WORK PLAN

ELM FORK WATERSHED

OF THE TRINITY RIVER WATERSHED

Montague, Cooke and Denton Counties, Texas

(Revised June 1956)

Prepared By

SOIL CONSERVATION SERVICE

U. S. DEPARTMENT OF AGRICULTURE

Temple, Texas

June 1956

WATERSHED WORK PLAN

AGREEMENT

between the

UPPER ELM RED SOIL CONSERVATION DISTRICT
(name of local organization)

DENTON - WISE SOIL CONSERVATION DISTRICT
(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 _____ Elm Fork 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.

Upper Elm Red Soil Conservation District
(Name of local organization)

By J W Hess

Title Chairman

Date June 21, 1956

The signing of this agreement was authorized by a resolution of the governing body of the Upper Elm-Red Soil Conservation District
(Name of local organization)

adopted at a meeting held on June 21, 1956.

Willard Kemplen
(Secretary, local organization)

Date June 21, 1956

Denton - Wise Soil Conservation District
(name of local organization)

By John W. Faught

Title Chairman, Board of Supervisors

Date June 5, 1956, 1956

The signing of this agreement was authorized by a resolution of the governing body of the Denton - Wise Soil Conservation District
(name of local organization)

adopted at a meeting held on June 5, 1956, 1956.

James Dyan
(Secretary, local organization)

Date June 5, 1956

_____
(name of local organization)

By _____

Title _____

Date _____, 195___

The signing of this agreement was authorized by a resolution of the governing body of the _____
(name of local organization)

adopted at a meeting held on _____, 195___.

_____
(Secretary, local organization)

Date _____, 195___

Soil Conservation Service
United States Department of Agriculture

By _____
(State Conservationist)

Date _____, 195___

WORK PLAN
ELM FORK WATERSHED
Of the Trinity River Watershed
Montague, Cooke, and Denton Counties, Texas

Participating Agencies

Upper Elm-Red Soil Conservation District
Denton-Wise Soil Conservation District
Agricultural Conservation Program Service
Extension Service
Soil Conservation Service

Prepared By

Soil Conservation Service
United States Department of Agriculture
June, 1956

TABLE OF CONTENTS

	Page
INTRODUCTION	1
Authority	1
Purpose and Scope of Plan	1
SUMMARY OF PLAN	2
Comparisons of Benefit and Cost	2
DESCRIPTION OF THE WATERSHED	2
Physical Data	2
Economic Data	6
WATERSHED PROBLEMS	7
Floodwater Damage	7
Sediment Damage	7
Erosion Damage	8
Problems Relating to Present Methods	9
WORKS OF IMPROVEMENT TO BE INSTALLED	9
Land Treatment Measures	9
Structural Measures for Flood Prevention	10
Effect of Works of Improvement on Damages and Benefits	12
COMPARISON OF BENEFITS AND COSTS	13
ACCOMPLISHING THE PLAN	13
Land Treatment Measures	13
Structural Measures for Flood Prevention	14
PROVISIONS FOR OPERATION AND MAINTENANCE	15
Land Treatment Measures	15
Structural Measures for Flood Prevention	15

List of Tables and Figures

Table 1 - Estimated Installation Cost	16
Table 2 - Status of Flood Prevention Job Prior to First Year of Work Plan	22
Table 3 - Annual Costs	23
Table 4 - Summary of Benefits	25

TABLE OF CONTENTS - Continued

	Page
Table 5 - Benefit-Cost Analysis	26
Table 6 - Structure Data (Preliminary Estimates for Floodwater Retarding Structures)	28
Table 6A- Structure Data (Estimated Structure Cost Distribution)	29
Table 7 - Summary of Physical Data	30
Table 8 - Summary of Plan Data	31
Figure 1 - Typical Floodwater Retarding Structure	11
Figure 2 - Structure Location Map	32

WORK PLAN
ELM FORK WATERSHED
Of the Trinity River Watershed
Montague, Cooke, and Denton Counties, Texas
Revised June, 1956

Authority

The Elm Fork Watershed Flood Prevention Project will be carried out 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).

Purpose and Scope of Plan

The Upper Elm-Red and Denton-Wise Soil Conservation Districts provide through their programs and work plans, for the application of a complete program of soil and water conservation and improved plant management within this watershed. Their objectives are to use each acre of agricultural land in accordance with its capabilities for sustained agricultural production and to treat each acre in accordance with its needs for protection and improvement. Such a program, when applied and maintained on all the land within the watershed, will be effective in reducing runoff from small rains and will effect some reduction in peak flows from excessive rains. An effective land treatment program will have a major effect in the reduction of upland erosion rates which in turn will reduce sediment damage. Additional structural measures for flood prevention are needed to complete the soil and water conservation and plant management program in the watershed and provide effective reductions in flood damage.

The purpose of this plan is (1) to state specifically the land treatment and structural practices and measures which are designed primarily for, or contribute directly to flood prevention, and (2) to specify how, when, and by whom they will be carried out to achieve the maximum practicable reduction of erosion, floodwater and sediment damages. Measures and practices planned herein constitute an integral part of the complete soil and water conservation and plant management program in this watershed and have been incorporated in the work plan of each of the soil conservation districts concerned.

Application of this mutually developed plan will provide the maximum protection to and improvement of land and water resources which can be justified economically and undertaken at this time with the combined facilities of local interests and State and Federal agencies. Upon completion and continued maintenance of the measures set forth in this plan a material contribution will be made toward increasing agricultural production to a level consistent with the capability of the land, thereby promoting the welfare of the landowners and operators, the community, the State and the Nation. The area in the watershed includes parts of Montague, Cooke,

and Denton Counties, and contains 253,810 acres (397 square miles).

SUMMARY OF PLAN

This plan is a combination of land treatment practices and flood prevention measures which contribute directly to soil and water conservation and flood prevention. The works of improvement listed in Tables 1 are planned to be installed at an estimated total cost of $4,649,046, of which $2,684,733 is to be borne by State and local interests and $1,964,313 by the Federal Government.

The Upper Elm-Red Soil Conservation District, under provisions of State enabling legislation, has agreed to assume responsibility for overall periodic inspection and maintenance of the floodwater retarding structures at an estimated annual cost of $3,266. The landowners and operators will maintain the land treatment measures at an estimated annual cost of $73,140 in accordance with provisions of the farmer-district cooperative agreements.

Comparisons of Benefit and Cost

When the works of improvement are applied and operating at full effectiveness the ratio of the estimated average annual benefit, $161,602, to the estimated average annual equivalent cost $73,078 is 2.21 to 1 based on 1955 price levels for most and long-term prices contained in the 1957 estimate by BAE for benefits.

DESCRIPTION OF THE WATERSHED

Physical Data

Elm Fork of the Trinity River rises near the town of Saint Jo in Montague County, Texas, and flows in a southerly direction for 94 miles, emptying into the Trinity River in the west-central part of Dallas County near the city of Dallas. This flood prevention work plan covers that portion of the Elm Fork above its confluence with Clear Creek, excluding the drainage area of Isle du Bois Creek. Spring, Wheeler, Pecan, Dry Elm and Brushy Creeks are the major tributaries in this watershed.

The watershed has an area of 253,810 acres (397 square miles) of which 244,533 acres are in farms and ranches and 9,277 acres are in urban areas, roads, railroads and other miscellaneous uses. The bottom land area included 21,291 acres of flood plain, and 2,000 acres of stream channels. This includes 11,591 acres of flood plain on the main stream and tributaries above the confluence of Elm Fork with Spring Creek, and 9,700 acres on the main stem and tributaries below this point. Under present conditions all of the flood plain would be inundated by the design storm of a 25-year frequency 24-hour duration which is expected to produce 4.95 inches of runoff. The largest rain considered in the 20-year period of study was one of 6.72 inches producing 3.17 inches of runoff. Under present conditions this storm would flood 8,826 acres on Elm Fork and its tributaries

above the confluence with Spring Creek, and 7,201 acres on the main stem and tributaries below this point.

The Elm Fork watershed lies within two principal problem areas in soil conservation. About 85 percent is in the Grand Prairie area, with a narrow band of Forested Coastal Plain soils along the eastern edge of the watershed. The Grand Prairie section of the watershed was at one time a grass-covered plain. Soils in this area were developed from limestone and shale formations. They are usually shallow and light brown in color. Most of the very shallow soils, which lie in the extreme headwater reaches of the watershed, are not suited for cultivation. The Grand Prairie soils in the central and lower reaches of the drainage area are deeper and more fertile, and are used extensively for the production of cultivated crops. A high percentage of the area is used for the production of small grain. The Forested Coastal Plain soils were largely timbered until cleared for cultivation. These soils have a light sand-textured topsoil with tight or compact subsoils. Only about 20 percent of the Forested Coastal Plain area is used for the production of cultivated crops at the present time.

The topography of the watershed ranges from gently rolling to rolling with a well developed drainage pattern. The general stream courses trend to the south and east. Local relief along the major valleys range from a minimum of 50 feet to a maximum of 200 feet near the headwaters. Elevations range from about 510 feet in the stream channel above Lake Garza-Little Elm to 1,200 feet above sea level at the northern divide.

At the present time approximately 46.5 percent of the watershed is in cultivation. Small grain and hay crops are grown on about 75 percent of the cultivated acreage. Row crops occupy about 10 percent and legumes, chiefly sweetclovers and alfalfa, are grown on 15 percent of the area.

Total land use in the watershed is estimated as follows:

Land Use	Acres	Percent
Cultivation	117,922	46.5
Pasture	83,211	32.8
Range	32,400	12.8
Wooded Pasture	3,000	1.2
Formerly Cultivated	8,000	3.1
Stream Channels	2,000	0.8
Lake Surface 1/	2,077	0.8
Miscellaneous 2/	5,200	2.0
Total	253,810	100.0

1/ Lake Garza-Little Elm.
2/ Includes roads, highways, railroads, towns, etc.

All of the western part of the drainage area, about 90 percent of the total, lies within the Central Lowland physiographic province, and the small strip along the eastern divide is in the West Gulf Coastal Plain. The oldest formation, which is the Paluxy sand of Lower Cretaceous age, occupies small linear strips along the valleys of headwater streams in the western edge of the drainage. This small area of sandy beds is the only representative of the West Cross Timbers Belt in the watershed. Many of the small streams have entrenched themselves in this formation, and sandy deposits in the upper valleys have been produced by erosion in this area.

About 85 percent of the drainage area, including all of the central part, lies within the Grand Prairie belt which is underlain by shales, marls and limestones of the Washita and Fredericksburg groups of Lower Cretaceous age. This area has been subject to relatively little accelerated erosion. Stream channels in general are swept clean of sediment and commonly flow over limestone ledges with intervening reaches of shales.

The narrow strip of Forested Coastal Plain along the eastern divide extends from Gainesville to Lake Garza-Little Elm. This strip is characterized by light colored, sandy, easily eroded soils which have developed from the underlying Woodbine formation.

Dams constructed in the Paluxy and Woodbine sands will be subject to some seepage. Foundation drains will be required to safeguard these dams. Emergency spillway erosion will be a problem. Dams constructed in the Washita and Fredericksburg formation will also suffer from leakage, but this should not endanger the dams. The cost of spillway and core trench excavation will be higher than average in these formations.

Rangeland is of one general type. The present condition of the grass cover ranges from poor to good as a result of some excessive use. There are three range sites in the watershed all within the Grand Prairie Problem area. These are described as follows:

The Medium Deep Soil Site. The topography is gently sloping to hilly. The predominant soils are from 10 to 20 inches in depth, fine textured and slowly permeable. The climax grasses include little bluestem, big bluestem, Indiangrass, switchgrass, sideoats grama, hairy grama and dropseeds. Invaders are threeawn, hairy tridens, buffalograss, silver bluestem, western ragweed and annuals. This site generally is in fair to good condition.

The Deep Land Site. The topography includes gently rolling and bottom lands. The predominant soils are in excess of 20 inches in depth, fine textured and slowly permeable. This site has the highest forage production, potential of any site in the watershed. The climax grasses include big bluestem, little bluestem, switchgrass, Indiangrass, sideoats grama, Canada wildrye and dropseeds. Invaders are silver bluestem, threeawn, buffalograss, western ragweed and annuals.

Shallow Land Site. The topography of this site ranges from almost level to low rolling hills. The soils included in this site are less than 10 inches in depth, usually stony, fine textured and slowly permeable. Climax grasses include sideoats grama, little bluestem, hairy grama and Texas wintergrass. Invaders are buffalograss, threeawn, prickly pear, ragweed, broomweed and annuals. This site is usually in poor to fair condition.

The following table describes the rangeland by range sites and condition class:

Range Site	Condition Class	Acres
Medium Deep Soil Site	Excellent	648
	Good	2,268
	Fair	2,268
	Poor	1,296
Total		6,480
Deep Land Site	Excellent	972
	Good	5,832
	Fair	3,888
	Poor	2,268
Total		12,960
Shallow Land Site	Excellent	648
	Good	2,592
	Fair	5,832
	Poor	3,888
Total		12,960
Total Acres Native Rangeland		32,400

Extreme temperatures range from 12 degrees below zero to 114 degrees above zero, with mean temperatures ranging from 43 degrees in the winter to 83 degrees in the summer. The average dates of the first and last killing frost are November 7 and March 25 respectively, giving an average growing season of 227 days.

The average annual precipitation is 34.2 inches with the greater amounts of rain falling during the months of April, May, June and October. Rains of high intensities are frequent.

Water for domestic use in the urban areas is supplied from deep wells into the Trinity Sand. Shallow wells provide the water for livestock and domestic use in rural areas, with many small ponds furnishing additional supplies for livestock. Long periods of drouth have lowered the water table to the extent of endangering the supply of water from the shallow wells. The quality of this water is very good. The expected future needs for domestic and industrial use will definitely create a demand for further water development.

The Elm Fork watershed is served by four Soil Conservation Service work units which are assisting the Upper Elm-Red and Denton-Wise Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 750 conservation plans on 170,892 acres within the watershed. Where land treatment measures have been applied and maintained for as long as two or three years, crop yields have increased 25 to 35 percent.

Economic Data

The lands in the upper portion of the watershed are used principally for the production of livestock and dairy products. The central and lower portions are used principally for dairying and the production of small grain and hay crops.

There are approximately 1,050 farms in the Elm Fork watershed with an average size of 230 acres. The present market value of land ranges from $100 per acre upward with well improved farms bringing $200 or more per acre.

Opportunities for off-the-farm work exist in all the larger cities and towns. Gainesville, the county seat of Cooke County, has a large per-capita industrial production. The manufacture of oil field supplies, aircraft parts, shoes, flour, cottonseed oil, foodstuffs, petroleum products and fishing supplies is carried on. Many residents within this area find employment in the industrial plants in the Dallas-Fort Worth area. Muenster is known for its dairy products processing plant

The principal crops grown on the upland in the watershed are oats, wheat, native hay, corn and cotton, with 46.5 percent of the farm land being devoted to the production of these crops. The approximate yields per acre are: oats, 35 bushels; wheat, 13 bushels; corn, 30 bushels, and lint cotton, 200 pounds. Other crops grown are sweet clovers, vetch and rye, grain sorghums, alfalfa and Johnsongrass hay. Production is still good on the level and gentle slopes but the need for improved crop rotations on much of the cropland to increase the organic matter and productivity of the soil is apparent. Cultivated areas on steeper slopes are badly eroded and should be planted to permanent grasses.

Approximately 55 percent of the flood plain on the main stem of Elm Fork is in cultivation, 18 percent in Johnsongrass, 13 percent in pasture, 4 percent idle, 7 percent woods, and 3 percent miscellaneous uses. The flood plain on the tributaries is less intensively used. The chief crops grown on the flood plain are alfalfa, Johnsongrass hay, wheat and corn.

The principal towns and communities in the watershed with their 1950 populations as given in the Texas Almanac are:

Towns	Population
Saint Jo	1,147
Muenster	896
Myra	180
Gainesville	13,500
Valley View	650

Approximately 8,500 people live in the rural areas of the watershed.

The 357 miles of roads, of which 90 miles are paved, are adequate to provide access to all parts of the watershed. Floods occasionally make some of the roads impassable because of bridge and road washouts. The detours thus occasioned cause delay and extra travel to and from places of market. The two railroads which traverse the watershed provide ample loading facilities for carload lot shipments. Many producing shallow oil wells have been drilled throughout the upper portion of the watershed.

WATERSHED PROBLEMS

Floodwater Damage

Elm Fork and its tributaries flood frequently and cause high annual damage. Flooding occurs several times a year on the watershed. The flood plain is wide and flat, consequently a small rise above bank-full stage will cause large areas to be flooded. During the 20-year period, 1923 to 1942 inclusive, there were 12 floods that covered more than one-half of the flood plain, and 23 smaller floods. Floods occurring during the growing season have caused considerable damage to growing crops. For the floods experienced during the 20-year period studied, the total direct floodwater and sediment damages were estimated to average $79,394 annually under present conditions, of which $53,748 is crop and pasture damage. In addition, there are numerous indirect damages such as the interruption of travel, initial losses sustained by dealers and industries in the area, and similar items. The total annual value of these indirect damages is estimated to be $17,939. The average annual monetary flood damages are summarized in Table 4.

Sediment Damage

Lake Dallas is located on the Elm Fork of the Trinity River and receives sediment from the 397 square miles of watershed included in the scope of this work plan. It is estimated that the lake receives 318 acre-feet of sediment deposition annually from the watershed under present land use conditions. It is estimated that after the application of land treatment practices and measures on the watershed the annual sediment accumulation in the reservoir will be reduced to 252 acre-feet. This is an average reduction of 25 percent. The addition of the proposed floodwater retarding structures is expected to reduce the sediment accumulation to 190 acre-feet annually, or a total reduction of 40 percent. Since Lake Dallas is a part of the storage basin of the Garza-Little Elm Reservoir constructed by the Corps of Engineers, the above rates for the area covered by this report will also apply to the new reservoir in the calculation of damages.

These estimates are based on a detailed sedimentation survey of Lake Dallas, made in 1938 by the Soil Conservation Service. The lake was 10.5 years old at the time of the survey.

It is estimated that modern overbank deposition has occurred on approximately 5,600 acres of Elm Fork and tributary valley flood plains. The major areas affected extend from the headwater tributaries to Myra, and from Valley View to the backwaters of Lake Garza-Little Elm. The deposits in the upper reaches consist mostly of sand, and the modern deposition in the lower reaches is principally clay and silt with some fine sand. Most of the deposits are in the form of natural levees that average 200 to 400 feet in width along each side of the stream channel. They range from 2 to 3 feet in thickness along the stream banks to about 0.5 of a foot along the outer edge which is located an average of 300 feet from the stream banks. The estimated average annual damages caused by these modern deposits are as follows. (1) 1,000 acres of cropland damaged 5 percent, 1,000 acres damaged 10 percent, and 300 acres damaged 20 percent; and (2) 1,500 acres of pastureland damaged 5 percent, 1,500 acres damaged 10 percent, and 350 acres damaged 20 percent.

Channel filling is of minor importance in the watershed. Gravel bars which partially plug the channel occur along the inside of bends above Lindsay. Reduction in channel capacity caused by these partial plugs is probably 5 percent or less. In the lower reaches of the drainage system below State Highway 10 the reduction in channel capacity averages 10 to 15 percent. Some of the smaller streams originating in the Forested Coastal Plain areas have lost up to 50 percent of their capacity, especially where they enter the Elm Fork flood plain.

Poor surface drainage or swamping has affected 180 acres of the flood plain. Of this area 150 acres are cultivated land and 30 acres are pastureland. Damages range from 50 to 90 percent. These damages which result when sediment deposits plug the outlets of scour channels into the natural stream, are included in the damages estimated from overbank deposition and flood plain scour.

Damage caused by the deposition of fine sediment (silt and clay) on field crops and pasture grasses is of minor consequence. Some damages have resulted from the deposition of sediment in urban residences, business establishments and on city streets and state highways. These damages were measured in terms of the cost of sediment removal and are included with floodwater damages, Table 4.

Erosion Damage

Erosion in the Elm Fork watershed consists largely of sheet erosion, with both sheet and gully erosion occurring in the outcrop area of the Woodbine sand (Forested Coastal Plain). Continued and intensive cultivation of the rather light sandy soils has depleted the land to the extent that numerous areas have been abandoned from crop production. The Grand Prairie area is covered by brown, clay prairie soils. These soils, in general, are not subject to extensive accelerated gully erosion because of the rather shallow soil mantle and hard underlying limestone and shale formations. Some of the cultivated land, especially on the steeper slopes, is subject to moderate to severe sheet erosion.

Damages caused by flood plain scour have been rather severe in the lower reaches of the watershed. Scour channels usually are not continuous but are found throughout the flood plain. These channels average 2 to 3 feet in depth and have sloping sides. Most channels are crossable with tillage implements, but yields of crops are materially reduced by lowered productivity and prolonged wet conditions. A total area of 2,440 acres has been damaged 10 to 50 percent by scouring or erosion of the surface soils. Of the total area affected, 90 percent is cropland.

Lateral bank erosion on the channels of the Elm Fork drainage system has been very slight. Some erosion has occurred along the outside of the stream meanders but this is partially offset by filling along the inside of the bends. Most of the bank erosion is occurring in the headwater tributaries.

Sediment yields for the watershed are generally low, but range from 0.5 to 3.0 acre-feet per square mile of drainage area. The low rates occur in the Grand Prairie rangeland area which has a low percentage of cultivated land. The high rates occur in the Forested Coastal Plain and Grand Prairie farming areas on small watersheds having a high percentage in cultivation. These rates are based on sedimentation surveys made in this and other watersheds in the Forested Coastal Plain and Grand Prairie Problem Areas in Soil Conservation.

Problems Relating to Methods now used in the Conservation, Development, Utilization and Disposal of Water

Work along the flood plain lands of this watershed has been carried on by individual landowners to control low flows which overflow the main channels and cause damage to crops and farm land. This has been accomplished to some extent by constructing small channels, diversion terraces and a few very small dykes. These measures have been ineffective for the larger stream flows. The clearing of brush from channels has opened some of the restricted sections. Decreased flows, as a result of the flood prevention program, will permit more effective protection and utilization of flood plain lands.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

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 Upper Elm-Red and Denton-Wise Soil Conservation Districts, is essential to a sound and continuing flood prevention program in the watershed. Basic to the attainment of this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices. Emphasis will be placed on accelerating the establishment of those land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

An important phase of the work is the establishing of 4,476 acres of vegetated waterways to facilitate the construction of 3,486 miles of terraces and 108 miles of diversions. These waterways must be established before the terracing program can progress. An equally important phase is planting 8,000 acres of formerly cultivated land to pasture, reseeding 8,750 acres of range and overseeding 8,000 acres of pasture which have been overgrazed to the extent that overseeding is necessary to establish effective stands and adequate cover to reduce erosion and sediment yield. These measures will be installed by the landowners and operators in the watershed.

Other land treatment measures which will have a direct effect on flood prevention and which will be applied include contour farming, cover cropping, rotation hay and pasture, crop residue utilization and proper use of both pasture and rangeland. A total of 892 farm ponds will be constructed for adequate distribution of grazing on the grassland. Legumes in a conservation crop rotation and in pasture improvement will be planted on 82,350 acres to improve water-holding capacity of the soils, increase infiltration rate, improve soil fertility and reduce erosion. Rotation hay and pasture will be practiced on 32,100 acres. Proper use of pasture and rangeland will be practiced on 106,761 acres. The estimated cost of planning and establishing these measures is $2,689,474, as shown in Table 1.

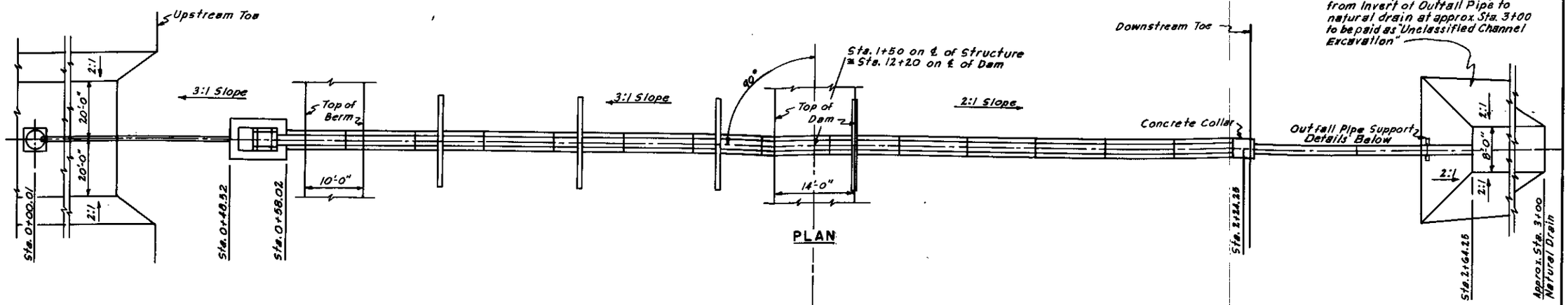
Under the guidance and with the assistance of the Upper Elm-Red and Denton-Wise Soil Conservation Districts, landowners will apply other needed measures not included in Table 1, such as improving adapted areas to provide cover for wildlife. Selected farm ponds will be stocked and managed for fish production. These practices are a part of a complete soil, plant and water conservation program, but since they do not contribute directly to flood prevention program their cost has not been included in Table 1.

Structural Measures for Flood Prevention

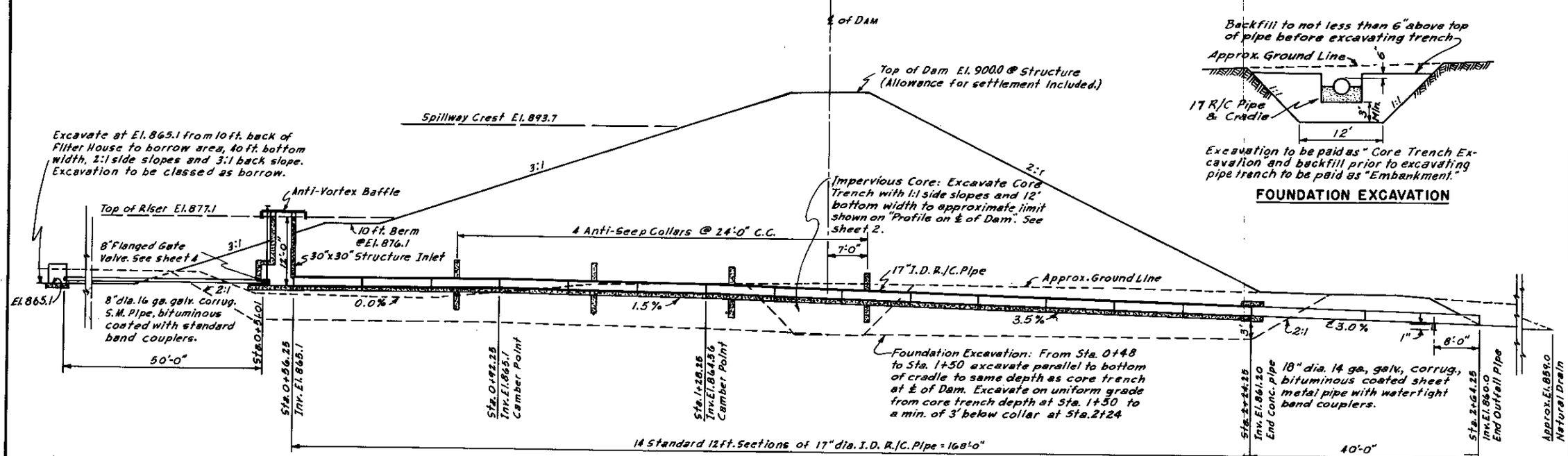
Waterflow Control Measures:

The floodwater retarding structures needed to provide flood protection for the flood plain lands, roads, bridges, and rural improvements are listed with their cost in Table 1. A plan of a typical floodwater retarding structure is shown by Figure 1. To comply with existing Texas State Laws no water will be stored in the sediment pool in excess of 200 acre-feet without the landowner receiving prior approval from the State Board of Water Engineers. The sediment pool and a portion of the detention pool will be designed to store the sediment yield expected from the drainage area of the structure during a 50-year period.

A system of 35 floodwater retarding structures is to be installed to protect the flood plain along Elm Fork and Brushy, Dry Elm, Montague, Pecan and Wheeler Creeks. The structures will be constructed at or



PLAN



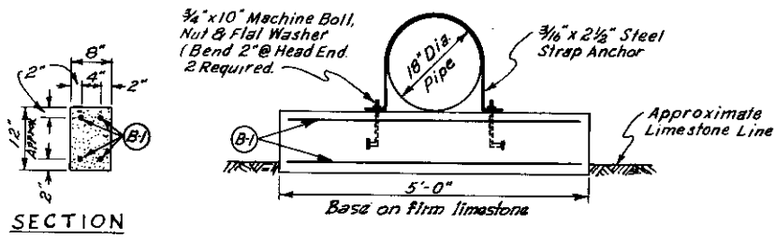
SECTION

STRUCTURE

DETAILS ON SHEET 4

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

FOUNDATION EXCAVATION



OUTFALL PIPE SUPPORT

Steel & Concrete quantities shown in Steel Schedule on Sheet No. 4

Figure 1

STRUCTURE — PLAN AND SECTION
FLOODWATER RETARDING STRUCTURE SITE No. 6-L
ELM FORK WATERSHED
OF THE
TRINITY RIVER WATERSHED — TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.W.T.	Date 12-13-55	Approved by W.M. REGD. ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS	
Drawn G.W.T. & G.R.			
Traced G.R.	1-3-56	STATE CONSERVATION ENGINEER, T.C.C. TEMPLE, TEXAS	
Checked G.W.T.	5/56	Sheet No. 3 of 6	Drawing No. 4-E-10,205

near the location shown on the Structure Location Map, Figure 2. Data concerning the floodwater retarding structures are summarized in Tables 6 and 6A. These structures will not inundate any of the flood plain area.

The system of structures will temporarily detain runoff from 36 percent of the watershed above Valley Section No. 9 located on the main stem of Elm Fork immediately above its confluence with Spring Creek. Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar type spillways.

The total estimated cost for installing the floodwater retarding structures is $1,938,937. Their annual equivalent cost, including operation and maintenance, is $73,078.

Effect of Works of Improvement on Damages and Benefits

The combined program of land treatment and structural measures described above would prevent damage on the flood plain of Elm Fork and its tributaries above the confluence with Spring Creek from all of the 28 minor floods such as occurred in the 20-year period 1923 - 1942 inclusive. Only benefits from the reduction of sediment damages have been claimed below this point. Of the 12 major floods that occurred during this period 11 would be reduced to minor floods.

Average annual flooding on Elm Fork and tributaries above the mouth of Spring Creek will be reduced from 5,682 acres to approximately 1,370 acres. The estimated average annual flood damage, based on the floods experienced in the 20-year period of study, will be reduced from $197,333 to $42,349. The estimated reduction in flood damages, $154,984, resulting from this program represents 78 percent of the estimated damages under present conditions.

Approximately 60 percent of the expected reduction in average annual flood damages, based on the investigation of damages caused over the 20-year period studied, would result from the system of floodwater retarding structures. Of the total reduction in damage from all measures shown in Table 4, that resulting from floodwater retarding structures is $118,742.

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore much of the land now in relatively unproductive use to more intensive use. The increased annual net income of such restoration is estimated at $14,286 after deduction of all expenses. Farmers operating flood plain lands indicate further that intensification of use beyond previous standards will take place in some areas. Alfalfa, corn and cotton would be grown in these areas. The increased annual net benefit from this intensified land use is estimated at $42,860.

The total flood prevention benefit, including both the reductions in flood damages and benefits from more intensive use of flood plain lands, are estimated to be $161,602 annually.

COMPARISON OF BENEFITS AND COSTS

The ratio of the average annual benefit from structural measures for flood prevention, $161,602, to the annual cost of the measures, $73,078, is about 2.21 to 1 based on 1955 price levels as projected by BAE in 1951 for cost and long-term prices for benefits.

ACCOMPLISHING THE PLAN

Land Treatment Measures

Land treatment measures itemized in Table 1 will be established on the land by farmers in cooperation with the Upper Elm-Red and Denton-Wise 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, based on the current program, for a portion of this cost through the existing Agricultural Conservation Program. The farmer cost, less the estimated ACP payment, is shown for each land treatment measure in Table 1. The soil conservation districts are giving assistance in the planning and application of these measures under their going programs. This assistance is being accelerated through the Soil Conservation Service work units to assure installation of the needed measures as rapidly as possible.

The governing bodies of the Upper Elm-Red and Denton-Wise Soil Conservation Districts will arrange for meetings according to a definite schedule, and by individual contacts will encourage the landowners and operators within the Elm Fork 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. Each district-governing body will make periodic inspections of the completed conservation measures within its district and follow through to see that needed maintenance is performed.

The Soil Conservation Service work units at Gainesville, Muenster, Pilot Point, and Denton will assist landowners and operators cooperating with the districts in accelerating the preparation and application of soil and water conservation plans.

The Extension Service will carry out the educational phase of the program by conducting general information and local farm meetings, the preparation of radio and press releases, and the use of other methods of disseminating information to reach the landowners and operators in the Elm Fork watershed to help achieve understanding and stimulate participation in carrying out the entire plan.

The Farmers Home Administration soil and water conservation loan program is 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 program.

The County ASC Committees will cooperate with the governing bodies of the soil conservation districts by selecting and providing 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 35 floodwater retarding structures. It will also provide technical specialists to plan, design, prepare specifications, supervise construction, prepare contract payment estimates, make final inspection, certify completion and perform related duties for the installation of these structural measures.

The Upper Elm-Red 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 that have favorable benefit-cost ratios based on those benefits that will accrue to each group.

Subwatershed Construction Units	No. of Sites	Annual Benefits (dollars)	Annual Cost (dollars)	Benefit-Cost Ratio (dollars)
1. Elm Fork above Confluence with Brushy, 1 through 5, 5A, 5B, 6H, 6I, 6J-2, 6K-2, 6L, 6M, 6N, 6-0	15	58,998	27,448	2.14:1
2. Brushy Creek, 6A-1, 6B, 6E	3	7,353	5,310	1.38:1
3. Dry Elm Creek 7A,7B,7D,7F,7G	5	25,190	11,828	2.13:1
4. Montague Creek, 9	1	8,975	3,038	2.95:1
5. Pecan Creek, 11A, 11A-1	2	5,831	3,188	1.61:1
6. Wheeler Creek, 11B, 12	2	8,650	3,854	2.24:1
7. Lower Elm Fork Tributaries, 14, 15, 16, 16B, 16C, 17, 18	7	46,605	18,412	2.53.1

Construction can be started on any one of the first six units as soon as local interests have obtained the necessary easements and rights-of-way for all structures in the groups and Federal funds are available.

Table 1 indicates the planned schedule of operation for each phase of the project. The cooperating parties have agreed that this schedule should

be followed to achieve the most efficient prosecution of the work. This schedule will be adjusted year-by-year on the basis of any significant changes in the plan found to be mutually desired and in light of current appropriations and accomplishments. 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 installed and maintained by the landowners or operators of the farms on which the measures are installed under agreements with the Upper Elm-Red and Denton-Wise Soil Conservation Districts. Representatives of the soil conservation districts will make periodic inspections of these measures to determine needs and encourage landowners and operators to perform maintenance. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The 35 floodwater retarding structures will be maintained by the Upper Elm-Red Soil Conservation District and the Elm Fork Watershed Association.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or stream flow. 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.

The estimated annual operation and maintenance cost is $3,266, based on present construction costs. The necessary maintenance work will be accomplished through the use of resources of the Upper Elm-Red Soil Conservation District and the Elm Fork Watershed Association

TABLE 1 - ESTIMATED INSTALLATION COST
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: 7/1/50 to 6/30/56

Items	Unit	No. Applied: 7/1/50 to 6/30/56	Estimated Cost: Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	15,300	-	15,300	15,300
Cover Cropping	Acre	19,500	-	195,000	195,000
Rotation Hay & Pasture	Acre	13,500	-	162,000	162,000
Crop Residue Utilization	Acre	29,500	-	14,750	14,750
Proper Use	Acre	13,300	-	26,600	26,600
Range Seeding	Acre	1,200	-	15,600	15,600
Pasture Planting	Acre	4,300	-	60,200	60,200
Terracing	Mile	485	-	48,500	48,500
Diversion Construction	Mile	30	-	7,500	7,500
Waterway Development	Acre	1,365	-	47,775	47,775
Pond Construction	No.	432	-	64,800	64,800
Technical Assistance (Accl.)			71,277	-	71,277
SCS Subtotal			71,277	658,025	729,302
TOTAL LAND TREATMENT			71,277	658,025	729,302
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	1,2,3,4,5,5A, 5B,6M,6N,6-0, 6H,6I,6J-2	468,440	-	468,440
TOTAL CONSTRUCTION COST			468,440	-	468,440
TOTAL INSTALLATION COST			139,304	-	139,304
TOTAL OTHER COST			-	38,623	38,623
TOTAL STRUCTURAL MEASURES			607,744	38,623	646,367
Work Plan Preparation Cost			20,635	-	20,635
GRAND TOTAL			699,656	696,648	1,396,304
SUMMARY					
Total SCS			699,656	696,648	1,396,304
GRAND TOTAL			699,656	696,648	1,396,304

Date: June, 1956

TABLE 1 - ESTIMATED INSTALLATION COST
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: Fiscal Year 1957

Items	Unit	No. to be Applied	Estimated Cost		Total
			Federal	Non-Federal	
			(dollars)	(dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	1,050	-	1,050	1,050
Cover Cropping	Acre	3,500	-	35,000	35,000
Rotation Hay & Pasture	Acre	3,040	-	36,480	36,480
Crop Residue Utilization	Acre	3,200	-	1,600	1,600
Proper Use	Acre	4,660	-	9,320	9,320
Range Seeding	Acre	120	-	1,560	1,560
Pasture Planting	Acre	630	-	8,820	8,820
Terracing	Mile	40	-	4,000	4,000
Diversion Construction	Mile	2	-	500	500
Waterway Development	Acre	160	-	5,600	5,600
Pond Construction	No.	50	-	7,500	7,500
Technical Assistance (Acct.)			7,000	-	7,000
SCS Subtotal			7,000	111,430	118,430
TOTAL LAND TREATMENT			7,000	111,430	118,430
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	6K-2, 6L, 7B	113,321	-	113,321
TOTAL CONSTRUCTION COST			113,321	-	113,321
TOTAL INSTALLATION COST			33,996	-	33,996
TOTAL OTHER COST			-	7,845	7,845
TOTAL STRUCTURAL MEASURES			147,317	7,845	155,162
Work Plan Preparation Cost			-	-	-
GRAND TOTAL			154,317	119,275	273,592
SUMMARY					
Total SCS			154,317	119,275	273,592
GRAND TOTAL			154,317	119,275	273,592

TABLE 1 - ESTIMATED INSTALLATION COST
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: Fiscal Year 1958

Items	Unit	No. to be Applied	Estimated Cost		Total
			Federal	Non-Federal	
			(dollars)	(dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	1,210	-	1,210	1,210
Cover Cropping	Acre	4,025	-	40,250	40,250
Rotation Hay & Pasture	Acre	3,500	-	42,000	42,000
Crop Residue Utilization	Acre	3,680	-	1,840	1,840
Proper Use	Acre	5,360	-	10,720	10,720
Range Seeding	Acre	140	-	1,820	1,820
Pasture Planting	Acre	725	-	10,150	10,150
Terracing	Mile	46	-	4,600	4,600
Diversion Construction	Mile	3	-	750	750
Waterway Development	Acre	184	-	6,440	6,440
Pond Construction	No.	60	-	9,000	9,000
Technical Assistance (Accl.)			6,500	-	6,500
SCS Subtotal			6,500	128,780	135,280
TOTAL LAND TREATMENT			6,500	128,780	135,280
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	6A-1, 6E, 6B, 7D	149,745	-	149,745
TOTAL CONSTRUCTION COST			149,745	-	149,745
TOTAL INSTALLATION COST			44,924	-	44,924
TOTAL OTHER COST			-	14,206	14,206
TOTAL STRUCTURAL MEASURES			194,669	14,206	208,875
Work Plan Preparation Cost			-	-	-
GRAND TOTAL			201,169	142,986	344,155
SUMMARY					
Total SCS			201,169	142,986	344,155
GRAND TOTAL			201,169	142,986	344,155

Date: June, 1956

TABLE 1 - ESTIMATED INSTALLATION COST
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: Fiscal Year 1959

Items	Unit	No. to be Applied	Estimated Cost		Total
			Federal (dollars)	Non-Federal (dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	1,365	-	1,365	1,365
Cover Cropping	Acre	4,550	-	45,500	45,500
Rotation Hay & Pasture	Acre	3,950	-	47,400	47,400
Crop Residue Utilization	Acre	4,160	-	2,080	2,080
Proper Use	Acre	6,060	-	12,120	12,120
Range Seeding	Acre	160	-	2,080	2,080
Pasture Planting	Acre	820	-	11,480	11,480
Terraces	Mile	52	-	5,200	5,200
Diversion Construction	Mile	4	-	1,000	1,000
Waterway Development	Acre	210	-	7,350	7,350
Pond Construction	No.	65	-	9,750	9,750
Technical Assistance (Accl.)			6,500	-	6,500
SCS Subtotal			6,500	145,325	151,825
TOTAL LAND TREATMENT			6,500	145,325	151,825
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	7A,7F,7G	125,212	-	125,212
TOTAL CONSTRUCTION COST			125,212	-	125,212
TOTAL INSTALLATION COST			37,564	-	37,564
TOTAL OTHER COST			-	9,728	9,728
TOTAL STRUCTURAL MEASURES			162,776	9,728	172,504
Work Plan Preparation Cost			-	-	-
GRAND TOTAL			169,276	155,053	324,329
SUMMARY					
Total SCS			169,276	155,053	324,329
GRAND TOTAL			169,276	155,053	324,329

Date: June, 1956

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: Remaining to be Done

Items	Unit	No. to be Applied	Estimated Cost		Total
			Federal (dollars)	Non-Federal (dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	59,590	-	59,590	59,590
Cover Cropping	Acre	50,775	-	507,750	507,750
Rotation Hay & Pasture	Acre	8,110	-	97,320	97,320
Crop Residue Utilization	Acre	46,760	-	23,380	23,380
Proper Use	Acre	77,381	-	154,762	154,762
Range Seeding	Acre	7,130	-	92,690	92,690
Pasture Planting	Acre	9,525	-	133,350	133,350
Terracing	Mile	2,863	-	286,300	286,300
Diversion Construction	Mile	69	-	17,250	17,250
Waterway Development	Acre	2,557	-	89,495	89,495
Pond Construction	No.	285	-	42,750	42,750
Technical Assistance (Accl.)			50,000	-	50,000
SCS Subtotal			50,000	1,504,637	1,554,637
TOTAL LAND TREATMENT			50,000	1,504,637	1,554,637
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	9, 11A, 11A-1, 11B, 12, 14, 15, 16, 16B, 16C, 17, 18	530,687	-	530,687
TOTAL CONSTRUCTION COST			530,687	-	530,687
TOTAL INSTALLATION COST			159,208	-	159,208
TOTAL OTHER COST			-	66,134	66,134
TOTAL STRUCTURAL MEASURES			689,895	66,134	756,029
Work Plan Preparation Cost			-	-	-
GRAND TOTAL			739,895	1,570,771	2,310,666
SUMMARY					
Total SCS			739,895	1,570,771	2,310,666
GRAND TOTAL			739,895	1,570,771	2,310,666

Date: June, 1956

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

For: Total Project

Items	Unit	Total to be Applied	Estimated Cost		Total
			Federal	Non-Federal	
			(dollars)	(dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	78,515	-	78,515	78,515
Cover Cropping	Acre	82,350	-	823,500	823,500
Rotation Hay & Pasture	Acre	32,100	-	385,200	385,200
Crop Residue Utilization	Acre	87,300	-	43,650	43,650
Proper Use	Acre	106,761	-	213,522	213,522
Range Seeding	Acre	8,750	-	113,750	113,750
Pasture Planting	Acre	16,000	-	224,000	224,000
Terracing	Mile	3,486	-	348,600	348,600
Diversion Construction	Mile	108	-	27,000	27,000
Waterway Development	Acre	4,476	-	156,660	156,660
Pond Construction	No.	892	-	133,800	133,800
Technical Assistance (Accl.)			141,277	-	141,277
SCS Subtotal			141,277	2,548,197	2,689,474
TOTAL LAND TREATMENT			141,277	2,548,197	2,689,474 1/
STRUCTURAL MEASURES					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	No.	35	1,387,405	-	1,387,405
TOTAL CONSTRUCTION COST			1,387,405	-	1,387,405
TOTAL INSTALLATION COST			414,996	-	414,996
TOTAL OTHER COST				136,536	136,536
TOTAL STRUCTURAL MEASURES	-		1,802,401	136,536	1,938,937
Work Plan Preparation Cost			20,635	-	20,635 2/
GRAND TOTAL			1,964,313	2,684,733	4,649,046
SUMMARY					
Total SCS			1,964,313	2,684,733	4,649,046
GRAND TOTAL			1,964,313	2,684,733	4,649,046

1/ Estimated $548,180 reimbursement to local interests by ACPS not included.
2/ Includes $14,235 cost of preparation of original plan.

Date: June, 1956

TABLE 2
STATUS OF FLOOD PREVENTION JOB PRIOR TO FIRST YEAR OF WORK PLAN
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
Date: June, 1956
(Trinity River Watershed)

Measure	Unit	Number	Federal Cost 1/	Non-Federal Construction 2/	Total Cost
			(dollars)	(dollars)	(dollars)
LAND TREATMENT MEASURES					
Contour Farming	Acre	17,100			
Cover Cropping	Acre	23,100			
Rotation Hay and Pasture	Acre	15			
Crop Residue Utilization	Acre	36,600			
Proper Use	Acre	19,850			
Range Seeding	Acre	350			
Pasture Planting	Acre	3,510			
Terracing	Mile	557			
Diversion	Mile	32			
Waterway Development	Acre	423			
Pond Construction	No.	185			
Technical Assistance (Accl.)	-	-			
Subtotal			39,545	535,040	574,585
STRUCTURAL MEASURES					
Floodwater Retarding Structures	Each	-	-	-	-
Subtotal		-	-	-	-
Total		-	39,545	535,040	574,585

1/ Flood Prevention Funds including acceleration funds
2/ Excludes estimated amount by which private interests were reimbursed from ACPS funds.

TABLE 3 - ANNUAL COSTS

Elm Fork Watershed, Texas
(Trinity River Watershed)

Measures	AMORTIZATION OF INSTALLATION COSTS 1/			OPERATION AND MAINTENANCE COSTS 2/			Total
	Federal	Non-Federal	Total	Federal	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
STRUCTURAL MEASURES FOR FLOOD PREVENTION							
Waterflow Control							
1. Floodwater Retarding Structure No. 1	1,929	207	2,136	-	115	115	2,251
2. Floodwater Retarding Structure No. 2	1,728	171	1,899	-	115	115	2,014
3. Floodwater Retarding Structure No. 3	1,887	212	2,099	-	115	115	2,214
4. Floodwater Retarding Structure No. 4	1,007	129	1,136	-	77	77	1,213
5. Floodwater Retarding Structure No. 5	3,177	646	3,823	-	154	154	3,977
6. Floodwater Retarding Structure No. 5A	1,101	45	1,146	-	77	77	1,223
7. Floodwater Retarding Structure No. 5B	1,629	63	1,692	-	115	115	1,807
8. Floodwater Retarding Structure No. 6H	1,154	41	1,195	-	77	77	1,272
9. Floodwater Retarding Structure No. 6I	1,438	76	1,514	-	77	77	1,591
10. Floodwater Retarding Structure No. 6J-2	1,274	72	1,346	-	77	77	1,423
11. Floodwater Retarding Structure No. 6K-2	1,055	57	1,112	-	77	77	1,189
12. Floodwater Retarding Structure No. 6L	1,650	95	1,745	-	77	77	1,822
13. Floodwater Retarding Structure No. 6M	1,975	44	2,019	-	77	77	2,096
14. Floodwater Retarding Structure No. 6N	1,452	40	1,492	-	77	77	1,569
15. Floodwater Retarding Structure No. 6-O	1,677	33	1,710	-	77	77	1,787
16. Floodwater Retarding Structure No. 6A	1,804	180	1,984	-	77	77	2,061
17. Floodwater Retarding Structure No. 6B	1,590	196	1,786	-	77	77	1,863
18. Floodwater Retarding Structure No. 6E	1,231	78	1,309	-	77	77	1,386
19. Floodwater Retarding Structure No. 7A	3,462	348	3,810	-	115	115	3,925
20. Floodwater Retarding Structure No. 7B	2,490	211	2,701	-	115	115	2,816
21. Floodwater Retarding Structure No. 7D	2,238	200	2,438	-	115	115	2,553
22. Floodwater Retarding Structure No. 7F	1,033	54	1,087	-	77	77	1,164
23. Floodwater Retarding Structure No. 7G	1,245	48	1,293	-	77	77	1,370
24. Floodwater Retarding Structure No. 9	2,673	250	2,923	-	115	115	3,038

TABLE 3 - ANNUAL COSTS - Continued
Elm Fork Watershed, Texas
(Trinity River Watershed)

Measures	AMORTIZATION OF INSTALLATION COSTS 1/			OPERATION AND MAINTENANCE COSTS 2/			Total
	Federal	Non-Federal	Total	Federal	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
STRUCTURAL MEASURES FOR FLOOD PREVENTION							
Waterflow Control							
25. Floodwater Retarding Structure No. 11A	1,301	214	1,515	-	77	77	1,592
26. Floodwater Retarding Structure No. 11A-1	1,366	153	1,519	-	77	77	1,596
27. Floodwater Retarding Structure No. 11B	1,615	146	1,761	-	77	77	1,838
28. Floodwater Retarding Structure No. 12	1,711	228	1,939	-	77	77	2,016
29. Floodwater Retarding Structure No. 14	2,329	388	2,717	-	115	115	2,832
30. Floodwater Retarding Structure No. 15	2,735	360	3,095	-	115	115	3,210
31. Floodwater Retarding Structure No. 16	2,127	214	2,341	-	115	115	2,456
32. Floodwater Retarding Structure No. 16B	1,258	120	1,378	-	77	77	1,455
33. Floodwater Retarding Structure No. 16C	1,366	106	1,472	-	77	77	1,549
34. Floodwater Retarding Structure No. 17	2,373	335	2,708	-	115	115	2,823
35. Floodwater Retarding Structure No. 18	3,469	503	3,972	-	115	115	4,087
Subtotal	63,549	6,263	69,812	-	3,266	3,266	73,078
TOTAL STRUCTURAL MEASURES FOR FLOOD PREVENTION	63,549	6,263	69,812	-	3,266	3,266	73,078
GRAND TOTAL	63,549	6,263	69,812	-	3,266	3,266	73,078

1/ Based on 1955 price levels
2/ Based on long-term price levels projected in 1951.

Date: June, 1956

TABLE 4 - SUMMARY OF BENEFITS
(Based on Long-Term Price Levels)
Elm Fork Watershed, Texas

(Trinity River Watershed)

Item	Estimated Average Annual Damage Without Project	Estimated Average Annual Damage Without Structural Measures	Estimated Average Annual Damage With Project	Benefits From Structural Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater	119,883	100,390	20,386	80,004
Sediment	20,713	13,650	8,004	5,646
Erosion	38,798	32,406	10,109	22,297
Indirect	17,939	14,645	3,850	10,795
Subtotal	197,333	161,091	42,349	118,742
Benefit from Changed Use of Land	xxx	xxx	xxx	42,860
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	161,602

Date: June, 1956

Elm Fork Watershed, Texas
(Trinity River Watershed)

Measures	AVERAGE ANNUAL BENEFITS						Average Annual Cost	Benefit-Cost Ratio
	Flood-water	Sediment	Erosion	Indirect	Change of Land Use	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
STRUCTURAL MEASURES FOR FLOOD PREVENTION								
Waterflow Control								
1. Floodwater Retarding Structure No. 1	3,256	230	907	439	1,744	6,576	2,251	2.92:1
2. Floodwater Retarding Structure No. 2	2,679	189	747	361	1,435	5,411	2,014	2.69:1
3. Floodwater Retarding Structure No 3	3,080	217	858	416	1,650	6,221	2,214	2.81:1
4. Floodwater Retarding Structure No. 4	617	44	172	84	331	1,248	1,213	1.03:1
5. Floodwater Retarding Structure No. 5	10,025	707	2,794	1,353	5,370	20,249	3,977	5.09:1
6. Floodwater Retarding Structure No. 5a	617	44	172	83	331	1,247	1,223	1.02:1
7. Floodwater Retarding Structure No. 5b	962	68	268	130	516	1,944	1,807	1.08:1
8. Floodwater Retarding Structure No. 6H	898	63	250	121	481	1,813	1,272	1.43:1
9 Floodwater Retarding Structure No. 6I	1,467	104	409	198	786	2,964	1,591	1.86:1
10 Floodwater Retarding Structure No. 6J-2	978	69	273	132	524	1,976	1,423	1.39:1
11. Floodwater Retarding Structure No. 6K-2	730	52	203	99	391	1,475	1,189	1.24:1
12 Floodwater Retarding Structure No. 6L	1,179	83	329	159	632	2,382	1,822	1.31:1
13. Floodwater Retarding Structure No. 6M	1,047	75	291	140	560	2,113	2,096	1.01:1
14. Floodwater Retarding Structure No. 6N	783	55	218	106	420	1,582	1,569	1.01:1
15. Floodwater Retarding Structure No. 6-O	889	63	248	120	477	1,797	1,787	1.01:1
16. Floodwater Retarding Structure No. 6A-1	1,844	130	514	249	988	3,725	2,061	1.81:1
17. Floodwater Retarding Structure No. 6B	954	67	266	129	511	1,927	1,863	1.03:1
18. Floodwater Retarding Structure No. 6E	842	59	235	114	451	1,701	1,386	1.23:1
19. Floodwater Retarding Structure No. 7A	5,550	392	1,547	749	2,973	11,211	3,925	2.86:1
20 Floodwater Retarding Structure No. 7B	2,775	196	773	374	1,486	5,604	2,816	1.99:1
21. Floodwater Retarding Structure No. 7D	2,711	191	756	366	1,452	5,476	2,553	2.14:1
22. Floodwater Retarding Structure No. 7F	714	50	199	96	382	1,441	1,164	1.24:1
23. Floodwater Retarding Structure No. 7G	722	51	201	97	387	1,458	1,370	1.06:1
24. Floodwater Retarding Structure No. 9	4,443	314	1,238	600	2,380	8,975	3,038	2.95:1
25. Floodwater Retarding Structure No. 11A	1,885	133	525	254	1,010	3,807	1,592	2.39:1
26. Floodwater Retarding Structure No. 11A-1	1,002	71	279	135	537	2,024	1,596	1.27:1

TABLE 5 - BENEFIT-COST ANALYSIS - Continued
Elm Fork Watershed, Texas
(Trinity River Watershed)

Measures	AVERAGE ANNUAL BENEFITS						Average Annual Cost	Benefit-Cost Ratio
	Flood-water	Sediment	Erosion	Indirect	Change of Land Use	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
STRUCTURAL MEASURES FOR FLOOD PREVENTION								
Waterflow Control								
27. Floodwater Retarding Structure No.11B	1,604	113	447	216	859	3,239	1,838	1.76:1
28. Floodwater Retarding Structure No.12	2,679	189	747	361	1,435	5,411	2,016	2.68:1
29. Floodwater Retarding Structure No.14	3,432	242	956	463	1,839	6,934	2,832	2.45:1
30. Floodwater Retarding Structure No.15	5,333	376	1,486	720	2,857	10,772	3,210	3.36:1
31. Floodwater Retarding Structure No.16	2,646	187	737	357	1,418	5,345	2,456	2.18:1
32. Floodwater Retarding Structure No.16B	1,676	118	467	226	898	3,385	1,455	2.33:1
33. Floodwater Retarding Structure No.16C	1,067	75	297	144	571	2,154	1,549	1.39:1
34. Floodwater Retarding Structure No.17	4,058	286	1,131	548	2,174	8,197	2,823	2.90:1
35. Floodwater Retarding Structure No.18	4,860	343	1,355	656	2,604	9,818	4,087	2.40:1
Subtotal	80,004	5,646	22,297	10,795	42,860	161,602	73,078	2.21:1
TOTAL STRUCTURAL MEASURES FOR FLOOD PREVENTION	80,004	5,646	22,297	10,795	42,860	161,602	73,078	2.21:1
GRAND TOTAL	80,004	5,646	22,297	10,795	42,860	161,602	73,078	2.21:1

Date: June, 1956

TABLE 6 - STRUCTURE DATA
Preliminary Estimates for Floodwater Retarding Structures
Elm Fork Watershed, Texas
(Trinity River Watershed)

Site No.	Drainage Area	STORAGE CAPACITY: Sediment Pool	Reserve Below Riser	Reserve Above Riser	Det. Pool	Total	Total Sed. Storage	Total Det. Storage	Total	SURFACE AREA: Top of Sed. Pool	Top Det. Pool	Max. Ht. of Dam	Volume of Fill	PRINCIPAL SPILLWAY: Maximum Discharge Capacity
	sq.mi.	acre-feet					inches			acres		ft	cu. yd.	c.f.s.
1 1/	4.06	127	-	-	1,052	1,179	0.59	4.86	5.45	18	79	42	113,185	21
2 1/	3.34	183	-	-	910	1,093	1.02	5.11	6.13	19	77	39	130,349	17
3 1/	3.84	191	-	-	1,009	1,200	0.93	4.92	5.85	24	87	45	130,145	20
4 1/	1.88	85	-	-	508	593	0.85	5.08	5.93	12	42	34	84,882	10
5 1/	12.50	199	331	-	4,870	5,400	0.80	7.30	8.10	85	340	45	289,688	63
5-A 1/	0.77	49	-	-	203	252	1.20	4.98	6.18	6	22	40	56,827	10
5-B 1/	1.20	64	-	-	321	385	1.00	4.95	5.95	8	34	35	130,953	9
6-H	1.12	65	-	-	295	360	1.10	4.95	6.05	8	25	38	60,334	10
6-I	1.83	73	-	-	426	499	0.75	4.35	5.10	10	37	40	76,607	10
6-I-2	1.22	91	-	-	322	413	1.40	4.95	6.35	10	31	38	67,212	10
6-K-2	0.91	73	-	-	241	314	1.51	4.97	6.48	9	24	41	54,664	10
6-L	1.47	109	-	-	387	496	1.40	4.95	6.35	12	38	34	88,756	9
6-M 1/	0.78	69	-	-	200	269	1.66	4.81	6.47	9	20	40	91,500	10
6-N 1/	0.73	59	-	-	187	246	1.50	4.78	6.28	9	24	34	62,000	9
6-O 1/	0.77	58	-	-	210	268	1.40	5.18	6.58	9	21	36	69,000	10
6-A-1	2.30	102	-	13	602	717	.93	4.90	5.83	22	80	27	97,601	12
6-B	1.19	51	-	-	314	365	.80	4.95	5.75	9	34	35	85,330	9
6-E	1.05	51	-	5	279	335	1.00	4.95	5.95	11	31	36	64,745	10
7-A	6.92	198	67	30	1,828	2,123	.80	4.95	5.75	45	135	35	191,144	35
7-B	3.46	116	-	14	915	1,045	.70	4.95	5.65	17	69	44	136,868	18
7-D	3.38	200	18	-	899	1,117	1.21	4.99	6.20	35	97	36	122,484	17
7-F	0.89	43	-	7	238	288	1.06	5.00	6.06	7	24	34	53,394	9
7-G	0.90	43	-	5	243	291	1.01	5.07	6.08	6	24	39	65,532	10
9	5.54	200	20	32	1,461	1,713	0.85	4.95	5.80	51	184	30	145,918	28
11-A	2.35	88	-	16	621	725	0.82	4.95	5.77	26	102	25	68,781	12
11-A-1	1.25	59	-	10	334	403	1.03	4.95	5.98	19	74	24	72,509	8
11-B	2.00	114	-	29	526	669	1.35	4.95	6.30	21	81	31	86,769	10
12	3.34	169	-	53	894	1,116	1.25	4.95	6.20	35	121	30	92,278	17
14	4.28	176	-	44	1,126	1,346	0.96	4.93	5.89	34	122	35	127,658	22
15	6.65	200	73	29	1,760	2,062	0.94	4.95	5.89	43	172	37	149,484	34
16	3.30	130	-	14	872	1,016	0.82	4.95	5.77	24	103	34	114,676	17
16-B	2.09	93	-	9	553	655	0.92	4.95	5.87	18	53	34	66,300	11
16-C	1.33	63	-	8	350	421	1.00	4.95	5.95	14	48	34	72,488	9
17	5.06	200	126	56	1,290	1,672	1.35	4.85	6.20	44	150	32	128,744	26
18	6.06	198	87	101	1,607	1,993	1.20	4.95	6.15	48	171	35	191,574	31
Total	99.76	3,989	722	475	27,853	33,039				777	2,776		3,640,379	

1/ Completed or under construction.

NOTE: No flood plain area is inundated by these structures.
Vegetative emergency spillways provided for all structures.

Date: June, 1956

TABLE 5A - STRUCTURE DATA
Estimated Structure Cost Distribution
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

Structure Site Number or Name	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST				Estimated Total Cost
	Contract	Installation Services	Contingencies	Adm. and Misc.	Total Federal	Easements (Land Value)	Legal Fees	Removing Obstacles	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
FLOODWATER RETARDING STRUCTURES										
1 1/	45,436	2,803	1,506	4,975	54,720	3,700	180	600	4,480	59,200
2 1/	36,000	6,047	2,511	4,456	49,014	3,560	135	-	3,695	52,709
3 1/	39,240	8,813	605	4,866	53,524	4,440	125	-	4,565	58,089
4 1/	20,379	5,597	0	2,598	28,574	2,000	150	700	2,850	31,424
5 1/	66,585	12,786	2,557	8,193	90,121	12,000	325	1,700	14,025	104,146
5-A 1/	21,758	6,408	212	2,838	31,216	900	75	-	975	32,191
5-B 1/	34,733	6,021	1,238	4,199	46,191	1,300	75	-	1,375	47,566
6-H	22,885	4,577	2,288	2,975	32,725	826	75	-	901	33,626
6-I	28,518	5,704	2,852	3,707	40,781	1,534	125	-	1,659	42,440
6-J-2	25,265	5,053	2,527	3,285	36,130	1,481	75	-	1,556	37,686
6-K-2	20,921	4,184	2,092	2,720	29,917	1,170	75	-	1,245	31,162
6-L	32,721	6,544	3,272	4,254	46,791	1,925	125	-	2,050	48,841
6-M 2/	39,170	7,834	3,917	5,092	56,013	877	75	-	952	56,965
6-N 2/	28,797	5,759	2,880	3,744	41,180	600	120	150	870	42,050
6-O 2/	33,255	6,651	3,326	4,323	47,555	600	120	-	720	48,275
6-A-1	35,785	7,157	3,578	4,652	51,172	3,813	75	-	3,888	55,060
6-B	31,537	6,307	3,154	4,100	45,098	3,100	225	1,000	4,325	49,423
6-E	24,412	4,882	2,441	3,174	34,909	1,610	75	-	1,685	36,594
7-A	68,664	13,733	6,866	8,926	98,189	5,778	240	1,500	7,518	105,707
7-B	49,377	9,875	4,938	6,419	70,609	3,225	125	1,200	4,550	75,159
7-D	44,398	8,880	4,440	5,772	63,490	4,233	75	-	4,308	67,798
7-F	20,482	4,096	2,048	2,663	29,289	1,093	75	-	1,168	30,457
7-G	24,684	4,937	2,468	3,209	35,298	967	75	-	1,042	36,340
9	53,010	10,602	5,301	6,891	75,804	4,640	75	800	5,515	81,319
11-A	25,800	5,162	2,581	3,355	36,907	4,497	125	-	4,622	41,529

TABLE 6A - STRUCTURE DATA - Continued
Estimated Structure Cost Distribution
(Based on 1955 Price Levels)
Elm Fork Watershed, Texas
(Trinity River Watershed)

Structure Site Number of Name	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST				
	Contract	Installation Services	Contingencies	Adm. and Misc.	Total Federal	Easements (Land Value)	Legal Fees	Removing Obstacles	Total Non-Federal	Estimated Total Cost
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
FLOODWATER RETARDING STRUCTURES										
11-A-1	27,099	5,420	2,710	3,523	38,752	3,230	75	800	3,305	42,057
11-B	32,035	6,407	3,204	4,165	45,811	3,042	100	-	3,142	48,953
12	33,942	6,788	3,394	4,412	48,536	4,695	225	-	4,920	53,456
14	46,189	9,238	4,619	6,005	66,051	5,449	225	2,700	8,374	74,425
15	54,244	10,849	5,424	7,052	77,569	7,539	250	-	7,789	85,358
16	42,195	8,439	4,219	5,485	60,338	4,442	200	-	4,642	64,980
16-B	24,950	4,990	2,495	3,244	35,679	2,506	75	-	2,581	38,260
16-C	27,092	5,418	2,709	3,522	38,741	2,187	100	-	2,287	41,028
17	47,065	9,413	4,707	6,119	67,304	6,787	200	300	7,287	74,591
18	68,813	13,763	6,881	8,946	98,405	6,570	100	5,000	11,670	110,073
Total	1,277,445	251,137	109,960	163,859	1,802,401	116,316	4,570	15,650	136,536	1,938,937
GRAND TOTAL	1,277,445	251,137	109,960	163,859	1,802,401	116,316	4,570	15,650	136,536	1,938,937

1/ Actual Costs.
2/ Cost figures based on contract price.

Date: June, 1956

TABLE 7 - SUMMARY OF PHYSICAL DATA
Elm Fork Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity At Time Of Revision	Quantity With Program
Watershed Area	Sq.Mi.	397	397
Watershed Area	Acres	253,810	253,810
Area of Cropland	Acres	117,922	117,922
Area of Pastureland	Acres	83,211	92,011
Area of Rangeland	Acres	32,400	32,400
Area of Wooded Pastureland	Acres	3,000	2,200
Formerly Cultivated	Acres	8,000	0
Miscellaneous 1/	Acres	9,277	9,277
Overflow Area Subject to Damage by Design Storm (Total)	Acres	21,291	17,262
Overflow Area Subject to Damage by Design Storm Above Confluence with Spring Creek	Acres	11,591	7,667
Area Damaged Annually by:			
Sediment	Acres	5,600	2,160
Flood Plain Scour	Acres	2,440	625
Swamping	Acres	180	0
Average Annual Rainfall	Inches	34.2	34.2

1/ Includes roads, railroads, highways, towns, and surface are of Lake Garza-Little Elm.

Date: June, 1956

TABLE 8 - SUMMARY OF PLAN DATA
Elm Fork Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity
Years to Complete Program	Year	10
Total Installation Cost		
Federal	Dollar	1,802,401
Non-Federal	Dollar	136,536
Annual O and M Cost		
Federal	Dollar	-
Non-Federal	Dollar	3,266
Annual Benefits	Dollar	161,602
Structural Measures		
Floodwater Retarding Structures	Each	35
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acre	0
Sediment Pool	Acre	0
Upland		
Detention Pool	Acre	1,999
Sediment Pool	Acre	777
Watershed Area above Structures	Acre	63,846
Reduction of Floodwater Damage		
Land Treatment Measures	Percent	16
Structural Measures	Percent	67
Reduction of Sediment Damage		
Land Treatment Measures	Percent	34
Structural Measures	Percent	27
Benefit From More Intensive Use of Land Resulting from Reduction of Flood Hazard	Dollar	42,860

Date: June, 1956

Figure 2

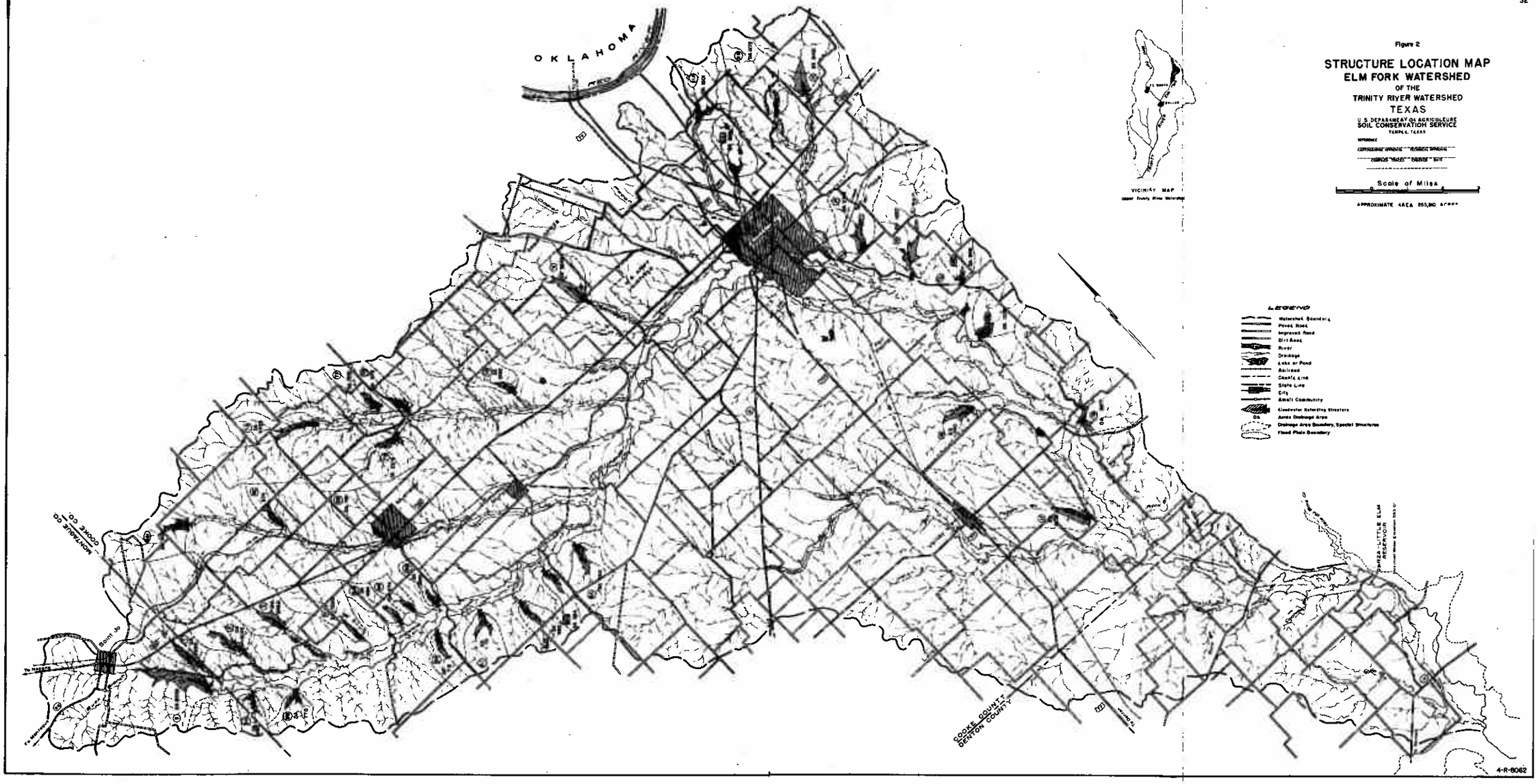
STRUCTURE LOCATION MAP
ELM FORK WATERSHED
OF THE
TRINITY RIVER WATERSHED
TEXAS

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

Scale of Miles

APPROXIMATE AREA 855,800 ACRES

VICINITY MAP
Upper Trinity River Watershed



4-R-6062

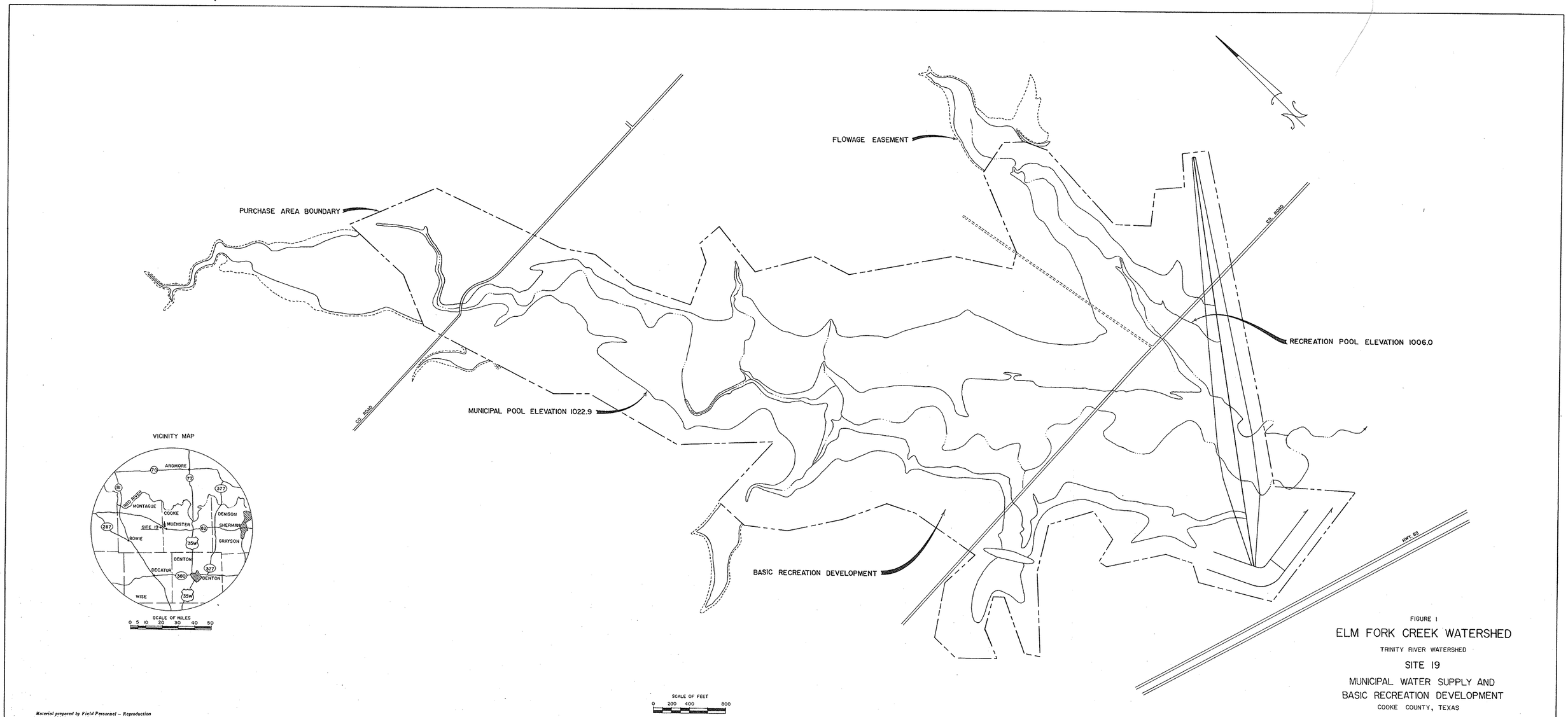


FIGURE 1

ELM FORK CREEK WATERSHED

TRINITY RIVER WATERSHED

SITE 19

MUNICIPAL WATER SUPPLY AND
BASIC RECREATION DEVELOPMENT

COOKE COUNTY, TEXAS

Material prepared by Field Personnel – Reproduction only by SCS Cartographic Unit, Fort Worth, Texas.

USDA–SCS–FORT WORTH, TEXAS 1979