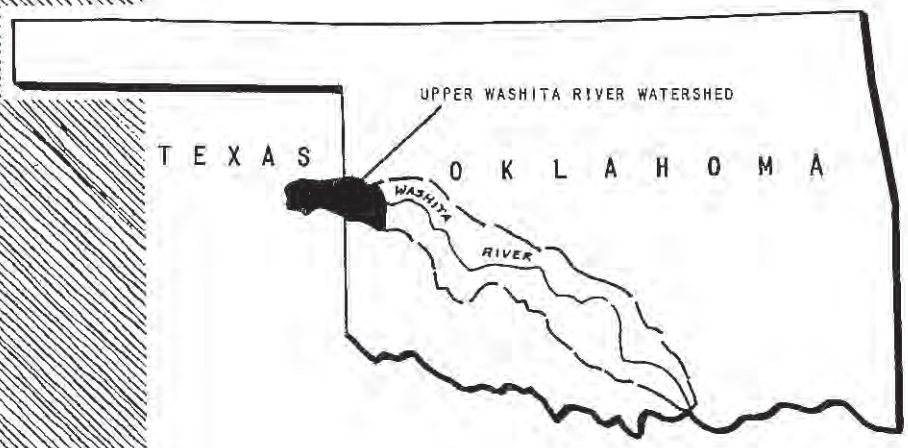
WORK PLAN

UPPER WASHITA RIVER WATERSHED

OF THE WASHITA RIVER WATERSHED
ROGER MILLS COUNTY, OKLAHOMA AND
HEMPHILL, WHEELER, AND ROBERTS COUNTIES, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Stillwater, Oklahoma
Temple, Texas
December, 1958

USDA-SCS-FORT WORTH, TEX. 1959

WATERSHED WORK PLAN AGREEMENT

between the

Hemphill County Soil Conservation District, Texas
Local Organization

Wheeler County Soil Conservation District, Texas
Local Organization

Roberts County Soil Conservation District, Texas
Local Organization

Upper Washita Soil Conservation District, Oklahoma

(Hereinafter referred to as the Districts)

Hemphill County Commissioners Court
Local Organization

Wheeler County Commissioners Court
Local Organization

(Hereinafter referred to as the Counties)

In the Statesof Oklahoma and Texas

and the

United States Department of Agriculture
Soil Conservation Service
(Hereinafter referred to as the Service)

Whereas, the Districts have heretofore entered into a Flood Control Supplemental Memorandum of Understanding with the Soil Conservation Service for assistance in constructing works of improvement for the prevention of floods in the Upper Washita River Watershed, States of Texas and Oklahoma under the authority of the Flood Control Act of 1944 (58 Stat. 887).

Whereas, the responsibility for carrying out all or a portion of the work of the Department on the watershed has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Districts and the Service a mutually satisfactory plan for works of improvement for the Upper Washita River Watershed, States of Texas and Oklahoma, hereinafter referred to as the Watershed Work Plan;

Whereas, the Counties will benefit from the carrying out of the plan for works of improvement through the reduction of damages to property, including County roads and bridges in the Counties that are located within the flood plain of the watershed;

It is mutually agreed that in installing and operating and maintaining the works of improvement described in the watershed work plan:

1. The Districts and/or the Counties will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement.

2. The Districts will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The Service will provide all construction costs and installation services applicable to works of improvement for flood prevention.

4. The Districts will obtain agreements from owners of not less than 50 percent of the land above each floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

5. The Districts will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

6. The Districts will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

7. The Districts and the Counties will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with an operation and maintenance agreement which is to be entered into.

8. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

9. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

Hemphill County Soil Conservation District, Texas
Local Organization

By J. Virgil Beard

Title Chairman

Date June 25, 1959

The signing of this agreement was authorized by a resolution of the governing body of the Hemphill County Soil Conservation District, Texas
Local Organization

adopted at a meeting held on June 25, 1959

Cleo J. Dahmer
(Secretary, Local Organization)

Date June 25, 1959

Hemphill County Commissioners Court
Local Organization

By Sanford F. Cole

Title County Judge

Date June 25, 1959

The signing of this agreement was authorized by a resolution of the governing body of the Hemphill County Commissioners Court
Local Organization

adopted at a meeting held on June 25, 1959

Ross Adcock
(Secretary, Local Organization)

Date June 25, 1959

Wheeler County Soil Conservation District, Texas
Local Organization

By Susan Pakan

Title Chairman

Date June 25, 1959

The signing of this agreement was authorized by a resolution of the governing body of the Wheeler County Soil Conservation District, Texas
Local Organization

adopted at a meeting held on June 25, 1959

Clarence Zybach
(Secretary, Local Organization)

Date June 25, 1959

Wheeler County Commissioners Court
Local Organization

By S. W. Hilly

Title County Judge

Date June 25, 1959

The signing of this agreement was authorized by a resolution of the governing body of the Wheeler County Commissioners Court
Local Organization

adopted at a meeting held on June 25, 1959

Shelby Pettet
(Secretary, Local Organization)

Date June 25, 1959

Roberts County Soil Conservation District - Texas
Local Organization

By David A. Wilson Jr.

Title Chairman

Date June 26, 1959

The signing of this agreement was authorized by a resolution of the governing body of the Roberts County Soil Conservation District - Texas
Local Organization

adopted at a meeting held on June 26 - 1959

C. E. Bean
(Secretary, Local Organization)

Date June 26 - 1959

Upper Washita Soil Conservation District - Oklahoma
Local Organization

By L. L. Waring

Title Vice Chairman

Date June 25 - 1959

The signing of this agreement was authorized by a resolution of the governing body of the Upper Washita Soil Conservation District - Oklahoma
Local Organization

adopted at a meeting held on June 25, 1959

W. S. Platt.
(Secretary, Local Organization)

Date June 25, 1959

United States Department of Agriculture
Soil Conservation Service

By H. N. Smith
State Conservationist - Texas

Date July 6, 1959

By Ray Walker
State Conservationist - Oklahoma

Date June 29, 1959

WORK PLAN

UPPER WASHITA RIVER WATERSHED

Of the Washita River Watershed
Roger Mills County, Oklahoma
and
Hemphill, Wheeler and Roberts Counties, Texas

Plan prepared and works of improvement to be installed under the authority of the Flood Control Act of 1936, as amended and supplemented.

Participating Agencies

Upper Washita Soil Conservation District, Oklahoma
Hemphill County Soil Conservation District, Texas
Wheeler County Soil Conservation District, Texas
Roberts County Soil Conservation District, Texas
Agricultural Stabilization and Conservation Office, USDA
Extension Service, USDA
Farmers Home Administration, USDA
Soil Conservation Service, USDA
Wheeler County Commissioners Court, Texas
Hemphill County Commissioners Court, Texas

Prepared By:

Soil Conservation Service
United States Department of Agriculture
December 1958

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SECTION 1

WORK PLAN

UPPER WASHITA RIVER WATERSHED
Of the Washita River Watershed
Roger Mills County, Oklahoma, and Hemphill, Wheeler and Roberts Counties, Texas

December 1958

SUMMARY OF PLAN

Description

Size:

Texas	301,440 acres	471.0 square miles
Oklahoma	170,290 acres	266.1 square miles
Total	471,730 acres	737.1 square miles

Land Use:

Cultivation	141,519 acres
Range and Pasture	320,776 acres
Miscellaneous (roads, railroads, etc)	9,435 acres

Flood plain area:

Excluding area in floodwater retarding structures	19,221 acres
Outside project area	12,835 acres
In floodwater retarding structures	642 acres

Soil Conservation District:

Upper Washita	170,290 acres
Hemphill County	250,819 acres
Wheeler County	38,845 acres
Roberts County	11,776 acres

Land Ownership:

Federal (Forest Service)	23,240 acres
Private	448,490 acres

Flood Frequency:

Total of 96 floods during 30-year period of study (1926 through 1955), of which 47 inundated more than half the flood plain area.

Land Treatment: (Private land)

Practice	Unit	Applied to Date	To Be Applied During Project Period
Conservation Crop Rotation	Acre	16,975	12,332
Contour Farming	Acre	25,178	34,558
Cover Cropping	Acre	59,124	19,908
Rotation Hay and Pasture	Acre	7,600	8,285
Stubble Mulching	Acre	52,401	29,420
Crop Residue Utilization	Acre	5,955	11,666
Strip Cropping	Acre	10,616	1,586
Proper Use Range	Acre	84,031	227,757
Deferred Grazing	Acre	13,721	49,233
Range Seeding	Acre	35,348	18,463
Pasture Planting	Acre	659	3,905
Wildlife Area Improvement	Acre	474	1,058
Terracing	Mile	909	898
Diversion Construction	Mile	81	82
Waterway Development	Acre	432	368
Pond Construction	No.	287	86

Land Treatment: (Forest Service land)

Proper Use Range	Acre	23,240	-
Range Seeding	Acre	11,400	-
Pond Construction	No.	12	-

Structural Measures:

Floodwater Retarding Structures - 63

Project Cost:

Item	Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment	28,428	1,076,830	1,105,258
Structural Measures	3,762,108	133,020	3,895,128
Work Plan Preparation	65,600	-	65,600
Total	3,856,136	1,209,850	5,065,986

Average Annual Damages and Benefits:
(Inside Project Area)

Item	Damage			Benefit	
	Without Project	With Land Treatment	With Project	Structural Measures	Total
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage	109,581	108,375	31,365	77,010	78,216
Sediment Damage	16,351	14,299	9,325	4,974	7,026
Erosion Damage (flood plain)	15,968	15,476	5,068	10,408	10,900
Indirect Damage	11,457	11,083	4,576	6,507	6,881
Total	153,357	149,233	50,334	98,899	103,023

Average Annual Benefits
(Outside Project Area) $107,503

Benefit-Cost Ratio - Structural Measures

Average Annual Benefits - Structures	$206,402
Average Annual Cost - Structures	145,445
Benefit-Cost Ratio	1.4:1

Operation and Maintenance:

Land Treatment Measures:

Upper Washita Soil Conservation District
Hemphill County Soil Conservation District
Wheeler County Soil Conservation District
Roberts County Soil Conservation District

Structural Measures:

Upper Washita Soil Conservation District, Oklahoma
Hemphill County Soil Conservation District, Texas
Wheeler County Soil Conservation District, Texas
Hemphill County Commissioners Court
Wheeler County Commissioners Court

Annual Cost - $6,390

DESCRIPTION OF WATERSHED

Physical Data

The Washita River heads in the southeastern part of Roberts County about 4 miles southeast of Miami, Texas. Some tributaries draining from the south head in Wheeler County, Texas. It flows east through Hemphill County, Texas and Roger Mills County, Oklahoma. The Upper Washita River watershed extends to the confluence of Broken Leg Creek with the Washita River, about three miles west of Cheyenne, Oklahoma. The development of this plan, however, includes evaluation studies on the mainstem of the Washita River from this point to the upper limits of the authorized Bureau of Reclamation's Foss Reservoir. The larger tributaries are Croton, Rush, Turkey, Hackberry, Gageby, and Major Creeks. The watershed has an area of 471,730 acres (737.1 square miles), nearly all of which is in farms and ranches.

Upland slopes generally range from 1 to 8 percent with some slopes as steep as 20 percent adjacent to the valley plains.

The High Plains Land Resource Area occupies approximately 50 percent of the watershed. The soils are fine and medium textured and the permeability is slow to very slow. They consist of deep to shallow soils and are the most fertile in the watershed. Thirty percent of the area is cultivated, 3 percent formerly cultivated, 66 percent is in native range and 1 percent is in miscellaneous uses. Forty-eight percent of the watershed is composed of Rolling Red Plains soils which are coarse to medium textured, mostly deep, and generally permeable to freely permeable. Under present conditions 32 percent of this land resource area in the watershed is in cultivation, 13 percent formerly cultivated, 53 percent in range and pasture and 2 percent in miscellaneous uses. The remaining 2 percent also is in the Rolling Red Plains, but most of this area is composed of shallow non-arable soils. Approximately 3 percent of this portion of the watershed is cultivated, 2 percent formerly cultivated, and 95 percent is in native range.

The land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cropland	141,519	30
Range and Pasture	320,776	68
Miscellaneous	9,435	2
Total	471,730	100

The flood plain considered in this plan is that area inundated by the runoff from a storm which can be expected to occur on an average of once in 25 years. This storm will produce a runoff of 1.0 inch and inundate 17,031 acres, excluding 2,190 acres of stream channels and 642 acres which will be inundated by the pools of the floodwater retarding structures. An additional 11,288 acres, excluding 1,547 acres of stream channel, will be inundated between the lower extremity of the watershed and the upper

limits of Foss Reservoir by a storm of this magnitude.

The flood plain land use is:

Land Use	Acres	Percent
Cropland	3,236	17
Range and Pasture	11,922	62
Meadow	1,533	8
Stream channels	2,190	11
Miscellaneous	340	2
Total	19,221	100

Approximately 70 percent of the cultivated land is in small grains and other close growing crops. Most of the soils are in fair condition.

Most of the rangeland in the Upper Washita River watershed is in medium to large size ranches. Approximately 60 percent of all rangeland is in fair condition, 23 percent poor condition, 16 percent good condition, and 1 percent excellent condition. There are 7 range sites: mixed upland, 36 percent; heavy upland or hardland, 10 percent; shallow land, 17 percent; red shale, 2 percent; sandy land, 28 percent; bottomland, 5 percent, and rough breaks 2 percent.

The mean annual rainfall ranges from 25.47 inches at Cheyenne, Oklahoma to 22.29 inches at Miami, Texas. These amounts are based on 30- and 41-year records, respectively. Approximately 80 percent of the rainfall normally occurs in the growing season, with the larger amounts occurring in April, May, June, September, and October. Individual rains of excessive amounts and high intensity occur at irrigular intervals, causing severe erosion and serious flood damage. The minimum recorded annual rainfall at Cheyenne was 13.20 inches and the maximum 43.58 inches.

Average temperatures range from 82 degrees Fahrenheit in July to 36 degrees in January. The normal frost-free period is 209 days at Cheyenne, Oklahoma and 194 days at Miami, Texas.

Surface waters of the watershed are not used for municipal or industrial purposes. Farm ponds and wells are the source of water for livestock and domestic uses.

Economic Data

The watershed economy is basically agricultural. The major ranch and farm enterprises are the production of beef, wheat, grain sorghums, cotton, and feed crops. Operating ranch and/or farm units average approximately 1600 acres in size with an average value of land and buildings of $52,000, according to the United States Census of 1954. Owner-operated farming is predominant.

Approximately 150 miles of hard surface roads traverse the watershed. In addition, there are 560 miles of local or county roads. Rail service is adequate for all sections of the area.

Reydon, Oklahoma, with a population of 331, is the largest town in the watershed. Allison, Texas, population 200, and Brisco, Texas population 150 are also in the watershed.

WATERSHED PROBLEMS

Floodwater Damage

Frequent flooding has caused damages of considerable magnitude in the watershed (figure 1). Large floods have occurred on an average of more than once a year. During the 30-year period studied, 1926 through 1955, there were 47 major floods which covered more than half the flood plain and 49 smaller floods covering less than half the flood plain. Sixty percent of the major floods and 57 percent of the smaller floods occurred during the growing season, causing considerable damage to land and to growing crops. It is estimated that the average annual direct monetary floodwater damage, under existing conditions, is $109,581 within the limits of the watershed. Of this amount, $65,414 is crop and pasture damage, $14,515 is other agricultural damage, and $29,652 is nonagricultural damage such as damage to roads, bridges, and railroads. In addition, there are numerous indirect damages, such as interruption of travel, losses in business sustained by dealers and industries in the area, and other losses estimated to average $11,457 annually.

The most recent major flood occurred in April, 1954 and inundated the entire flood plain.

Erosion Damage

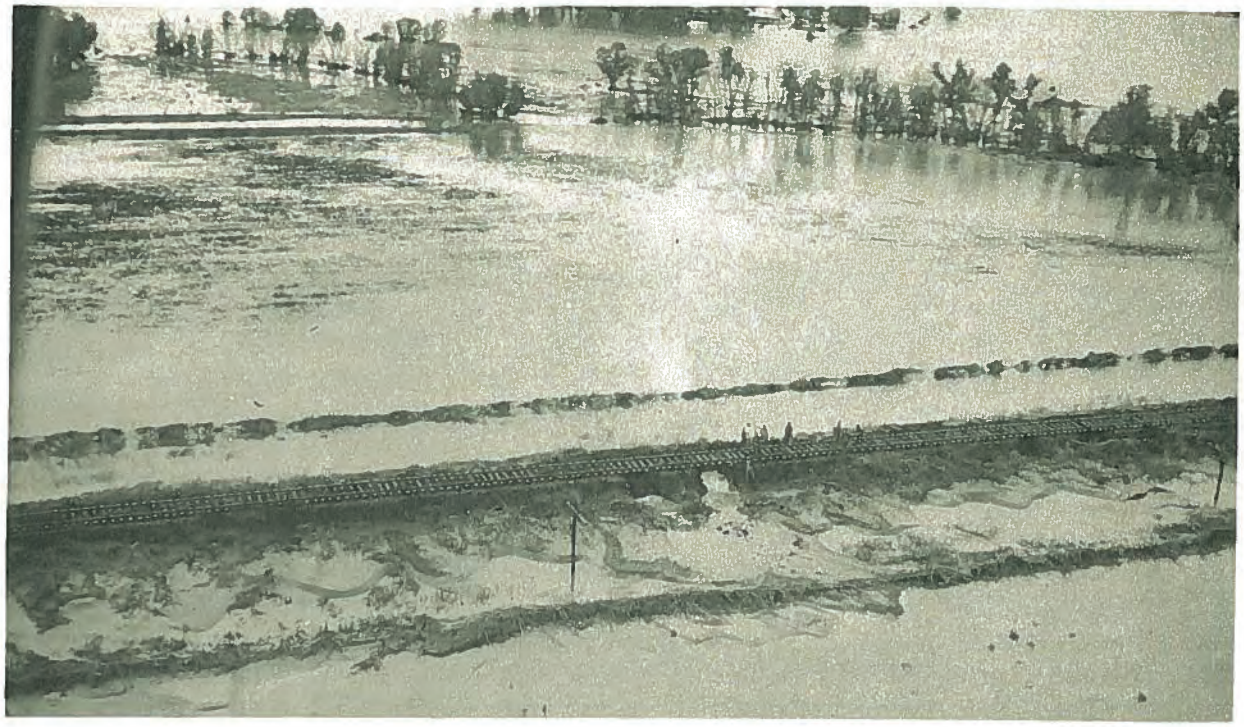
The general condition of soils in the watershed is improving. More soil conservation practices are being applied to the land. There are less row crops, more sown crops, and more reseeding of native grasses on eroded land which has been in cultivation. A relatively high percent of the arable land has been terraced.

Fifty-six percent of the total annual gross erosion which occurs in the watershed results from sheet erosion, 6 percent from gully erosion, 6 percent from streambank erosion, 15 percent from flood plain scour, and 17 percent from bedload.

The highest sediment producing area are in reaches VII, IX, X and XI. These reaches represent that part of the Ogallala geological formation (Lower Pliocene) which rests unconformably upon the Permian Red beds (Doxey shales). Since the soils of the Lower Pliocene were developed from loosely cemented sandstones, they are coarse textured and highly erodible. Generally, the pattern of erosion has been similar in these

"Hammon flood" of 1934, east of Hammon, Oklahoma, on the Washita River in which 17 lives were lost. Note carcass of cow and debris in tree.

Confluence of Turkey Creek and Washita River north of Reydon, Oklahoma during October 1926 flood.



April 30, 1954 - Flooding on the Washita River
north of Hammon, Oklahoma.

June 1956 flood showing bridge damage on Gageby Creek
approximately 3 miles west of U. S. Highway 83, north
of Wheeler, Texas.

Gageby Creek flood plain, approximately 3 miles west of U. S. Highway 83, north of Wheeler, Texas during May 1957 flood.

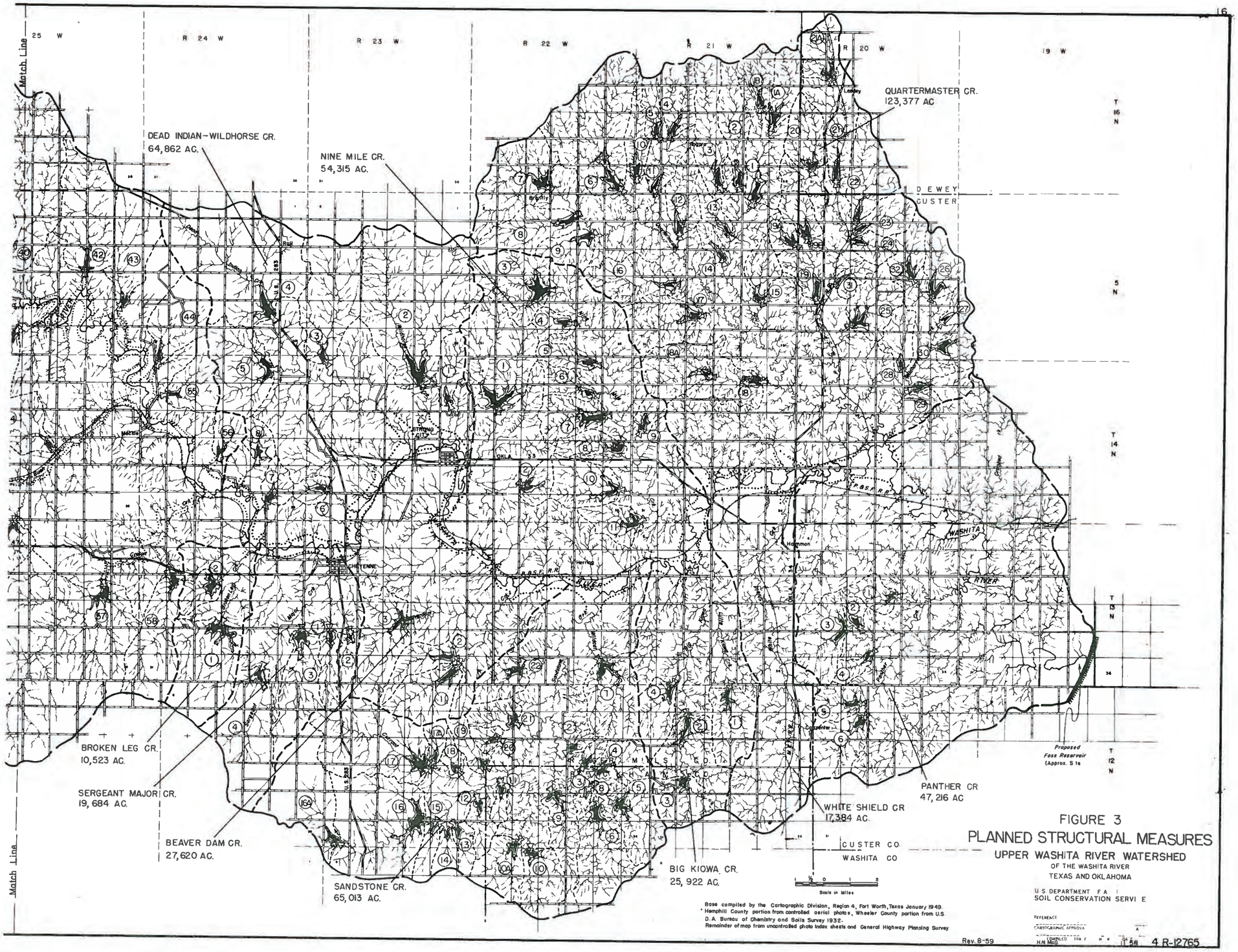
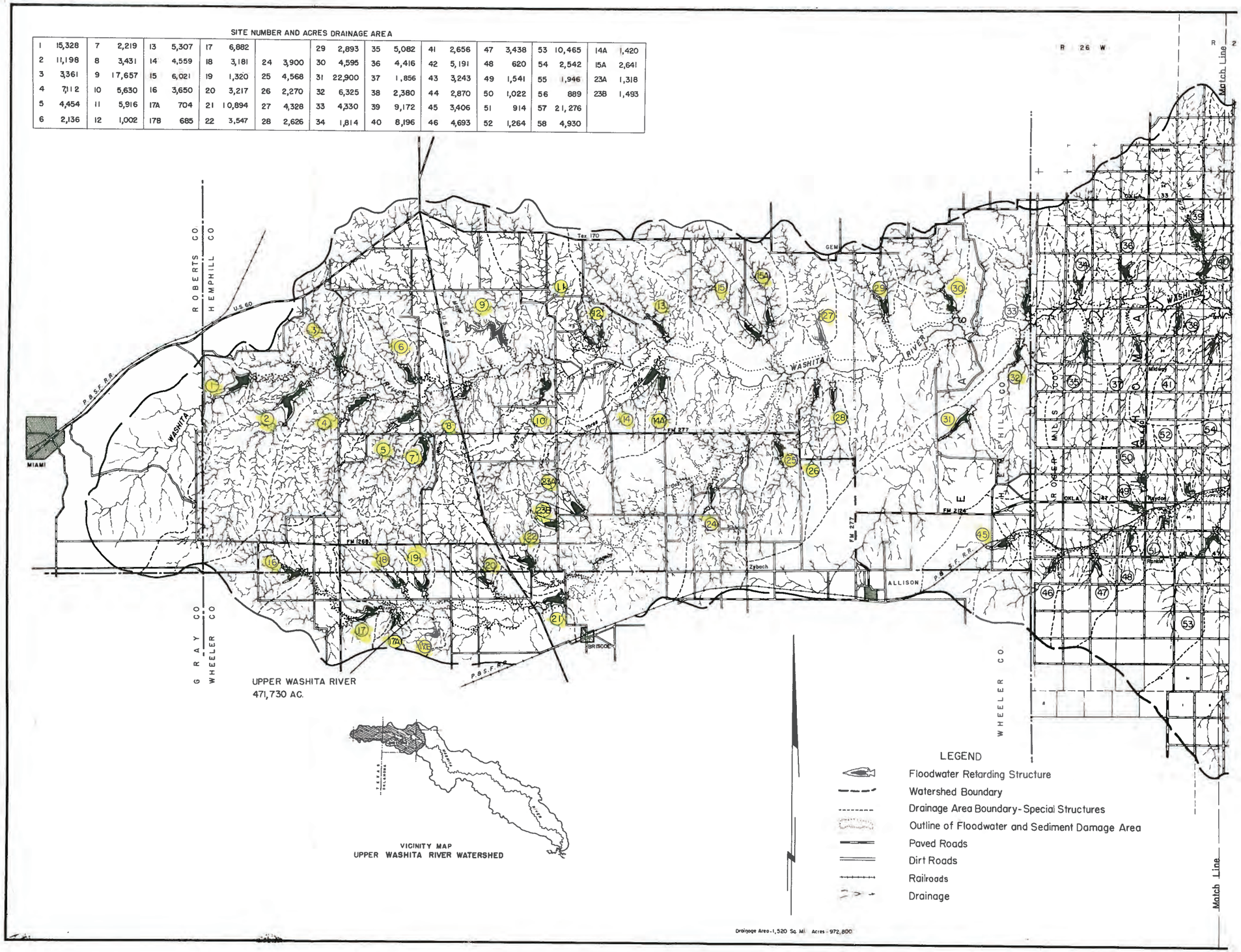


FIGURE 3
PLANNED STRUCTURAL MEASURES
UPPER WASHITA RIVER WATERSHED
OF THE WASHITA RIVER
TEXAS AND OKLAHOMA

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SITE NUMBER AND ACRES DRAINAGE AREA

1	15,328	7	2,219	13	5,307	17	6,882			29	2,893	35	5,082	41	2,656	47	3,438	53	10,465	14A	1,420
2	11,198	8	3,431	14	4,559	18	3,181	24	3,900	30	4,595	36	4,416	42	5,191	48	620	54	2,542	15A	2,641
3	3,361	9	17,657	15	6,021	19	1,320	25	4,568	31	22,900	37	1,856	43	3,243	49	1,541	55	1,946	23A	1,318
4	7,112	10	5,630	16	3,650	20	3,217	26	2,270	32	6,325	38	2,380	44	2,870	50	1,022	56	889	23B	1,493
5	4,454	11	5,916	17A	704	21	10,894	27	4,328	33	4,330	39	9,172	45	3,406	51	914	57	21,276		
6	2,136	12	1,002	17B	685	22	3,547	28	2,626	34	1,814	40	8,196	46	4,693	52	1,264	58	4,930		



The total flood prevention benefits, including reduction of floodwater damages, reduction of sediment deposition on flood plain lands and in the Foss Reservoir, the reduction in flood plain scour damages, benefits from restoration of flood plain lands, and reduction of indirect damages are estimated to be $210,526 annually, of which $206,402 will be the result of structural measures.

COMPARISON OF BENEFITS AND COSTS

The average annual equivalent cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be $145,445. When the structures are completely installed they are expected to produce average annual benefits of $206,402, a benefit of $1.42 for each dollar of cost. There are other substantial values which will accrue from these structural measures, such as increased opportunity for recreation, improved wildlife conditions and a sense of security, which have not been used for project justification.

ACCOMPLISHING THE PLAN

Land Treatment Measures

Land treatment measures for privately owned lands, itemized in table 1, will be established by farmers over a 5-year period in cooperation with the Upper Washita, Hemphill County, Wheeler County, and Roberts County Soil Conservation Districts. The cost of applying these measures, which is exclusive of expected reimbursement from the Agricultural Conservation Program or other Federal programs, based on current program criteria, will be borne by owners and operators of the land. The soil conservation districts, assisted by the Soil Conservation Service, are giving assistance in the planning and application of these measures under their going programs. Accelerated technical assistance from the Soil Conservation Service has been made available with flood prevention funds for several years to get application of needed land treatment measures in balance with the structural phase of the program. This assistance will be continued to assure application of the planned land treatment measures within the 5-year installation period of the project.

The governing bodies of the four soil conservation districts will arrange for meetings according to a definite schedule. By this means and by individual contacts they will encourage the landowners and operators to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with the existing arrangements for equipment usage in the districts. The district governing bodies will make periodic inspections of the completed conservation measures within the districts and follow through to see that needed maintenance is performed.

The soil and water conservation loan program of the Farmers Home Administration is available to all eligible individual farmers and ranchers in

the area. Educational meetings will be held in cooperation with other agencies to outline the services available and eligibility requirements. Present FHA clients will be encouraged to cooperate in the project.

The County ASC Committees will cooperate with the governing bodies of the soil conservation districts by selecting and recommending financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, preparing radio and press releases, and using other methods of getting information to landowners and operators in the Upper Washita River watershed.

Structural Measures

The Soil Conservation Service will contract for the construction of the 63 floodwater retarding structures. Technical assistance will be provided to plan, design, prepare specifications, supervise construction, prepare contract payment estimates, make final inspections, certify completion, and perform related duties for the installation of the structural measures. The Forest Service will participate in the final plans for sites 40, 42, 43, 44, 53 and 57 which are partially on lands administered by them.

The soil conservation districts will furnish the land, easements, and rights-of-way for all the structural measures.

The Forest Service will approve the use of Federal lands under its jurisdiction for structural measures.

It is the policy of the Washita Valley Council to obtain easements and rights-of-ways for the entire project before construction will begin.

The structural measures on Croton Creek have an annual cost of $9,349 and effect an average annual benefit of $9,006 within its drainage boundary. They will also effect an average annual benefit of $846 in reduction of sediment to Foss Reservoir. Structural measures on Gageby Creek have an annual cost of $19,827 and effect an average annual benefit of $22,890 within its drainage boundary. The cooperating parties have agreed to an installation schedule of 5 years for the structural measures. The estimated schedule of obligations for the complete 5-year installation period, (exclusive of current fiscal year) covering installation of both land treatment and structural measures is shown on the following schedule which will be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desired and in light of appropriations and accomplishments actually made.

The various features of cooperation between the cooperating parties have been covered in appropriate memoranda of understanding and working agreements.

Schedule of Installation[1/]

Fiscal Year	Measure	Federal Funds: Texas (dollars)	Federal Funds: Oklahoma (dollars)	Non-Federal Funds (dollars)	Total Funds (dollars)
Current	Land Treatment	-	-	130,000	130,000
	Land Treatment	-	2,000	47,000	49,000
First Year	Sites 1,2,16,17 17A & 17B	385,012	-	17,045	402,057
	Sites 57 & 58	-	250,761	7,730	258,491
	Land Treatment	3,600	-	130,000	133,600
	Land Treatment	-	2,000	47,000	49,000
Second Year	Sites 3,4,5,6,18, 19,20 & 21	374,559	-	22,790	397,349
	Sites 46,47,48,49, 50 & 51	-	227,247	6,160	233,407
	Land Treatment	3,700	-	130,000	133,700
	Land Treatment	-	2,000	47,000	49,000
Third Year	Sites 7,8,9,10,22, 23A,23B,24 & 25	408,082	-	18,855	426,937
	Sites 52,53,54,34, 35,36 & 37	-	513,648	8,819	522,467
	Land Treatment	3,728	-	130,000	133,728
	Land Treatment	-	2,000	47,000	49,000
Fourth Year	Sites 11,12,13,14A, 14B, 15A,15B,26, 27 & 28	517,745	-	18,985	536,730
	Sites 38,39,40 & 41	-	296,401	9,156	305,557
	Land Treatment	3,800	-	145,323	149,123
	Land Treatment	-	2,000	47,000	49,000
Fifth Year	Sites 29,30,31,32, 33 & 45	429,429	-	18,160	447,589
	Sites 42,43,44,55, & 56	-	359,224	5,320	364,544
	Land Treatment	3,600	-	130,000	133,600
	Land Treatment	-	-	46,507	46,507
	TOTAL	2,133,255	1,657,281	1,209,850	5,000,386

1/ Does not include cost of work plan preparation.

OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the owners and operators of the farms and ranches on which the measures are installed, under agreements with the Upper Washita, Hemphill County, Wheeler County, and Roberts County Soil Conservation Districts. The maintenance of land treatment measures installed on Federal lands will be done under the direction of the Forest Service.

Structural Measures

The Hemphill County Soil Conservation District and the Hemphill County Commissioners Court have entered into a Watershed Protection Operation and Maintenance Agreement with the Soil Conservation Service to assume responsibility for maintenance of the 31 floodwater retarding structures located in Hemphill County. These structures are sites 1 through 15B, 22 through 33, and 45. The Wheeler County Soil Conservation District and Wheeler County Commissioners Court have entered into a similar agreement for the 8 structures located in Wheeler County. These are sites 16 through 21. The Upper Washita Soil Conservation District will maintain the remaining 24 structures which are located in Oklahoma.

All structural measures will be inspected annually and after each heavy rain or streamflow by representatives of the organizations responsible for operation and maintenance. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as a part of the floodwater retarding structures. The responsible soil conservation district will maintain a record of all maintenance inspections and work done and make this record available to Soil Conservation Service personnel.

Provisions will be made for free access of district and Federal representatives to inspect the structural measures and their appurtenances at any time.

The estimated annual operation and maintenance cost is $6,390 based on long-term price levels. The necessary maintenance work will be accomplished through the use of resources of the soil conservation districts, the county commissioners court, and through maintenance associations of benefited landowners. It will be performed by force account or contract. Major repairs will be made according to plans furnished by the district and approved by the Soil Conservation Service.

The soil conservation districts fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of any invitation to bid.

CONFORMANCE OF PLAN TO FEDERAL AND STATE LAWS AND REGULATIONS

The installation of the flood prevention project on the Upper Washita River watershed will give added protection to flood plain lands along this stream and reduce the sediment load carried by it. This project plan conforms to all Federal laws and regulations.

Structural design in the State of Oklahoma will conform with Oklahoma Water Resources Board Resolution dated June 18, 1954.

SECTION 2

INVESTIGATIONS, ANALYSIS, SUPPORTING TABLES AND FIGURES

PROJECT OBJECTIVES

Reconnaissance Survey

The reconnaissance survey of the watershed was made by the planning party specialists and representatives from both Soil Conservation Service State offices involved. Its purpose was to acquaint the planning party members with the watershed and to select valley cross section locations and inspect possible sites for floodwater retarding structures.

Eighty-two valley sections were located along the mainstem of the Washita River above the authorized Foss Reservoir, 12 on Rush Creek, 3 on Croton Creek, 1 on Spring Creek, and 15 on Gageby Creek. The runoff from the 6-hour, 25-year frequency storm in this area is approximately 1.3 inches; however, it was decided to provide between 2 and 2.5 inches of detention storage in the floodwater retarding structures to reduce spillway costs and problems if economically justified.

Desires of Local People

A meeting was held with representatives of the soil conservation districts and interested landowners to review the progress in the Upper Washita River watershed and to ascertain the desires of the local people in the type of flood prevention program that would be required and the degree of protection needed. The local peoples' responsibilities in the flood prevention program were discussed. Particular emphasis was given to their operation and maintenance responsibilities.

The local people expressed the belief that a high degree of control was desirable in the watershed because the flood plain lands below the limits of the watershed have been flooded frequently by severely damaging floods. They requested that at least 70 percent areal control by floodwater retarding structures be planned, if possible.

Work Outline

Subsequent to the reconnaissance survey and the meeting with the local people, a work outline was prepared showing in proper sequence the major jobs to be done, who would do each job, and when each job would be initiated and completed. The work outline set forth the means by which the local people would be kept informed of progress in planning, and a goal date for completion of the watershed work plan.

INVESTIGATION

Land Treatment

The watershed was divided into four parts in order to obtain a hydrologic

grouping of soils. These groups and their approximate areas are:

Hard and shallow land	183,500 acres
Sandy land (predominantly shallow)	117,940 acres
Sandy land (predominantly deep)	121,650 acres
Red Shale land	48,640 acres

The range specialist, soil scientists, planning party hydrologist, and work unit conservationists developed the soil-cover complex for each of these groups by the random sample method. The cultivated land was mapped showing land use, treatment or practice, hydrologic condition, and hydrologic soil group. Rangeland was mapped showing range class and condition, hydrologic condition, and hydrologic soil group. The future condition was determined by considering the needs of the land in each capability unit. Rainfall-runoff curve numbers were determined for each of the groups. With moisture condition II they are:

Group	Present Condition	Future Condition
Hard and shallow land	80.6	80.3
Sandy land (predominantly shallow)	65.6	65.1
Sandy land (predominantly deep)	63.0	62.7
Red shale land	74.1	73.8

The land use for the watershed was determined by the random sampling expanded to the total area. Land use of the flood plain was planimetered from aerial photographs. Land treatment needs were supplied by the local work units of the Soil Conservation Service. It is estimated that 80 percent of the remaining needed land treatment measures will be applied during the 5-year project installation period.

Structural Measures

Determination was then made of structural measures for flood prevention which would be feasible to install. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs located all probable floodwater retarding structure sites, the limits and the area of the flood plain and points where valley cross sections should be taken for the determination of hydraulic characteristics of the channel and valley and for flood-routing purposes. A field reconnaissance was made to further substantiate the location of these sections. This information was placed on the watershed base map for use in field surveys. Cross sections of the flood plain were surveyed at the selected locations (figure 1). Data developed from these cross sections permitted the

computation of stage-area inundated relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations and other pertinent information were recorded.

2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not show good storage possibilities or which would inundate highways or improvements, for which the cost of relocating could not be economically justified, were dropped from further consideration. From the remaining sites a system of floodwater retarding structures was selected for further consideration and detailed survey. Plans of a floodwater retarding structure, typical of those planned for this watershed, are illustrated by figures 4 and 4A.

3. A topographic map was made of the pool area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the dam and the areas of flood plain and upland that would be inundated by the sediment and detention pools. The heights of the dams and the sizes of the pools were determined by the storage volume needed to temporarily detain the runoff from the design storm and to provide the additional storage needed for sediment, with due consideration to site differences and minimization of costs. The limits of the detention pools and sediment pools of all satisfactory sites and the flood plain of the streams were drawn to scale on a copy of the base map. Structure data tables were developed to show, for each structure, the drainage area, the storage capacity needed for floodwater detention and for sediment storage in acre feet and in inches of runoff from the drainage areas, the release rate of the principal spillway, the acres inundated by the sediment and detention pools, the volume of fill in the dams, the width and depth of flow of the emergency spillways, and the estimated cost of the structures (tables 2 and 3).

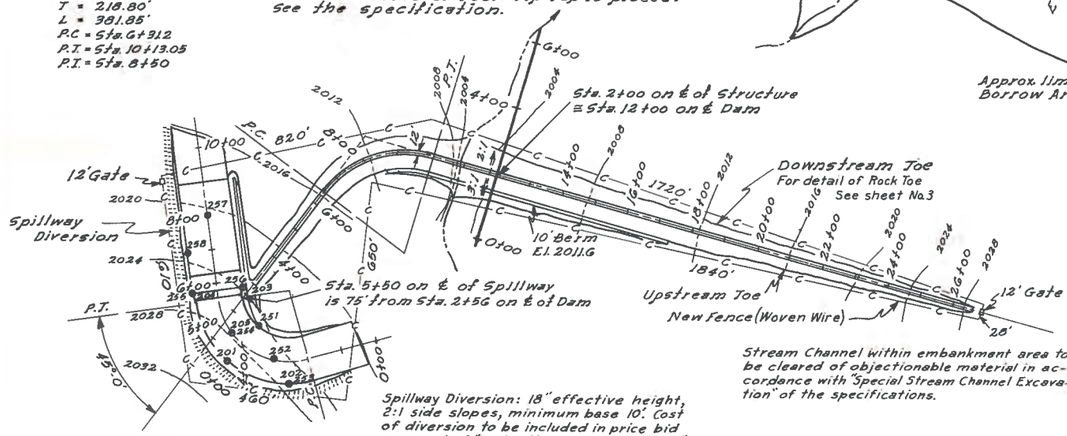
4. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and field surveys of flood plain areas and flood routing under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of area inundated and depth of inundation as determined by flood routing under future conditions, assuming that the works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of the effect of each on reduction of damages. In this manner it was

C.	Clay	Clayey	Cal.	Calcareous
Si.	Silt	Silty	Vug.	Vugular
Ch.	Chalk	Chalky	Fc.	Fractured
S.	Sandy	Sandy	Fri.	Friable
Gr.	Gravel	Gravelly	Fi.	Firm
M.	Marl	Marly	Vi.	Very
Ls.	Limestone		So.	Soft
Flg.	Flagstone		H.	Hard
Mas.	Massive		Cob	Cobbles
Mat	Matrix			

LEGEND OF BORINGS

EMBANKMENT CURVE DATA
Δ = 69°-0'
D = 18°-04.3'
R = 318.36'
T = 218.80'
L = 381.85'
P.C. = Sta. 6+91.2
P.T. = Sta. 10+13.05
P.T. = Sta. 8+50

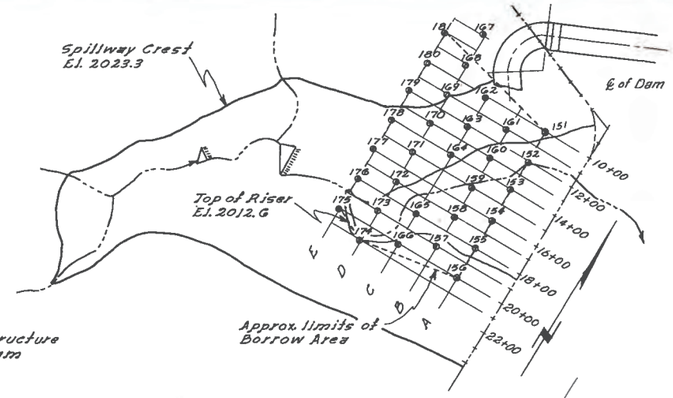
A minimum of 6" of topsoil to be placed in spillway and on all embankment, dike, spillway slopes and waste area except where rock is encountered or rock rip rap is placed. See the specification.



SPILLWAY CURVE DATA
Δ = 98°-0'
D = 28°-0'
R = 206.68'
L = 350.0'
P.C. = Sta. 2+00
P.T. = Sta. 5+50

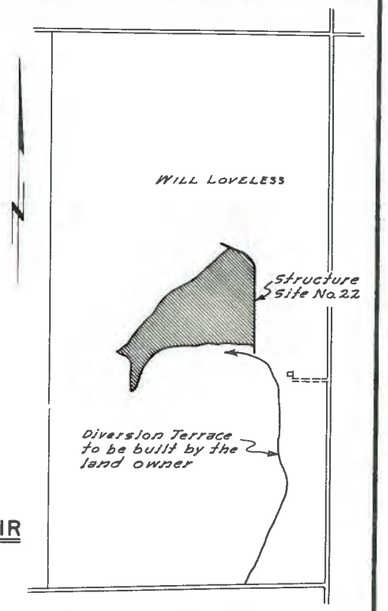
PLAN OF EMBANKMENT AND SPILLWAY

0 200 400 1000
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

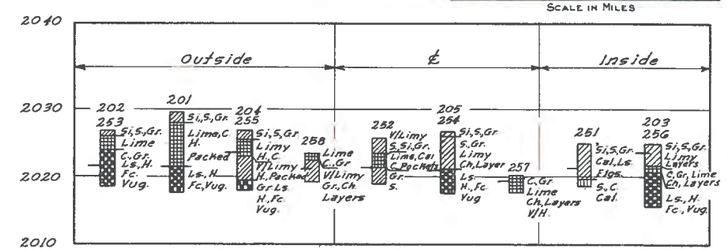
0 400 800 1600
SCALE IN FEET



Located 5½ mi. East and 4 mi. South of Eden, Concho County, Texas

VICINITY MAP

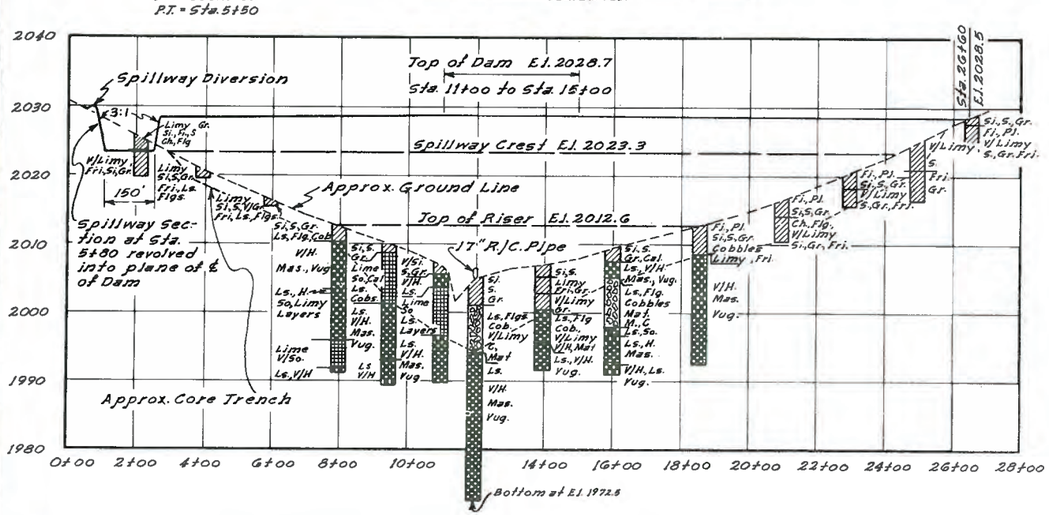
0 ¼ ½ 1
SCALE IN MILES



Note: Bar at left of boring is at spillway grade.

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY



PROFILE ON ℄ OF DAM

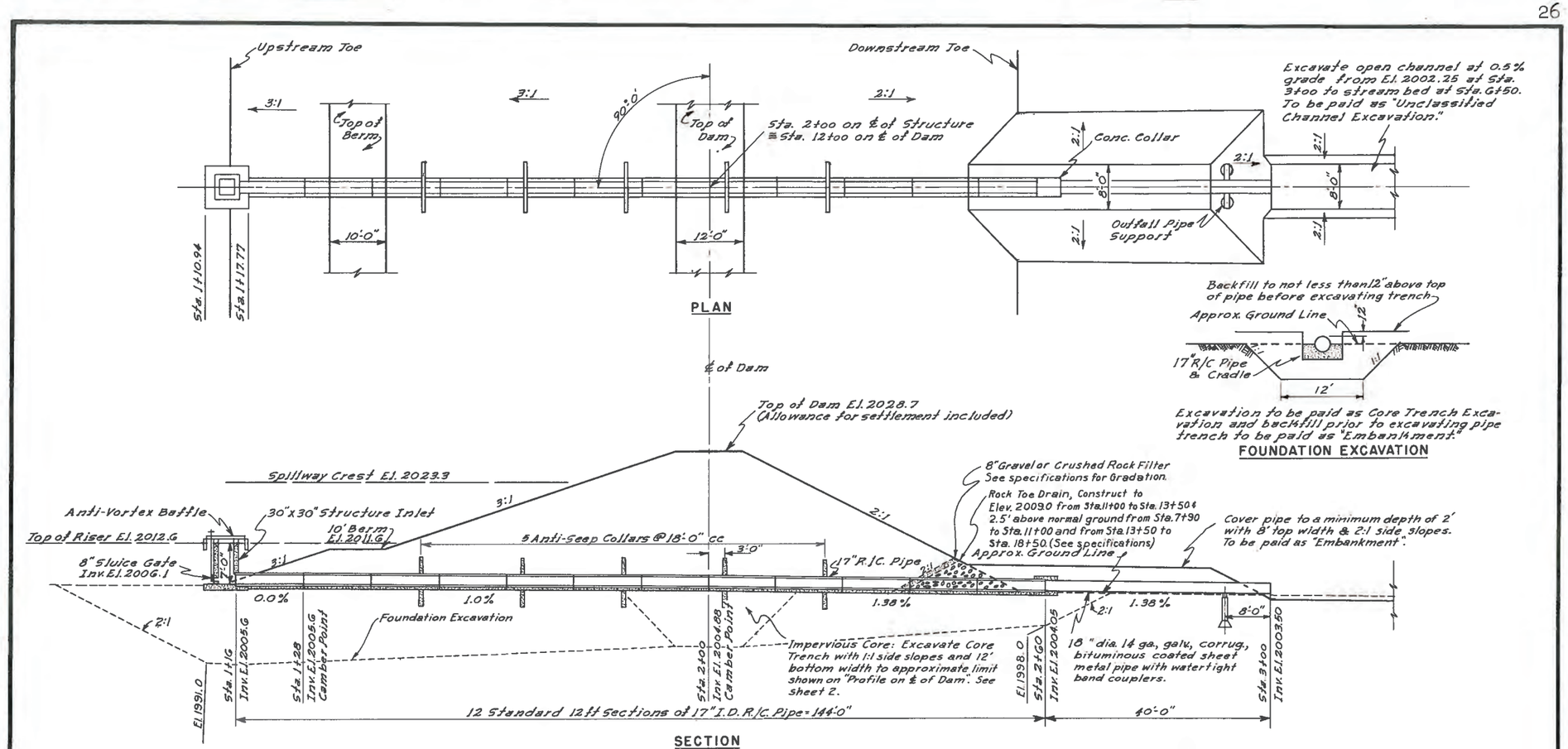
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
2012.6	16.84	51.70	0.50
2016.0	30.76	132.66	1.28
2020.0	54.21	302.60	2.92
2023.3	74.94	515.68	5.00
2024.0	79.33	569.68	5.50
2028.0	108.17	944.68	9.13

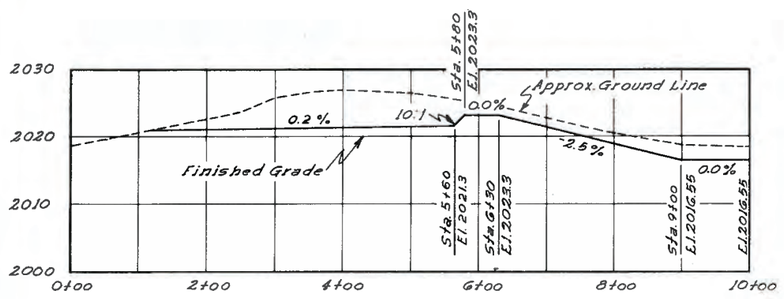
Top of Dam (Effective) Elev.	2028.5
Spillway Crest Elev.	2023.3
Top of Riser Elev.	2012.6
Sediment Pool Elev.	2012.6
Drainage Area, Acres	1243.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	464.0

Figure 4
TYPICAL FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

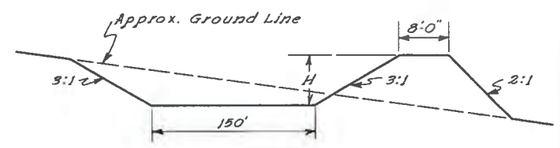
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed H.C.N. Date 8-56
Drawn H.C.N. & G.R. 8-56
Traced G.R. 8-56
Checked H.C.N. & H.H.L. 9/56
Approved by W. M. HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Approved by Amp STATE CONSERVATION ENGINEER, S. C. S., TEMPLE, TEXAS
Sheet No. 2 of 7
Drawing No. 4-E-10,760





PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.55 from Sta. 5+00 to Sta. 6+30 12 ft. top width with 10:1 end slope. Transition from El. 2028.55 at Sta. 6+30 to 4 ft. height at Sta. 7+00, top width 8 ft. H = 4 ft. from Sta. 7+00 to Sta. 9+00, top width 8 ft. with 10:1 end slope.

TYPICAL SPILLWAY SECTION

Figure 4A

TYPICAL FLOODWATER RETARDING STRUCTURE

PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed H.C.N.	Date 8-56	Approved by H.M. — HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS	
Drawn H.C.N. & G.R.	8-56	STATE CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS	
Traced G.R.	8-56	Sheet No. 3 of 7	Drawing No. 4-E-10,760
Checked H.C.N. & H.H.L.	8/56		

determined that a system of floodwater retarding structures on the Upper Washita River watershed could be economically justified. Alternate systems of sites were investigated until a system of floodwater retarding structures was developed which most nearly meet project objectives at minimum cost. After evaluation of the floodwater retarding structures it was found that frequent flooding will continue on portions of the watershed. This is due to small existing channels and large drainages contributing to these areas.

When the land treatment measures and those structural measures for flood prevention had been determined, a table was developed to show the total cost of each type of measure. The summation of the total costs for all the needed measures represented the estimated cost of the planned flood prevention project (tables 1 and 2). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 4).

Hydraulic and Hydrologic

The following steps were taken as part of the hydraulic and hydrologic investigations and determinations:

1. Basic meteorologic and hydrologic data were tabulated from climatological bulletins, U. S. Weather Bureau and Water Supply Papers, U. S. Geological Survey.

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities and other hydraulic characteristics, and on proposed structure sites to collect data used in design.

3. Determination was made of the hydrologic conditions of the watershed, taking into consideration such factors as geology, soils, land use, topography, cover and climate.

4. Determination was made of the rainfall-runoff relationship, using the soil-cover complex data. This was then compared to actual gaged runoff as recorded on the Washita River at Cheyenne, Oklahoma. The frequency of occurrence of meteorologic events and the relationship of precipitation to runoff, peak discharge, flood stage, and area inundated were determined.

5. Determination was made of peak discharges under present watershed conditions, as related to area inundated and damages.

6. Determination was made of peak discharges and area

inundated under conditions which would exist due to:

a. The present conditions in the watershed remaining static.

b. Effect of land treatment measures.

c. Effect of land treatment measures and floodwater retarding structures.

d. Consideration of alternative programs and measures.

7. Inflow hydrographs for structure sites were developed.

From a graph showing cumulative departures from normal precipitation, the rainfall for the period 1926 to 1955, inclusive, was selected as representative of a normal rainfall period for the Upper Washita River watershed. This period permitted the use of 17 years of gaged records on the watershed.

After investigation and analysis of the meteorologic, hydraulic, hydrologic, geologic and economic characteristics of the watershed, it was determined that a structural program was feasible.

The largest runoff-producing rain considered during the 30-year period of study was a storm of 2.75 inches extending over a 2-day interval. An average rain of this magnitude would produce 1.00 inch of runoff, under present conditions, and would inundate 17,031 acres of flood plain in the project area and 11,288 acres of Washita River flood plain between the lower project limits and Foss Reservoir. If such a rain were to occur after land treatment practices had been applied, it is estimated that the area inundated would be reduced to 16,872 acres in the project area and 11,192 acres below the project limits. With land treatment measures applied and the 63 floodwater retarding structures installed it is estimated that the area inundated would be reduced to 12,078 acres in the project area and 10,333 acres below the project limits. These areas exclude 2,190 acres of stream channel in and 1,547 acres below the project limits, and areas in the pools of all proposed floodwater retarding structures. The runoff from the 6-hour, 25-year frequency storm was used to establish the minimum floodwater detention storage requirements. The minimum detention storage requirement, based on an analysis of the conditions existing in the watershed, was established as 1.1 to 2.2 inches. Inflow hydrographs for structure design were developed using the runoff that would be produced by one-half of a point rain of 10.0 to 10.8 inches in a period of 6 hours, in accordance with Washington Engineering Memorandum No. 27, assuming Moisture Condition II. The hydrograph of runoff was routed through each structure to determine the emergency spillway width and depth of flow.

From a study of the relationship between runoff and flood stage for this watershed it was found that a runoff of 0.01 inch was the minimum that

would cause flooding to a depth of 6 inches at any cross section. Due to changes in runoff-producing characteristics for different antecedent moisture conditions, rains of 0.35 inch to 2.00 inches over the entire watershed would be required, on an average, to cause 0.01 inch of runoff and produce a discharge of 700 cubic feet per second at the stream gage near Cheyenne, Oklahoma. The peak discharge at the stream gage for the largest runoff-producing rain in the 30-year period used in the evaluation study, under present conditions, is 70,000 cubic feet per second. After installation and full functioning of the planned measures the discharge at the same section would be reduced to 25,000 cubic feet per second for the same storm.

Sedimentation

The field surveys of the sedimentation problems in the watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans," Water Conservation-6, SCS, Region 4, Revised February 1954 and Oklahoma Watershed Planning Handbook. Field studies to locate areas of damaging overbank deposits and damaging scour on the flood plain and to determine the extent of streambank erosion were made at many points along the length of the channels. Data from sedimentation surveys of 6 selected farm ponds, detailed erosion studies made on the drainage areas of 14 planned floodwater retarding structures, and expanded data from 48,000 acres of previous sediment source surveys were analyzed and used. In addition, semi-detail studies were made of the land use and gully erosion on the drainage areas of the remaining sites. These data were used to compute total gross erosion.

It is estimated that under present conditions in the watershed, approximately 415 acre-feet of sediment is delivered annually to the Foss Reservoir site. With land treatment measures installed the volume of sediment delivered is expected to be approximately 335 acre-feet. The effect of both land treatment and structural measures is expected to reduce the volume of sediment delivered annually to Foss Reservoir to 180 acre-feet. This represents a delivery rate of 20 percent of the total annual gross erosion from all sources in the watershed.

In preparation of the work plan tabular summaries of all the above findings, with explanatory text, were prepared and used by the economist as a basis for calculating monetary damages.

Estimates of sediment storage requirements in the planned floodwater retarding structures were based on detailed and semi-detailed sediment source surveys above each site. The study of aerial photographs and interviews with local people also furnished important information for the survey. Estimates of annual sediment production rates were made for the areas above and below structures to determine the present and future annual sediment yield from the entire Upper Washita River watershed.

Based on these studies, the total annual gross erosion in the watersheds of all planned floodwater retarding structures was estimated to be as follows: 872 acre-feet from sheet erosion; 93 acre-feet from gullies and overfalls; 58 acre-feet from streambank erosion. In addition to the above it is estimated that 44 acre-feet of bedload is transported to the structure annually. The estimated average annual rate of sediment production above structures is 0.82 acre-foot per square mile based on a 10-year installation period and a 40-year period with conservation treatment applied.

It is estimated that 75 percent of the annual sediment deposition on the flood plain originates as sheet erosion, 9 percent as gully erosion, 7 percent from streambank erosion and 9 percent from flood plain scour. Land treatment measures applied in the watershed are expected to reduce the amount of deposition originating from all the above sources by 24 percent. The complete watershed program, including land treatment and floodwater retarding structures will reduce the annual deposition an estimated 63.9 percent.

Geologic

The Upper Washita River watershed lies within two different physiographic areas, the High Plains and the Red Hills:

1. The upper part of the watershed lies in the High Plains area and is underlain by the Ogallala formation of Pliocene age. This formation consists chiefly of sand and gravel with frequent caliche beds. The elevations range from 2,500 to 3,000 feet above mean sea level. The width of the main alluvial valley ranges from approximately 200 feet in the upper part to more than 1,400 feet in the lower part of this area.

2. The central and lower parts of the watershed lie within the Red Hills physiographic area. The central part is an area characterized by coarse textured and moderately deep soils. These soils are derived from loosely cemented sandstones of Pliocene age and from the Elk City sand member of the Quartermaster formation of Permian age.

   There are remnants of Ogallala sand and gravel in the higher elevations. The elevation of this area ranges from 2,200 to 2,500 feet above mean sea level. The width of the main alluvial valley ranges from approximately 1,900 feet in the upper part to approximately 2,000 feet in the lower part. The sands have been reworked by wind to form an undulating to rolling relief pattern. Numerous areas of sand dunes occur along the mainstem of the river.

   The Red Hills area in the lower part of the watershed is characterized by medium-textured, shallow to very shallow

soils which are derived from the Doxey shale member of the Quartermaster formation and from the Cloud Chief formation of Permian age. The rocks are sandstones, siltstones, and shales. The elevations range from 2,000 to 2,400 feet above mean sea level, and the relief pattern is characterized by rolling prairies and "haystack" hills. The width of the main alluvial valley ranges from approximately 2,000 feet in the upper part to more than 3,000 feet in the lower part of the area.

The proposed sites are located in the Ogallala and the Quartermaster (Doxey) formations. Investigations with power and hand augers indicate that suitable fill material will be available at the sites.

The foundations for the proposed structures will be located in the Ogallala formation, the Quartermaster formation, or in valley alluvium. However, wide stream channels filled with "quick sand" characterize many of the structure sites, especially in the areas of the Ogallala formation. Special studies on selected sites indicate that this may not be a difficult construction problem. Those sites which are entirely in the Ogallala sand formation may require relatively flat embankment side slopes for stability. Some sites will probably require special drainage measures, such as, foundation drains or relief wells. In some instances, an additional benefit may be derived from groundwater recharge.

Economic

Damage schedules covering approximately 87 percent of the flood plain areas of the Upper Washita River watershed were obtained from landowners or operators. These schedules covered land use, crop distribution, yields, and historical data on acres flooded and flood damages. The suggested damage factors in Table 6 of the Oklahoma Watershed Planning Handbook, Appendix III, were weighted with the percent of runoff by months, per season, during the historical series to determine damage rates for various seasons and depths of flooding. The applicable rates of damage were applied to floods of the historical series and an adjustment was made to take into account the effect of recurrent flooding when several floods occur within one crop year.

Estimates of normal yields were based on data obtained from schedules, supplemented by information obtained from farmers, soil scientists, work unit conservationists, and other agricultural workers in the area.

Operators of flood plain lands, when interviewed for flood damage information, were asked what land use changes they had made as a result of past flooding and the changes they would make if flooding were reduced. An analysis of this information provided the basis for establishing the benefits that would accrue from restoration of the flood plain land to its former use. The restoration of flood plain land to its former level

of production would provide annual benefits of $27,310. This has been included with benefits from reduced crop and pasture damage in table 5. Consideration was given to the effect of acreage allotment restrictions in the analysis of benefits from restoration of flood plain land.

The monetary value of physical damage to the flood plain from bank cutting, scour, and deposition of sediment was based on the value of the production lost; taking into account the lag in recovery of productivity and the cost of farm operations. Estimates of damage to other agriculture property such as fences, livestock, and farm equipment, was obtained from analysis of schedules, correlated with size of floods. The major items of nonagricultural damage were those sustained by railroads, county and state roads, and bridges. Estimates of these damages were obtained from county, state, and railroad officials. Indirect damage to agricultural enterprises involves extra farming expenses such as additional travel time to market, extra cost of purchasing feed for livestock, and interruption of school bus and mail services. Nonagricultural indirect damages include delayed deliveries, interrupted travel, and loss of business. Information regarding damages of this type was obtained from farmers, ranchers, landowners, local residents, and public officials. Upon analysis of data it appeared that indirect damage amounted to at least 10 percent of direct damage. excluding damage or losses brought about by the necessity of growing crops of lower value than formerly grown because of frequent flooding. Evaluation of the damage by sediment accumulation in Foss Reservoir was made by straight-line depreciation based on the construction cost (as estimated by the Bureau of Reclamation, July 1957 prices) adjusted to long-term prices.

Washita River mainstem benefits were determined by a detailed study of the effects which a combined program of land treatment and floodwater retarding structures in the Upper Washita River watershed would have on reducing floodwater damage within the Washita River flood plain area between the lower limits of the watershed and Foss Reservoir.

Damages were calculated by using present watershed conditions and those which will prevail after the installation of each class of measures included in the recommended project. The difference between average annual damages at the time of initiation of each class of measures and those expected after their installation constitutes the benefit brought about by that group through reduction of damage. Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effects of reduction in area inundated and reduced depth of inundation. Benefits from reduction of valley sediment damages, derived from each class of measure, were determined on the basis of reduction in sediment yield after installation of each class of measure. Areas that will be inundated by sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. An estimate was made of production that will be lost in the sediment and detention pools after installation of the structures. In this appraisal it was considered there would be no production in the sediment pools. The land

temporarily covered by the detention pools was presumed to be left in grass under project conditions.

The average annual loss of production within the sites of the Upper Washita River watershed based on long-term prices, was less than the amortized current calue of land in pool areas; therefore, in accordance with sound economic principles the larger of the two figures was used in determining the economic evaluation of the program.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Upper Washita River Watershed - Oklahoma and Texas
(Washita River Watershed)
Price Base: 1957

Installation Cost Item	Unit	Number to be Applied: Federal Land	Number to be Applied: Non-Federal Land	Number to be Applied: Total	Estimated Cost: Federal	Estimated Cost: Non-Federal 1/	Estimated Cost: Total
					(dollars)	(dollars)	(dollars)
LAND TREATMENT FOR							
Watershed Protection							
Soil Conservation Service							
Conservation Crop Rotation	Acre	-	12,332	12,332	-	18,498	18,498
Contour Farming	Acre	-	34,558	34,558	-	51,837	51,837
Cover Cropping	Acre	-	19,908	19,908	-	117,040	117,040
Rotation Hay and Pasture	Acre	-	8,285	8,285	-	57,316	57,316
Stubble Mulching	Acre	-	29,420	29,420	-	48,692	48,692
Crop Residue Utilization	Acre	-	11,666	11,666	-	11,666	11,666
Strip Cropping	Acre	-	1,586	1,586	-	2,379	2,379
Proper Use Range	Acre	-	227,757	227,757	-	397,355	397,355
Deferred Grazing	Acre	-	49,233	49,233	-	47,407	47,407
Range Seeding	Acre	-	18,463	18,463	-	120,906	120,906
Pasture Planting	Acre	-	3,905	3,905	-	17,572	17,572
Wildlife Area Improvement	Acre	-	1,058	1,058	-	16,114	16,114
Terracing	Mile	-	898	898	-	94,380	94,380
Diversion Construction	Mile	-	82	82	-	15,888	15,888
Waterway Development	Acre	-	368	368	-	29,422	29,422
Pond Construction	No.	-	86	86	-	30,358	30,358
Technical Assistance (Accel.)					28,428	-	28,428
SCS Subtotal					28,428	1,076,830	1,105,258
TOTAL LAND TREATMENT					28,428	1,076,830	1,105,258
STRUCTURAL MEASURES							
Soil Conservation Service							
Floodwater Retarding Structures	No.			63	2,931,838	-	2,931,838
SCS Subtotal					2,931,838	-	2,931,838
Subtotal - Construction					2,931,838	-	2,931,838
Installation Services							
Soil Conservation Service							
Engineering Services					544,543	-	544,543
Other					270,727	-	270,727
SCS Subtotal					815,270	-	815,270
Forest Service							
Engineering Services					15,000	-	15,000
FS Subtotal					15,000	-	15,000
Subtotal - Installation Services					830,270	-	830,270
Other Costs							
Land, Easements and R/W					-	128,235	128,235
Legal Fees					-	4,785	4,785
Subtotal - Other						133,020	133,020
TOTAL STRUCTURAL MEASURES					3,762,108	133,020	3,895,128
WORK PLAN PREPARATION COST					65,600	-	65,600
TOTAL PROJECT					3,856,136	1,209,850	5,065,986
SUMMARY							
Subtotal SCS					3,841,136	1,209,850	5,050,986
Subtotal FS					15,000	-	15,000
TOTAL PROJECT					3,856,136	1,209,850	5,065,986

1/ Excludes $404,949 that may be available from other Federal Funds (ACPS), to reimburse private interests.

December 1958

TABLE 1A - ESTIMATED INSTALLATION COST

Upper Washita River Watershed - Oklahoma and Texas
(Washita River Watershed)
Price Base: 1957

Installation Cost Item	Unit	Number Applied: Federal Land 1/	Number Applied: Non-Federal Land	Number Applied: Total	Prior to December 1958 Estimated Cost: Federal	Prior to December 1958 Estimated Cost: Non-Federal 2/	Prior to December 1958 Estimated Cost: Total
					(dollars)	(dollars)	(dollars)
LAND TREATMENT FOR							
Watershed Protection							
Soil Conservation Service							
Conservation Crop Rotation	Acre	-	16,975	16,975	-	25,462	25,462
Contour Farming	Acre	-	25,178	25,178	-	37,767	37,767
Cover Cropping	Acre	-	59,124	59,124	-	323,402	323,402
Rotation Hay and Pasture	Acre	-	7,600	7,600	-	47,346	47,346
Stubble Mulching	Acre	-	52,401	52,401	-	94,712	94,712
Crop Residue Utilization	Acre	-	5,955	5,955	-	5,955	5,955
Strip Cropping	Acre	-	10,616	10,616	-	14,332	14,332
Proper Use Range	Acre	-	84,031	84,031	-	84,031	84,031
Deferred Grazing	Acre	-	13,721	13,721	-	13,721	13,721
Range Seeding	Acre	-	35,348	35,348	-	221,171	221,171
Pasture Planting	Acre	-	659	659	-	2,966	2,966
Brush Control	Acre	-	6,199	6,199	-	25,876	25,876
Wildlife Area Improvement	Acre	-	474	474	-	16,589	16,589
Terracing	Mile	-	909	909	-	88,550	88,550
Diversion Construction	Mile	-	81	81	-	19,060	19,060
Waterway Development	Acre	-	432	432	-	34,058	34,058
Pond Construction	No.	-	287	287	-	81,348	81,348
Technical Assistance (Accl.)		-	-	-	30,000	-	30,000
SCS Subtotal					30,000	1,136,346	1,166,346
Forest Service							
Proper Use Range	Acre	23,240	-	23,240	23,240	-	23,240
Range Seeding	Acre	11,400	-	11,400	114,000	-	114,000
Pond Construction	No.	12	-	12	5,400	-	5,400
Technical Assistance		-	-	-	34,860	-	34,860
FS Subtotal					177,500	-	177,500
TOTAL LAND TREATMENT					207,500	1,136,346	1,343,846
STRUCTURAL MEASURES							
Soil Conservation Service							
Floodwater Retarding Structures					-	-	-
SCS Subtotal					-	-	-
Subtotal - Construction					-	-	-
Installation Services							
Soil Conservation Service							
Engineering Services					-	-	-
Other					-	-	-
Subtotal - Installation Services					-	-	-
Other Costs							
Land, Easements and R/W					-	-	-
Legal Fees					-	-	-
Subtotal - Other					-	-	-
TOTAL STRUCTURAL MEASURES					-	-	-
WORK PLAN PREPARATION COST					-	-	-
TOTAL PROJECT					207,500	1,136,346	1,343,846
SUMMARY							
Subtotal SCS					30,000	1,136,346	1,166,346
Subtotal FS					177,500	-	177,500
TOTAL PROJECT					207,500	1,136,346	1,343,846

1/ Land managed by USDA - Forest Service.
2/ Excludes $474,351 that was reimbursed from other Federal Funds (ACPS) to private interests.

December 1958

TABLE 1B - ESTIMATED INSTALLATION COST

Upper Washita River Watershed - Oklahoma and Texas
(Washita River Watershed)
Price Base: 1957

Installation Cost Item	Unit	Number to be Applied: Federal Land 2/	Number to be Applied: Non-Federal Land	Number to be Applied: Total	Estimated Cost: Federal	Estimated Cost: Non-Federal 3/	Total 1/: Total
					(dollars)	(dollars)	(dollars)
LAND TREATMENT FOR							
Watershed Protection							
Soil Conservation Service							
Conservation Crop Rotation	Acre	-	29,307	29,307	-	43,960	43,960
Contour Farming	Acre	-	59,736	59,736	-	89,604	89,604
Cover Cropping	Acre	-	79,032	79,032	-	440,442	440,442
Rotation Hay and Pasture	Acre	-	15,885	15,885	-	104,662	104,662
Stubble Mulching	Acre	-	81,821	81,821	-	143,404	143,404
Crop Residue Utilization	Acre	-	17,621	17,621	-	17,621	17,621
Strip Cropping	Acre	-	12,202	12,202	-	16,711	16,711
Proper Use Range	Acre	-	311,788	311,788	-	481,386	481,386
Deferred Grazing	Acre	-	62,954	62,954	-	61,128	61,128
Range Seeding	Acre	-	53,811	53,811	-	342,077	342,077
Pasture Planting	Acre	-	4,564	4,564	-	20,538	20,538
Brush Control	Acre	-	6,199	6,199	-	25,876	25,876
Wildlife Area Improvement	Acre	-	1,532	1,532	-	32,703	32,703
Terracing	Mile	-	1,807	1,807	-	182,930	182,930
Diversion Construction	Mile	-	163	163	-	34,948	34,948
Waterway Development	Acre	-	800	800	-	63,480	63,480
Pond Construction	No.	-	373	373	-	111,706	111,706
Technical Assistance (Accel)					58,428	-	58,428
SCS Subtotal					58,428	2,213,176	2,271,604
Forest Service							
Proper Use Range	Acre	23,240	-	23,240	23,240	-	23,240
Range Seeding	Acre	11,400	-	11,400	114,000	-	114,000
Pond Construction	No.	12	-	12	5,400	-	5,400
Technical Assistance		-	-	-	34,860	-	34,860
FS Subtotal					177,500	-	177,500
TOTAL LAND TREATMENT					235,928	2,213,176	2,449,104
STRUCTURAL MEASURES							
Soil Conservation Service							
Floodwater Retarding Structures	No.			63	2,931,838	-	2,931,838
SCS Subtotal					2,931,838	-	2,931,838
Subtotal - Construction					2,931,838	-	2,931,838
Installation Services							
Soil Conservation Service							
Engineering Services					544,543	-	544,543
Other					270,727	-	270,727
SCS Subtotal					815,270	-	815,270
Forest Service							
Engineering Services					15,000	-	15,000
FS Subtotal					15,000	-	15,000
Subtotal - Installation Services					830,270	-	830,270
Other Costs							
Land, Easements, and R/W					-	128,235	128,235
Legal Fees						4,785	4,785
Subtotal - Other					-	133,020	133,020
TOTAL STRUCTURAL MEASURES					3,762,108	133,020	3,895,128
WORK PLAN PREPARATION COST					65,600	-	65,600
TOTAL PROJECT					4,063,636	2,346,196	6,409,832
SUMMARY							
Subtotal SCS					3,871,136	2,346,196	6,217,332
Subtotal FS					192,500	-	192,500
TOTAL PROJECT					4,063,636	2,346,196	6,409,832

1/ Summation of tables 1 and 1A.
2/ Land managed by USDA - Forest Service.
3/ Excludes $879,300 that was or may be reimbursed from other Federal funds (ACPS) to private interests.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)
Price Base: 1957

Structure Site Number	Federal Installation Cost: Construction: Engineers Estimate	Federal Installation Cost: Construction: Contingencies	Federal Installation Cost: Installation Services: Engineering	Federal Installation Cost: Installation Services: Other	Federal Installation Cost: Total Federal	Non-Federal Installation Cost: Legal Fees	Non-Federal Installation Cost: Easements and R/W	Non-Federal Installation Cost: Total Non-Federal	Estimated Total Cost
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	93,785	9,379	19,601	9,410	132,175	80	5,790	5,870	138,045
2	79,370	7,937	16,588	7,964	111,859	60	3,600	3,660	115,519
3	26,129	2,613	5,461	2,622	36,825	100	4,275	4,375	41,200
4	38,122	3,812	7,967	3,825	53,726	60	3,530	3,590	57,316
5	39,554	3,956	8,267	3,969	55,746	60	1,710	1,770	57,516
6	22,634	2,263	4,731	2,271	31,899	20	1,215	1,235	33,134
7	23,064	2,306	4,821	2,314	32,505	60	1,215	1,275	33,780
8	47,558	4,756	9,940	4,772	67,026	20	1,455	1,475	68,501
9	76,002	7,600	15,885	7,626	107,113	40	5,475	5,515	112,628
10	33,442	3,344	6,989	3,356	47,131	40	1,905	1,945	49,076
11	50,993	5,099	10,657	5,117	71,866	40	2,115	2,155	74,021
12	18,369	1,837	3,839	1,843	25,888	20	630	650	26,538
13	40,822	4,082	8,532	4,096	57,532	20	2,355	2,375	59,907
14	32,493	3,249	7,148	3,732	46,622	75	2,310	2,385	49,007
14-A	19,005	1,900	4,181	2,183	27,269	50	945	995	28,264
15	45,593	4,559	10,031	5,237	65,420	75	3,330	3,405	68,825
15-A	39,769	3,977	8,749	4,568	57,063	50	1,605	1,655	58,718
16	29,183	2,918	6,099	2,928	41,128	60	2,120	2,180	43,308
17-A	12,020	1,202	2,512	1,206	16,940	40	795	835	17,775
17-B	12,239	1,224	2,558	1,228	17,249	40	870	910	18,159
17	46,590	4,659	9,737	4,675	65,661	20	3,570	3,590	69,251
18	32,582	3,258	6,810	3,269	45,919	100	2,190	2,290	48,209
19	24,591	2,459	5,140	2,467	34,657	80	1,065	1,145	35,802
20	34,017	3,402	7,110	3,413	47,942	80	2,160	2,240	50,182

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/- Continued

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)
Price Base: 1957

Structure Site Number	Federal Installation Cost: Construction: Engineers Estimate	Construction: Contingencies	Installation Services: Engineering	Installation Services: Other	Total Federal	Non-Federal Installation Cost: Legal Fees	Easements and R/W	Total Non-Federal	Estimated Total Cost
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
21	48,140	4,814	10,061	4,830	67,845	100	6,045	6,145	73,990
22	28,119	2,812	6,186	3,230	40,347	50	2,950	3,000	43,347
23-A	10,895	1,090	2,397	1,251	15,633	20	690	710	16,343
23-B	11,579	1,158	2,547	1,330	16,614	20	825	845	17,459
24	28,243	2,824	5,903	2,834	39,804	40	1,815	1,855	41,659
25	29,737	2,974	6,214	2,984	41,909	60	2,175	2,235	44,144
26	31,101	3,110	6,500	3,121	43,832	20	1,275	1,295	45,127
27	55,409	5,541	11,581	5,560	78,091	60	2,700	2,760	80,851
28	31,335	3,134	6,549	3,144	44,162	20	1,290	1,310	45,472
29	26,147	2,615	5,465	2,623	36,850	40	2,115	2,155	39,005
30	65,395	6,540	13,667	6,562	92,164	20	2,595	2,615	94,779
31	112,063	11,206	23,421	11,245	157,935	20	6,690	6,710	164,645
32	32,857	3,286	6,867	3,297	46,307	60	3,180	3,240	49,547
33	53,748	5,375	11,234	5,393	75,750	20	2,040	2,060	77,810
34	30,243	3,024	6,321	3,035	42,623	40	810	850	43,473
35	44,653	4,465	9,332	4,481	62,931	160	1,785	1,945	64,876
36	56,880	5,688	11,888	5,707	80,163	80	2,740	2,820	82,983
37	39,764	3,976	8,311	3,990	56,041	120	915	1,035	57,076
38	35,760	3,576	7,474	3,588	50,398	160	765	925	51,323
39	70,517	7,051	14,738	7,076	99,382	160	3,315	3,475	102,857
2/ 40	62,977	6,298	13,162	6,319	88,756	200	3,266	3,466	92,222
41	41,058	4,106	8,581	4,120	57,865	120	1,170	1,290	59,155
2/ 42	75,012	7,501	15,678	7,527	105,718	160	522	682	106,400
2/ 43	69,747	6,975	14,577	6,998	98,297	120	1,177	1,297	99,594
2/ 44	60,021	6,002	12,544	6,022	84,589	120	1,281	1,401	85,990

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/ - Continued

Upper Washita River Watershed, Oklahoma and Texas

(Washita River Watershed)

Price Base: 1957

Structure Site Number	Federal Installation Cost: Construction: Engineers Estimate (dollars)	Federal Installation Cost: Construction: Contingencies (dollars)	Federal Installation Cost: Installation Services: Engineering (dollars)	Federal Installation Cost: Installation Services: Other (dollars)	Federal Installation Cost: Total Federal (dollars)	Non-Federal Installation Cost: Legal Fees (dollars)	Non-Federal Installation Cost: Easements and R/W (dollars)	Non-Federal Installation Cost: Total Non-Federal (dollars)	Estimated Total Cost (dollars)
45	13,781	1,378	3,312	1,952	20,423	105	1,275	1,380	21,803
46	42,753	4,275	8,935	4,290	60,253	160	1,860	2,020	62,273
47	35,010	3,501	7,317	3,513	49,341	80	1,320	1,400	50,741
48	20,244	2,024	4,231	2,031	28,530	80	450	530	29,060
49	21,670	2,167	4,529	2,174	30,540	80	855	935	31,475
50	20,281	2,028	4,239	2,035	28,583	80	660	740	29,323
51	21,286	2,129	4,449	2,136	30,000	40	495	535	30,535
52	29,530	2,953	6,172	2,963	41,618	80	645	725	42,343
2/ 53	108,953	10,895	22,771	10,932	153,551	160	39	199	153,750
54	54,438	5,444	11,377	5,462	76,721	120	1,125	1,245	77,966
55	29,475	2,948	6,160	2,958	41,541	80	1,110	1,190	42,731
56	20,633	2,063	4,313	2,070	29,079	120	630	750	29,829
2/ 57	123,050	12,305	25,717	12,347	173,419	120	5,115	5,235	178,654
58	54,878	5,488	11,470	5,506	77,342	200	2,295	2,495	79,837
Grand Total	2,665,308	266,530	559,543	270,727	3,762,108	4,785	128,235	133,020	3,895,128

1/ Does not include work plan preparation cost.

2/ These sites partially on Federal land (USDA Forest Service).

December 1958

TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES
Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Drainage Area	Sq.Mi.	23.95	17.50	5.25	11.11	6.96	3.34	3.46	1/ 5.36	27.59	8.80	9.24
Storage Capacity												
Sediment Pool 2/	Ac.Ft.	397	215	123	237	160	80	90	123	265	249	222
Sediment Reserve Above Riser	Ac.Ft.	128	65	0	0	0	0	0	0	88	80	74
Floodwater Detention	Ac.Ft.	3,692	2,426	717	1,511	965	491	536	906	4,650	1,173	1,366
Total	Ac.Ft.	4,217	2,706	840	1,748	1,125	571	626	1,029	5,003	1,502	1,662
Surface Area												
Sediment Pool (top of riser)	Ac.Ft.	77	50	18	58	27	17	16	21	55	29	31
Floodwater Detention Pool	Acre	291	190	67	144	87	64	65	76	310	98	110
Maximum Height of Dam	Foot	54	54	49	43	44	35	36	50	50	41	49
Volume of Fill	Cu.Ft.	267,960	226,770	74,660	108,920	113,010	64,670	65,900	135,880	217,150	95,550	145,690
Emergency Spillway												
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use 3/	Year	30	27	25	25	25	25	25	30	31	25	26
Design Storm (emergency spillway hydrograph)												
Duration	Hour	6	6	6	6	6	6	6	6	6	6	6
Rainfall 4/	Inch	3.75	3.85	4.19	3.98	4.12	4.28	4.27	4.05	3.93	4.23	4.30
Runoff	Inch	1.88	1.96	2.23	2.07	2.19	2.32	2.31	2.12	2.03	2.28	2.29
Bottom Width	Foot	230	280	120	208	200	80	85	200	315	214	240
Design Depth	Foot	0	0	0	0	0	0	0	0	0	0	0
Design Capacity	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Freeboard 5/	Foot	6	6	5	5.5	5	5	5	4.8	6	5.5	5
Total Capacity	c.f.s.	8,510	10,360	3,840	7,700	6,400	2,560	2,720	6,000	11,655	6,840	7,680
Principal Spillway												
Capacity	c.f.s.	120	88	26	56	35	17	17	44	138	44	46
Capacity Equivalents												
Sediment Volume	Inch	.31	.23	.44	.40	.43	.45	.47	.43	.18	.53	.45
Sediment Reserve Above Riser	Inch	.10	.7	0	0	0	0	0	0	.06	.17	.15
Detention Storage	Inch	2.88	2.60	2.56	2.55	2.60	2.76	2.81	3.17	3.16	2.06	2.79
Spillway Storage 6/	Inch	1.77	1.31	1.38	1.49	1.44	2.22	2.18	1.44	1.45	1.63	1.21
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

Footnotes last page.

December 1958

TABLE 3 - STRUCTURE DATA - Continued
FLOODWATER RETARDING STRUCTURES
Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 12	13	14	14A	15	15A	16	17	17A	17B	18
ainage Area	Sq.Mi.	1.57	8.29	7.12	2.22	9.41	4.13	5.70	1/10.75	1.10	1.07	4.97
orage Capacity												
Sediment Pool 2/	Ac.Ft.	58	203	334	106	376	165	140	350	32	27	156
Sediment Reserve Above Riser	Ac.Ft.	0	0	84	26	125	55	0	115	0	0	53
Floodwater Detention	Ac.Ft.	224	1,212	988	336	1,440	660	712	1,342	182	210	817
Total	Ac.Ft.	282	1,415	1,406	468	1,941	880	852	1,807	214	237	1,026
rface Area												
Sediment Pool (top of riser)	Acre	10	32	46	17	58	28	23	58	8	6	36
Floodwater Detention Pool	Acre	32	125	108	46	164	79	85	180	28	32	110
ximum Height of Dam	Foot	38	42	36	36	33	34	38	38	25	26	34
lume of Fill	Cu.Ft.	52,480	116,630	92,836	54,300	130,267	113,627	83,380	133,110	34,340	34,970	93,090
ergency Spillway												
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use 3/	Year	25	25	25	25	25	25	25	25	25	29	26
Design Storm (emergency spillway hydrograph												
Duration	Hour	6	6	6	6	6	6	6	6	6	6	6
Rainfall 4/	Inch	4.69	4.34	4.20	4.50	4.30	4.50	4.44	4.11	4.74	4.74	4.46
Runoff	Inch	2.67	2.38	2.00	2.20	1.50	1.60	2.46	2.18	2.71	2.71	2.48
Bottom Width	Foot	125	240	120	80	130	70	220	300	63	54	70
Design Depth	Foot	0	0	0	0	0	0	0.3	0	0	0	0
Design Capacity	c.f.s.	0	0	0	0	0	0	60	0	0	0	0
Freeboard 5/	Foot	4	5	5	4	4	4	4.7	5.5	4	4	5
Total Capacity	c.f.s.	2,762	7,680	3,540	1,632	2,580	1,390	7,040	10,350	1,392	1,193	2,240
incipal Spillway												
Capacity	c.f.s.	8	41	36	11	47	21	29	83	8	8	50
pacity Equivalents												
Sediment Volume	Inch	.69	.46	.88	.88	.75	.75	.46	.61	.55	.47	.59
Sediment Reserve Above Riser	Inch	0	0	.22	.22	.25	.25	0	.20	0	0	.20
Detention Storage	Inch	2.69	2.74	2.60	2.80	2.87	3.00	2.34	2.34	3.10	3.68	3.08
Spillway Storage 6/	Inch	2.06	1.59	1.65	1.70	1.51	2.13	1.48	1.79	2.25	2.17	2.22
ass of Structure		A	A	A	A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - Continued

FLOODWATER RETARDING STRUCTURES

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 19	20	21	22	23A	23B	24	25	26	27	28
Drainage Area	Sq.Mi.	2.06	5.02	1/17.02	5.54	2.06	2.33	6.09	7.14	3.55	6.75	4.10
Storage Capacity												
Sediment Pool 2/	Ac.Ft.	60	134	518	142	52	58	254	202	174	209	96
Sediment Reserve Above Riser	Ac.Ft.	0	27	163	0	15	17	0	72	47	69	0
Floodwater Detention	Ac.Ft.	328	992	2,950	798	223	290	663	876	466	1,143	541
Total	Ac.Ft.	388	1,153	3,631	940	290	365	917	1,150	687	1,421	637
Surface Area												
Sediment Pool (top of riser)	Acre	18	28	101	20	11	11	34	46	27	42	22
Floodwater Detention Pool	Acre	62	116	302	82	35	44	87	99	58	138	64
Maximum Height of Dam	Foot	28	36	38	34	28	33	43	35	38	35	29
Volume of Fill	Cu.Yd.	70,260	97,190	137,540	80,341	31,129	33,082	80,690	84,960	88,860	158,310	89,530
Emergency Spillway												
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use 3/	Year	25	31	35	25	25	25	25	28	28	29	28
Design Storm (emergency spillway Hydrograph)												
Duration	Hour	6	6	6	6	6	6	6	6	6	6	6
Rainfall 4/	Inch	4.64	4.46	3.69	4.40	4.60	4.60	4.42	4.38	4.54	4.40	4.51
Runoff	Inch	2.63	2.48	1.83	4.20	2.21	2.21	1.34	1.32	1.42	2.13	1.40
Bottom Width	Foot	40	40	302	150	130	100	170	75	70	90	85
Design Depth	Foot	0	0	0	0	0	0	0	0	0	0	0
Design Capacity	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Freeboard 5/	Foot	4.5	5	5.3	5	4	4	4	5	4	5	4
Total Capacity	c.f.s.	1,080	1,280	10,050	4,425	2,640	2,040	3,757	2,400	1,547	2,880	1,878
Principal Spillway												
Capacity	c.f.s.	21	50	305	44	10	12	30	36	18	34	21
Capacity Equivalents												
Sediment Volume	Inch	.55	.50	.57	.48	.47	.47	.78	.53	.92	.58	.44
Sediment Reserve Above Riser	Inch	0	.10	.18	0	.14	.14	0	.19	.25	.19	0
Detention Storage	Inch	2.98	3.70	3.25	2.70	2.03	2.33	2.04	2.30	2.46	3.17	2.47
Spillway Storage 6/	Inch	2.98	2.51	2.00	1.50	1.51	1.71	1.18	1.48	1.47	2.32	1.37
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - Continued

FLOODWATER RETARDING STRUCTURES

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 29	30	31	32	33	34	35	36	37	38	39
Drainage Area	Sq.Mi.	4.52	7.18	35.78	1/9.88	6.77	2.83	7.94	6.90	2.90	3.72	14.33
Storage Capacity												
Sediment Pool 2/	Ac.Ft.	140	348	958	364	375	119	208	361	104	97	665
Sediment Reserve Above Riser	Ac.Ft.	43	88	312	121	123	39	0	118	34	0	222
Floodwater Detention	Ac.Ft.	757	942	4,080	1,054	873	372	974	780	368	442	1,590
Total	Ac.Ft.	940	1,378	5,350	1,539	1,371	530	1,182	1,259	506	539	2,477
Surface Area												
Sediment Pool (top of riser)	Acre	45	45	115	60	41	14	26	50	14	13	69
Floodwater Detention Pool	Acre	96	128	331	152	95	40	93	113	44	38	152
Maximum Height of Dam	Foot	29	41.2	49.4	32.4	45	35	39	33	35	36	43
Volume of Fill	Cu. Yd.	74,710	186,840	320,180	93,880	153,570	79,590	117,510	162,520	104,643	94,100	201,480
Emergency Spillway												
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use 3/	Year	29	25	29	31	25	25	28	25	25	25	25
Design Storm (emergency spillway hydrograph)												
Duration	Hour	6	6	6	6	6	6	6	6	6	6	6
Rainfall 4/	Inch	4.50	4.46	3.82	3.71	4.48	4.89	4.70	4.74	5.04	4.76	4.48
Runoff	Inch	2.04	2.07	0.99	0.92	2.36	1.87	1.74	1.70	1.84	1.64	1.38
Bottom Width	Foot	130	100	260	280	150	80	190	150	75	85	260
Design Depth	Foot	0	0	0	0	0	0	0	0	0	0	0
Design Capacity	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Freeboard 5/	Foot	4	6	5	4.5	6	4	4	4	4	4	4
Total Capacity	c.f.s.	2,873	3,700	8,320	7,560	5,550	1,715	4,135	3,205	1,632	1,900	5,909
Principal Spillway												
Capacity	c.f.s.	23	36	179	228	34	14	40	35	15	19	72
Capacity Equivalents												
Sediment Volume	Inch	.58	.91	.46	.69	1.04	.79	.49	.98	.67	.49	.87
Sediment Reserve Above Riser	Inch	.18	.23	.15	.23	.34	.26	0	.32	.22	0	.29
Detention Storage	Inch	3.14	2.46	1.96	2.00	2.42	2.46	2.30	2.12	2.38	2.23	2.08
Spillway Storage 6/	Inch	1.78	2.35	1.00	1.52	1.89	1.15	96	1.28	1.31	.86	.85
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - Continued

FLOODWATER RETARDING STRUCTURES

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 40	41	42	43	44	45	46	47	48	49	50
Drainage Area	Sq.Mi.	1/12.81	4.15	8.11	5.07	4.48	5.32	7.33	5.37	.97	2.41	1.60
Storage Capacity												
Sediment Pool 2/	Ac.Ft.	622	120	337	205	182	156	211	195	64	87	59
Sediment Reserve Above Riser	Ac.Ft.	232	33	113	68	60	0	0	66	21	30	20
Floodwater Detention	Ac.Ft.	1,229	440	878	649	665	397	825	581	121	281	221
Total	Ac.Ft.	2,083	593	1,328	922	907	553	1,036	842	206	398	300
Surface Area												
Sediment Pool (top of riser)	Acre	76	21	40	26	23	31	34	25	10	16	12
Floodwater Detention Pool	Acre	169	57	89	62	63	54	90	67	20	41	32
Maximum Height of Dam	Foot	33	29	43	40	36	28	37	34	37	32	27
Volume of Fill	Cu.Yd.	165,730	108,050	197,400	183,540	157,950	40,691	112,510	92,130	53,270	57,030	53,370
Emergency Spillway												
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use 3/	Year	25	25	25	25	25	25	25	25	25	25	25
Design Storm (emergency spillway hydrograph)												
Duration	Hour	6	6	6	6	6	6	6	6	6	6	6
Rainfall 4/	Inch	4.28	4.86	4.68	4.82	4.84	4.50	4.72	4.81	5.13	4.99	5.05
Runoff	Inch	1.20	1.41	1.44	1.83	2.15	1.40	1.47	1.52	1.90	1.95	2.00
Bottom Width	Foot	300	70	160	140	145	150	135	120	45	90	40
Design Depth	Foot	0	0	0	0	0	0	0	0	0	0	0
Design Capacity	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Freeboard 5/	Foot	4.5	4	4	4	4	5	4	4	4	4	4
Total Capacity	c.f.s.	7,985	1,555	3,610	3,165	3,232	4,358	3,000	2,640	1,001	1,240	840
Principal Spillway												
Capacity	c.f.s.	136	21	41	25	23	27	37	27	5	12	8
Capacity Equivalents												
Sediment Volume	Inch	.91	.54	.78	.76	.76	.55	.54	.68	1.24	.68	.69
Sediment Reserve Above Riser	Inch	.34	.15	.26	.25	.25	0	0	.23	.41	.23	.23
Detention Storage	Inch	1.80	1.99	2.03	2.40	2.78	1.40	2.11	2.03	2.33	2.19	2.60
Spillway Storage 6/	Inch	1.22	1.12	.93	.99	1.21	1.05	1.05	1.03	2.82	1.03	1.88
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Item	Unit	STRUCTURE NUMBER 51	52	53	54	55	56	57	58	Total
Drainage Area	Sq.Mi.	1.43	1.98	16.35	3.97	3.04	1.39	33.24	7.70	470.02
Storage Capacity										
Sediment Pool 2/	Ac.Ft.	58	73	445	140	123	66	1,082	460	14,431
Sediment Reserve Above Riser	Ac.Ft.	19	24	192	47	41	17	354	152	3,892
Floodwater Detention	Ac.Ft.	199	249	1,718	527	476	230	4,007	1,068	62,819
Total	Ac.Ft.	276	346	2,355	714	640	313	5,443	1,680	81,142
Surface Area										
Sediment Pool (top of riser)	Acre	8	12	46	19	18	10	98	46	2,144
Floodwater Detention Pool	Acre	25	31	145	56	58	32	276	107	6,334
Maximum Height of Dam	Foot	35	37	40	38	33	23	54	47	xxx
Volume of Fill	Cu.Yd.	56,020	77,710	311,290	143,260	77,567	54,300	323,820	144,420	7,406,163
Emergency Spillway										
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Frequency of Use 3/	Year	25	25	25	25	25	25	25	25	xxx
Design Storm (emergency spillway hydrograph)										
Duration	Hour	6	6	6	6	6	6	6	6	xxx
Rainfall 4/	Inch	5.08	5.02	4.48	4.88	4.95	5.08	4.20	4.95	xxxx
Runoff	Inch	2.01	1.83	1.53	1.86	2.32	2.50	1.40	2.00	xxx
Bottom Width	Foot	45	50	370	115	100	50	300	210	xxx
Design Depth	Foot	0	0	0	0	0	0	0	0	xxx
Design Capacity	c.f.s.	0	0	0	0	0	0	0	0	xxx
Freeboard 5/	Foot	4	4	4	4	4	4	5	4	xxx
Total Capacity	c.f.s.	995	1,130	3,390	2,530	2,187	1,090	9,340	4,732	xxx
Principal Spillway Capacity	c.f.s.	7	10	82	20	15	8	166	39	xxx
Capacity Equivalents										
Sediment Volume	Inch	.76	.69	.51	.66	.76	.89	.61	1.12	xxx
Sediment Reserve Above Riser	Inch	.25	.23	.22	.22	.25	.23	.20	.37	xxx
Detention Storage	Inch	2.61	2.36	1.97	2.49	2.94	3.11	2.26	2.60	xxx
Spillway Storage 6/	Inch	1.43	1.39	.74	1.21	1.55	2.00	.83	1.11	xxx
Class of Structure		A	A	A	A	A	A	A	A	xxx

1/ Excludes the area from which runoff is controlled by other floodwater retarding structures in series.
2/ Risers of structures in Texas will be ported at 200 acre-feet elevation and in Oklahoma in accordance with Oklahoma Water Resources Board resolution dated June 18, 1954.
3/ Based on gaged runoff.
4/ 0.5P - from figure 3.21-1, NEH - A.
5/ Texas (H_p for 1.0P) - (H_p for 0.5P) + 1.0'. Oklahoma (H_p for 1.0P) - (H_p for 0.5P) or 4.0' if greater.
6/ Storage from emergency spillway crest to top of dam.

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TABLE 4 - ANNUAL COST 1/

Upper Washita River Watershed - Oklahoma and Texas
(Washita River Watershed)

Measures	Amortization of Installation Costs 2/			Operation and Maintenance Costs 3/		Other Economic Costs 4/	Total
	Federal	Non-Federal	Total	Non-Federal	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
1 through 58 5/	132,645	6,192	138,837	6,390	6,390	218	145,445
TOTAL	132,645	6,192	138,837	6,390	6,390	218	145,445

1/ Does not include work plan preparation cost.
2/ 1957 prices amortized for 50 years at 2.5 percent for Federal and 4.0 percent non-Federal.
3/ Long-term prices as projected by ARS, June 1957.
4/ Estimated value of loss of production from sites on Federal land.
5/ Interdependent measures.

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TABLE 5 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Upper Washita River Watershed - Oklahoma and Texas
(Washita River Watershed)
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project	After Land Treatment for Watershed Protection 2/	With Project	Average Annual Monetary Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	65,414	64,658	19,429	45,229
Other Agricultural	14,515	14,065	5,222	8,843
Nonagricultural	29,652	29,652	6,714	22,938
Subtotal	109,581	108,375	31,365	77,010
Sediment Damage				
Overbank Deposition	16,351	14,299	9,325	4,974
Subtotal	16,351	14,299	9,325	4,974
Erosion Damage				
Flood Plain Scour	12,557	12,065	2,781	9,284
Streambank Cutting	3,411	3,411	2,287	1,124
Subtotal	15,968	15,476	5,068	10,408
Indirect Damage	11,457	11,083	4,576	6,507
Subtotal	11,457	11,083	4,576	6,507
Total - All Damage	153,357	149,233	50,334	98,899
Benefits Outside Project Area				
Washita Mainstem	xxx	xxx	xxx	100,408
Benefits from Reduced Sediment to Foss Reservoir	xxx	xxx	xxx	7,095
Subtotal	xxx	xxx	xxx	107,503
TOTAL FLOOD PREVENTION BENEFITS	-	-	-	206,402
TOTAL PRIMARY BENEFITS	-	-	-	206,402
TOTAL MONETARY BENEFITS	-	-	-	206,402

1/ As projected by ARS-AMS, September 1957.
2/ Land treatment for watershed protection included all needed land treatment measures. Extra column not needed.

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TABLE 6 - BENEFIT-COST ANALYSIS

Upper Washita River Watershed, Oklahoma and Texas
(Washita River Watershed)

Measures	AVERAGE ANNUAL BENEFITS 1/								
	Flood Prevention								
	Flood-water	Sediment	Erosion	Indirect	Washita River Mainstem	Reduced Sediment to Foss Reservoir	Total	Average Annual Cost 2/	Benefi Cost Ratio
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures									
1 through 58 3/	77,010	4,974	10,408	6,507	100,408	7,095	206,402	145,445	1.4:1
GRAND TOTAL	77,010	4,974	10,408	6,507	100,408	7,095	206,402	145,445	1.4:1

1/ Long-term prices as projected by ARS-AMS, September, 1957.
2/ Installation costs based on current prices, operation and maintenance cost based on long-term prices as projected by ARS-AMS, September 1957. Work plan cost not included.
3/ All floodwater retarding structures are interdependent.

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