REPORT OF INVESTIGATION NO. 10 1951

STATE OF ILLINOIS

ADLAI E STEVENSON, Governor

THE SILTING OF LAKE BRACKEN

Galesburg, Illinois

B.O.Larson, KM.Smith, ELSauer, and
S.W. Melsted

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

DEPARTMENT OF REGISTRATION AND EDUCATION

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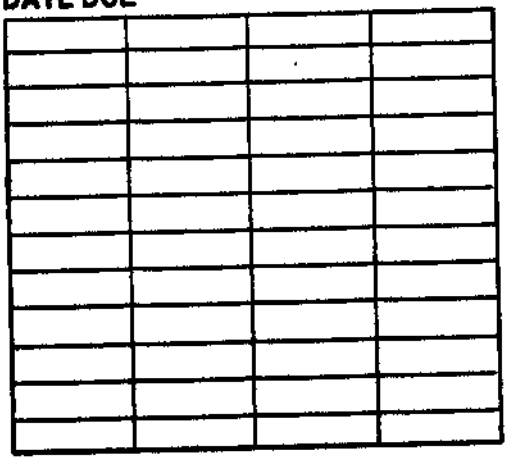

Larson, Bernt O.
THE SILTING OF LAKE BRACKEN, GALESBURG, ILLINOIS

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CONTENTS

REMEDIAL MEASURES

SUMMARY

1. Lake Bracken, near Galesburg, Illinois, was constructed in 1923 by the Chicago, Burlington and Quincy Railroad to furnish water for locomotives and for the local shops. Original storage capacity,was 2881 acre-feet and the watershed area is 9. 14 square miles.

2. A sedimentation survey made in 1936 showed that the reservoir had lost 0. 61 percent of original capacity per year. A second-survey made in 1949 indicated an annual loss of 0. 56 percent during the latter period, a slight decrease.

3. During the 25. 6 years the lake has been in existence a total of 14. 9 percent of the original capacity-has been lost to sediment.

4. Extensive recreational use is made of the lake both by private individuals and the Knox County Country Club. Many cabins have been built on the lake shores.

5. The sediment deposited in the lake represents a loss of 3. 37 tons per year from every acre in the drainage area.

6. Deposition has been considerably heavier in the extreme" upper end of all arms of the reservoir, particularly above road fills across the lake. Deltas in these areas have caused storage losses as high as 90 percent of original capacity.

7. Maximum annual pumpage from the lake amounted to 523. 5 million gallons (1943). Since then there has been a gradual decrease to 315 million gallons in 1949.

8. At the present rate of storage loss, Lake Bracken appears adequate to furnish water for the Chicago, Burlington and Quincy Railroad at the present pumping rate for the next 50 to 60 years.

9. The 16. 8 acre-feet of storage space lost to sediment every year in Lake Bracken Would cost $5565 to replace at 1950 prtce levels.

10. The particle-size distribution of sediment samples shows coarser sediments in upper portions of the lake, becoming finer in texture nearer the dam. Apparently some colloidal materials, both inorganic and organic, are carried on out of the lake over the spillway.

11. The sediment in the reservoir represents a yearly loss of plant food equivalent to approximately 80 pounds of a 25-5-4 fertilizer per acre of cropland in the watershed.

12. Comparison of chemical characteristics of sediment samples taken in 1936 and 1947 suggests that during the latter period (1936 to 1949) relatively more sediment came from erosion of subsoil materials than during the earlier period (1923 to 1936). Apparently erosion which occurred on surface soils prior to 1936 has progressed into the subsoils in more recent years.

13. Dark-colored, medium-textured, moderately permeable soils occupy 49. 3 percent of the drainage area. Approximately 46 percent of the drainage area has a slope of less than 2 percent and 72 percent of the area has a slope less than 10 per,cent.

14. The watershed survey shows that 67. 3 percent of the land is suitable for continuous cultivation (land capability classes I, II, and III). At present only minor adjustments are necessary in the watershed in so far as converting cropland to pasture and pasture to cropland. However, the cultivated land in the watershed in general is being cropped too strenuously. Too high a percentage of the land is cropped to corn and soybeans. This is true on the level land as well as the sloping areas.

15. It is estimated that 95 percent of the sediment reaching the reservoir comes from sheet erosion on the watershed.

16. A sound land-use program is needed on this watershed and must be based on an inventory of the land. This inventory may be obtained from a soil conservation survey map. Cropland and pasture areas should be tested and treated according to test The most strenuous rotation should allow the land to remain in stand-over grasses and legumes at least one fourth of the time. ,

17. Conservation practices are generally needed on all sloping cropland. These practices alone may reduce the soil loss from these areas as much as 75 percent. Pasture renovation and proper pasture management are needed and will increase farm income as well as reducesoil losses.

18. It is estimated that a complete watershed conservation program, based on the capabilities of the land and outlined in this report, would reduce the rate of siltation in the lake by approximately 84 percent.

19. The adoption of soil conservation practices means increased net income to the farmer. Illinois studies in an area comparable to the Lake Bracken watershed showed high-conservation farms had net incomes of $3. 46 per acre per year more than low conservation farms (after all costs of conservation were paid).

20. It is recommended that the lake owners and others interestedin the future life of Lake Bracken, undertake the development of a soil and water conservation program on the watershed as a means of reducing permanently the rate of sedimentation in the lake. Expenditures for such a program could be justified to an extent of approximately $4700 per year, the replacement cost of avoidable loss of storage space destroyed each year. In addition to the reductionin rate of siltation in the lake, a conservation program would save the farmers on the watershed thousands of dollars annually in plant nutrients saved. The watershed program should be carried out in cooperation with the Knox County Soil Conservation District and other agricultural agencies, and in accordance with the findings of the foregoing report.

THE SILTING OF LAKE BRACKEN
Galesburg, Illinois

by

B. O. Larson, Associate Engineer, Illinois State Water Survey Division, Urbana, Illinois

H. M. Smith, Soil Scientist, Soil Conservation Service, Urbana, Illinois

E. L. Sauer, Project Supervisor, Research, Economics of Soil Conservation, Soil Conservation Service and Illinois Agricultural Experiment Station Cooperating, Urbana, Illinois

S. W. Melsted, Associate Professor of Soil Analysis.Research, Agronomy Department, College of Agriculture and Agricultural Experiment Station, University of Illinois, Urbana, Illinois

INTRODUCTION

OBJECTIVES OF STATE-WIDE PROGRAM

For a hundred years or more surface water has been impounded in reservoirs to pro ide a reliable source of water supply for public and industrial uses in some sections of the United States. The presence of sediment in surface water and the fact that this sediment is carried by the flowing streams, into the impounding reservoirs has long been recognized. It has also been realized that this sediment that is deposited, reduces the capacity of the reservoir to store water for future use. However, until rather recently there was little quantitative data on the rates at which these reservoirs were being filled with sediment. There also had been little appreciation of the relationship between the sources of sediment on the lands of the watershed and the losses of reservoir capacity due to sedimentation.

The need for information and quantitative data on the effects and rates of siltation on surface water supplies began to be recognized in Illinois as early as 1930. A more comprehensive study of sedimentation problems was made possible when the Soil Conservation Service was created in 1935 as a permane nt agency of the U. S. Department of Agriculture for. the control of soil erosion. At this time a nation-wide study was undertaken to determine the effects of accelerated soil erosion on rates of reservoir sedimentation. Related studies were made of land use and erosion on the drainage areas. In 1936 Lake-Bracken was one of four reser oirs in Illinois that were surveyed as a part of this program.

Need for Data. Man is dependent on the soil and water, two of the most basic natural resources. Water is obtained either from ground or surface-water supplies. Precipitation gives us our surface water in that a portion of it finds its way to the lakes and streams. Since streams sometimes dry up or have a low flow due to lack of precipitation, man has constructed impounding reservoirs, the purpose being to store water from large flows during wet seasons to be available for use during periods of drouth and low run-off.

There are now some 500 lakes and reservoirs in the State of Illinois and a study of the state has been made which shows that there still remain 600 sites" where suitable reservoirs can be built economically to furnish supplies of water for various purposes.

Many of the present impounding reservoirs in Illinois have been designed and built in the past 20 to 30 years. In the design of these reservoirs the effect of sedimentation was not considered because data necessary for design on rates of sediment production were not available.

The erosion of land has long been recognized and certain corrective measures have been taken to keep the soil in place. In Illinois a considerable amount of stream-borne sediment comes from sheet erosion of comparatively level or gently sloping lands, these lands being used for production of intertilled crops. With the beginning of World War II and the need for increased production of food, more land was converted to cultivation resulting in an increase of soil erosion, and a greater amount of sediment finding its way to the streams. Due to erosion the topsoil is removed from the land-, the land becomes less productive and eventually becomes useless for crop production. Some of this eroded material enters streams on which water supply reservoirs have been built. If erosion on the land is great, the sediment load carried by the stream is large. A large portion of it is deposited in the stream channel and impounding reservoirs. As the reservoirs become filled with the sediment, the abillty to store water is reduced, and if the loss of capacity due to sedimentation is high, the reservoir may rapidly become useless. An example

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

of this is Spring Lake, a reservoir which furnishes the municipal supply for Macomb, Illinois. In 20 years, Spring Lake has lost 47. 3 percent of its original capacity due to sediment deposits. Since storage capacity is decreasing and Macomb's water demand is increasing, by 1953 the reservoir will be inadequate to furnish the needs in the event of a severe drouth.

Illinois Program. Because of the seriousness of erosion and the subsequent rapid reservoir sedimentation together with the lack of any suitable quantitative data relative to the problem, the Illinois Water Survey Division, the Illinois Agricultural Experiment Station and the Soil Conservation Service in 1936 joined in a cooperative study of sedimentation in Illinois. It was desired to determine the effects of the various watershed and climatic factors on the rate of sediment production and the rate of sedimentation of reservoirs. The original sedimentation survey of Lake Bracken in 1936 and the resurvey in 1949 were made under this program. At present sedimentation data are available on 33 Illinois reservoirs. To date detailed sedimentation surveys of 13 reservoirs have been made. It is possible from these surveys to determine accurately the original and present volume of the reservoir as well as the rate of storage loss per year. Four of these reservoirs, including Lake Bracken, have been resurveyed after an elapsed period of 10 years or more, to determine changes in rate of sedimentation. Reconnaissance surveys of seven additional reservoirs have been made to obtain, with a minimum of field effort, a maximum of data on rates of sediment production and rates of erosion. Miscellaneous data have been collected from five other lakes by observation rather than by the approved survey methods. Preliminary cross-sections have been established on five new conservation lakes that are being constructed in different parts of the state. This has also been done on several farm ponds and small lakes. In the future, resurveys of these established cross-sections will furnish data as to the amount of sediment that has been deposited on the floor of the reservoir during the elapsed period of time.

Orientation. The southern two-thirds of the state depends largely on surface water for supply, whereas the northern one-third is generally dependent on ground water sources. In the "surface water resources" area 110 communities are not adequately served by a public water supply. Ground water in this area is generally not adequate for municipal supplies. Therefore, any future water supply developments would normally include the construction of impounding reservoirs.

In classifying areas for study, the physiographic divisions and boundaries of soils of the state were considered and the program of work set up to prevent duplication and give a maximum of useful data. By doing this it will be possible to compare results of data collected under many varying conditions of soils and physiography within the state.

Reservoir sites must be considered as natural resources and every effort should be made to prevent the waste of these sites due to high rates of siltation. It is desirable to establish information on all factors that affect sedimentation. There is definitely a need for a more complete understanding of the sedimentation problem by everyone concerned: the public or private industry which will authorize funds for the construction of future reservoirs, the engineer who will be designing and building them, and the farmer who will benefit by having his topsoil retained on the land.

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) to develop methods of sedimentation control.

Need for This Report. These surveys and this report on Lake Bracken are a part of the state-wide program. This reservoir is representative of one having a very small watershed and a high capacity-watershed ratio. "As a whole the watershed is in a youthful stage of regional topographic development. The valleys are V-shaped, short, and have high gradients. At least one-third of the area lies on the loess-covered upland of the gently undulatory Illinoian till plain, into which the gullies and larger valleys have not yet extended their heads. The maximum relief of the watershed is about 100 feet. All streams contributing to the lake are intermittent."[3]

SCOPE OF INVESTIGATIONS

Lake Survey. A detailed survey of Lake Bracken was made by the Central Reservoir Party, Section of Sedimentation Studies, Division of Research of the Soil Conservation Service, between July 9 and August 15, 1936. L. M. Glymph, Jr. was chief of the party. In this survey the original and the 1936 shoreline of the lake were mapped and a series of thirty silt ranges was established on the lake. By this means the original and the 1936 capacities of the lake were determined as well as the volume of sediment deposited within the lake since its construction. Permanent monuments, consisting of iron pipe stamped with identifying station numbers and set in concrete, were used to mark all stations and range ends.

2. "The Silt Problem at Spring Lake, Macomb, Illinois, " State Water Survey Division, Report of Investigation No. 4, 1949.

3. V. H. Jones, "Advance Report on the Sedimentation of Lake Bracken, Galesburg, Illinois," U. S. Soil Conservation Service SCS - SS - 14, 10 pp., illus., processed, Washington, D. C., May 1937.

A resurvey of Lake Bracken was begun in 1947 and completed June 15 to June 29, 1949, by a field party of the Illinois State Water Survey Division. Soundings along the thirty original ranges were taken and the new cross-sections obtained. By this means the present capacity of the lake was determined as well as the total volume of silt deposited within the lake since its construction, and also the amount that had accumulated since the 1936 survey. New shorelines were mapped where the exposed delta in the tributary arms had advanced downstream beyond where they had been in the 1936 survey.

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, and erosion are included in this report. By these data it is possible to point out definite soil and water conservation measures needed on this watershed which would effectively reduce the soil losses and the sediment accumulating in the reservoir.

An additional study has been made by the Soil Conservation Service and Agricultural Experiment Station cooperating, of the land use 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 1936 survey a series of fourteen sediment samples were taken from various parts of the lake by, means of a special sampler. Chemical and physical analyses of these samples were made by the Illinois Agricultural Experiment Station. In 1947 another series of fifteen sediment samples were taken from the lake in approximately the same places they had been taken before. The chemical and physical analyses were again made by the Illinois Agricultural Experiment Station. These analyses report the texture, colloidal content, density, 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. A comparison is made of the samples obtained in 1936 and in 1947.

Interpretation of Results. The final interpretation of the silting problem at Lake Bracken has been made on the basis of the complete reservoir and watershed data by the three cooperating agencies. Results are presented so as to be most helpful to reservoir owners. Although the rate of deposition of sediment in the reservoir is not great, remedial measures to reduce this rate by the application of a complete watershed protective program are discussed.

ACKNOWLEDGMENT

Chicago, Burlington and Quincy Railroad Company. The agencies conducting this survey wish to acknowledge the generous assistance and cooperation of the Chicago, Burlington and Quincy Railroad Company owners of Lake Bracken. In 1936 Charles Bayliss, Supervising Engineer of the Galesburg Division, supplied information on the lake and dam, early maps, material for construction of the survey monuments, and space for drafting was made available to the field party when needed. E. C. Stewart, pump engineer at the lake, provided storage space for equipment during the survey and information on the quantity of water pumped from the lake. In the 1949 resurvey, Mr. H. E. Hinshaw, General Superintendent, and Mr. W. R. Eble made arrangements for helpers to assist in the survey field work.

Mr. Arnold Sweborg, Caretaker and Secretary of the Knox County Country Club, gave permission to use the club's boats for the period of the 1949 survey. Mr. Durbin, pump engineer at the lake, served as watchman of survey equipment stored temporarily at the pumping plant.

State Water Survey Division. The resurvey of Lake Bracken was made by a field party of the State,Water Survey consisting of the following men: John B. Stall, Chief of Party; Bernt O. Larson, Associate Engineer; Leslie Jones, Douglas Rucker, Thomas E. Young, and John Singer. This Division made the computations on the results of the lake resurvey, including the water and sediment volumes. The engineering section of this report was prepared by Bernt O. Larson. The entire report was prepared and edited by Mr. Stall under the supervision of Mr. H. E. Hudson, Jr., Head of the Engineering Subdivision of the Survey.

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 original survey of Lake Bracken was made by the Central Reservoir Party, Section of Sedimentation Studies, Division of Research, from July 9 to August 16, 1936. The field personnel consisted of L. M. Glymph, Jr., Chief of Party; V.. H. Jones, Assistant Chief; W. G. Shannon, H. L. Fischer, and O. D. Price. Preliminary arrangements for the survey were made by D. H. Eargle. The original survey results and computations of water and sediment volumes were made by the Soil Conservation Service, and the Advanced Report on the Sedimentation Survey was prepared by Victor H. Jones.

The Sedimentation Section of the Office of Researchin Washington furnished the specialized field equipment for the resurvey work. Mr. L. C. Gottschalk, Head of the Sedimentation Section, gave technical assistance during two weeks spent with the survey party at the beginning of the summer's work in 1947 and cooperated with the authors

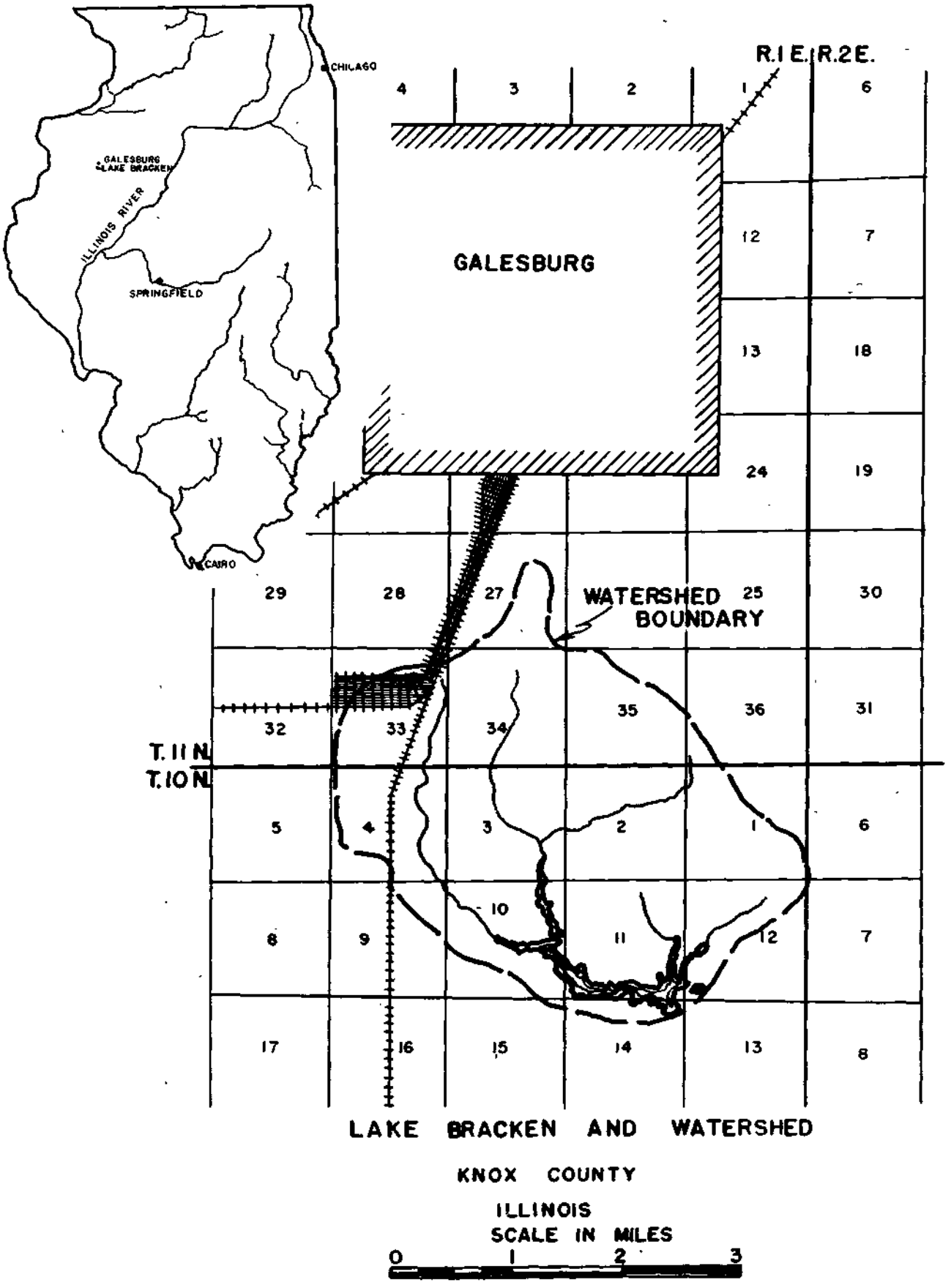
CHICAGO
GALESBURG
LAKE BRACKEN
ILLINOIS RIVER
SPRINGFIELD
CAIRO
R.1E.
R.2E.
GALESBURG
WATERSHED
BOUNDARY
T. 11 N.
T. 10 N.
N
LAKE BRACKEN AND WATERSHED
KNOX COUNTY
ILLINOIS
SCALE IN MILES
0
1
2
3

FIG. 1.

in the compilation of this report.

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

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. During the 1936 survey the Soil Conservation Service field party obtained 14 sediment samples from the reservoir. With the cooperation of Dr. E. E. DeTurk, Professor of Soil Fertility, these samples were analyzed in detail,in the laboratory of the Agricultural Experiment Station. The interpretation of the 1936 and 1949 analyses and their comparison to watershed soils has been carried out by Dr. S. W. Melsted, Associate Professor of Soil Analysis. Dr. Melsted also compiled the section of this report interpreting the analytical results.

The Illinois State Soil Conservation Districts Board cooperated in this study by financing the laboratory work in making the sediment analysis. This work was carried out in the laboratories of the Illinois Agricultural Experiment Station.

RESERVOIR

GENERAL INFORMATION

Dam. Lake Bracken is impounded by an earth dam 650 feet long, and is located in the N. E. 1/4 of Section 14, T. 10 N., R. 1 E,, Knox County. (See Figure 1.) The dam runs approximately in an east-west direction. The average elevation of the top of the dam is 707 feet above mean sea level. The maximum height of the dam is 49 feet above the valley bottom, and it is 12 feet wide at the top. The upstream face of the dam, on a slope of 3:1, is covered with a riprap of loose rock to a height of 4 feet above crest level. The slope of the downstream face is 2:1.

Spillway. The concrete spillway at the west end of the dam is 214 feet long, with the crest at 700 feet above mean sea level. Water approaches the spillway through a flat-bottomed channel about 100 feet long and 25 feet wide. The overflow descends to the level of the valley below the dam over a series of steps between concrete wingwalls. In 1931 calibrated iron V-notched weir plates were installed along the crest in order to facilitate measuring spillage. The details of the spillway crest as well as the outlet channel below the spillway are shown in Figure 2.

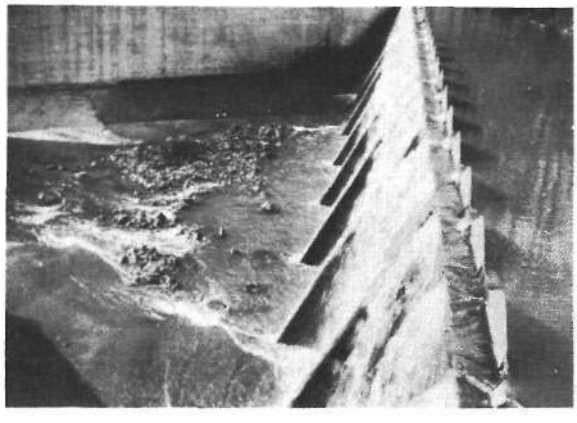

FIG. 2. SPILLWAY CREST AND OUTLET CHANNEL.

Reservoir. The reservoir is located 5 1/2 miles due south of the city square of Galesburg, Illinois, in Sections 3, 10, 11, 12, and 14, T. 10 N. , R. 1 E. of Knox County. The lake receives the drainage of Brush Creek and small tributaries. Brush Creek flows for a distance of 10 miles in a southeast direction to join Haw Creek 3 miles above its confluence with the Spoon River, which flows into the Illinois River. The lake was constructed in 1923, thus at the date of the resurvey it had been in existence about 26 years. During this time it has been the source of water for the Chicago, Burlington and Quincy Railroad. The water is used for locomotive supply and for use in the local shops of the railroad. The pumping station is located on the north shore of the lake about a half mile west of the dam. The intake tower is near the south shore and opposite the pumping station, with a line extending from the bottom of the tower to the pumping station. The 16-inch discharge line runs in a northerly direction from the pumping station to the railroad yards.

In addition to furnishing water for use by the railroad, the lake is also used for recreational purposes, chiefly by members of the Knox County Country Club.

"Lake Bracken is long, narrow and sinuous in general outline, but its shoreline is made very irregular by several tributary arms."[4] (See

4. Ibid., p. 4.

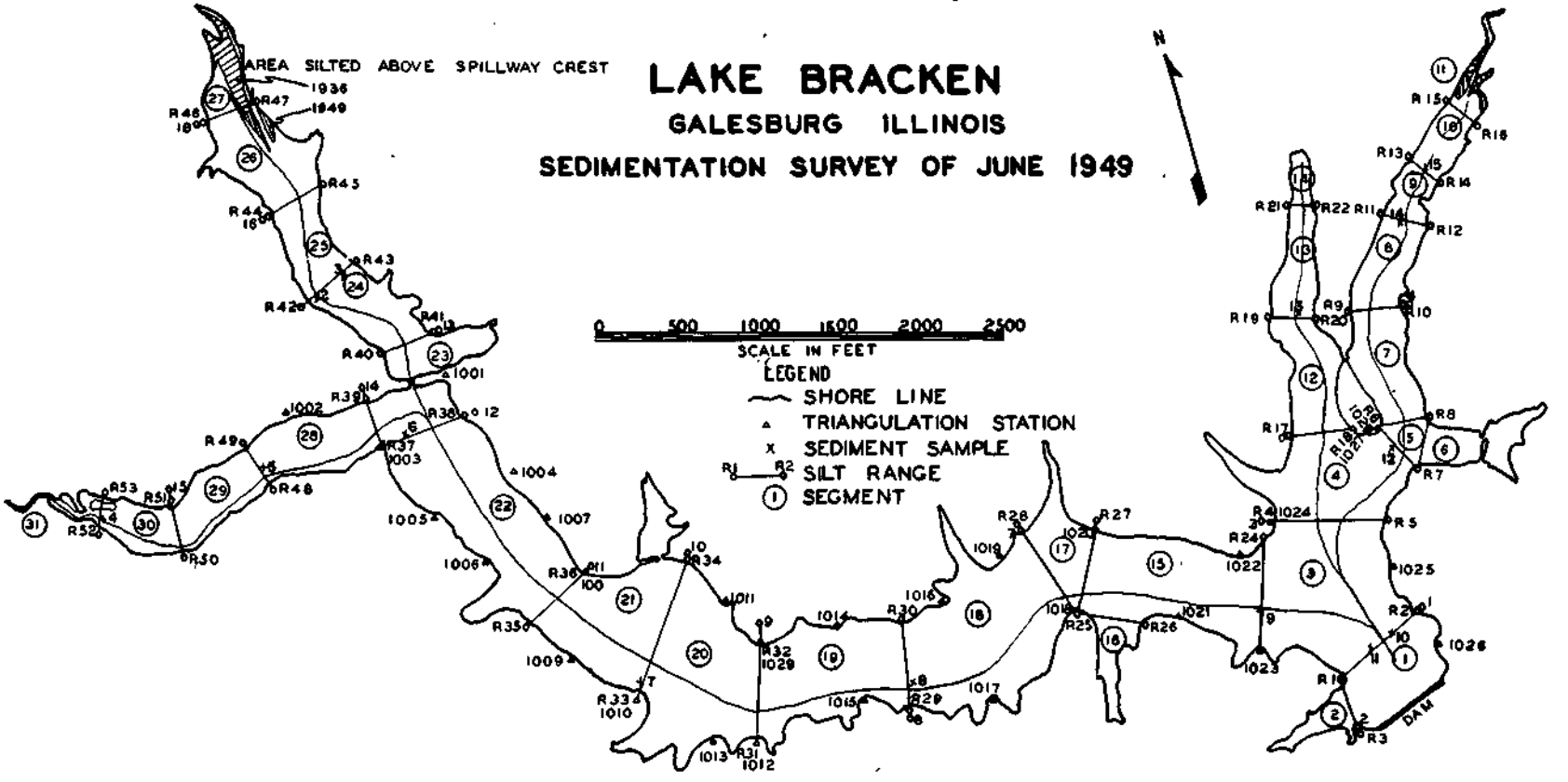
LAKE BRACKEN
GALESBURG ILLINOIS
SEDIMENTATION SURVEY OF JUNE 1949
AREA SILTED ABOVE SPILLWAY CREST
1936
1949
N
0 500 1000 1500 2000 2500
SCALE IN FEET
LEGEND
SHORE LINE
TRIANGULATION STATION
SEDIMENT SAMPLE
SILT RANGE
SEGMENT
DAM

FIG. 3.

Figure 3.) "The main lake is nearly 2 miles long and is 500 to 600 feet wide through most of its length, tapering gradually toward the head of backwater."[5]

"In proportion to its width, the lake is rather deep, because it occupies a youthful section of the valley which is incised in Pennsylvanian sandstone. Along all shorelines the submerged slopes are precipitous except at the heads of the several arms and bays. "[6] The original depth in the old creek channel near the dam was nearly 38 feet and 34 feet on the narrow flood plain, although the valley bottom along range R1-R2 is less than 250 feet wide. "The gradient of the submerged creek channel is about 19 feet per mile within the limits of the reservoir. The length of the ponded channels at the heads of the several arms does not exceed 350 feet."[7]

Watershed. The watershed is generally oval in shape and is drained by Brush Creek and small tributaries as shown in Figure 1. The watershed extends north of the reservoir with its highest point at an elevation of approximately 780 feet above mean sea level. The watershed covers 9. 14 square miles.

METHODS OF SURVEY

Range System. The original and present storage capacities and sediment volumes of the reservoir were determined by the range method of the survey developed by the Soil Conservation Service and described in their bulletin No. 524, "Silting of Reservoirs."[8]

In 1936 a baseline 1, 000 feet in length was measured by steel tape along the graveled road adjacent to segments 23 and 28. (See Figure 3.) From this base a triangulation system of control of 29 stations was established for all mapping. "The lack of a suitable original map necessitated complete mapping of the shoreline, which was done with plane table and telescopic alidade on a scale of 200 feet to the inch. A total of 10.9 miles of shoreline was mapped, including both the original and present lake margins at the heads of the three tributary arms.""

In the 1949 resurvey it was necessary to map the new shoreline at the heads of the tributary arms due to the delta deposits which had grown larger since the original survey. (See Figure 3.)

Measurement of Sediment. Thirty ranges were established. Along each of these ranges at intervals of 20 to 25 feet soundings of water depth were taken to locate the elevation of the top of the sediment. The soundings were made with a bell-shaped 5-pound aluminum sounding weight with base diameter of 5 inches and a height of 6 inches. At intervals of approximately 50 feet, or with alternate soundings, the thickness of the sediment was measured with a "spud." In the resurvey of 1949, the water depth and sediment thickness were remeasured with a sounding pole. This consists of a 1 3/4-inch diameter calibrated aluminum pole constructed in three 10-foot sections. This pole is shown in use in Figure 4. The pole is lowered in the water until it rests lightly on the top of the sediment deposit. The pole is then thrust on down through the soft sediment until it strikes the hard soil of the original reservoir bottom. In this manner the present water depth and the sediment thickness are measured. As the boat is rowed across the range, a cross-section of water depth and sediment thickness is obtained. In the resurvey, soundings were taken as nearly as possible in the same locations as they were made in the original survey. A total of 453 sediment measurements were made on the 30 ranges during the 1949 resurvey.

FIG. 4. USE OF SOUNDING POLE.

Survey Markers. Permanent monuments, consisting of iron pipe stamped with the station numbers and set in concrete bases, had been installed in 1936 to mark the triangulation stations, range ends, and cut-in stations. A number of these survey markers could not be located during the resurvey. They had originally been too close to the water's edge on steep slopes and in the 13-year interval between surveys were lost due to shore erosion. (See Figure 5.) Others were apparently removed when boat docks and homes were constructed. Since a sufficient number of stations could be found to run the resurvey, it was decided not to locate new markers or replace the lost survey markers.

5. Jones, loc. cit.
6. Loc. cit.
7. Loc. cit.
8. H. M. Eakin, "Silting of Reservoirs," U. S. Dept. of Agriculture Technical Bulletin No. 524, revised by C. B. Brown, 168 pp., illus., Washington, D. C., U. S. Govt. Printing Office, 1939.
9. Jones, loc. cit.

Table 1

Summary of Sedimentation Data
Lake Bracken, Galesburg, Illinois

		Quantity	Units
Age:[1]	1923-1936	12.7	Years
	1936-1949	12.9	Years
	1923-1949	25.6	Years
Watershed, total area[2]		9. 14	Square miles
Reser\ oir			
Area at spillway level:	1923	186	Acres
	1936	184	Acres
	1949	181	Acres
Storage capacity at spillway level:	1923	2881	Acre-feet
	1936	2660	Acre-feet
	1949	2452	Acre-feet
Capacity per square mile of drainage area:[2]	1923	315.3	Acre-feet
	1936	291.0	Acre-feet
	1949	268.3	Acre-feet
Sedimentation			
Total sediment:	1923-1936	221	Acre-feet
	1936-1949	208	Acre-feet
	1923-1949	429	Acre-feet
Average annual accumulation from entire drainage area:	1923-1936	17.5	Acre-feet
	1936-1949	16.1	Acre-feet
	1923-1949	16.8	Acre-feet
Per square mile of drainage area:[3]	1923-1936	1.97	Acre-feet
	1936-1949	1.82	Acre-feet
	1923-1949	1.90	Acre-feet
Per acre of drainage area by volume:[3]	1923-1936	134. 4	Cubic feet
	1936-1949	123.9	Cubic feet
	1923-1949	129.1	Cubic feet
Per acre of drainage area by weight:[4]	1923-1936	3.61	Tons
	1936-1949	3.12	Tons
	1923-1949	3.37	Tons
Depletion of storage			
Loss of original capacity per year:	1923-1936	0.61	Percent
	1936-1949	0.56	Percent
	1923-1949	0.58	Percent
Total:	1923-1936	7.68	Percent
	1936-1949	7.22	Percent
	1923-1949	14.90	Percent

1. Storage began December 1, 1923. Date, of first survey was July 9 to August 15, 1936. Date of second survey was June 15 to 29, 1949.
2. Including area of lake.
3. Excluding area of lake.
4. Based on an average specific weight of 50. 9 pounds per cubic foot as determined from fourteen sediment samples taken in 1947.

SEDIMENTATION IN THE RESERVOIR

Summary of Data. Table 1 is a summary of the sedimentation data obtained from the survey in 1936, the resurvey in 1949 of Lake Bracken, together with the data derived therefrom which are pertinent to the sedimentation problem in this lake. Several of the significant findings shown in this summary are:

1. At the present spillway crest elevation the 186-acre surface area of the reservoir has been reduced by 5 acres or 2, 7 percent in the 25. 6-year life of the lake.

2. During the same period, the capacity of the reservoir for water storage has been reduced from 2881 acre-feet to 2452 acre-feet, or 14. 9 percent.

3. The data indicate that the loss of original storage capacity has decreased slightly from an average of 0. 61 percent annually during the period 1923-1936 to 0.56 percent during the succeeding 13 years, 1936-1949. Although field measurements show a slight decrease in the average annual loss of storage capacity during the period between the two surveys, this conclusion is not considered to be precise. Compaction of the lower sediment layers has probably continued during this period, but at present this compaction cannot be evaluated quantitatively.

4. For the entire period the average annual loss has been 0. 58 percent.

5. The sediment accumulation in the lake represents an average annual soil loss of 129. 1 cubic feet of soil per acre from the watershed annually.

One of the outstanding facts to be noted from Table 1 is the relationship of the original capacity of the reservoir to the watershed area. The original capacity/watershed ratio (C/W ratio) was 315. 3 acre-feet per square mile for Lake Bracken. In other words, the reservoir was designed and constructed to furnish about 315 acre-feet storage space for every square mile of watershed. This high C/W ratio is significant in that it means that practically all of the incoming sediment was trapped in the lake. Sedimentation studies in Illinois and in other parts of the country[10] have shown that the original C/W ratio of a reservoir is significant in determining the rate at which it will trap sediment. A small-capacity reservoir which receives the sediment from a large watershed area will lose capacity much faster than a high-capacity reservoir on a small watershed. It should be apparent that for a given amount of sediment inflow, the larger the storage capacity of the reservoir the smaller will be the percent of annual storage loss.

FIG. 5. SHORELINE EROSION, LAKE BRACKEN.

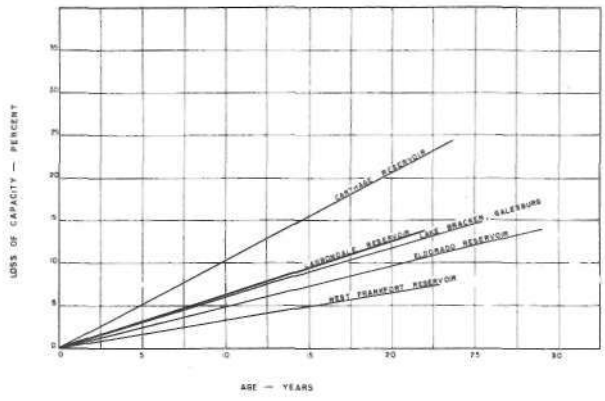

FIG. 6. STORAGE LOSS IN LAKE BRACKEN COMPARED TO OTHER ILLINOIS RESERVOIRS.

It can be seen in Table 2 that the C/W ratio of Lake Bracken compares very favorably with three other reservoirs in the state that have been recently surveyed. The annual loss of capacity in percent compares even more favorably. Figure 6 shows a comparison of the annual loss in capacity in percent for these same reservoirs.

Distribution of Sediment. In the 1936 survey, it was found that the north arm, including segments 23 to 27, had received the heaviest accumulation of sediment in the lake. The deposit nearly everywhere exceeded 3 feet in thickness and on range R44-R45 attained a maximum depth of 6. 6 feet. An exposed delta at the head of this arm had advanced the shoreline in one place about 450 feet downstream and produced an average shortening of about 300 feet. About one-third of the storage capacity in this arm had been destroyed by sedimentation.

In the 1949 survey this same north arm continues to accumulate sediment at a rate greater than any other place in the lake. A maximum depth of 12. 8 feet of sediment is now deposited in the channel along range R45-R47, and the average sediment thickness in the entire arm is now 6 to 7 feet, and covers the original bottom very uniformly. The exposed delta has now advanced the shoreline about 750 feet downstream. The average loss in storage capacity in this arm is

10. C. B. Brown, "The Control of Reservoir Silting," U. S. Soil Conservation Service Miscellaneous Publication 521, Washington, D. C., 1944.

Table 2

Sedimentation of Lake Bracken Compared to Other Illinois Reservoirs

	Lake Bracken, Galesburg	Eldorado Reservoir	Carthage Reservoir	West Frankfort Reservoir	Carbondale Reservoir
Watershed area					
Square miles	9. 14	2. 23	2. 94	4. 00	3. 1
Original capacity					
Acre-feet	2881	844	406	1608	1386
Million gallons	942	258	133	526	453.2
Original capacity /watershed ratio					
Acre-feet/square mile	315. 3	453	138. 2	424	462
Age when surveyed					
Years	25.6	29. 0	23.4	22. 9	22. 1
Total loss of capacity					
Percent	14. 9	14. 0	24. 1	7. 5	13.9
Annual loss of capacity					
Acre-feet	16.8	4. 1 ,	4.2	5-3	8.8
Million gallons	5. 5	1. 3	1. 4	1. 7	2.9
Percent	0. 58	0.48	1. 03	0. 33	0.63
Annual rate of soil loss					
Cubic feet/acre	129	149	99	102	208
Tons/acre	3. 4	5. 0	2. 5	4. 0	7. 7

approximately 78 percent. Figure 7 shows the total amount of silt deposited along range R44-R45 at the time of the two surveys.

The west arm along ranges R50-R51, and ranges R52-53, has lost approximately 90 percent of the original capacity, and a delta has formed that now extends downstream 700 feet. The depth of the water above range R50-R51 now averages less than 1 foot.

In the two arms extending northward from the dam the sediment depth over most of the area averaged about one foot in 1936. The sediment depth in these two arms in 1949 averaged about two feet.

At the time of the 1936 survey the greater part of the submerged flood plain had received a relatively thin deposit of sediment and the accumulation in the channel in some places was only slightly thicker. In the main basin below range R31-R32 about one foot of sediment covered the flood plain and the common thickness in the channel was about 2 feet. Above range R31-R32 the sediment thickness on the flood plain was still about one foot whereas in the channel the thickness was between 3 and 4 feet. During the period between the 1936 and 1949 surveys the sediment thickness has increased uniformly approximately one foot on the flood plain and the channel as well. Figure 7 shows two typical cross-sections and the distribution and accumulation of sediment deposited at the time of the two surveys.

The presence of highway fills in segments 9 and 23 has caused a concentration of sediment in the upper ends of the respective arms. Water is ponded there during the floods and finds entrance into the main lake only through small culverts and is thus effectively desilted. As a result, the storage capacity above these fills is being destroyed many times more rapidly than that of the remainder of the lake.

RESERVOIR OPERATION AND NEED

General. The function of any water supply impounding reservoir is to store runoff from the watershed during wet periods when the stream flow exceeds the consumption. The water thus stored is available for use during dry periods when the flow of water in the stream is insufficient to furnish the users need. Consequently, to obtain the full value from a reservoir it should be

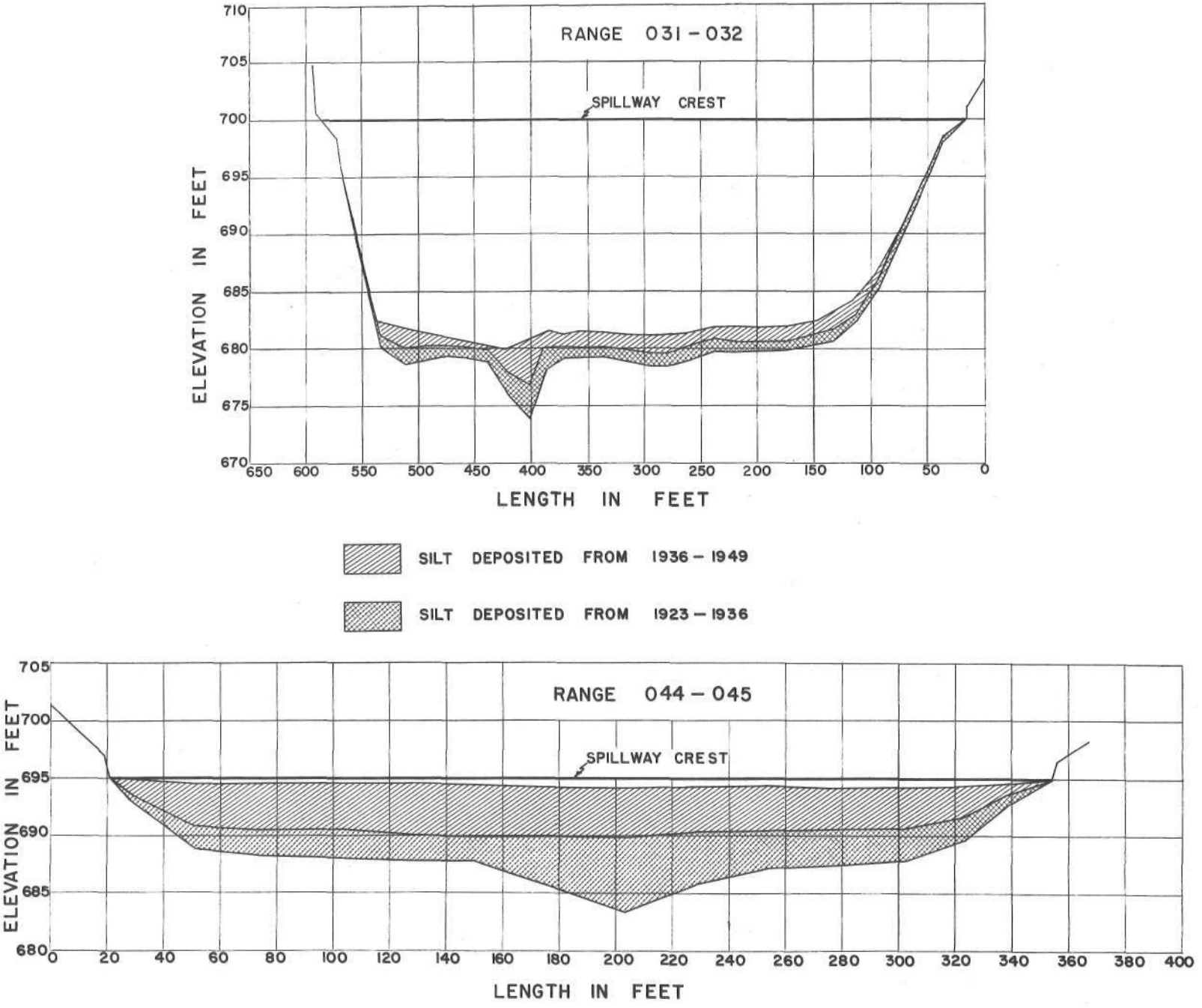
RANGE 031 – 032
SPILLWAY CREST
ELEVATION IN FEET
710
705
700
695
690
685
680
675
670
650 600 550 500 450 400 350 300 250 200 150 100 50 0
LENGTH IN FEET
SILT DEPOSITED FROM 1936 – 1949
SILT DEPOSITED FROM 1923 – 1936
RANGE 044 – 045
SPILLWAY CREST
ELEVATION IN FEET
705
700
695
690
685
680
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400
LENGTH IN FEET

FIG. 7

designed so that the runoff coming into the reservoir is large enough to o\erbalance the consumption plus the losses. The storage volume of the reservoir should be large enough to fulfill all needs during the driest season for which it was designed.

The best indication of the usefulness and the need of a water supply reservoir is the fluctuation of the water level in the lake. Every time the water level is drawn down in the reservoir, demand is exceeding the inflow. This means there would be a water shortage if the lake were not present. Likewise, the best indication of the impending inadequacy of a reservoir is the occurrence of serious drawdowns during dry periods when inflow is small and consumption is great. Sediment deposits steal needed storage space. This loss of water storage capacity causes increasingly heavy drawdowns during dry periods.

Drawdown Data. Since 1933, when accurate lake level records were started,[11] and to the present date, the most serious drawdown occurred August 31 to September 1, 1934, and amounted to 6. 75 feet. This drawdown is equivalent to approximately 67 million gallons, or 7 percent of the total lake capacity. During this year records show annual precipitation was 4. 18 inches below normal and the lake level was never at spillway crest.

The maximum annual pumpage was in 1943 and amounted to 523. 5 million gallons. Since that time there has been a gradual decrease with 315 million gallons being pumped in 1949.

The storage capacity of Lake Bracken is being reduced by an average of 0.58 percent annually, and the maximum annual pumpage to date has been just slightly more than one half of its original capacity. At the present rate of silting, by the year 2015 the lake capacity will be equal to the maximum annual pumpage to date. This does not mean, however, that the lake will be able to provide the maximum required pumpage every year up to that time. The above figures assume that the lake is at spillway crest at the beginning of any year. It is also assumed that the minimum runoff that can be expected will provide sufficient quantity to overcome the evaporation. Lake Bracken appears adequate to furnish water for the CB&Q Railroad at the present pumping rates for the next fifty to sixty years.

ECONOMIC LOSS FROM SEDIMENTATION

The Chicago, Burlington and Quincy Railroad has invested $347, 400 in the development of Lake Bracken, which includes cost of the dam, spillway, and land flooded by the lake. Since this survey shows the original capacity of the reservoir to be 2881 acre-feet, it is seen that this storage thus cost originally $120 per acre-foot. The present survey also shows that 16. 8 acre-feet of storage capacity are being lost per year to sediment. At this rate, the loss amounts to $2033 of the original investment lost per year.

Replacement of this lost storage capacity at present day prices would be expensive. In 1923, when Lake Bracken was constructed, the general cost was much less than at present. One of the most widely used indices of such construction cost is the Engineering News-Record Construction Cost Index, which is computed monthly and considers current prices of certain basic construction commodities such as cement, steel, labor, etc. In 1923 the Construction Cost Index was 190 (based

Table 3

Chemical and Physical Data on Lake Bracken 1947 Sediment Samples

Sample No.	Range	Total N (%)	Total C (%)	Base Ex. Capacity (m.e./l00)	Total Bases (m.e./l00)	Bulk Density	PH	Available K (lb./acre)	Available P (lb./acre)	Sand (%)	Silt (%)	Clay (%)
1	046-047	0.08	1. 13			1.45	7. 12	216	134			
2	042-043	e. 16	1.97			0.874	6.60	300	144			
3	042-043	0. 17	2. 18			0.908	6.80	292	154			
4	053-052	0. 08	1. 31			1.48	7.55	166	164			
5	048-049	0. 16	1.84			0. 942	6.99	270	177			
6	038-037	0.20	2.25	35. 1	39. 3	0.777	7.01	300+	144	0.8	45. 7	48.4
7	034-033	0. 17	1. 98			0.746	7.20	300+	120			
8	029-030	0.20	2.26	35.5	31.4	0.632		300+	134	0.4	42.0	51. 7
9	023-024	0.26	2.81	35.6	36.0	0. 585	6.80	300+	192	0.5	38.4	56.7
10	01-02	0.26	2.68			0.617	6.74	300+	149			
11	02-01	0.22	2.65			0.648	6.45	300+	164			
12	06-07	0. 16	2.04			0.656	6.20	300+	170			
13	019-020	0.09	1 19			0. 938	6.82	250	192			
14	012-011	0. 13	1. 75				6.94	250	177			
15	013-014	0. 13	1.64			1.03	6.99	280	200			

11. W. J. Roberts, "Hydrology of Five Illinois Water Supply Reservoirs," Illinois State Water Survey Division, Bulletin No. 38, Urbana, Illinois, 1948.

on the year 1913 = 100),[12] and in August, 1950, this index had risen to 521.[13] In consideration of this increase in cost, the 16.8 acre-feet of Lake Bracken storage which are lost to sediment every year would cost $5565 to replace at the present time. It is pointed out subsequently in this report that the proposed watershed treatment program will reduce the total sediment load brought into the reservoir by approximately 84 percent. Therefore, the avoidable annual loss of value of lake storage would be approximately $4700. Applying the same increase in cost figures to the original cost of the reservoir development, the cost today to build a new reservoir of the same capacity would be $951,000.

In addition to supplying water for use by the railroad, Lake Bracken is used extensively for recreational purposes. Recreational value is highly intangible, and it is difficult to place a price tag on it. As the lake becomes filled with sediment, its use for recreation is destroyed, and the properties along the lake shore decrease in value. The lake owner as well as the owners of the property on the shore could certainly justify the spending of a certain sum of money each year to reduce the sedimentation in the lake to prolong the life of the lake.

SEDIMENT CHARACTERISTICS

Analyses Made. Sediment samples, taken within the lake, were analyzed to determine some of the physical and chemical characteristics of the sediments. These analyses included determinations,for total nitrogen, total organic carbon, volume weight, pH, available potassium, and available phosphorus. Samples number 6, 8, and 9 were analyzed for base-exchange properties and particle size fraction distributions. The data are given in Table 3.

The sediments are quite variable in their chemical and physical nature, but these variations are in accordance with expectations. Samples number 1, 4, 13, and 15 are low in both total organic carbon and total nitrogen but high in volume weight. These samples indicate areas of coarser sediments and represent those areas of the lake where the incoming load of the river waters strikes the lake proper, allowing the coarser materials to settle out. As the water moves toward the dam and spillway, considerable sorting of sediment occurs, the sediments getting finer in texture as the dam is approached. This trend is indicated by samples number 6, 7, 8, 9, 10, and 11, which are high in total nitrogen and total organic carbon but low in volume weight. Apparently some of the colloid fractions, both inorganic and organic, are carried over the spillway. The distribution of texture of sediments presents the usual picture of the inter-relationship of incoming load to settling velocities and detention time of the water in the lake. In the dam area of the lake more than half (sample No. 9) of the sediment is 2 microns or less in size and would be classified in the clay fraction.

Lake Bracken is located in a fertile-soil area and therefore the sediments, which represent soil erosion, are high in plant food materials. The high total nitrogen and available phosphorus and potassium values of the sediments indicate a high loss of plant food elements from the farm soils. In terms of commercial fertilizers the yearly loss is equivalent to approximately 8 tons of muriate of potash (0-0-50), 25 tons of superphosphate (0-20-0), and 75 tons of ammonium nitrate (33-0-0); or, stated another way, this yearly loss of plant food is equivalent to approximately 80 pounds of a 25-5-4 fertilizer per acre of cropland in the watershed area.

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 8.

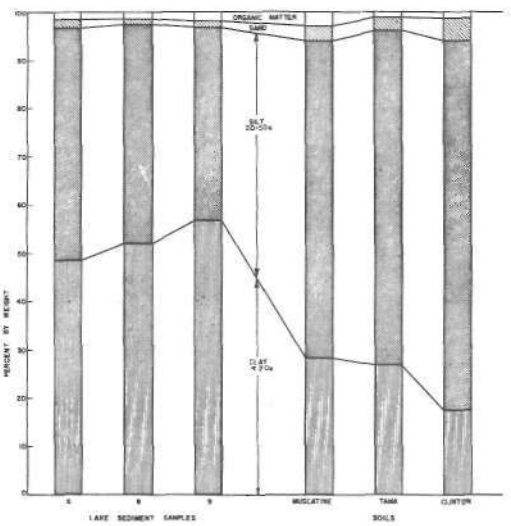

FIG. 8. COMPARISON OF SEDIMENT TEXTURE TO WATERSHED SOILS.

The origin of the sediments accumulating in Lake Bracken cannot be traced to any single dominant source by chemical and mechanical analyses. Loess, and soils of loess origin, appear to be the principal source of lake sediment along with considerable amounts of Illinoian till. The high pH values of the sediment in all portions of the lake indicate a considerable amount of calcareous loess must be contributing to the sediments. The lower organic matter values found in the sediments, as

12. Engineering News-Record, March 23, 1950, Vol. 144, No. 12, p. 144, McGraw-Hill Publishing Company, New York, New York.

13. Engineering News-Record, August 17, 1950, Vol. 145, No. 7, p. 31, McGraw-Hill Publishing Company, New York, New York.

Table 4

Analytical Data on Lake Bracken 1936 Sediment Samples

Range on Lake	Laboratory Sample No.	Total Organic Carbon (%)	Total Nitrogen (%)	Base Exchange Total (m. e./100)	Base Capacity Inorganic (m. e./lOO)
01-02	S10873	2.91	0.297		
01-02	S10874	2.83	0.277		
04-05	S10875	2.42	0.234		
1028-0X28	S10876	2. 38	0.230		
023-024	S10877	2.85	0.265	38.6	29.6
019-020	S10878	1.46	0. 130		
011-012	S10879	1.76.	0. 161		
029-039	S10880	2. 70	0.260		
033-034	S10881	2. 79	0.259		
037-038	S10882	2.60	0.262		
048-049	S10883	2.21	0.201		
052-053	S10884	2. 16	0. 191		
042-043	S10885	2. 56	0.245		
042-043	S10886	2.40	0. 220		
047-046	S10887	1.60	0. 129		

compared with that of the soils of the watershed area, indicate a dilution with other materials much lower in organic matter. Since the surface soils of the area are acid in nature and the lake sediments are neutral to alkaline, the deep loess may be contributing materially to the sediment in the lake.

In comparing sediment analyses made in 1936, Table 4, with those of the 1947 samples, a general decrease in total organic carbon and total nitrogen is indicated for this later sampling. This suggests that during the last 13 years (1936 to 1949) relatively more sediment came from sheet erosion of subsoil materials than occurred during the period 1923 to 1936. Apparently sheet erosion is still active and it is suggested that erosion control measures should be aimed at the control of these areas of the watershed.

WATERSHED

INTRODUCTION

The major factors affecting the rate of siltation in a lake or reservoir are the age and size of the reservoir, the size of the drainage area, the general topography, the length and steepness of slopes, rainfall characteristics, the kind of soil and the land use pattern. These factors must be evaluated at each site. Some of these factors can be corrected to reduce siltation in the lake, whereas others cannot be changed.

The source of sediment must be determined before an effective watershed program can be recommended. The Soil Conservation Service made a soil conservation survey of Lake Bracken watershed as well as a special study of farming conditions to be used as a basis for reducing the rate of siltation in the lake. This survey consisted of mapping the kind of soil, steepness of slope, degree of erosion and present land use on aerial photographs having a scale of four inches to a mile. Channel erosion and amount of deposition was also recorded on the survey. A sample system was used in which a 160-acre block was mapped out of each section of land. This sample survey data was extended to represent 5700 acres. The total land area of the basin is actually only 5664 acres, or 8. 85 square miles.

PHYSIOGRAPHY

Lake Bracken is located in Knox County, Illinois. The drainage area (including reservoir surface area) is 9. 14 square miles in size and is located four miles directly south of Galesburg. The topography in the watershed is generally level with rolling to steep slopes adjacent to the drainageways. The general land formation consists of a thick mantle of loess over weathered Illinoian drift. The loess in general is over 5 feet thick on the level areas, thinning out on the steeper slopes to where it is entirely absent.

SOIL GROUPS

Five mam soil groups occur in the watershed. These soil groups consist largely of the

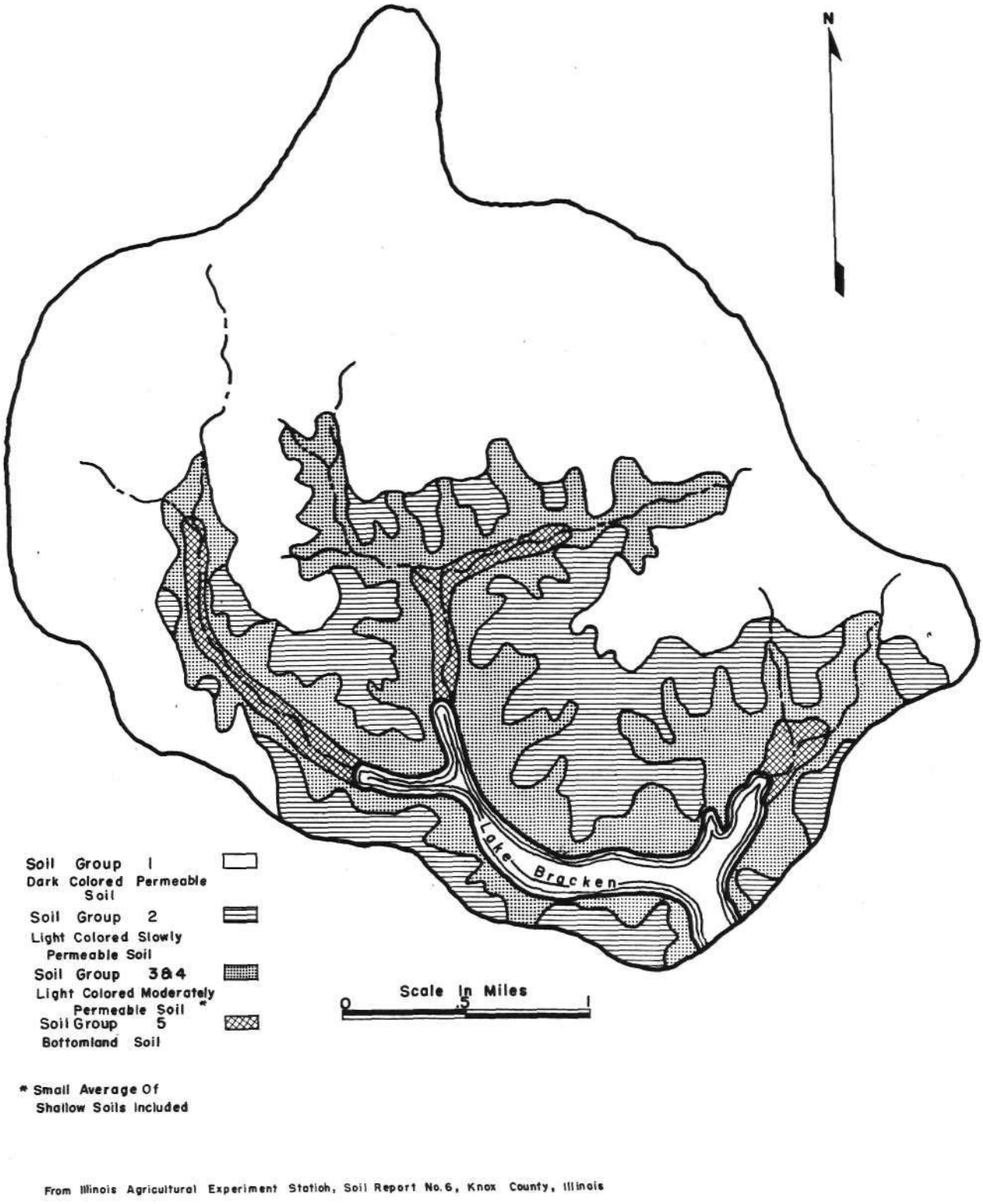

FIG. 9. GENERALIZED SOIL GROUP MAP OF LAKE BRACKEN WATERSHED.

Table 5

Acreages and Percentages of Various Soil Groups
Lake Bracken Watershed

Soil Group		Acres	Percent
1. Dark-colored, medium-textured, moderately permeable soils:			
Ipava silt loam group		633	11.1
Sable-Illiopolis silty clay loam group		52	0.9
Muscatine-Bolivia silt loam group		1,877	32.9
Tama-Tovey silt loam group		203	3.6
Denny silt loam group*		45	0.8
	Total	2,810	49.3
2. Light-colored, medium-textured, slowly permeable soils:			
Berwick silt loam group		688	12.1
Blair silt loam group		41	0.7
Clinton silt loam (mottled B) group		56	1.0
	Total	785	13.8
3. Light-colored, medium-textured, moderately permeable soils:			
Clary silt loam group		405	7.1
Clary silt loam (shallow to till) group		65	1.1
	Total	470	8.2
4. Shallow, stony and gravelly loam soils:			
Rough stony land group		8	0.1
Hickory gravelly loam group		1,343	23.6
	Total	1,351	23.7
5. Bottomland soils:			
Imperfectly drained Huntsville group		83	1.5
Huntsville loam group		177	3.1
Peaty loam group		24	0.4
	Total	284	5.0
	Entire watershed	5,700	100.0

*Very slow permeability.

following soils: (1) Bolivia, Ipava silt loam group, (2) Berwick, Mottled Clinton Silt loam group, (3) Clary silt loam group; (4) Hickory gravelly loam group, and (5) Huntsville silt loam group. The acreages and percentages of the various soil groups in the watershed may be found in Table 5. Figure 9 is a very generalized soil map of the watershed showing some of the soil groups listed in Table 5.

Group 1 consists largely of dark-colored, medium-textured, moderately permeable soils. These soils generally occur on level land with a small amount of them on gentle slopes adjacent to drainageways. They are very productive and on the more level areas respond to tile drainage. Small depressions occur on the broad level prairie areas. Some of these depressions are heavy textured and often are called "gumbo." Other depressions are minor in extent, covering only 1.6 percent of the watershed.

The soils in group 2 are light-colored timber soils that have a well developed subsoil and are slowly permeable to water. For the most part they occur on level ridge tops adjacent to drainageways. A small percentage of the soils in this group may be found on slopes. These sloping soils have a shallow loess deposit on weathered Illinoian drift. The drift may be encountered from 12 to 36 inches from the surface. The major problem is drainage and fertility with erosion control practices needed on sloping land.

Group 3 soils are also light in color but differ from those in group 2 by being more permeable in the subsoil, better oxidized and formed on deeper loess. The depth to drift is usually over 5 feet. The major problems on these soils are fertility and erosion control.

The soils in group 4 were developed almost entirely from Illinoian drift material. They are a loam to gravelly loam in texture and are found on the steeper slopes adjacent to drainageways.

All bottomland soils were placed in group 5. These soils are dark in color and are very productive; however, they occur along small drainageways that are subject to frequent overflow.

Table 6

Estimated Crop Yields in Lake Bracken Watershed on Soils under Good and Fair Management

Soils	Percent of Watershed	Soil Management Systems	Average Yields[b] (bushels per acre) Corn	Solybeans	Oats
1. Dark-colored, medium-textured, moderately permeable soils	49. 3	good	75	27	46
		fair	60	25	43
2. Light-colored, medium-textured, slowly permeable soils	13. 8	good	45	19	36
		fair	40	16	33
3. Light-colored, medium-textured, moderately permeable soils	8.2	good	64	24	37
		fair	59	20	34
4. Shallow stony and gravelly loam soils	23. 7	Best suited to pasture and woods.			
5. Bottomland soils	5. 0	Variable, depending orL overflow.			
Total	100. 0				

[a] C rop yields were estimated from data in Illinois Agricultural Experiment Station Bulletin #522 entitled, "Productivity of Central Illinois Soils," by R. T. Ode 11.

b The yield estimates apply only to the areas suitable for safe cultivation.

In addition, the areas are cut up by meandering stream channels, resulting in areas too small to cultivate.

The relative productivity of the soils in the watershed may be found in Table 6.

SLOPES

The length and steepness of slope influence the speed at which water runs off the land and consequently the amount of soil lost. It is, one of the important factors influencing soil losses.

Table 7 indicates that 45. 9 percent of the watershed has slopes of less than 2 percent. Twenty-six and two-tenths percent of the watershed ranges from 2 to 10 percent slope; 6. 7 percent from 10 to 15 percent slope and 21. 2 percent of the land area is over 15 percent slope. The steeper slopes may be found adjacent to the larger drainageways with the broad level areas in between the drainageways.

Approximately 70 percent of all the level land in the watershed belongs to soil group 1. Over 61 percent of the soils in the watershed on slopes of from 2 to 10 percent also occur in this group. A total of 1209 acres in the watershed are over 15 percent slope; eleven hundred fifty-seven acres of this belong to soil group 4.

PRESENT LAND USE AND LAND CAPABILITY

The kind and intensity of land use is a very important factor influencing soil losses and sediment production. Four kinds of land use, namely, cropland, pasture, woodland, and miscellaneous, were classified in the watershed. Cropland is all land on which crops were grown at the time the survey was made. It includes land in row crops, small grain and hay. Pasture land is land in perennial grasses, and woodland is land which is at least 40 percent covered by tree canopy. Miscellaneous land use consists of land used for farmsteads, roads and other miscellaneous purposes.

The soil groups having the most favorable cropping conditions, such as productivity and slope, also have the highest percentage of their total area in cropland. Soil group 1 has the highest percentage of land in cultivation, whereas soil group 5 has the lowest (Table 8). Of the entire watershed; 56. 3 percent is in cropland, 23. 9 percent in pasture, 16. 1 percent in woods, and 3. 7 percent in miscellaneous use.

Cropland in the watershed ranges from level land up to 20 percent slope (Table 9). Over 60 percent of the cropland occurs on level land, 33. 7 percent on slopes of 2 to 10 percent, and 5. 6 percent on slopes of 10 to 20 percent. Over one-half of the pasture in the watershed occurs on land less than 5 percent slope, while 81.2 percent of the land in woods may be found on slopes over 20 percent.

The land in Lake Bracken watershed can be classified into three general categories: land suitable for regular cultivation (Class I, II, and III),. land suitable for limited cultivation (Class IV), and land suitable for pasture and woods (Class

Table 7

Distribution of Soil Groups in Each Slope Class
Lake Bracken Watershed

Soil Group	A slopes (0-2%) Acres	A slopes (0-2%) Pct.	B slopes (2-5%) Acres	B slopes (2-5%) Pct.	C slopes (5-10%) Acres	C slopes (5-10%) Pct.	D slopes (10-15%) Acres	D slopes (10-15%) Pct.	E slopes (15-20%) Acres	E slopes (15-20%) Pct.	F slopes (20-30%) Acres	F slopes (20-30%) Pct.	G slopes (over 30%) Acres	G slopes (over 30%) Pct.	Total Acres
1. Dark-colored, medium-textured, moderately permeable soils	1822	69.7	538	61.0	380	61.8	70	18.4	---	----	---	----	---	----	2810
2. Light-colored, medium-textured, slowly permeable soils	508	19.4	174	19. 7	75	12.2	14	3. 7	14	7.6	---	----	---	----	785
3. Light-colored, medium-textured, moderately permeable soils	---	----	170	19. 3	152	24.7	110	29.0	38	20.6	---	----	---	----	470
4. Shallow, stone and gravelly loam soils	---	----	---	----	8	1. 3	186	48.9	132	71.8	975	100.0	50	100.0	1351
5. Bottomland soils	284	10.9	---	----	---	----	---	----	---	----	---	----	---	----	284
Total	2614	100.0	882	100. 0	615	100.0	380	100.0	184	100.0	975	100.0	50	100.0	5700
Percent of Total Watershed	45.9		15.5		10. 7		6.7		3.2		17. 1		0.9		100. 0

Table 8

Distribution of Soil Groups in Each Land Use Class
Lake Bracken Watershed

Soil Group	Cropland		Pasture		Woodland		Miscellaneous		Total
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres
1. Dark-colored, medium-textured, moderately permeable soils	2,486	77.5	221	16.2	---	----	103	49. 1	2,810
2. Light-colored, medium-textured. slowly permeable soils	374	11.7	222	16.2	110	12.0	79	37.6	785
3. Light-colored, medium-textured, moderately permeable soils	194	5.8	258	19.0	15	2.0	3	1.4	470
4. Shallow, stony and gravelly soils	145	4.5	391	28.5	790	85. 9	25	11.9	1,351
5. Bottomland soils	9	0. 3	275	20. 1	---	----	---	----	284
Total	3,208	100.0	1,367	100.0	915	100.0	210	100. 0	5,700
Percent of Total Watershed	56.3		23.9		16. 1		3. 7		100

V, VI, and VII). These three general land categories can be further broken down into 7 land capability classes. These land capability classes are described in detail in Table 10.

In the Lake Bracken watershed 67. 3 percent of the land is suitable for regular cultivation, 2. 8 percent suitable for limited cultivation (largely hay land) and 29. 9 percent is best suited for pasture or woods (Table 10). Approximately 5 percent of the land in the watershed now being cultivated should be in pasture or woods. Forty-one percent of the land now in permanent pasture is suitable for regular cultivation, while 13. 6 percent of the land in woods is suitable for cropping. A careful analysis of Table 10 indicates that no major adjustments in land use are necessary in the watershed. That is to say, very little land is now being cultivated that should be in permanent vegetation.

The land use history of Galesburg and Cedar Townships, in which most of the watershed lies, is shown in Table 11.

The average size of farms in Galesburg and Cedar townships increased from 149 acres in 1938 to 194 acres in 1946. The average tillable land in clean tilled crops, small grain, hay and pasture, and miscellaneous use for the period of 1938 to 1947 is as follows: clean tilled crops, 64 percent; small grain, 19 percent; hay and pasture, 15 percent; and miscellaneous, 2 percent. These data indicate that the cropland is being farmed too severely to clean tilled crops such as corn and soybeans, and not a high enough percentage of the land is allowed to remain in grass and legume crops.

EROSION

It is necessary to know the source and amount of sediment being deposited if a sound watershed treatment program is to be recommended. This was done on the soil conservation survey map by measuring the amount of sheet and gully erosion as well as recording the areas of deposition.

Erosion was determined by measuring the depth of topsoil and comparing it to an uneroded or virgin area under a similar land condition. The following erosion groups were mapped:

No apparent erosion: Approximate original depth of topsoil still remains.

Slight to moderate erosion: Over seven inches of the original topsoil remaining, no sub-

FIG. 10. LEVEL LAND CAN BE CROPPED TO CLEAN-TILLED CROPS HALF-TIME WITH VERY LITTLE SOIL LOSS.

FIG. 11. SOIL LOSSES OF 50 TONS PER ACRE PER YEAR ARE NOT UNCOMMON WHEN SLOPES ARE CROPPED TO CORN AND SOYBEANS.

FIG. 12. EXCESSIVE SHEET EROSION RESULTS IN GULLIES BEING FORMED.

FIG. 13. GRASS WATERWAYS ARE NEEDED IN CULTIVATED FIELDS.

soil exposed by the plow.

Moderately severe erosion: Occasional to frequent exposure of subsoil by plow, three to seven inches of topsoil remaining.

Severe erosion: Erosion of the subsoil, less than three inches of surface soil remaining.

Very severe erosion: Frequent gullies too deep to cross with farm implements or very severe sheet erosion that has penetrated into parent material.

It is estimated from the results of the survey that over 95 percent of the eroded material comes from sheet erosion. A program to reduce siltation in the reservoir would necessarily require conservation measures and practices that would greatly reduce sheet erosion in the watershed. (See Figures 10 to 13.)

An analysis of the data in Table 12 indicates that 4.2 percent of the watershed was classed as severely or very severely eroded, 14. 6 percent moderately severely eroded, 36. 6 percent slightly to moderately eroded, and 44. 6 percent with no apparent erosion. Approximately 81 percent of the land classed as having no apparent erosion belongs to soil groups 1 and 5, while 55 percent of the land classed as severe or very severe erosion belongs to soil group 4.

Table 13 shows that 99 percent of the land having no apparent erosion occurs on level land. The largest percentage of the more severely eroded land may be found on slopes of 5 to 15 percent. This, no doubt, is a result of cropping these slopes without regard to contour or soil loss.

A major portion of the land in the watershed classified as having moderately severe, severe, or very severe erosion is now being utilized as cropland (Table 14). To be more specific, 58. 5 percent of the moderately severely eroded land, 86. 4 percent of the severely eroded land, and 100 percent of the very severely eroded land in the watershed is now being cropped. Approximately 25 percent of the pastureland is moderately severe or worse in erosion.

SOIL CONSERVATION

The land in the Lake Bracken watershed is used more intensively than would be recommended in a sound watershed treatment program. The present intensity of cropping is not good for the soil and in the long run the farmer will suffer due to excessive soil and fertility loss. By the same

Table 9

Distribution of Slope Classes for Each Land Use Class
Lake Bracken Watershed

Slope Class	Cropland		Pasture		Woodland		Miscellaneous		Total	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
A (0-2 percent)	1,947	60.7	513	37.5	57	6.2	97	46.2	2,614	45. 8
B (2-5 percent)	594	18.5	156	11.4	54	5.9	78	37. 1	882	15. 5
C (5-10 percent)	489	15.2	102	7. 5	14	1.6	10	4. 8	615	10.8
D (10-15 percent)	177	5.5	199	14.6	--	----	4	1.9	380	6.7
E (15-20 percent)	1	0. 1	182	13.3	1	0. 1	--	----	184	3.2
F (20-30 percent)	---	----	215	15.7	743	81.2	17	8. 1	975	17. 1
G (over 30 percent)	---	----	---	----	46	5.0	4	1.9	50	0.9
Total	3, 208	100.0	1, 367	100.0	915	100. 0	210	100. 0	5, 700	100.0

Table 10

Land Capability Compared with Existing Land Use at Time of Survey
Lake Bracken Watershed

	Cropland		Pasture		Woodland		Miscellaneous		Entire Watershed	
	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.
Class I Land Suitable for cultivation, requiring no erosion-control practices to maintain soil for general agricultural practices	1662	51.9	57	4.2	---	----	64	30.5	1783	31.3
Class II Land Good land that can be cultivated safely with easily applied practices	811	25.3	316	23.2	61	6.7	68	32.4	1256	22.2
Class III Land Moderately good land that can be safely cultivated with such intensive treatments as terracing and strip cropping	482	15. 1	191	13.9	63	6.9	52	24. 7	788	13.8
Class IV Land Best suited to hay or pasture, but can be cultivated occasionally, usually not more than 1 year in 6	83	2. 5	81	5.9	1	0. 1	1	0.5	166	2.8
Class V Land Level land best suited to permanent pasture. Narrow bottoms subject to overflow and impractical to cultivate	9	0.2	275	20. 1	---	----	---	---	284	4. 9
Class VI Land Not recommended for cultivation. Best suited for permanent pasture	35	1. 1	423	30. 9	744	81.3	21	10.0	1223	21.5
Class VII Land Not recommended for cultivation. Suited for woodland or pasture with major restrictions in use	126	3.9	24	1.8	46	5.0	4	1. 9	200	-3.5
Entire Watershed	3208	100.0	1367	100.0	915	100.0	210	100.0	5700	100.0
Percent of Total Watershed	56.3		23.9		16. 1		3.7		100	

Table 11

Average Land Use, Galesburg and Cedar Townships
Knox County, Illinois, 1938-1947[a]

	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947[b]
Acres per farm	149	147	155	141	173	194	197	198	194	---
Percent of farm tillable	65	64	67	65	68	67	66	67	68	---
Percent tillable land in:										
Corn	53	50	45	48	46	50	54	52	51	51
Soybeans	11	14	15	14	18	15	17	17	14	14-
Small grains	23	20	18	21	17	18	14	19	20	19
Hay and pasture	11	14	19	16	18	13	15	12	15	13
Other and idle	2	2	3	1	1	4	0	0	---	3

[a]Based on assessor's acreage census.
[b]Preliminary data.

Table 12

Distribution of the Soil Groups in Each Erosion Group
Lake Bracken Watershed

Soil Group	No apparent erosion		Slight to moderate erosion		Moderately severe erosion		Severe erosion		Very severe erosion		Total
	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres
1. Dark-colored, medium-textured, moderately permeable soils	1774	69.8	600	28.7	432	52.0	4	1.8	---	---	2810
2. Light-colored, medium-textured, slowly permeable soils	461	18.1	206	9.9	44	5.3	66	28.9	8	100.0	785
3. Light-colored, medium-textured, moderately permeable soils	25	1.0	235	11.2	168	20.2	34	14.9	---	---	470
4. Shallow, stony and gravelly loam soils	---	---	1048	50.2	179	21.5	124	54.4	---	---	1351
5. Bottomland soils	284	11.1	---	---	---	---	---	---	---	---	284
Total	2544	100.0	2089	100.0	831	100.0	228	100.0	8	100.0	5700
Percent of Total Watershed	44.6		36.6		14.6		4		2		100

Table 13

Distribution of Slope Classes in Each Erosion Group
Lake Bracken Watershed

Slope Class	No apparent erosion		Slight to moderate erosion		Moderately severe erosion		Severe erosion		Very severe erosion		Total
	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres
A (0-2 percent)	2519	99.0	95	4.6	---	---	---	---	---	---	2614
B (2-5 percent)	---	---	844	40.4	38	4.6	---	---	---	---	882
C (5-10 percent)	25	1.0	30	1.4	504	60.6	48	21.1	8	100.0	615
D (10-15 percent)	---	---	62	3.0	147	17.7	171	75.0	---	---	380
E (15-20 percent)	---	---	57	2.7	118	14.2	9	3.9	---	---	184
F (20-30 percent)	---	---	965	46.2	10	1.2	---	---	---	---	975
G (over 30 percent)	---	---	36	1.7	14	1.7	---	---	---	---	50
Total	2544	100.0	2089	100.0	831	100.0	228	100.0	8	100.0	5700

Table 14

Distribution of Land Use Classes in Each Erosion Group
Lake Bracken Watershed

Land Use Class	No apparent erosion		Slight to moderate erosion		Moderately severe erosion		Severe erosion		Very severe erosion		Total
	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres
Cropland	1864	73.3	653	31.3	486	58.5	197	86.4	8	100.0	3208
Pasture	526	20.7	506	24.2	306	36.8	29	12.8	---	---	1367
Woodland	57	2.2	836	40.0	21	2.5	1	0.4	---	---	915
Miscellaneous	97	3.8	94	4.5	18	2.2	1	0.4	---	---	210
Total	2544	100.0	2089	100.0	831	100.0	228	100.0	8	100.0	5700

token, this method of cropping increases the rate of siltation in the lake.

In addition to the land being cropped too intensively, it is also being farmed "up and down" the slopes rather than on the contour or "with the slope." This method of farming done without regard to the contour of the land will double the soil loss from the fields. There are very few grass waterways in the watershed that are adequate in so far as design is concerned. The pastures, in general, in the area are overgrazed and in need of renovation. All of these factors contribute to the silt problem as well *a.s* reduce the income of the land owner and tenant.

The first step in a sound watershed treatment program is to classify the land according to its abilities to safely produce crops such as corn, hay, pasture and woods. Soil conservation survey maps, such as those developed on a portion of the watershed, supply the necessary information upon which to base a sound land use program. This survey furnishes on every farm and each field in the watershed the type of information found in Table 10 of the report. It furnishes the farmer with the necessary basic information as to the best use for each kind of land *on* his farm. This survey is essential in developing a sound watershed treatment program.

Before proper rotations can be established, the soil must be tested and treated according to test. Many of the soils in the area are in need of limestone and may respond to phosphate application. The most strenuous rotation that should be used on any land, even the best, is not over two years of clean tilled crops, one year of grain, and one year of stand-over grass and legumes. The poorer, steeper cropland areas should remain in hay land or pasture most of the time. All sloping cropland should be farmed on the contour, and practices such as terracing, strip cropping, and grass waterways established. Permanent pastures should be tested, treated and renovated. Pasture management is as essential as the renovation program to insure the greatest return from the land. In some instances earth and concrete structures or flumes may be needed along water courses and at the end of tile lines. Timber areas should not be grazed in order to encourage new growth as well as reduce soil losses. Small isolated areas along drainageways, fence corners, etc., should be allowed to grow up in order that adequate cover be provided for wildlife. Some new plantings, such as multiflora rose and others, may be desirable.

REMEDIAL MEASURES

Practicability. This sedimentation survey reveals that Lake Bracken is losing capacity at a rate of 16. 1 acre-feet per year. At the present rate of pumping, the lake will furnish the needs of the CB&Q Railroad for the next 50 to 60 years. If the pumping demand should increase, however, a water shortage would occur earlier than this. It does not seem, however, that immediate steps are necessary to avert a water shortage. As stated earlier, however, the storage space lost to sediment every year would cost $5565 to replace at the present time.

Raising the Dam. One of the first measures usually considered when it becomes necessary to provide additional reservoir storage space is the raising of the present dam and spillway. In many cases such action can provide the additional storage necessary to postpone a water shortage. At Lake Bracken, however, a water shortage is not imminent and such action is not believed necessary at present.

Dredging. Some reservoir owners have resorted to dredging to restore reservoir capacity lost by sedimentation. The two limiting factors in this method are the cost and the disposal of dredged material. In the past, dredging has compared unfavorably financially to other methods of providing storage space. This has proved economical only where large shallow areas appear in lakes with very high recreational and esthetic values. At Lake Bracken, delta areas and shallows are beginning to appear in the upper portions of the lake. The removal of sediment deposits by dredging gives only temporary relief, however, and the high relative cost of dredging should be considered carefully in taking action.

Sediment Basins. Detention basins could be constructed on the principal streams above the lake to trap much of the sediment before it reaches the lake. The present road fill in segment 23 is acting as a sedimentation basin at present in that deposition has been greater on the upstream side of the fill. The construction of more sediment basins to protect Lake Bracken would be temporary measures since the basins would eventually fill, with sediment. In addition, the cost of constructing such a basin is usually greater per unit of storage than the reservoir it protects.

Vegetative Plantings. The planting of trees in areas best suited for woods is desirable. Wildlife plantings are essential if proper cover is to be provided for wildlife. These plantings need not be large or require a great deal of effort. The local Farm Advisor or Soil Conservation District personnel should be consulted for the best location for such plantings and the species to be planted.

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14. Brown, op cit., p. 10.

Table 15

Estimated Reduction in Sheet Erosion Annually from a Watershed Treatment Program
Lake Bracken, Illinois

Soil	Cultivated Acres	Cultivated Loss (tons)	Permanent Pasture Acres	Permanent Pasture Loss (tons)	Woodland Acres	Woodland Loss (tons)	Miscellaneous Acres	Miscellaneous Loss (tons)	Total Annual Soil Loss (tons)
PRESENT LAND USE									
1. Dark-colored, medium-textured, moderately permeable soils. Largely Ipava-Muscatine silt loam soil groups	2486	13,299	221	103	---	---	103	62	13,464
2. Light-colored, medium-textured, slowly permeable soils. Largely Barwick soil groups	374	4,650	222	32	110	66	79	47	4.795
3. Light-colored, medium-textured, moderately permeable soils. Fayette silt loam soil groups.	194	7,463	258	155	15	9	3	4	7,631
4. Shallow, stony and gravelly loam soils. Hickory gravelly loam group.	145	14,619	391	234	790	474	25	15	15,342
5. Bottomland soils. Mostly Huntsville silt loam group.	9	---	275	---	---	---	---	---	---
Total	3208	40,031	1367	524	915	549	210	128	41,232

Total soil loss annually under present land use, 41,232 tons.
Average annual soil loss, 7. 02 tons per acre.

RECOMMENDED LAND USE

1. Dark-colored, medium-textured, moderately permeable soils. Largely Ipava-Muscatine silt loam soil groups.	2486	3115	221	34	---	---	103	62	3211
2. Light-colored, medium-textured, slowly permeable soils. Largely Barwick soil groups.	354	241	242	15	110	22	79	47	325
3. Light-colored, medium-textured, moderately permeable soils. Fayette silt loam soil groups.	193	566	259-	53	15	3	3	4	626
4. Shallow, stony and gravelly loam soils. Hickory gravelly loam group.	---	---	529	106	797	159	25	15	280
5. Bottomland soils. Mostly Huntsville silt loam group.	---	---	284	---	---	---	---	---	---
Total	3033	3922	1535	208	922	184	210	128	4442

Total soil loss annually under proposed land use, 4442 tons.
Average annual soil loss, 0. 78 ton per acre.
89% reduction in silt due to improved watershed program:

General Notes

(1) A soil loss factor of 0.2 ton per acre per year was assumed on pasture and woods under the conservation program and 0. 6 ton under present management. No loss was assumed on level pasture and woods.

(2) Rotation used as basis for land use without program based on assessor's acreage figures for Cedar and Galesburg townships. This rotation was a corn, corn, soybeans, oats and clover rotation.

(3) Slope and practice data and land use capability recommendations were used on the basis for the recommendations in this conservation program.

(4) It is assumed in the proposed program that all land in cropland and pasture in the watershed will be treated according to soil test. All pastures will be renovated and seeded to desirable grasses and legumes.

Watershed Treatment Program. Information presented earlier in this report indicates that approximately 15 percent of the total capacity of Lake Bracken has been lost due to sediment depositing in the lake. This sediment represents a great loss to the farmers in the watershed in terms of plant food and valuable topsoil. In addition, this loss in water storage capacity in terms of replacing the reservoir is one that represents thousands of dollars.

It is far more economical to stop the sediment at its source than to dredge it from a reservoir or to build new reservoirs. The rate of sedimentation in Lake. Bracken can be reduced by a watershed treatment program consisting of measures outlined in a preceding section and shown in Table 15. This proposed program was not designed to prevent further siltation in the lake but to reduce the rate of siltation. It is a balance between farming the land and obtaining an economical return for a long period of time as well as reducing the present soil losses from the fields approximately 89 percent.

The estimated soil loss in the watershed from the present farming system as compared to the proposed program was developed from the soil conservation survey maps and available research information. These soil loss figures are relative and are especially valuable in comparing the difference between the two programs. In comparing the acreages in cultivated land, pasture land, and woodland between the two programs (Table 15) there is very little difference.

On individual fields and farms there would be some adjustment from cropland to pasture and vice versa, but the watershed picture as a whole would change very little. In comparing the estimated soil loss between the two programs, however, one finds a great deal of difference: The soil losses on the proposed program were reduced by the following methods: (1) land would be used according to its capabilities (Table 10); (2) it was assumed that sloping cropland would be either contoured, terraced, or strip cropped; (3) rotations with more grasses and legumes would be followed; (4) soils would be treated according to test; (5) pasture land would be reseeded and properly managed; and (6) waterways would be shaped, seeded and managed, and the necessary concrete and earthen structures built.

The suggested amounts and kinds of erosion control practices and rotations needed in a watershed treatment program may be found in Table 16. No erosion control practices are needed on 1939 acres of the 3033 acres of cropland in the watershed. The major practice recommended is contouring. If more terracing were used on the sloping cropland, it would be possible to crop some areas more strenuously. It should be noted that the most strenuous rotation allows the land to remain in grasses and legumes at least one fourth of the time and that this rotation is allowed only on the best land. Tables 15 and 16 give a general watershed treatment program. In order to develop sound land use programs on individual farms, assistance should be obtained from the Farm Advisor or the local Soil Conservation District. Although the measures shown in Table 16 are designed primarily to reduce sheet erosion from the field, it is estimated that over 95 percent of the total soil loss from the watershed is derived from this source. Therefore, such a program should effect a reduction of approximately 84 percent of the total sediment load brought to the reservoir.

The lake owners and others with interest in the future life and use of Lake Bracken would profit greatly from these erosion control meas-

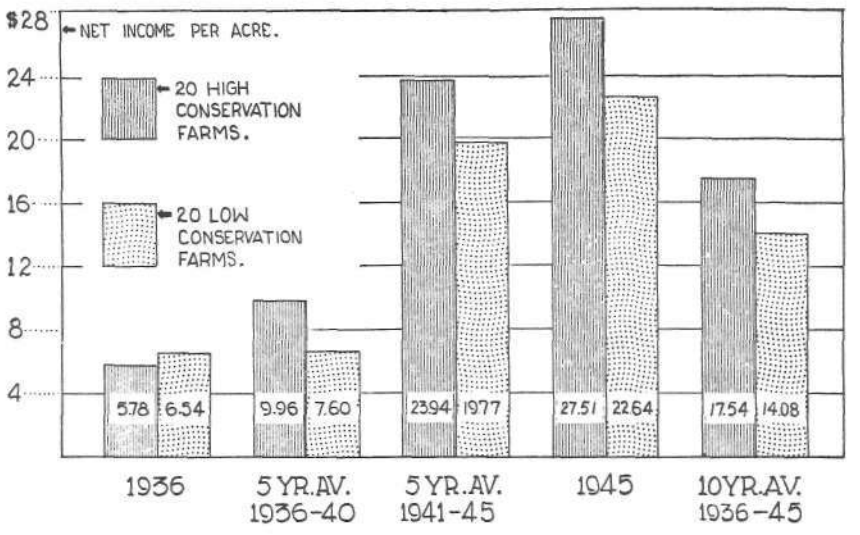

FIG. 14. NET INCOME PER ACRE, IDENTICAL FARMS WITH HIGH AND LOW CONSERVATION SCORES, MCLEAN COUNTY, 1936-1945.

15. C. A. Van Doren and A. A. Klingebiel, "Slope and Practice Limitations for Illinois," mimeographed release, January 1948, Urbana, Illinois.

Table 16

Estimated Conservation Practices and Rotations Needed on Cropland in Lake Bracken Watershed

Soils	Suggested Erosion Control Practices				Suggested Rotations					
	No Practices	Contour[a] Cultivation	Terraces	Strip[a] Cropping	Corn,[b] soybeans, oats, meadow	Corn, b soybeans, oats, 2 years meadow	Corn, soybeans, 3 years meadow	Corn, oats, 2 years meadow	Corn, oats, 4 years meadow	Total Cropland
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
1. Dark-colored, medium-textured, moderately permeable soils. Largely Ipava Muscatine silt loam soil group.	1701	555	228	2	1779	236	343	126	2	2486
2. Light-colored, medium-textured, slowly permeable soils. Largely Berwick soil group.	238	59	---	57	---	238	---	64	52	354
3. Light-colored, medium-textured, moderately permeable soils. Fayette silt loam soil group.	---	104	60	29	---	63	65	---	65	193
4. Shallow, stony and gravelly loam soils. Hickory gravelly loam group.	None in cultivation									---
5. Bottomland soils. Mostly Huntsville silt loam group.	None in cultivation									---
Totals	1939	718	288	88	1779	537	408	190	119	3033

[a] Terracing may be used in some cases to further reduce soil losses.
Soil losses may be further reduced by leaving the land in grasses and legumes a greater percentage of the time.

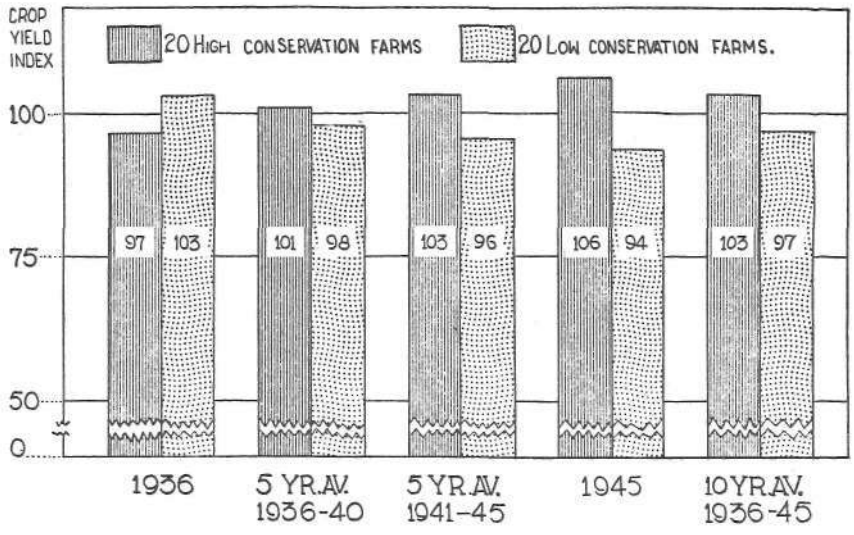

FIG. 15. CROP YIELD INDEX, IDENTICAL FARMS WITH HIGH AND LOW CONSERVATION SCORES, MCLEAN COUNTY, 1936-1945. (AVERAGE YIELDS OF ALL CROPS FOR ALL FARMS EQUALS 100.)

ures on the watershed. In similar cases in which the lake is used for municipal water supply, the control of the watershed area above the lake is considered so important in many parts of the country that the municipality purchases the entire drainage basin. The land is leased to private parties for agricultural use under the terms of the municipality in order that excessive soil loss is avoided. The operation of such lands by the lake owners is normally profitable in itself in addition to saving the soils. In some cases the purchase of only the most critical areas would be satisfactory, or the lake owners could furnish only financial aid to the private farmers in establishing conservation and soil-saving measures on the land, A good educational program to point out the value of soil conservation would be very helpful.

Cost and Benefits of Conservation. The adoption of a soil conservation program by farmers in the watershed would be a definite benefit to the lake owners by reducing the volume of sediment coming into the lake. Studies of actual farms in the state show that the application of soil conservation measures can be justified economically by the farmer himself because increased crop yields from conservation-farmed land mean increased farm income.

The long-time benefits of conservation are certain. However, considerable effort and money must usually be expended before positive results are achieved. Conservation benefits are demonstrated by studies comparing matched high and low conservation farms in McLean County for the period 1936-1945. The farms compared had similar land capabilities and were similar in size but used different amounts of soil and water conservation practices. Figures 14 and 15 show the benefits of conservation in terms of income changes and crop yield changes.

16. W. R. LaDue, "Reservoir Lands Pay Their Way - Balanced Use of Reservoir Lands," Journal American Waterworks Association, August, 1948.

Conservation costs amounted to approximately $35 per acre on the high-conservation-score farms. This was about twice the amount spent for conservation on the low-conservation-score farms.

The high-conservation farms had average net incomes of $3.46 per acre per year more for the 10-year period. (This was after accounting for all expenses, including costs of conservation.) This increased income amounted to $5, 536 for a 160-acre farm for the 10-year period. At 1945 prices the increased net income from conservation amounted to $4. 77 an acre, or $7,632 for a 160-acre farm for a 10-year period.

Conservation costs and benefits in the Lake Bracken watershed would probably be comparable to those in the McLean County study. While the McLean County farms studied have a higher proportion of tillable land, this would be offset by the present unproductive pasture land in the Lake Bracken watershed which would be brought into profitable production by application of a complete conservation plan.

RECOMMENDATION

It is recommended that the lake owners and others interested in the future life of Lake Bracken undertake the development of a soil and water conservation program on the watershed as a means of reducing permanently the rate of sedimentation in the lake. Expenditures for such a program could be justified to an extent of approximately $4700 per year, the replacement cost of avoidable loss of storage space destroyed each year. In addition to this, the proposed conservation program would reduce the present plant nutrient loss of 80 pounds of a 25-5-4 fertilizer per cropland acre per year to less than 10 pounds. This item alone would be a great saving to the farmers on the watershed. The watershed program should be carried out in cooperation with the Knox County Soil Conservation District and other agricultural agencies and in accordance with the findings of the foregoing report.

REPORTS OF INVESTIGATIONS

ISSUED BY THE STATE WATER SURVEY

No. 1. Temperature and Turbidity of Some River Waters in Illinois. 1948

No. 2. Groundwater Resources in Winnebago County, with Specific Reference to Conditions at Rockford. 1948.

No. 3. Radar and Rainfall. 1949.

No. 4. The Silt Problem at Spring Lake, Macomb, Illinois. 1949.*

No. 5. Infiltration of Soils in the Peoria Area. 1949.

No. 6. Groundwater Resources in Champaign County. 1950.

No. 7. The Silting of Ridge Lake, Fox Ridge State Park, Charleston, Illinois. 1951*

No. 8. The Silting of Lake Chautauqua, Havana, Illinois. 1951.

No. 9 The Silting of Carbondale Reservoir, Carbondale, Illinois. 1951

*Out of Print.