WORK PLAN

LOWER SAN SABA RIVER WATERSHED

Of the Middle Colorado River Watershed

San Saba, McCulloch, Mason and Menard Counties,

Texas

Prepared By

SOIL CONSERVATION SERVICE

U.S. DEPARTMENT OF AGRICULTURE

Temple, Texas

December, 1956

WATERSHED WORK PLAN

Lower San Saba River Watershed
Of The Middle Colorado River Watershed
San Saba, McCulloch, Mason and Menard Counties, Texas

Prepared Under the Authority of the Soil Conservation Act of 1935 (Public Law No. 46, 74th Congress), the Flood Control Act of June 22, 1936 (Public Law No. 738, 74th Congress) and the Flood Control Act of December 22, 1944 (Public Law No. 534, 78th Congress 2nd Session).

Participating Agencies

San Saba-Brady Soil Conservation District
Mason County Soil Conservation District
Menard County Soil Conservation District
Concho Soil Conservation District
Agricultural Stabilization and Conservation Office
Extension Service
Soil Conservation Service

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture
December, 1956

WATERSHED WORK PLAN

AGREEMENT

between the

SAN SABA-BRADY SOIL CONSERVATION DISTRICT
(name of local organization)

(name of local organization)

(name of local organization)

STATE OF TEXAS,
(hereinafter referred to as the local organization)

and the

SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE
(hereinafter referred to as the Service)

Whereas, the responsibility for administration of the Flood Prevention Program authorized by the Flood Control Act of 1936, as amended and supplemented, has been assigned by the Secretary of Agriculture to the Soil Conservation Service; and

Whereas, there has been developed through the cooperative efforts of the local organization and the Service a mutually satisfactory plan for works of improvement for said watershed, designated as the watershed work plan for Lower San Saba River Watershed, State of Texas, which watershed work plan is annexed to and made a part of this agreement; and

Whereas, the watershed work plan describes the watershed and its problems, and sets forth a plan for works of improvement including a schedule of operations, the kinds and quantities of measures to be installed, the estimated cost, cost-sharing arrangements, maintenance and other responsibilities of those participating in the project, and economic justification for installing, operating and maintaining the works of improvement; and

Now, therefore, in view of the foregoing considerations, the local organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan will be installed, operated, and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

It is further understood that this agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and that financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose and on the execution of supplemental agreements setting forth the cost-sharing arrangements and other conditions that are applicable to specific works of improvement.

It is further agreed that the watershed work plan may be amended or revised, and that this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

No member of or Delegate to Congress 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.

SAN SABA-BRADY SOIL CONSERVATION DISTRICT
(name of local organization)

By O. B. Starkey

Title **Chairman, Board of Supervisors**

Date Feb 5, 1957

The signing of this agreement was authorized by a resolution of the governing body of the **San Saba-Brady Soil Conservation District**
(name of local organization)

adopted at a meeting held on Feb 5, 1957.

Geo. H. Johanson
(Secretary, local organization)

Date Feb 5, 1957

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WATERSHED WORK PLAN

Lower San Saba River Watershed
(Middle Colorado River Watershed)
San Saba, McCulloch, Menard and Mason Counties, Texas
December, 1956

SUMMARY OF PLAN

General Summary

This flood prevention work plan for the Lower San Saba River watershed, Texas, was prepared by the San Saba-Brady, Concho, Menard County and Mason County Soil Conservation Districts with technical assistance provided by the United States Department of Agriculture.

The watershed covers an area of approximately 878 square miles (561,920 acres) in San Saba, McCullough, Menard and Mason Counties, Texas. Approximately 13 percent of the watershed is cropland, 85 percent is grassland, and 2 percent is in miscellaneous uses, such as stream channels, towns, roads, etc.

No Federal lands or water management developments are involved.

The work plan proposes a 10-year project for the protection and development of the watershed at a total estimated installation cost of $2,094,153. The local or non-Federal share of this cost will be $1,199,516. In addition, local interests will bear the entire cost of operation and maintenance with a capitalized value of $31,600. Of the total project cost of $2,125,753, the non-Federal share will be $1,231,116 and the Federal share $894,637.

Land Treatment Measures

The cost of land treatment measures is estimated at $1,102,579, all of which will be borne by the local people.

Structural Measures

After thorough investigation it was found that in the Lower San Saba River watershed there were only two tributaries (Richland Creek and Jerrys Branch) where a structural program could be justified economically.

The structural measures included in the plan consist of 9 floodwater retarding structures on Richland Creek and 3 on Jerrys Branch, having aggregate total storage capacities of 9,493 acre-feet and 2,313 acre-feet, respectively. The total cost of these measures, including the capitalized value of operation and maintenance, is $842,258 for Richland Creek and $153,952 for Jerrys Branch, of which the local share is $99,478 and $29,059, respectively. The non-Federal share of the total cost of structural measures includes land, easements and rights-of-way, 75 percent, and operation and maintenance, 25 percent.

Damages and Benefits

The estimated average annual damage without the project is $62,573.

The estimated average annual damage with the project, including land treatment and structural measures, is $19,358.

The average annual primary benefits accruing to structural measures is $49,799, which is distributed as follows:

	Jerrys Branch	Richland Creek	Total
Floodwater damage reduction	$5,378	$22,334	$27,712
Erosion damage reduction	711	5,501	6,212
Indirect damage reduction	609	2,784	3,393
Benefits from changed use of land	1,815	7,697	9,512
Benefits from mainstem, Lower San Saba	206	2,764	2,970
Total	$8,719	$41,080	$49,799

The ratio of the average annual benefits to the average annual costs are as follows:

	Jerrys Branch	Richland Creek	Total
Average Annual Costs	$5,748	$30,827	$36,575
Average Annual Benefits	8,719	41,080	49,799
Benefit Cost Ratio	1.52:1.0	1.33:1.0	1.36:1.0

The total benefits of land treatment measures were not evaluated in monetary terms since experience has shown that these soil and water conservation measures produce benefits in excess of their costs.

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the landowners or operators of the farms and ranches on which the measures are installed under agreements with the San Saba-Brady, Concho, Menard County and Mason County Soil Conservation Districts. The 12 floodwater retarding structures will be operated and maintained by the San Saba-Brady Soil Conservation District.

DESCRIPTION OF WATERSHED

Physical Data

The San Saba River heads in the central part of Schleicher County, approximately 2 miles east of Eldorado, Texas, and flows toward the northeast for about 120 miles. It runs into the Colorado River about 10 miles east of the town of San Saba, in San Saba County. The Lower San Saba River watershed consists of the portion of the San Saba River(excluding the Brady Creek drainage area) from the beginning of the gorge section, located approximately 4 miles northeast of Hext, Texas to its confluence with the Colorado River. The Lower San Saba River watershed is about 70 miles in length. The largest tributaries are Simpson, Richland, Wallace, Deep and Katemcy Creeks and Jerrys Branch. Of these tributaries, only Richland Creek and Jerrys Branch have bottom land subject to appreciable damage by floodwaters.

The Lower San Saba River watershed has an area of 561,920 acres, nearly all of which is in farms and ranches. Richland Creek and Jerrys Branch, the two tributaries subject to appreciable damage, have drainage areas of 65,920 acres and 12,800 acres, respectively.

The remainder of the San Saba River drainage area is covered by the Upper San Saba River watershed work plan and the Brady Creek watershed work plan.

The topography of the watershed is extremely varied, ranging from large stream terraces or bench-land areas to rough hill land, etched by geologic erosion of limestone, granite or sandstone formations. Elevations range from about 2,000 feet above mean sea level in the upper part to 1,119 feet just above the confluence of the San Saba and Colorado Rivers. The main alluvial valley of the San Saba River ranges from approximately 5,300 feet wide in the lower reaches to less than 300 feet wide at the upper end.

About 70 percent of the watershed lies in the Edwards Plateau, 11 percent in the Reddish Prairie, 2 percent in the Cross Timbers and 17 percent in the Granitic land resource areas. These variations contribute to a diversity of soils from the standpoints of depth, texture, color, fertility, and usefulness. Approximately 60 percent of the soils in cultivation are deep and fine textured. The remainder are distributed equally between deep, medium-textured and deep, coarse-textured soils, except for a very small percentage of shallow soils. The majority of the pasture and rangeland soils are shallow or very shallow. About 47 percent of the soils of the watershed are in poor physical condition. The original range cover of midgrasses has deteriorated, especially on the shallow soils. It is estimated that the watershed as a whole has lost approximately one-half inch of topsoil and much organic matter.

The overall land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cultivation	71,126	13
Pasture and Range	479,566	85
Woodland	-	-
Miscellaneous 1/	11,228	2
Total	561,920	100

1/ Includes roads, highways, railroad rights-of-way, towns, stream channels, etc.

The largest storm considered in the 40-year period studied was a 7.59-inch rain extending over three days that produced 4.99 inches of runoff on Richland Creek and 5.23 inches of runoff on Jerrys Branch. This runoff flooded 84 percent of the 5,345 acres of flood plain on Richland Creek and 85 percent of the 2,177 acres of flood plain on Jerrys Branch. Under present watershed conditions, 76 percent of the Richland Creek and 71 percent of the Jerrys Branch flood plain would be flooded by the runoff from the maximum storm expected once in 25 years. At the present time about 57 percent of the Richland Creek flood plain is in cultivation and 41 percent in pasture. Of the Jerrys Branch flood plain 64 percent is in cultivation and 34 percent in pasture.

Average temperatures range from 82 degrees Fahrenheit in the summer to 49 degrees in the winter. The normal frost-free season of 212 days extends from April 3 to November 1.

The mean annual rainfall is 27.00 inches. It is well distributed, with the wettest months being April, May and October. Individual excessive rains causing serious erosion and flood damage may occur in any season, but are most frequent in the spring. The minimum recorded annual rainfall was 6.63 inches; the maximum was 45.55 inches.

Water for livestock and domestic use in the Edwards Plateau land resource area is supplied by shallow wells, springs and small farm ponds. It is supplied by shallow wells and farm ponds in the Reddish Prairie land resource area, but the supply is not always dependable and presents a serious problem. All of the towns in the watershed obtain water from springs.

Economic Data

The prosperity of the watershed depends almost entirely upon its farms and ranches. Livestock enterprises producing beef cattle, goats, and sheep predominate in the watershed. Winter feeding and pasturing of lambs has recently become a major practice. In the last decade there has been a large increase in the production of turkey and chicken hatching eggs. About 96 percent of the cropland is used for production of feed crops such as grain sorghum, hay, oats, and crops that will produce winter grazing. The most important cash crop grown in the watershed is pecans.

The Lower San Saba River watershed is served by Soil Conservation Service work units at San Saba, Brady, Mason, Menard and Eden, which are assisting the San Saba-Brady, Mason County, Menard County, and Concho Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 430 soil and water conservation plans on 329,735 acres (60 percent of the agricultural land) within the watershed and in giving guidance in establishing and maintaining planned measures. Where land treatment measures have been applied and maintained as long as three to five years, average crop yields have increased about 25 percent.

San Saba, with a population of about 4,100, the county seat of San Saba County, is located in the eastern part of the watershed. It is the marketing and shipping point for pecans, wool, mohair, cattle and poultry products for a large area of the watershed. Richland Springs, with a population of about 600, is located in the Richland Creek area and furnishes a railroad loading point for agricultural products.

Good fishing and hunting along the San Saba River provide a source of additional income to landowners and others within the watershed area.

The drainage area is served adequately by 437 miles of roads, of which 157 miles are paved. Adequate rail service is provided by one railroad.

WATERSHED PROBLEMS

Floodwater Damage

Flooding occurs frequently on Jerrys Branch and Richland Creek and causes severe damage (Figure 1). Large floods have occurred on an average of one every two or three years, the latest one being in May 1955. During the 40-year period studied, 1916 to 1955, there were 38 major floods which covered more than half the flood plain on Richland Creek and Jerrys Branch, and 73 smaller floods. Fifty-seven percent of the major floods and half of the smaller floods occurred during the growing season and caused considerable damage to growing crops. It is estimated that the average annual direct monetary floodwater damage, under existing conditions, is $48,040, of which $29,567 is crop and pasture damage. In addition, there are numerous indirect damages, such as interruption of travel, initial losses sustained by dealers and industries in the area, and similar losses, estimated to average $5,688 per year.

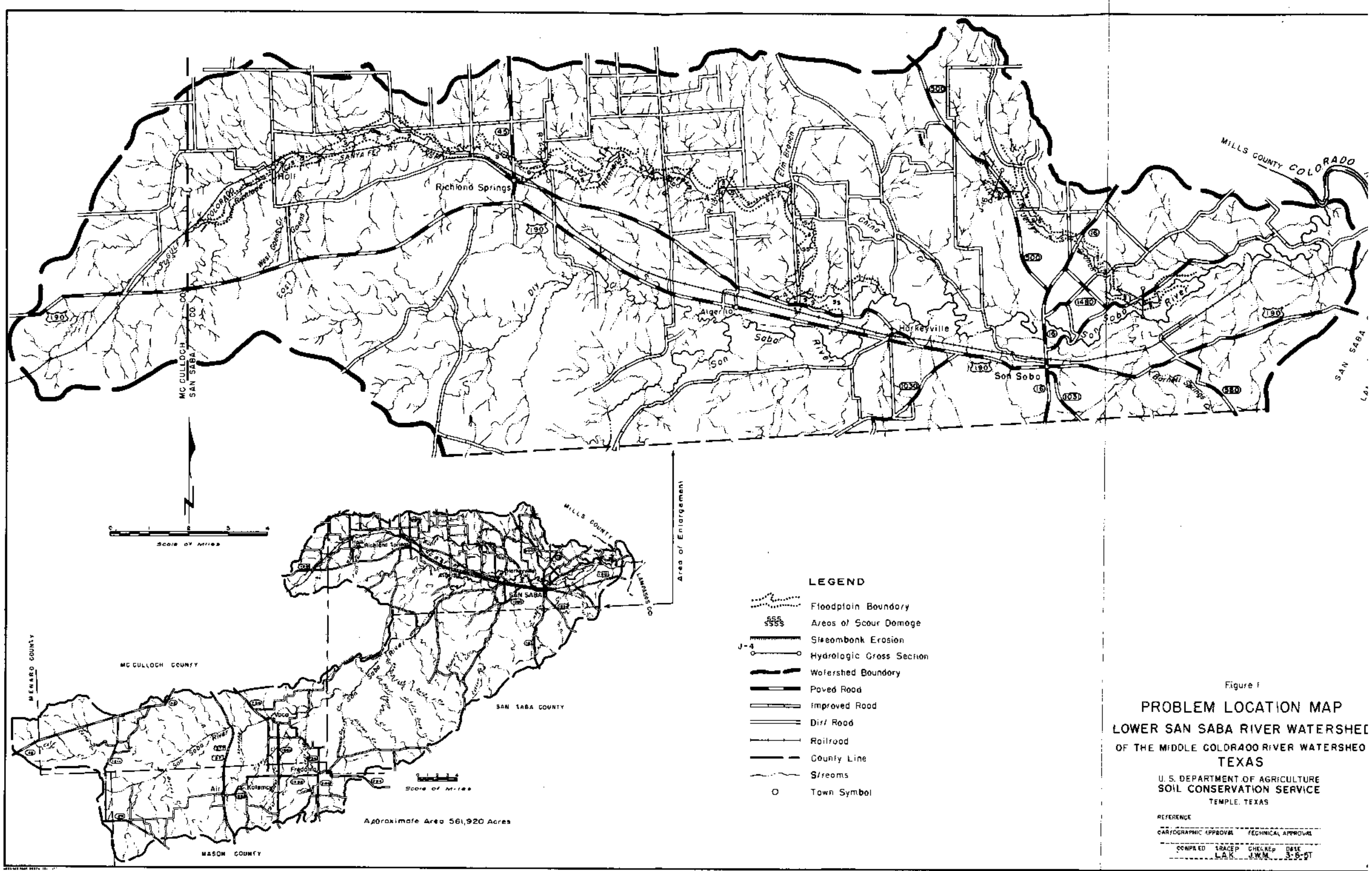


Figure I

PROBLEM LOCATION MAP
LOWER SAN SABA RIVER WATERSHED
OF THE MIDDLE COLORAOO RIVER WATERSHEO
TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE
CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL
COMPILED TRACED CHECKED DATE
L.A.K. J.W.M. 3-6-57

Flood of May, 1955 at Richland Springs, Texas. Looking north on Farm Road No. 45. Estimated floodwater damage to flood plain of Richland Creek - $70,927.

Sediment Damage

Sediment damage in the flood plains of Jerrys Branch and Richland Creek was determined to be of minor consequence. Some sedimentation takes place on pasturelands located below severely scoured areas, at confluences of streams, and on areas where backwater occurs due to flooding. However, this sediment was determined by the survey to be nondamaging.

Erosion Damage

Erosion rates are relatively low, as 85 percent of the area is rangeland. Sheet erosion accounts for about 95 percent of the sediment produced. It ranges from 0.21 acre-foot per square mile on the rangeland to 1.48 acre-feet per square mile on intensively cultivated areas. The low to moderate erosion rates on cropland can be attributed to the high percentage of conservation measures established as well as to the planting of large acreages of close-growing crops.

Gully erosion is minor. Channel and streambank erosion are also minor, contributing only about 5 percent of the sediment production. The majority of this erosion occurs on the tributaries.

The greatest area of land damage on the flood plain has been caused by sheet scour during major floods. Approximately 35 percent of the flood plain has been damaged,on the average, to the extent of 25 percent of its productive capacity (Figure 1). This loss is especially aevere when flooding occurs during land preparation stages. The estimated annual damage from flood plain scour is $8,845. Damage from deep scour channels is minor

Flooding on Antelope Creek caused crop loss and scour damage.

Problems Relating to Methods Now Used in the Conservation, Development, Utilization and Disposal of Water

Problems relating to methods now used in the conservation, development, utilization and disposal of water are minor in this watershed and do not warrant a study at this time. Although there is some irrigation activity along the flood plain of the San Saba River and in isolated upland areas, problems are of a minor nature. Drainage problems are practically nonexistent. No individual landowner or groups of landowners have indicated an interest in providing additional storage capacity in any of the floodwater retarding structures for irrigation purposes. At the present time all of the towns in the watershed obtain an adequate supply of water from springs.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Only minor efforts have been made to prevent floods in the watershed. Some farmers and ranchers have been trying to enlarge, straighten, or levee stream channels on an individual and widely scattered basis. These efforts have had little effect on the reduction of flood damages. During the past 10 years small neighbor groups of farmers and ranchers, cooperating with the San Saba-Brady, Concho, Menard County and Mason County Soil Conservation Districts, have been preparing conservation plans on their holdings on a community and watershed basis in order to protect their lands and reduce flooding. Civic groups of the towns of San Saba and Richland Springs have been very active in soil and water conservation as it is related to flood prevention. They have exerted their influence toward promoting a high degree of interest in conservation in the watershed. Except for small reductions that the project will provide in the rate of sediment accumulation in downstream reservoirs, there are no existing or proposed works of improvement of any other agency which would affect or be affected by the measures included in this plan.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures For Watershed Protection

Land treatment measures are important for protection of the 34,291 acres of Richland Creek and Jerrys Branch watersheds above the 12 planned structures. On the remaining acreage of the Lower San Saba River watershed, land treatment measures are all-important since they constitute the only planned measures for watershed protection.

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the four Soil Conservation Districts serving the watershed, is necessary for a sound flood prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on the establishment of those land treatment practices which will have a measurable effect on the reduction of floodwater and sediment damages.

The amounts and estimated cost of establishment of the measures that will be installed by the landowners and operators are shown on Table 1. The estimated total cost of installing these measures, exclusive of expected reimbursement from ACPS or other Federal funds, is $1,102,579.

Most of the land treatment measures will function principally to decrease erosion damage to fields and pastures by providing improved soil-cover conditions. These measures include cover cropping, use of rotation hay and pasture, crop residue utilization for croplands, and range seeding to establish good cover on grasslands. They also include: brush eradication, to allow grass stands to improve for replacement of the poor cover afforded by brushy pastures; the construction of farm ponds, to provide adequate numbers and locations of watering places to prevent cover-destroying, seasonal concentrations of livestock; and proper use and deferred grazing of range and pasture to provide improvement, protection, and good maintenance of grass stands. These measures, especially the cropland measures and range seeding, also effectively improve soil conditions which allow larger amounts of rainfall to soak into the soil.

In addition to the above soil improvement and cover measures, land

TABLE 1 - ESTIMATED INSTALLATION COST
(Based on 1955 Price Levels)
Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

For: Total Project

Item	Unit	No. to be Applied	Estimated Cost Federal	Estimated Cost Non-Federal 1/	Total
			(dollars)	(dollars)	(dollars)
ID TREATMENT PRIMARILY FOR:					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	23,021	-	28,776	28,776
Cover Cropping	Acre	37,145	-	346,538	346,538
Rotation Hay & Pasture	Acre	7,636	-	106,904	106,904
Crop Residue Utilization	Acre	33,282	-	59,575	59,575
Proper Use	Acre	157,742	-	100,955	100,955
Deferred Grazing	Acre	48,987	-	22,044	22,044
Range Seeding	Acre	7,436	-	86,305	86,305
Brush Control	Acre	50,026	-	200,104	200,104
Terracing	Mile	217	-	74,431	74,431
Diversion Construction	Mile	61	-	14,457	14,457
Waterway Development	Acre	330	-	28,050	28,050
Pond Construction	No.	164	-	34,440	34,440
echnical Assistance		-	-	-	-
AL LAND TREATMENT				1,102,579	1,102,579
UCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	12	667,443	-	667,443
AL CONSTRUCTION COSTS			667,443	-	667,443
TALLATION SERVICE					
Soil Conservation Service					
Engineering Services			121,353	-	121,353
Other			78,877	-	78,877
AL INSTALLATION SERVICES			200,230	-	200,230
ER COSTS					
Land, Easements and R/W			-	96,937	96,937
Administering Contracts			-	-	-
AL OTHER COSTS			-	96,937	96,937
AL INSTALLATION STRUCTURES			867,673	96,937	964,610
PLAN PREPARATION COSTS			26,964	-	26,964
AL INSTALLATION			894,637	1,199,516	2,094,153
IARY					
otal SCS			894,637	1,199,516	2,094,153
AL			894,637	1,199,516	2,094,153

Exclusive of reimbursement from ACPS or other Federal funds.
Note: There are no Federal lands in the watershed.

Date: December, 1956

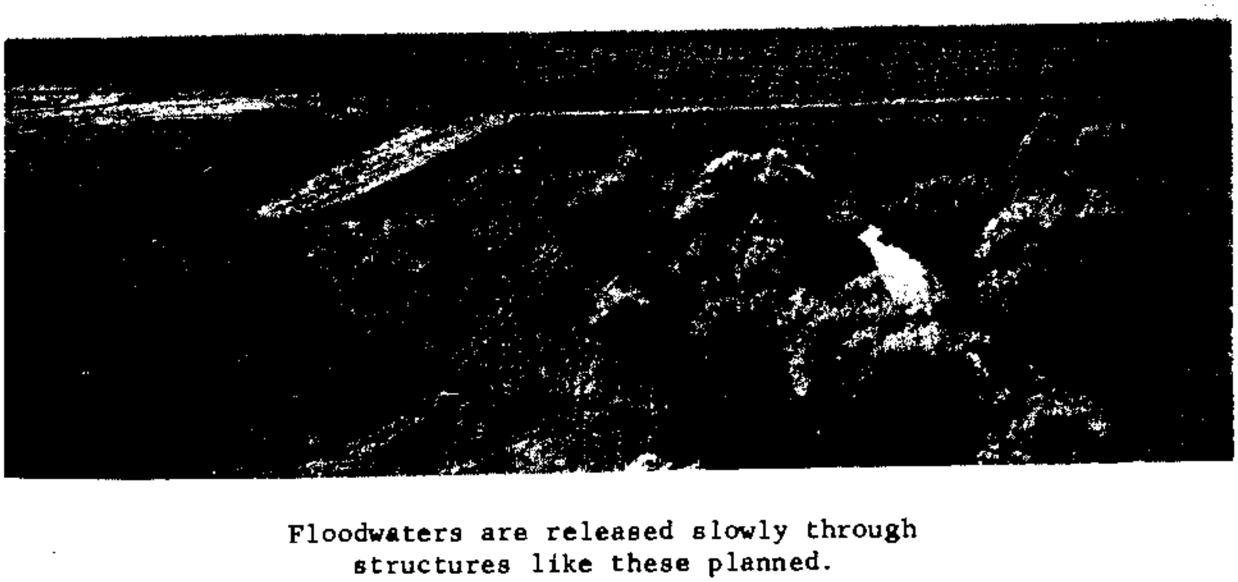
Legumes and utilization of crop residues protect San Saba cropland.

Good grass cover on Richland Creek lets large amounts of rainfall soak into the soil.

treatment includes contour farming, terracing, diversion construction, and waterway development to serve these measures, all of which have a measurable effect in reducing peak discharge by reducing the velocity of runoff water from fields. These measures also help the soil improvement and cover measures to reduce erosion damage and sediment yield.

Structural Measures for Flood Prevention

A system of nine floodwater retarding structures on Richland Creek and three structures on Jerrys Branch will be installed to afford the needed protection to flood plain lands along these tributaries that cannot be provided by land treatment measures alone. No structures were feasible in the remainder of the Lower San Saba watershed. The system of floodwater retarding structures will detain the total runoff from 43 percent of the Richland Creek waterahed and 48 percent of the Jerrys Branch watershed from a storm that can be expected to occur no more often than once in 25 years. Figure 2 shows a schematic drawing of a typical floodwater retarding structure.



Floodwaters are released slowly through structures like these planned.

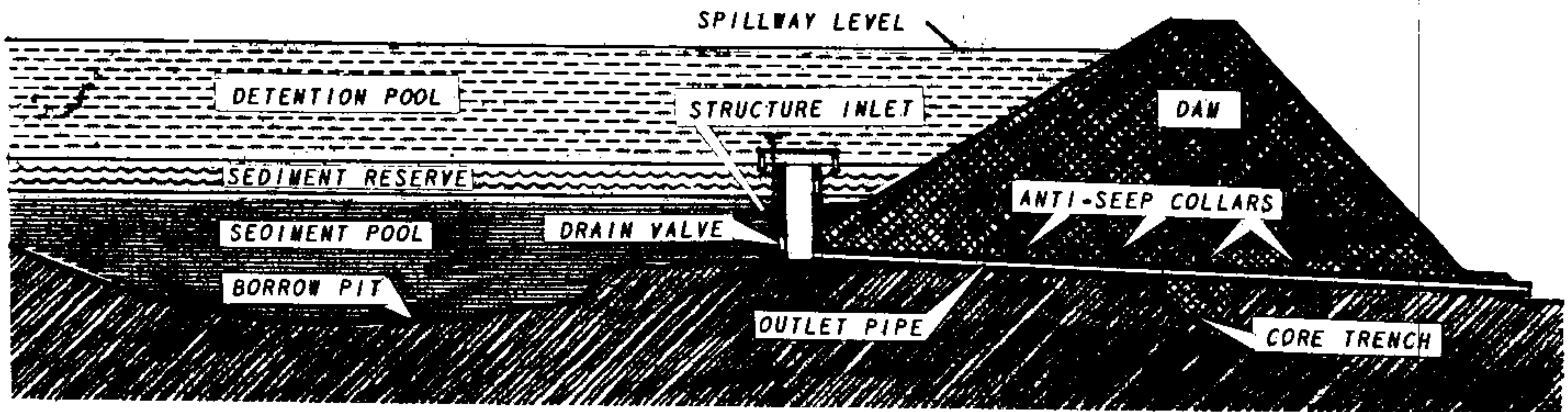


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

Sites for the floodwater retarding structures will be provided by local interests at no cost to the Federal Government. The value of these sites is estimated to be $96,937 based on market values furnished by real estate dealers and other local people. Only 28 acres of flood plain will lie within the sediment pools and 19 additional acres within the detention pools of the proposed structures.

The locations of the floodwater retarding structures are shown on the Planned Structural Measures Map, figure 3. The total estimated cost of establishing these works of improvement is $964,610, of which $96,937 will be borne by non-Federal interests and $867,673 by the Federal Government.

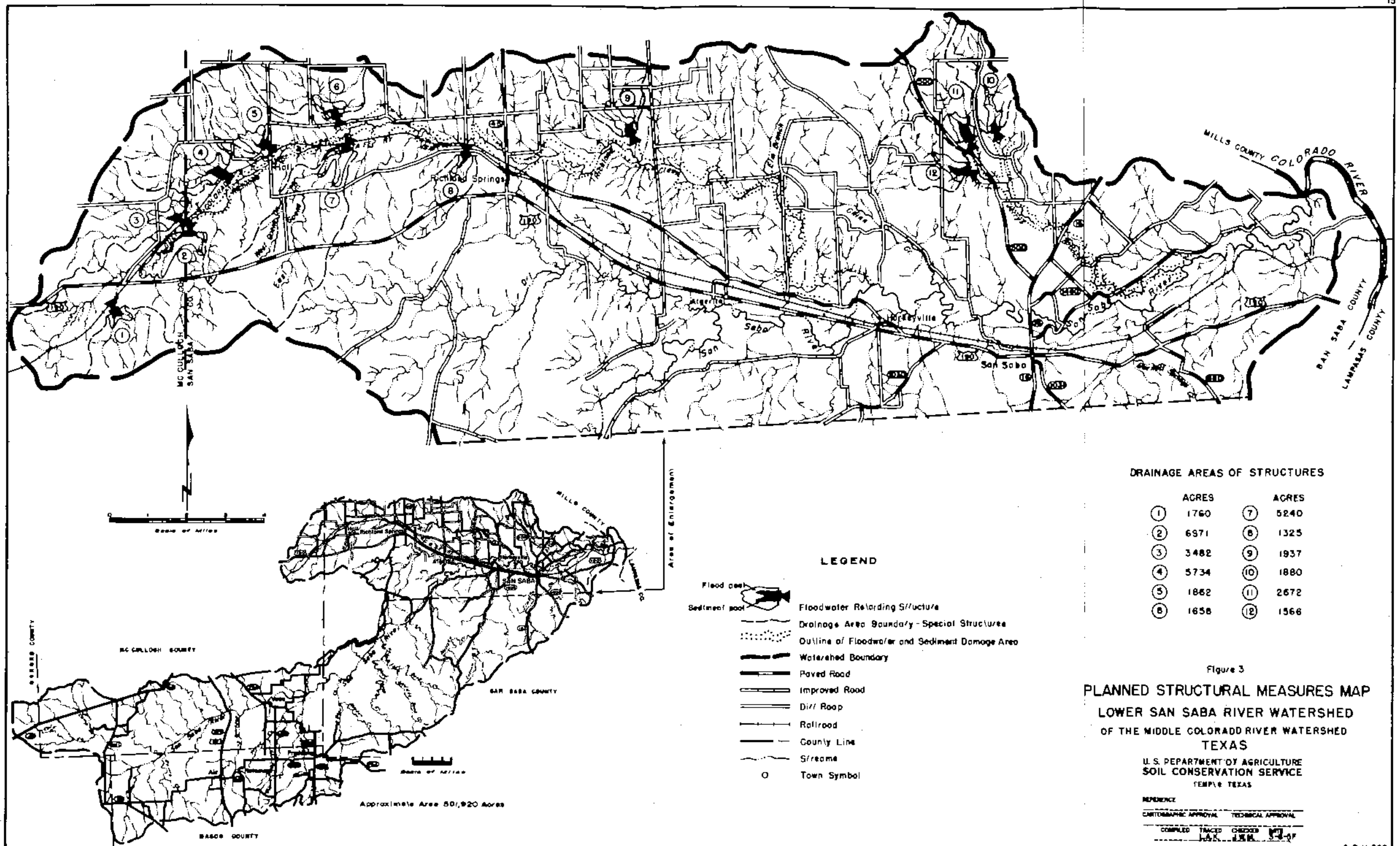
BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures for the Richland Creek and Jerrys Branch tributaries would prevent flood damage from 17 of the 111 storms, such as occurred in this watershed from 1916 through 1955. Of the 38 major floods 29 would be reduced to minor floods. Average annual flooding throughout the watershed would be reduced from 5,885 acres to about 2,352.

The estimated average annual floodwater and erosion damage stemming from these two tributaries would be reduced from $62,573 to $19,358, or a reduction of 69 percent. About 87 percent of the expected reduction in the average annual damage would result from the system of floodwater retarding structures. With the project installed, the flood plain of Richland Creek above cross-section 23 and the tributary flood plains below floodwater retarding structures will be essentially flood-free for all storms up to the size that can be expected to occur no more frequently than once in 15 years. The Richland Creek flood plain between cross-sections 16 and 23 will experience some flooding from storms larger than can be expected to occur once in five years, while below section 13 a 2-year frequency storm will cause flooding. On Jerrys Branch, storms larger than can be expected to occur once in five years will cause flooding.

Owners and operators of flood plain lands say that if adequate flood protection is provided they will intensify their use of these lands by growing high-value crops such as corn, maize and oats on areas now used for pasture and low-value crops because of the frequency of flooding. It is estimated that this more intensive use would increase the net income, after all expenses are deducted, by $9,512 (long-term prices) annually.

Benefits from reduction of damages on the mainstem of the Lower San Saba River accrue to the floodwater retarding structures on Richland Creek and Jerrys Branch in the amount of $2,970 annually. No appraisal was made of damage reduction on the Lower San Saba mainstem that can be expected to result from the land treatment program planned for the other tributaries of the watershed. Some reductions in mainstem damage can be expected to result, also, from project installations on the Brady Creek and Upper San Saba River watersheds.


MILLS COUNTY
COLORADO RIVER
SAN SABA COUNTY
LAMPASAS COUNTY
MC CULLOCH
SAN SABA
Richland Springs
Holt
San Saba
San Saba River
Algerita
Area of Enlargement
Scale of Miles
MC CULLOCH COUNTY
SAN SABA COUNTY
MILLS COUNTY
SAN SABA
Approximate Area 501,920 Acres
LEGEND
Flood pool
Sediment pool
Floodwater Retarding Structure
Drainage Area Boundary - Special Structures
Outline of Floodwater and Sediment Damage Area
Watershed Boundary
Paved Road
Improved Road
Dirt Road
Railroad
County Line
Streams
Town Symbol
DRAINAGE AREAS OF STRUCTURES
ACRES ACRES
(1) 1760 (7) 5240
(2) 6971 (8) 1325
(3) 3482 (9) 1937
(4) 5734 (10) 1880
(5) 1862 (11) 2672
(6) 1658 (12) 1566
Figure 3
PLANNED STRUCTURAL MEASURES MAP
LOWER SAN SABA RIVER WATERSHED
OF THE MIDDLE COLORADO RIVER WATERSHED
TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

The total flood prevention benefits, including both the reduction in flood damages and the benefits from more intensive use of flood plain lands, are estimated to be $55,697 annually, of which $49,799 is the result of structural measures.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be $36,575. When the structures are completely installed they are expected to produce average annusl benefits of $49,799, a benefit of $1.36 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

Federal assistance for carrying out the works of improvement, as described in this work plan, will be provided under the Soil Conservation Act of 1935 (Public Law No. 46, 74th Congress), the Flood Control Act of June 22, 1936 (Public Law No. 738, 74th Congress) and the Flood Control Act of December 22, 1944 (Public Law No. 534, 78th Congress, 2nd Session).

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 Lower San Saba River watershed. This activity will help to get the land treatment practices and the structural measures for flood prevention carried out.

Land Treatment Measures

Land treatment measures itemized in table 1 will be established by farmers in cooperation with the San Saba-Brady, Mason County, Menard County and Concho Soil Conservation Districts. The cost of applying these measures will be borne by the owners and operators of the land. It is expected that the owners and operators will be reimbursed for a portion of this cost through the existing Agricultural Conservation Program or other Federal programs. The amount of reimbursement to be expected has been estimated, based on current program criteria, and this amount has not been included in the total estimated non-Federal cost for land treatment listed in table 1. The soil conservation districts are giving assistance in the planning and application of these measures under its going program. This assistance will be continued to assure application of the planned measures within the 10-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 within the Lower San Saba River watershed 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 will be made available to all eligible individual farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies outlining 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.

Structural Measures for Flood Prevention

The Soil Conservation Service will contract for the construction of the 12 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 these structural measures.

The San Saba-Brady Soil Conservation District will furnish the land, easements and rights-of-way for all the structural measures at no cost to the Federal Government.

The following is a grouping of structures for construction purposes, each of which has a favorable benefit-cost ratio, based on those benefits that will accrue to each group:

Construction Units	No. of Sites	Annual Benefits	Annual Cost	Benefit Cost Ratio
		(dollars)	(dollars)	(dollars)
1. Richland Creek Sites 1 through 9	9	38,639	30,827	1.25:1
2. Jerrys Branch Sites 10, 11, 12	3	8,190	5,748	1.42:1

All necessary land, easements, and rights-of-way will be obtained for each construction unit before Federal financial assistance is made available for installation of any part of that construction unit.

The cooperating parties have agreed on an installation schedule of five years for the structural measures during the 10-year period for completion of the project. It is planned to construct structures in the following order: numbers 3, 4, and 11, first; numbers 1, 5, 6, and 12, next; then, numbers 2 and 10; and numbers 7, 8, and 9, last. This schedule will be adjusted 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.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the landowners and operators of the farms and ranches on which the measures are installed, under agreements with the San Saba-Brady, Mason County, Menard County and Concho Soil Conservation Districts. Representatives of these soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage landowners and operators to perform maintenance. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The 12 floodwater retarding structures will be maintained by the San Saba-Brady Soil Conservation District.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or streamflow. 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 fences and gates installed as a part of the floodwater retarding structures. The sponsoring local organization will maintain a record of all maintenance inspections and work done.

Provisions will be made for free access of District and Federal representatives to inspect the 12 floodwater retarding structures and their appurtenances at any time.

The estimated annual operation and maintenance cost is $1,471, based on long-term price levels. The necessary maintenance work will be accomplished through the use of resources of the San Saba-Brady Soil Conservation District.

The sponsoring local organization fully understands its obligations for maintenance and will execute specific maintenance agreements prior to the issuance of any invitation to bid.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the proposed flood prevention project on the Lower San Saba River and the expansion of this program to the remainder of the Colorado River and its tributaries would give added protection to flood plain lands along this stream and greatly reduce the sediment load carried by it. This project plan conforms to all Federal laws and regulations, and will have no known detrimental effect on any downstream project that might be constructed in the future.

SECTION 2

INVESTIGATIONS, ANALYSES AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

About 47 percent of the soils in the watershed are in relatively poor physical condition as a result of prolonged intensive cultivation and the type of farming operations and grazing practices used. Approximately 75 percent of the cropland soils are in relatively poor physical condition, due to loss of fertility and organic matter as a result of sheet erosion and past farming practices. Most cropland soils are used to grow small grains and temporary pasture crops.

Cover Conditions and Range Sites

A random sample comprising 5 percent of the Edwards Plateau and 15 percent each of the Reddish Prairie, Cross Timbers, and Granitic Land Resource area was taken to determine the physical condition of the rangeland in the Lower San Saba River watershed. This sample revealed that the rangeland in the watershed is 0.2 percent in good condition, 30.3 percent in fair condition and 69.5 percent in poor condition.

There are four range sites in the Edwards Plateau Land Resource area; Shallow Upland, Deep Upland, Low Stony Hills, and Bottom Land. These are described as follows:

. The Shallow Upland site is characterized by shallow, fine-textured, lowly permeable, stony and gravelly soils which occupy slopes from about percent to an extreme of 12 percent. The better forage grasses that grow n this site are little bluestem, Indiangrass, sideoats grama and Texas intergrass. When these grasses decrease from overgrazing, curly mesquite, erennial threeawn, catclaw acacia and cedar increase.

. The Deep Upland site occurs in the valleys, usually along the drainageways. oils are deep, dark reddish-brown or grayish-brown clays or clay loams. lopes range from nearly level to five percent. Climax vegetation includes high percentage of little bluestem, Indiangrass and vine mesquite. When vergrazed such grasses as buffalograss, curly mesquite, silver bluestem, nnual grasses and weeds, and woody vegetation increase as the better rasses disappear.

. The Low Stony Hills site is characterized by very shallow, fine-textured, oderately permeable, stony soils. This soil occupies slopes from 0 to 40 ercent with the usual slopes ranging from 5 to 10 percent. Bounder-size rocks usually predominate on steep slopes and breaks. The better grasses found on this site are little bluestem, side-oats grama and Texas wintergrass. Grasses that increase with misuse of the rangeland are curly mesquite, perennial threeawn and hairy triden. Further degeneration brings about increases in the woody species such as scrubby mesquite and liveoak, cedar, and catclaw acacia.

4. The Bottom Land site has a soil that is deep, fine-textured, moderately permeable, and subject to occasional overflow. The slope usually range from 0 to 3 percent, with 5 percent slopes not uncommon. Good grasses to be found on this site are switchgrass, little bluestem and side-oats grama. Minor species present are bermudagrass, rescuegrass, and silver bluestem. Woody plants common to this site are pecan, elm, hackberry and mesquite.

In the Reddish Prairie Land Resource area in this watershed there are three range sites - Bottom Land, Deep Mixed Upland, and Shallow Upland. These are described as follows:

1. The Bottom Land site is located along streams and creeks which have a well-defined channel. Soils of this site are deep and are subject to overflow. Very little vegetation of excellent quality is found on this site. Plants which increase with heavy range use, such as Canada wildrye, Texas wintergrass, and bermudagrass comprise most of the forage-producing vegetation. The principal woody plants found are post oak, blackjack oak, elm, and pecan.

2. The Deep Mixed Upland site is located on old terrace benchland and in broad, gently sloping valleys which are drained by small draws. The slope usually ranges from 0 to 3 percent but may occasionally exceed 5 percent. This site is characterized by deep, medium-textured, slowly and moderately permeable soils. As a rule, this soil permits rapid water intake only when a good cover is present. The better grasses are mainly in protected areas and include buffalograss, curly mesquite, side-oats grama, and Texas wintergrass. Woody vegetation, annual grasses and weeds, and other plants which replace climax species with heavy use of range, provide a considerable amount of the cover but little forage for livestock.

3. The Shallow Upland site is located on shallow ridges and stony hills. The slope usually ranges about 2 to 8 percent with slopes occasionally up to 30 or 40 percent. Soils are shallow, light brown to light reddish-brown, sandy loams underlain at 10 to 20 inches by reddish clay or sandy clay. Soils of this site permit rapid water intake only when a good cover is present. A considerable portion of the site is barren of usable forage plants. Practically no little bluestem, Indiangrass, or side-oats grama are present. The better grasses present are those that increase under heavy range usage, such as buffalograss, curly mesquite, Texas wintergrass, and Halls panicum. Annual grasses and weeds make up a considerable part of the cover under poor range condition.

There are four range sites in the Granitic Land Resource area - Sandy Loam, Shallow Upland, Course Sand, and Rough Stony Hills. These are described as follows:

1. The Sandy Loam site is located in valleys, and on some low, rounded hills in the gently rolling country. The site is characterized by deep, medium-textured, moderately permeable soils. The surface is normally loose and friable and permits a rapid water intake, except under poor range conditions and where there is insufficient cover, making crusting and compaction a problem. The slope usually ranges from 0 to 3 percent, and occasionally up to 5 percent. The principal vegetation consists of species that increase with heavy range use, such as side-oats grama, buffalograss, hooded windmill-grass, and bristlegrass. Comparatively small amounts of little bluestem and Indiangrass which decrease with range use, may be found in the Sandy Loam site.

2. The Shallow Upland site occurs on low, rolling hills, below rough stony hills and above the deep, coarse, sandy soils. The soils are shallow, medium-textured and moderately permeable. The surface is ordinarily loose and friable and permits a rapid water intake even under poor range conditions and where there is insufficient cover. Slopes usually range from 2 to 5 percent, and occasionally up to 8 percent. The grasses are primarily those which increase with range use, such as side-oats grama, perennial threeawn, and mourning lovegrass. Little bluestem and Indiangrass, the better climax species which decrease with range use, are common to this site.

3. The Coarse Sand site is usually located on rather steep valley land. The site has deep, coarse-textured, freely permeable soils. This site was a post oak-blackjack savannah generally with liveoak on the south slopes. The original climax grasses were sand lovegrass, Indiangrass, and little bluestem. The site condition has deteriorated to such an extent that the vegetation consists mainly of hooded windmillgrass and threeawns. In places post oak has increased in density, greatly retarding grass growth, and in more open areas mesquite has invaded.

4. The Rough Stony Hills site is characterized by rough, broken, stony land, which makes up about 75 percent of the site, and is covered with rock ranging from boulders a few feet in diameter to rock formations covering several acres. Little bluestem, Indiangrass and side-oats grama are found in the crevices and on ledges. Mosses and hairy grama grow on the partially weathered granite areas. The woody vegetation consists of scattered scrub liveoak, postoak, blackjack oak, mescalbean, buckeye, and some Texas persimmon.

There are two range sites in the Cross Timbers Land Resource area - Bottom Land and Shallow Upland, described as follows:

1. The Bottom Land site is located along streams and creeks which have a well-defined channel. Soils of this site are deep and are subject to overflow. Originally this site was covered with little bluestem and Indiangrass. Currently the vegetation is composed of grasses which increase with range

use, such as Texas wintergrass, bermudagrass, Halls panicum and Canada wildrye. Woody vegetation consisting of elm, mesquite, hackberry, and chinaberry has invaded parts of this site.

2. The Shallow Upland site is located on shallow ridges and stony hills. Soils are shallow, light brown to light reddish-brown sandy loams. A considerable amount of the vegetation is woody and is composed of blackjack oak, elm, and mesquite. Better grasses found on this site are sand dropseed, Halls panicum, hooded windmillgrass, silver bluestem and side-oats grama. Red lovegrass, threeawn, sand dropseed, and annuals are found on the areas of poor range condition.

The condition classes of the rangeland of the watershed is shown in the following table:

RANGE SITES AND CONDITION CLASS

Condition Class	Acres	Percent for Site
	Shallow Upland Site - Edwards Plateau	
Fair	50,319	21.5
Poor	183,725	78.5
Total	234,044	100.0
	Deep Upland Site - Edwards Plateau	
Fair	11,708	30.6
Poor	26,555	69.4
Total	38,263	100.0
	Low Stony Hills Site - Edwards Plateau	
Fair	53,713	59.6
Poor	36,409	40.4
Total	90,122	100.0
	Bottom Land Site - Edwards Plateau	
Fair	348	20.0
Poor	1,392	80.0
Total	1,740	100.0

RANGE SITES AND CONDITION CLASS - Continued

Condition Class	Acres	Percent for Site
Bottom Land Site - Reddish Prairie		
Fair	1,090	7.2
Poor	14,055	92.8
Total	15,145	100.0
Deep Mixed Upland Site - Reddish Prairie		
Good	207	1.2
Fair	7,472	43.3
Poor	9,561	55.5
Total	17,240	100.0
Shallow Upland Site - Reddish Prairie		
Good	211	1.6
Fair	3,002	23.1
Poor	9,876	75.3
Total	12,999	100.0
Sandy Loam Site - Granitic		
Fair	5,472	14.2
Poor	33,064	85.8
Total	38,536	100.0
Shallow Upland Site - Granitic		
Fair	11,931	65.5
Poor	6,285	34.5
Total	18,216	100.0
Coarse Sand Site - Granitic		
Poor	9,997	100.0
Total	9,997	100.0
Rough Stony Hills Site - Granitic		
Poor	588	100.0
Total	588	100.0

RANGE SITES AND CONDITION CLASS - Continued

Condition Class	Acres	Percent for Site
Bottom Land Site - Cross Timbers		
Poor	756	100.0
Total	756	100.0
Shallow Upland Site - Cross Timbers		
Good	420	21.9
Fair	430	22.4
Poor	1,070	55.7
Total	1,920	100.0
All Sites		
Good	838	0.2
Fair	145,485	30.3
Poor	333,243	69.5
Total	479,566	100.0

Land Use and Treatment Needs

The land use on the upland was obtained by using a random sample composed of 5 percent of the Edwards Plateau and 15 percent each of the Reddish Prairie, Cross Timbers and Granitic Land Resource areas. These sample areas were expanded to the total upland acreage. The land use of the flood plain was planimetered from the flood plain strip map that was developed during the economic investigations.

The current conservation needs for the soil conservation districts involved were used as the basis for arriving at the land treatment needs for the watershed. Local personnel made adjustments as necessary to fit the land resource areas, the trends, and the project objectives as reflected in their respective areas. The land treatment needs for the watershed were obtained by combining these estimates.

Program Determination

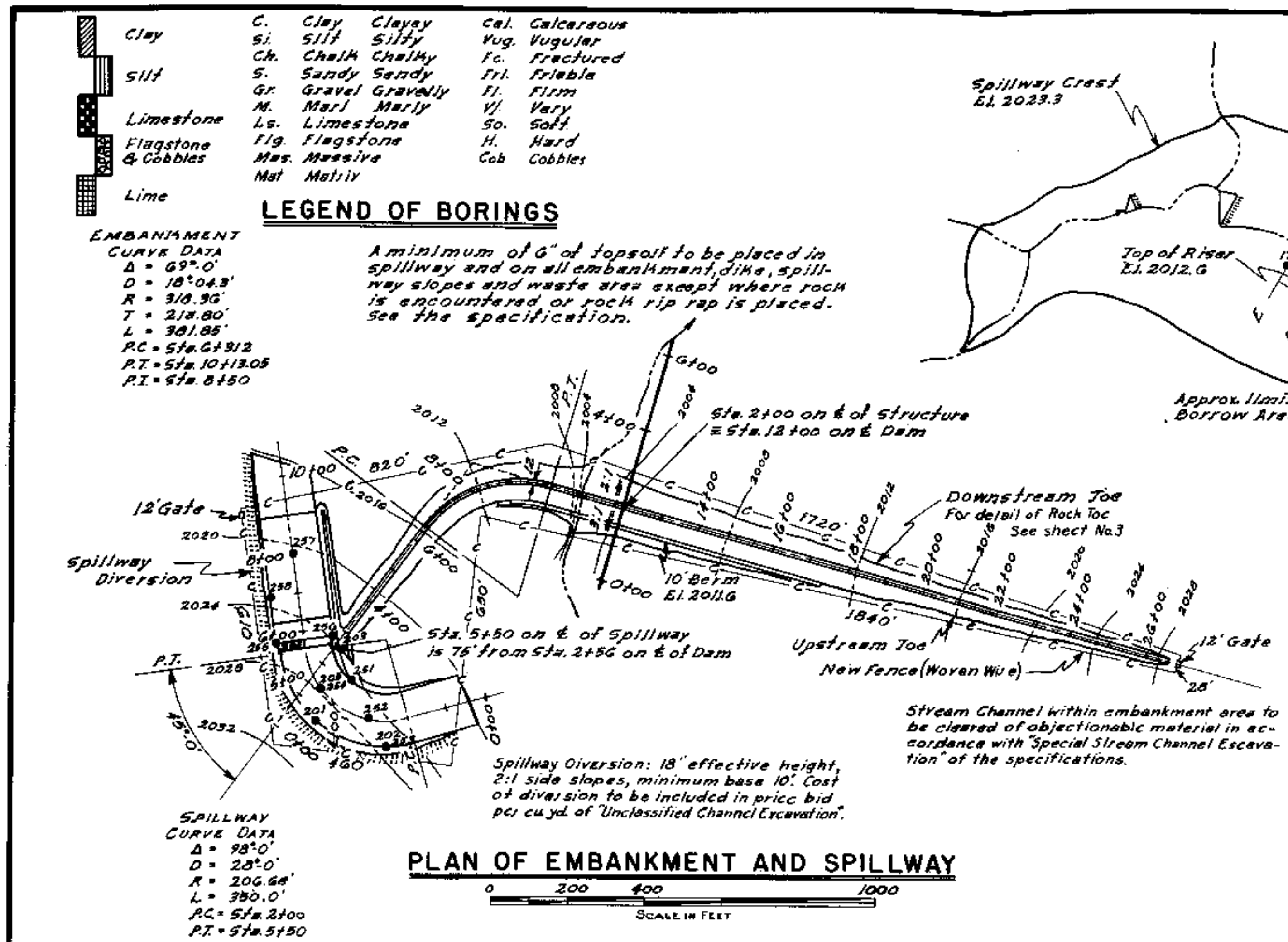
Determination was made, first, of the needed land treatment measures, which remain to be applied in the watershed and which contribute directly to flood prevention, based on current range condition classes and land capability classes developed from soil surveys. The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effects of these measures in terms of the reduction of flood damages resulting from such treatment. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required on the Richland Creek and Jerrys Branch tributaries to attain the desired degree of watershed protection and flood damage reduction.

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. Using consecutive 4-inch aerial photographs and a stereoscope, all probable floodwater retarding structure sites were located, the limits and the area of the flood plain delineated, and points marked where valley cross sections should be taken for the determination of hydraulic characteristics of the channel and valley and for flood routing purposes. 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. 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.

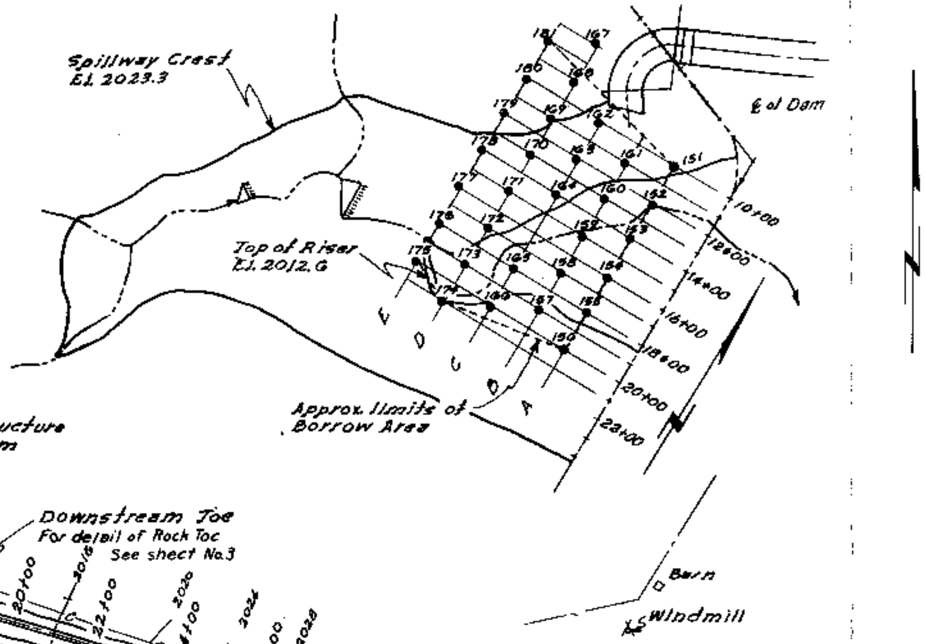
2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not show good storage possibilities or which would inundate highways or improvements were dropped from further consideration. From the remaining sites a system of 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 in order 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 flood pools. The height of the dams and the size 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. The limits of the flood 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



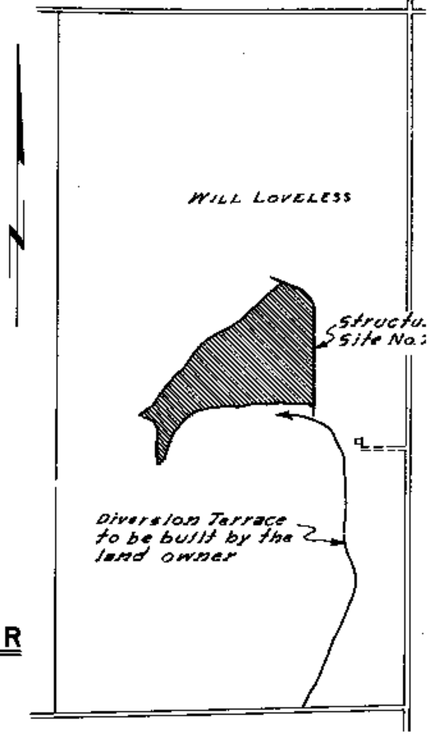
PLAN OF EMBANKMENT AND SPILLWAY

SCALE IN FEET: 0, 200, 400, 1000



GENERAL PLAN OF RESERVOIR

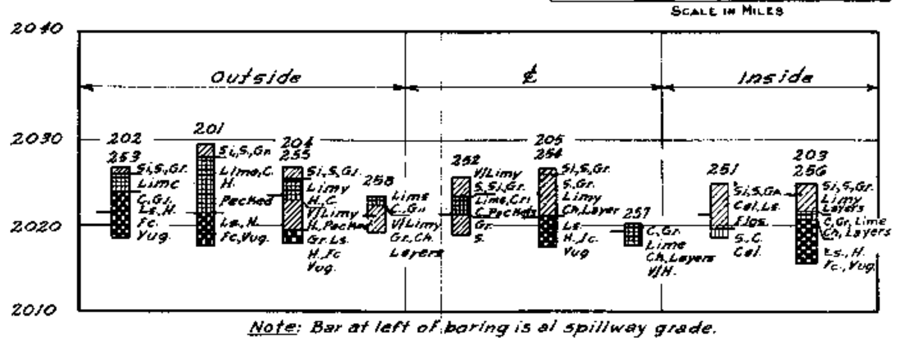
SCALE IN FEET: 0, 400, 800, 1600



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

VICINITY MAP

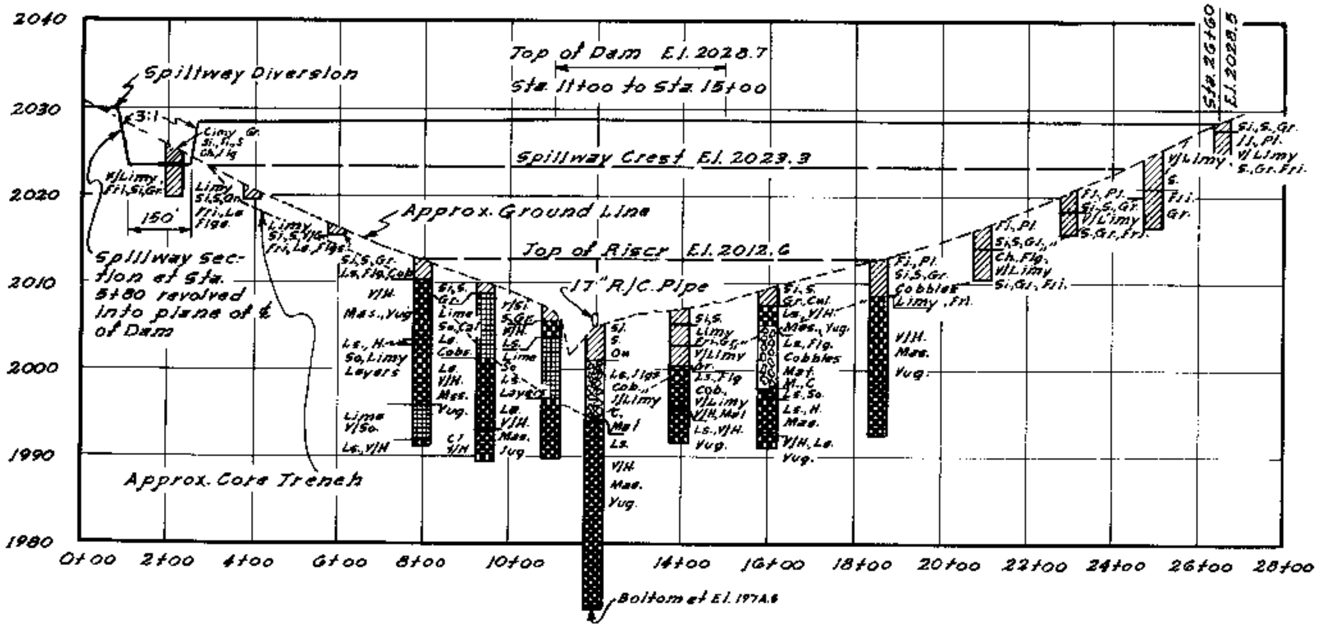
SCALE IN MILES: 0, ¼, ½, 1



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	1242.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	464.0

Figure 4

TYPICAL FLOODWATER RETARDING STRUCTUR

GENERAL PLAN AND PROFILE

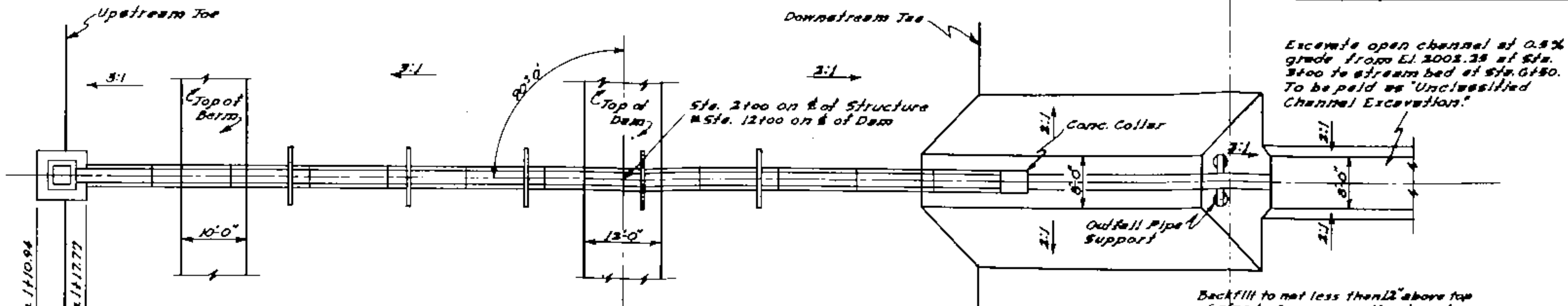
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	H.C.N.	8-56
Drawn	H.C.N. & G.R.	8-56
Traced	G.R.	8-56
Checked	H.C.N. & H.H.L.	9/56

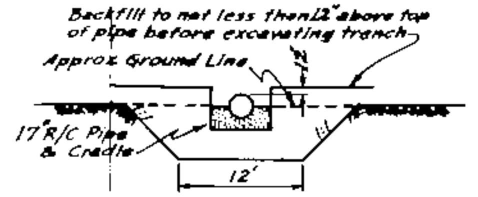
Approved by H.M. — Head, Engineering & Watershed Planning Unit, Fort Worth, Texas

State Conservation Engineer, S.C.S., Temple, Texas

Sheet No. 2 of 7 — Drawing No. 4-E-10,T60

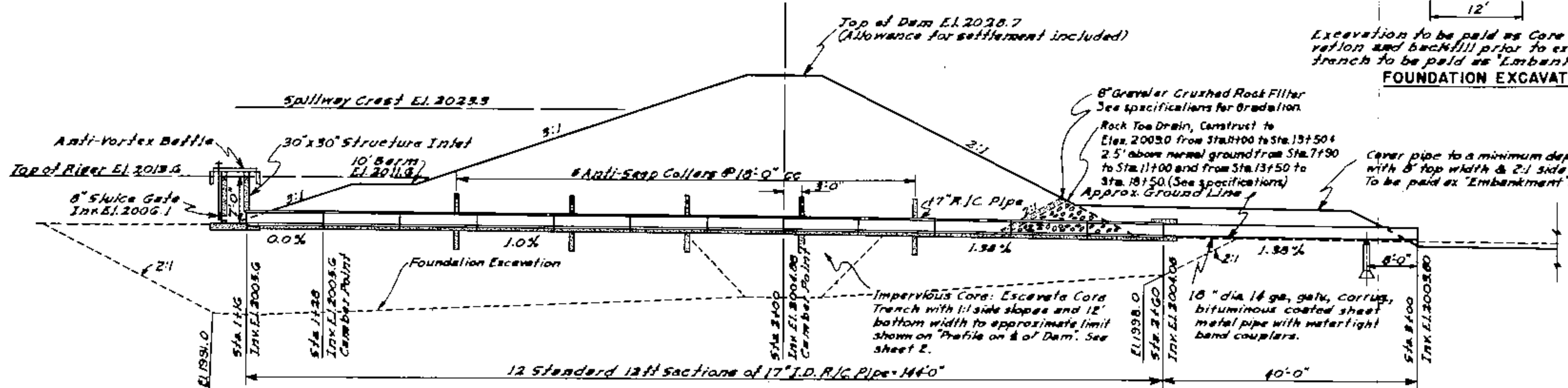


PLAN

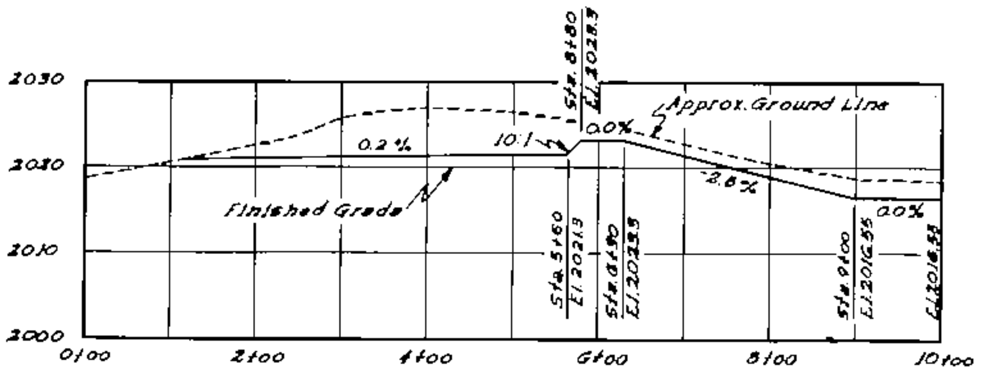


Excavation to be paid as Core Trench Excavation and backfill prior to excavating pipe trench to be paid as "Embankment".

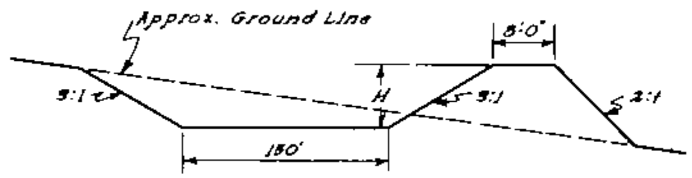
FOUNDATION EXCAVATION



SECTION
STRUCTURE



PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.56 from Sta. 8+00 to Sta. 6+90
12 ft. top width with 10:1 end slope.
Transition from El. 2028.55 at Sta. 6+90 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.	8-56	Approved by	
Drawn H.C.N. & G.R.	8-56		
Traced G.R.	8-56		
Checked H.C.N. & H.H.L.	8/56	Sheet 3 of 7	Drawing No. 4-E-10,760

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 material in the dams, the estimated cost of the structures, and the width and depth of flow of the emergency spillways (tables 2 and 3).

4. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and surveys of sample areas. 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. These flood routings were made using present conditions and future conditions, assuming that the proposed 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 on reduction of damages. In this manner it was determined that floodwater retarding structures on Richland Creek and Jerrys Branch could be economically justified. By further analysis those individual floodwater retarding structures and interrelated structures which had favorable benefit-cost ratios were determined. These were included in the plan. Those which were unfavorable were dropped from further consideration and, where replacements were found to be necessary to effect needed control, alternate sites were investigated until a system of floodwater retarding structures was developed which would give maximum net benefits.

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 (table 1). 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 6).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated and analyzed.

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 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 nearby actual gaged runoff. The frequency of meteorologic events was determined by computing the percent - chance of occurrence of annual events and plotting on Hazen probability paper. The relationship of precipitation to runoff, peak discharge, flood stage, and area inundated was 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. Effect of land treatment measures.

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

   c. Effect of land treatment measures, floodwater retarding structures and other associated works of improvement.

   d. Consideration of alternative programs and measures.

7. Development of inflow hydrographs for structure sites was made.

Rainfall records were available from rain gages in and near the watershed for the period 1915 to 1955, inclusive. The storms that occurred in this 40-year period were used to determine the effect of the program on average annual flooding. One rain of 21.44 inches, which fell in an eight-day period, was not considered since its expected frequency of occurrence was much less than once in 40 years. However, much of the historical information on flood damages, stages and distribution obtained from landowners was related to this storm.

After a thorough investigation and analysis of the meteorologic, hydraulic, hydrologic and economic characteristics of the watershed, it was determined that only two tributaries of the mainstem, Richland Creek and Jerrys Branch, could justify a structural program.

The largest rain which was considered during the 40-year period studied was a storm of 7.59 inches. An average rain of this magnitude would produce 4.99 inches of runoff on Richland Creek and 5.25 inches on Jerrys Branch. Under present conditions 4,495 acres of flood plain in Richland Creek and

1,850 acres of flood plain in Jerrys Branch would be flooded by runoff from this storm. 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 4,460 acres and 1,819 acres respectively. With land treatment measures applied and the structural measures for flood prevention in operation only 3,165 acres and 1,210 acres, respectively would be flooded.

The runoff from the 6-hour, 25-year frequency storm was used to establish the minimum detention storage requirements. The minimum detention storage requirement in the floodwater retarding structures from analysis of the conditions existing in the watershed was established as 3.4 inches. Inflow hydrographs for structure design were developed using the runoff that would be produced by a 14.5-inch rain in a period of 6 hours, assuming soil Moisture Condition II. The hydrograph of runoff was routed through each structure to determine the emergency spillway width and depth of flow.

It was found that a rain of 4.60 inches, Moisture Condition 0; 2.40 inches, Moisture Condition I; 1.05 inches, Moisture Condition II; and 0.58 inch Moisture Condition III, would produce an average of 0.15 inch of runoff on Richland Creek. It was also determined that a rain of 3.65 inches, Moisture Condition 0; 1.80 inches, Moisture Condition I; 1.00 inch, Moisture Condition II; and 0.35 inch, Moisture Condition III, would produce an average of 0.08 inch of runoff on Jerrys Branch. These are the minimum depth of runoff that would cause flooding to a depth of six inches at the smallest channel cross section in these respective tributaries of the watershed. Therefore, no rains producing less than this amount of runoff were considered for flood-routing purposes. A runoff of 0.15 inch on Richland Creek would produce a discharge of 1,370 cubic feet per second at the minimum cross section (No. R-4), which is also the reference cross section. This cross section is located about 2 miles west of the confluence of Richland Creek with the San Saba River. A runoff of 0.08 inch on Jerrys Branch would produce a discharge of 111 cubic feet per second at the minimum cross section (No. J-16). This same amount of runoff would produce 260 cubic feet per second at the reference section (No. J-1). The minimum cross section, No. J-16, is located about 0.2 mile northwest of the bridge on FM Road No. 500. The reference cross section on Jerrys Branch (No. J-1) is located about 0.1 mile south of the Bridge on FM Road No. 1480.

The channel capacity of the reference section on Richland Creek is 1,370 cubic feet per second and 1,120 cubic feet per second on Jerrys Branch. The peak discharge at these points for a 7.79-inch rain under present conditions is estimated to be 44,910 cubic feet per second on Richland Creek and 16,900 cubic feet per second on Jerrys Branch. After installation and full functioning of the planned measures, the discharge at the same points would be reduced to 25,470 and 8,560 cubic feet per second respectively.

Sedimentation Investigations

Detailed sediment-source investigations, in excess of the usual 25 percent coverage of the watershed, were made on the drainage areas above the proposed floodwater retarding structure sites. This was necessary because of several land resource areas which presented a variety of conditions that influence sediment production. The estimated sediment yields resulting from detailed investigations were derived by use of formulae and criteria set forth in the publication "Suggested Criteria for Establishing Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation", Soil Conservation Service, Region 4, February, 1953 and by data developed subsequent to this publication. Sediment yields, for sites that were not investigated in detail, were based on those sites studied in detail, with proper adjustments for such factors as watershed size, average land slopes, channel density and land use.

Study of aerial photographs, field studies, and obtaining historical data locally by interviews with landowners in the watershed were methods used in making estimates of rates of sediment production above sites where gully and streambank erosion were the primary sediment sources.

From these studies, present total annual sediment yields above the proposed floodwater retarding structure sites were estimated as follows: 33.01 acre-feet from sheet erosion, 0.01 from gully erosion, and 1.86 from streambank erosion. The estimated average annual yield of sediment above structures is 0.64 acre-foot per square mile at present. The principal source of sediment is cultivated land.

Effect of Watershed Treatment on Sediment Yields

Cultivated land produces most of the sediment in the watershed but poor range is an important contributor in some areas. The application of needed land treatment and range improvement measures will reduce the present low sediment yield by an estimated 58 percent. Areas damaged by flood plain scour will be rendered productive again after they have been protected from flooding and needed land treatment and range improvement measures have been put into effect. In addition, the future rates of damage caused by these erosion processes will be greatly reduced.

Geologic Investigations

A field survey was made using techniques related to the fields of stratigraphy, structural geology, geomorphology, and historical geology. Also used in the survey were aerial photographs, maps and publications pertaining to the area.

The watershed, because of its size and location, encompasses a very complex area, geologically. Many different geological systems are represented in the watershed. Four land resource areas, with a wide variety of soils, give testimony of the complexity of the geology that lies beneath the surface. This complexity is caused by the fact that the watershed lies on portions of the northern and northwestern flanks of an eroded dome called the Llano Uplift. Faulting associated with the uplift radiates outwardly from the geographic center of the dome.

Subsequent erosion of the dome, exposing alternating hard and soft formations, has influenced the shape of the stream pattern and the topography. In some cases the stream pattern has been altered further by faulting. For example, at the downstream end, Richland Creek flows through a bottleneck formed by faulting.

Geology by Land Resource Areas is as follows:

1. Granitic

This area is underlain by rocks of the pre-Cambrian and Cambrian ages. Also, a formation of granite wash and sand, called the Hickory sand, is present. This sand is important economically because it furnishes water for many West Texas towns and the Granitic Land Resource area is the only recharge area for it. Limestone and shale of the Cap Mountain and Wilberns formations border the Granitic area in many places.

2. Edwards Plateau

This area, in the western part of the watershed, is underlain by the Edwards limestone formation of Cretaceous age. It is an important aquifer, especially when the rangeland is in good condition. Another portion of this area is underlain by the Marble Falls limestone of Early Pennsylvanian age (late Mississippian, according to some authorities). This is a cherty, hard limestone. Soils produced from it vary slightly from the usual Edwards Plateau soils. The Marble Falls limestone is not considered a good aquifer. Also underlying this area is the Ellenburger limestone of Cambro-Ordovician age. This formation is very important economically because of its oil production. The Edwards Plateau is the only water recharge area for this formation south of Oklahoma. A good range improvement program would help surface water penetration into this aquifer. Many of the large springs in the area emit water from the Ellenburger formation directly or indirectly into the San Saba River.

3. Reddish Prairie

This area is underlain by the Smithwick shale of Lower Pennsylvanian age and by alternating thin beds of sandstone and shale of the Strawn group of Lower Pennsylvanian age. The presence of these shales precludes ground water except at great depths. The soils in this area change rapidly with surface elevation, generally in north-south strips over the Richland Creek and Jerrys Branch watershed.

4. Cross Timbers

This area is underlain by small outliers of Trinity sand of Lower Cretaceous age and some of the more sandy segments of the Strawn group of Lower Pennsylvanian age. The Trinity sand is generally regarded as a good aquifer but in this watershed it is disconnected from the bulk of the formation and water cannot flow through the sand to the subsurface below other areas.

Foundation and Borrow Investigations

Some adjustments in site locations were made during planning to compensate for faulting and to obtain better spillway locations. Investigations revealed that in all land resources areas spillway construction may entail excessive and difficult rock excavation. These factors required careful consideration of structure location, design and costs to minimize overall installation costs.

One site (No. 9) is located in a fault area. Its alignment was adjusted to parallel an echelon of faults in the area. The final position with respect to upstream and downstream location must be located exactly by core drill investigation. Foundations at sites other than No. 9 are believed to be adequate, with cutoff achieved in shale. Here relief wells or foundation drains may be an optional choice to deep coring. The soils in the borrow areas are expected to be adequate for construction from the standpoint of quality and quantity. Some leakage through cavernous limestones may occur, but this should not endanger the structures.

Economic Investigations

Determination of Annual Benefit from Reduction in Damage

Damage schedules covering 60 percent of the flood plain area of Richland Creek and Jerrys Branch and 50 percent of the flood plain of the Lower San Saba River were obtained from landowners or operators. These schedules covered land use and crop distribution, yields and historical data on flooding and flood damages. Analysis of the information contained therein formed the basis for determining damage rates for various depths and seasons of flooding. In the calculation of crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of the damage. The proper rates of damage were applied, flood-by-flood, to the floods occurring in the historical series and an adjustment was made to take into account the effect of recurrent flooding where several floods occurred within the same crop year.

The flood plain land use was mapped in the field. Normal yields were based on data obtained from the schedules, supplemented by information obtained from soils technicians and other agricultural workers in the area. It was found that differences in land use, yields and flood frequencies were significant. Therefore, to facilitate accurate appraisal, the flood plain was divided into three evaluation reaches, each with its own damageable value and flood history. These were Lower Richland Creek (Cross Section 19 to mouth of Richland), Upper Richland Creek (Cross Section 19 to top of Richland), and Jerrys Branch. The monetary value of the physical damage from flood plain scour was based on the value of production lost, taking into account both the lag for recovery of productivity and the costs of farm operations to speed recovery.

Damage to other agricultural property such as fences, livestock and farm equipment was estimated from analysis of schedules correlated with sizes of floods. The major items of nonagricultural damage were those sustained by roads, bridges and railroads. Estimates of these damages were based on information supplied by county commissioners and highway and railroad officials, with supplementary data from local farmers.

As the Lower San Saba River watershed is almost entirely an agricultural area, indirect damages primarily involve extra farming expense, additional travel time to market, extra cost of purchasing additional feed for livestock and the like. Information regarding damages of this type was obtained from local residents. Upon analysis it appeared that indirect damages were rather small, amounting to only about 10 percent of the direct damage.

Floodwater and scour damages were calculated under present conditions and those which will prevail after the installation of each class of measures included in the 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.

Flood damage schedules and data from the Middle Colorado River Watershed Survey Report were analyzed and benefits accruing to Jerrys Branch and Richland Creek below their confluence with the San Saba River were determined on the basis of the reduction in flooding due to structural measures in these two tributaries. No evaluation was made of benefits accruing on the mainstem of the Colorado River.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. However, an estimate was made of the value of production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pool. The land covered by the detention pools was assumed to be converted to grassland under project conditions.

Determination of Annual Benefit from Changed Land Use in the Flood Plain

During the course of the field investigation, farmers were asked to state the changes made in the use of their flood plain lands as a result of past flooding. Operators of flood plain lands were also asked what changes they would make in their use of the flood plain if flooding were reduced 50 percent. Analysis of these responses provided the basis for estimating both the benefits from restoration of lands to their former use, and from the utilization of lands to a greater degree than had been formerly possible. Additional factors considered in this analysis were the size and location of the areas affected, land capability, existence of available markets, management skills of the operators, reduction in frequency of flooding, and similar factors. All benefits from change in flood plain land use were discounted over a 10-year buildup period to allow for a lag in installation. Associated restoration and development expenses were deducted as associated costs to obtain the net benefit.

Details of Methodology

Details of the procedures used in the investigations are described in the Interim Economics Guide for Watershed Protection and Flood Prevention, Revised April 1, 1956. Methods described therein for use with the historical series were applied to the economics analyses for this work plan.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)
Price Base: 1955

Structure Site No.	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST		Estimated Total Cost
	Contract	Contin-gencies	Installa-tion Services	Adm. and Misc.	Total Federal	Easement and R/W	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	61,935	6,193	12,387	8,051	88,566	4,750	4,750	93,316
2	125,792	12,579	25,158	16,353	179,882	20,450	20,450	200,332
3	62,870	6,287	12,574	8,173	89,904	9,200	9,200	99,104
4	45,500	4,550	9,100	5,915	65,065	10,300	10,300	75,365
5	30,841	3,084	6,168	4,009	44,102	6,050	6,050	50,152
6	24,563	2,456	4,913	3,193	35,125	5,800	5,800	40,925
7	106,312	10,631	21,262	13,819	152,024	8,600	8,600	160,624
8	33,803	3,380	6,760	4,394	48,337	2,600	2,600	50,937
9	27,815	2,781	5,563	3,616	39,775	6,250	6,250	46,025
10	17,524	1,752	3,505	2,278	25,059	8,250	8,250	33,309
11	37,360	3,736	7,472	4,857	53,425	8,225	8,225	61,650
12	32,454	3,245	6,491	4,219	46,409	6,462	6,462	52,871
GRAND TOTAL	606,769	60,674	121,353	78,877	867,673	96,937	96,937	964,610

Date: December, 1956

TABLE 3 - STRUCTURE DATA

Floodwater Retarding Structures

Lower San Saba River Waterahed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	Total
Drsinage Area 1/	sq.mi.	2.75	10.89	5.44	5.83	2.91	2.90	8.19	2.07	3.03	2.94	4.18	2.45	53.58
Storage Capacity														
Sediment Pool	ac.ft.	44	134	119	143	65	68	149	33	81	110	200	144	1,290
Sediment Reserve Above Riser	ac.ft.	-	-	-	-	-	-	-	-	26	31	52	37	146
Floodwater Detention	ac.ft.	499	2,713	886	1,070	528	526	1,485	375	549	533	757	449	10,370
Total	ac.ft.	543	2,847	1,005	1,213	593	594	1,634	408	656	674	1,009	630	11,806
Surface Area														
Sediment Pool	acre	24.	46	36	42	23	25	29	9	19	32	58	37	380
Floodwater Detention Pool	acre	71	335	151	164	92	85	121	43	97	110	132	100	1,501
Maximum Height of Dam	feet	24.0	25.9	26.2	26.0	25.8	24.2	41.5	34.1	25.6	23.7	29.4	25.3	-
Volume of Fill	cu.yds.	138,171	279,072	139,487	100,000	67,503	53,200	236,606	75,820	55,320	37,100	81,500	70,350	1,334,129
Emergency Spillway														
Type		veg.	veg.	veg.	veg.	veg.	veg.	veg.	veg.	veg.	veg.	veg.	veg.	xxx
Frequency of Use	years	25	55	25	25	25	25	25	25	25	25	25	25	xxx
Design Storm Rainfall														
Duration	hours	6	6	6	6	6	6	6	6	6	6	6	6	xxx
Total	inches	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	xxx
Bottom Width	feet	300	400	200	250	150	150	400	100	150	100	200	100	xxx
Design Depth	feet	3.2	4.0	3.9	3.9	3.7	3.7	4.2	4.0	3.2	4.4	3.8	3.4	xxx
Design Capacity	c.f.s.	4,600	8,880	4,050	5,275	2,840	3,000	9,700	2,200	2,350	2,575	4,020	1,660	xxx
Total Freeboard 2/	feet	4.2	5.0	4.9	4.9	4.7	4.7	5.2	5.0	4.2	5.4	4.8	4.4	xxx
Total Capacity	c.f.s	7,100	12,936	6,425	7,700	4,250	4,430	13,700	3,200	3,650	3,625	6,425	2,570	xxx
Principal Spillway														
Capacity	c.f.s.	27	136	54	58	29	29	82	20	30	15	21	12	xxx
Capacity Equivalents														
Sediment Volume	inches	.3	.23	.41	.46	.42	.44	.34	.30	.66	.9	1.13	1.38	xxx
Detention Volume	inches	3.40	4.67	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	3.40	xxx
Spillway Storage	inches	2.28	3.35	3.24	3.47	3.55	3.16	1.68	2.43	3.16	4.60	3.47	4.09	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	A	A	A	xxx

1/ Excluding the area from which runoff is controlled hy other structures.
2/ Difference between spillway crest elevation and elevation of the top of the dam.

Date: December, 1956

TABLE 4 - SUMMARY OF PHYSICAL DATA

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	Quantity Without Program	Quantity With Program
Watershed Area	Sq.Mi.	878	xxxx
Watershed Area	Acres	561,920	xxxx
Area of Cropland	Acres	71,126	71,126
Area of Grassland	Acres	479,566	479,566
Overflow Area Subject to Damage by Design Storm	Acres	5,611 1/	3,583 1/
Area Damaged Annually by:			
Sediment	Acres	Nil	Nil
Flood Plain Scour	Acres	1,969	408
Sheet Erosion	Acres	261,322	81,819
Average Annual Rainfall	Inches	27	xxx

1/ Applicable only to Jerrys Branch and Richland Creek.

Date: December, 1956

TABLE 5 - SUMMARY OF PLAN DATA

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	Quantity
Years to Complete Program	Year	10
Total Installation Cost		
Federal	Dollar	894,637
Non-Federal	Dollar	1,199,516
Annual O & M Cost		
Federal	Dollar	-
Non-Federal	Dollar	1,471
Average Annual Monetary Benefits	Dollar	49,799
Agricultural	Percent	92
Nonagricultural	Percent	8
Structural Measures		
Floodwater Retarding Structures	Each	12
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acre	28
Sediment Pool	Acre	19
Upland		
Detention Pool	Acre	1,093
Sediment Pool	Acre	361
Watershed Area Above Structures	Acre	34,291
Reduction of Floodwater Damage	Dollar	32,276
By Land Treatment Measures For Watershed Protection	Percent	10
By Structural Measures	Percent	58
Reduction of Erosion Damage	Dollar	7,011
By Land Treatment Measures For Watershed Protection	Percent	9
By Structural Measures	Percent	70
Flood Prevention Benefit from Changed Land Use	Dollar	9,512

Date: December, 1956

TABLE 6 - ANNUAL COSTS

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Structure Site Number	AMORTIZATION OF INSTALLATION COSTS 1/			OPERATION AND MAINTENANCE COSTS 2/		Total
	Federal	Non-Federal	Total	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
loodwater Retarding Structures						
1 and 2	9,465	1,173	10,638	332	332	10,970
3	3,170	428	3,598	142	142	3,740
4	2,294	479	2,773	142	142	2,915
5	1,555	282	1,837	95	95	1,932
6	1,238	270	1,508	95	95	1,603
7	5,360	400	5,760	190	190	5,950
8	1,704	121	1,825	95	95	1,920
9	1,402	291	1,693	95	95	1,788
10	884	384	1,268	95	95	1,363
11	1,884	383	2,267	95	95	2,362
12	1,636	301	1,937	95	95	2,032
[AL	30,592	4,512	35,104	1,471	1,471	36,575

Amortization period, 50 years; Federal interest rate, 2½ percent; non-Federal interest rate, 4 percent; based on 1955 prices.
Based on long-term price levels as projected by ARS, June 1956.

Date: December, 1956

TABLE 7 - SUMMARY OF MONETARY BENEFITS 1/

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Price Base: Long-Term 2/

Item	ESTIMATED AVERAGE ANNUAL DAMAGES: Without Project	After Land: Treatment For W/S Protection	With Project	Average Annual Monetary Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
'loodwater Damage				
Crop and Pasture	29,567	26,726	11,109	15,617
Other Agricultural	12,211	10,990	2,950	8,040
Nonagricultural				
Roads and Bridges	6,262	5,760	1,705	4,055
Subtotal	48,040	43,476	15,764	27,712
rosion Damage				
Flood Plain Scour	8,845	8,046	1,834	6,212
Subtotal	8,845	8,046	1,834	6,212
ndirect Damage	5,688	5,153	1,760	3,393
otal, All Damage	62,573	56,675	19,358	37,317
enefit from Changed Land Use				
Intensification	xxx	xxx	xxx	9,291
Restoration of Production	xxx	xxx	xxx	221
enefit Outside Project Area	xxx	xxx	xxx	2,970
OTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	49,799
OTAL MONETARY BENEFITS	xxx	xxx	xxx	49,799

/ In consideration of area affected by programs for the Richland Creek and Jerrys Branch tributaries only

/ As projected by ARS, June, 1956.

Date: December, 1956

TABLE 8 - BENEFIT-COST ANALYSIS

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Structure Site Number	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit-Cost Ratio
	Flood Prevention						
	Floodwater	Erosion	Indirect	Other	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures							
1 and 2	7,115	1,776	888	3,430	13,209	10,970	1.20:1
3	2,837	708	355	1,268	5,168	3,740	1.38:1
4	3,040	759	380	1,354	5,533	2,915	1.90:1
5	1,518	380	190	676	2,764	1,932	1.43:1
6	1,512	378	190	673	2,753	1,603	1.72:1
7	4,274	1,067	534	2,007	7,882	5,950	1.32:1
8	1,080	270	135	480	1,965	1,920	1.02:1
9	958	163	112	573	1,806	1,788	1.01:1
10	1,652	218	187	621	2,678	1,363	1.96:1
11	2,349	311	266	883	3,809	2,362	1.61:1
12	1,377	182	156	517	2,232	2,032	1.10:1
GRAND TOTAL	27,712	6,212	3,393	12,482	49,799	36,575	1.36:1

1/ Long-term price levels, as projected by ARS, June, 1956.
2/ Derived from installation costs based on 1955 price level and operation and maintenance costs based on long-term price level, as projected by ARS, June, 1956.

Date: December, 1956

TABLE 8A - BENEFITS AND COSTS BY CONSTRUCTION UNITS

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Construction Unit and Structures	Annual Benefits 1/	Annual Costs 2/
	(dollars)	(dollars)
Construction Unit No. 1 (Richland Creek)		
Structure Nos. 1 to 9	38,639	30,818
Construction Unit No. 2 (Jerrys Branch)		
Structure Nos. 10 to 12	8,190	5,757

1/ Long-term price level, as projected by ARS, June, 1956.

2/ Derived from installation costs based on 1955 prices and operation and maintenance costs, based on long-term price level, as projected by ARS, June, 1956.

Date: December, 1956

TABLE 9 - COST-SHARING SUMMARY

Lower San Saba River Watershed, Texas
(Middle Colorado River Watershed)

Price Base - 1955 1/

Type of Cost	Federal Cost		Non-Federal Cost		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment						
Non-Federal Land 2/ For Watershed Protection	-	-	1,102,579	100	1,102,579	52
Total Land Treatment Cost	-	-	1,102,579	100	1,102,579	52
Structural Measures						
Installation Flood Prevention	867,673	90	96,937	10	964,610	46
Operation & Maintenance 3/	-	-	31,600	100	31,600	2
Total Structural Cost	867,673	87	128,537	13	996,210	48
TOTAL PROJECT COST	867,673	41	1,231,116	59	2,098,789	100

1/ Except operation and maintenance, which is based on long-term prices as projected by ARS, June, 1956.

2/ This cost is exclusive of reimbursement from ACP or other Federal funds.

3/ Capitalized at estimated borrowing rate of organizations guaranteeing operation and maintenance.

Date: December, 1956