UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON, D. C.
H. H. BENNETT, CHIEF

***

ADVANCE REPORT
on the
SEDIMENTATION SURVEY OF MISSION LAKE
HORTON, KANSAS

April 15 to May 6, 1937

by

Victor H. Jones

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In Cooperation With

Kansas Agricultural Experiment Station
Manhattan, Kansas
L. E. Call, Director

Sedimentation Studies
Division of Research
SCS-SS-22
July, 1938

ADVANCE REPORT ON THE

SEDIMENTATION SURVEY OF MISSION LAKE

HORTON, KANSAS

GENERAL INFORMATION

Location (fig. 1):

State: Kansas.

County: Brown. Sections 21 and 28, T. 4 S., R. 17 E.

Distance and direction from nearest city: The dam is 0.7 mile northeast of the center of Horton.

Drainage and backwater: The dam impounds the water of Mission Creek which flows into the Delaware River near Muscotah approximately 7 miles south of the reservoir. The Delaware River is a northern tributary of the Kánsas River, and joins it near Perry in Jefferson County.

Ownership: City of Horton.

Purpose served: Municipal water supply.

Description of dam: Mission Lake dam (fig. 2) has a total length of 1,170 feet and extends in a northwest direction across Mission Creek valley. It is an earth-fill structure with a maximum height of 34 feet and top and bottom widths of 10 feet and 145 feet, respectively. The earthen embankment is made watertight by a puddled core extending from crest level to the natural valley bottom and Wakefield wooden sheet piling extending to bedrock. The upstream face is covered with 6-inch reinforced concrete slab with expansion joints at 25-foot intervals, and has a slope of 3:1. The downstream face has a slope of 2:1.

The concrete spillway, at the east end of the dam, has an effective crest length of 170 feet. Overflow water is carried past the dam through a rock and concrete trough 20 feet wide and 200 feet long. Crest level is 6 feet below the top of the

FIGURE I


MAP SHOWING LOCATION OF
MISSION LAKE
KANSAS
NEBRASKA
MISSOURI
KANSAS
MISSOURI RIVER
NEMAHA
BROWN
DONIPHAN
Mission Lake
Horton
St. Joseph
Atchison
ATCHISON
JACKSON
Delaware River
JEFFERSON
Leavenworth
LEAVEN-WORTH
WYAN-DOTTE
KANSAS CITY
Kansas River
Topeka
SHAWNEE
DOUGLAS
JOHNSON
N
SCALE
10 5 0 10 20 30 MILES
LOCATION MAP_MISSION LAKE & WATERSHED
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief
REFERENCE: VICTOR H. JONES
SUBMITTED:
APPROVED:
COMPILED: G.A.Z.
TRACED: E.E.H.
CHECKED: J.T.C.
DATE 5-6-38
L-2129

.Figure 2.--View of the dam of Mission Lake from the west end.

Figure 3 .--View along the east shore of Mission Lake from the dam, showing rock riprap.

dam and 29 feet above the natural bottom of the stream channel. The elevation of the spillway crest is 1,047.32 feet above mean sea level, as determined by level traverse from United States Geological Survey bench mark P 107 (elevation 1,029.27) located in the southwest corner of the municipal power plant below the dam.

Construction and history of reservoir: The first municipal water supply of Horton was a small pool ponded by an 8-foot dam across Mission Creek channel a quarter of a mile below the present dam. In 1923 the scarcity of water necessitated the limitation of per capita consumption to about 35 gallons per day.

After considerable investigation of reservoir sites in the vicinity by a firm of consulting engineers, the present dam for city water supply was constructed in 1924, and storage of water began in May of that year. The original cost of the reservoir, including the land, spillway, and dam, was $175,000. In June 1925 a series of heavy rains, bringing a total precipitation of 16 inches in 5 days, occurred, and the spillway was partly washed out. The lake level was lowered 8 feet but not completely drained by the wash-out, and extensive repairs were made immediately. The total cost of the reservoir, including repairs to the spillway and maintenance of the surrounding property, was $400,000, according to municipal records.

The age of Mission Lake at the time of the survey was 13 years.

Length of lake: The extreme length of the lake on Mission Creek channel is 1.77 miles. Three tributary arms have lengths of 0.4, 0.5, and 0.6 miles, respectively, above the junctions with the main lake. Sedimentation had not appreciably reduced the length of any major arm of the reservoir at the time of survey.

Area of lake at spillway stage:

	Acres
Original	169
At date of survey	168
Reduction by sedimentation	1

Storage capacity to spillway level:

	Acre-feet	
Original........................	1,852	(603,400,000 gallons)
At date of survey.............	1,563	(509,240,000 gallons)
Reduction by sedimentation.	289	(94,160,000 gallons)

General character of reservoir basin: Mission Lake is long and narrow with generally irregular shore lines. The lower portion ranges from 750 to 1,300 feet in width and extends somewhat west of north about 4,300 feet from the dam to the mouth of the first major tributary arm. Above segment 11 (fig. 4, following p. 15) the lake consists chiefly of 4 principal arms ranging from 0.4 to 0.6 mile in length.

The original meandering stream channel had a gradient of 13.3 feet per mile through the length of the lake. Its average depth below the general valley level was about 6 feet, and its width ranged from 50 to 100 feet, but it is now almost entirely filled with sediment.

Submerged slopes are in general moderately steep, and descend about 14 feet from crest level to the valley bottom within a horizontal distance of 200 feet. A riprap of loose rock, extending 2.5 feet below and 1 foot above crest, has been placed along the shore line of the lower part of the lake to prevent wave erosion (fig. 3).

Roads built around the lake shores have necessitated fills extending across 7 minor tributary arms. In order to create effective silt traps in the small ponds thus formed, the culverts have been set just above crest level so that much of the sediment from these tributaries is deposited before the ponded water overflows into the reservoir.

Area of drainage basin: 11.4 square miles, according to a survey made in 1923 by Black and Veatch,[1] consulting engineers of Kansas City, Mo.

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[1]Black, E. B., and Veatch, N. T., Jr. Report on water-supply investigation, Horton, Kans., January 1923 (unpublished).

General character of drainage basin:

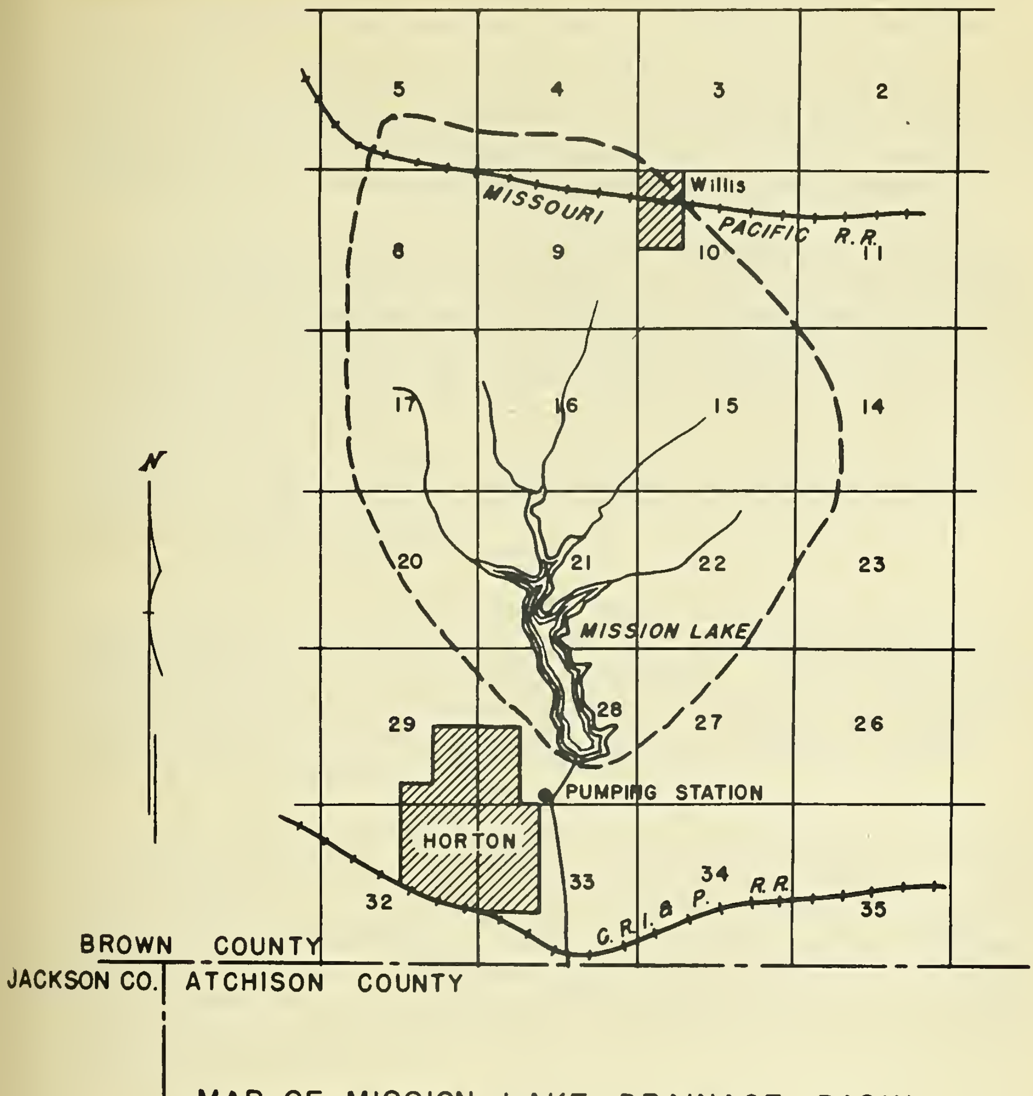
Geology: The drainage basin of Mission Lake (fig. 5) lies in the glaciated portion of the Interior Lowland province, in the lower Missouri River Basin. A generalized section of the geological formations which occur at and near the surface of the area is given in the following tabulation.

Generalized section of geological formations in the Mission Lake drainage basin[2]

	Feet
Recent:	
Alluvial and colluvial clay, silt, sand, and gravel; at foot of slopes and on valley bottoms........................	0-15
Pleistocene:	
Peorian and later Kansan:	
Loess, brown; covers almost entire drainage basin.........................	0-10
Glacial till, pebbly, oxidized; in road cuts and valley slopes..................	0-40
Pennsylvanian:	
Virgil series:	
Wabaunsee group:	
Tarkio formation--	
Limestone, yellow and brown; only a few outcrops high on valley slopes...........	10
Willard formation--	
Sandstone and shale, brown; a few outcrops in valleys.............................	40
Elmont formation--	
Limestone, gray and blue; in lower valley slopes.................................	10
Harveyville formation--	
Shale, blue and brown; exposed only on valley bottoms........................	12
Reading formation--	
Limestone, blue-gray; not exposed within the watershed............................	10

[2]Compiled from field notes and from publications of the Kansas Geological Survey, especially Moore, R. C. Stratigraphic classification of the Pennsylvanian rocks of Kansas. Kans. Univ. Bull. 22, 1936.

FIGURE 5



MAP OF MISSION LAKE DRAINAGE BASIN
BROWN COUNTY, KANSAS

SCALE

0 1 2 3 4 5 6 7 8 9 10 THOUSAND FEET

LEGEND

— — WATERSHED BOUNDARY

▨ CITIES AND TOWNS

MISSION LAKE WATERSHED
BROWN CO., KANSAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT, Chief

REFERENCE: LELAND H. BARNES
MAP - (MR. GENE A. ZWERNER)

SUBMITTED: H. J. Wright		APPROVED:		
COMPILED:	TRACED: F.L.B	CHECKED: J.T.C.	DATE 3-28-38	L-2128

The widespread loess occurs at the surface throughout the drainage area, except on some of the steeper slopes where it has been removed by erosion, and is responsible for about 85 percent of the soils. It is a brown- to buff-colored deposit of eolian origin, ranging from a few inches to 10 feet or more in thickness, which covers all but limited areas of older formations. It is soft, highly porous, and easily eroded, and yields most of the sediment carried by run-off waters.

The Kansan till is an oxidized boulder clay with some sand and many pebbles and cobbles of heterogeneous composition. It covers the entire drainage basin beneath the loess except where streams have cut through it to bedrock. A persistent bed of sand and gravel ranging from a few inches to a few feet in thickness lies between the till and the underlying bedrock surface. This zone between till and bedrock follows an old irregular land surface and occurs around the lake at heights ranging from a few feet below crest level to about 20 feet above it.

All the consolidated rock formations at and near the surface within the watershed belong to the Virgil series of Pennsylvanian age. The Tarkio limestone, which lies immediately beneath the Pleistocene formations on the uplands, has practically no outcrop area, as only its edges on eroded slopes are exposed.

The Willard shale beneath the Tarkio limestone includes a soft impure sandstone about 22 feet thick, which crops out at the dam. It was erosion of the Willard shale by overflow waters which caused the partial destruction of the original spillway in 1925. Subsequently it was necessary to construct the present large and relatively expensive spillway with its heavy rock and concrete walls to prevent further undermining of the structure.

Limestone and shale strata below the Willard lie beneath the ground surface, except for small outcrops in the lower portions of the valley slopes, and consequently exert practically no influence upon sedimentation in the reservoir.

Topography and drainage: The topography of the Mission Lake catchment area as a whole has attained early maturity. A dendritic system of drainage has developed, and the creek and its tributaries above the lake have only intermittent flow. Around the lake the slopes rise approximately 50 feet to the upland within an average horizontal distance of 0.1

mile. At increasing distances from the lake the slopes become more gentle and approach flatness near the watershed boundary.

The maximum relief within the area is approximately 160 feet, and the average elevation is about 1,050 feet above sea level. The only appreciable area of flat valley bottom occurs in Mission Creek valley within the reservoir basin.

Soils: Soils of the drainage basin as mapped by Burgess, Tharp, and Lyman[3] fall into two principal series, (1) Marshall soils, and (2) Yazoo soils. The character and occurrence of the various soil types are shown in table 1.

Table 1.--Nature and occurrence of important soil types in the Mission Lake drainage basin

Soil type	Description	Occurrence
Marshall silt loam.	Dark brown silt loam.	uplands and slopes; 90 percent of the drainage area.
Marshall gravelly loam[1].	Brown to gray gravelly loam.	One small area on slope in sections 16 and 21.
Rough stony land.	Reddish-brown to gray silt loam to clay loam.	Only on steep slopes in sections 20, 21, 22, and 28. Covers 4 percent of the drainage area.
Yazoo silt loam.	Dark heavy silt loam.	Covered entirely by the lake.

[1]Under present classification this would probably be mapped as Shelby loam, as gravelly soils are no longer included in the Marshall series.

Only one soil type, the Marshall silt loam, has sufficient importance within the watershed to merit detailed description. It covers the entire upland and all gentle and moderate slopes.

[3]Burgess, J. L., Tharp, W. E., and Lyman, W. S. Soil Survey of Brown County, Kansas, U. S. Dept. Agr., Bur. Chem and Soils, 1906.

It is derived from the underlying loess and forms the basis of the extensive agricultural development of the area. It is very porous, fertile, and well drained, but must be well protected from sheet and gully erosion if its productive capacity is to be permanently maintained.

The combined areas of the rough stony land and Marshall gravelly loam comprise only 5 percent of the drainage area, but the rough areas will surely increase if soil-protection measures are not adopted. All the Yazoo soil area is covered by the reservoir.

Erosion conditions: Erosion far in excess of the normal rate is occurring in many areas within one mile of the lake. Numerous small gullies have developed on the cultivated slopes, and their headward growth is rapid in the soft loess and loess-derived soils. The gullies are most numerous and active in the east half of sections 21 and 28 near the lake shores.

Sheet erosion is also removing large quantities of soil in sections 21 and 28 (fig. 6) as well as in most cultivated areas farther from the reservoir where gully development is not so serious. Soil-conservation practices have not yet come into general use in the drainage basin.

Land use: The following figures on land use were obtained by means of an automobile traverse during the survey, and should be regarded as estimates.

Land use in the Mission Lake drainage area

	Percent
Cultivated:	
Hay crops	12
Wheat	48
Corn	14
Orchards	1
Garden crops	2
Total cultivated land	77
Pasture	21
Timber	1
Urban areas	1
Total drainage area	100

Figure 6.—Erosion on cultivated slope near Mission Lake dam.

Figure 7.—Silt trap or settling basin behind road fill on east side of Mission Lake.

Wheat was the most important crop in 1937, about 60 percent of the drainage area being devoted to its cultivation. However, in normal years in this region the corn acreage averages 3 to 4 times that of wheat.

Near the lake on the steeper slopes, pasture land is predominant. Park areas around the lake shore are included as pasture in the above tabulation. Trees are confined to the valley bottoms, the park areas, and some slopes along the valley of Mission Creek.

Rainfall: The average annual rainfall from 1890 to 1937 was 33 inches, according to records of a rain gage at the municipal water plant. The annual precipitation ranges from a minimum of 21 inches (1901) to a maximum of 45.5 inches (1915). More than 70 percent of the rainfall occurs between March 31 and October 1.

Draft on the reservoir: The maximum draft on the reservoir is approximately 11,000,000 gallons per month, and occurs during July and August. Consumption during the winter season falls as low as 7,000,000 gallons per month.

HISTORY OF SURVEY

The sedimentation survey of Mission Lake was made by a field party of the Section of Sedimentation Studies, Division of Research, Soil Conservation Service, during the period April 15 to May 6, 1937. The personnel of the party were as follows: Leland H. Barnes, chief of party, Mark P. Connaughton, Alvin T. Talley, Robert M. Dill, Richard K. Frevert, and Alfred J. Kjarsgaard. Preliminary data were secured and arrangements for the survey were made by F. F. Barnes. A study of the lake sediment and an inspection of the drainage area were made by Victor H. Jones, assisted by the field party. F. L Duley, field representative of the Division of Research, prepared cooperative agreements with state agencies and assisted in making arrangements for the survey.

The Soil Conservation Service acknowledges the cooperation of the city of Horton through T. E. Berney, city clerk, and especially H. L. Lingo, superintendent of the Municipal Light and Water Department. Storage space for equipment was provided at the light and water plant, and material for monuments was furnished by the city. Mr. Lingo also made available complete data on construction and history of the reservoir.

Col. Charles H. Browne, editor of the Horton Headlight, supplied information on the history of the municipal water supply, and J. W. McManigal, photographer, furnished aerial photographs of the reservoir and drainage area.

The texture and moisture content of the samples of bottom sediment were determined under the direction of Professor W. H. Metzger in the soils laboratories of Kansas State College, at Manhattan.

In order to provide an accurate base map the shore line of the reservoir was mapped on a scale of 1 inch to 200 feet. Primary triangulation was begun by establishing a chained base line 1,000 feet long extending across the dam. From the base line 11 additional points were established by plane-table triangulation. The crest-level contour line, having a total length of 8.7 miles, was then mapped by plane table and telescopic alidade. Water and sediment volumes were determined by the range method of survey.[4] For this purpose 26 ranges extending across the reservoir in appropriate positions were established, as shown in figure 4. Range ends were numbered from R1 to R2 and permanently marked with concrete monuments 6 inches in diameter and 18 inches deep placed so that the top surfaces are flush with ground level. The appropriate survey numbers were stamped on 2-inch strips of strap iron which were imbedded in the tops of the monuments.

Six samples of bottom sediment from various parts of the lake were obtained with the 1½-inch tubular sampler previously described.[5] Samples were taken in iron pipe nipples 1½ inches in diameter and 4 inches long which were screwed to the bottom of the sampling apparatus and removed after the sample was obtained. The 4-inch nipples containing the samples were capped with threaded airtight iron covers for shipment to the laboratory.

Estimates of the amount of sediment in the small silt-trap basins behind the road fills around the lake (fig. 7) were made during the course of the survey.

A capacity curve (fig. 8) showing water-storage capacity at the date of survey, was prepared by means of 1-foot contours on the silt surface drawn from sounding data.

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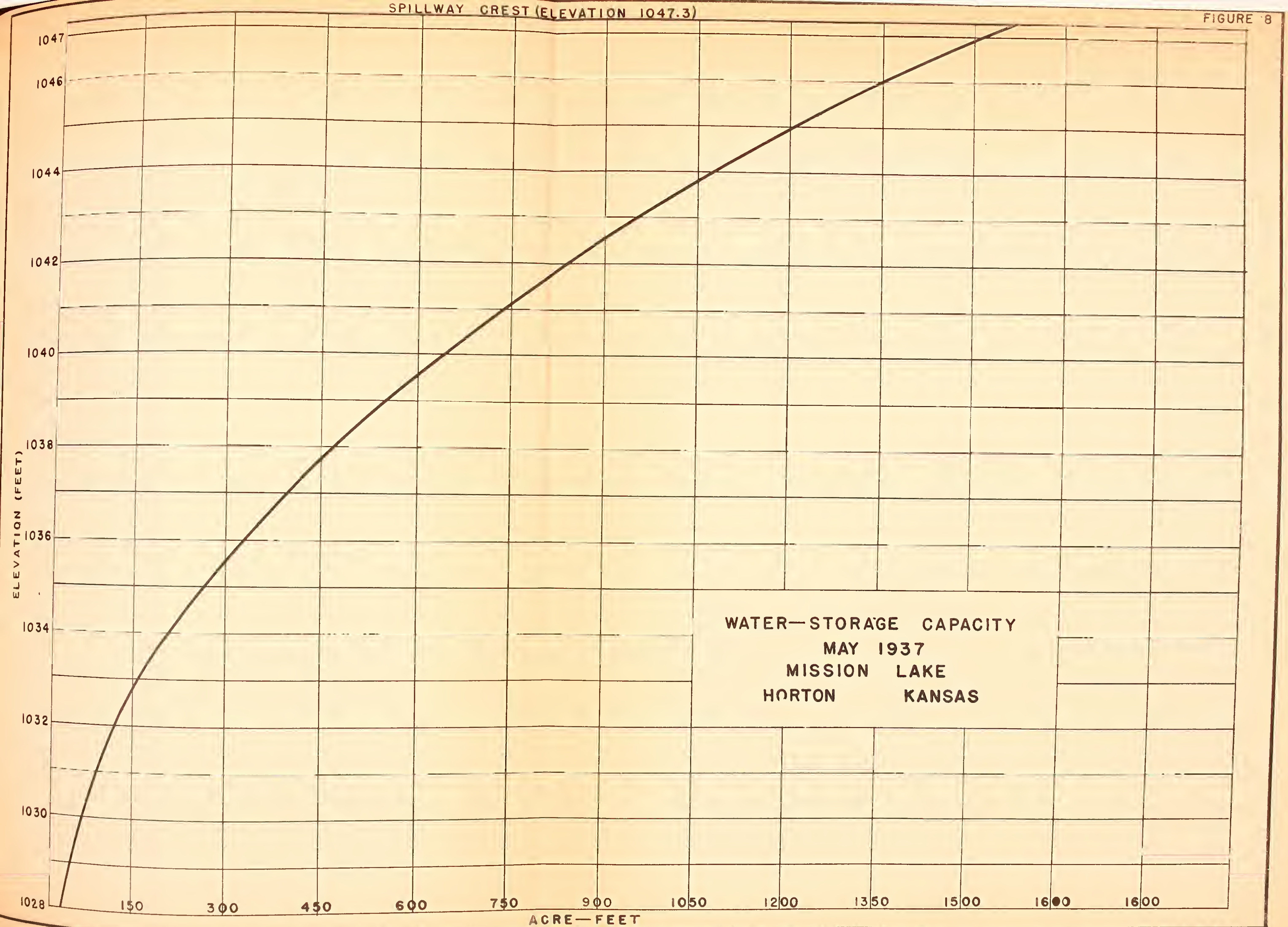
[4]Eakin, H. M. Silting of reservoirs. U. S. Dept. Agr. Tech. Bull. 524: 25-28, 129-135, 1936.

[5]Jones, Victor H. Advance report on the sedimentation survey of Lake Bracken, Galesburg, Ill. U. S. Dept. Agr. Soil Conserv. Serv. SS-14, p. 7, May 1937. (Mimeographed).


SPILLWAY CREST (ELEVATION 1047.3)
FIGURE 8
1047
1046
1044
1042
1040
1038
1036
1034
1032
1030
1028
ELEVATION (FEET)
150
300
450
600
750
900
1050
1200
1350
1500
1600
1600
ACRE—FEET
WATER—STORAGE CAPACITY
MAY 1937
MISSION LAKE
HORTON KANSAS

0-2232

SEDIMENT DEPOSITS

Character of Sediment

The sediment in the deeper portions of the lake basin below range R13-R14 is chiefly fine sand, silt, and clay, which ranges from buff to nearly black in color. The usual color is deep brown. Little compaction has occurred and the material adhered to the spud with only slight tenacity. Irregular black banding, probably representing carbonaceous accumulations from buried leaves, was observed in the thickest sediment on several ranges.

Above range R13-R14 the sediment becomes increasingly sandy toward the heads of the various arms. The most abundant minerals in the sands are quartz, hydrous iron oxides, and white mica. Zones of coarse sediment in the form of small terraces occur around most of the shore below range R16-R22. The material in these zones, consisting of sand, gravel, and a small proportion of cobbles, is chiefly the residuum of wave erosion of Kansan till along the shore. In a few places near the dam the shore material is almost entirely sand, derived from a sandy zone of the Willard shale which crops out at and near crest level.

The location and depth relations of the samples of bottom sediment are shown in table 2.

Table 2.--Bottom sediment samples from Mission Lake

Location	Sample No.	Water depth	Silt thickness	Penetration[1]
		Feet	Feet	Feet
Range R1-R2, 703 feet from R1.......	32	23.7	5.5	4.8
Range R5-R6, 206 feet from R6.......	33	22.3	4.0	3.9
Range R11-R12, 665 feet from R12....	34	17.5	2.5	2.5
Range R15-R16, 599 feet from R16....	35	14.8	6.0	4.2
Range R16-R17, 555 feet from R16....	36	14.8	4.6	4.0
Range R23-R24, 54 feet from R23.....	37	5.8	3.9	3.5

[1]Depth to which lower end of sampler penetrated sediment.

The results of mechanical analyses and moisture determinations of the samples appear in table 3. Under the heading "Sand" is included all material coarser than silt, consisting chiefly of fine and very fine sand. The analyses were made by the hydrometer method. The points of separation between sand and silt on the one hand and silt and clay on the other are 0.05 and 0.005 millimeter in diameter, respectively.

On the basis of the moisture determinations and an assumed average specific gravity of 2.6 for the dry sediment, the average dry weight of the reservoir sediment has been computed as 62.2 pounds per cubic foot.

Table 3.--Mechanical composition and moisture content of bottom sediment from Mission Lake

Sample No.	Sand	Silt	Clay	Relation of moisture to dry weight of sediment
	Per-cent	Per-cent	Per-cent	Percent
32	54.4	16.5	29.1	67.1
33	54.4	15.9	29.7	68.7
34	60.4	21.5	18.1	48.8
35	56.4	14.5	29.1	63.6
36	54.9	15.9	29.2	89.1
37	56.9	14.5	28.6	46.5

Distribution of Sediment

The general distribution of sediment is illustrated in figure 9. The thickest deposits have accumulated in the lower portions of the main tributary arms in segments 16, 17, 18, 21, 22, 23, and 25 (fig. 4). In this area the currents of water entering the wider portion of the lake from the smaller arms encounter deeper water and are sharply retarded, with resulting deposition of much suspended

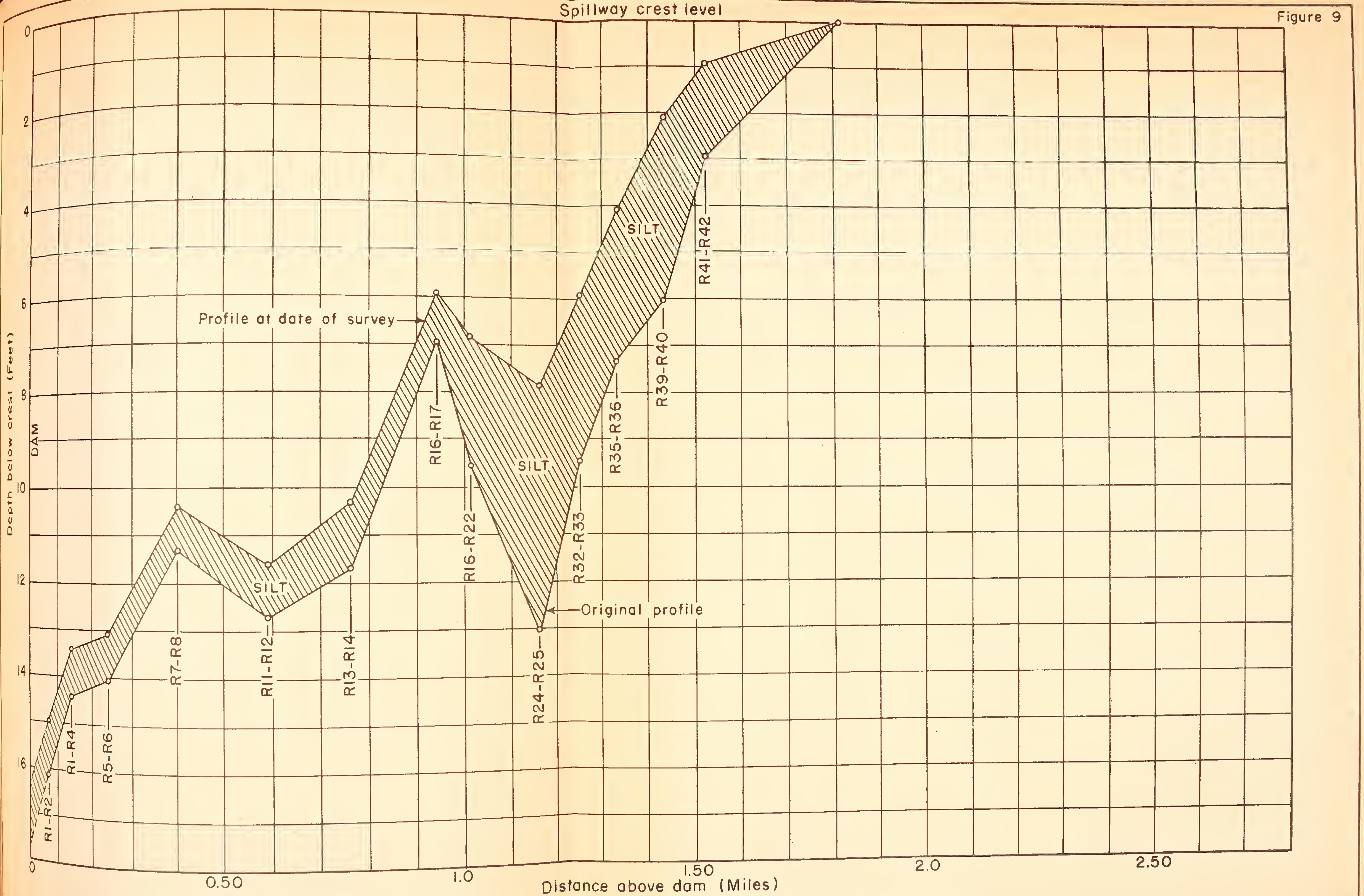


FIGURE 9. Average-depth profiles, Mission Lake, Horton, Kansas.

sediment. The sediment thicknesses in segments 16, 17, and 18 illustrate this effect. On ranges R26-R27 and R28-R29 the maximum thickness of sediment in the channel is approximately 10 feet, and the average thickness on the 2 ranges is nearly 6 feet. On range R23-R24 the maximum and average thicknesses are 8 feet and 2.4 feet, respectively. The original stream channel has been completely filled in this part of the reservoir. Comparable deposits have accumulated in all the other important arms above segment 11.

Measurements on range R13-R14 in the upper part of the main lake showed a maximum sediment thickness of 5.9 feet in the channel beneath 18 feet of water and an average thickness of 2.6 feet on the flatter portions of the bottom beneath an average water depth of 14.5 feet. Below range R13-R14, maximum thicknesses in the channel range from 3.6 to 5.6 feet, but the sediment on the flatter portions of the bottom becomes considerably thinner toward the dam.

Littoral zones, including wave-cut banks 1 to 4 feet in height just above crest and thin gravel and sand terraces below crest, have formed along approximately 40 percent of the shore line below range R16-R17. In a few places this has occurred in spite of a protective riprap of loose rock and concrete blocks along the shore.

Very small areas of sediment have filled shallow parts of the basin to crest level in segments 8, 13, 14, 24, and 29, but the total reduction in lake area by sedimentation to date has been only 1 acre.

An estimated total of 2.32 acre-feet of sediment has accumulated in the check basins behind the road fills. In the absence of the silt traps nearly all of this sediment would have been deposited in the reservoir basin. Figure 7, (following p. 7) illustrates one of the road-fill basins on the east side of the lake.

Origin of Sediment

An accurate analysis of the sources of the sediment deposited in the reservoir would require a detailed study of the entire drainage basin, but certain conclusions are possible even after only a brief examination. It is estimated that 85 percent of the reservoir sediment is derived from loess and loessial soils of the drainage area, and that probably one-half of this material originated by erosion of relatively steep slopes within 0.5 mile of the lake. Probably ten percent of the reservoir sediment originated by erosion of Kansan till on steep slopes around the lake, and the

remaining 5 percent by erosion of Pennsylvanian shales, sandstones, and limestones on valley slopes.

Sediment eroded by wave action along the shores originates chiefly from loess, till, and various bedrock strata and probably comprises less than 3 percent of the reservoir deposits, but it includes all the coarser materials. The contributing streams carry into the lake only very insignificant quantities of materials coarser than sand of medium texture.

CONCLUSIONS AND RECOMMENDATIONS

The measurement of sediment in Mission Lake showed that a total of 289 acre-feet of material has been deposited in the basin in the 13 years since construction of the dam. Although the lake level is not often high enough to cause loss of water over the spillway, some sediment has been carried in suspension entirely through the lake and over the spillway crest. No records on this material are available, and it has not been considered in any computations in this report. Calculation of the average rate of erosion in the drainage basin shows that 136 cubic feet of sediment for each acre of drainage area is deposited annually in the reservoir. If the average dry weight of the reservoir sediment is 62.2 pounds per cubic foot,[6] and that of the soil in the drainage basin is 69.9 pounds per cubic foot,[7] the measured rate of sedimentation indicates that the maximum time required to remove 1 inch of soil from the entire area is only about 30 years. This high rate of erosion is the result of two major factors, (1) unchecked sheet erosion in the gently sloping cultivated fields of the area, and (2) rapid gully and sheet erosion on many of the steeper slopes within one-half mile of the lake. Two minor factors also account for some sediment, (1) wave erosion along shores, and (2) erosion of a small area of sandy bottomland soil in valleys immediately above the heads of the lake.

Under the direction of Superintendent Lingo of the Municipal Light and Water Department, the city of Horton has adopted some protective measures which have retarded the rate of deposition in

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[6]See footnote 4, page 15.

[7]Based on the volume weights given for the Marshall silt loam (the dominant soil of the Mission Lake drainage area) by Middleton, H. E., Slater, C. S., and Byers, H. G. The physical and chemical characteristics of the soils from the erosion experiment stations--second report. U. S. Dept. Agr. Tech. Bull. 430:21, 1934.

the reservoir. The silt-trap basins behind road fills have prevented some sediment from reaching the lake, but the total quantity of material thus controlled is less than 1 percent by volume of the total reservoir sediment. Park facilities now being established around the lake shores will further retard deposition by reducing gully development and sheet erosion on some of the steeper slopes. Trees have been planted and grass cover is being developed on most of the slopes within 200 yards of the shore line around most of the lake. The application of riprap around the shores below range R13-R14 has reduced wave erosion, but in several places the riprap was not built high enough above crest level. As a result wave action has carved new shore lines behind the riprap.

The greater part of the reservoir sediment originates in the extensive cultivated areas beyond municipal jurisdiction, and the city officials, although recognizing the urgent need of erosion control in remote sections of the drainage basin, have no authority to institute protective measures. The basin is a rich grain-producing area but is now losing at a minimum, an average of approximately 4.2 tons of soil from each acre annually by erosion.

Gully-control measures around the lake and a scientific erosion-control program throughout the drainage area are needed if the productivity of the land is to be maintained and the utility and beauty of the reservoir preserved. The success of such a program would be measured by the degree of cooperation between the city of Horton and farmers within the watershed in their efforts to protect the lands from erosion and the reservoir from excessive sedimentation.

The results of the sedimentation survey of Mission Lake are summarized in the following tabulation.

Summary of data on Mission Lake, Horton, Kansas.

	Quantity	Unit
Age[1]	13.0	Years
Watershed area[2]	11.4	Sq. miles
Reservoir:		
Area at spillway stage:		
Original	169	Acres
At date of survey	168	Acres
Storage capacity to spillway level:		
Original	1,852	Acre-feet
At date of survey	1,563	Acre-feet
Storage per square mile of drainage area:[2]		
Original	162.46	Acre-feet
At date of survey	137.11	Acre-feet
Sedimentation:		
Total sediment	289	Acre-feet
Average annual accumulation:		
From entire drainage area	22.2	Acre-feet
Per 100 sq. miles of drainage area[3]	200	Acre-feet
Per acre of drainage area:[3]		
By volume	135.87	Cubic feet
By weight[4]	4.23	Tons
Depletion of storage:		
Loss of original capacity:		
Per year	1.20	Percent
To date of survey	15.60	Percent

[1] Storage began May 1924; average date of survey, May 1937.
[2] Including area of reservoir.
[3] Excluding area of reservoir.
[4] Based on the average dry weight of six samples of 62.2 pounds per cubic foot, computed from the moisture content (table 2) and an assumed specific gravity of 2.6.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

H. H. BENNETT, Chief W. C. LOWDERMILK, Associate Chief

MISSION LAKE

HORTON
KANSAS

SEDIMENTATION SURVEY OF APRIL 15 TO MAY 6, 1937

G. C. DOBSON, Acting Head, Sedimentation Studies, Division of Research

500 0 1000 2000

Scale in feet

LEGEND

1937 Spillway Crest Line

Original Spillway Crest Line

Area Silted Above Original Crest

Thalweg of Original Stream Channels

R1 —— R2 Silt Range

1001 △ Triangulation Station

① Reservoir Segment Number

Leland H. Barnes, in Charge of Field Survey

0-1891

6-14-37