REPORT OF SEDIMENTATION SURVEY

LAKE WINTERS

RUNNELS COUNTY, TEXAS

1970

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

4-30293 4-71

USDA-SCS-FORT WORTH, TEX. 1971

Report of Sedimentation Survey

LAKE WINTERS

Runnels County, Texas

1970

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United States Department of Agriculture

Soil Conservation Service

Temple, Texas

4-30293 4-71

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REPORT OF SEDIMENTATION SURVEY

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TABLE OF CONTENTS

ILLUSTRATIONS AND TABLES

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INTRODUCTION

This report describes the results of a sedimentation survey of Lake Winters, Runnels County, Texas made by the United States Department of Agriculture, Soil Conservation Service, Temple, Texas, in cooperation with the City of Winters. The survey was made at the request of the Runnels Soil and Water Conservation District and was conducted during the period July 21 to 23, 1970. There were no previous sedimentation investigations on this reservoir prior to this survey.

The City of Winters originally obtained its water supply from a small reservoir on a tributary of Bluff Creek. This reservoir was abandoned because of sediment accumulation. Lake Winters was built in 1945 to provide a new water supply for the city. Normal use began in January of 1946. At that time the city's population was about 2,700 persons. Since construction of the lake, a gradual rise in population, as well as higher per capita consumption, has increased the annual amount of water used. These facts, and the knowledge that sediment deposition in the lake has decreased its capacity, caused concern as to the adequacy of the remaining water storage for the city's future needs.

OBJECTIVES OF THE SURVEY

Major objectives of the investigation were to determine the capacity loss of the reservoir due to sedimentation, to determine the annual rate of sediment production per unit of drainage area, to evaluate the effects of conservation practices in the watershed on sediment yield to the reservoir, and to determine the characteristics of sediment deposition in the reservoir.

LAKE WINTERS SYSTEM

Location - Lake Winters is located 5.25 miles east of Winters, Runnels County, Texas. The dam is constructed across Elm Creek 17.5 river miles upstream from its confluence with the Colorado River.

The Dam and Spillway - The dam is a rolled earth fill 2,080 feet long extending approximately east-west across the stream valley. It has a maximum height of 32.8 feet at the channel and a base width of 220 feet at the same point. The crown width is 20 feet. The embankment has a 2:1 slope on the downstream side. The upstream slopes are 3:1 from the base to elevation 1789 feet above mean sea level and 2:1 above that elevation. The upstream side has a minimum of two feet of riprap from elevation 1780 feet above m.s.l. to elevation 1798.

4-30293 4-71

The outlet system consists of two uncontrolled overflow spillways, one on each side of the dam. The left spillway, which is 600 feet wide, has a crest elevation of 1793 feet above m.s.l. The emergency spillway on the right side of the dam is 300 feet wide. Located within this outlet is a service spillway approximately 30 feet wide with a concrete toe wall 100 feet from the dam. The crest elevation of the service spillway as determined by this survey is 1790 feet above m.s.l. The service spillway crest elevation was used as the maximum elevation in computing sediment deposition in the reservoir.

The low water discharge is a concrete inlet tower with two sluice gates at elevations 1777 and 1770 feet above m.s.l. A 12-inch pipe extends through the embankment with invert at elevation 1764 feet above m.s.l. Municipal water is pumped from a station house located near the west shoreline of the reservoir. This water is transported to the pump station through a 10-inch pipe which extends from the west side of the inlet structure.

The Reservoir - The original surface area of the lake at service spillway crest elevation was 306.6 acres, and the original capacity was 2,518.2 acre-feet, as determined by this survey. The lake area has not changed appreciably since it was built. Its shoreline is only moderately irregular and has only one small bay in the vicinity of the right spillway. The area covered by the lake is a relatively flat valley with a narrow, uniform channel. Maximum water depth, other than in the channel and borrow pit, found during this survey was 12 feet. Original maximum depth was 14 feet.

THE WATERSHED

General Geology - Geologic strata are Permian shales, limestones, and dolomites of the Clear Fork group, and sandstone of the Double Mountain group. These strata are overlain by Edwards Plateau outliers. Two large outcrops of the Edwards occur on the eastern and western edges of the watershed about midway between the lake and at the uppermost part of the watershed forming the drainage area boundaries in this portion of the watershed. The Edwards Plateau outliers consist of Cretaceous sands and sandstones of the Trinity group and shales and hard limestones of the Fredricksburg group.

Topography and Drainage - The topography of the watershed is mostly rolling. The stream valleys are gently sloping and moderately narrow. The strongest relief is in the middle eastern and western parts. The hills and outliers of the Edwards have nearly level tops and steep side slopes. A drop of 300 feet within a distance of a quarter mile is not uncommon. Elevations range from about 2,300 feet above m.s.l. to 1771 feet, which is the present lowest elevation in Lake Winters.

Climate - Runnels County has a warm-temperate, subtropical climate. Winters are dry, and summers are humid. The average annual rainfall is 22.63 inches. About two-thirds of this amount falls during the period from April through September. The amount of rainfall varies widely from year to year, with the heaviest rains occurring as thunderstorms. The range has been from 10.7 inches, in 1917, to 50.6 inches in 1935.

The mean annual temperature for the period 1900-1968 was 64 degrees Fahrenheit.

4-30293 4-71

The average annual lake evaporation is estimated at 68 inches. Of this amount, about 47 inches is evaporated during the period May through October.

The mean annual runoff is 1.25 inches, or 4,240 acre-feet.[1/]

Land Resource Areas and Soils - The watershed of Lake Winters lies within the Central Rolling Red Plains and Edwards Plateau Land Resource Areas.

The Central Rolling Red Plains is typically represented by the following soil associations:[2/]

1. Potter-Mereta association: Nearly level to undulating, loamy soils that are moderately deep to very shallow over caliche, on outwash plains. This association occupies broad areas on upland in most parts of the watershed. Although Portales soils are not mapped in the upper portion of the drainage area, these soils comprise about 37 percent of the association in Runnels County. About two-thirds of this association is used as native range, while the rest is being farmed.

2. Rowena-Tobosca association: Nearly level to gently sloping, deep, loamy and clayey soils, mainly on outwash plains. This association is characterized by broad areas on uplands, by upland valleys, and by scattered shallow depressions. The soils are well suited to cultivation.

3. Spur-Colorado-Miles association: Nearly level to gently sloping, deep, loamy soils mainly on floodplains, but also on outwash plains and old stream terraces. These soils comprise a very small percentage of watershed soils, occurring only on the floodplain of Elm Creek for a distance of about three miles above Lake Winters. These soils are also well suited for cultivation.

4. Olton-Vernon-Rowena association: Nearly level to gently sloping, deep, loamy soils on outwash plains and gently sloping to steep, shallow, clayey soils on uplands. This association comprises the greatest portion of the soils in the Lake Winters watershed. The gradient is 0 to 25 percent, and the drainage pattern is complex. In Taylor County where this association is not mapped, Sagerton and Rotan soils predominate. Most of this association is well suited to range and is used for this purpose.

The Edwards Plateau Land Resource Area is represented by soils of the Tarrant-Rough stony land association which is described as undulating to steep, very shallow, clayey soils and steep, stony areas. This association is well suited to range and wildlife habitat. It produces a wide variety of desirable forage for livestock and deer. Most of the acreage is used for range.

4-30293 4-71

Land Use - The following tabulation shows the land use, excluding the lake area, in the watershed at the time of survey:

Land Use	Watershed Acres	Total Percent
Cropland	14,144	35
Rangeland	26,266	65
Total	40,410	100

Roads, towns, homesteads, etc. comprise less than one percent of the total watershed land.

Desirable range grasses are little bluestem, blue grama, sideoats grama, hairy grama, silver bluestem, and buffalograss. Major crops grown are cotton, grain sorghum, wheat, and oats.

Erosion and Sediment Production - Generalized sediment source studies were made in the drainage area of the lake. These studies included tabulating soil units by slope in percent; slope length in feet; land use; cover conditions on rangeland; and lengths, widths, depths, and estimated lateral erosion of gullies, stream banks, and scour channels. Separate studies were made based upon land use, cover conditions, and conservation practices in effect in 1945 and 1970.

In computing gross erosion, the quantity of material derived from sheet erosion and channel erosion are computed separately. Sheet erosion was computed by use of the Musgrave[3/] equation. Channel erosion was computed by a formula described by Renfro.[4/]

Under 1945 conditions, the estimated annual gross erosion from all sources was 65 acre-feet. Application of conservation practices in the watershed has reduced this erosion to 56 acre-feet, a decrease of 14 percent. Sheet erosion accounts for approximately 82 percent, gully and streambank erosion 10 percent, and flood plain scour 8 percent of the total annual gross erosion.

The average annual sediment yield to the reservoir is 12.6 acre-feet. The reservoir has an estimated trap efficiency of 93 percent. The density of submerged sediment is only 39 pounds per cubic foot as compared to a density of 85 pounds per cubic foot for in-place soil. Due to this significant difference in densities, sediment occupies more than twice as much space in the reservoir as it does as soil in-place. Thus the average annual capacity loss due to sediment deposition is 25.54 acre-feet.

A comparison of the annual gross erosion in the watershed to the annual sediment yield to the reservoir was made. This shows that, for the life of the reservoir, only 21 percent of the erosional material has been delivered to and deposited in the reservoir.

4-30293 4-71

SURVEY METHODS AND CALCULATIONS

Aerial photographs were utilized in making the survey. Permanent range end markers were established to aid in any future surveys which may be made.

The following survey procedures were used:

1. Initially, elevations were run from the top of the inlet tower to a temporary bench mark established at the pump house. Elevations were then taken from the T.B.M. to the water surface and then to the range end by use of a dumpy level. The map of the shoreline at service spillway crest contour was prepared by a combination of plane table mapping and use of existing aerial photographs.

2. A steel airplane cable was tightly stretched from shore to shore on line between the range ends. Ranges were located so as to give the best possible data on sediment deposition for this type of survey.

3. A boat with a line meter was then attached. As the boat traversed along the range, distances were recorded. Water depths and sediment thickness measurements were made at regular intervals.

4. Water depths were measured with a standard 5-pound conical-shaped sounding pea attached to a graduated copper-cored line. Sediment thicknesses were obtained with grooved spud bars and sounding poles.

Approximately 350 measurements were made on the eight ranges. Original and present capacities were computed using the prismoidal formula as described by Eakin and Brown.[5/]

Plottings of representative range cross sections showing the original and present elevations are shown in figure 3.

Area and capacity curves were constructed using a contour map plotted from the present water depth measurements taken during this survey. (See figure 4.)

Sediment samples were obtained with a piston-type sampler which employs a clear plexiglass tube inserted inside the newly-modified aluminum outer cylinder. The plexiglass tube affords the advantages of noncompression of sediment, visual examination of the sample, and accurate measurements of sample volume. Recovery was good, and representative samples were submitted for testing.

SEDIMENTATION IN THE RESERVOIR

Character of Sediment - Six sediment samples were taken from the reservoir, one sample from each of the first six ranges. The five samples obtained from ranges 1 through 5 were extremely similar in texture and volume weight. They consist of 96 percent clay and 4 percent silt size particles. None of the samples contained sand. The sample from range 6 is considered

representative of sediment deposited in the upper segments of the lake. It was composed of 78 percent clay and 22 percent silt. The sediments are dark brown in color.

Distribution of Sediment - As shown by the segment data, Table 2, capacity loss is relatively uniform throughout the first 7 segments. The greater capacity losses due to sediment are in segments 8 and 9, at the upper end of the reservoir. As the water level of the lake drops during times of low rainfall and runoff, these upper segments have the largest proportion of shallow water or dry areas in the lake. This situation is conducive to accelerated growth of aquatic weeds and other vegetation which slows the flow of water and thus increases the deposition of sediment. The reservoir, to date, has lost 25 percent of its original capacity.

Volume Weight of Sediment - All samples were taken from areas of the reservoir which have not been exposed to air drying. Volume weights were determined by the Soil Conservation Service Materials Testing Section at Fort Worth, Texas. The six samples had an average unit dry weight of 39 pounds per cubic foot. Samples ranged in weight from 35 to 48 pounds per cubic foot. The average unit dry weight of upland samples is 85 pounds per cubic foot.

Trap Efficiency of Reservoir - The trap efficiency of Lake Winters is 93 percent. This was obtained by using curves developed by Brune[6/] which relate capacity-inflow to the percent of sediment trapped.

SOIL CONSERVATION

Conservation treatment on lands in the watershed is carried out under the direction of the Runnels and Middle Clear Fork Soil and Water Conservation Districts assisted by the Soil Conservation Service work units in Ballinger and Abilene. This effective conservation program is based upon the use of each acre of agricultural land within its capabilities and treatment in accordance with its needs. The work units have assisted farmers and ranchers in preparing soil and water conservation plans on 33,540 acres, or 83 percent of the watershed. They have furnished technical assistance in establishing and maintaining the planned measures. To date, approximately 60 percent of the land treatment measures have been applied. Much of the land in the watershed not under cooperative agreement has received some conservation treatment.

Land treatment measures decrease erosion and the resultant sediment yield from cropland and rangeland by providing improved soil-cover conditions. These measures include conservation cropping systems, cover and green manure crops, and crop residue use for cropland. On grassland they include proper use, range seeding, and brush control to improve grass cover; farm ponds to provide livestock water; and proper distribution of grazing to improve, protect, and maintain grass stands. These measures also effectively improve soil conditions and increase infiltration of rainfall into the soil.

4-30293 4-71

In addition to soil improving and cover measures, land treatment includes contour farming, level terraces, and grassed waterways, which have a measurable effect in reducing peak discharge by slowing runoff water from fields and in reducing erosion and sediment damages.

Application for a watershed protection and flood prevention project for Elm Creek watershed has been submitted and a field examination report has been prepared by Soil Conservation Service specialists H. N. McGill and W. W. Snyder.[7/] The report indicates that a favorable benefit-cost ratio can be obtained.

Land treatment measures applied since construction of the lake have reduced sediment production by 14 percent. If a work plan is developed for the Elm Creek watershed, accelerated establishment of land treatment practices and structural works of improvement will further reduce the annual capacity loss due to sediment deposition in Lake Winters.

SUMMARY

As shown by the Reservoir Sediment Data Summary Sheet, Table 1, the reservoir has lost 632 acre-feet of its original capacity due to sedimentation during its 25-year life. The average annual rate of deposition is 25.5 acre-feet, which represents a rate of 0.40 acre-foot per square mile of watershed area. Conservation treatment measures by farmers and ranchers in the watershed have reduced sediment production by 14 percent since 1945. The total capacity loss of the reservoir to date is 25 percent, which represents an average annual loss of 1.0 percent.

4-30293 4-71

REFERENCES

1. U. S. Dept. of Agriculture, Soil Conservation Service, Average Annual Runoff Map, 1954.

2. U. S. Dept. of Agriculture, Soil Conservation Service, Soil Survey of Runnels County, Texas, March 1970.

3. Musgrave, G. W., The Quantitative Evaluation of Factors in Water Erosion - A First Approximation, Journal of Soil and Water Conservation, Vol. 2, No. 3, pp 133-138, July 1947.

4. Renfro, G. W. and Moore, C. M., Sedimentation Studies in the Western Gulf States, Proceedings, ASCE, Hydraulics Div., Oct. 1958.

5. Eakin, H. M., Silting of Reservoirs, U. S. Dept. of Agriculture Tech. Bull. 524 (Revised by C. B. Brown), 166 pp. illus., 1939.

6. Brune, G. M., Trap Efficiency of Reservoirs, Trans. American Geophys. Union, Vol. 34, No. 3, pp 407-418, June 1953.

7. McGill, H. N. and Snyder, W. W., Field Examination Report, Elm Creek Watershed, Soil Conservation Service, April 1968.

4-30293 4-71

TABLE 1

RESERVOIR SEDIMENT DATA SUMMARY

SCS-34 Rev. 6-66

LAKE WINTERS

NAME OF RESERVOIR

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DATA SHEET NO.

DAM

1. OWNER City of Winters	2. STREAM Elm Creek	3. STATE Texas
4. SEC. TWP. RANGE	5. NEAREST P. O. Winters	6. COUNTY Runnels
7. LAT. 31° 57′ 10″ LONG. 99° 52′ 20″	8. TOP OF DAM ELEVATION 1801	9. SPILLWAY CREST ELEV. 1790

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE	1790	306.6	2518.2	2518.2	10-45
c. POWER					
d. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN
e. IRRIGATION					
f. CONSERVATION					1-46
g. INACTIVE					

17. LENGTH OF RESERVOIR 2.02 MILES | AV. WIDTH OF RESERVOIR 0.24 MILES

WATERSHED

18. TOTAL DRAINAGE AREA 63.62 SQ. MI.	22. MEAN ANNUAL PRECIPITATION 22.63 (68) INCHES
19. NET SEDIMENT CONTRIBUTING AREA 63.14 SQ. MI.	23. MEAN ANNUAL RUNOFF 1.25 INCHES
20. LENGTH 14.62 MILES, AV. WIDTH 4.35 MILES	24. MEAN ANNUAL RUNOFF 4241.07 AC.-FT.
21. MAX. ELEV. 2301, MIN. ELEV. 1764	25. ANNUAL TEMP.: MEAN 64°F RANGE 44°F - 83°F

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
10-45	--	--	Range (D)	Eight Ranges	306.6	2518.2	0.59
7-70	24.75	24.75			306.6	1886.2	0.44

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET: a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	36. WATER INFL. TO DATE, AC.-FT.: a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET: a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET: a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
7-70	632.0	25.54	0.40	632.0	25.54	0.40

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.: a. PERIOD	b. TOTAL TO DATE	41. STORAGE LOSS, PCT.: a. AV. ANN.	b. TOT. TO DATE	42. SED. INFLOW, PPM: a. PERIOD	b. TOT. TO DATE
7-70	39(6)	340	340	1.01	25.0	--	--

4-30293 4-71

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, CREST ELEVATION											
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR													
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	-105	-110	-115	-120	-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION														

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AC.-FT.

46. 1970 ELEVATION-AREA-CAPACITY DATA

ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
1772	0.18	0.18	1782	103.53	302.49			
1774	0.66	1.04	1784	129.72	539.52			
1776	1.93	3.67	1786	192.07	866.52			
1778	35.41	41.61	1788	255.19	1321.03			
1780	58.89	137.44	1790	306.6	1886.20			

47. REMARKS AND REFERENCES

48. AGENCY MAKING SURVEY Soil Conservation Service

49. AGENCY SUPPLYING DATA Sedimentation Survey Party - Texas

50. DATE February 1971

TABLE 2

SEGMENT DATA
LAKE WINTERS
1970 SURVEY

SEGMENT	ORIGINAL SURFACE AREA (Acres)	ORIGINAL CAPACITY (Ac.-Ft.)	CAPACITY AT DATE OF SURVEY (Ac.-Ft.)	SEDIMENT VOLUME (Ac.-Ft.)	CAPACITY LOSS (Percent)
1	24.9	300.5	211.6	88.9	30
2	36.3	487.0	373.7	113.3	23
3	40.4	421.7	335.8	85.9	20
4	41.8	384.3	307.8	76.5	20
5	48.4	383.1	304.2	78.9	20
6	40.3	247.0	181.2	65.8	27
7	40.4	190.4	120.8	69.6	36
8	29.1	94.9	47.2	47.7	50
9	5.0	9.3	3.9	5.4	58
Total	306.6	2518.2	1886.2	632.0	25

4-30293 4-71

Form SCS-354
Rev. 2/59

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL MECHANICS LABORATORY DATA
Sheet 1 of 1

Laboratory Sample Number F71-	Field Number	Texas CO-01 Lake Winters, (Sed.) Location and Description	cu. ft.	Field Classification	Fines .002 mm	Fines .005	Fines .02	Fines .05	Fines #200 0.074	Sand #140 0.105	Sand #60 0.250	Sand #40 0.42	Sand #20 0.84	Sand #10 2.0	Sand #4 4.76	Gravel 3/8" 9.525	Gravel 1/2" 12.7	Gravel 3/4" 19.05	Gravel 1" 25.4	Gravel 1 1/2" 38.1	Gravel 3" 76.2 mm	Atterberg Limits LL	Atterberg Limits PI	Unified Classification	Soluble Salts %	Dispersion %	Moisture-Density Relationships (☐ Standard ☐ Modified) Curve No.	Max γ_d pcf	w_o %	Undisturbed Sample Data γ_d g/cc	w_n %	G_s	Special Tests				
1200	1	Portales - Potter - Mereta	.140		22	29	39	50	55					100																					[illegible]		
1201	2	Rowena - tabosa	.140		29	42	63	78	85					100																					91.1		
1202	3	Spur - Colorado - Miles	.140		23	27	35	46	51					100																					75.5		
																																			81.4		
																																		used	85		

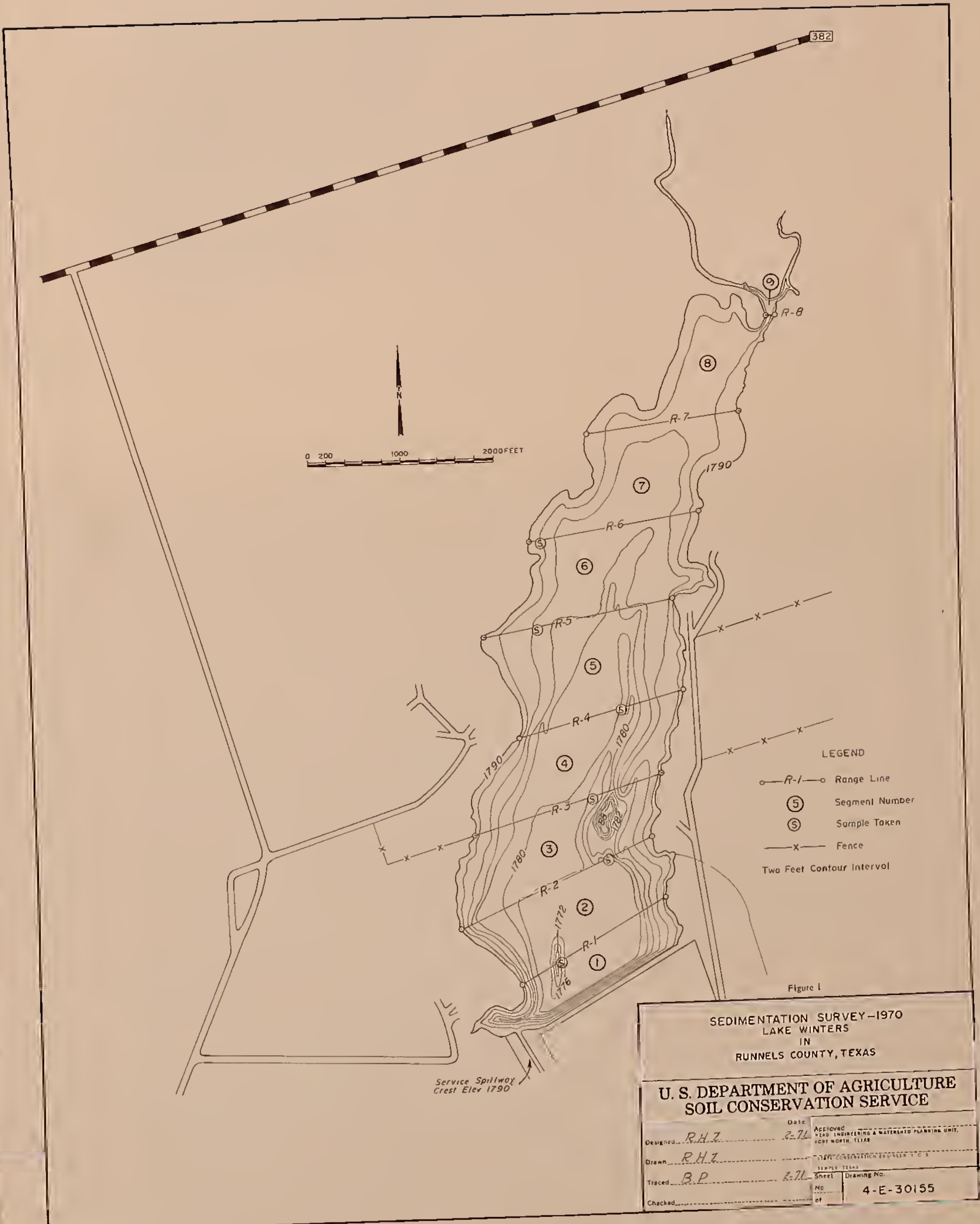
382
0 200 1000 2000 FEET
N
R-1
R-2
R-3
R-4
R-5
R-6
R-7
R-8
1790
1780
1772
1776
Service Spillway
Crest Elev 1790
LEGEND
R-1 Range Line
5 Segment Number
S Sample Taken
—x— Fence
Two Feet Contour Interval
SEDIMENTATION SURVEY–1970
LAKE WINTERS
IN
RUNNELS COUNTY, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Date
Designed R.H.Z. 2-71
Drawn R.H.Z.
Traced B.P. 2-71
Checked
Approved
Sheet
No.
of
Drawing No.
4-E-30155

Figure I

Figure 2
LAKE WINTERS WATERSHED
TAYLOR AND RUNNELS COUNTIES
TEXAS

APPROX. SCALE 1:61,570

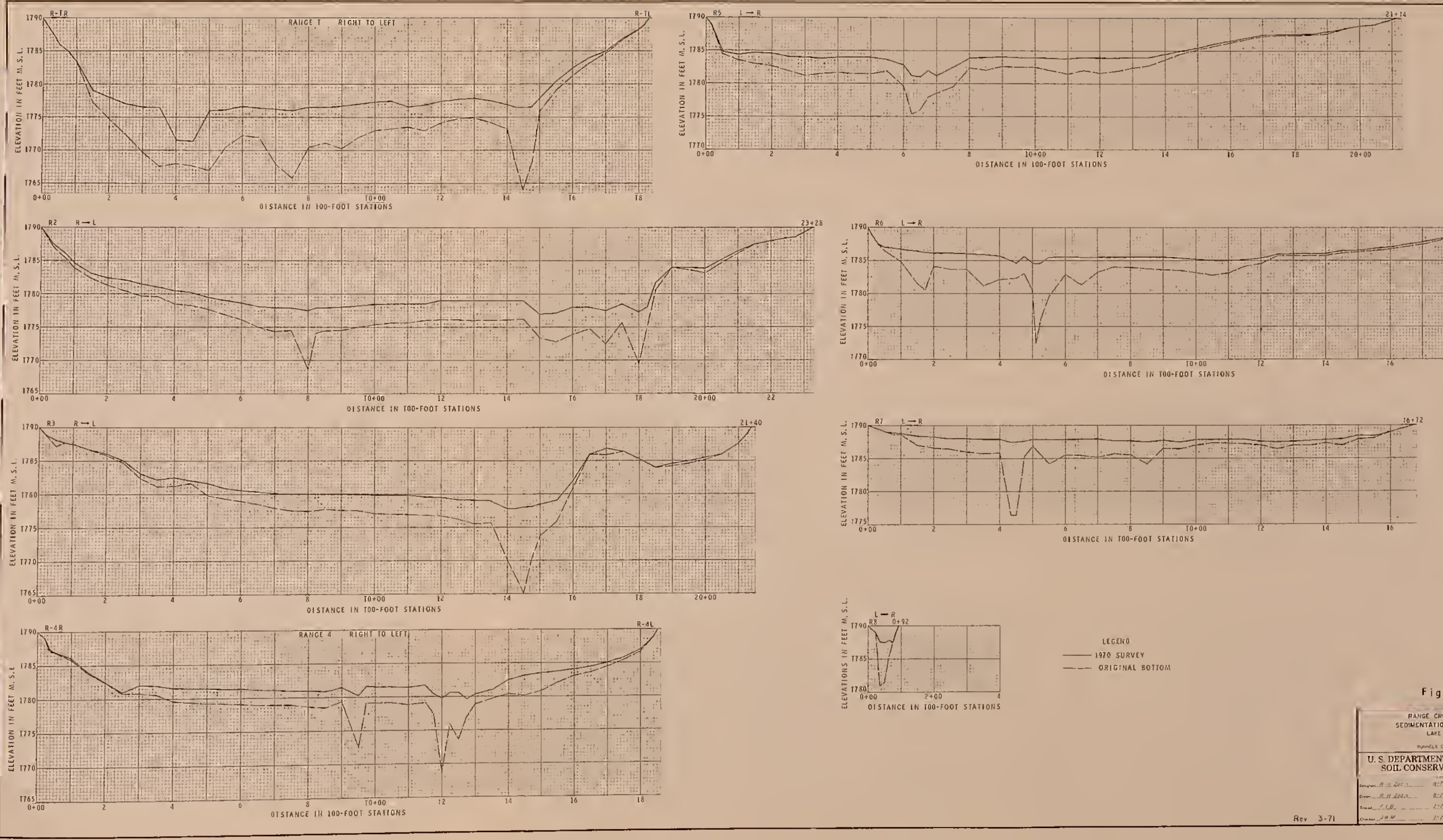

Figure 3

RANGE CROSS SECTIONS
SEDIMENTATION SURVEY-1970
LAKE WINTERS
RUNNELS COUNTY, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

4-R-30,153

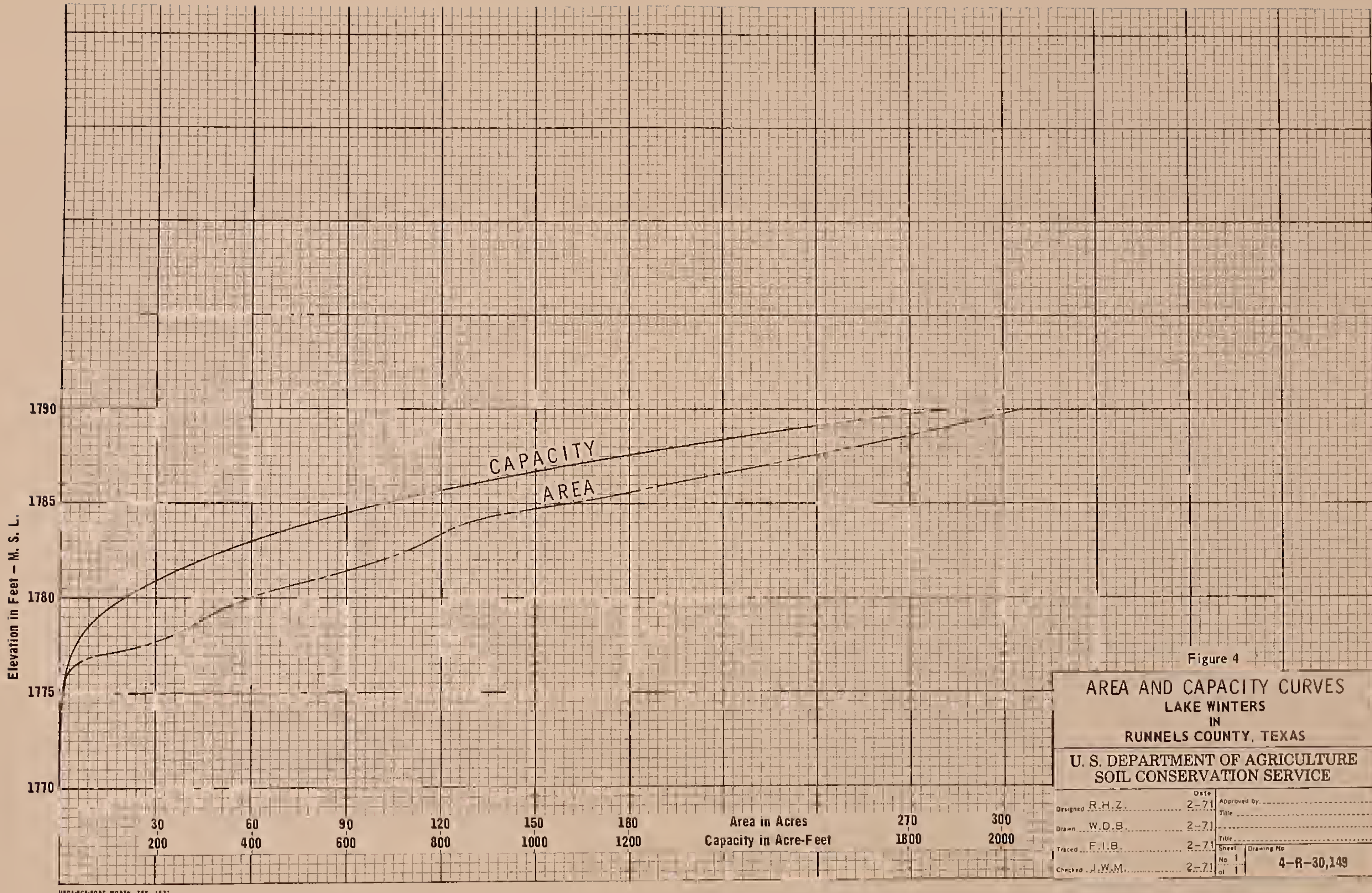
Figure 4
AREA AND CAPACITY CURVES
LAKE WINTERS
IN
RUNNELS COUNTY, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Date
Designed R.H.Z. 2-71
Drawn W.D.B. 2-71
Traced F.I.B. 2-71
Checked J.W.M. 2-71
Approved by
Title
Title
Sheet No 1 of 1
Drawing No 4-R-30,149
CAPACITY
AREA
Elevation in Feet – M. S. L.
1790
1785
1780
1775
1770
Area in Acres
30
60
90
120
150
180
270
300
Capacity in Acre-Feet
200
400
600
800
1000
1200
1800
2000