Flood Prevention 20

WORK PLAN

LITTLE ELM AND LATERALS WATERSHED

Of The Trinity River Watershed

Collin, Denton, and Grayson Counties, Texas

Prepared By

SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
March 1957

USDA-SCS-FORT WORTH, TEX. 1957

WATERSHED WORK PLAN

AGREEMENT

between the

COLLIN COUNTY SOIL CONSERVATION DISTRICT
(name of local organization)

DENTON-WISE SOIL CONSERVATION DISTRICT
(name of local organization)

UPPER ELM-RED SOIL CONSERVATION DISTRICT
(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 Little Elm and Laterals 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.

COLLIN COUNTY SOIL CONSERVATION DISTRICT
(name of local organization)

By _____

Title Chairman, Board of Supervisors

Date Sept 9, 195 7

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

adopted at a meeting held on Sept. 9, 195 7.

Ben E Wood
(Secretary, local organization)

Date Sept 9, 195 7

DENTON-WISE SOIL CONSERVATION DISTRICT
(name of local organization)

By John D. Paught

Title Chairman, Board of Supervisors

Date 4-16-, 1957

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 4-16, 1957.

James Dixon
(Secretary, local organization)

Date 4-16, 1957

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

By Rush Freeman

Title Chairman, Board of Supervisors

Date 4-11, 1957

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 April 11, 1957.

[illegible]
(Secretary, local organization)

Date April 16, 1957

Soil Conservation Service
United States Department of Agriculture

By _____
(State Conservationist)

Date _____, 195___

WORK PLAN

LITTLE ELM AND LATERALS WATERSHED
Of The Trinity River Watershed

Collin, Denton and Grayson Counties, Texas

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

Participating Agencies

Denton-Wise Soil Conservation District
Collin County Soil Conservation District
Upper Elm-Red Soil Conservation District
Agricultural Stabilization and Conservation Office, USDA
Extension Service, USDA
Soil Conservation Service, USDA

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture
March 1957

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WORK PLAN

LITTLE ELM AND LATERALS WATERSHED
Of the Trinity River Watershed

Collin, Denton and Grayson Counties, Texas

March 1957

SUMMARY OF PLAN

General Summary

The watershed covers an area of 288.75 square miles (184,800 acres) in Denton, Grayson and Collin Counties, Texas. Approximately 60 percent of the watershed is cropland, 34 percent is grassland, 3 percent is woodland, 2 percent is in miscellaneous uses, such as towns, roads, etc., and 1 percent is in stream channels.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 10-year period, a project for the protection and development of the watershed at a total estimated installation cost of $3,829,363, including $107,180 of Federal flood prevention expenditures and $1,229,459 of non-Federal expenditures prior to preparation of the work plan, and $27,585 for work plan preparation. The local or non-Federal share of this cost will be $2,834,242. In addition, local interests will bear the entire cost of operation and maintenance with a capitalized value of $48,958. Of the total project cost of $3,878,321, the non-Federal share will be $2,883,200 and the Federal share $995,121.

Land Treatment Measures

The cost of land treatment measures is estimated at $2,828,573 (including expenditures prior to work plan preparation) of which the non-Federal share is $2,651,132. The Federal share of $177,441 is for accelerated technical assistance to plan and apply land treatment measures, including expenditures prior to work plan preparation and for two small drop structures ($2,180) already installed.

Structural Measures

The structural measures included in the plan consist of 23 floodwater retarding structures having an aggregate total storage capacity of 21,257 acre-feet. The total cost of these measures, including the capitalized value of operation and maintenance, is $1,022,163, of which

the local share is $232,068 and the Federal share is $790,095. The non-Federal share of the total cost of structural measures includes: land, easements and rights-of-way, 78.9 percent; and operation and maintenance, 21.1 percent.

Damages and Benefits

The estimated average annual damage without the project is $158,051. The estimated average annual damage with the project, including land treatment and structural measures, is $74,419. The average annual primary benefits accruing to structural measures are $77,863, distributed as follows:

Floodwater damage reduction	$59,498
Sediment damage reduction	1/ 5,335
Erosion damage reduction	1,468
Indirect damage reduction	6,630
Benefits from changed use of land	4,932

1/ Includes $638 sediment damage reduction to Garza-Little Elm Reservoir.

The ratio of the average annual benefits ($77,863) to the average annual equivalent costs of structural measures ($38,659) is 2.01 to 1.

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

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the landowners or operators of the farms and ranches on which the measures are installed, under agreements with the Denton-Wise, Upper Elm-Red and Collin County Soil Conservation Districts. The 23 floodwater retarding structures will be operated and maintained by the Soil Conservation District in which the individual structures are located.

DESCRIPTION OF WATERSHED

Physical Data

Little Elm Creek heads in the southern part of Grayson County about five miles northeast of Gunter. It flows south and west to enter the Garza-Little Elm Reservoir near the town of Little Elm in Denton County, Texas. The largest tributaries are Pecan and Mustang Creeks and Clarks and Hearne Branches. Laterals included in this work plan which flow directly into the reservoir are Doe Branch and Panther, Stewart and Cottonwood Creeks. The watershed has an area of 184,800 acres, nearly all of which is in farms and ranches.

The topography ranges from rolling along the eastern edge of the watershed to gently rolling and nearly level in the central and western parts. Elevations range from 520 feet to 790 feet above mean sea level. The main alluvial valley of Little Elm Creek ranges from about 3,200 feet in width near the mouth of Pecan Creek to 1,600 feet at the headwaters.

Approximately 81 percent of the drainage area lies in the Blackland Prairie Land Resource Area. The remainder is in the Forested Coatal Plain. The Blackland soils are medium to fine textured and the color ranges from light gray to a very dark brown. The Forested Coastal Plain soils are medium to coarse textured and the color is light gray. Less than five percent of these soils are shallow; 95 percent are very deep. In general, the cultivated soils are in fair to good physical condition because a large amount of wheat and an appreciable amount of sweetclover, vetch and alfalfa are grown. Most of the pastures are in fairly poor condition, resulting from the drought of the past few years and overgrazing. A relatively large percent of the pasture was formerly cultivated. A good base grass is lacking in many pastures.

The overall land use is:

Land Use	Acres	Percent
Cropland	110,009	59.7
Pasture	63,339	34.4
Woodland	6,291	3.1
Stream Channels	1,464	0.8
Miscellaneous 1/	3,697	2.0
Total	184,800	100.0

1/ Includes roads, railroads, towns, etc.

The mean annual rainfall is 39.95 inches, based on a 27-year record at McKinney. It is well distributed, with the wettest months being April, May and October. Individual excessive rains causing serious floodwater and sediment damage may occur in any season, but are most frequent in the

spring. The minimum recorded annual rainfall was 20.76 inches; the maximum was 54.97 inches.

The largest storm that occurred in the 20-year period of study was a 6.07-inch rain extending over three days which produced 3.84 inches of runoff. This runoff inundated 94 percent of the 15,638 acres of flood plain. Under present conditions of the watershed, 96 percent of the flood plain would be flooded by the runoff from a storm that can be expected once in 25 years. At the present time about 50 percent of the flood plain is in cultivation, 43 percent in pasture and 7 percent in woods and miscellaneous land use.

Average temperatures range from 84 degrees Fahrenheit in the summer to 44 degrees in the winter. The normal frost-free period is 229 days.

Water for livestock and domestic use in the watershed area is obtained from shallow wells, springs and small farm ponds. The supply is not always dependable and presents a serious problem. All of the towns in the watershed obtain water from artesian wells.

Economic Data

The watershed economy is basically agricultural but residents of the area have taken advantage of available employment opportunities offered by business and industries of nearby urban areas to supplement income obtained from their agricultural enterprises. This is particularly in evidence throughout the lower portion of the watershed where, in many instances, farming operations have been modified to permit additional time for off-farm work.

Cash-crop farming predominates in the northeast and central portions, with small grains, cotton, sorghums and hay the principal crops. Livestock enterprises lead in the western part of the watershed with approximately 80 percent of the cattle used for beef production.

Facilities for processing or storing agricultural products are located at Frisco, Prosper, Celina and Pilot Point. A large plant for generating electricity is located about two and one-half miles south of Prosper.

The Little Elm and Laterals watershed is served by Soil Conservation Service work units at McKinney, Whitesboro, Pilot Point and Grapevine, which are assisting the Upper Elm-Red, Denton-Wise and Collin County Soil Conservation Districts. These work units have given technical assistance to farmers and ranchers in preparing 560 soil and water conservation plans on 109,220 acres (59 percent of the agricultural land) within the watershed and in establishing and maintaining planned measures.

Approximately 119 miles of hard-surfaced roads traverse the watershed. In addition, there are 75 miles of local or county roads. Rail service is adequate for all sections of the area.

Pilot Point, with a population of 1,200, is the largest town in the

watershed. Others, with their latest available population, are: Celina, 1051; Frisco, 736; Aubrey, 491; Gunter, 463;and Prosper, 243.

WATERSHED PROBLEMS

Floodwater Damage

Frequent flooding has caused damages of considerable magnitude (figure 1). Large floods have occurred on an average of more than once every two years. During the 20-year period studied, 1923 to 1942, there were 39 major floods which covered more than half the flood plain, and 39 smaller floods. Fifty-one percent of the major floods and half of the smaller floods occurred during the growing season and caused considerable damage to growing crops. It is estimated that the average annual direct monetary floodwater damage, under existing conditions, is $128,121, of which $91,201 is crop and pasture damage, $28,026 is other agricultural damage, and $8,894 is nonagricultural damage to roads and bridges. In addition, there are numerous indirect damages, such as interruption of travel, initial losses sustained by dealers and industries in the area, and similar losses, estimated to average $14,368 per year.

Sediment Damage

Much of the flood plain area has received considerable amounts of sediment deposition. Most of the damaging sediment consists of silt and clay from erosion of upland subsoils. These deposits are low in organic matter and tend to seal the surface of the flood plain soils. Nearly all of the sediment has been deposited in the areas below planned locations for floodwater retarding structures. It is estimated that crop and pasture production on 2,071 acres has been reduced about 5 percent. Production on an additional 811 acres has been reduced 10 percent. The annual value of this damage is estimated to be $9,302.

Drainage from this watershed flows into the Garza-Little Elm Reservoir. An estimated 188 acre-feet of sediment from the Little Elm and Laterals watershed is being deposited annually in this water supply and flood control reservoir, under present uncontrolled conditions. About 67 acre-feet of sediment originate on the watersheds of the two stream systems on which structural measures are planned, Little Elm and Mustang Creeks. The estimated value of this damage is $3,873 annually from the whole watershed, of which $1,375 of damage results from the sediments from Little Elm and Mustang Creek drainage areas.

Farm ponds, in general, have suffered moderate losses in storage capacity from sedimentation.

Erosion Damage

Erosion rates are low to moderate because there is a large amount of conservation treatment applied on cultivated land, particularly in the use of small grains and legumes, giving good cover and soil condition to

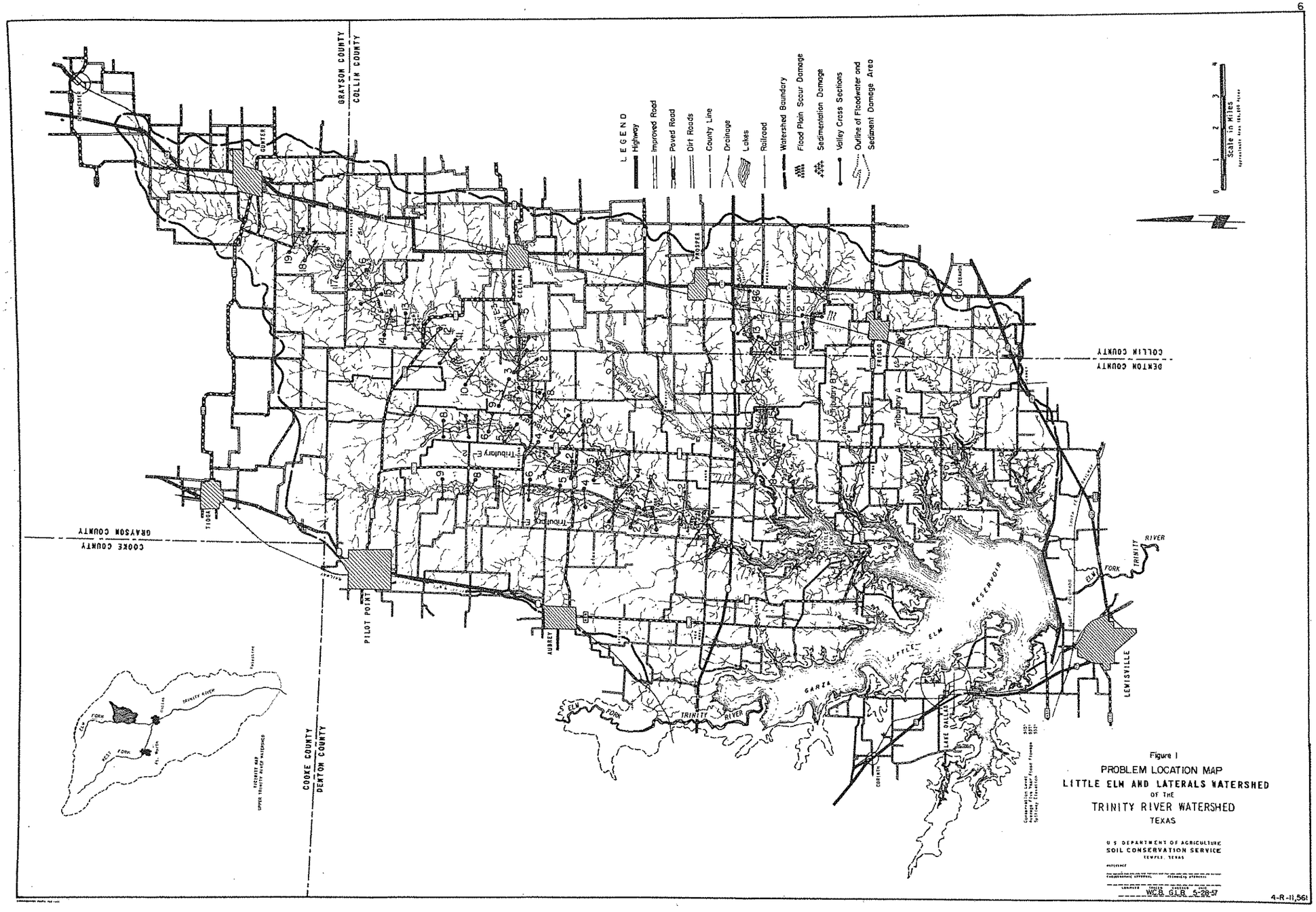

Figure 1

PROBLEM LOCATION MAP

LITTLE ELM AND LATERALS WATERSHED

OF THE

TRINITY RIVER WATERSHED

TEXAS

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

WCS GLR 5-28-57

4-R-11,561

much cultivated land. A relatively large amount of the pasture has only a fair cover. Sheet erosion accounts for about 85 percent of the total annual gross erosion. The remaining 15 percent is from gully and channel erosion. No channel erosion was estimated below planned structure locations as investigations indicated the amounts of such damage to be insignificant.

There are 131 acres of scour channels resulting from floodwaters. This damage ranges from 10 to 90 percent in terms of reduced productive capacity. Acreages affected each year and percent damage were estimated to be:

Acres	Percent	Acres	Percent
27.7	10	20.7	60
32.0	30	24.0	75
25.0	50	1.8	90

The estimated annual value of this scour damage is $2,387.

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

Problems relating to methods now used in the conservation, development, utilization and disposal of water are minor and do not warrant a study at this time. There is but little activity relative to drainage or irrigation. No individual landowners or groups of landowners have indicated an interest in providing additional storage capacity in any of the floodwater retarding structures for irrigation purposes. At the present time all the towns in the watershed obtain an adequate supply of water from wells.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Efforts to prevent or control floods have been minor, exerted in the main by individual farmers as they tried to straighten or levee stream channels. These efforts have had little effect on the reduction of flooding and accompanying flood damages. During the past several years small groups of farmers, cooperating with their respective soil conservation districts, have been preparing conservation plans on a community and subwatershed basis in an attempt to protect their lands and to reduce flooding. The Little Elm Creek Watershed Association has selected a committee of leaders in the various communities to assist the supervisors in getting soil and water conservation measures established. The Soil Conservation Service, with Flood Prevention funds, accelerated technical assistance to help the landowners and operators apply a large amount of land treatment for watershed protection. Two special drop structures for land stabilization were installed, also, with Flood Prevention funds.

The streams of this watershed drain into the Garza-Little Elm Reservoir, formed by the Lewisville dam. This was a Federally authorized structure, constructed by the Corps of Engineers and completed in 1955. It has a total planned storage of 1,016,200 acre-feet of which 526,700 acre-feet

are for flood control, 415,000 acre-feet are for water supply for Dallas and 21,000 acre-feet are for water supply for Denton. Planned sediment-storage capacity is 53,500 acre-feet. The reservoir contained the former reservoir area of Lake Dallas. Effective treatment of this watershed will reduce appreciably and measurably the sediment yield from the watershed and sediment delivery from these sources to the Garza-Little Elm Reservoir. Related damage, such as swamping, will be reduced, also.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures For Watershed Protection

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

About 40,000 acres of the total watershed area of 184,800 acres lie above 23 proposed floodwater retarding structures. Land treatment is especially important to support and supplement the control of these structures. There are an additional 130,000 acres, 70 percent of the watershed area for which no structural control has been planned. Establishment and maintenance of land treatment measures are the only planned measures for this large area. The greater damages, however, are concentrated on the flood plain below the 40,000 acres to be treated structurally, so that neither the damages nor reduction thereof resulting from land treatment will be high in the rest of the watershed area.

The amounts and estimated cost of establishing the remaining measures that will be installed by the landowners and operators are shown on table 1. The estimated total cost of planning and installing these measures, exclusive of expected reimbursement from ACPS or other Federal funds, is $1,491,934, based on current program criteria. In addition landowners and operators have established, prior to work plan preparation, large amounts of land treatment at an estimated total cost of $1,336,639, with Federal technical assistance.

Most of the land treatment measures will function principally to decrease erosion damage to fields and pastures by providing improved soil-cover conditions. These measures include cover cropping, use of rotation hay and pasture, crop residue utilization for croplands, and pasture planting to establish good cover on grasslands. They also include: brush control, to allow grass stands to improve and replace poor cover afforded

TABLE 1 - ESTIMATED INSTALLATION COST

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)
Price Base: 1955

Total Project 1/

Item	Unit	No. to be Applied	Estimated Cost		Total
			Federal (dollars)	Non-Federal 2/ (dollars)	(dollars)
LAND TREATMENT PRIMARILY FOR:					
I. Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	36,913	-	36,913	36,913
Cover Cropping	Acre	33,086	-	231,602	231,602
Rotation Hay and Pasture	Acre	18,078	-	151,855	151,855
Crop Residue Utilization	Acre	33,705	-	33,705	33,705
Strip Cropping	Acre	1,138	-	3,642	3,642
Proper Use Pasture	Acre	39,941	-	79,882	79,882
Pasture Planting	Acre	24,838	-	388,218	388,218
Brush Control	Acre	4,602	-	88,588	88,588
Wildlife Area Improvement	Acre	992	-	14,880	14,880
Terracing	Mile	2,143	-	147,331	147,331
Diversion Construction	Mile	70	-	26,250	26,250
Waterway Development	Acre	2,046	-	103,058	103,058
Pond Construction	No.	484	-	90,751	90,751
Drop Inlets and Drop Structures	No.	16	-	13,200	13,200
Sod Flumes	No.	143	-	11,798	11,798
Technical Assistance (Accel.)					
Planning	Acre	59,504	16,661	-	16,661
Application	Acre	69,610	53,600	-	53,600
SCS Subtotal			70,261	1,421,673	1,491,934
TOTAL LAND TREATMENT			70,261	1,421,673	1,491,934
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	23	607,765	-	607,765
SCS Subtotal			607,765	-	607,765
TOTAL CONSTRUCTION COSTS			607,765	-	607,765
INSTALLATION SERVICE					
Soil Conservation Service					
Engineering Services			110,503	-	110,503
Other			71,827	-	71,827
SCS Subtotal			182,330	-	182,330
TOTAL INSTALLATION SERVICES			182,330	-	182,330
OTHER COSTS					
Land, Easements and R/W			-	183,110	183,110
TOTAL OTHER COSTS				183,110	183,110
TOTAL INSTALLATION-STRUCTURES			790,095	183,110	973,205
WORK PLAN PREPARATION COST			27,585	-	27,585
TOTAL INSTALLATION			887,941	1,604,783	2,492,724
SUMMARY					
Total SCS			887,941	1,604,783	2,492,724
TOTAL			887,941	1,604,783	2,492,724

1/ At time of work plan preparation; does not include prior expenditures of Flood Prevention funds or accomplishments resulting therefrom (see table 1a).

2/ Excludes $711,590 that will be reimbursed from ACPS or other Federal funds, based on current program criteria.

March 1957

by brushy pastures; the construction of farm ponds, to provide adequate numbers and locations of watering places to prevent cover-destroying, seasonal concentrations of livestock; and proper use and deferred grazing of pasture to provide improvement, protection, and good maintenance of grass stands. These measures, especially the cropland measures and pasture planting, also effectively improve soil conditions, allowing larger amounts of rainfall to soak into the soil.

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

Structural Measures for Flood Prevention

A system of 23 floodwater retarding structures will be installed to effect the needed protection to flood plain lands that cannot be provided by land treatment measures alone. The system of floodwater retarding structures will temporarily detain runoff from 22 percent of the entire watershed. Runoff will be detained from 62 percent of the area above the mouth of Pecan Creek, above which all structural control is to be concentrated. Figure 2 shows a section of a typical floodwater retarding structure.

Sites for the floodwater retarding structures will be provided by local interests. The value of these sites is estimated to be $179,980, based on local market values. There will be an estimated $3,130 of additional costs connected with obtaining these sites. The sediment pools of the 23 structures will contain 432 acres of flood plain and the detention pools will contain an additional 216 acres of flood plain. The sediment pools will contain 527 acres of upland and the detention pools will contain 1,492 additional acres of upland.

The locations of floodwater retarding structures are shown on the Planned Structural Measures Map, figure 3. All planned structures are located on Mustang Creek, other Little Elm Creek tributaries upstream from the mouth of Mustang Creek, or on headwaters of Little Elm Creek. The total estimated cost of establishing these works of improvement is $973,205, of which $183,110 will be borne by non-Federal interests and $790,095 by the Federal government. The average annual equivalent cost is estimated to be $36,380 for installation and $2,279 for operation and maintenance, a total average annual cost of $38,659.

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures described above would prevent flood damage from 15 of the 78 floods which occurred in this watershed from 1923 through 1942. Eighteen of the 39 major floods would be reduced to minor floods. Average annual flooding would be reduced

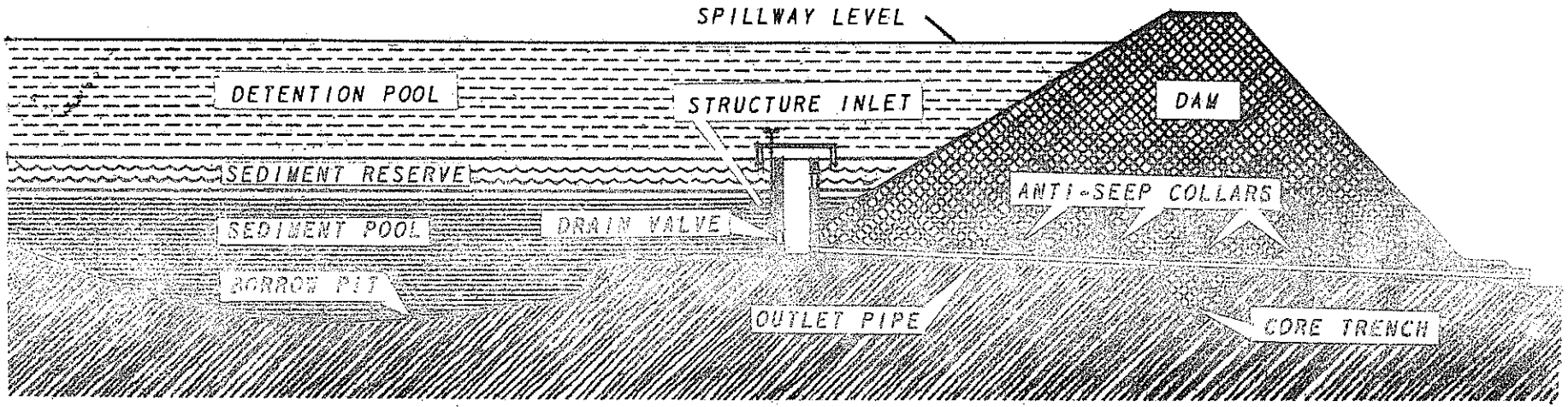

Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

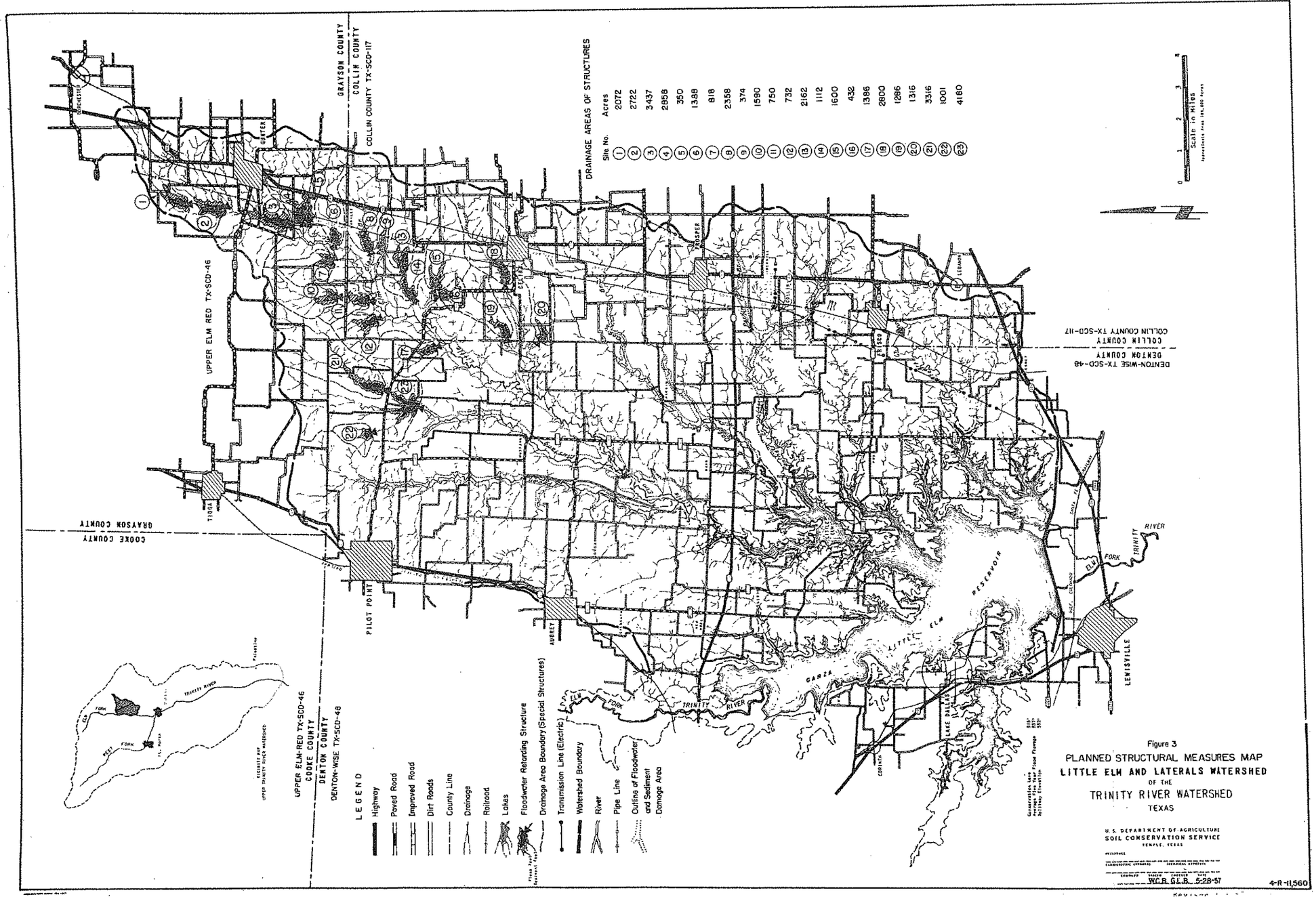

Figure 3

PLANNED STRUCTURAL MEASURES MAP
LITTLE ELM AND LATERALS WATERSHED
OF THE
TRINITY RIVER WATERSHED
TEXAS

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SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

W.C.B. G.L.B. 5-28-57

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from 15,174 acres to 7,268 acres for the entire watershed.

With the project installed, the flood plain of Little Elm Creek above hydrologic cross section 12 (see figure 1) and the tributary flood plains below floodwater retarding structures will be essentially flood-free for all storms up to the size that can be expected to occur no more frequently than once in 15 years. The Little Elm Creek flood plain between hydrologic cross sections 5 and 12 will experience some flooding from storms larger than can be expected to occur once in five years, while below section 7 a two-year-frequency storm will cause flooding. On Mustang Creek storms larger than can be expected to occur once in five years will cause some flooding between hydrologic cross sections 1 and 5.

Below the confluence of Little Elm and Mustang Creeks, storms up to the size that can be expected to occur once in five years will flood approximately 40 percent of the flood plain.

In the watershed as a whole the estimated average annual floodwater, erosion and sediment damage would be reduced from $158,051 to $74,419, a reduction of 52.9 percent. About 87 percent ($72,931) of the expected reduction in average annual damage would result from the system of floodwater retarding structures.

Exclusive of Pecan Creek and other tributary areas for which no structural control is planned, the estimated average annual floodwater, erosion and sediment damage would be reduced from $125,470 to $44,217, a reduction of 65 percent. In this segment, about 93 percent of the expected reduction in average annual damage would result from the system of floodwater retarding structures.

In the Pecan Creek and other tributary areas, not controlled by planned structures, the estimated average annual floodwater, erosion, and sediment damage would be reduced from $32,581 to $30,202, a reduction of only 7.3 percent, which would result entirely from land treatment.

The installation of the land treatment measures will reduce by approximately 14 percent (26 acre-feet) the volume of sediment from the Little Elm and Laterals watershed that would reach Garza-Little Elm Reservoir. With the floodwater retarding structures installed, as well, the amount of sediment from the watershed that would reach the reservoir will be reduced by 30 percent (57 acre-feet). The reduction in average annual damage to Garza-Little Elm Reservoir resulting from the project will be $1,183, of which the structural measures will account for $638.

Benefits from the reduction of indirect damage, such as the interruption of travel, extra farming expense and extra costs of purchasing additional feed for livestock, are estimated to average $7,603 annually, $6,630 of which would result from the planned floodwater retarding structures.

Owners and operators of flood plain lands say that, with an adequate

reduction of flooding, they will change the use of some of the pasture to the production of higher value crops, such as small grain, sorghum and alfalfa. Some owners stated that with flood protection they would clear wooded flood plain land for use as improved pasture or as cropland. Increased net income expected from restoration to former use and intensified use of land is estimated to be $4,932 annually, based on long-term price levels.

No floodwater damages or benefits from reductions thereof were estimated for that flood plain area which lies below the water elevation of the Garza-Little Elm Reservoir, estimated to result from a 10-year-frequency storm.

The total flood prevention benefits, including reduction in flood damages, reduction of sediment deposition on flood plain lands and in the Garza-Little Elm Reservoir, reduction in flood plain scour damage, benefits from restoration and more intensive use of flood plain lands and reduction of indirect damages are estimated to be $88,564 annually, of which $77,863 will be the result of structural measures.

COMPARISON OF BENEFITS AND COSTS

The average annual equivalent cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be $38,659. When the structures are completely installed they are expected to produce average annual benefits of $77,863, a benefit of $2.01 for each dollar of cost. There are other substantial values which will accrue from these structural measures, such as increased opportunity for recreation, improved wildlife conditions and a sense of security, which have not been used for project justification.

ACCOMPLISHING THE PLAN

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

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, preparing radio and press releases, and using other methods of getting information to landowners and operators in the Little Elm and Laterals watershed. This activity will help to get the land treatment practices and the structural measures for flood prevention carried out.

Land Treatment Measures

Land treatment measures itemized in table 1 will be established by farmers over a 10-year period in cooperation with the Denton-Wise, Upper Elm-Red

and Collin County Soil Conservation Districts. The cost of applying these measures is exclusive of expected reimbursement from the Agricultural Conservation Program or other Federal programs, based on current program criteria, and will be borne by the owners and operators of the land. The Soil Conservation Districts, assisted by the Soil Conservation Service, are giving assistance in the planning and application of these measures under their going programs. Accelerated assistance from the Soil Conservation Service, with Flood Prevention funds, has been made available for several years to get land treatment needed in conjunction with planned structural measures applied. This assistance will be continued to assure application of the planned land treatment measures within the 10-year installation period of the project.

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

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

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

Structural Measures for Flood Prevention

The Soil Conservation Service will contract for the construction of the 23 floodwater retarding structures. Technical assistance will be provided to plan, design, prepare specifications, supervise construction, prepare contract payment estimates, make final inspections, certify completion, and perform related duties for the installation of these structural measures.

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

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

Construction Units	No. of Sites	Annual Benefits (dollars)	Annual Cost (dollars)	Benefit Cost Ratio (dollars)
1. Mustang Creek Sites 21, 22, 23	3	7,729	5,566	1.39:1
2. Hearne Branch Sites 18, 19, 20	3	6,170	5,835	1.06:1
3. Little Elm Creek Sites 1 through 17	17	1/33,932	27,258	1.24:1

1/ Includes benefits on Little Elm Creek above its confluence with Hearne Branch, only.

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

The cooperating parties have agreed on an installation schedule of six years for the structural measures during the 10-year period for completion of the project. It is planned to construct structures in the following order: numbers 21, 22 and 23, first; numbers 18, 19 and 20, next; then, numbers 1, 2, 3, 4 and 5; and numbers 6 through 17 last. This schedule will be adjusted year to year on the basis of any significant changes in the plan found to be mutually desired, and in light of appropriations and accomplishments actually made.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

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

Structural Measures for Flood Prevention

The 23 floodwater retarding structures will be maintained by the soil conservation district in which the structure is located.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or streamflow by representatives of the soil

conservation district in which the structure is located and the Soil Conservation Service. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as a part of the floodwater retarding structures. The responsible soil conservation district will maintain a record of all maintenance inspections and work done.

Provisions will be made for free access of District and Federal representatives to inspect the 23 floodwater retarding structures and their appurtenances at any time.

The estimated annual operation and maintenance cost is $2,279, based on long-term price levels. The necessary maintenance work will be accomplished through the use of resources of the soil conservation districts and through maintenance associations of benefited landowners.

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

COST SHARING

Including that which has been provided prior to work plan preparation, the Federal Government expects to provide technical assistance in the amount of $175,261 ($105,000 has been provided prior to work plan preparation) to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. In addition, $2,180 of Flood Prevention funds have been expended by the Federal government prior to work plan preparation in the installation of two special small drop structures for land stabilization. Private interests will install all other land treatment measures, at an estimated cost of $2,651,132, including that which has been done prior to work plan preparation ($1,229,459) with accelerated technical assistance from Flood Prevention funds. Expected reimbursements, based on current program criteria, from ACPS or other Federal funds, are not included in these amounts.

The required non-Federal costs for structural measures consist of the cost of land, easements, and rights-of-way ($183,110) and the capitalized value of annual operation and maintenance of the works of improvement ($48,958). These estimated costs total $232,068.

The entire cost of constructing the structural measures, amounting to $607,765, will be borne by the Federal Government. In addition, the installation services cost of $182,330 will be a Federal expense. This is a total Federal cost of $790,095 for the installation of structural measures.

The total project cost, $3,878,321, including work plan preparation cost and the capitalized value of structure operation and maintenance, will be

shared 25.7 percent ($995,121) by the Federal Government and 74.3 percent ($2,883,200) by non-Federal interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the flood prevention project on the Little Elm and Laterals watershed would give added protection to flood plain lands along this stream and greatly reduce the sediment load carried by it. This project plan conforms to all Federal laws and regulations, and will have no known detrimental effect on existing downstream projects or any that might be constructed in the future.

SECTION 2

INVESTIGATIONS, ANALYSES AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil and Cover Conditions

About 17 percent of the watershed is in relatively poor physical condition or has a poor cover condition because of prolonged intensive cultivation, the type of farming operations used, or the grazing practices used. Approximately 21 percent of the cropland soils are in relatively poor physical condition, due to loss of fertility and organic matter as a result of sheet erosion and past farming practices. However, a relatively large amount of cultivated land is maintained with a good cover of small grain or legumes much of the time. Most cropland soils are used to grow small grains, cotton, peanuts and grain sorghum. Most of the pastures are in fairly poor condition because of long-continued drought and overgrazing. These determinations were made on the basis of observations of randomly selected samples used in the soil-cover complex study of the watershed.

Land Use and Treatment Needs

The land use on the upland was estimated by using a 5 percent random sample from the Blackland Prairie and Forested Coastal Plain soils. These sample areas were expanded to the total upland acreage. Data thus obtained were verified by comparing with information and records available from the four Soil Conservation Service work units serving the Little Elm and Laterals watershed. The land use of the flood plain was planimetered from the flood plain strip map that was developed during the economic investigations.

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

Program Determination

Determination was made, first, of the needed land treatment measures, which remain to be applied in the watershed and which contribute directly to flood prevention, based on current land capability classes developed from soil surveys. The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effects of these measures in terms of the

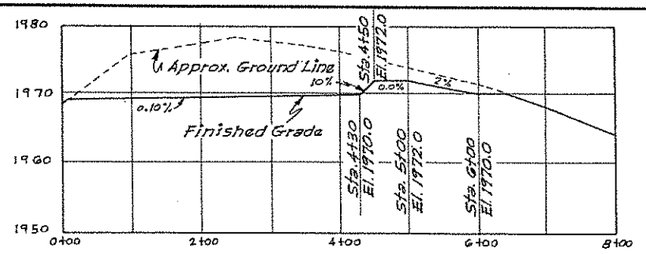
reduction of flood damages resulting from such treatment. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the desired degree of watershed protection and flood damage reduction.

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

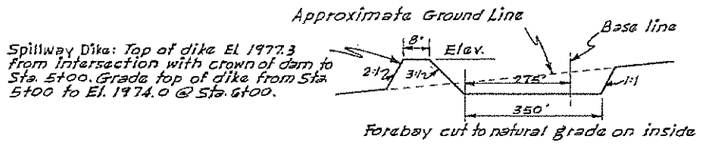
1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs located all probable floodwater retarding structure sites, the limits and the area of the flood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

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

3. A topographic map was made of the pool area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the dam and the areas of flood plain and upland that would be inundated by the sediment and detention pools. The heights of the dams and the sizes of the pools were determined by the storage volume needed to temporarily detain the runoff from the design storm and to provide the additional storage needed for sediment, with due consideration to site differences and minimization of costs. The limits of the detention pools and sediment pools of all satisfactory sites and the flood plain of the streams were drawn to scale on a copy of the base map. Structure



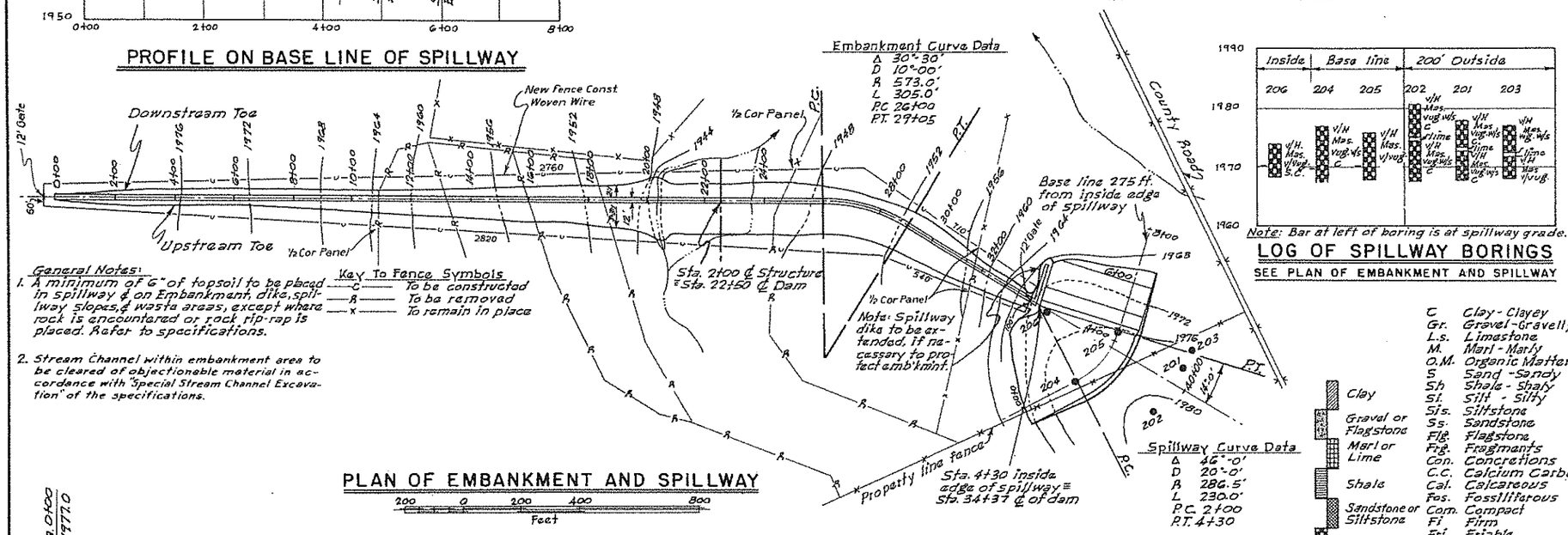
PROFILE ON BASE LINE OF SPILLWAY



Spillway Dike: Top of dike El. 1977.3 from intersection with crown of dam to Sta. 5+00. Grade top of dike from Sta 5+00 to El. 1974.0 @ Sta. 6+00.

Forebay cut to natural grade on inside

TYPICAL SPILLWAY SECTION



PLAN OF EMBANKMENT AND SPILLWAY

200 0 200 400 800 Feet

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

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

General Notes:

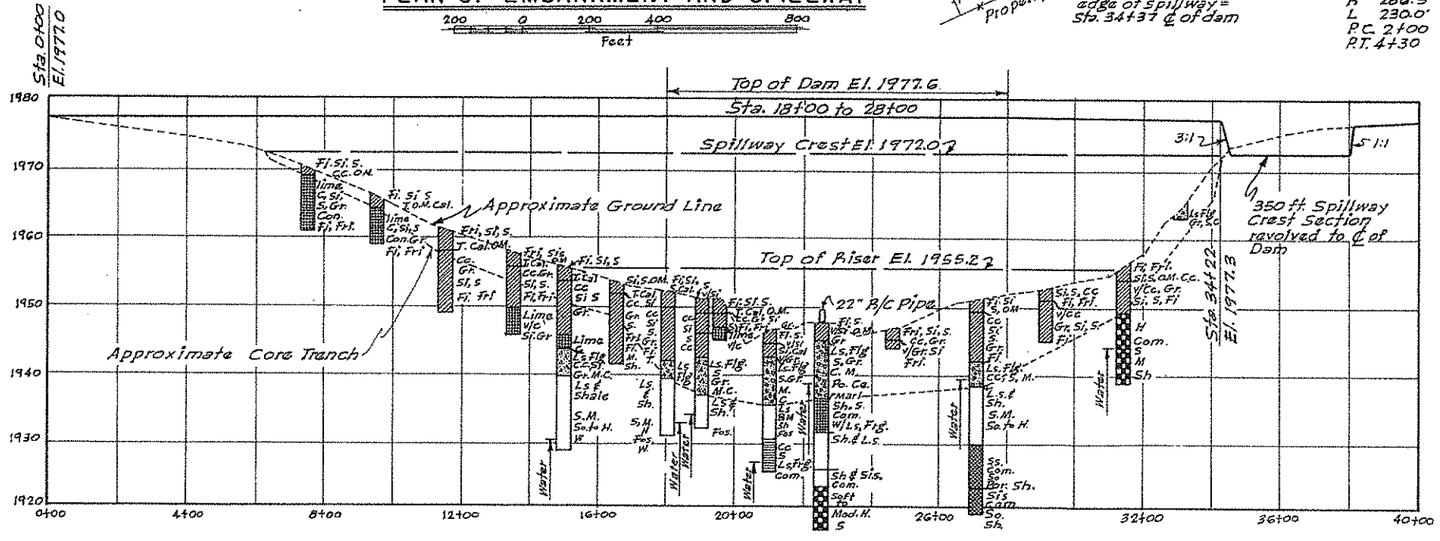
1. A minimum of 6" of topsoil to be placed in spillway & on Embankment, dike, spillway slopes, & waste areas, except where rock is encountered or rock rip-rap is placed. Refer to specifications.
2. Stream Channel within embankment area to be cleared of objectionable material in accordance with "Special Stream Channel Excavation" of the specifications.

Key To Fence Symbols

—C— To be constructed
—R— To be removed
—X— To remain in place

C	Clay - Clayey
Gr.	Gravel - Gravelly
L.s.	Limestone
M.	Marl - Marly
O.M.	Organic Matter
S	Sand - Sandy
Sh	Shale - Shaly
Sl.	Silt - Silty
Sis.	Siltstone
Ss.	Sandstone
Flg.	Flagstone
Frg.	Fragments
Con.	Concretions
C.C.	Calcium Carbonate
Cal.	Calcareous
Fos.	Fossiliferous
Com.	Compact
Fi	Firm
Fri.	Friable
H	Hard
Mas.	Massive
Mod.	Moderately
Po. Ce.	Poorly Cemented
Por.	Porous
So.	Soft
T.	Tough
v	Very
Vug.	Vugular
w	With
W.	Weathered

LEGEND OF BORINGS



PROFILE ON ℄ OF DAM

Figure 4

TYPICAL FLOODWATER RETARDING STRUCTURE

GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	G.W.T.	8/56	Approved by: [illegible]
Drawn	G.W.T.-D.S.	8/56	REGIONAL ENGINEER OR WATERSHED PLANNING UNIT
Traced	D.S.	8/56	STATE CONSERVATION ENGINEER
Checked	C.E.G. G.W.T.	9/56	TEMPLE, TEXAS

Sheet No. 3 of 8

Drawing No. 4-E-10,752

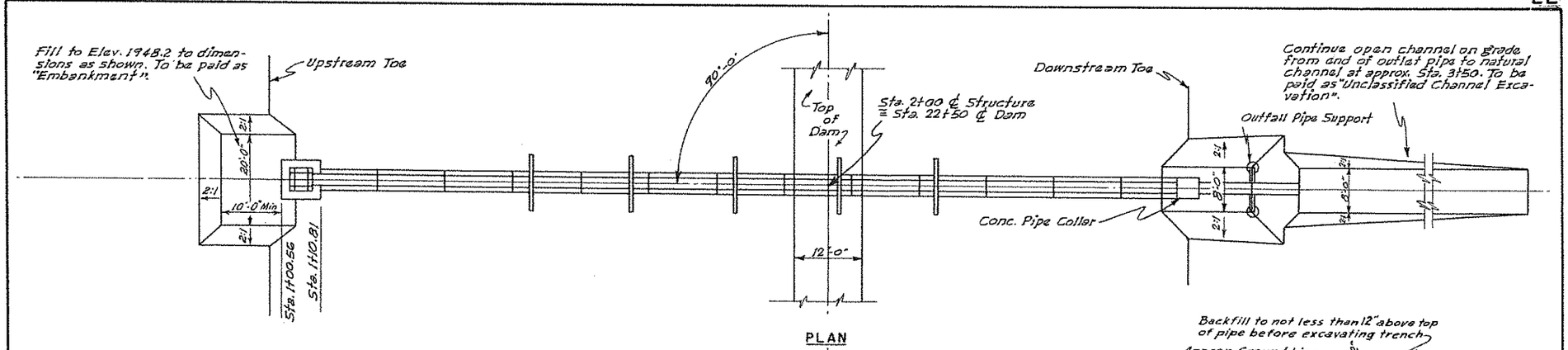


Figure 4A

TYPICAL FLOODWATER RETARDING STRUCTURE

PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	G.W.T.	8/56	Approved by	K.M.
Drawn	G.W.T. - D.S.	8/56		
Traced	D.S.	8/56		
Checked	C.F.C. - G.W.T.	9/56	Sheet No. 4 of 8	Drawing No. 4-E-10,752

HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS

STATE CONSERVATION ENGINEER, S. C. S., TEMPLE, TEXAS

data tables were developed to show, for each structure, the drainage area, the storage capacity needed for floodwater detention and for sediment storage in acre-feet and in inches of runoff from the drainage areas, the release rate of the principal spillway, the acres of flood plain and upland inundated by the sediment and detention pools, the volume of fill in the dams, the width and depth of flow of the emergency spillways, and the estimated cost of the structures (tables 2 and 3).

4. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and field surveys of flood plain areas and flood routing under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of area inundated and depth of inundation as determined by flood routing under future conditions, assuming that the works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of the effect of each on reduction of damages. In this manner it was determined that a system of floodwater retarding structures on Little Elm Creek above its confluence with Pecan Creek could be economically justified. By further analysis, those individual floodwater retarding structures and interrelated structures which had favorable benefit-cost ratios were determined. These were included in the plan. Those which were unfavorable were dropped from further consideration and, where replacements were found to be necessary to effect needed control, alternate sites were investigated until a system of floodwater retarding structures was developed which would give maximum net benefits.

When the land treatment measures and those structural measures for flood prevention had been determined, a table was developed to show the total cost of each type of measure. The summation of the total costs for all the needed measures represented the estimated cost of the planned flood prevention project (tables 1 and 2). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 6).

Hydraulic and Hydrologic Investigations

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

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

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections,

channel capacities and other hydraulic characteristics, and on proposed structure sites to collect data used in design.

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

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

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

6. Determination was made of peak discharges and area inundated under conditions which would exist due to:

   a. Effect of land treatment measures.
   b. Effect of land treatment measures and floodwater retarding structures.
   c. Consideration of alternative programs and measures.

7. Inflow hydrographs for structure sites were developed.

From a graph showing cumulative departures from normal precipitation, the rainfall for the period 1923 to 1942, inclusive, was selected as most representative of a normal rainfall period for the Little Elm and Laterals watershed.

After investigation and analysis of the meteorologic, hydraulic, hydrologic and economic characteristics of the watershed, it was determined that a structural program was feasible only on that portion of Little Elm Creek above its confluence with Pecan Creek. Structural measures were not found to be feasible on the remainder of the watershed due to present and expected future use of the flood plain located below investigated sites.

The largest runoff-producing rain considered during the 20-year period of study was a storm of 6.07 inches extending over a 3-day interval. An average rain of this magnitude would produce 3.84 inches of runoff, under present conditions, and would inundate 14,754 acres of flood plain. If such a rain were to occur after land treatment practices had been applied, it is estimated that the area inundated would be reduced to 14,673 acres. With land treatment measures applied and the structural measures for flood prevention in operation 11,261 acres would be flooded.

The runoff from the 6-hour, 25-year frequency storm was used to establish the minimum floodwater detention storage requirements. The minimum detention storage requirement, based on an analysis of the conditions existing in the watershed, was established as 3.4 inches. Inflow hydrographs for structure design were developed using the runoff that would be produced by a rain of 14.0 to 14.2 inches in a period of 6 hours, assuming Moisture Condition II. The hydrograph of runoff was routed through each structure to determine the emergency spillway width and depth of flow.

From a study of the relationship between runoff and flood stage for this watershed it was found that a runoff of 0.12 inch was the minimum that would cause flooding to a depth of 6 inches at the smallest cross section. Due to changes in runoff-producing characteristics at different antecedent moisture conditions, rains of 0.70 inch to 2.10 inches would be required, on an average, to cause 0.12 inch of runoff and produce a discharge of 730 cubic feet per second at Valley Section No. 1 on Little Elm Creek, located approximately one mile above State Highway 24.

The peak discharge at Valley Section No. 1 on Little Elm Creek for the largest runoff-producing rain in the 20-year period used in the evaluation study, under present conditions, is 23,270 cubic feet per second. After installation and full functioning of the planned measures the discharge at the same section would be reduced to 13,896 cubic feet per second.

Sedimentation Investigations

The field surveys of the sedimentation problems in the Little Elm and Laterals watershed were made according to methods described in the revised Sedimentation Section of "Procedures for Developing Flood Prevention Work Plans," Water Conservation - 6, SCS, Region 4, revised February, 1954. Field studies included reconnaissance surveys of geology and soils, studies of overbank sediment deposits, flood plain scour, streambank erosion, and the nature of channels and valleys on or near valley cross sections.

Investigations of sediment sources in the watershed above proposed floodwater retarding structures were made according to standard procedures and predictions were made for future sedimentation rates in each basin.

Sediment Source Studies

The sediment derived from sheet erosion was estimated by the method presented in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairies Problem Area in Soil Conservation", Soil Conservation Service, Region 4, February 1953. The formula is based on watershed surveys including the following data:

1. Soil unit in acres, by slope in percent, slope length in feet, and land use, (cultivated, pasture or woods).

2. Average farming practices (percent row crops and/or percent small grains, terracing, etc.)

3. Cover condition classes on pasture and woods.

4. Maximum 30-minute rainfall intensity to be expected once in 2 years.

5. An estimate of annual gully and streambank erosion.

The principal source of sediment above the planned floodwater retarding structures is sheet erosion. About 85 percent of the sediment is produced by sheet erosion with the other 15 percent being fairly evenly divided between gully and channel enlargement.

Effect of Watershed Treatment on Sediment Yields

Cultivated land produces most of the sediment in the watershed but pasture with poor cover is an important contributor in some areas. The application of needed cropland treatment and pasture improvement measures will reduce the present sediment yield by an estimated 20 percent. Areas damaged by flood plain scour will be rendered productive again after they have been protected from flooding and needed land treatment and pasture improvement measures have been put into effect. In addition, the future rates of damage caused by these erosion processes will be greatly reduced.

Geologic Investigations

Reconnaissance geologic inspections were made at 12 representative floodwater retarding structure sites. These included studies of the valley slopes, alluvium, channel banks and exposed rock outcrops, including lithology, stratigraphy and structure.

No serious construction problems are foreseen for these sites. Most of the proposed sites are located in the Eagle Ford Shale formation. The available fill material consists chiefly of suitable watertight clays. Excavation for foundations and abutments should be sufficiently deep to reach unweathered material. The sides of spillway cuts will need to be sloped back sufficiently to prevent slides from occurring, especially where the dip of the strata is toward the cut. Some rock excavation will be found necessary in spillway excavation.

Economic Investigations

Determination of Annual Benefit from Reduction in Damage

Damage schedules covering 47 percent of the flood plain area of Little Elm Creek and tributaries were obtained from landowners or operators. These schedules covered land use and crop distribution, yields and historical data on flooding and flood damages. Analysis of the information contained therein formed the basis for determining damage rates for

various depths and seasons of flooding. In the calculation of crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of the damage. The proper rates of damage were applied to each flooding event recorded in the historical series and an adjustment was made to take into account the effect of recurrent flooding where several floods occurred within the same crop year.

The flood plain land use was mapped in the field. Estimates of normal yields were based on field data obtained from the schedules, supplemented by information received from soil technicians and other agricultural workers in the area. Significant differences were found in land use, yields and flood frequencies. Therefore, to facilitate accurate appraisal, the flood plain was divided into eleven evaluation reaches, each with its own damageable value and flood history. The monetary appraisal of the physical damage from flood plain scour and overbank deposition of sediment was based on the value of production lost, taking into account both the lag for recovery of productivity and the costs of farm operations to speed recovery.

Damage to other agricultural property, such as fences, livestock and farm equipment, was estimated from analysis of tabulated field data, correlated with sizes of floods. The major items of nonagricultural damage were those sustained by roads and bridges. Estimates of these damages were based on information supplied by county road commissioners and watershed residents.

As the Little Elm and Laterals watershed is an agricultural area, indirect damages primarily involve extra farming expense, additional travel time to market, extra cost of purchasing additional feed for livestock and similar items. Information regarding damages of this type was obtained from local residents. Based upon analysis of this and data from areas previously evaluated, indirect damage was determined to be 10 percent of the estimated total direct damage.

Damages were calculated under present conditions and those which will prevail after the installation of each class of measures included in the project. The difference between average annual damages at the time of initiation of each class of measures and those expected after their installation constitutes the benefit attributed to that group through reduction in damage. Benefits from reduction of floodwater damages and flood plain scour resulted from the combined effects of a smaller area flooded and reduced depth of inundation. Reductions in sediment output and in area flooded were jointly responsible for benefits from reduction of damage by overbank deposition.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. However, an estimate was made of the value of production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pool. The land covered by the detention pools was assumed to be converted to grassland under project conditions. The amortized current value of land in pool areas $8,378, exceeds the annual value of production lost within the structure sites at long-term

price levels. Consequently, the higher figure was used in the economic evaluation of the project.

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

During the course of the field investigation, farmers were asked to state the changes made in the use of their flood plain lands as a result of past flooding. Operators of flood plain lands were also asked what changes they would make in flood plain use if flooding were reduced 50 percent. Analysis of these responses provided the basis for estimating both the benefits from restoration of lands to their former use, and from change to a more intensive use than has been formerly possible. Additional factors considered in this analysis were the size and location of the areas affected, land capability, existence of available markets, and reduction in frequency of flooding. All benefits from change in flood plain land use were discounted over a 5-year buildup period to allow for a lag in installation. Associated restoration and development expenses were deducted as associated costs to obtain the net benefit.

Details of Methodology

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

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/

(Based on 1955 Price Levels)
Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Measures	Unit	Applied to Date	Total Federal Cost 2/ (dollars)	Total Non-Federal Cost 3/ (dollars)
LAND TREATMENT				
Contour Farming	Acre	24,789		
Cover Cropping	Acre	75,563		
Rotation Hay and Pasture	Acre	10,702		
Crop Residue Utilization	Acre	53,835		
Strip Cropping	Acre	1,415		
Proper Use Pasture	Acre	15,774		
Pasture Planting	Acre	20,788		
Brush Control	Acre	641		
Wildlife Area Improvement	Acre	739		
Terracing	Mile	795		
Diversion Construction	Mile	21		
Waterway Development	Acre	635		
Pond Construction	No.	232		
Drop Inlets and Drop Structures	No.	2		
Sod Flumes	No.	13		
Technical Assistance (Accel.)				
Planning	Acre	109,220		
Application	Acre	96,647		
TOTAL		xxx	107,180	1,229,459

1/ At time of work plan preparation.
2/ Flood Prevention funds, including acceleration funds.
3/ Excludes $549,947 that was reimbursed from other Federal funds (ACPS) to private interests.

March 1957

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/
Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)
Price Base: 1955

Structure Site No.	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST		Estimated Total Cost
	Contract	Contingencies	Installation Services	Adm. and Misc.	Total Federal	Easement and R/W	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	36,435	3,644	7,287	4,736	52,102	10,470	10,470	62,572
2	24,398	2,440	4,880	3,172	34,890	12,120	12,120	47,010
3	22,730	2,273	4,546	2,955	32,504	16,460	16,460	48,964
4	50,033	5,003	10,007	6,504	71,547	9,870	9,870	81,417
5	11,846	1,185	2,369	1,540	16,940	1,690	1,690	18,630
6	22,412	2,241	4,482	2,914	32,049	4,990	4,990	37,039
7	14,789	1,479	2,958	1,922	21,148	3,640	3,640	24,788
8	34,113	3,411	6,822	4,435	48,781	9,980	9,980	58,761
9	12,099	1,210	2,420	1,573	17,302	2,220	2,220	19,522
10	22,514	2,251	4,503	2,927	32,195	7,860	7,860	40,055
11	16,210	1,621	3,242	2,107	23,180	5,110	5,110	28,290
12	16,685	1,669	3,337	2,169	23,860	4,490	4,490	28,350
13	24,138	2,414	4,827	3,138	34,517	7,290	7,290	41,807
14	17,674	1,767	3,535	2,298	25,274	7,360	7,360	32,634
15	30,364	3,036	6,073	3,947	43,420	7,250	7,250	50,670
16	13,105	1,311	2,621	1,704	18,741	2,060	2,060	20,801
17	26,171	2,617	5,234	3,402	37,424	7,380	7,380	44,804
18	33,051	3,305	6,610	4,297	47,263	11,840	11,840	59,103
19	23,093	2,309	4,619	3,002	33,023	8,330	8,330	41,353
20	30,363	3,036	6,073	3,947	43,419	5,380	5,380	48,799
21	27,152	2,715	5,430	3,530	38,827	13,740	13,740	52,567
22	20,041	2,004	4,008	2,605	28,658	7,170	7,170	35,828
23	23,098	2,310	4,620	3,003	33,031	16,410	16,410	49,441
GRAND TOTAL	552,514	55,251	110,503	71,827	790,095	183,110	183,110	973,205

1/ Does not include work plan preparation cost.

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER											
		1	2	3	4	5	6	7	8	9	10	11	12
Drainage Area 1/	sq.mi.	3.24	4.25	5.37	4.47	0.55	2.17	1.28	3.68	0.58	2.48	1.17	1.14
Storage Capacity													
Sediment Pool	ac.ft.	171	200	200	200	53	131	65	200	56	200	112	116
Sediment Reserve Below Riser	ac.ft.	-	60	169	102	-	-	-	57	-	17	-	-
Sediment Reserve Above Riser	ac.ft.	14	21	32	24	6	10	5	20	6	17	13	9
Floodwater Detention	ac.ft.	898	1,014	1,489	1,158	146	601	354	1,022	156	689	325	325
Total	ac.ft.	1,083	1,295	1,890	1,484	205	742	424	1,299	218	923	450	450
Surface Area													
Sediment Pool 2/	acre	41	64	72	52	9	22	16	49	12	36	26	25
Floodwater Detention Pool	acre	166	176	256	143	24	75	56	149	32	120	75	64
Maximum Height of Dam	feet	25	20	25	32	27	29	25	30	23	24	22	25
Volume of Fill	cu.yds	104,102	69,709	64,942	142,951	33,845	64,035	42,254	97,465	34,568	64,326	46,313	47,671
Emergency Spillway													
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of Use	years	100 /	72	100 /	100 /	100 /	100 /	100 /	100 /	100 /	100 /	100 /	100 /
Design Storm Rainfall													
Duration	hours	6	6	6	6	6	6	6	6	6	6	6	6
Total	inches	12.78	12.62	12.46	12.59	13.50	12.96	13.20	12.88	13.66	12.89	13.43	13.45
Bottom Width	feet	90	205	335	350	45	145	110	90	65	125	310	75
Design Depth	feet	3.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	3.0
Design Capacity	c.f.s.	1,181	4,545	7,403	4,787	589	1,980	1,523	1,219	403	1,692	4,204	999
Total Freeboard 3/	feet	4.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	3.0	4.0	4.0	4.0
Total Capacity	c.f.s.	1,998	6,560	10,720	7,770	999	3,219	2,442	1,998	894	2,775	6,882	1,665
Principal Spillway													
Capacity	c.f.s.	16	38	64	22	8	11	8	18	8	12	18	8
Capacity Equivalents													
Sediment Volume	inches	1.07	1.24	1.40	1.37	2.00	1.22	1.03	1.41	2.00	1.77	2.00	2.05
Detention Volume	inches	5.20	4.47	5.20	4.86	5.00	5.20	5.20	5.20	5.00	5.20	5.20	5.33
Spillway Storage	inches	3.73	1.75	4.90	1.87	3.00	2.21	2.77	3.39	2.60	3.13	4.40	3.62
Class of Structure	-	A	A	A	A	A	A	A	A	A	A	A	A

(Footnotes last page)

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TABLE 3 - STRUCTURE DATA - Continued

FLOODWATER RETARDING STRUCTURES

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER											Total
		13	14	15	16	17	18	19	20	21	22	23	
Drainage Area 1/	sq.mi.	3.38	1.74	2.50	0.68	2.17	4.38	2.01	2.06	5.18	1.56	6.53	62.57
Storage Capacity													
Sediment Pool	ac.ft.	200	171	200	116	185	200	200	189	200	153	200	3,718
Sediment Reserve Below Riser	ac.ft.	4	-	9	-	-	248	49	-	101	-	253	1,069
Sediment Reserve Above Riser	ac.ft.	16	14	16	9	15	35	20	15	28	12	35	392
Floodwater Detention	ac.ft.	710	482	767	185	601	1,122	557	570	1,219	434	1,254	16,078
Total	ac.ft.	930	667	992	310	801	1,605	826	774	1,548	599	1,742	21,257
Surface Area													
Sediment Pool 2/	acre	42	43	39	22	38	67	54	29	70	44	87	959
Floodwater Detention Pool	acre	101	103	104	44	83	167	111	77	202	99	240	2,667
Maximum Height of Dam	feet	29	23	30	24	28	32	22	29	28	22	26	-
Volume of Fill	cu.yds.	68,967	50,498	86,754	37,444	74,774	94,430	65,979	86,750	77,577	57,261	65,995	1,578,610
Emergency Spillway													
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	-
Frequency of Use	years	28	100 ≠	100 ≠	100 ≠	100 ≠	100 ≠	100 ≠	100 ≠	67	100 ≠	31	-
Design Storm Rainfall													
Duration	hours	6	6	6	6	6	6	6	6	6	6	6	-
Total	inches	12.92	13.25	13.06	13.63	12.98	12.80	13.20	13.20	12.49	13.12	12.32	-
Bottom Width	feet	170	320	120	40	190	245	100	145	115	25	360	-
Design Depth	feet	4.0	4.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0	4.0	-
Design Capacity	c.f.s.	3,735	7,147	1,678	510	2,583	3,357	1,409	1,995	2,537	345	7,979	-
Total Freeboard 3/	feet	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	5.0	4.0	5.0	-
Total Capacity	c.f.s.	5,440	10,240	2,664	888	4,218	5,439	2,220	3,219	3,680	555	11,520	-
Principal Spillway													
Capacity	c.f.s.	17	25	13	8	11	22	10	10	26	8	67	-
Capacity Equivalents													
Sediment Volume	inches	1.22	2.00	1.69	3.47	1.73	2.07	2.51	1.86	1.19	1.98	1.40	-
Detention Volume	inches	3.94	5.20	5.75	5.14	5.20	4.81	5.20	5.20	4.41	5.20	3.60	-
Spillway Storage	inches	2.76	5.20	2.68	4.01	2.07	2.22	3.39	1.50	3.70	4.22	3.25	-
Class of Structure	-	A	A	A	A	A	A	A	A	A	A	A	-

1/ Excluding the area from which runoff is controlled by other structures.
2/ Area at the elevation of the top of riser.
3/ Difference between emergency spillway crest and elevation of the top of the dam.

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity Without Program	Quantity With Program
Watershed Area	sq.mi.	288.75	xxx
Watershed Area	acres	184,800	xxx
Area of Cropland	acres	110,009	106,303
Area of Pasture	acres	63,339	67,189
Area of Woodland	acres	6,291	6,147
Stream Channels and Miscellaneous	acres	5,161	5,161
Overflow Area Subject to Damage by Design Storm	acres	15,638	13,303
Area Damaged Annually by:			
Sediment	acres	2,884	980
Flood Plain Scour	acres	131	80
Sheet Erosion	acres	31,922	17,227
Average Annual Rainfall	inches	39.95	xxx

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TABLE 5 - SUMMARY OF PLAN DATA

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity
Years to Complete Program	Year	10
Total Installation Cost		
Federal 1/	Dollar	995,121
Non-Federal 2/	Dollar	2,834,242
Annual O & M Cost		
Federal	Dollar	-
Non-Federal	Dollar	2,279
Average Annual Monetary Benefits	Dollar	77,863
Agricultural	Percent	95
Nonagricultural	Percent	5
Structural Measures		
Floodwater Retarding Structures	Each	23
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acre	216
Sediment Pool	Acre	432
Upland		
Detention Pool	Acre	1,492
Sediment Pool	Acre	527
Watershed Area Above Structures	Acre	40,044
Reduction of Floodwater Damage	Dollar	67,328
By Land Treatment Measures For Watershed Protection	Percent	6.1
By Structural Measures	Percent	46.4
Reduction of Sediment Damage	Dollar	6,924
By Land Treatment Measures For Watershed Protection	Percent	12.1
By Structural Measures	Percent	40.5
Reduction of Erosion Damage	Dollar	1,777
By Land Treatment Measures For Watershed Protection	Percent	12.9
By Structural Measures	Percent	61.5
Flood Prevention Benefit From Changed Land Use	Dollar	4,932

1/ Includes $107,180 of Flood Prevention expenditures prior to work plan preparation (see table 1a) and $27,585 for work plan preparation.

2/ Includes $1,229,459 of non-Federal expenditures prior to work plan preparation in connection with the Flood Prevention program (see table 1a).

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TABLE 6 - ANNUAL COSTS 1/

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Structure Site Number	Amortization of Installation Costs 2/			Operation & Maintenance Costs 3/		Total
	Federal	Non-Federal	Total	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures						
1, 2 and 3	4,213	1,818	6,031	332	332	6,363
4	2,523	459	2,982	142	142	3,124
5	597	79	676	95	95	771
6	1,130	232	1,362	95	95	1,457
7	746	169	915	95	95	1,010
8	1,720	465	2,185	95	95	2,280
9	610	103	713	95	95	808
10 and 11	1,952	604	2,556	190	190	2,746
12	841	209	1,050	95	95	1,145
13 and 14	2,108	682	2,790	190	190	2,980
15	1,531	337	1,868	95	95	1,963
16	661	96	757	95	95	852
17	1,320	344	1,664	95	95	1,759
18	1,666	551	2,217	95	95	2,312
19	1,164	388	1,552	95	95	1,647
20	1,531	250	1,781	95	95	1,876
21, 22 and 23	3,544	1,737	5,281	285	285	5,566
TOTAL	27,857	8,523	36,380	2,279	2,279	38,659

1/ Does not include work plan preparation cost.

2/ Amortization period, 50 years; Federal interest rate, 2½ percent; non-Federal interest rate, 4 percent; based on 1955 prices.

3/ Based on long-term price levels as projected by ARS, June 1956.

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TABLE 7 - SUMMARY OF MONETARY BENEFITS

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Price Base: Long-Term 1/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits
	Without Project	After Land Treatment For W/S Protection	With Project	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	91,201	85,948	39,825	46,123
Other Agricultural	28,026	26,007	15,444	10,563
Nonagricultural				
Road and Bridge	8,894	8,336	5,524	2,812
Subtotal	128,121	120,291	60,793	59,498
Sediment Damage				
Overbank Deposition	9,302	8,258	3,561	4,697
Reservoirs 2/	3,873	3,328	2,690	638
Subtotal	13,175	11,586	6,251	5,335
Erosion Damage				
Flood Plain Scour	2,387	2,078	610	1,468
Subtotal	2,387	2,078	610	1,468
Indirect Damage	14,368	13,395	6,765	6,630
Total - All Damage	158,051	147,350	74,419	72,931
Changed Land Use	xxx	xxx	xxx	4,932
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	77,863
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	77,863
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	77,863

1/ As projected by ARS, June 1956.

2/ Garza-Little Elm Reservoir.

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TABLE 8 - BENEFIT-COST ANALYSIS

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Structure Site Number	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention: Floodwater	Sediment	Erosion	Indirect	Changed Land Use	Total	Average Annual Cost 2/	Benefit-Cost Ratio
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures								
1, 2 and 3	14,892	1,474	365	1,673	814	19,218	6,363	3.02:1
4	5,175	511	128	582	283	6,679	3,124	2.14:1
5	637	64	14	72	35	822	771	1.07:1
6	2,367	221	56	264	138	3,046	1,457	2.09:1
7	1,396	129	34	156	82	1,797	1,010	1.78:1
8	4,013	374	95	449	233	5,164	2,280	2.26:1
9	633	59	16	72	36	816	808	1.01:1
10 and 11	3,982	371	95	444	230	5,122	2,746	1.87:1
12	1,244	115	30	139	72	1,600	1,145	1.40:1
13 and 14	4,601	443	137	518	299	5,998	2,980	2.01:1
15	2,204	217	66	249	618	3,354	1,963	1.71:1
16	600	60	17	67	168	912	852	1.07:1
17	1,678	156	46	188	124	2,192	1,759	1.25:1
18	4,662	269	81	500	54	5,566	2,312	2.41:1
19	2,140	124	38	230	24	2,556	1,647	1.55:1
20	2,194	127	38	235	25	2,619	1,876	1.40:1
21, 22 and 23	7,080	621	212	792	1,697	10,402	5,566	1.87:1
GRAND TOTAL	59,498	5,335	1,468	6,630	4,932	77,863	38,659	2.01:1

1/ Long-term prices, as projected by ARS, June 1956.
2/ Derived from Installation costs based on 1955 price level and operation and maintenance costs based on long-term prices, as projected by ARS, June 1956. Work plan preparation cost not included.

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TABLE 8A - BENEFITS AND COSTS BY CONSTRUCTION UNITS

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Construction Unit and Structures	Annual Benefits 1/	Annual Costs 2/
	(dollars)	(dollars)
Construction Unit No. 1 (Mustang Creek - Drainage E-2)		
Structure Nos. 21, 22 and 23	7,729	5,566
Construction Unit No. 2 (Hearne Branch - Drainage E-3)		
Structure Nos. 18, 19 and 20	6,170	5,835
Construction Unit No. 3 (Little Elm Creek - Drainage E)		
Structure Nos. 1 to 17	3/ 33,932	27,258

1/ Long-term prices, as projected by ARS, June 1956

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

3/ Includes benefits on Little Elm Creek above its confluence with Hearne Branch.

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TABLE 9 - COST SHARING SUMMARY

Little Elm and Laterals Watershed, Texas
(Trinity River Watershed)

Price Base: 1955 1/

Type of Cost	Federal Cost		Non-Federal Cost		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment 2/						
Non-Federal Land For Watershed Protection	177,441	6.3	2,651,132	93.7	2,828,573	72.9
Subtotal	177,441	6.3	2,651,132	93.7	2,828,573	72.9
Structural Measures						
Installation Flood Prevention	790,095	81.2	183,110	18.8	973,205	25.1
Subtotal	790,095	81.2	183,110	18.8	973,205	25.1
Work Plan Preparation	27,585	100.0	-	-	27,585	0.7
Total Installation Cost	995,121	26.0	2,834,242	74.0	3,829,363	98.7
Operation and Maintenance 3/	-	-	48,958	100.0	48,958	1.3
Total Structural Cost	790,095	77.3	232,068	22.7	1,022,163	26.4
TOTAL PROJECT COST	995,121	25.7	2,883,200	74.3	3,878,321	100.0

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

2/ Including $107,180 of Flood Prevention expenditures and $1,229,459 of non-Federal expenditures in conjunction therewith, incurred prior to work plan preparation.

3/ Capitalized for 50 years at 4 percent.

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