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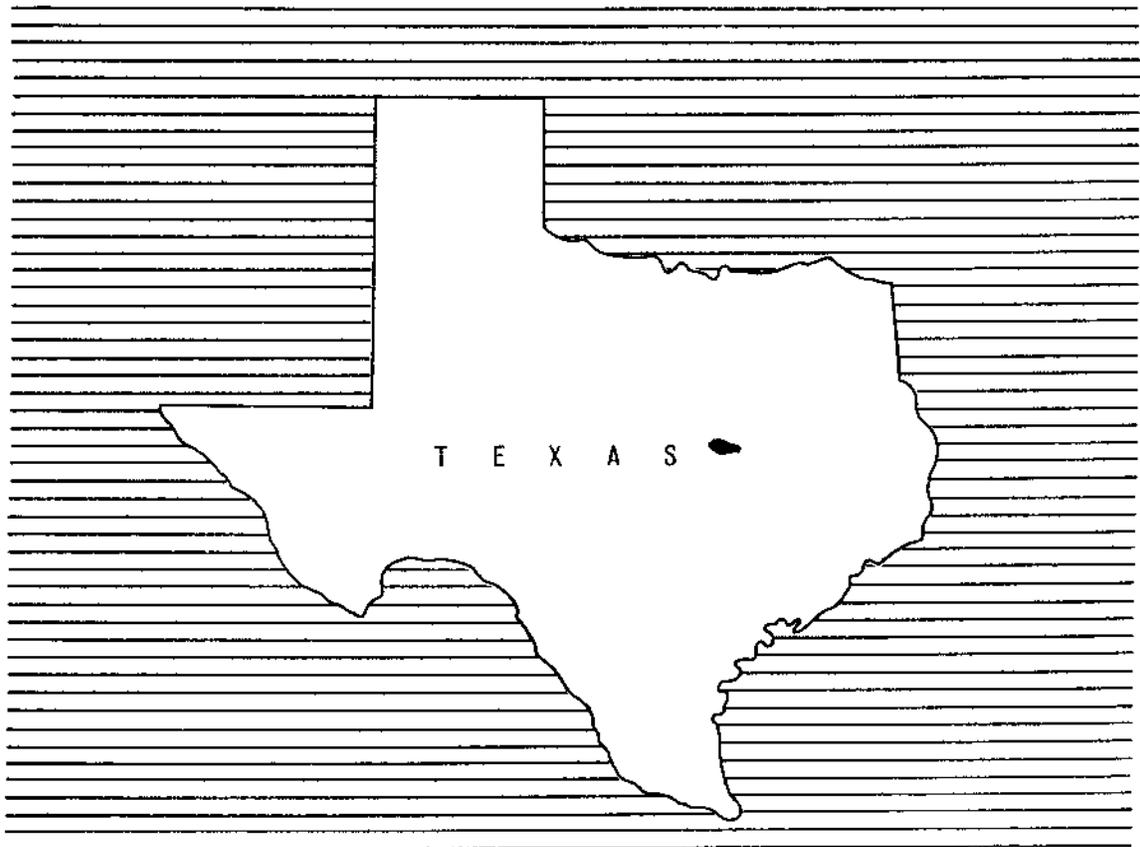
WORK PLAN

- For Watershed Protection and Flood Prevention

COW BAYOU WATERSHED

McLENNAN AND FALLS COUNTIES, TEXAS

OFFICIAL FILE COPY



April 1963

SUPPLEMENTAL WATERSHED WORK PLAN AGREEMENT

between the

McLennan County Soil Conservation District
Local Organization

Central Texas Soil Conservation District
Local Organization

(Hereinafter referred to as the Districts)

McLennan County Commissioners Court
Local Organization

Falls County Commissioners Court
Local Organization

(Hereinafter referred to as the Counties)

In the State of Texas

and the

United States Department of Agriculture
Soil Conservation Service

(Hereinafter referred to as the Service)

Whereas, the Districts, the Counties and the Service have heretofore entered into Watershed Work Plan Agreements for the carrying out of a satisfactory plan for Works of Improvement for the Cow Bayou Watershed, State of Texas; and

Whereas, a Revised Watershed Work Plan has been developed through the cooperative efforts of the Districts, the Counties and the Service to provide additional flood protection; and

Whereas, it has been found necessary to modify by mutual consent the original Watershed Work Plan to provide the additional flood protection desired by the Districts and the Counties, and

Now, therefore, in view of the foregoing considerations, the Districts, the Counties and the Service hereby agree to the Revised Watershed Work Plan annexed hereto and further agree that the works of improvement and land treatment measures as set forth in the Revised Plan can be installed in about three years.

It is mutually agreed that in installing, operating and maintaining the added works of improvement substantially in accordance with the terms, conditions and stipulations provided for in the Revised Watershed Work Plan:

1. The Districts will acquire without cost to the Federal Government such land, essements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost \$137,782).
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 added works of improvement.
3. The percentages of construction costs of the added structural measures to be paid by the Districts and by the Service are as follows:

<u>Added Works of Improvement</u>	<u>Districts (percent)</u>	<u>Service (percent)</u>	<u>Estimated Construction Cost (dollars)</u>
20 Floodwater Retarding Structures	0	100	859,009

The Districts will pay all of the costs allocated to purposes other than flood prevention and irrigation, drainage and other agricultural water management (none anticipated).

4. The Service will bear the costs of administering the contracts.
5. The Districts and the Counties will be responsible for the operation and maintenance of the added structural works of improvement in the same manner as provided in the Operations and Maintenance Agreements entered into between the Districts, the Counties and the Service on May 11, 1962, and April 15, 1963.
6. The Watershed Work Plan and the revision annexed hereto may be amended or revised and this agreement may be modified or terminated only by mutual agreement of the parties hereto.
7. All terms, conditions and stipulations of the original work plan agreements and the original work plan remain unchanged except as modified herein or in the annexed Revised Watershed Work Plan, including Tables 1, 1a, 1b, 2, 3, 4, 5, and 6.

McLennan County Soil Conservation District
Local Organization

By *Dave Simons*
Dave Simons

Title *Chairman Board*

Date *Nov 4, 1963*

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

adopted at a meeting held on *Nov 4, 1963*

Leon Thompson, Dist Secy.
(Secretary, Local Organization)
Leon Thompson

Date *Nov 4, 1963*

Central Texas Soil Conservation District
Local Organization

By *J. E. Goad*
J. E. Goad

Title Chairman

Date *Nov. 1, 1963*

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

adopted at a meeting held on *Nov. 1, 1963*

Jerry Bedrich
(Secretary, Local Organization)
Jerry Bedrich

Date *Nov. 1, 1963*

McLennan County Commissioners Court

Local Organization

By

Raymond R. Mormino
Raymond R. Mormino

Title

County Judge

Date

11-4-63

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

Local Organization

adopted at a meeting held on

November 4, 1963

FLOYD MITCHELL County Clerk

By Marianne J. Berkeley

(Secretary, Local Organization)

Floyd Mitchell

Date

November 6, 1963

Falls County Commissioners Court

Local Organization

By

R. W. Halley Sr.
R. W. Halley, Sr.

Title

County Judge

Date

11/26/63

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

Local Organization

adopted at a meeting held on

11/26/63

Margaret W. Denard
(Secretary, Local Organization)

Date

11/26/63

Soil Conservation Service
United States Department of Agriculture

By

State Conservationist

Date

REVISED WORK PLAN
FOR
WATERSHED PROTECTION AND FLOOD PREVENTION
Cow Bayou Watershed
McLennan and Falls Counties, Texas

Prepared Under the Authority of the Soil Conservation Act of 1935 (Public Law 46 and 74th Congress) as Implemented by the Watershed Protection Item in the Department of Agriculture Appropriation Act, 1954.

Prepared By:

McLennan County Soil Conservation District
(Sponsor)

Central Texas Soil Conservation District
(Sponsor)

McLennan County Commissioners Court
(Sponsor)

Falls County Commissioners Court
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

April 1963

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PREFACE

The Cow Bayou watershed work plan was developed in 1954. During the intervening years considerable change has occurred in land use and other physical characteristics within the watershed. The criteria used for evaluation of watershed projects has been refined and improved greatly in recent years. Flood events experienced and resulting damages, since the original plan was prepared, have pointed up deficiencies in the criteria used during planning. The inability of the sponsors to install all of the planned structural measures also contributed to the inadequacy of the protection afforded. These conditions prompted the sponsors to request a revision of the work plan to incorporate additional control which would reduce flood damages to an acceptable level. It was felt that this action was warranted.

The evaluation procedures used in this revised work plan are based on the following factors:

1. Current hydrologic conditions were considered and current criteria were used.
2. Current land use and crop distribution in the flood plain were used.
3. Without project conditions assume no floodwater retarding structures installed.
4. Actual costs of construction and installation services were used for the 9 floodwater retarding structures included in the original plan. The non-Federal installation costs shown for these 9 structures are the same as those shown in the original plan. Total installation costs for the 20 additional floodwater retarding structures are based on 1962 prices.
5. The total installation costs for the 9 existing and 20 planned floodwater retarding structures were amortized at 3 percent interest for 50 years.
6. Long-term prices as projected by ARS, September 1957, were used to determine annual benefits and operation and maintenance costs.

The changes in the physical characteristics in the watershed, use of current criteria for evaluating the project, and the use of more liberal price projections has resulted in greatly increased damage and benefit values.

REVISED WORK PLAN
COW BAYOU WATERSHED
McLennan and Falls Counties, Texas
April 1963

SUMMARY OF PLAN

General Summary

The work plan, as revised, proposes installing in a 3-year period additional measures for the protection and development of the watershed at an estimated installation cost of \$2,334,411 exclusive of work plan preparation cost. Of this amount, \$1,141,329 will be paid from special Federal funds. The remaining cost will be borne by Public Law 46 funds, Agricultural Conservation Program Service funds, and by local interests.

The Cow Bayou watershed, a tributary of the Brazos River, is located in McLennan and Falls Counties, Texas. The total area comprises 111.3 square miles or 71,250 acres. About 53 percent is cropland, 39 percent is pasture, 3 percent is rangeland, and 5 percent is in miscellaneous uses such as roads, railroads, farmsteads, and villages.

The principal problem in the watershed is one of frequent and extensive flooding on portions of 6,200 acres of flood plain along the main stem and tributaries of the Cow Bayou. In addition, approximately 800 acres in the Brazos River Bottom outside the watershed are inundated by larger floods which originate in the Cow Bayou watershed.

The watershed is one of the pilot watersheds for which plans were developed and partially carried out under the authority of the Soil Conservation Act of 1935 (Public Law 46) as implemented by the Watershed Protection item in the Department of Agriculture Appropriation Act for 1954. Under this authority, land treatment measures and 9 of the 11 planned floodwater retarding structures were installed. Table 1 shows the amount and the cost of measures to be installed during the 3-year installation period. Table 1A shows the status of measures installed prior to April 1963. Table 1B is a summary total of data presented in tables 1 and 1A.

The sponsors of the project are the McLennan County Soil Conservation District, the Central Texas Soil Conservation District, and the McLennan County and Falls County Commissioners Courts.

Land Treatment Measures

The cost of land treatment measures included in this plan is estimated to be \$1,055,300 which includes ACP payments and \$29,400 to be spent by the Soil Conservation Service for technical assistance under the going district program. Special Federal funds will provide \$24,800 for accelerated technical assistance. Land treatment measures included in the work plan will be installed during the 3-year installation period (table 1).

Structural Measures

The 20 floodwater retarding structures included in this plan and the 9 existing floodwater retarding structures will have a total of 5,101 acre-feet of sediment storage and 15,212 acre-feet of floodwater detention capacity. The 20 planned structures will have 2,562 acre-feet of sediment storage and 7,087 acre-feet of floodwater detention capacity. The total cost of structural measures is \$2,023,117 of which \$1,254,311 represents the cost of structural measures remaining to be installed. The local share of this remaining cost is \$137,782 which includes the value of land, easements, and rights-of-way. The structures will be installed during a 2-year period.

Damages and Benefits

The reduction in floodwater, sediment, erosion, and indirect damage, will benefit directly 58 landowners of the 7,000 acres of frequently flooded bottom land. The estimated average annual damage without the project totals \$166,984 at long term price levels. The estimated average annual damage will be reduced to \$46,724 with the project installed. Average annual damage reduction benefits accruing to the project will be \$120,260 and are distributed as follows:

Floodwater damage reduction	\$80,511
Sediment damage reduction	7,602
Erosion damage reduction	21,214
Indirect damage reduction	10,933

Secondary benefits will average \$10,840 annually.

Recreation benefits that are incidental to the project amount to \$3,800 annually. Redevelopment benefits from project employment of presently underemployed local labor are expected to total \$920. The ratio of the average annual benefits accruing to structural measures (\$130,620) to the average annual cost of these measures (\$83,745) is 1.6 to 1.0.

Provisions for Financing Local Share of Installation Costs

All land, easements, and rights-of-way required for installation of the structural measures will be donated to the McLennan County Soil Conservation District or the Central Texas Soil Conservation District by the grantors. Landowners and operators will install the land treatment measures with financial assistance furnished from Agricultural Conservation Program Funds.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by landowners and operators of the land on which these measures will be installed under agreements with the Central Texas and McLennan County

Soil Conservation Districts. Each district will be responsible for the operation of all floodwater retarding structures which have been or will be constructed within their district area of the watershed. The McLennan County and Falls County Commissioners Courts will maintain all structures located in their respective portions of the watershed. The average annual cost of operating and maintaining the structural measures is estimated to be \$5,106 at long-term price levels.

DESCRIPTION OF THE WATERSHED

Physical Data

Cow Bayou Watershed is located in the southwestern part of McLennan County and in the northwestern part of Falls County, Texas. It lies approximately 12 miles south of the city of Waco. Cow Bayou heads near the town of Moody and flows southeasterly for approximately 27 miles into the Brazos River near the town of Satin. Two major streams, North Cow Bayou and South Cow Bayou, make up the drainage in McLennan County. These streams join in Falls County to form the mainstem of Cow Bayou. The total watershed drainage area is 111.3 square miles (71,250 acres).

The topography of the watershed ranges from gently to steeply rolling. The upper one-third of the watershed is underlain by shale and thin bedded limestone of the Lake Waco and South Bosque formations of the Eagle Ford group (Upper Cretaceous age). This area is characterized by steep slopes and relatively steep stream gradients. The Austin chalk formation is found in the moderately rolling central portion. The Taylor marl formation in the lower portion of the watershed is gently rolling, except for a narrow area south of the mainstem of Cow Bayou which is characterized by short, moderately steep slopes. Elevations range from 850 feet above sea level in the head waters to 350 feet at the confluence with the Brazos River.

The watershed lies entirely within the Blackland Prairies land resource area. The soils are dark colored clays which have developed from shales, limestones, marls, and chalks under a tall grass prairie vegetation. The predominating soil series include the Houston Black, Houston, Austin, and Eddy. Small areas of the Lewisville series have developed on terrace deposits along the stream. The highly productive alluvial soils in the flood plain are of the Catalpa series.

The total land use in the watershed is estimated to be as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cropland	37,871	53
Pasture	28,151	39
Rangeland	1,990	3
Miscellaneous <u>1/</u>	<u>3,238</u>	<u>5</u>
Totals	71,250	100

1/ Includes roads, highways, farmsteads, railroad rights-of-way, and villages.

The flood plain is utilized more intensively than the uplands with 65 percent in cultivation, 30 percent in pasture, and 5 percent in miscellaneous uses.

The mean annual precipitation of 34.29 inches is well distributed, with larger average monthly rainfalls occurring in April, May, and June. The minimum and maximum recorded annual rainfall was 13.39 inches and 60.20 inches respectively.

Mean temperatures range from 86 degrees Fahrenheit in the summer to 48 degrees in winter. The extreme recorded temperatures are 5 degrees below zero and 111 degrees above zero. The average date of the last killing frost is March 10 and that of the first killing frost is November 15, providing a normal frost free period of 249 days.

Water for domestic and livestock purposes in rural areas is obtained from cisterns, farm ponds, and wells. Some for household use is hauled from nearby communities. During extended drouth periods nearly all water for on-farm use must be imported. Deep wells supply water for the residents of Moody, Bruceville, Lorena, Mooreville, Golinda, and Satin from sands of the Trinity Group.

Economic Data

The economy of this watershed is derived basically from agriculture. The principal crops on flood plain lands are cotton, oats, alfalfa, maize, corn, and Johnsongrass. Oats usually are grazed and then harvested for feed. During the past decade there has been a significant conversion from cropland to pasture. This shift represents a general trend throughout the surrounding area. Several factors have contributed to this land use change. Some of the most significant are increased job opportunities in nearby cities and military installations, unfavorable cost-price relationship for agricultural commodities, and shortage of farm labor. In McLennan County, the average farm unit increased in size from 170 acres in 1954 to 230 acres in 1959. The estimated value of land and buildings per farm has increased from \$19,908 to \$33,384. The size and value of farm units located in Falls County increased from 162 acres to 230 acres and from \$13,247 to \$26,189 during the same period.

The towns of Lorena, with a population of 242, and Bruceville, with a population of 250, are in the central part of the watershed. Mooreville and Satin, with populations of 150 and 125, respectively, are in Falls County at the lower end of the watershed. Falls County has been designated as an area of underemployment under the Area Redevelopment Act. Waco, with a population estimated at 100,000 in 1960, is located within 12 miles of the watershed. This city is the county seat of McLennan County. It is the banking, educational, commercial, and industrial center for a number of east central Texas counties.

The watershed has approximately 144 miles of roads, of which 34 miles are paved. Interstate Highway 35 and U. S. Highway 77 traverse the watershed. Adequate rail facilities are available through the Atchison, Topeka, and Santa Fe; the Missouri, Kansas and Texas; and the Texas and New Orleans Railroads.

Land Treatment Data

The watershed is located within the McLennan County and Central Texas Soil Conservation Districts. Technical assistance is furnished by Soil Conservation Service work units at Waco and Rosebud. Basic soil and water conservation plans have been prepared for 352 of the 398 farms and ranches located in the watershed. Of these, 225 plans need to be revised. A total of 45 percent of the needed vegetative treatment and slightly over 70 percent of the needed mechanical treatment has been applied to date. Land treatment measures which were installed prior to the development of this revised work plan are shown in table 1A.

WATERSHED PROBLEMS

Floodwater Damage

Frequent flooding on Cow Bayou has caused high annual damages. Devastating floods occurred April 21, 1945 and May 11, 1957. The flood of May 11, 1957, with an estimated recurrence interval of 65 years, resulted in complete crop loss and major fence damage. Roads and bridges which cross Cow Bayou were heavily damaged. An 80-foot section of the U. S. Highway 77 bridge was washed out causing the highway to be closed for many weeks. One life was lost by drowning. The highway has since been raised to eliminate the hazard. Although 6 floodwater retarding structures had been constructed in the watershed prior to the storm, approximately 4,700 acres were flooded. If the structures had not been installed, an estimated 5,100 acres would have been inundated. The flood plain area expected to be flooded on an average of once in 100 years without structural control is 6,200 acres. A flood of this magnitude would overflow an additional 800 acres outside the watershed in the Brazos River bottom.

An average of four floods occur annually on Cow Bayou and cause severe damage. Of the 75 floods studied during the 20-year evaluation period, 1923 through 1942, 9 were major floods which inundated more than one-half of the flood plain and 66 were minor floods which inundated less than half of the flood plain. Many of the floods occurred during the growing season and caused extensive crop damage. Often, planting operations are delayed until after the optimum planting dates. The largest storm in the 20-year period occurred on November 23-24, 1940, and flooded approximately 5,900 acres.

The average value of flood plain land is \$200 per acre. The value is maintained at this level because of the highly productive nature of the



Torrential rains on April 19, 1957, caused severe flood damage below Site 10 prior to its construction.



Inundated farmland in flood plain following 10 to 14 inches of rainfall in watershed April 19, 1957. Such flooding is not only disastrous to crops but take a heavy toll of topsoil and leaves sediment deposits that take several years to condition for cropping.

soil. Owners and operators continue to cultivate these areas although damage is probable. As the bottom land is much more productive than the upland, farmers utilize the flood plain as much as possible despite heavy losses.

Under non-project conditions the average annual direct monetary floodwater damage is \$113,324 of which \$81,846 is crop and pasture, \$13,429 is other agricultural, and \$18,049 is nonagricultural such as damage to roads and bridges. Indirect damage such as interruption of travel, rerouting of school buses and mail routes, losses sustained by business men in the area and similar losses is estimated to average \$15,181 annually.

Sediment Damage

Sediment damage is moderately high in the watershed. Silts and clays, which are derived from sheet erosion, older gullies, and streambank erosion have damaged 1,346 acres of flood plain lands from 10 to 25 percent and have added to the sediment load of the Brazos River. Changed land use and land treatment applied since the original plan has reduced sediment damage by about 20 percent. The largest volume of sediment is being produced by sheet erosion from unprotected steeply rolling cropland. Smaller volumes of highly damaging sediment of partially weathered bedrock are being produced from old gullies which originate in overgrazed steeply sloping pastures.

Numerous small alluvial fans are found along the outer edge of the flood plain in the lower reaches of Cow Bayou. Short tributaries with steep stream gradients carry large loads of highly damaging sediment which is derived mostly from gullies. Much of this sediment is dropped where the streams emerge onto the level flood plain. Approximately 164 acres of the affected area have been damaged by deposits ranging from 0.5 to 1.0 foot in depth.

The average annual monetary value of sediment damage to flood plain lands without project is \$12,211.

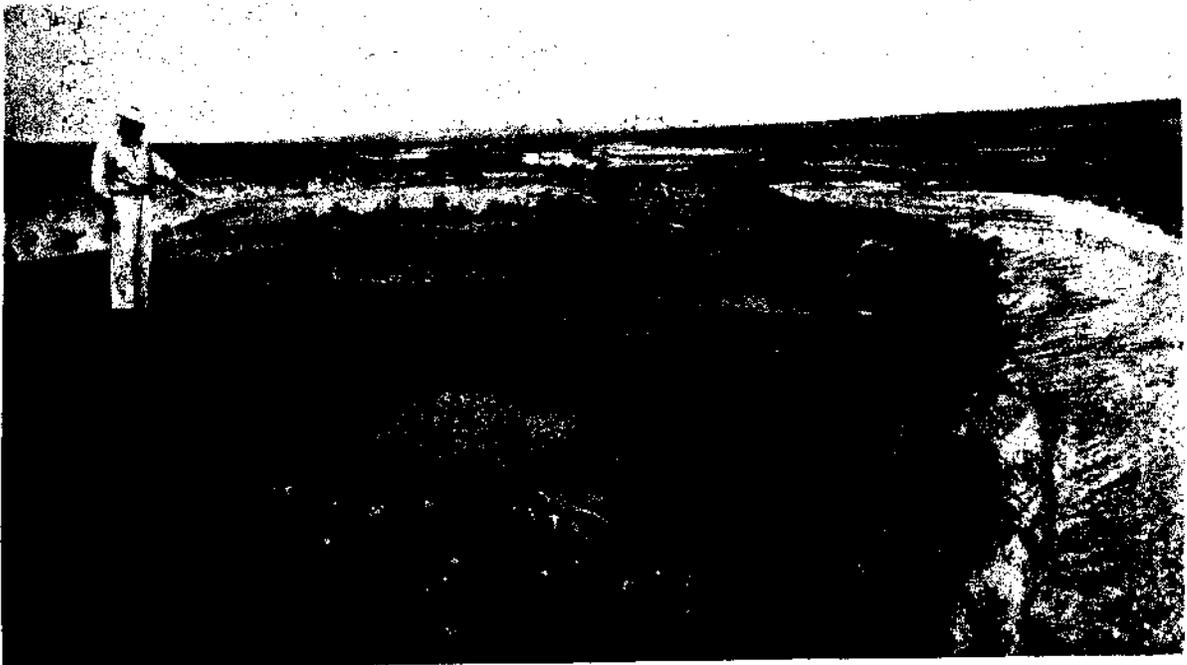
Erosion Damage

Erosion rates in the uplands are moderately high. The accelerated application of needed land treatment measures and changes in land use, provided for in the original work plan, have reduced upland erosion considerably. Approximately 21 percent of the watershed area has been taken out of cultivation and converted to pasture since 1954. Most of this change occurred on the severely eroded lands in Capability Class IV, VI, and VII. This has resulted in a reduction of 40 percent in sheet erosion and 19 percent in gully erosion. Of the total upland erosion, 92 percent occurs as sheet erosion and 4 percent each as gully and streambank erosion.

Flood plain erosion is causing production losses on approximately 2205 acres. The estimated annual damage in terms of reduced productivity is



Receding floodwater just below confluence of north and south branches of Cow Bayou. Damage is to the Mooreville-Cottonwood road.



Scene typical of hundreds in Cow Bayou watershed after April and May rains of 1957. Many tons of fertile topsoil were removed, causing clogged drains, and reservoirs filled with sediment.

as follows: 475 acres damaged 10 percent, 1,711 acres damaged 20 percent, and 19 acres damaged 50 percent. The estimated average annual monetary damage of flood plain scour without the project is \$26,268. The major tributaries appear to be entrenching slightly throughout most of their lengths. Although bank erosion occurs throughout the flood plain area, it is not serious. Channel degradation is occurring at several locations below the confluence of North and South Cow Bayous.

Problems Relating to Water Management

The shortage of agricultural and nonagricultural water in the Cow Bayou watershed is a problem. Most of the water for domestic and livestock use is supplied by cisterns or farm ponds. During drought years water is hauled in. Some of the larger communities have drilled deep wells. The sediment pools of the nine existing floodwater retarding structures are providing water for both agricultural and nonagricultural use. The landowners and operators were not interested in developing additional conservation storage for rural community use except that which will be provided in the sediment pools of the planned structures.

There is no land in the watershed which requires surface or subsurface drainage. Supplemental irrigation is used on one or two farms.

The nine existing structures are being used for various types of water sport recreation. There is no interest in developing additional storage for recreational use in any of the floodwater retarding structures. Stream pollution is not a problem.

PROJECTS OF OTHER AGENCIES

The Corps of Engineers has built the Whitney Reservoir and has the Waco Reservoir under construction. Both of these are multiple-purpose flood control and conservation storage reservoirs. They are located on the Brazos and Bosque Rivers upstream from the Cow Bayou watershed. These reservoirs will reduce the frequency of floods from the Brazos in the lower reaches of the Cow Bayou flood plain. In this respect the major reservoirs will complement the project by making it possible to provide a higher level of protection for the agricultural land near the mouth of Cow Bayou.

BASIS FOR PROJECT FORMULATION

All of the planned structural measures included in the 1954 work plan have been installed except floodwater retarding structures 9 and 11 and 2.56 miles of stream channel improvement. The original sponsoring organizations were unable to secure the needed easements and rights-of-way for sites 9 and 11. The channel could not be installed without sites 9 and 11.

This watershed depends almost entirely on agricultural enterprises for its source of income. The uncontrolled flooding causes loss of livestock and severe damage to flood plain lands, crops, pastures, and other agricultural properties. Flood damages experienced since the installation of the originally planned works of improvement, and experience gained in evaluating projects of this type led to the conclusion that a greater degree of protection was needed. This prompted the sponsors to request reconsideration of the plan with the objective of reducing flood damages to an acceptable level.

A meeting was held with the local sponsoring organizations to discuss existing problems and to formulate the objectives for revision of the 1954 Cow Bayou watershed work plan. Local responsibilities in connection with completing the project were discussed. The following specific objectives were named by local interests:

1. Establish land treatment measures which contribute directly to watershed protection and flood prevention, based on current needs, and which can be installed in a 3-year period.
2. Install a system of floodwater retarding structures which will reduce average annual flood damages on agricultural land sufficiently to insure sustained agricultural production on the flood plain and to maintain the economy of the watershed.

It was agreed that the revised plan would provide for flood damage reduction of at least 65 percent.

In selecting the sites for the additional floodwater retarding structures, consideration was given to locations which would provide the desired level of protection for areas subject to flood damage. Easement requirements for each structural measure were determined and discussed with the local people. The size, number, design, and cost of the structures were influenced by the location of the damaged areas, the complex topography, the geologic conditions of the watershed, and the availability of embankment fill material. The recommended system of 20 floodwater retarding structures, with the existing structures, meets the project objectives by providing the desired level of protection for the watershed.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Farmers and ranchers cooperating with the McLennan County and Central Texas Soil Conservation Districts are applying needed conservation practices on 352 of the 398 farms and ranches in the watershed. The use of each acre of

agricultural land within its capabilities and its treatment in accordance with its needs is necessary for a sound watershed protection and flood prevention project on the watershed.

Grassland practices consisting of pasture and range proper use, pasture renovation, and brush control are needed to maintain and improve vegetative cover for better hydrologic conditions. Pasture planting and range seeding are needed to improve areas with poor cover. Construction of needed farm ponds will help distribute watering places and prevent cover destroping concentrations of livestock. Treatment of cropland through the use of cover crops, conservation cropping systems, and crop residue will help improve the physical conditions of these soils. Mechanical practices, including contour farming, diversions, terracing, and grassed waterways are needed on cropland to facilitate the safe removal of runoff and to reduce soil loss. A number of steeply rolling areas where erosion is severe will be stabilized by vegetative plantings and minor structural measures.

Structural Measures

Twenty floodwater retarding structures will be built to supplement the 9 floodwater retarding structures already constructed to provide flood protection to 6,200 acres of flood plain land in the Cow Bayou watershed and approximately 800 acres outside the watershed in the Brazos River bottom. The estimated total installation cost of these additional measures is \$1,254,311. The total installation cost of the 9 existing structures was \$768,806.

The locations of the planned structural measures are shown on the project map (figure 4).

The system of 29 floodwater retarding structures will detain runoff from 48 percent of the entire watershed. The total capacity of the 29 structures is 20,313 acre-feet, of which 5,101 acre-feet is provided for sediment accumulation over a 50-year period. The floodwater retarding structures will detain an average of 5.4 inches of runoff from the watershed above them. This is equivalent to 2.6 inches of runoff from the entire 71,250 acre watershed. The amount of runoff controlled by each structure is shown in table 3. Figures 1, 2, and 2A illustrate pertinent features of a floodwater retarding structure typical of those planned.

Details on quantities, costs, and design features of structural measures are shown in tables 1, 2, and 3.

EXPLANATION OF INSTALLATION COSTS

Local interests will install the land treatment measures listed in table 1 at an estimated cost of \$1,055,300 at present prices in the area. This includes \$29,400 for technical assistance to be provided under Public Law 46 and ACP payments. It was determined that \$24,800 of additional Federal

funds will be needed to furnish technical assistance to accomplish the accelerated program. The land treatment measures to be applied and the unit cost of each measure were estimated by the Central Texas and the McLennan County Soil Conservation Districts and the Soil Conservation Service work units at Rosebud and Waco.

The required local costs for the 20 additional floodwater retarding structures are estimated at \$137,782. These consist of land easements (\$125,982); changes in utilities (\$2,100); road and bridge changes (\$6,900) and legal fees (\$2,800). In addition, local funds have been expended for the nine existing floodwater retarding structures in the amount of \$104,105.

The estimated value of land for rights-of-way is based on appraisals made by the sponsors and concurred in by the Service. The County Commissioners Courts and utility companies furnished cost estimates for modification of their facilities.

The cost of the 20 additional structures to be borne by Federal funds is \$859,009 for construction and \$257,520 for installation services. In addition Federal funds have been spent in the amount of \$664,701 for installation of the nine existing structures.

The engineer's estimates of construction costs for the 20 proposed floodwater retarding structures are based on unit costs of structural measures constructed in Cow Bayou and similar areas. More foundation and borrow area investigations will be made before construction begins on the 20 proposed structures. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs.

Installation services include engineering and administrative costs based on Service experience for similar works. The engineering portion of this cost consist of, but is not limited to, detail surveys, geological investigations, laboratory reports, designs, cartographic services and inspection services. All of the cost for the structural measures were allocated to flood prevention. Federal funds will bear the entire construction and installation services cost of these structural measures. Local interests will bear all of the cost of land, easements, rights-of-way, and relocations.

Table 2 shows an itemized breakdown of costs for each planned structure. Lump sum costs are shown for the nine floodwater retarding structures which have been built. The Federal costs shown for the existing structures are the actual costs. Non-Federal costs are those shown in the original work plan.

The estimated schedule of obligations for the 3-year installation period is as follows:

Schedule of Obligation

Fiscal Year :	Measures	Federal Funds :	Other Funds :	Total :
		(dollars)	(dollars)	(dollars)
1st	Sites 11B, 11C, 11E, 12, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, and Land Treatment	613,172	409,986	1,023,158
2nd	Sites 15, 16, 27, 28, 29, 30, and Land Treatment	519,891	431,330	951,221
3rd	Land Treatment	8,266	351,766	360,032
Total		1,141,329	1,193,082	2,334,411

EFFECTS OF WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures would eliminate damage from a recurrence of 10 of the 66 minor floods used in the 20-year evaluation period. Eight of the 9 remaining major floods would be reduced to minor floods.

With 6 structures in place, the storm of May 11, 1957 produced a flood which inundated about 4,700 acres and caused floodwater damage in excess of \$266,000. Had the 29 floodwater retarding structures been in place, this storm would have flooded less than 3,200 acres and produced damages less than \$138,000. This is a reduction of 32 percent in the area flooded and 52 percent in the amount of damages incurred. A storm of this magnitude has an average recurrence interval of once every 65 years.

The following tabulation shows by evaluation reaches (figure 3) the expected reduction in flooding from the 2-year, 5-year, and 25-year frequency floods.

Evaluation :	Area Inundated - Average Recurrence Interval -Acres					
	2-Year		5-Year		25-Year	
Reach :	Without :	With :	Without :	With :	Without :	With :
:	Project :	Project :	Project :	Project :	Project :	Project :
1 & 5	762	94	1,986	407	2,811	1,287
2	530	425	588	492	620	550
3	630	197	980	345	1,210	515
4	600	280	715	525	885	642
6	63	24	86	34	125	44
Total	2,585	1,020	4,355	1,803	5,651	3,038

Reaches 1 and 5 have been combined because 108 acres in Reach 1 is common flood plain with Reach 5.

Evaluation Reach	Flood Plain Land Use by Reaches		
	Pasture (percent)	Wooded Pasture (percent)	Cultivated (percent)
1 & 5	8	5	87
2	41	6	53
3	25	18	57
4	61	15	24
6	30	9	61

This project will benefit directly about 58 owners of agricultural land in the flood plain. It is estimated that the value of land will increase by \$50 per acre for cultivated land and \$25 per acre for pasture with the project installed.

After installation of the combined project of land treatment and structural measures, the area on which damaging overbank deposition of sediment occurs will be reduced from 1,346 acres to 483 acres while scour damage will be reduced from 2,205 acres to 419 acres.

Land treatment measures will reduce the upland erosion rates by 18 percent after they are installed.

Interruption, delays, and additional travel caused by flooded roads and washed out bridges will be eliminated largely by the project. This is especially important for school busses, mail carriers, and the marketing of agricultural products. Road and bridge damage from a 5-year frequency storm will be reduced by 79 percent. The average annual reduction in all damages will be 72 percent.

The sediment pools of the floodwater retarding structures will provide year around recreational facilities for fishing, picnicking, boating, and seasonal facilities for other means of recreation associated with water, such as swimming, and water skiing. Pools of structures already installed are being used heavily by residents of Waco, a city of over 100,000 people, as well as by local residents. Based on the use of existing structures, it is expected that the project will have an average use of approximately 15,200 visitor days annually for the first 30 years after installation. Its use for recreation probably will cease after about 40 years. Peak use can be expected to occur from use of the pools by Sunday School classes, Boy Scouts, and similar groups from Waco.

The facilities of these pools will not be competitive with larger nearby reservoirs. Many people prefer the quiet uncrowded facilities provided by the smaller structures. These benefits will be incidental to the flood

prevention purpose because additional project features will not be needed for their realization.

In addition these pools will provide a valuable source of water supply for livestock and domestic use.

Installation and operation and maintenance of the structural measures will provide opportunities for the use of presently underemployed local labor. Although contractors have their own machine operators, they usually hire local unskilled labor for construction. The use of this labor will be especially helpful to the economy of Falls County since the county has been designated as an area of underemployment under the Area Redevelopment Act.

Secondary benefits stemming from the project will accrue to the trade area through increased income from sales and services resulting from the increased production as a result of project installation.

It is not expected that changes in more intensive land use or restoration of former productivity will take place after installation of the project.

PROJECT BENEFITS

The average annual monetary floodwater, sediment, erosion, and indirect damages (table 5) within the watershed will be reduced from \$166,984 to \$46,724, a reduction of 72 percent.

The average annual damage reduction by evaluation reach is presented as follows:

Average Annual Damages						
Evaluation Reach	:	Without Project (dollars)	:	With ^{1/} Project (dollars)	:	Reduction (percent)
1		65,944		11,509		83
2		37,882		20,731		45
3		39,842		7,503		81
4		14,806		5,393		64
5		4,651		1,201		74
6		3,859		387		90
Total		166,984		46,724		72

^{1/} Includes land treatment measures.

It is estimated that the project will produce secondary benefits averaging \$10,840 annually in the local area. Secondary benefits of national significance are not expected. Therefore, only those benefits of a local or area nature were considered important in the economic evaluation.

Redevelopment benefits stemming from employment of local labor during the project installation will amount to an amortized value of \$920 annually.

The sediment pools of the floodwater retarding structures will provide facilities for recreational pursuits such as fishing, picnicking, boating and swimming to organized groups and the general public. Based on the use made of the sediment pools of the nine structures existing in the watershed, it is felt that the facilities provided by the additional structures will be complementary rather than competitive with the existing structures and larger nearby reservoirs.

It is estimated that about 15,200 visitor days of use will be made annually during the first 30 years after installation. A gross value of 50 cents per visitor day with associated costs of 20 cents was used for evaluation. After discounting for decreased use after 30 years, the annual value of incidental recreation benefits is estimated at \$3,800.

The total benefits from structural measures are estimated to be \$130,620 annually. In addition to the monetary benefits, there are other substantial benefits which will accrue to the project such as an increased sense of security, better living conditions, and improved wildlife habitat. None of these additional benefits were evaluated in monetary terms; nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures (amortized total installation cost, plus operation and maintenance) is \$83,745. The installation of the structural measures is expected to produce average annual primary benefits of \$119,780. The ratio of primary benefits to cost will be 1.43 to 1.

Total benefits, including secondary benefits, from the structural measures will provide a benefit cost ratio of 1.56 to 1 (table 6).

PROJECT INSTALLATION

Farmers and ranchers will establish the land treatment measures, itemized in table 1, during the 3-year installation period.

The Central Texas and McLennan County Soil Conservation Districts will cooperate and will give assistance in the planning and application of the conservation measures in the watershed. The districts' governing bodies will assume aggressive leadership in accelerating land treatment. The landowners within the watershed will be encouraged to adopt and carry out more of the soil and water conservation measures planned on their farms and ranches. The owners of the 46 farms who are not district cooperators will be encouraged to become cooperators and to plan and carry out proper farm plans.

The soil and water conservation loan program of the Farmers Home Administration is available to all eligible farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies to outline the services available. Present FHA clients will be encouraged to cooperate in the program.

The Agricultural Stabilization and Conservation County committees will cooperate with the governing bodies of the soil conservation districts in selecting and providing financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

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

The Soil Conservation Service will contract for the construction of the 20 additional floodwater retarding structures to be built. It also will provide technical specialists to prepare plans and specifications, supervise construction, prepare contract payment estimates, make contract payments, make final inspections, certify completion, and perform related duties for the installation of the structural measures.

The Central Texas and McLennan County Soil Conservation Districts will obtain the land, easements, and rights-of-way and arrange for road, utility, and improvement changes for all structural measures. Since all structures are needed to obtain the desired reduction in damages, no attempt was made to separate the watershed into construction units. All necessary land, easements, and rights-of-way will be obtained prior to the expenditure of Federal funds for construction in the watershed.

The 20 floodwater retarding structures will be constructed during a 2-year period. The general sequence for installation is:

First year, sites 11B, 11C, 11E, 12, 17, 18, 19, 20, 21,
22, 23, 24, 25, and 26;

Second year, Sites 15, 16, 27, 28, 29, and 30.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement as described in the revised work plan will be provided under the authority of the Soil Conservation Act of 1935 (Public Law No. 46, 74th Congress) as implemented by the Watershed Protection item in the Department of Agriculture Appropriation Act, 1954.

Initiation of construction is contingent upon the sponsors furnishing assurance that all necessary land, easements and rights-of-way have been secured.

The Central Texas and McLennan County Soil Conservation Districts have obtained guarantees from all grantors that easements and rights-of-way for all proposed structural measures will be provided.

The cost of the land treatment measures will be borne by the individual farmers and ranchers upon whose lands they will be installed. Federal cost sharing will be available for those measures which are eligible for ACPS payments, based on present program criteria. Financing for the farmers and ranchers share of the cost can be arranged through local lending institutions and the Farmers Home Administration. The cost of technical assistance to plan and apply the land treatment measures will be borne by special Federal funds (\$24,800) and Public Law 46 funds (\$29,400).

The structural measures will be constructed during a 2-year installation period pursuant to the following conditions:

1. The requirements for land treatment in the drainage area above structures have been satisfied.
2. All land, easements, and rights-of-way have been obtained for all structural measures.
3. Court orders have been obtained from the McLennan County or Falls County Commissioners Courts showing that the county roads affected by floodwater retarding structures will be relocated, raised two feet above emergency spillway crest elevation at no cost to the Federal government, closed, or permission granted to temporarily inundate the road, provided equal alternate routes can be provided.
4. Project and operation and maintenance agreements have been executed.
5. Federal funds are available.

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 will be maintained by the landowners and operators of farms and ranches on which the measures are applied. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs. Landowners and operators will be encouraged to perform the management practices and needed maintenance.

The estimated annual operation and maintenance cost is \$5,106 for the 9 existing and the 20 proposed floodwater retarding structures based on long term prices. The Central Texas and McLennan County Soil Conservation Districts are responsible for operation of the structural measures in their respective districts. The McLennan County and the Falls County Commissioners Courts will be responsible for maintenance of the structures in their respective counties. Funds for maintenance will come from existing county tax revenue which is available and adequate.

The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods.

The floodwater retarding structures will be inspected by representatives of the Central Texas and McLennan County Soil Conservation Districts, and the McLennan County and Falls County Commissioners Courts after each heavy streamflow or at least annually. Soil Conservation Service representatives will participate in these inspections at least annually. Inspection items, covering features which may require attention, will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the earth fill, the emergency spillway, and the fences and gates installed as a part of the structure.

The Soil Conservation Service, through the Central Texas and McLennan County Soil Conservation Districts, will participate in operation and maintenance by furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the Central Texas and McLennan County Soil Conservation Districts, commissioners courts, and Federal agencies to inspect and provide maintenance for all structural measures and their appurtenances at any time.

The Central Texas and McLennan County Soil Conservation Districts and the McLennan County and Falls County Commissioners Courts fully understand their obligations for operation and maintenance. Specific operation and maintenance agreements will be executed prior to the issuance of invitation to bid on construction of the structural measures.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/
Gov Bayou Watershed, Texas

Installation Period
 July 1963 - July 1966

Installation Cost Item	Unit	Number to be Applied	Estimated Cost (Dollars) 2/		
			Federal Funds	Going Program and Other	Total
LAND TREATMENT					
Soil Conservation Service					
Conservative Grazing System	Acres	24,500	-	\$4,000	\$4,000
Contour Farming	Acres	11,500	-	17,500	17,500
Cover and Grass Manure Crops	Acres	14,200	-	\$80,000	\$80,000
Grass Residue Use	Acres	27,000	-	124,000	124,000
Pasture Proper Use	Acres	18,400	-	46,000	46,000
Pasture and Hayland Planting	Acres	1,200	-	31,200	31,200
Pasture and Hayland Renovation	Acres	1,000	-	38,000	38,000
Critical Area Planting	Acres	35	-	13,000	13,000
Brush and Weed Control	Acres	1,000	-	64,000	64,000
Diversions	Feet	17,000	-	1,400	1,400
Terrace Gradient	Feet	304,000	-	9,200	9,200
Terrace Parallel	Feet	91,000	-	5,400	5,400
Grassed Waterway or Outlet	Acres	50	-	5,500	5,500
Wash Pond	No.	50	-	22,500	22,500
Grass Stabilization Structures	No.	12	-	12,000	12,000
Technical Assistance			\$4,000	22,000	\$26,000
Subtotal			\$4,000	307,000	\$311,000
WATER TREATMENT					
Soil Conservation Service					
Structure Retarding Structures	No.	20	\$39,000	-	\$39,000
Subtotal - Construction			\$39,000	-	\$39,000
Installation Services					
Soil Conservation Service					
Engineering Service			178,415	-	178,415
Other			79,104	-	79,104
Subtotal			\$257,519	-	\$257,519
General Installation Services			\$17,300	-	\$17,300
Other Items			-	57,702	57,702
Subtotal - Other			-	57,702	57,702
WATER TREATMENT SERVICES			\$178,300	57,702	\$236,002
Wet Plan Preparation			\$0,000	-	\$0,000
TOTAL PROJECT			\$178,300	323,002	\$501,302
Subtotal			\$178,300	323,002	\$501,302
TOTAL PROJECT			\$178,300	323,002	\$501,302

1/ Does not include prior expenditures of watershed protection (Pilot) funds or accomplishments resulting therefrom (see Table 1a).

2/ Price Base: 1962.

3/ It is expected that this level of application of the management and waterway-type practices will be reached by the end of the project period.

Note: There are no Federal lands in the watershed.

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT ^{1/}
Cow Bayou Watershed, Texas

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) ^{2/}		
			Federal Funds ^{3/}	Prior to July 1963	
				Going Program and Other	Total
LAND TREATMENT					
Soil Conservation Service					
Conservation Cropping System	Acra	13,200 ^{4/}	-	98,000	98,000
Contour Farming	Acra	10,700 ^{4/}	-	39,200	39,200
Cover and Green Manure Crops	Acra	11,500 ^{4/}	-	783,000	783,000
Crop Residue Use	Acra	19,600 ^{4/}	-	265,300	265,300
Pasture Proper Use	Acra	12,100 ^{4/}	-	47,300	47,300
Pasture and Hayland Planting	Acra	6,200	-	148,200	148,200
Pasture and Hayland Renovation	Acra	1,100	-	26,400	26,400
Critical Area Planting	Acra	0	-	0	0
Brush and Weed Control	Acra	1,600	-	72,000	72,000
Diversions	Foot	206,000	-	16,500	16,500
Terrace Gradient	Foot	3,404,000	-	170,200	170,200
Terrace Parallel	Foot	37,000	-	2,400	2,400
Stripped Waterway or Outlet	Acra	750	-	42,300	42,300
Farm Road	No.	200	-	146,300	146,300
Grade Stabilization Structures	No.	0	-	0	0
Technical Assistance			22,000	50,500	112,000
ECR Subtotal			22,000	2,828,300	2,850,300
STRUCTURAL MEASURES					
Soil Conservation Service					
Flashboard Retarding Structures	No.	2	22,044	-	22,044
Subtotal - Construction			22,044	-	22,044
Installation Services					
Soil Conservation Service					
Engineering Service			78,344	-	78,344
Other			47,023	-	47,023
ECR Subtotal			125,367	-	125,367
Subtotal - Installation Services					
Other Costs					
Land, Easements and Rights-of-way			-	204,105	204,105
Physical - Other			-	204,105	204,105
TOTAL STRUCTURAL MEASURES			125,367	408,210	533,577
Work Plan Preparation			12,011	-	12,011
TOTAL PROJECT			137,378	4,192,405	4,329,783
SUBTOTAL					
Subtotal ECR			137,378	4,192,405	4,329,783
TOTAL PROJECT			137,378	4,192,405	4,329,783

^{1/} At time of preparation of the revised work plan.

^{2/} Price Base: 1962.

^{3/} Watershed protection (pilot) funds only.

^{4/} The level of application of the management and monitoring programs reached at time of preparation of the revised work plan.

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TABLE 1B - TOTAL ESTIMATED INSTALLATION COSTS
Cow Bayou Watershed, Texas

Installation Cost Item	Unit	Number	Total Project 1/		
			Estimated Cost (Dollars) 2/		
			Federal Funds 3/	Going Program and Other	Total
LAND TREATMENT					
Soil Conservation Service					
Conservation Cropping System	Acres	26,200 4/	-	152,000	152,000
Contour Farming	Acres	11,600 4/	-	56,700	56,700
Cover and Green Manure Crops	Acres	14,300 4/	-	1,343,000	1,343,000
Crop Residue Use	Acres	27,600 4/	-	400,100	400,100
Pasture Proper Use	Acres	18,400 4/	-	133,500	133,500
Pasture and Hayland Planting	Acres	7,500	-	180,000	180,000
Pasture and Hayland Renovation	Acres	2,700	-	64,800	64,800
Critical Area Planting	Acres	65	-	13,000	13,000
Brush and Weed Control	Acres	3,400	-	136,000	136,000
Diversions	Feet	223,500	-	17,900	17,900
Terrace Gradient	Feet	3,368,000	-	179,400	179,400
Terrace Parallel	Feet	128,000	-	9,000	9,000
Deceased Waterway or Outlet	Acres	800	-	88,000	88,000
Farm Pond	No.	440	-	168,800	168,800
Grade Stabilization Structure	No.	12	-	12,000	12,000
Technical Assistance			46,800	119,400	166,200
SCS Subtotal			46,800	3,083,600	3,130,400
NON-SCS LAND TREATMENT					
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	RP	1,398,053	-	1,398,053
Subtotal - Construction			1,398,053		1,398,053
Installation Services					
Soil Conservation Service					
Engineering Services			256,980	-	256,980
Other			186,197	-	186,197
SCS Subtotal			443,177		443,177
Subtotal - Installation Services			443,177		443,177
Other Costs					
Land, Easements and Rights-of-Way			-	241,887	241,887
Subtotal - Other				241,887	241,887
TOTAL STRUCTURAL MEASURES			1,781,230	241,887	2,023,117
Mark Plan Preparation			89,012	-	89,012
TOTAL PROJECT			1,877,042	3,325,487	5,202,529
SUMMARY					
Subtotal SCS			1,877,042	3,325,487	5,202,529
TOTAL PROJECT			1,877,042	3,325,487	5,202,529

1/ Tables 1 and 1A combined.

2/ Price Base: 1962.

3/ Watershed protection (plot) funds only.

4/ It is expected that this level of application of the management and recurring-type practices will be reached by the end of the project period.

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TABLE 2 - ESTIMATED FEDERAL AND NON-FEDERAL COST DISTRIBUTION
 Cow Bayou Watershed, Texas
 (Dollars) 1/

Structure Site Number	Federal Installation Cost			Non-Federal			Total Installation Costs
	Construction	Engineering	Other	Construction	Easements & R/W	Installation	
1, 2, 3, 4, 5, 6, 7, 8 and 10	539,044	78,564	47,093	664,701	104,105	104,105	768,806 2/
11B	26,565	7,173	2,573	36,311	8,525	8,525	44,836
11C	29,665	7,416	2,827	39,908	5,425	5,425	45,333
11E	37,740	8,680	3,540	49,960	3,848	3,848	53,808
12	55,883	10,618	5,071	71,572	3,800	3,800	75,372
15	84,829	13,573	7,503	105,905	28,050	28,050	133,955
16	53,372	9,607	4,802	67,781	14,850	14,850	82,631
17	24,208	6,294	2,326	32,828	3,320	3,320	36,148
18	32,266	7,744	3,051	43,061	3,076	3,076	46,137
19	25,776	6,960	2,496	35,232	2,450	2,450	37,682
20	25,184	7,029	2,450	34,583	1,950	1,950	36,533
21	32,728	7,653	3,094	43,475	9,850	9,850	53,325
22	45,325	9,518	4,182	59,025	2,900	2,900	61,925
23	38,024	8,365	3,537	49,926	4,850	4,850	54,776
24	25,861	6,982	2,504	35,347	1,700	1,700	37,047
25	30,164	7,541	2,875	40,580	3,525	3,525	44,105
26	23,878	6,686	2,331	32,895	3,000	3,000	35,895
27	44,063	9,253	4,065	57,381	5,200	5,200	62,581
28	39,096	8,601	3,637	51,334	5,388	5,388	56,722
29	99,304	14,896	8,708	122,908	12,475	12,475	135,383
30	85,158	13,625	7,532	106,315	13,600	13,600	119,915
Subtotal	859,009	178,416	79,104	1,116,529	137,782	137,782	1,254,311
GRAND TOTAL	1,398,053	256,980	126,197	1,781,230	241,887	241,887	2,023,117

1/ Price Base: 1962, except for sites 1 through 8 and site 10.

2/ Constructed prior to 1962, actual cost.

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TABLE 4 - ANNUAL COST

Cow Bayou Watershed, Texas

(Dollars)

Evaluation Unit	: Amortization of : Installation : Cost <u>1/</u>	: Operation : and : Maintenance : Cost <u>2/</u>	: Total
29 Floodwater Retarding Structures	78,639	5,106	83,745
TOTAL	78,639	5,106	83,745

1/ Price Base: Actual costs for sites 1 through 8 and site 10, and 1962 prices for the remaining sites amortized at 3 percent for 50 years.

2/ Long-term prices as projected by ARS, September 1957.

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TABLE 3 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Cow Bayou Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop and Pasture	81,846	23,857	57,989
Other Agricultural	13,429	3,934	9,495
Non-agricultural	18,049	5,022	13,027
Subtotal	113,324	32,813	80,511
Sediment			
Overbank Deposition	12,211	4,609	7,602
Erosion			
Flood Plain Scour	26,268	3,054	23,214
Indirect	15,181	4,248	10,933
TOTAL	166,984	44,724	120,260

1/ Price Base: Long-term prices as projected by ARS, September 1957.

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**TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Cow Bayou Watershed, Texas**

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Total	Average Annual Cost 2/	Benefit : Cost Ratio
	Flood Prevention	Damage : Incidental	Reduction : Recreation	Secondary : Redevelopment			
29 Floodwater Retarding Structure	115,060	3,800	10,840	920	130,620	83,745	1.6:1
GRAND TOTAL	2/ 115,060	3,800	10,840	920	130,620	83,745	1.6:1

1/ Price used: Long-term prices as projected by ARS, September 1957.

2/ From Table 4.

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$5,200 annually.

INVESTIGATIONS AND ANALYSES

Land Treatment Measures

The status of land treatment measures for the watershed was developed by supervisors of the Central Texas and the McLennan County Soil Conservation Districts with assistance from personnel of the Soil Conservation Service work units at Rosebud and Waco. The measures needed and those already applied were listed for each farm or group of farms on which conservation plans were available. This information was expanded to represent the watershed. Amounts of land treatment practices already applied, soil conditions, trends in farming operations, grassland, cover, and other pertinent data were used in estimating future land treatment needs. Estimates were made of practices that will be applied during the 3-year installation period for the entire watershed. The cost of these was based on current prices (table 1).

Structural Measures

Stereoscopic photo and topographic map studies supplemented by field examinations indicated that 23 possible floodwater retarding structure sites were available. These are in addition to the 9 structures constructed and in place. The system of 23 floodwater retarding structures was presented to the sponsoring local organizations for further consideration.

A list of landowners whose farms would be affected by structural measures was submitted to the local sponsors for their information and use.

Engineering surveys were started after agreement was reached with the sponsoring local organizations on locations of structural measures to be studied. For floodwater retarding structure sites, topographic maps were made with 4-foot contour intervals and a scale of 8 inches equal to one mile. Topographic maps with 2-foot contour intervals and a scale of 1 inch equals 100 feet were made for each emergency spillway. These surveys provided the necessary data to determine if the required sediment and floodwater detention storage could be obtained, to estimate the installation cost, and to determine the most economical design for each structure. Criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441 were used to determine the sediment and floodwater detention storage requirements, structure classification, and principal and emergency spillway design. Data obtained in land treatment needs studies for the watershed, as well as hydraulic, hydrologic, geologic, sedimentation, and economic investigations provided the necessary means for evaluating various combinations of floodwater retarding structures. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 2 and 2A.

Investigations showed that improvement of the existing channel would not be feasible.

It was found that a system of 20 additional floodwater retarding structures would be economically feasible to install and would provide the desired degree of protection. Although several of the sites control small drainage areas, resulting in higher than average costs, they are strategically located with respect to sediment damage areas and therefore are considered to be justified.

Cost distribution (table 2) and structure data table (table 3) were prepared to show for each structure: the estimated cost, drainage area, detention and sediment storage capacity in acre-feet and inches of runoff from the drainage area, release rate of the principal spillway, acres inundated by the sediment and detention pools, volume of fill in the dam, and other pertinent data.

Hydraulic and Hydrologic Investigations

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

1. The original precipitation records for 1923 through 1942 were used with the same method of grouping two days of gage records for a single storm event. However, the method of classifying storms according to antecedent moisture conditions was changed from the old single seasonal curves to the following: Condition I, less than 1.5 inches; Condition II, between 1.5 and 2.5 inches; and Condition III, greater than 2.5 inches. The number of days used to determine antecedent moisture was 20 days for the period November through March, 15 days during April, May, June, and October, and 10 days for July, August, and September. The change in the method of classifying storm events resulted in the following differences between the floods reported in the original report and the revision:

	<u>Original Report</u>	<u>Revision</u>
Number of minor floods	65	66
Number of major floods	<u>17</u>	<u>9</u>
Total number at time of plan	82	75

2. Resurveys were made of channel and valley cross sections R-9 and R-10 where considerable change in channel size and some change in the flood plain has taken place. The short valley cross section K-0 and the channel portion of section K-1 were surveyed because of channel enlargement induced by the new bridge and the new, larger channel downstream from F. M. Road 2116. The two channel segments on R-3 and the main channel at valley cross sections R-1, R-4, and R-4A were resurveyed. Reconnaissance surveys indicated that there were no appreciable changes on the other portions of the stream channels.

Valley cross sections N-106, S-12, and E-1 were surveyed to supplement the original surveys. The locations of the valley cross sections are shown in figure 3.

3. The original plan used rainfall-runoff relationships based on the soil-cover complex classifications then in use and the Chambers Creek gage data. The current hydrologic condition was determined by surveying 9 sample areas representing 18 percent of the watershed. The resulting runoff curve numbers were used with figure 3.10-1, National Engineering Handbook, Section 4, Supplement A to determine the depth of runoff for individual storms.

The change to "curve number" has changed average annual runoff from 5.17 inches to 7.25 inches. This new runoff matches gaged runoff (7.2 inches) from Richland Creek in a similar Blackland area. The computed runoff is much closer to actual values than the 1954 estimate.

The future hydrologic condition was determined by considering the changes in land use and treatment that could be expected during the installation period.

4. New cross section rating curves were computed from field survey data listed in item 2, above, by solving water surface profiles for the following cross sections: 8, 9, 10, S-12, N-106, E-1, K-0, and K-1. Survey data for the remaining cross sections were plotted and studied.
5. The relationship of peak discharge and drainage area was modified to increase the peak discharges on small drainage areas. The original value of 6,000 c.f.s. per inch of runoff for the entire watershed based on the Deer Creek gage was not changed. The concordant flow exponent of 0.8 used in the original plan was changed to 0.5. The original 0.8 concordant flow slope was used to match peak flow with high-water marks utilizing rather sketchy rainfall information. The revision shows close agreement to gaged data from Blackland watersheds.
6. New stage-area inundation curves were developed for each portion of the flood plain represented by a single cross section. Area of inundation by depth increments was determined at each cross section for selected amounts of runoff. Composite runoff-area inundated curves were developed for each evaluation reach.
7. Determinations were made of the area that would have been inundated by each storm in the evaluation series for the

following conditions:

- a. The hydrologic condition of the watershed at this time and assuming no floodwater retarding structures installed.
 - b. The installation of land treatment measures included in table 1b.
 - c. The installation of land treatment measures included in table 1b and 29 floodwater retarding structures.
 - d. Alternate systems of structural measures.
8. The feasibility of enlarging the present mainstem channel through evaluation reach 2 was studied. Investigations based on critical tractive force, for cohesive soils, revealed that the existing channel in reaches 1 and 2 will be stable when carrying only the release flows from the floodwater retarding structures. To provide additional flood protection, with channel improvement, extensive grade stabilization measures would be required in reaches 1 and 2.
 9. Detention volumes equal or exceed the minimum criteria set forth in Engineering Memorandum SCS-27. Detention volumes exceed the Texas State Manual Supplement 2441 criteria in most sites to obtain a more economical or desirable emergency spillway or structure design. Percent chance of use of emergency spillways based on regional analysis of 2-day gaged runoff from similar watersheds, was determined by adding to the actual detention storage the volume which would be released by the principal spillway during a 2-day period.
 10. The average principal spillway release rate is approximately 9 csm for the floodwater retarding structures.
 11. The emergency spillway and freeboard design storms were selected from Figures 3.21-1 and 3.21-4 of NEH, Section 4, Supplement A, in accordance with criteria contained in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441.
 12. Inflow hydrographs were developed for each site in the watershed. The emergency spillway and freeboard hydrographs were computed using moisture condition II with 0.5 and 1.21 for Class (A), and 0.75 for Class (B) structures, respectively, of the adjusted point rainfall for the 6-hour storm. Since routing of the emergency spillway hydrographs resulted in either no flow or very shallow flow through the emergency spillways,

the dimensions of the emergency spillways were determined from the freeboard hydrographs. Hydrographs were developed for each of the floodwater retarding structures by the distribution graph method. An empirical equation was used to develop a curve to estimate a range of values from which the most economical spillway was determined. The final design was made by the flood routing method described on page 5.8-12 of the NEH, Section 5.

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the 20 planned floodwater retarding structure sites. Detailed geologic dam site investigations were made at the 9 existing floodwater retarding structures prior to their construction. The preliminary investigations included studies of valley slopes, alluvium, channel banks, and exposed geologic formations.

Description of Problems

The watershed is located in the Black Prairie physiographic area and is underlain by Upper Cretaceous (Gulf series) rocks of the South Bosque and Lake Waco formations of the Eagle Ford group, the Austin formation, and the Taylor formation. These strata dip southeasterly at 30 feet or more per mile. The Balcones fault system extends across the central portion of the watershed. The trends of these faults are generally parallel with the strike of the beds. Minor faults with small displacement, along with jointing, are common in a wide zone extending several miles east and west of the larger faults.

The approximate stratigraphic location of all floodwater retarding structure sites is shown as follows:

	Eagle Ford Group				
Structure:	Lake Waco Formation	South	Austin	Taylor	
Number	Bluebonnet	Cloice	Bouldin	Bosque	For-
	Member	Member	Member	Formation	mation
1*	XXXXXXXXXXXXX				
2*	XXXXXXXXXXXXX				
3*	XXXXXXXXXXXXX				
4*			XXXXXXX		
5*				XXXXX	
6*					XXX
7*					XXXX
8*				XXXXX	
10*		XXXXXXXXXXXXX			

(See (*) footnote at end of table.)

Approximate stratigraphic location of all floodwater retarding structure sites - Continued

		Eagle Ford Group					
Structure Number	Bluebonnet Member	Cloice Member	Bouldin Member	South Bosque Formation	Austin For- mation	Taylor For- mation	
11B			XXXXXXXXXX				
11C			XXXXXXXXXX				
11E				XXXXXX			
12					XXXXXX		
15						XXXXXX	
16						XXXXXX	
17	XXXXXXXXXXXXXXXXXX						
18	XXXXXXXXXXXXXXXXXX						
19	XXXXXXXXXXXXXXXXXX						
20	XXXXXXXXXXXXXXXXXX						
21	XXXXXXXXXXXXXXXXXX						
22	XXXXXXXXXXXXXXXXXX						
23	XXXXXXXXXXXXXXXXXX						
24	XXXXXXXXXXXXXXXXXX						
25					XXXX		
26					XXXX		
27					XXX		
28					XXX		
29						XXXXX	
30						XXXX	

* Have been constructed.

The Lake Waco formation consists of brown and black carbonaceous shales, interbedded with dark gray limestone flags and bentonite seams. Fourteen structure sites are partially to completely located in beds of this formation. Borrow materials are ample at these sites but will consist of montmorillonitic clays (CH, CL, and MH). Wet foundation conditions due to isolated springs and seeps may cause design and construction problems on individual sites. Very little or no rock excavation is expected.

Black shales with some thin bedded platy limestones make up the South Bosque formation. Existing site 4 is located entirely within this formation. Five other structures, 2 of which have been constructed, are partially located on these beds. Spillway side slopes are unstable in this formation because of montmorillonitic clays, and require flatter than normal slopes. Structures located on the Austin-South Bosque contact may require additional foundation preparation to remove covered ledges and reduce danger of differential settlement. Borrow materials are similar to the Lake Waco formation.

The Austin chalk formation consists of alternating beds of massive marly limestone, marls, and marly shale. Nine structures are partially to completely located on these beds. Three of these structures have been constructed. Rock excavation in the emergency spillways will be necessary on most of these sites but the total volume will not be excessive. Some sloping of rock bluffs will be necessary in foundation preparation. Borrow materials will be adequate from the sediment pool areas of all sites except sites 25 and 26. However, at sites 25 and 26 adequate materials are available within the detention pools immediately above the sediment pools. These materials consist of clays and gravelly clays (CH, CL, and GC).

Five sites are located on beds of the Taylor marl formation. One of these structures, Site 7, has been constructed. Borrow materials at these sites consist of montmorillonitic clays (CH, MH, and CL).

Channel Stability Studies

Field investigations and studies were made on degrading and stable reaches of the lower Cow Bayou channels. Streambank and bed materials consist of highly plastic and cohesive clays. Stable reaches of the channel were found to be on slopes of 0.0009 foot per foot. The degrading reaches were found on slopes averaging 0.0018 foot per foot. The natural gradient of the Cow Bayou channel was increased when landowners straightened the original meandering channel.

Sedimentation Investigations

Sedimentation investigations for the revision of the work plan were made in accordance with procedures as outlined in Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1961, and Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs", September 1959, U. S. Department of Agriculture, Soil Conservation Service.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 20 planned structures according to the following procedures:

1. Detailed investigations were made in the drainage areas of 7 of the planned structures. Estimates of sediment rates for the remaining 13 planned structures were based on similarity of these drainage areas to areas which had been surveyed in detail.
2. Field surveys included mapping soil units by slope in percent; slope length in feet; present land use; present

land treatment on cultivated land; present cover condition classes on grassland; land capability classes; lengths, widths, and depths of gullies; lengths, widths, and depths of stream channels affected by erosion; and estimating annual rate of lateral erosion of gullies and streambanks.

3. Office computations included summarizing erosion by sources (sheet, gully, and streambank) in order to fit these data into formulas for computation of the annual gross erosion in tons.
4. The erosion rates were adjusted to reflect the effect on expected land treatment on the drainage areas of the planned structures. Erosion rates were adjusted for expected delivery of annual gross erosion and trap efficiency of the floodwater retarding structures.
5. The ratio of sediment storage volume in the pools to soil in place was based on volume weights of 81 to 84 pounds per cubic foot (soil-in-place) and 50 to 52 pounds per cubic foot (sediment).
6. The allocation of sediment to the structure pools was based on 10 percent deposition in the detention pool and 90 percent deposition in the sediment pool.

Field examinations of gullied areas and overfalls were made to determine sediment production and land loss damage in 11 areas. Type of needed treatment as well as monetary evaluation of land and sediment damages were used as a guide to determine the need for any special treatment measures.

Flood Plain Sedimentation and Scour Damages

The physical extent of sedimentation and scour damages to flood plain lands was obtained from previous investigations made at the time the original work plan was developed.

The damages were summarized by evaluation reaches for the entire flood plain and adjusted for the estimated recoverability of productive capacity. These estimates were developed as a result of field studies and interviews with farmers.

Using the average annual erosion rates as a basis, the annual sediment yield (with adjustments for sources of damaging sediment) to each evaluation reach on the flood plain was estimated for present conditions, with land treatment, and with structures installed. The results were compared to show the average reduction of overbank deposition in the watershed. The estimated reduction of scour damage due to installation of the complete project is based on reduction of depth and area inundated.

Economic Investigations

Basic methods used in the economic investigations and analyses are outlined in the Economics Guide issued December 1958. Benefits evaluated in the previous work plan were based on the long-term price projections issued in 1951. Benefits in this work plan are based on the long-term price projections issued in 1957. This change along with the use of current methods, as outlined in Economics Memorandum EWP-1, to evaluate sediment and erosion damages account for a part of the change in project benefits.

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based upon schedules obtained in earlier work plan preparation from owners and operators of 100 percent of flood plain property. These studies were supplemented by a recent investigation covering 10 percent of the flood plain. Schedules covered past and present land use, crop distribution under normal conditions, crop yields, and data on flooding and flood damage.

The current flood plain land use was mapped in the field. Estimates of normal yields were based on data obtained from the schedules and supplemental information from agricultural workers in the area.

Analysis of this information formed the basis for determining damage rates for various depths and seasons of flooding. In calculating crop and pasture damage, expenses saved, such as cost of harvesting, were deducted from the gross value of the damage.

The proper rates of damage were applied to the damageable values in areas inundated by floods occurring during the period 1923 - 1942. An adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year.

Field studies indicated that differences in land use, yields, frequency of flooding and anticipated future use warranted division of the flood plain into six evaluation reaches. A different damageable value was used for each reach.

The locations of the evaluation reaches shown on figure 3 are:

- Reach 1 - From the mouth of Cow Bayou through valley cross section 9.
- Reach 2 - From valley cross sections 9 through 12.
- Reach 3 - From valley cross sections S-1 through S-11.
- Reach 4 - From valley cross sections N-1 through N-7, and to Site 11-E.

Reach 5 - From valley cross section A-1 to Site 16.

Reach 6 - From valley cross section K-1 to Site 15.

Estimates of damages to other agricultural property such as fences, livestock, on-farm roads and farm equipment were made from the analysis of flood damage schedules.

The estimated monetary value of the physical damage to the flood plain from erosion was based on the value of production lost. The estimate took into account the lag in recovery of productivity and the cost of farm operations to speed recovery. Damage from erosion was related to depth of flooding, giving greater weight to deeper flows.

Indirect damages involve such items as additional travel time for farmers, re-routing of general traffic, school buses and mail deliveries and costs of extra feed for livestock during and after floods. Based on information and data obtained from watersheds previously analyzed, it was determined indirect damages approximate 10 percent of the direct damages.

Farmers and ranchers were asked what changes they would make in their flood plain land use or cropping systems if flood protection was provided. They indicated that no change in land use would be made. Consequently it is not expected that acreages of crops subject to acreage allotments will be increased as a result of the project. No benefits were claimed from more intensive land use or restoration of lands to former productivity.

Evaluation of incidental recreation benefits was based on an economic analysis of pertinent data from the nine structures existing in Cow Bayou watershed. This analysis indicated that the project will have an average use of approximately 15,200 visitor days annually and net benefits of \$0.30 per visitor day, after allowances of \$0.20 for associated costs. It was estimated that the capacity of the sediment pools would remain adequate for recreational purposes for 30 years and decline to zero at the end of 40 years. The incidental recreation benefits were discounted to allow for this depletion in capacity.

The value of local secondary benefits stemming from the project was considered to be equal to 10 percent of the direct primary benefits. This excludes all indirect benefits from the computation of secondary benefits. Secondary benefits which may be induced by the project were not considered.

Secondary benefits from a national viewpoint were not considered pertinent to this economic evaluation.

Redevelopment benefits which would accrue during project installation were calculated by applying prevailing wage rates to the amount of local labor by classes and types that will be used by contractors. This estimate

was converted to an average annual equivalent value by the application of appropriate amortization factors. The estimate of the amount of local labor which will be used was based on an analysis of recent contracts. These benefits will accrue to the four structures to be built in Falls County. Falls County has been designated as eligible for assistance under the Area Redevelopment Act. Benefits from employment stemming from the use of project improvements and from employment in their operation and maintenance were not used for project justification.

The value of easements was determined through local appraisal, giving full consideration to the current real estate market values. An estimate was made of the value of the production lost in the pool areas after installation of the program. In this appraisal it was considered that the sediment pool would yield no production. The land covered by the detention pools would continue to be used as pasture after installation of the program. The average annual loss in production within the structure sites plus secondary costs therefrom were compared with the amortized value of easements. The easement value was found to be greater and therefore was used in economic justification to assure a conservative benefit cost analysis.

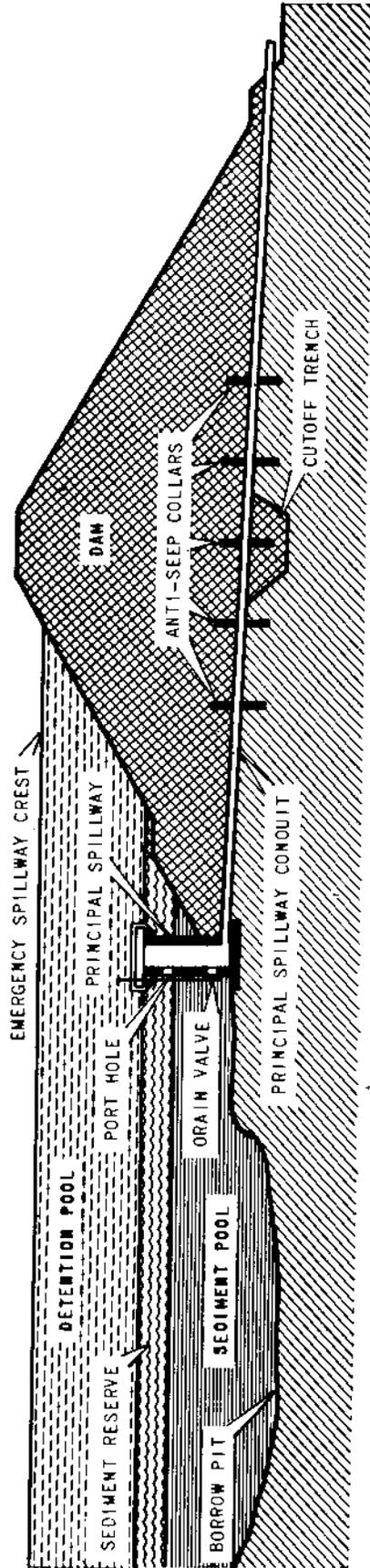


Figure 1
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

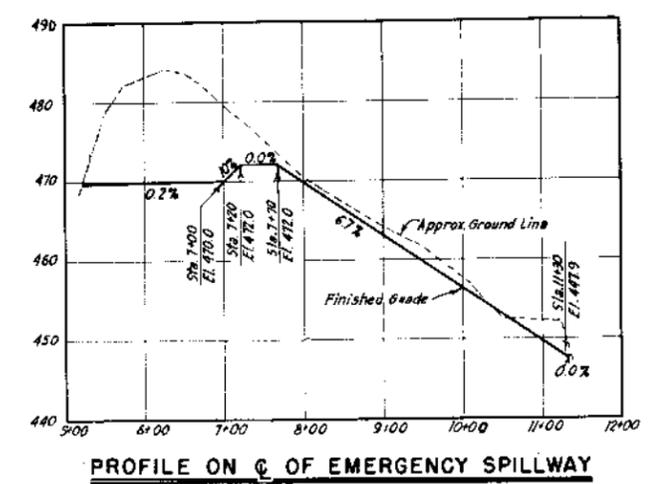
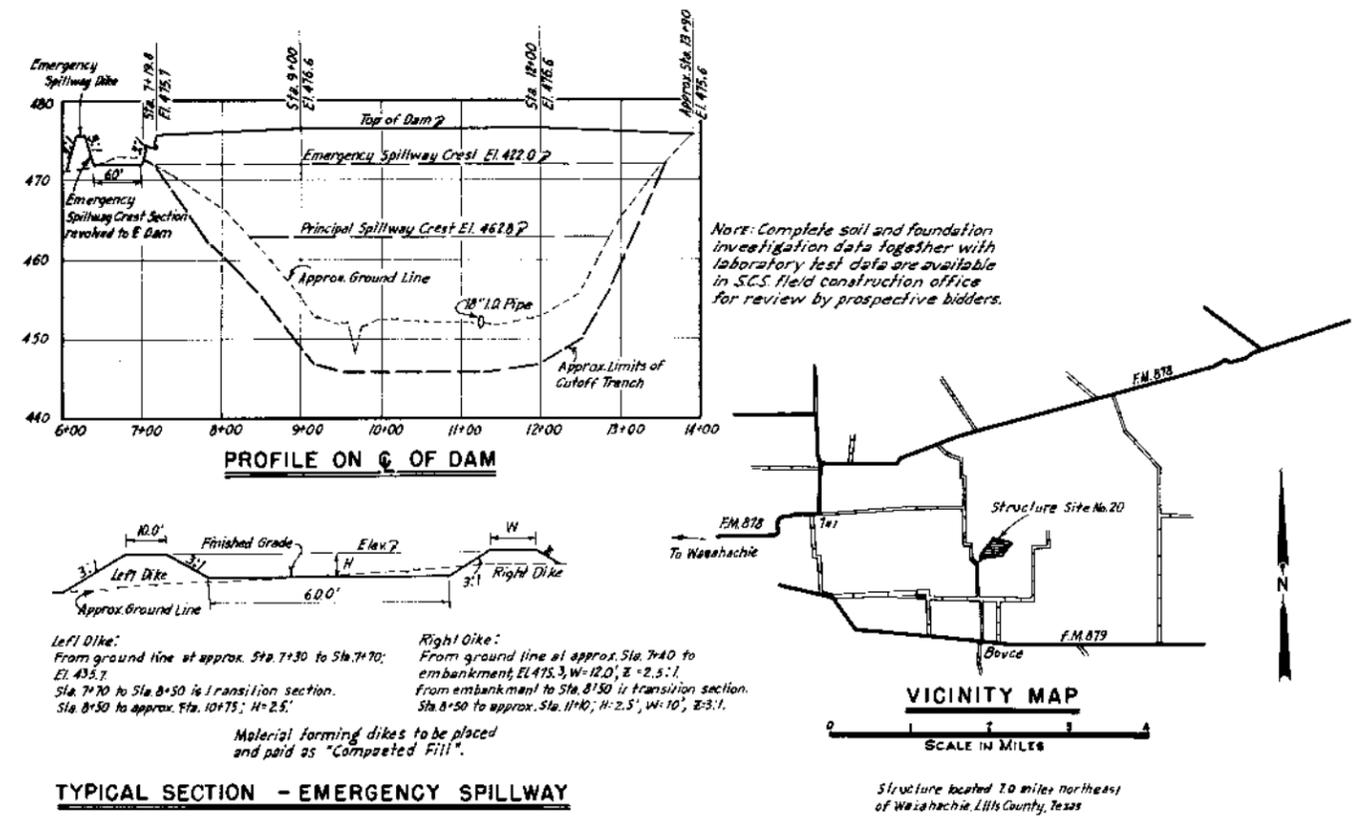
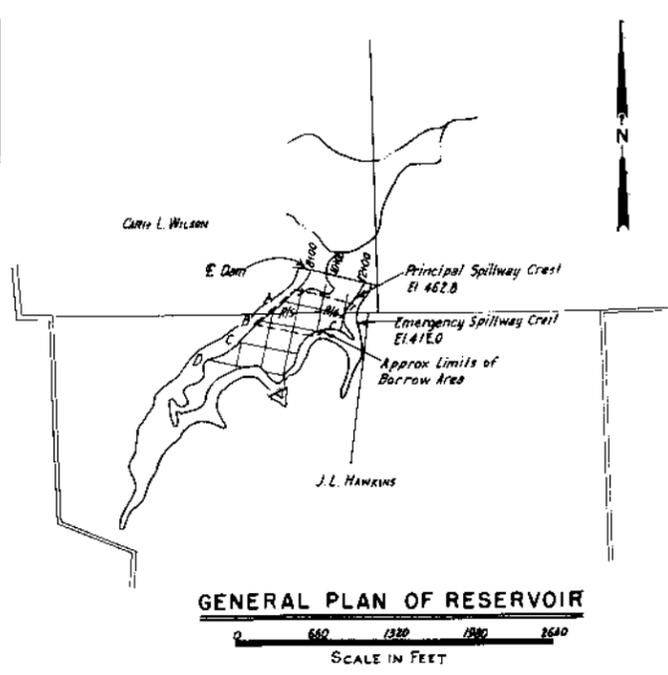
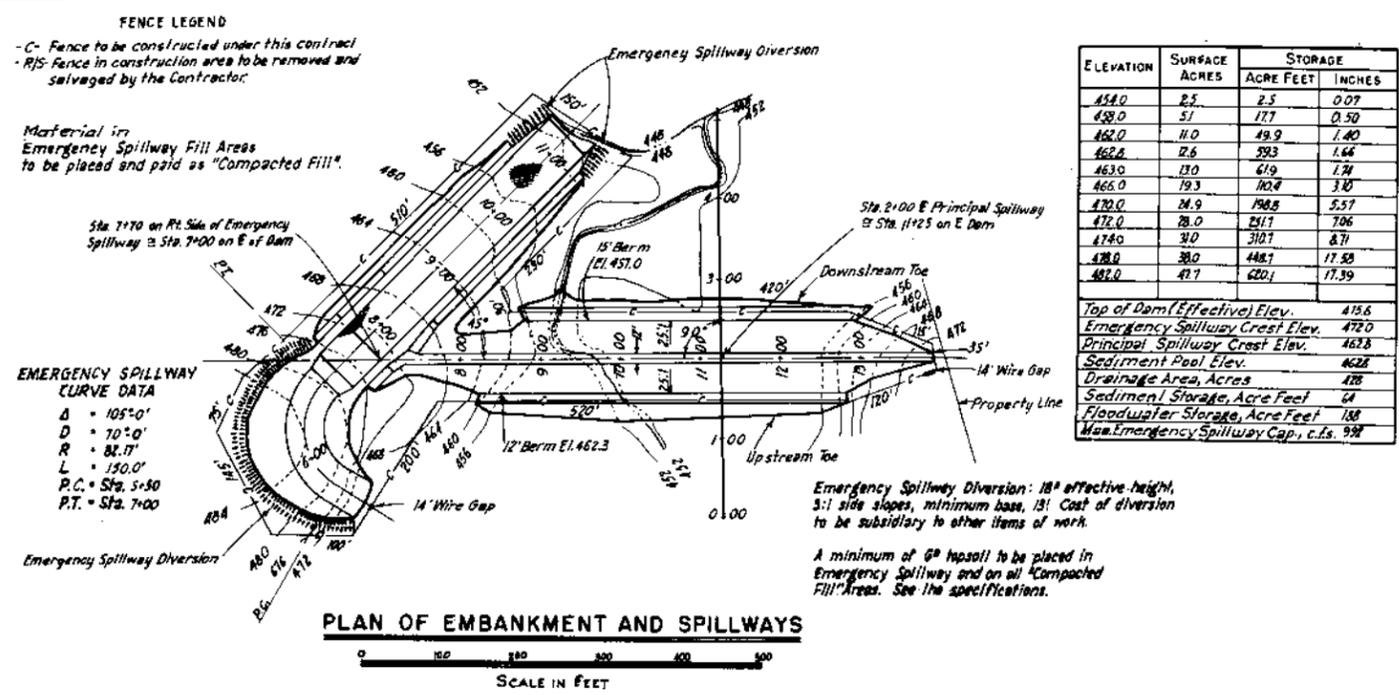


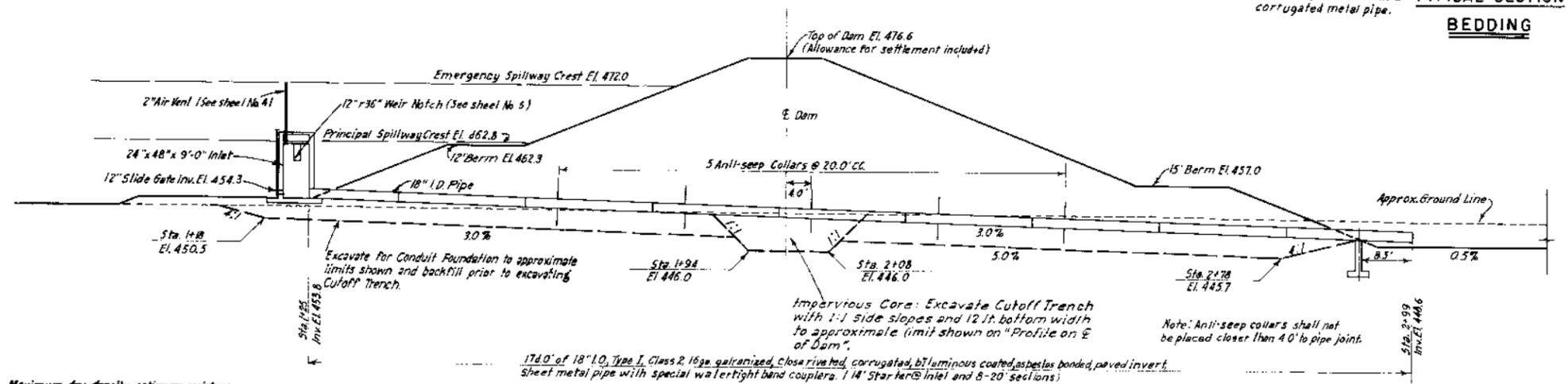
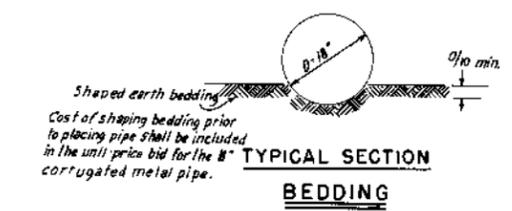
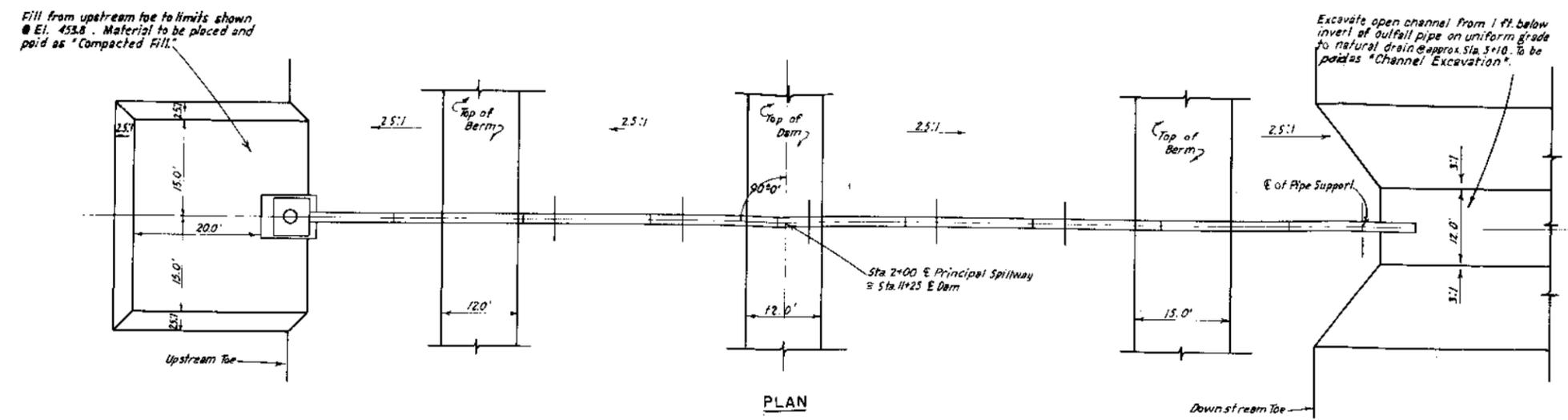
Figure 2
TYPICAL GRADE STABILIZATION STRUCTURE - PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

Designed: S.M.B. DATE: 3-63
 Drawn: S.M.B. 3-63
 Project: J.P. 3-63
 Checked: S.M.B. & G.W.C. 3-63

APPROVED: [Signature]
 DISTRICT ENGINEER, SOIL CONSERVATION SERVICE

Sheet No. 4-E-17,717
 of 7



Maximum dry density, optimum moisture, minimum acceptable dry density and moisture range shown are for material particles passing the number 6 sieve.

TABULATION - RECOMMENDED USE OF MATERIALS											
Sec No	Description	Location	SOURCE OF FILL MATERIAL		LAB TESTS				COMPACTION REQUIREMENTS		Lor. Curve
			From	To	Ave. Depth Feet	Mod/Std	Max Dry Den	Optim Moist	Min. Dry Density	Moisture Range	
	Any Section	Borrow	0	11	107.0	88.0	91.0	18.0	1		
		Emergency Spillway Cutoff Trench & Conduit Foundation	0	6	108.5	77.0	92.0	17.0	2		

The Engineer will direct a selective placement of all materials to produce a homogeneous embankment.

EMBANKMENT DATA

No upward limits of placement moisture are established. Upper limits of placement moisture will be established during construction by the engineer, based on the workability aspects of the materials being placed in the fill and the densities reached.

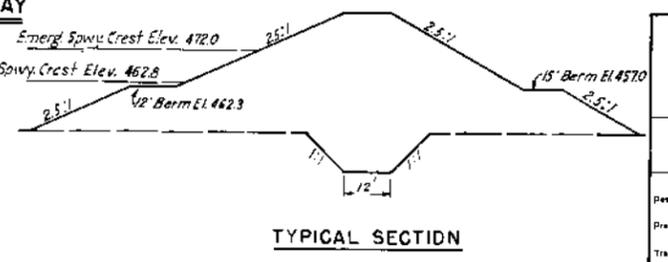
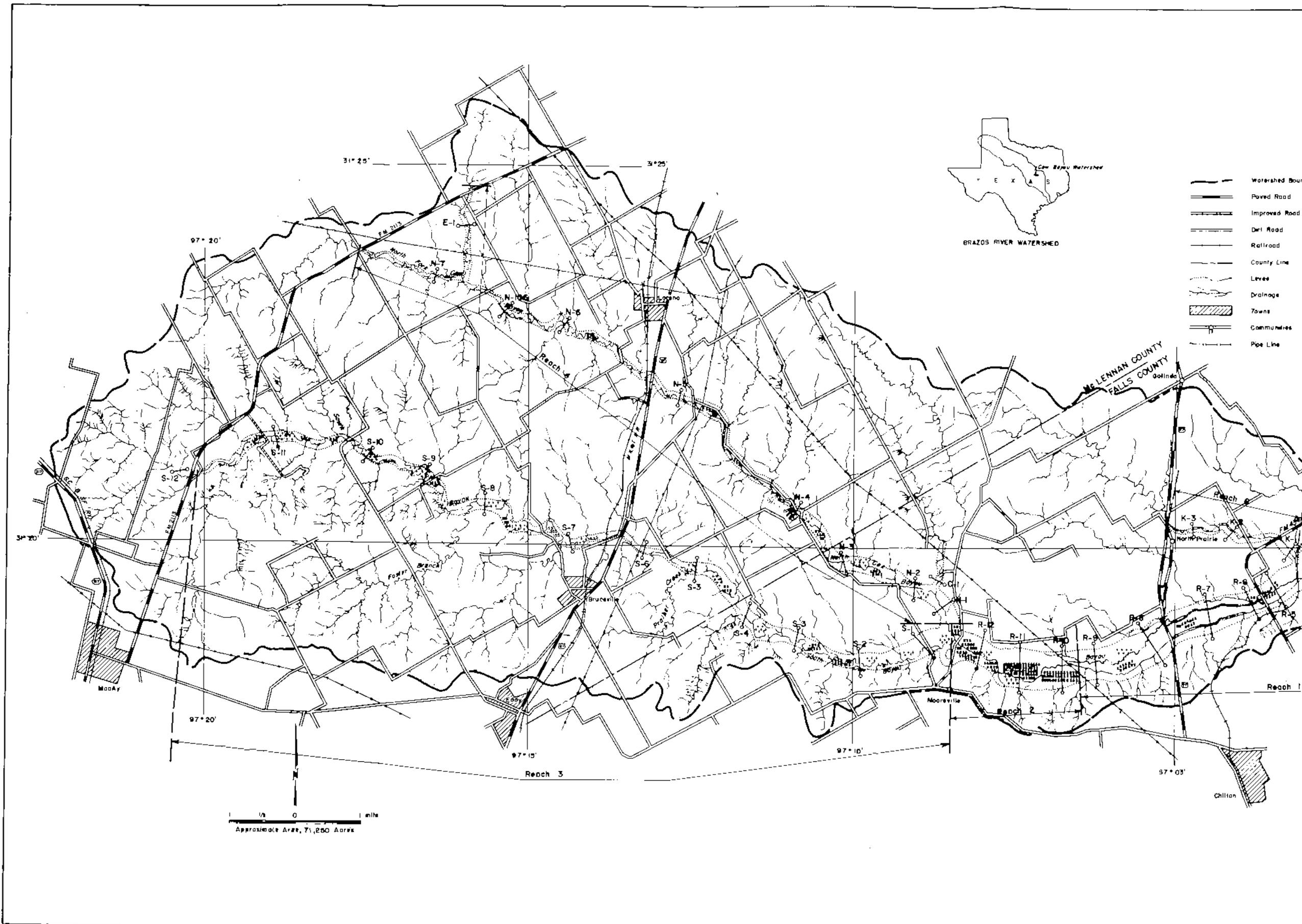


Figure 2A
TYPICAL FLOODWATER RETARDING STRUCTURE
PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date: 3-63
Designed: S.M.B.
Drawn: S.M.B.
Traced: L.P.
Checked: S.M.B. & G.W.T.

Approved by: [Signature]
FOOT PRINT SEAL
DATE CONSTRUCTION PERMITS: [Signature]
SHEET: 3 of 7
DRAWING NO.: 4-E-17,717



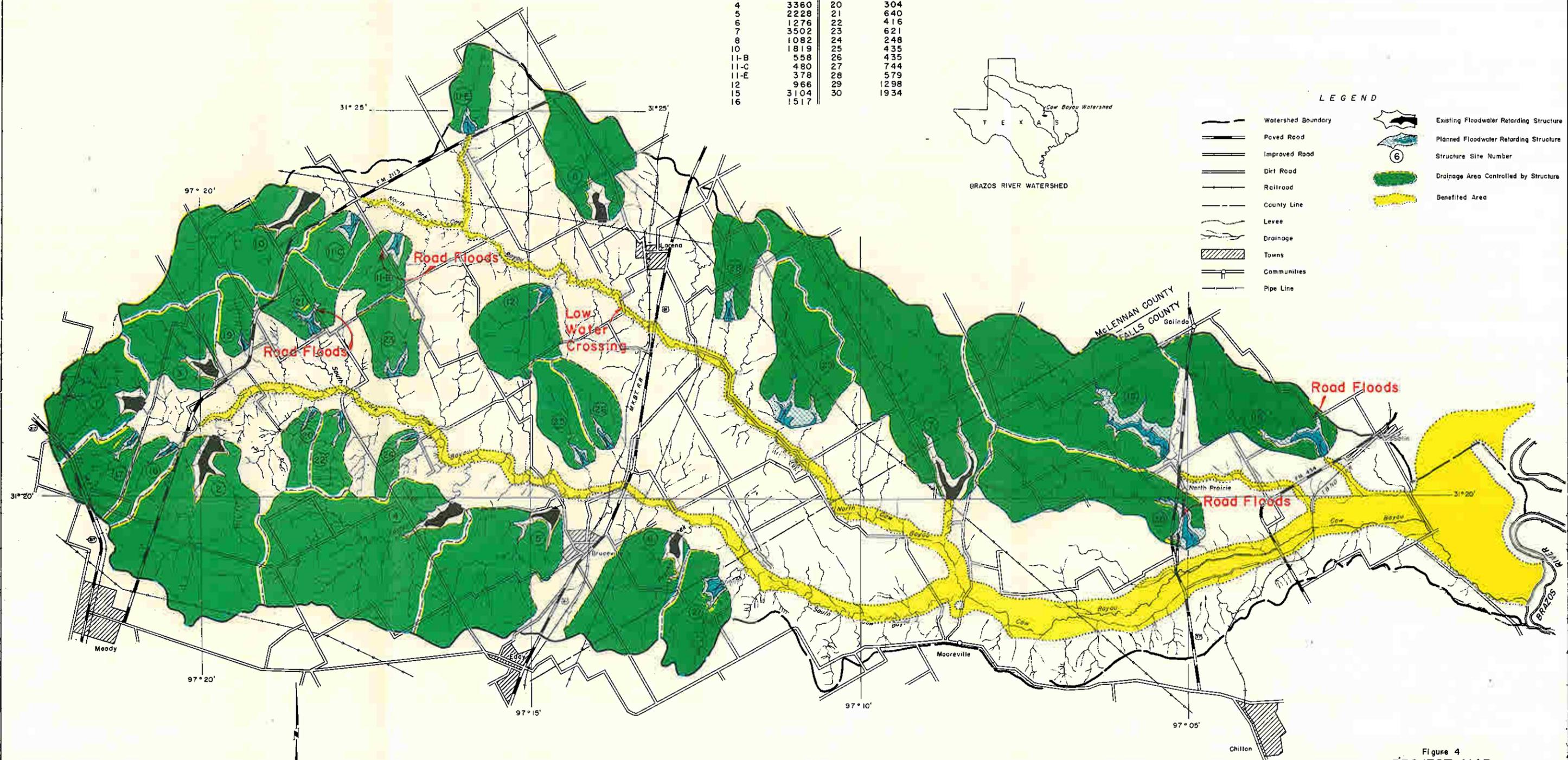
Site Numbers and Drainage Areas in Acres

No.	Acres	No.	Acres
1	966	17	506
2	2818	18	506
3	896	19	294
4	3360	20	304
5	2228	21	640
6	1276	22	416
7	3502	23	621
8	1082	24	248
10	1819	25	435
11-B	558	26	435
11-C	480	27	744
11-E	378	28	579
12	966	29	1298
15	3104	30	1934
16	1517		



LEGEND

- Watershed Boundary
- Paved Road
- Improved Road
- Dirt Road
- Railroad
- County Line
- Levee
- Drainage
- Towns
- Communities
- Pipe Line
- Existing Floodwater Retarding Structure
- Planned Floodwater Retarding Structure
- Structure Site Number
- Drainage Area Controlled by Structure
- Benefited Area



Approximate Area, 71,250 Acres

Figure 4
PROJECT MAP
 COW BAYOU WATERSHED
 FALLS AND McLENNAN COUNTIES
 TEXAS
 U.S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE
 TEMPLE, TEXAS