep for the surface area. The high wooded banks of the reservoir tend to enhance the beauty of the lake setting, and also to reduce evaporation losses from the reservoir.

Watershed

The watershed of the lake covers 1.41 square miles and the lake is fed by a single intermittent stream.

METHODS OF SURVEY

The original and present storage capacities and silt volumes of the reservoir were determined by the range method of survey. This method was developed by the Soil Conservation Service and is described in U. S. Department of Agriculture Technical Bulletin No. 524, "Silting of Reservoirs."[4]

4. Eakin, H. M., Silting of Reservoirs, U. S. Department of Agriculture, Technical Bulletin No. 524, revised by C. B. Brown, 168 pp., illus., Washington, D. C., U. S. Government Printing Office, 1939 Appendix.

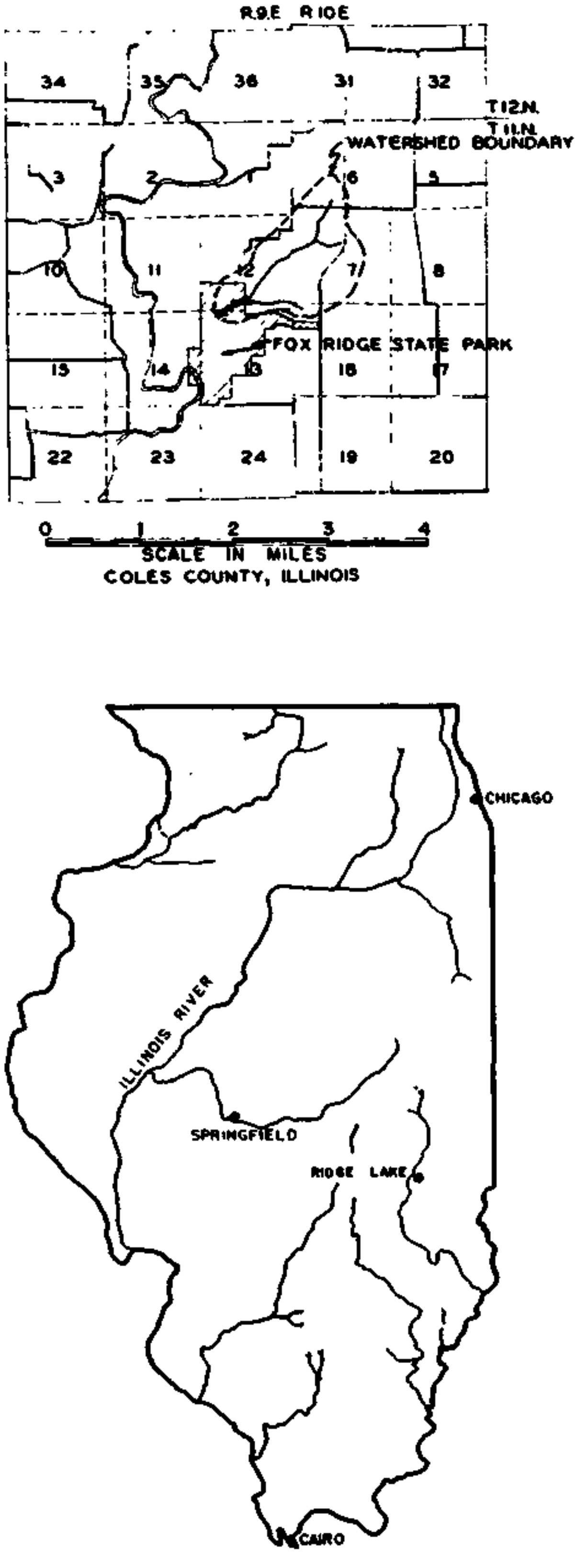

Figure 1. Ridge Lake and Watershed Location

Range System

A triangulation network, consisting of 10 stations, was expanded from a 350-foot base-line across the dam and served as control for mapping the shoreline and for the establishment of the silt ranges. The shoreline mapping was done with a planetable and telescopic alidade to a scale of 1 inch equal to 100 feet. After mapping the shoreline, a system of six silt ranges was established as shown in Figure 2.

Measurement of Silt

Along each silt range at intervals of 25 feet, the water depth and silt thickness were measured with a sounding pole. This consists of a 1 l/2-inch diameter calibrated aluminum pole constructed in sections to give a total length of 30 feet. This pole is shown in use in Figure 3. The pole is lowered into the water until it rests lightly on top of the silt deposit, and thus the present water depth is measured. The pole is then thrust on down through the soft silt until it strikes the hard soil of the original reservoir bottom. In this manner silt thickness is measured. As the boat is rowed across the range, a cross-section of water depth and silt thickness is obtained. A total of 50 silt measurements were made on the five ranges on Ridge Lake which were under water.

Above Crest Deposits

The uppermost range (Range 011-012) was laid out just above the present head of the reservoir. The only water on this range was in the creek channel. In this area, however, some deposition of silt has occurred above spillway crest level during flood periods. It is believed that the cross-section of Range 011-012 is representative of this above crest deposit. Along this range the elevation of the top of the silt was determined by dumpy level, and silt thicknesses were measured with a 1 l/2-inch soil auger. Such silt elevations were taken every 25 feet and borings made every 50 feet. The original and present shorelines of the lake in these delta areas were mapped and are shown on Figure 2.

Survey Markers

All triangulation stations and range ends were marked permanently in the field with concrete posts 4 1/2 inches square and 4 1/2 feet long. As shown in Figure 4, these posts were set into the ground with about one foot exposed. These permanent markers will be of value in the future when it becomes desirable to make a resurvey of Ridge Lake along these same silt ranges.

SEDIMENTATION IN THE RESERVOIR

Summary of Data

Table 1 is a summary of the sedimentation data obtained from this survey of Ridge Lake, together with data derived therefrom which are pertinent to the sedimentation problem in this lake. Several of the significant findings shown in this summary are:

1. The 18. 1 acre surface area of the reservoir has been reduced by 0. 4 acres in 6. 4 years.
2. The capacity of the reservoir for water storage has been reduced from 187. 4 acre feet to 171. 9 acre feet or 8. 3 per cent in 6. 4 years.
3. The sediment accumulation in the lake represents a soil loss equivalent to 120 feet per acre per year from the watershed.

Distribution of Sediment

The thinnest sediment deposits in the reservoir are in Segments 1 and 2 (see Figure 2), just above the dam. The silt becomes uniformly thicker toward the upper end of the lake and it is in Segments 6 and 7 that the greatest loss of storage capacity has occurred. Figure 5 shows the cross-section of Ranges 01-02 and 09-010. On Range 01-02, where original water depths varied from 19. 5 to 23. 5 feet, approximately 1 foot of silt has been deposited. This is typical of the lower segments of the reservoir where about 5 per cent of the original capacity has now been lost. On Range 09-010 where original channel depth was about 11 feet the present channel is about 7. 5 feet deep. The silt thicknesses here vary from 1 foot to 3. 5 feet. This range typifies the upper part of the reservoir, where as much as 40 per cent of the original storage capacity has now been lost.

Upon occasion of the periodical drainings of the lake for fish counting, it was possible to inspect and photograph the sediment deposits in the bottom of the lake. Figure 6 shows a general view of the bottom of the lake in the lower portion or main body of the lake. The silt shown is approximately 1 to 2 feet in thickness. Silt has practically filled the original stream channel and has deposited in a uniform blanket on the pre-reservoir valley flatland.

At the head of the lake, near the inlet, the thicker underwater deposits and delta deposits

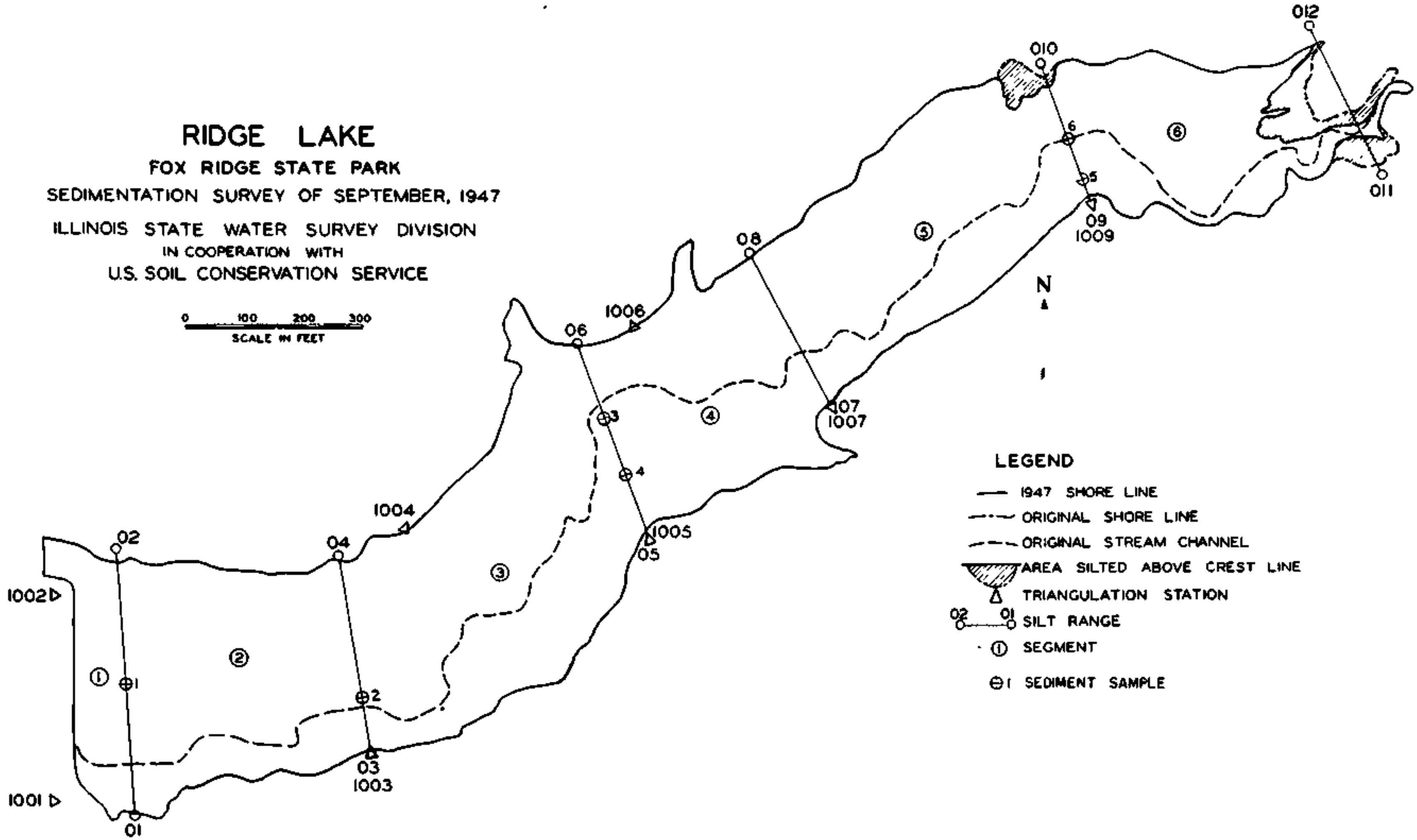

Figure 2. Ridge Lake Map.

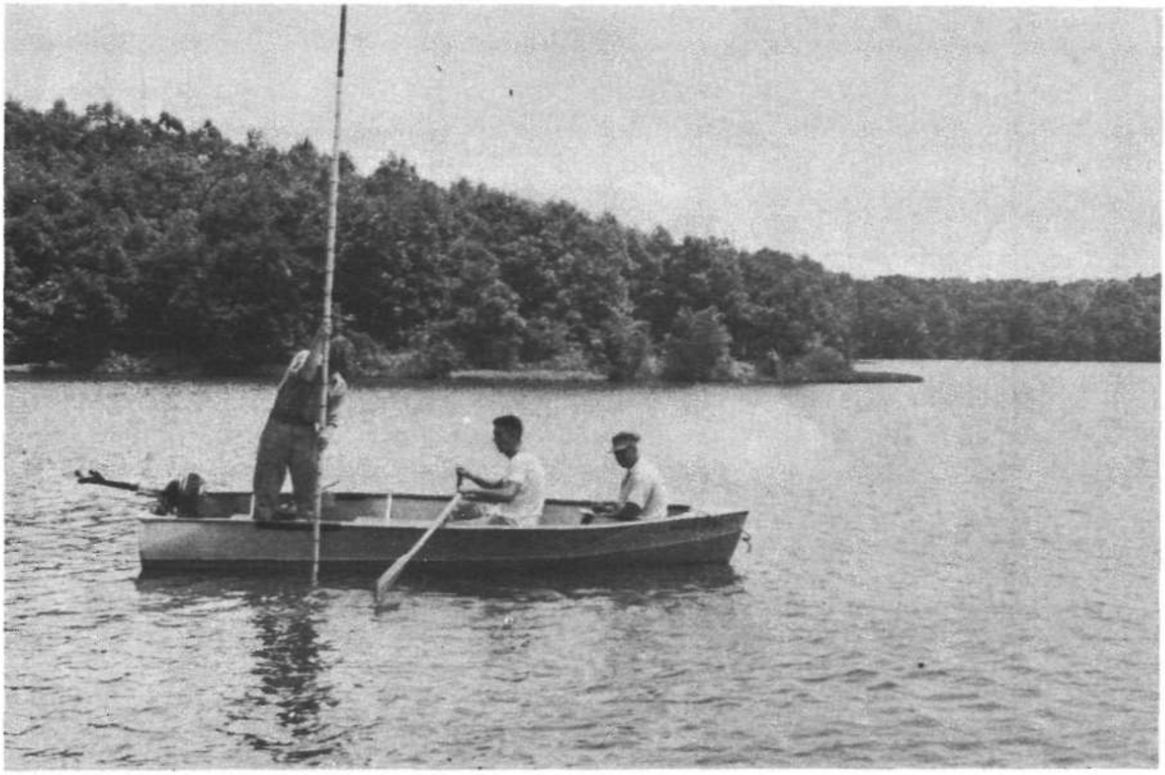

Figure 3. Use of Sounding Pole in Measuring Silt Thickness.

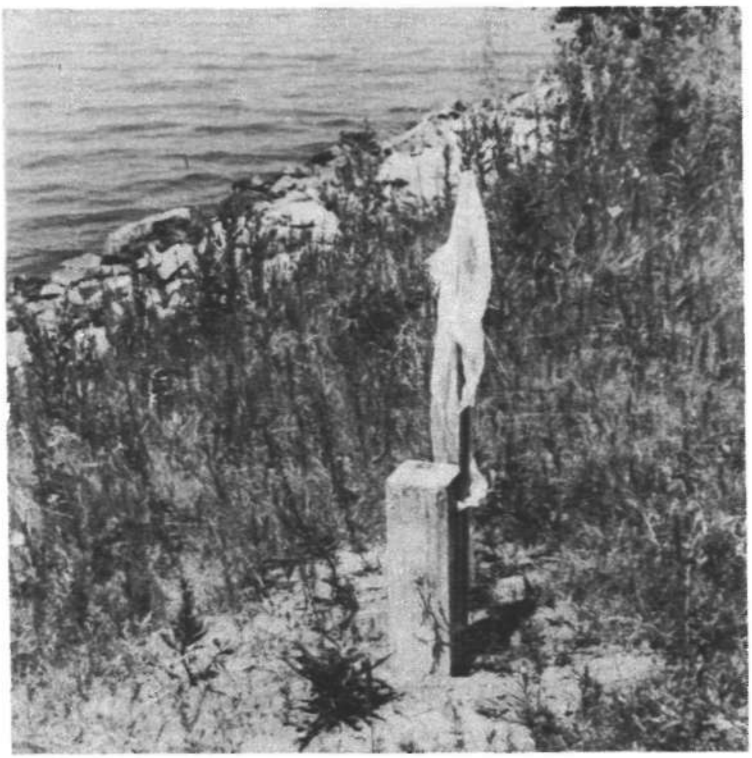

Figure 4. Concrete Post Used to Mark Survey Stations.

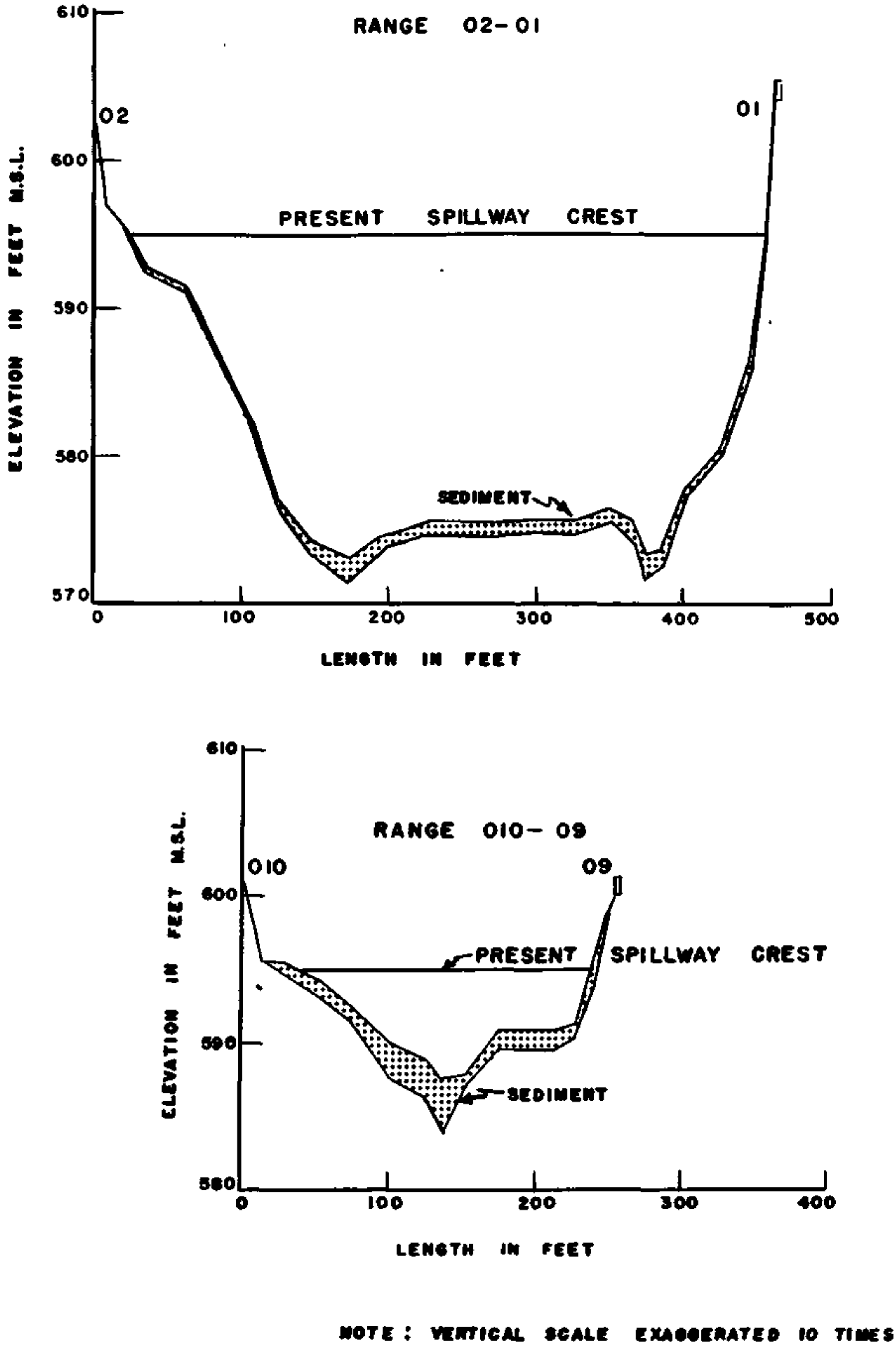

Figure 5. Typical Silt Cross Sections-Ridge Lake.

Figure 6. Sediment Deposit on Reservoir Bottom.

Figure 7. Delta at Inlet of Lake (looking downstream).

TABLE 1. SUMMARY OF SEDIMENTATION DATA ON RIDGE LAKE
Fox Ridge State Park, Charleston, Illinois

	Quantity	Units
AGE[1]	6.42	Years
WATERSHED		
Total Area[2]	1. 41	Square miles
or	902 4	Acres
RESERVOIR:		
Area at spillway crest stage:		
Original	18. 11	Acres
Present	17.65	Ac res
Storage capacity at crest stage-		
Original	187. 35	Acre feet
Present	171.86	Acre feet
Storage per square mile of drainage area:[2]		
Original	132 87	Acre feet
Present	121. 89	Acre feet
Storage per acre of drainage area[2]		
Original	2. 49	Acre inches
Present	2.29	Acre inches
SEDIMENTATION-		
Reservoir sediment	15. 49	Acre feet
Above crest deposits	0. 18	Acre feet
Total sediment	15 67	Acre feet
Average annual sediment accumulation:		
From entire watershed	2.44	Acre feet
	3848	Tons
Per square mile of drainage area[3]	1. 77	Acre feet
Per acre of drainage area[3]		
By volume	120. 34	Cubic feet
By weight[4]	4. 36	Tons
DEPLETION OF STORAGE:		
Loss of original capacity per year	1.29	Per cent
Loss of original capacity to date of survey	8 27	Per cent

1. Storage began in April 1941, average date of survey, September 1947.
2. Including area of lake
3 Excluding area of lake.
4 Based on four volume-weight samples, one cubic foot of silt weighs 72.4 pounds.

form. Figure 7 shows these deposits exposed. At the left of this picture is shown the water of the inflowing creek with the large flat delta formed along the inflow channel. At the right is shown the delta which has formed at an elevation above the spillway crest and extending into the lake.

In Figure 8 is shown a general view of the reservoir bottom on occasion of the draining of the lake. Here the incision of the flowing stream makes it possible to see the thickness of sediment deposits. In this upper part of the reservoir storage capacity has been reduced in the last six years by as much as 40 per cent. In Figure 9 is shown a close-up. cross-sectional view of the sediment deposit nearly 3 feet in thickness, which now covers the layer of leaves and organic matter on the original reservoir floor.

In the "pper end of the lake on Range 011-012, and above, there has been considerable deposition of silt above the spillway crest in

Figure 8. Reservoir Bottom When Lake Was Drained (looking upstream).

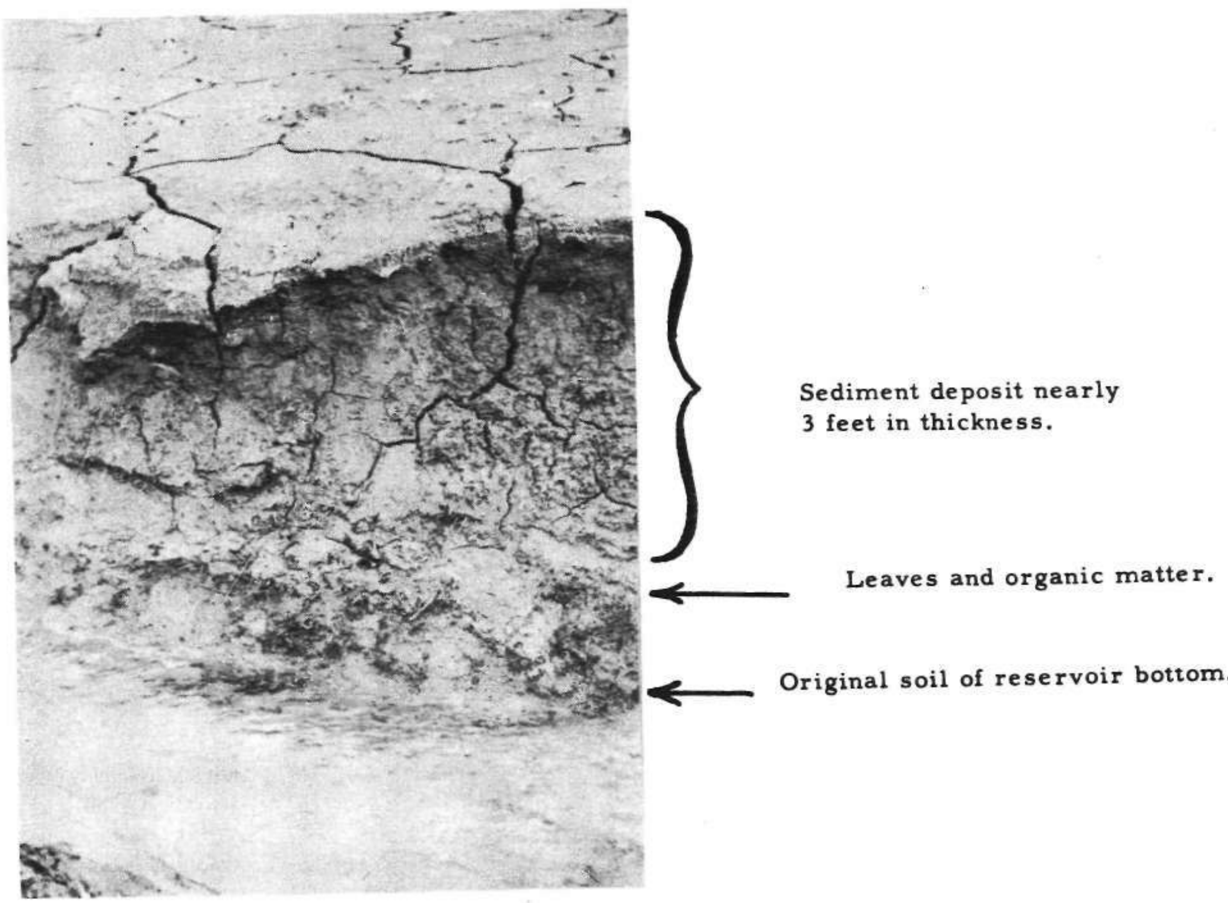

Figure 9. Cross-section View of Sediment Deposit in Ridge Lake.

deltas. There is also a small delta on the north side of the lake near Station 010. These areas are shown in Figure 2 and at present are well covered with vegetation and willow growths. Figure 10 shows a general view of the thick growing vegetation on the present flood plain above Ridge Lake. From this picture it is seen that a great deal of silt is stopped by such vegetation. This means that in reality the rate of soil loss from the watershed is somewhat in excess of the measured silt within the reservoir. Such vegetative growths tend to protect the reservoir proper from excessive sedimentation by stopping this silt above the reservoir.

SEDIMENT CHARACTERISTICS

PROPERTIES OF THE LAKE SEDIMENT

The chemical and physical characteristics of the Ridge Lake sediment were determined from sediment samples taken at five representative locations in the reservoir, as shown in Figure 2. Samples No. 5 and No. 6 consisted of two parts. The "a" sample was taken from the top of the sediment deposit, and the "b" sample was taken immediately below this. All samples were chemically analyzed for: (a) total nitrogen, (b) total organic carbon,(c) base-exchange capacity, (d) total replaceable bases, (e) pH, (f) available potassium, and (g) available phosphorus. The physical measurements involved particle size determinations and specific weight analyses. The data of these analyses are given in Tables 2 and 3.

Chemical Characteristics

In general, the sediment within the main body of the lake bed area, as represented by samples No. 1, 2, 3, and 4, is quite similar in its chemical and physical porperties. The pH is rather uniformly high, ranging from 7. 4 to 7. 9, indicating the presence of free carbonates. The presence of carbonates is further indicated by the high "total bases" values and the high "per cent base - saturation" values. With the exception of sample No. 1, the total nitrogen and the organic carbon values are not significantly different for any portion of the lake bed area. There is some evidence of sorting of sediment within the body of the lake. This is indicated by the slightly higher base-exchange capacity and clay content of samples No. 1 and 4, which are some distance away from the former main channel, as compared with samples No. 2 and 3. The general level of available potassium and phosphorus is high, indicating the relatively high fertility nature of the eroding soils within the watershed.

TABLE 2. CHEMICAL DATA ON RIDGE LAKE SEDIMENT

Sample No.	Range	Total N Per cent	Total C Per cent	Base Ex. Cap. m. e.	Total Bases m. e.	Base Saturation Per cent	pH	Avail. K lb. /A	Avail. P lb. /A
1	02-01	0.038	0.47	14.2	40.7	286	7.9	232	34
2	04-03	0.08	0.92	11.0	18.4	167	7.7	232	59
3	06-05	0.08	1.00	9.2	17.5	190	7.8	300 +	113
4	06-05	0.10	1.27	13.3	19.6	147	7.4	224	75
5a	010-09	0.10	1.28	13.2	32.1	242	7.7	300 +	117
5b	010-09	0.10	1 26	9.5	12.2	128	7.5	208	73
6a	010-09	0.10	1.31	12.4	31.4	253	7.8	300 +	129
6b	010-09	0.07	0.95	10.5	23.1	220	7.9	300 +	104

Physical Characteristics

The textural distribution of the sediments indicates a rather uniform type of sediment throughout the main body of the lake (samples No. 1, 2, 3, and 4). The sediments are coarse, consisting of over 20 per cent sands and less than 25 per cent clay. Some evidence of the sorting-action of water is indicated by the higher percentage of clay in the samples collected farthest away from the former channel. The sediments in all areas of the lake would fall under the "loam" textural classification for soils. Of particular interest is the relatively low proportion of the clay fraction found in any of the sediments. This lack of fine material in the sediment may be due to the nature of the eroded material; or it may be an indication that the sediment-laden water passes over the spillway before the fine fractions have had an opportunity to settle out.

Figure 10. Sediment Deposits in Thick Vegetation on Flood Plain of Creek above Ridge Lake.

TABLE 3. PHYSICAL DATA ON RIDGE LAKE SEDIMENT

Sample No.	Range	Apparent Vol. Wt. gm./c.c.	Sand, > 50 microns per cent	Silt, 20-50 microns per cent	Silt, 2-20 microns per cent	Clay, 2-0.2 microns per cent	Clay less than 0.2 microns per cent
1	02-01		20.5	12.7	28.5	14.1	14.3
2	04-03	1.18	36.1	17.7	21.6	7.8	10.4
3	06-05	1.19	40.9	14.8	21.1	4.0	12.4
4	06-05		33.1	14.2	24.8	9.0	14.7
5a	010-09		1.4	21.4	45.8	14.1	9.0
5b	010-09	1.16	43.7	18.8	19.1	5.1	6.3
6a	010-09		5.9	23.2	39.2	10.4	11.0
6b	010-09	1.10	10.0	23.5	44.0	8.9	7.9

SIMILARITY OF SEDIMENT TO WATERSHED SOILS

The particle size distribution of the lake sediment and surface soils similar to those found in the watershed area, are shown graphically in Figure 11. The striking feature of these data is the large amount of sand in the lake sediment. This may be an indication of a rather high velocity of water movement within the reservoir, or a source material that is quite coarse in texture. Most of the upland soils in this region are of loess origin and are therefore naturally low in sand content. The loess is usually 20 inches or more in depth so that any surface material eroding from these soils would be expected to be low in sand content. The presence of these large amounts of sand in the sediment may be accounted for in one, or both, of the following ways. First the source of this material may be primarily from gully erosion extending down through the loess sheet into the coarser Wisconsin till subsoil, which is texturally a loam (see Figure 11); or second, the velocity of the water within the lake may be sufficiently rapid, and the retention time sufficiently short, to permit sand accumulations. Of these alternatives, the first is supported by the chemical data which indicate the presence of free carbonates in the sediments. Since the Wisconsin till is highly calcareous in nature, while the loess-derived soils of this area are acid in the surface, the probability is that a large proportion of the sediment is derived from the underlying Wisconsin till.

The physical characteristics of the sediment do not appear to follow the conventional pattern of sediment deposits found in most lakes in loessal soil areas. There is very little apparent accumulation of clay in any portion of the lake, and there is no apparent increase-in the silt or sand fractions as one progresses upstream within the lake bed area. The general character of the sediment indicates very little sorting action by the water within the reservoir. This suggests rapid runoff and considerable water movement within the lake, permitting uniform distribution of the eroding material without significant sorting.

WATERSHED

General

Many watershed factors affect the rate of sediment production and the resultant rate of silting of reservoirs. The influence of such factors as size of drainage area, topography, nature of soils, land use, and farming practices, must be determined in order to develop design data. Furthermore, the sources of sediment must be delineated if an adequate watershed treatment program is to be developed for the reduction of sedimentation damages. A soil conservation survey was made of the entire watershed, as part of this study, for the purpose of determining sediment source areas and developing methods of control.

Physiography and Soils

The watershed of Ridge Lake lies entirely within Coles County, Illinois. The lower half of the watershed is in Pleasant Grove Township and the upper half in Hutton Township. The dam is located on Dry Run Creek, a tributary to the Embarrass River. The stream rises in the SW 1/4 of Section 6, T. 11 N., R. 10 E., and flows southwestward. The total length of the stream from its origin to the junction with the Embarrass River is slightly less than 3 miles.

The watershed is located on the Shelbyville Moraine which forms the southern outer bound-

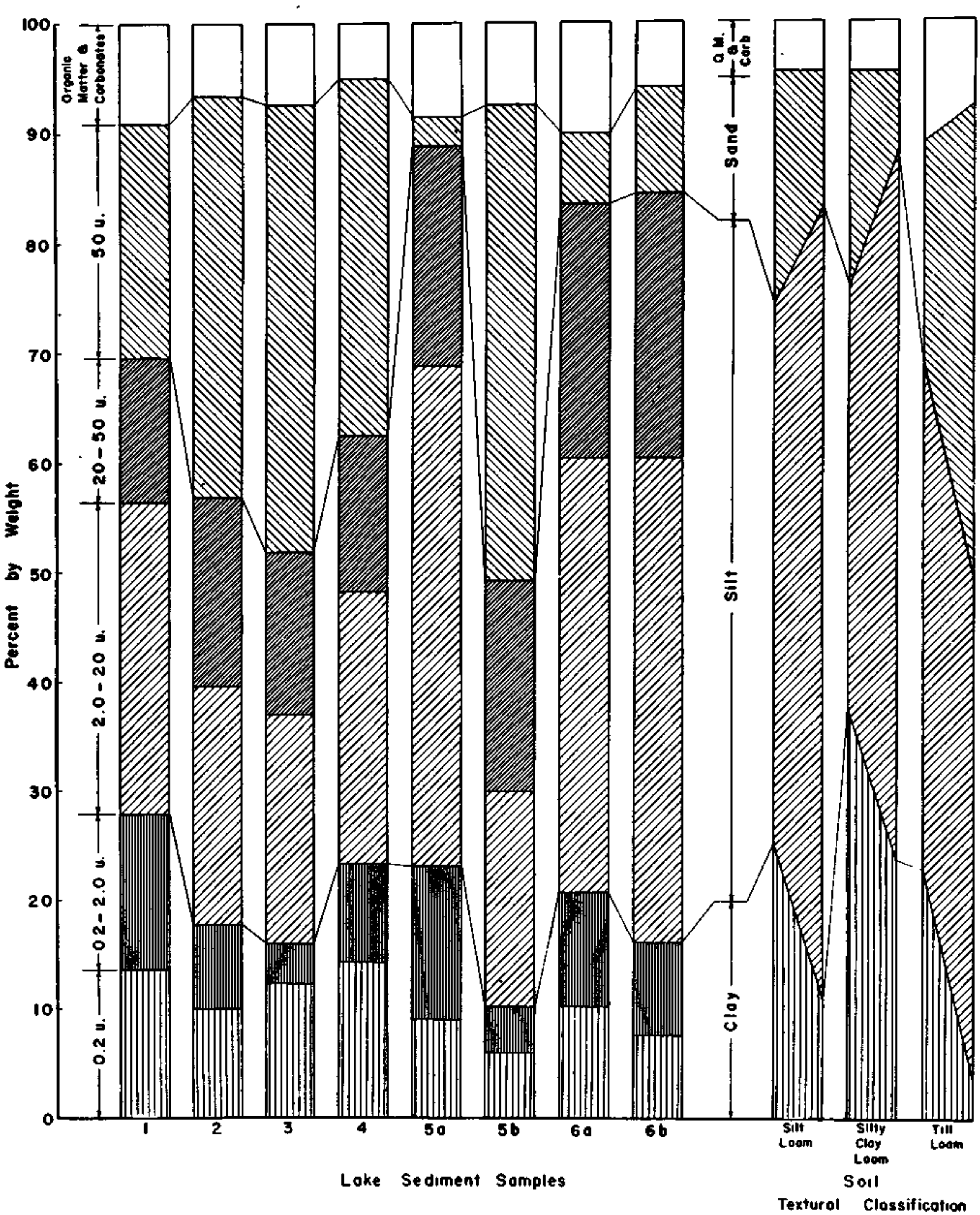

Figure 11. Particle Size Distribution of Lake Sediment and Soils Similar in Texture to the Watershed Soils.

ary of the Bloomington Ridged Plain,[5] a minor division of the Central Lowland Province. The Bloomington Ridged Plain is characterized by flat or gently undulatory till plain interspersed with low, broad morainic ridges.

The topography of the watershed above Ridge Lake is related to stream sculpture, with local modification by underlying rock structure. In general, the watershed might be considered as a gently rolling plain, deeply incised by the main and tributary valleys. Two-thirds of the total watershed area, comprising its outer margins, is level to gently sloping topography, whereas one-third, occupied by the stream valleys, is steep and rough. Steepest slopes are found on the side walls of the lower part of the main valley adjacent to the lake. The shape of the drainage basin is ovoid and the drainage pattern is dendritic. The channel density, or length of channelization per unit of drainage area, amounts to 64. 22 feet per acre, as determined from aerial photographs.

Five soil groups were mapped in the soil conservation survey. (See Figure 12.) The soils of the watershed are largely light-colored, medium - textured, upland timber soils, with moderate to slow permeability. The predominant soil groups which occupy 95. 8 per cent of the total area of the watershed are the Ward silt loam group, the Sabina silt loam group, and the Hennepin gravelly loam group. The Ward silt loam group, which extends over 24. 5 per cent of the area, occurs on the level outer margins of the watershed. These soils are characterized by being rather poorly drained and having a moderately heavy subsoil. Adequate proportions of grasses and legumes in the crop rotation, soil fertility treatment in accordance with soil tests, addition of residues and organic matter, and drainage on level areas are needed to improve these soils. The Sabina silt loam soil group, the largest in the watershed, occurs on 37. 8 per cent of the area, mostly on moderately sloping land between the level upland and the upper slopes of the valley. These soils are moderately well drained (internal drainage), being one step better than the Ward soils in that respect. These soils should also be treated according to soil tests. Rotations should be followed, allowing the land to remain in grasses and legumes at least one-third of the time and crop residues returned to the soil. Conservation practices, such as contouring, should be followed on the sloping land. The Hennepin gravelly loam group, occupying 33.5 per cent of the watershed area, occurs on the steep side slopes of the main valley and tributaries. These soils are largely derived from glacial material with very thin loessal mantle. They are best adapted to pasture or trees. The Virden silty clay loam group occurs in the depressional areas on the level upland. This is a darker soil, probably developed under timber vegetation. The moist conditions favoring organic matter accumulation during the early period of soil development caused the darker color. These soils differ from Drummer silty clay loam in that they are not as dark in color and are less permeable. Bottomland soils occupy 1.3 per cent of the watershed area. Excepting them, all soils in the watershed are developed from a thin loess covering over permeable glacial materials of the Wisconsin age. The acreage and percentage of the various soil groups in the watershed[6] are shown in Table 4.

Upland timber soils such as those occurring in the Ridge Lake watershed, are usually low in organic matter and less productive than upland prairie soils found elsewhere in the State.

Slopes

Steepness of slope affects the velocity of runoff and the rate of erosion. Slopes were defined in seven slope classes in the conservation survey. "A" slopes are those of less than 1 1/2 per cent; "B", 1 1/2-4 per cent; "C", 4-7 per cent; "D", 7-12 per cent; "E", 12-18 per cent; "F", 18-30 per cent; and "G", over 30 per cent. (See Table 5.) In general, the distribution of slopes in this watershed is abnormal. The higher land of the watershed, occupying about 65 per cent, or nearly two-thirds of the area, is moderately sloping to nearly level. This area breaks off abruptly into steep valley side slopes of the large tributaries and the main stream of the watershed.

Soil groups are closely related to slopes with the Virden silty clay loam and the Ward silt loam groups occurring on "A" slopes; Sabina silt loam occurring mainly on "B" slopes; and the Hennepin gravelly loam group occurring on "G" slopes. Soils occupying level to gently sloping land are light to moderately dark, and medium to moderately heavy textured. Permeability is moderately slow to slow. Soils on the steeper slopes are light-colored and medium textured with moderate permeability.

Land Use

One of the most important factors influencing erosion and the rate of sediment production is land use and farming practices. Four classes

5. Leighton, M. M. , Ekblaw, George E. , and Horberg, Leland. "Physiographic Divisions of Illinois," Illinois Geological Survey, Report of Investigation No. 129, 33 pp. , illus , Urbana, Ill. 1948.

6. For more detailed information on the soils in the watershed refer to the mimeographed material "Soil Group Description of Illinois for Farm Planning Surveys" prepared by the Soil Conservation Service.

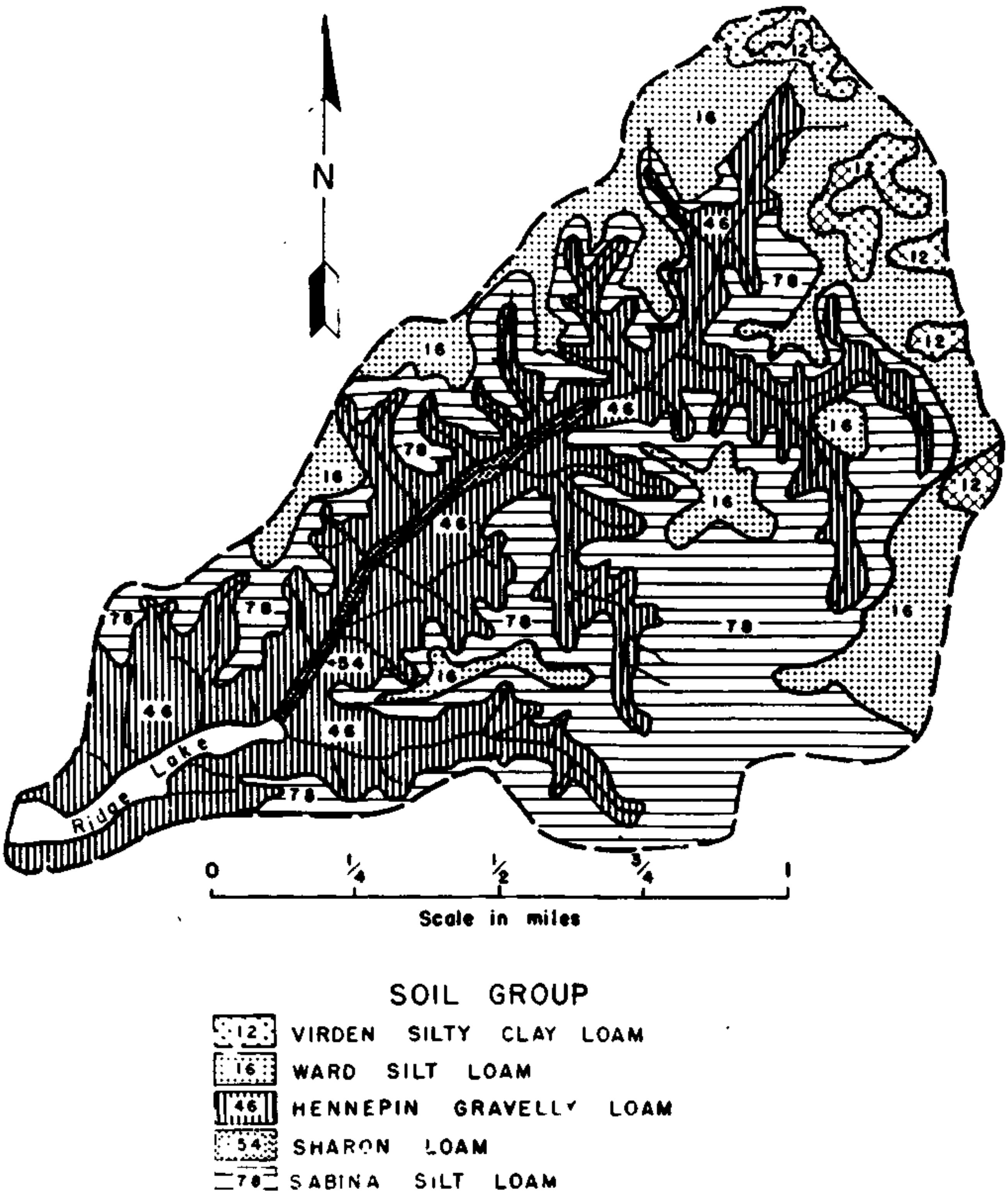

Figure 12. Soil Group Map--Ridge Lake Watershed.

TABLE 4. ACREAGE AND PERCENTAGES OF VARIOUS SOIL GROUPS IN RIDGE LAKE WATERSHED
Fox Ridge State Park, Charleston, Illinois

Soil Group	Area	
	Acres	Per cent
12. Moderately dark, to dark colored, moderately heavy textured, moderately slow permeability soils; Virden silty clay loam soil group	26.0	2.9
78. Light-colored, medium-textured, moderately slow permeability soils: Sabina silt loam soil group	334	37. 8
16. Light-colored, medium-textured, moderately slow to slow permeability soils: Ward silt loam soil group	217	24. 5
46. Light-colored, medium textured, moderate permeability soils: Hennepin gravelly loam soil group	296	33. 5
54. Light-colored, medium-textured, moderate permeability bottomland soils Sharon loam soil group	12	1. 3
Entire watershed	885	100. 0

TABLE 5. DISTRIBUTION OF THE SLOPE CLASSES IN EACH SOIL GROUP

Soil Group	A slopes (0 - 1 1/2 per cent)		B slopes (1 1/2 - 4 per cent)		C slopes (4 - 7 per cent)		E slopes (12 - 18 per cent)		G slopes (over 30 per cent)		Total
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres
12. Moderately dark, to dark moderately heavy textured, moderately slow permeability soils. . . .	26	100.0	---	---	---	---	---	---	---	---	26
78. Light-colored, medium textured, moderately slow permeability soils .	---	---	320	95.8	14	4.2	---	---	---	---	334
16. Light-colored, medium textured, moderately slow to slow permeability soils	201	92.6	16	7.4	---	---	---	---	---	---	217
46. Light-colored, medium textured, moderate permeability soils . .	---	---	---	---	---	---	5	1.8	291	98 3	296
54. Light-colored, medium textured, moderate permeability bottomland soils.	12	100.0	---	---	---	---	---	---	---	---	12
Entire watershed	239	26.6	336	38.0	14	1.6	5	0.6	291	33.2	885

of land use were mapped in the conservation survey, namely: cropland, woodland, pasture, and miscellaneous. Cropland is all land on which crops were grown at the time the survey was made. It includes land in row crops, grains, and hay. Pasture land, is land in perennial grasses; and woodland is land which is at least 40 per cent covered by the spread of trees. Miscellaneous land includes farmsteads, roads, parks, etc. As shown in Table 6, 46. 0 per cent of the land in Ridge Lake watershed is cropland; 12.6 per cent is pasture; 37.2 per cent is woodland; and 4.2 percent is used for miscellaneous purposes. Distribution of land use is shown in Figure 13.

Land use in general follows soil groups, which in turn are related to slopes. Thus, practically all cropland and pasture is located on level to moderately sloping upland, whereas most of the woodland is located on the steeper valley slopes. A large part of the woodland, however, is pastured. Eighty per cent of land on "A" slopes is used for cropland, while over 99 per cent of land on "G" slopes is used for woodland. The distribution of land use according to slopes is shown in Table 7.

In 1947, a rather high proportion of the cultivated land in this watershed was in corn and soybeans. However, in 1948 the rotation followed on the farms having the largest amount of cropland in the watershed was either a three-year rotation of corn, oats, and legumes, or a four-year rotation of corn, oats, and two years of legumes. In this way, the land use was improved and erosion reduced. Actual figures on past land use in this watershed are not available,

TABLE 6 DISTRIBUTION OF LAND USE CLASSES IN EACH SOIL GROUP

Soil Group	Cropland		Pasture		Woodland		Miscellaneous		Total
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres
12. Moderately dark to dark, moderately heavy textured, moderately slow permeability soils	26	100.0	---	---	---	---	---	---	26
78. Light-colored, medium-textured. moderately slow permeability soils	209	62.5	78	23. 3	15	4. 7	32	9.5	334
16. Light-colored, medium-textured, moderately slow to slow permeability soils	170	78. 3	34	15.6	8	3.6	5	2 5	217
46. Light-colored, medium textured, moderate permeability soils	2	0.7	---	---	294	99 3	---	---	296
54 Light-colored, medium-textured, moderate permeability bottomland soils	---	---	---	---	12	100.0	---	---	12
Entire waterahed	407	46.0	112	12.6	329	37.2	37	42	885

TABLE 7. DISTRIBUTION OF LAND USE CLASSES IN EACH SLOPE CLASS

Land Use Class	A slopes (0 - 1 1/2 per cent)		B slopes (1 1/2 - 4 per cent)		C slopes (4 - 7 per cent)		E slopes (12 - 18 per cent)		G slopes (over 30 per cent)		Entire Watershed	
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent
Cropland	188	78.8	210	62.5	7	50.0	---	---	2	0. 7	407	46.0
Pasture	34	14.2	72	21.4	6	42.9	---	---	---	---	112	12.6
Woodland	12	5.0	23	6.9	---	---	5	100.0	289	99. 3	329	37.2
Miscellaneous	5	2.0	31	9.2	1	7. 1	---	---	---	---	37	4.2
Total	239	100.0	336	100.0	14	100.0	5	100.0	291	100.0	885	100.0

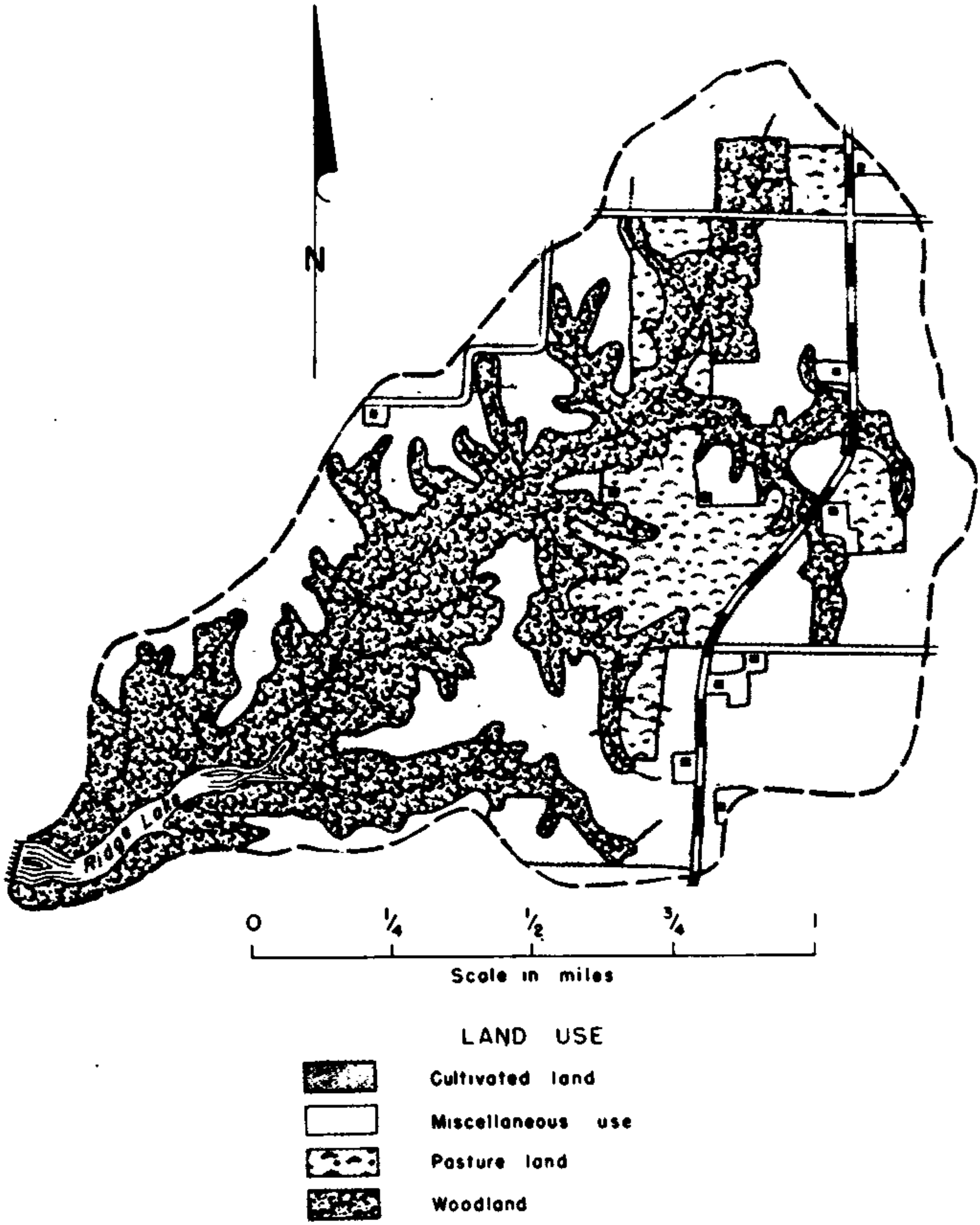

Figure 13. Land Use Map--Ridge Lake Watershed.

but presumably it followed a pattern similar to that of Hutton and Pleasant Townships, and Coles County as a whole. During the war years the tillable land in this county was cropped more intensively than is desirable from the standpoint of a sound, long-time land use program. The acreages of intertilled crops, corn and soybeans, were increased, while acreages of small grains, hay and rotation pasture, were decreased. (See Table 8.) In this watershed, however, most of the rolling land has been kept in pasture or in timber, a large part of which is pastured.

Approximately 65.0 per cent of the total land in the watershed is suitable for safe cultivation with protective rotations and conservation treatments. Of this, 2.9 per cent is Class I land, 58. 8 per cent is Class II land, and 3. 3 per cent is Class III land (see Table 9). Of the land suitable for cultivation, practically all requires easily applied conservation treatments. Only

TABLE 8. LAND USE, COLES COUNTY AND HUTTON AND PLEASANT GROVE TOWNSHIPS, 1938-47 AVERAGES

Crops	Coles County			Hutton and Pleasant Grove Townships		
	3-year average 1938-40	3-year average 1945-47	10-year average 1938-47	3-year average 1938-40	3-year average 1945-47	10-year average 1938-47
Corn and soybeans (intertilled crops)	57	67	62	46	49	50
Small grains	10	12	11	7	7	8
Hay and rotation pasture (legume and grasses)	23	18	20	40	36	36
Other (includes idle and failure)	10	3	7	7	8	6

TABLE 9. LAND CAPABILITY COMPARED WITH EXISTING LAND USE AT TIME OF SURVEY

	Cropland		Pasture		Woodland		Miscellaneous		Total	
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent
Class I Land Suitable for cultivation, requiring no erosion control practices to maintain soil for general agricultural purposes	26	100	---	---			---	---	26	2.9
Class II Land Good land that can be cultivated safely with easily applied practices	364	70.0	106	20.3	15	2.8	36	6.9	521	58.8
Class III Land Moderately good land that can be cultivated safely with such intensive treatments as terracing and strip-cropping	15	50.0	6	20.	8	26.6	1	3.4	30	3.3
Class V Land	---	---	---	---	12	100	---	---	12	1.3
Class VI Land Not recommended for cultivation. Best suited for permanent pasture	---	---	---	---	5	100.0	---	---	5	0.5
Class VII Land Not recommended for cultivation. Suited for woodland or pasture with major restrictions in use	2	0.7	---	---	289	99.3	---	---	291	33.2
Entire watershed	407	46.0	112	12.6	329	37.2	37	4.2	885	100.0

46.0 per cent of the watershed area was being used for cropland in 1948. Existing land use in comparison with land use capability is shown in Table 9. In this watershed most of the land is used properly in relation to its capability.

Erosion

The amount of gross erosion in a watershed depends primarily on the nature of the soils, slopes, land use, and farming practices. The rate of sedimentation of a reservoir depends on how much of the eroded material is transported to the reservoir. Erosion occurs in two different forms, sheet erosion and gully or channel erosion. In the conservation survey both sheet erosion and channel erosion were mapped. In addition, deposition at the base of slopes and in channels was mapped to provide a basis for determining not only the relative source of sediment, but also for estimating the relative proportions of sediment delivered to the reservoir.

The degree of erosion that has taken place in the watershed was mapped by comparing the thickness of different soil layers with that of similar soils and slopes in locations protected from erosion. The following erosion groups were mapped:

0. No apparent erosion: Approximate original depth of topsoil still remains.
1. Slight to moderate erosion: Over seven inches of original topsoil remaining, no subsoil exposed by plow.
2. Moderately severe erosion: Occasional to frequent exposure of subsoil by plow, three to seven inches of topsoil remaining.
3. Severe erosion: Erosion of the subsoil, less than three inches of surface soil remaining.

The conservation survey shows that no apparent erosion occurs on 27.0 per cent of the area. Erosion has been slight to moderate on 62.5 per cent of the area, moderately severe on 7.8 per cent of the area, and severe on 2.7 per cent of the area. (See Table 10.) The severe erosion occurs on "G" slopes which are all in woodland. Moderately severe erosion occurs on "B", "C", and "E" slopes (see Table 11) from land that is mostly in croplands (see Table 12). Slight to moderate erosion occurs mainly on "B" slopes used predominantly for cropland and pasture, and on "G" slopes used largely as woodland pasture.

Sources of Sediment

Because of the steep slopes in this watershed, runoff is rapid, and because of the high channel density, there is little chance for deposition of the sediment once it is thrown into suspension in the runoff water. There is some evidence of deposition on the flood plain of the main stream above the reservoir. However, most of the material eroded, both from the upland areas and from gullies and natural water courses, is carried through the drainage system to the reservoir delta and to the reservoir bottom.

The rather uniform "loam" texture of the sediment in all areas of the lake and its similarity to the underlying Wisconsin till, as shown by mechanical analysis of sediment deposits, is highly suggestive of gully erosion. Within the

TABLE 10. DISTRIBUTION OF THE EROSION GROUP IN EACH SOIL GROUP

Soil Group	No apparent erosion		Slight to moderate erosion		Moderately severe erosion		Severe erosion		Total
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres
12. Moderately dark, to dark, moderately heavy textured, moderately slow permeability soils	26	100.0	---	---	---	---	---	---	26
78. Light-colored, medium-textured, moderately slow permeability soils			270	81.4	64	18.6	---	---	334
16. Light-colored, medium-textured, moderate to slow permeability soils	201	92.6	16	7.4	---	---	---	---	217
46 Light-colored, medium-textured, moderate permeability soils	---	---	267	90.2	5	1.7	24	8.1	296
54. Light-colored, medium textured, moderate permeability bottomland soils	12	100.0	---	---	---	---	---	---	12
Total	239	27.0	553	62.5	69	7.8	24	2.7	885

TABLE 11. DISTRIBUTION OF EROSION GROUPS IN EACH SLOPE CLASS

Erosion Group	A slopes (0 - 1 1/2 per cent)		B slopes (1 1/2 - 4 per cent)		C slopes (4 - 7 per cent)		E slopes (12 - 18 per cent)		G slopes (over 30 per cent)		Entire Watershed	
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent
No apparent erosion	239	100.0	--	---	---	---	--	---	---	---	239	27.0
Slight to moderate erosion	---	---	286	85.1	---	---	---	---	267	91.8	553	62.5
Moderately severe erosion	---	---	50	14.9	14	100.0	5	100.0	---	---	69	7.8
Severe erosion	---	---	---	---	---	---	---	---	24	8.2	24	2.7
Total	239	100.0	336	100.0	14	100.0	5	100.0	291	100.0	885	100.0

TABLE 12. DISTRIBUTION OF EROSION GROUPS IN EACH LAND USE CLASS

Erosion Group	Cropland		Pasture		Woodland		Miscellaneous		Entire Watershed	
	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent
No apparent erosion	188	46.2	34	30.4	12	3.6	5	13.5	239	27
Slight to moderate erosion	166	40.8	68	60.7	288	87.5	31	83.8	553	62.5
Moderately severe erosion	53	13.0	10	8.9	5	1.6	1	2.7	69	7.8
Severe erosion	---	---	---	---	24	7.3		---	24	2.7
Total	407	100.0	112	100.0	329	100.0	37	100.0	885	100.0

watershed area, only the Hennepin gravelly loam (Soil Group No. 46, Figure 12) is sufficiently eroded to have an exposed subsoil. It is therefore quite probable that this soil which is largely in woodland, is the source of a large part of the sediment accumulating in the lake.

The reservoir survey shows that 3848 tons of sediment per year are deposited in the reservoir proper and in the above crest deposits near the head of the reservoir. The watershed conservation survey indicates that under present conditions the soil loss from sheet erosion amounts to 1632 tons per year. It may be concluded that the remaining 2216 tons of sediment which reaches the reservoir each year is derived from gully and channel erosion on the steeper slopes along the main watercourses. Thus, 42 per cent of the total volume of material eroded from this watershed is derived from sheet erosion, and '58 per cent from channel erosion.

Conservation

Application of intensive conservation practices on all cultivated, pasture, and woodland, will achieve a measurable reduction of erosion and sediment production.

Nearly all of the land in the watershed suitable for continuous cultivation is Class II land, which requires easily applied practices such as contouring with proper crop rotations to reduce soil erosion and increase productivity. Because of the low productivity and high percentage of sloping land in the watershed, land use recommendations should be adjusted to reduce the acreage of intertilled crops and to increase acreages of small grains, hay, and rotation pasture. This is especially important if lake sediment is to be reduced. A large amount of the cropland has been limed and some phosphate has been supplied.

Very little of the pasture land has been treated. This land could be improved by adequate applications of limestone and phosphate, and the use of alfalfa-brome grass combination for the hay and pasture used in rotation. Permanent pastures in the watershed, for the most part, are badly in need of a pasture-rejuvenation program. At the present time the livestock population is in excess of the carrying capacity of these untreated pastures. A complete pasture improvement program, including application of needed limestone and mixed fertilizers, phosphate, terracing, and reseeding to a good legume-grass mixture, plus controlled grazing should reduce soil erosion and pay dividends in this area.

Better treatment and management of timber land is also needed. A large part of the timber is pastured. Where livestock are allowed to graze on the steeper slopes, increased erosion occurs. Proper woodland management in the watershed would greatly reduce erosion on the steeper slopes, which now provide a sizeable proportion of the total sediment deposited in Ridge Lake.

Coles County Soil Conservation District

The Coles County Soil Conservation District was formed in December 1949, for the purpose of promoting and carrying out soil and water conservation work in the county. This District is a local unit of government, operating under state law. The District is similar to the other 94 soil conservation districts within the State of Illinois. These districts cover 95 per cent of the area of the state.

The Soil Conservation District, as set up under Illinois law, has five directors. The directors are landowners who plan and guide the program of soil conservation within the district. In the self-governing district, farmers cooperate to protect their land. The work of each farmer on his own farm fits into a district-wide plan. Farmers often work in groups, helping each other apply good land use and conservation measures to their land. The directors of the soil conservation district are empowered to develop, with the cooperation of farmers, comprehensive plans for the conservation of soil and water resources within the district. They are also authorized to enter into agreements with agencies, governmental or private, which are in a position to assist them with the program.

The principal agencies which have cooperated with the districts up to this time, have been the Soil Conservation Service of the U. S. Department of Agriculture, and the Extension Service in Agriculture and Home Economics of the University of Illinois. The Soil Conservation Service has assisted by furnishing trained conservationists, engineers, and soils surveyors to aid in carrying out each district's program. The Extension Service, through the county farm advisor, has carried on an educational program, both preceding the district organization and as part of the district program.

Some erosion problems are so acute that they can not wait. Work on these critical areas must be done now to prevent lasting damages, not only to the land itself, but in this case, to Ridge Lake. Other problems can wait a few years without so much damage. Therefore, the supervisors of the district usually plan to work first on those areas that are most dangerous. After the work plan has been made for the district, a conservation plan is made for each of the individual farms, showing how each field should be used and treated. An individual plan is needed for each farm, because each farm is operated as a separate unit. In a watershed treatment program each farm plan should dovetail into the plans for neighboring farms to give full protection to all the land of that particular watershed. In the Ridge Lake watershed, such a group plan will be necessary so that a coordinated erosion-control program can be accomplished without unbalancing the operation of any individual farm, and to make the program most effective.

RESULTS

CAUSE OF HIGH RATE OF STORAGE LOSS

Reservoir Design Factors

It appears that the original design of Ridge Lake was not seriously inadequate from the standpoint of sedimentation. As late as 1935-1940 when this design was being executed, there was little available information from which to estimate the rate of sediment production from a watershed of this nature and small size. The Ridge Lake design work was carried out on the basis of results from much larger watersheds which have characteristically lower rates of sediment production.

Table 13 presents several of the pertinent facts concerning the sedimentation of Ridge Lake as compared to similar data on five other reservoirs in Central Illinois. It is seen from Table 13 that the annual rate of storage loss is generally largest where the original capacity/watershed ratio is low. It is understandable that in cases where a large storage capacity is developed on a given watershed, the per cent of storage lost each year is smaller than in the case where a small capacity reservoir is built on the same watershed. For example, Lake Springfield, with an original capacity of 230 acre-feet per square mile of drainage, is silting at a rate of 0. 30 per cent annually; while Spring Lake, which has nearly the same rate of sediment production from the watershed as Lake Springfield, is losing capacity at a rate of 2. 32 per cent annually.

TABLE 13. SEDIMENTATION OF RIDGE LAKE COMPARED IO OTHER ILLINOIS RESERVOIRS

	Ridge Lake	Pittsfield Reservoir	Lake Bracken, Galesburg	Spring Lake, Macomb	Lake Springfield	Lake Decatur
Watershed Area						
Square miles	1.41	1.84	8.91	20.2	265	906
Original Capacity						
Acre-feet	187	367	2.881	607	61,039	19, 738
Million gallons	61.1	120	942	198	19,959	6,454
Original Capacity-Watershed Ratio						
Acre-feet/Square mile	133	199	323	30.1	230	21.8
Age When Surveyed						
Years	6.4	21.5	25.6	20.4	14.6	24.2
Total Loss of Capacity						
Per cent	8. 3	36.8	14.9	47.3	4.4	26.2
Annual Loss of Capacity						
Acre-feet	2.4	6. 3	16.8	14.2	182	236
Million gallons	0.8	2. 1	5.5	4.6	59.5	77.2
Per cent	1.29	1.71	0.58	2.32	0.30	1.20
Annual Rate of Sediment Production						
Cubic feet/Acre	120.3	241	132.6	48.2	48	17.8
Tons/Acre	4.36	4.83	3.45	1.44	1.03	0.46

REMEDIAL MEASURES

Practicability

During the 6.4-year life of Ridge Lake prior to this survey, the rate of storage loss was 1.29 per cent per year. The total capacity loss in this time, however, amounts to 8. 3 per cent. At Lake Decatur it has been shown' that a comparable rate of storage loss (1. 20 per cent per year) has seriously threatened the adequacy of the reservoir for water supply in only 26.2 years. At Spring Lake, Macomb, the usefulness of the reservoir has been seriously impaired after only 20. 4 years.[8]

7. Brown, C. B. , Stall, J. B. , and DeTurk, E. E. "Causes and Effects of Sedimentation in Lake Decatur," Illinois State Water Survey Division, Bulletin No. 37, 1947.

8. Stall, J. B., Gottschalk, L. C., Klingebiel, A. A., Sauer, E. L., and DeTurk, E. E. "The Silt Problem at Spring Lake, Macomb, Illinois," Illinois State Water Survey Division, Report of Investigation No. 4, 1949.

It is believed that stringent remedial measures carried out on the Ridge Lake watershed in the near future would be of great value in lengthening the total life of this lake. It is fortunate that the rapid rate of storage loss has been discovered early in the life of the lake so that remedial measures 'can be applied in time to be of full benefit.

General

In cases where reservoir sedimentation has resulted in serious loss of capacity, measures such as raising the dam, dredging, developing auxiliary storage, construction of upstream sediment basins, planting thick-growing vegetative screens near the head of the lake, watershed treatment measures, etc. , are given consideration.[9] In cases such as Ridge Lake, where the seriousness of the sediment-control prob-

9. "The Control of Reservoir Silting, " U. S. Department of Agriculture, Misc. Publ. No. 521, Washington, D. C. 1944.

lem is realized soon enough, a watershed treatment program can be installed to extend the life of the lake. Such a program, in addition to reducing reservoir sedimentation, keeps the soil from leaving the farm land.

Raising the Dam

One of the first actions usually considered by lake-owners when it becomes necessary to overcome sediment encroachment, is the raising of the dam and spillway to increase the volume of storage in the lake. At Lake Decatur such action has been recommended by consulting engineers 10 as the first step in perpetuating adequate storage space for a water supply for the City of Decatur. At Ridge Lake, however, the demand for adequate storage space>for water supply does not exist; no water is pumped from the lake. At this early stage in the life of Ridge Lake, when the total capacity loss has been only 8. 3 per cent, it is not believed that raising the spillway is necessary. Other control measures, as discussed below, seem more applicable in this case.

Dredging

Past experiences of lake-owners indicate that the removal of sediment by dredging is usually uneconomical compared to other methods of restoring or saving storage space. However, where it is impracticable or very expensive to raise the dam to develop additional storage, or where deltas appear to mar the recreational value and lower esthetic appeal, dredging has been undertaken. At Ridge Lake it appears that measures other than dredging are more applicable since the lake is relatively young and extensive delta areas have not yet appeared.

Sedimentation Basins

Sedimentation basins have been used by some reservoir owners for control of sedimentation. They are particularly effective if: (1) the sediment load consists primarily of coarser silts and sand, (2) suitable sites are available on the principal sediment-contributing streams, (3) immediate control of sediment is necessary, and (4) no other means of control can be developed. At best, sedimentation basins afford only temporary relief, but are useful to reduce sediment inflow until such time as other means of control can be established. The use of sedimentation basins in this watershed should be considered as a possible supplement to other methods of control in the event that a more complete reduction of sediment is desired than that provided by a land treatment and gully control program.

10. "Report on Lake Decatur Development and Water Supply Improvements," City of Decatur, Illinois, October 1948. Prepared by Warren & Van Praag, Consulting Engineers, Decatur, Illinois.

Land Treatment Program

It should be recognized that the maintenance of the necessary storage capacity in Ridge Lake or any other lake, can be assured by the provision of large amounts of excess storage for the silt which deposits therein. When the sedimentation problem becomes acute and physical conditions permit, raising the dam would provide excess storage which would overcome the immediate problem. This 'would be a form of insurance against premature depletion of needed storage capacity. It may be, however, that this excess investment could be better spent in another way; namely, in reducing the rate of sediment production from the drainage area through aid to the soil conservation program to reduce sheet and gully erosion.

One of the methods of effecting a permanent reduction in the rate of sediment inflow to Ridge Lake, is the establishment of an intensive land treatment program on the watershed to control sheet erosion on the farmland. Such a program has the double benefit of reducing siltation in the lake, and providing for more permanent productivity of the farmland. Because of the seeming feasibility of establishing such a conservation program on the Ridge Lake watershed, an investigation has been made of the elements of such a program and the possible benefits.

By study of the conservation survey data, it is possible to estimate the annual soil loss from sheet erosion in this watershed, and the probable reduction that can be accomplished under a land treatment program.

Table 14 shows the estimated reduction in sheet erosion that could be effected by a land treatment program. Under present conditions, the total soil loss from sheet erosion is calculated to be 1,632 tons per year. To establish this estimate, a review was made of the land use followed during the past two years. This showed that a corn - oats - clover rotation prevailed in this area. An annual soil loss of 0. 6 tons per acre was assumed for pasture and woods under present management. It is estimated this could be reduced to 0. 2 ton per acre under the recommended conservation program. No loss was assumed for level pasture and woods.

Table 14 shows that the present total annual soil loss, 1,632 tons, could be reduced to approximately 1, 071 tons, or 34 per cent (reduction by weight). This would amount to a reduction of about 14 per cent of the estimated average annual sediment inflow to the reservoir. The program recommended to bring about such a reduction is itemized in Table 14. This recom-

TABLE 14. ESTIMATED REDUCTION IN SHEET EROSION FROM A WATERSHED TREATMENT PROGRAM
RIDGE LAKE WATERSHED, ILLINOIS

Without Program

Soil	Land in Cultivation		Land in Pasture		Land in Misc. Use		Total Annual Soil Loss
	Acres	Annual Soil Loss Tons	Acres	Annual Soil Loss Tons	Acres	Annual Soil Loss Tons	
12. Moderately dark to dark colored, moderately heavy textured, moderately slow permeability soils	26	0	0	0	0	0	0
16. Light colored, medium textured moderately slow to slow permeability soils	170	168	42	5	5	0	173
46. Light colored, medium textured moderate permeability soils	2	110	294	402	0	0	512
54. Light colored, medium textured moderate permeability bottomland soils	0	0	12	0	0	0	0
78. Light colored, medium textured moderately slow permeability	209	870	93	57	32	20	947
Total	407	1,148	441	464	37	20	1,632

With Conservation Program

Soil	Land in Cultivation		Land in Pasture		Land in Misc. Use		Total Annual Soil Loss	Recommended Practice	Recommended Rotation	Acres
	Acres	Annual Soil Loss Tons	Acres	Annual Soil Loss Tons	Acres	Annual Soil Loss Tons				
12. Moderately dark to dark colored, moderately heavy textured, moderately slow permeability soils	26	0	0	0	0	0	0	None	2-1-1	26
16. Light colored, medium textured, moderately slow to slow permeability soils	184	166	28	2	5	0	168	None Contour'	1-1-1	176 8
46. Light colored, medium textured, moderate permeability soils	0	0	296	59	0	0	296	Stabilize gullies	Protect woods, control grazing on pastures	296
54. Light colored, medium textured, moderate permeability bottomland soils	0	0	12	0	0	0	0	None		12
78. Light colored, medium textured, moderately slow permeability soils	249	576	53	11	32	20	607	Contour Contour Contour	2-1-2 1-1-1 1-1-4	196 46 7
Total	459	742	389	72	37	20	1,071			

mended program is based on standard land use capability recommendations and slope practice data of the Soil Conservation Service.

Under the conservation program outlined in Table 14, the major change in land use is in the , conversion of 52 acres from pasture to cultivation. Contour cultivation is recommended on 8 acres of Ward and on the 249 acres of Sabina soil groups. On the 296 acres of Hennepin gravelly loam in the watershed, it is recommended that pasture and woodlands be established. This soil should not be cultivated. Woodland in this area should be protected from grazing, and where necessary more trees should be planted. This protection from grazing and establishment of forest cover is especially important on slopes over 30 per cent. The crop rotations now being followed in the watershed can be considered generally adequate. The rotations recommended in Table 14 do not represent a major change in this respect. The entire conservation program outlined here is considered adequate from a farming standpoint to hold soil losses to a reasonable level. If a more intensive program were desired to reduce further the soil losses, a higher percentage of grasses and legumes would be introduced into the crop rotations.

Since the conservation program outlined in Table 14 accomplishes only a 34 percent reduction in soil loss, and a 14 per cent reduction in the sediment reachingthe reservoir, more rigid land treatment measures may be necessary to extend further the life of the lake. Such measures would be concentrated on the critical sheet erosion areas on sloping and steep land adjacent to drainageways. Serious erosion is taking place around some of the building lots and livestock pens on and near the steep slopes adjacent to natural drainageways.

In addition, supplemental means must be developed to effect a substantial additional reduction of sediment inflow to the reservoir. To achieve this, a complete watershed treatment program, including gully stabilization, is necessary.

Gully Control Measures

Stabilization measures are recommended in Table 14 on the 296 acres of Hennepin soils on this watershed (see Figure 13). As shown in earlier sections of this report, it is believed that 58 per cent of the sediment reaching Ridge Lake originates from gully erosion in this soil.

Inspection of the slope data on the main channel of Dry Run Creek does not suggest that this channel is actively eroding. For approximately 4,000 feet above the head of Ridge Lake, the slope of the stream bed is 1.02 per cent; for the upper reaches of the channel (approximately an additional 4,000 feet) the slope is 2.08 per cent. In Figure 14 is shown the appearance of the main channel about 2, 000 feet above the headwaters of the lake. Although this channel is not believed to be degrading seriously, the steep stream banks may be eroding due to the lateral meanderings of the stream. In period of flood this stream leaves its banks completely and inundates much of the flood plain of the lower stream. At such times the thick vegetation of the flood plain greatly reduces the velocity of runoff and considerable deposition of silt takes place as stated earlier (see Figure 10).

The watershed survey shows that many of the smaller gullies in the Hennepin Soil Group are actively eroding. Many are incised into the steep side slopes of the main valley. Other active gullies occur in the upper reaches of the main channel. The side gullies have very steep grades and side slopes, and control of these gullies can be accomplished only by very stringent measures. Some gullies may be controlled by shaping and seeding. In all cases slopes should be protected from grazing and vegetation, or forest cover should be introduced and maintained. In many cases gully control structures may be necessary, ranging from simple, inexpensive check dams, to large, permanent check dams; or drop structures constructed of concrete blocks, reinforced concrete or masonry.

In Figure 15 is shown gully erosion at the head of one of the main waterways leading into Ridge Lake. Note the hogs in the gully. The hogs root loose sod helping to speed up erosion. Areas such as this contribute heavily to the sediment load of the stream which carries it into the lake. The need for control measures is evident in the photograph.

It is believed by the authors that stabilization of these gullies is the most important single control measure needed to reduce the sedimentation in the lake.

Reduction of Sedimentation

The amount of reduction of sediment achieved by stabilization of gullies will depend on the completeness of application of control measures. For the purpose of further analysis of the effects of a watershed treatment program, it is estimated that with a reasonable amount of control of major sediment-producing gullies, soil loss from this source can be reduced by one-half. Sheet erosion is contributing 42 per cent of the sediment reaching the lake, so this 34 per cent reduction in sheet erosion will reduce the sediment reaching the reservoir by 14 per cent. Gully erosion is contributing 58 per cent of the sediment reaching the lake, so the reduction of gully erosion by 50 per cent will reduce the sediment reaching the lake by 29 per cent. The combination of the 14 per cent reduction by land treatment, and 29 per cent reduction by gully stabilization will effect a total reduction of 43

Figure 14. View of Stream Channel above Lake.

Figure 15. Gully Erosion on One of the Main Waterways Leading into the Lake.

per cent of the sediment inflow to the lake. The rate of storage loss would thus be reduced from 1.29 per cent to 0.74 per cent per year. The volume of sediment reaching the lake each year would be reduced from 2.44 acre feet to 1.39 acre feet.

In Figure 16 is shown the loss of capacity of Ridge Lake compared to similar losses in several other Illinois reservoirs. It is seen that the present rate of loss (1.29 per cent per year) is very close to that occurring in Lake Decatur Also shown in this figure, is the reduction of the silting rate which could be accomplished by the watershed program described above. If such a program were established beginning in 1951, the capacity loss would follow the line labelled "43 per cent reduction." Greater reductions could be achieved only through more complete control of gullies or development of sedimentation basins.

This application of land treatment and gully control should be carried out immediately if the most benefit is to be derived from the work. It is believed that such a program could be applied to this watershed within a period of five years if effort were concentrated.

COSTS AND BENEFITS OF CONSERVATION

The adoption of a soil conservation program on the land in the Ridge Lake watershed would, in the long run, benefit the farmers financially. It would also benefit the lake owner by reducing the sediment coming into Ridge Lake. Studies of the costs and benefits of soil and water conservation and erosion control over the past ten years, show that a definite program of soil and water conservation pays the farmer in dollars and cents. It also results in reduction or elimination of erosion.

Present Practices

Increased farm returns can be secured from the crop, pasture, and woodland in Ridge Lake watershed by some adjustments in land use, erosion control and soil treatment. Approximately 46 per cent of the 885 acres in the watershed is in cropland which needs limestone, phosphate, and potash, as determined by soil tests. Land use adjustments should be made according to land- use capabilities; and contouring, terraces, and waterways would increase crop production, and reduce erosion. Pasture now occupies approximately 13 per cent of the watershed. These pastures are producing only about one-half of what they could produce if renovated, treated, reseeded, and properly grazed. Approximately 37 per cent of the watershed is in woodland on the steeper slopes. Most of this woodland is pastured, with the result that timber productionis low and livestock receive very little feed. Grazing steep woodland slopes causes much erosion.

Research studies in Indiana as reported in Purdue University Bulletin No. 391, indicate that:

> Under present grazing practices the actual forage production in farmwoods is insufficient to maintain animal weights over a six-months' season. [11]

Similar studies in Wisconsin, reported in the Journal of Forestry, show:

> 1. Woodland pastures in the 15 to 25 per cent and 26 to 35 percent slope classes, produced average annual yields of 292 and 259 pounds of dry matter per acre, respectively, during the five-year period 1941 to 1945 inclusive.
> 2. Renovated and untreated open pasture produced annually an average of 3,210 and 1,453 pounds or 11.6 and 5.3 times more forage per acre than woodland pastures. [12]

From such data it is seen that the grazing of the timbered slopes on the Ridge Lake watershed is probably uneconomical. For example, if one acre of pasture on the more level land were renovated, it would produce more forage than ten acres of the woodland. For every acre of improved pasture established, ten acres of present woodland could be protected from grazing and converted to permanent woodlot with no loss in available forage.

Land Treatment Measures

A study of 76 farms in this central area of Illinois for the five-year period 1940-1945, showed definite advantages from adopting and following a complete soil and water conservation program. In this study, farms following a conservation program were matched with farms of similar physical characteristics (land-use capabilities--soil type, slope, and degree of erosion) following the usual non-conservation system of farming. The farms with conservation plans had a land-use program and crop rotations based on the capabilities of their land. The non-conservation farms averaged only 7 per cent of their cropland in legumes and grasses, compared to 33 per cent for the farms with conservation

11. Den Uyl, Daniel and Day, R. K. , "Woodland Carrying Capacities and Grazing Injury Studies, " Purdue University Agricultural Experiment Station Bulletin No. 391, Lafayette, Indiana, 1934.

12. Ahlgren, H. L. , Wall, M. L. , Muckenhim, R. J., and Sund, J. M. , "Yields of Forage from Woodland Pasture on Sloping Land in Southern Wisconsin," Journal of Forestry, Vol. 44, pp. 709-711, Society of American Foresters, Washington, D. C., 1946.

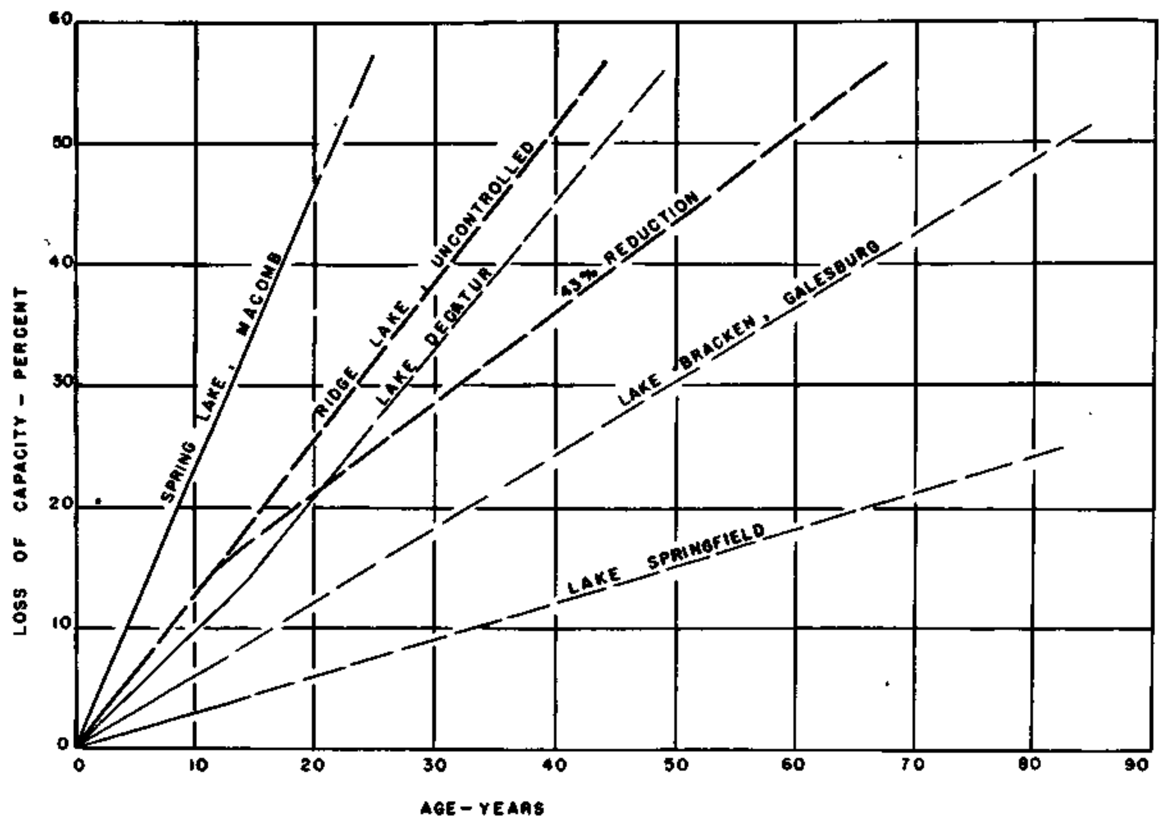

Figure 16. Silting Rate of Ridge Lake Compared to Other Illinois Reservoirs.

plans. For the five years of the study, corn yields averaged 7 bushels an acre higher on the conservation farms. The value of grain crops was equal for the two groups. In addition, the conservation farms had a large acreage of hay and pasture, resulting in livestock returns approximately three times those of the non-conservation farms. For the five-year period net farm incomes averaged $6.65 per acre per year more on the farms having conservation farm plans.

Studies of the costs and benefits of contour farming in this area show that contour farming alone, contour strip cropping and terracing result in higher crop yields and do not increase the over-all cost of farm operation. Corn, soybeans, and oats yields were increased 12, 13, and 16 per cent, respectively, from contouring. Labor, power, and machinery costs per crop acre averaged $1.20 an acre lower on the farms that were farming on the contour.

Based on studies of costs of establishing conservation in comparable areas, the cost of establishing a land treatment program for the 885 acres in the watershed would total approximately $ 16, 000. This would include costs of applying needed limestone, phosphate, and potash, establishing pasture seedings, and fencing out woodland from livestock. At present prices and considering the type of farming in this area, the cost could be repaid in five years from the increased income of a conservation program. Under normal price relationships, the cost of establishing a conservation program would probably be repaid in from five to eight years. In addition, the soil resources would be maintained and the fertility level and productivity of the farmland increased.

Gully Control Measures

Generally, the control of larger gullies by landowners is not feasible from a monetary standpoint. The financial burden must rest, therefore, with the reservoir owners if they hope to achieve a reasonable reduction in the rate of sediment production from watersheds such as this. The reservoir owners have several means of accomplishing this. They can assist the landowners to control gullies by supplying materials, labor and equipment. They can purchase or lease land too steep for cultivation or pasture and retire it to woodland, applying such supplementary measures as may be needed to stabilize gullies. They can also construct sedimentation basins above the reservoir, although this method of control is temporary and may be more costly than other methods.

The cost of installation of gully control measures in this watershed cannot be determined without further study of major eroding gullies and development of the design of structures and measures for control. The cost of controlling gullies in this watershed, however, will be considerably higher than the cost of controlling sheet erosion, but the benefits to the reservoir owners would also be greater.

RECOMMENDATIONS

It is recommended that the lake owners and operators initiate the immediate application of gully control measures and a land treatment program on this watershed. This program should be carried out in cooperation with the Coles County Soil Conservation District and other agricultural agencies in accordance with the findings of the foregoing report.

To enable full application of the needed measures, certain critical land should be acquired by the lake owner.