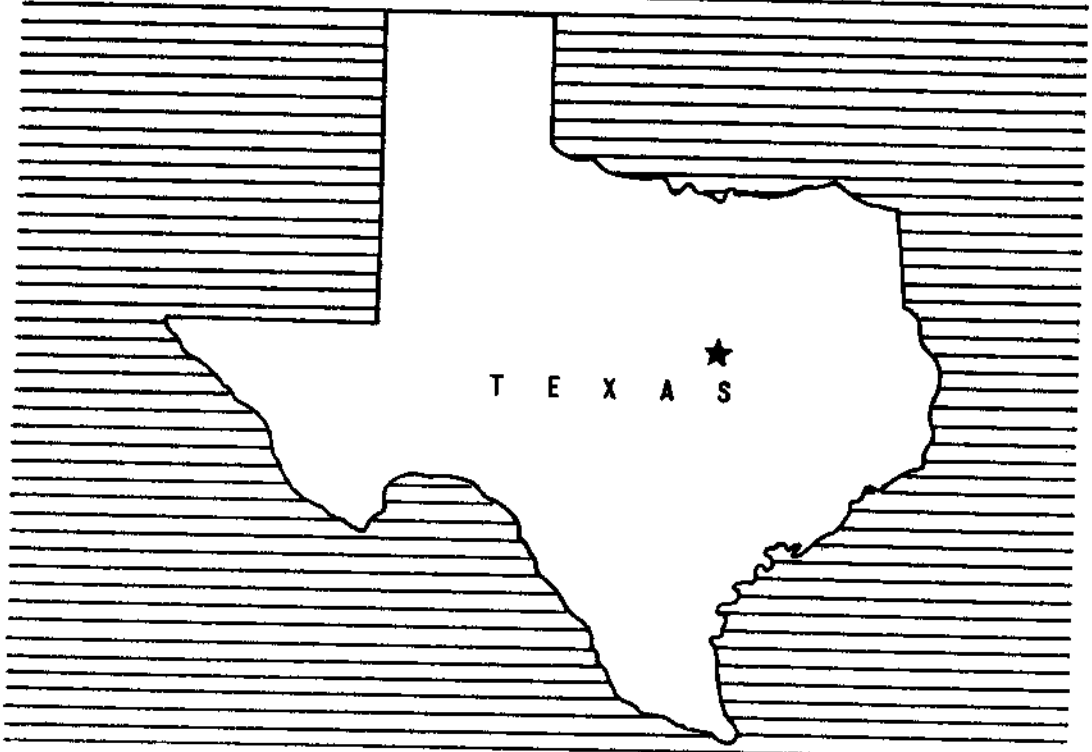
WORK PLAN
FOR WATERSHED PROTECTION AND FLOOD PREVENTION

ELM CREEK WATERSHED (CEN-TEX)

BELL, FALLS, McLENNAN, and MILAM COUNTIES, TEXAS



February 1975

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ADDENDUM

ELM CREEK WATERSHED, TEXAS (CEN-TEX)

INTRODUCTION

This addendum is based on the Water Resource Council's "Principles and Standards for Planning Water and Related Land Resources," which became effective October 30, 1973. It is prepared to be consistent with the requirements of the Water Resource Council's Procedure No. 1 for the phase-in of the Principles and Standards. The information presented is:

Part I - Benefits to Cost Comparison

An evaluation of the selected plan using current normalized prices, current construction costs, and the current interest rate.

Part II - Four Account Displays

Evaluated effects of the selected plan are displayed under separate accounts for (1) National Economic Development, (2) Environmental Quality, (3) Regional Development, and (4) Social Well-Being. The displays are consistent with the intent of the Principles and Standards.

Part III - Abbreviated Environmental Quality Plan

An environmental quality plan, consistent with the intent of the Principles and Standards, but which is abridged in detail, has been developed by an interdisciplinary team. It is an alternative plan to the selected plan and is formulated to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. This plan was formulated from information and data obtained during the investigative and analysis phases of project planning. Formulation began with the inventory and recognition of the watershed problems and needs. Desired environmental effects, as translated from the problems and needs, provided a basis for examining appropriate water and land resource use and management opportunities. Opportunities that emphasized contributions to the component needs were selected and are shown as plan elements of the abbreviated environmental quality plan. The cost of $21,327,800 for its installation is a preliminary estimate.

Implementation of features of this environmental quality plan would require acceptance by the local people. Adequate legal authorities do exist for installation; however, funding for all plan elements is presently not available through existing legislative authorities.

PART I

BENEFITS TO COST COMPARISON

Elm Creek Watershed (Cen-Tex), Texas

This addendum shows the project costs, benefits, and benefit-cost ratio based on a 6-1/8 percent interest rate; current normalized prices, October 1974; and the 1974 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1.	Project costs are	$316,290
2.	Project benefits are	$577,550
3.	The project benefit-cost ratio is	1.8 to 1.0
4.	Project benefit-cost ratio excluding secondary benefits is	1.3 to 1.0

PART II

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT
Elm Creek Watershed, Texas

Components	Measures of effects 1/
Beneficial effects:	
A. The value to users of increased outputs of goods and services	
1. Flood prevention	$413,840
2. Incidental livestock water	4,260
Total beneficial effects	$418,100

Components	Measures of effects 1/	
Adverse effects:		
A. The value of resources required for a plan		
1. Forty-five floodwater retarding structures		
a. Project installation		$256,940
b. Project administration		35,070
c. Operation and maintenance		12,100
Total adverse effects		$304,110
Net beneficial effects		$113,990

1/ Average annual

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Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT

Elm Creek Watershed, Texas

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of naturol beauty	1. Creace 1,776 surface acres of water.
	2. Require 2,347 acres of cropland, 3,932 acres of grassland, and 255 acres of stream channel for project installation.
B. Quality considerations of water and land resources	1. Reduce erosion on 3,188 acres of agricultural land.
	2. Reduce sediment deposition on 3,737 acres of agricultural land.
	3. Reduce the destructioo of an average of 1.4 acres of produccive flood plain land due to streambank erosion.
	4. Reduce the destruction of on average of 6.9 acres of productive flood plain land due to valley trenching.
	5. Suspended sediment concentration carried by runoff water leaving the watershed will be reduced from 3,600 mg./l. to 1,100 mg./l.
	6. Initially reduce the average annual volume of discharge by about 4.4 percent.
C. Biological resources and selected ecosystems	1. Enhance habitat and food supply and provide improved distribution of water for game animals, and game and nongame birds throughout the watershed.
	2. Creare 1,776 surface acres of lake fish habitat.
	3. Provide 1,776 surface acres at the reservoirs for migratory waterfowl resting areas.
D. Irreversible or irretrievable commitments	1. Conversion of 2,204 acres of cropland, rangeland, pastureland, and intermittent stream channels to dams, emergency spillways, and sediment pools and change 1,621 acres of cropland to pastureland in the area needed for the detantioo pools.

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Selected Plan
REGIONAL DEVELOPMENT ACCOUNT

Elm Creek Watershed, Texas

Components	Measures of effects[1/] Region[2/]	Rest of Nation
A. Income		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region.		
a. Flood prevention	$413,840	-
b. Incidental livestock water	4,260	-
c. Secondary	157,530	-
Total beneficial effects	575,630	-

Components	Measures of effects[1/] Region[2/]	Rest of Nation
A. Income		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Forty-five floodwater retarding structures		
Project installation (structural measures)	$ 55,680	$201,260
Project administration	1,380	33,690
Operation and maintenance	12,100	-
Total adverse effects	$ 69,160	$234,950
Net beneficial effects	$506,470	-$234,950

1/ Average annual
2/ The region consists of Bell, Falls, McLennan, and Milam Counties, Texas

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Selected Plan
REGIONAL DEVELOPMENT ACCOUNT (continued-2)

Elm Creek Watershed, Texas

Components	Measures of effects: Regional/	Measures of effects: Rest of Nation
B. Employment		
Beneficial effects:		
1. Increase in the number and types of jobs		
a. Agricultural employment	25 permanent semi-skilled jobs	-----
b. Employment for project construction	154 man-years of semi-skilled employment during the installation period (10 years)	-----
Total beneficial effects	25 permanent semi-skilled jobs	-----
	154 man-years of semi-skilled employment over the installation period (10 years)	-----
C. Population Distribution		
Beneficial effects:	Create 22 permanent semi-skilled jobs in a rural area and 154 man-years of semi-skilled employment over the installation period (10 years).	-----
D. Regional Economic Base and Stability		
Beneficial effects:	Create 22 permanent semi-skilled jobs and 154 man-years of semi-skilled employment over the installation period (10 years). Reduce flood hazard on 21,481 acres of flood plain.	

	Measures of effects: Regional/	Measures of effects: Rest of Nation
B. Employment		
Adverse effects:		
1. Decrease in number and types of jobs		
a. Lost in agricultural employment of project-take area	3 permanent semi-skilled jobs	0
Total adverse effects	3 permanent semi-skilled jobs	0
Net beneficial effects	22 permanent semi-skilled jobs	
	154 man-years of semi-skilled employment over the installation period (10 years)	
C. Population Distribution		
Adverse effects:	-----	-----
D. Regional Economic Base and Stability		
Adverse effects:	-----	-----

1/ The region consists of Bell, Falls, McLennan, and Milam Counties, Texas

February 1975

Selected Plan

SOCIAL WELL-BEING ACCOUNT

Elm Creek Watershed, Texas

Components	Measures of Effects
Beneficial and adverse effects:	
A. Real Income distribution	1. Create 22 permanent semi-skilled jobs and 154 man-years of semi-skilled employment over the installation period (10 years).
	2. Create regional income benefit distribution of $575,630 benefits by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	8	40
3,000 - 10,000	45	50
More than 10,000	47	10

	3. Local average annual costs of $69,160 will be borne by the Elm Creek Watershed Authority and financed by tax revenues. The percentage of contributions to local costs, by income classes, is not readily available.
B. Life, health, and safety	1. Provide protection to users of the transportation system.
C. Recreational opportunities	1. Create 1,776 surface acres of water initially for lake fisheries, and waterfowl resting areas.

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PART III

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Elm Creek Watershed, Texas

The goals of this environmental quality plan for the Elm Creek watershed are to preserve and enhance areas of natural beauty; maintain and improve the quality of the water, land, and air resources; and preserve and enhance the biological resources and ecosystems of the watershed so that man can live in an aesthetically and culturally pleasing environment.

The principal environmental quality problems in the watershed are the deterioration of the land, plant, and water resources associated with intensified agricultural use and the threat of loss of property and impairment of livelihood by flooding of the flood plain lands of the watershed.

The watershed lies within the Black Prairie physiographic area. The topography varies from nearly flat on the wide flood plain in the lower reaches of Elm Creek to gently and moderately rolling in the uplands. Broad areas of gently rolling lands occur on the northern side of the mainstem of Elm Creek and most of the major tributaries. Moderately rolling to sometimes steep topography occurs along the south and southwestern sides of the mainstem and the major tributaries. Some steeply rolling areas also occur in the upper portion of the watershed where it is underlain by harder bedrock.

Around the turn of the century, most original plant ecosystems were destroyed by the conversion of these prairies to cropland. Intensive cotton production on the rolling uplands resulted in severe soil erosion. Fortunately, much of this land has since been converted to tame pasture grasses such as common and coastal bermudagrass, with this trend expected to continue into the future.

Very few remnants of climax ecotypes remain. Most of the 13,065 acres of rangeland contain less than 25 percent of its climax flora. Buffalograss, threeawns, texas wintergrass, silver bluestem, and small amounts of little bluestem make up most of the currently existing range flora. Introduced tame pasture grasses such as common bermudagrass and coastal bermudagrass currently occupy 62,263 acres of the watershed. Woody plants such as hackberry, elm, ash, oak, and bumelia occur as dominants on 14,000 acres.

Active sheet, gully and roadside, streambank, valley trenching, and flood plain erosion contribute to heavy sediment loads carried by Elm Creek and its tributaries. Streambank erosion and resultant destruction of streambank vegetation detract from the scenic quality of Elm Creek. Erosion from the large network of dirt and gravelled county

roads pollutes the air and contributes to sediment production. Flooding of the agricultural lands in the flood plain poses a threat of damage to crops and other agricultural properties, which will impair the livelihood of the residents. The city of Troy does not have an adequate source of water supply.

Component needs for solving problems relating to specific environmental conditions are listed below:

1. Areas of Natural Beauty

    a. Reduce sheet and gully and roadside erosion in the uplands.

    b. Maintain aesthetic value of landscape.

    c. Reduce streambank erosion and valley trenching on Elm Creek and its tributaries.

2. Quality of Water, Land, and Air Resources

    a. Improve the quality of the streamflow of Elm Creek and its tributaries by reducing the sediment being delivered to the streams from streambank erosion, valley trenching, roadside and gully erosion, sheet erosion, and flood plain scour.

    b. Prevent pollution of the landscape by uncontrolled dumping of refuse.

    c. Protect the land resource base from deterioration by reducing sheet erosion, gully erosion, flood plain scour, streambank erosion, valley trenching, and sediment deposition.

    d. Maintain and enhance the productivity of the land resource base.

    e. Improve the quality of the air by reducing the dust associated with dirt and gravel roads.

    f. Provide human inhabitants of the watershed a dependable water supply.

    g. Reduce damage to transportation systems and sources of livelihood of human inhabitants by flooding.

3. Biological Resources and Ecosystems

    a. Preserve and enhance the habitat for fish and wildlife by streamflow augmentation.

b. Preserve and enhance the habitat conditions for fish and wildlife species present in the watershed by:

(1) Eliminating destruction of the existing habitat.

(2) Providing more dependable food supplies.

(3) Reducing damage to habitat from flooding, sedimentation, scour, etc.

(4) Creating additional cover for selected species of wildlife.

(5) Creating additional habitat for fish.

The plan elements for environmental quality consist of a system of management practices, land treatment measures, structural measures, and land acquisition. Cropland treatment measures would include conservation cropping systems (use of diversified crops in rotation and management of residues), grassed waterways and terraces, contour tillage, and fertilizing as needed.

Grassland treatment consists of grazing management to improve or maintain the more desirable forage plants, including rotating or systematically grazing pastures while others are rested to permit the better plants to recover vigor and grow, and grazing at intensities that will not damage the vigor of the forage plants. Weedy or undesirable woody plants that are a problem will be controlled to limit their competition with the more desirable forage plants. This will be accomplished in patterns that will leave ample amounts of these plants for the maintenance of desirable wildlife habitat and aesthetic values. Some 38,900 acres of grassland and 24,600 acres of cropland remain to be treated. Land users would be encouraged to apply and maintain these measures by the local soil and water conservation districts, with technical assistance to be supplied by the Soil Conservation Service. Financial assistance, usually on a cost-share basis, is available through programs such as the Rural Environmental Conservation Program administered by the Agricultural Stabilization and Conservation Service.

Installation of 44 single-purpose floodwater retarding structures would reduce flood stages on Elm Creek and its tributaries. One multiple-purpose structure would be installed to store floodwater and municipal water for the inhabitants of Troy. Streambank stabilization measures consisting of the necessary shaping, vegetation, and structural measures would be installed to prevent further erosion on 104 acres along Elm Creek and its tributaries. These elements would be implemented by the county governments, the local soil and water conservation districts, and private landowners. Cost-sharing funds are available under Public Law 566.

The improvement of the 300 miles of county road would consist of hard surfacing the roads to reduce dust and necessary improvements to

prevent roadside erosion. This element would require implementation by the county governments at their expense.

Sanitary landfills would be installed at convenient points for public use to prevent pollution of the landscape and possible stream pollution by waste and litter. This element would be implemented by the county governments.

The flood plain management element would consist of restricting the use of the flood plain. Information concerning the flood hazard would be developed and furnished to the public. A zoning ordinance would be enacted to prevent destruction of woody vegetation and construction of improvements within a designated floodway. Development in the flood-fringe area (outside the floodway) would be allowed if improvements were constructed so that significant damage would not be caused by the 100-year frequency flood. The floodway could be used for recreation, most forms of agriculture, open spaces, wildlife areas, parking lots, etc. This element would be implemented through the county and city governments.

The estimated installation costs of the elements of the environmental quality plan are as follows:

1. Completion of the application of land treatment measures: $1,717,800

2. Forty-four single-purpose floodwater retarding structures and one multiple-purpose structure: $5,500,000

3. Streambank stabilization of 1.4 acres: $10,000

4. Improvement of 300 miles of county road: $13,500,000

5. Installation of four sanitary landfills at convenient points for public use throughout the watershed: $100,000

6. Flood plain management program for Elm Creek and its tributaries: $500,000

The total installation cost of the environmental quality plan is estimated to be $21,327,800.

The environmental effects that would result from installation of the environmental plan are as follows:

1. Areas of Natural Beauty

    a. Enhance the appearance of the 1,550 farms and ranches in the watershed through application and maintenance of land treatment measures.

b. Maintain the aesthetic value of the landscape through the preservation and enhancement of the land resource base which sustains the aesthetic value.

c. Improve or enhance the scenic quality on about 8 miles of Elm Creek by streamflow augmentation, land treatment, and revegetation of 1.4 acres of active streambank erosion; reduction in scour damage on 3,188 acres of flood plain cropland annually; and reduction in valley trenching on 6.9 acres annually.

d. Improve the scenic quality of gullied areas and roadside erosion areas by shaping and revegetation.

e. Provide greater diversity of landscape by superimposing the embankments and water impoundments of floodwater retarding and multiple-purpose structures into the existing setting of the watershed.

2. Quality of Water, Land, and Air Resources

a. Reduce the sediment load carried by Elm Creek and its tributaries through reduction of sheet erosion, gully erosion, streambank erosion, valley trenching, and flood plain scour.

b. Reduce potential for waterborne pollution and contamination by installation of sanitary landfills at convenient points for public use throughout the watershed.

c. Prevent the deterioration of the land resource base by providing protection from erosion by installing needed vegetative and mechanical treatment measures.

d. Maintain and enhance the productivity of the land resource base by applying agronomic and vegetative management practices.

e. Reduce flooding on 22,900 acres of agricultural land.

f. Reduce dust and associated pollution of air and adjoining vegetation along 300 miles of dirt- and gravel-surfaced county roads.

g. Provide inhabitants of Troy with an adequate water supply.

h. Reduce damage to agricultural properties and sources of livelihood for about 530 owners of property on the flood plain of Elm Creek.

i. Reduce the interruption of the transportation system at crossings along the flood plain.

j. Encourage preservation of open spaces on the flood plain through zoning, restrictions, or management programs. Also reduce the possibility of increased damages due to future developments on the flood plain.

k. Result in initial reduction in average annual runoff of about 5 percent from the watershed due to evaporation and seepage losses from the sediment pools and the municipal water supply pool.

l. Reduce sediment load carried downstream into the Little River.

m. Restrict future land use on 6,534 acres of land needed to install and operate the structural measures.

n. Require loss of 726 acres of cropland, 1,336 acres of pastureland and rangeland, and 142 acres (37 miles) of intermittent stream channels.

o. Result in occasional interruption in the use of 4,330 acres of land in the retarding pool areas subject to temporary inundation.

p. Require the clearing of woody vegetation on 560 acres.

3. Biological Resources and Selected Ecological Systems

a. Enhance the fishery habitat in the streams and in farm and ranch ponds by reducing sediment content of runoff.

b. Improve habitat for some wildlife species as the result of improvement of plant composition on the rangeland in the watershed.

c. Improve wildlife habitat on upland through installation of certain land treatment measures.

d. Change 1,776 acres of small game habitat to fish habitat and waterfowl resting areas.

4. Irreversible or Irretrievable Commitments

a. Require the use of 6,534 acres needed to install, operate, and maintain the floodwater retarding structures and multiple-purpose structure.

b. Require the dedication of 4,000 acres of land along Elm Creek and its tributaries for use as a floodway.

c. Require the commitment of labor, materials, energy, and capital needed to install, operate, and maintain the project.

WATERSHED WORK PLAN AGREEMENT

between the

Central Texas Soil and Water Conservation District

McLennan County Soil and Water Conservation District

Bell County Commissioners Court

Falls County Commissioners Court

McLennan County Commissioners Court

Milam County Commissioners Court

Elm Creek Watershed Authority

(hereinafter referred to as the Sponsoring Local Organization)

State of Texas

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Elm Creek (Cen-Tex) Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Elm Creek (Cen-Tex) Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring 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 can be installed in about 10 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire, with other than PL-566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost $ 937,921)

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the sponsoring local organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	37.04	62.96	13,100

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement. (Estimated cost $1,770 .)

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures	-	100.00	3,183,700

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
Floodwater Retarding Structures	-	100.00	222,150

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $23,400 and $571,440, respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

9. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the availability of appropriations for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.

    An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsor(s) having specific responsibilities for the particular structural measure involved.

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

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Central Texas Soil and Water Conservation District
Local Organization

By V. A. Hansen
V. A. Hansen

Title Chairman

Address Rt. 1, Chalton, Texas 76632
Zip code

Date 8/19/75

The signing of this agreement was authorized by a resolution of the governing body of the Central Texas Soil and Water Conservation District
Local Organization
adopted at a meeting held on August 19, 1975

(Secretary, Local Organization)
Ellis G. Marshall DDS

Address First Natl. Bank Bldg., Temple, Texas
Zip Code 76501

Date 8/19/75

McLennan County Soil and Water Conservation District
Local Organization

By
Dave Simons

Title Chairman

Address Box 601 Waco TX 76703
Zip Code

Date 8/19/75

The signing of this agreement was authorized by a resolution of the governing body of the McLennan County Soil and Water Conservation District
Local Organization
adopted at a meeting held on August 19, 1975

(Secretary, Local Organization)
Leon Thompson

Address Box 601, Waco, TX 76703
Zip Code

Date 8/19/75

Bell County Commissioners Court
Local Organization

By H. F. Harris

Title County Judge

Address Box #336 Belton 76513
Zip code

Date 9-15-75

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

adopted at a meeting held on 9-15-75

(Secretary, Local Organization)
Ruby McKee

Address County Clerk
Belton, Texas 76513 Zip Code

Date 9-15-75

Falls County Commissioners Court
Local Organization

By Johnnie C. Ward
Johnnie C. Ward

Title County Judge

Address Chilton, Texas 76632
Zip Code

Date August 25, 1975

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

adopted at a meeting held on August 25, 1975

G. L. Burks
(Secretary, Local Organization)
G. L. Burks, Falls Co. Clerk

Address Marlin, Texas 76661
Zip Code

Date August 25, 1975

McLennan County Commissioners Court
Local Organization

By Bob L. Thomas
Bob L. Thomas

Title County Judge

Address 2nd Floor Courthouse
Waco Texas 76701
Zip code

Date August 13, 1975

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

adopted at a meeting held on August 13 1975

Frank Denny
Frank Denny, County Clerk
(Secretary, Local Organization)
By Maurine Dunaway, deputy

Address 4th Floor Courthouse Annex 76701
Waco, Texas
Zip Code

Date August 13, 1975

Milam County Commissioners Court
Local Organization

By
O. B. Warden

Title

Address
Zip Code

Date Aug. 11, 1975

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

adopted at a meeting held on Aug. 11 1975

(Secretary, Local Organization)
Wayne E. Weiser

Address
Zip Code

Date Aug. 11, 1975

Elm Creek Watershed Authority
Local Organization

By Edward Coufal
Edward Coufal

Title President

Address Rt 3 Temple 76501
Zip Code

Date 9-11-75

The signing of this agreement was authorized by a resolution of the governing body of the Elm Creek Watershed Authority
Local Organization

adopted at a meeting held on September 11, 1975

(Secretary, Local Organization)
Reuben Mikeska

Address Rt 3 Temple Tex 76501
Zip Code

Date 11 Sept 75

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

By Edward C. Thomas

Date OCT 1 1975

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

ELM CREEK WATERSHED (CEN-TEX)
Bell, Falls, McLennan, and Milam Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Prepared by:

Central Texas Soil and Water Conservation District

McLennan County Soil and Water Conservation District

Bell County Commissioners Court

Falls County Commissioners Court

McLennan County Commissioners Court

Milam County Commissioners Court

Elm Creek Watershed Authority

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
February 1975

WATERSHED WORK PLAN

ELM CREEK WATERSHED
Bell, Falls, McLennan, and Milam Counties, Texas

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Elm Creek watershed was prepared by the Central Texas and the McLennan County Soil and Water Conservation Districts, the Bell, Falls, McLennan, and Milam Counties Commissioners Courts, and the Elm Creek Watershed Authority. Technical assistance was provided by the Soil Conservation Service of the U. S. Department of Agriculture. The Fish and Wildlife Service of the U. S. Department of the Interior collaborated with the Texas Parks and Wildlife Department in the preparation of a reconnaissance report of the fish and wildlife aspects of the watershed. Financial assistance for development of the work plan was provided by the Texas State Soil and Water Conservation Board, and the Soil Conservation Service. An archeological survey of the watershed was made by the Archeology Research Program of Southern Methodist University.

Elm Creek watershed comprises an area of 207,360 acres, or 324 square miles, in the Brazos River Basin in Central Texas. It drains portions of southwestern McLennan, eastern Bell, western Falls, and northern Milam Counties (figure 4). Approximately 59 percent of the watershed is cropland, 30 percent is pastureland, 6 percent is rangeland, and 5 percent is in other uses such as roads, railroads, farmsteads, urban, and built-up areas.

The major soil and water problems in the watershed are erosion on the uplands and damages caused by floodwater, scour, and overbank deposition on about 22,900 acres of flood plain. Runoff from this watershed also contributes to the flooding downstream on the Little River.

The estimated average annual floodwater, sediment, erosion, and indirect damages within the benefited area and without the project total $580,500 at current normalized prices for agricultural damages and 1974 prices for nonagricultural damages.

Project objectives are the proper use, treatment, and management of soil and water resources in the watershed, the protection of flood plain lands and property, and the stimulation of the economic development of the area as the result of project installation. The project as formulated meets these objectives.

The work plan proposes the installation, during a 10-year period, of a project for the protection and development of the watershed at a total cost of $6,671,330. The share of the cost to be borne by Public Law 566 funds is $4,200,448. The share to be borne by other than Public Law 566 funds is $2,470,882. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

Land users will be encouraged to establish and maintain needed land treatment measures on 24,600 acres of cropland, 33,500 acres of pastureland, and 5,400 acres of rangeland at an accelerated rate during the 10-year installation period, in addition to the maintenance of those measures already applied. These measures will improve the hydrologic condition of both cropland and grassland. This improvement in soil condition and cover will reduce sediment to floodwater retarding structures and will reduce average annual damages from floodwater, sediment, and scour by about 6 percent. The installation cost of these land treatment measures is estimated to be $1,717,849, of which $1,502,939 will be from funds other than Public Law 566. Public Law 566 funds will provide $214,910 in order to accelerate technical assistance needed for the application and maintenance of these measures. Of this amount, $2,750 will be used for the completion of needed soil surveys during the first two years of project installation.

Structural Measures

The structural measures included in this plan consist of 45 floodwater retarding structures. The estimated total cost of structural measures is $4,953,481, of which the local share is $967,943 and the Public Law 566 share is $3,985,538. The local share of the cost consists of land rights and project administration.

Environmental Impact

The project action will contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources.

The project will reduce flooding to agricultural land and the transportation system.

Sediment contributed to the flood plain of Elm Creek and the Little River will be reduced. The watershed lands will be protected from erosion and the productivity maintained and increased. Additional water impoundment areas will be created and can be used for waterfowl feeding and resting areas, development of fisheries, and livestock watering areas.

The project will preserve and enhance the habitat for most species of wildlife.

Additional opportunities for employment will be created, and income to households and demand for services will be increased.

Installation of the project will require the use of 6,534 acres of land of which 428 acres are needed for dams and emergency spillways, 1,776 acres are needed for sediment pools, and 4,330 acres are needed for detention pools.

The existing vegetation will be destroyed on the 428 acres of land needed for construction of dams and emergency spillways and on most of the 1,776 acres of land needed for the sediment pools. All land exposed by construction and not permanently inundated by water in the sediment pools will be revegetated.

Initially, the project will cause a minor reduction in the volume of average annual streamflow because of seepage and evaporation losses in the sediment pools. However, the periods when no streamflow occurs will be decreased. As sediment accumulates in the sediment pools, the streamflow is expected to again approach pre-Public Law 566 project conditions.

The average annual primary benefits accruing to structural measures are estimated to be $418,100. Secondary benefits will amount to $157,530. The ratio of total annual benefits ($575,630) resulting from the installation of structural measures to the annual cost ($304,110) is 1.9 to 1.0.

Provisions for Financing Local Share of Installation Cost

The cost of installing the needed land treatment measures during the 10-year installation period will be borne by the landowners and operators of the land on which these measures are installed. The Farmers Home Administration, local banks, and other lending institutions can arrange financing for the landowners and operators' share of the cost.

Funds for the local share of the cost of installing the structural measures will be provided by the Elm Creek Watershed Authority. The Elm Creek Watershed Authority plans on obtaining a loan from the Farmers Home Administration. Negotiations, including the filing of a preliminary application, are under way with the state director of the Farmers Home Administration. A $300,000 bond issue has been approved by the taxpaying voters of Improvement District Number 1 of the Elm Creek Watershed Authority.

Operation and Maintenance

The Elm Creek Watershed Authority will be responsible for the operation of the floodwater retarding structures. Land treatment measures for

watershed protection will be maintained by landowners or operators of the farms or ranches upon which the measures will be installed under agreements with the soil and water conservation districts. The Elm Creek Watershed Authority and the commissioners court of the county in which the structure is located will be responsible for the maintenance of the structural measures.

The estimated average annual cost of operation and maintenance is $12,100.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

Elm Creek watershed project comprises an area of 207,360 acres, or 324 square miles, in the Brazos River Basin in Central Texas. It drains portions of southwestern McLennan, eastern Bell, western Falls, and northern Milam Counties.[1/]

The project area lies about 20 miles south of the metropolitan area of Waco and about 60 miles north of Austin. The city of Temple, population 33,431, lies on the western watershed divide. Moody, population 1,286, lies on the northern divide near the headwaters of Elm Creek and Cameron, population 5,546, lies on the southern divide near the confluence of Elm Creek with the Little River. The small towns of Rogers, population 1,030, and Buckholts, population about 100, lie on the southwestern watershed divide between Temple and Cameron. Troy, population 542, lies in the north central part and is the only town lying completely within the watershed. Numerous small community centers having populations of less than 50 occur throughout the generally well populated rural areas.[2/]

The watershed is in the Texas-Gulf Water Resource Region.[3/] Elm Creek flows into the Little River about 18 miles upstream from the confluence of the Little River with the Brazos River. There are no major reservoirs on the mainstem of the Little River or the Brazos River downstream from the project.

The watershed lies within the Black Prairie physiographic area. The topography varies from nearly flat on the wide flood plain in the lower reaches of Elm Creek to gently and moderately rolling in the uplands. Broad areas

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1/ All information and data, except as otherwise noted by reference to source, were collected during watershed planning investigation by the Soil Conservation Service, U. S. Department of Agriculture.

2/ U. S. Department of Commerce, Bureau of Census, 1970 Census of Population, January 1974.

3/ U. S. Department of Agriculture, Soil Conservation Service, Atlas of River Basins of the United States, Washington, D. C., June 1971.

of gently rolling lands occur on the northern side of the mainstem of Elm Creek and most of the major tributaries. Moderately rolling to sometimes steep topography occurs along the south and southwestern sides of the mainstem and the major tributaries. Some steeply rolling areas also occur in the upper portion of the watershed where it is underlain by harder bedrock. Elevations above mean sea level range from 300 feet on the flood plain near the Little River to 850 feet on the northern watershed divide.

The watershed is underlain by sedimentary rocks of the Upper Cretaceous and Eocene ages.[4/] The Upper Cretaceous rocks occur under all of the watershed except the lower part. The Eocene rocks occur in the lower part near Cameron. A remnant of terrace gravel, possibly of Pliocene age, occurs along the southern watershed divide in the Rogers and Buckholts area and on other high divide areas in the lower part of the watershed. Pleistocene age terrace deposits and Recent age alluvial deposits occur in widths ranging from about 5,000 feet in the valley of Elm Creek to less than 200 feet on the smaller tributaries.

The bedrock is dominantly soft shale but includes some moderately hard shaly limestone of Upper Cretaceous age in the upper part of the watershed. The dip of the beds is to the southeast at a rate of slightly less than 100 feet per mile. The Balcones Fault System traverses the upper and central parts of the watershed. The trends of these faults are generally northeast to southwest, lying parallel with the outcrops of the southeasterly dipping rock units.

The watershed lies mainly within the Texas Blackland Prairie Land Resource Area.[5/] Deep, dark colored, heavy clay soils of the Houston Black-Heiden-Austin association predominate. These soils are used extensively for cropland. Small areas of less intensively used shallow soil and soils of the Branyon-Stephen-Eddy association occur on the chalk bedrock in the upper portion of the watershed and mixed soils of the Wilson-Crockett-Burleson association occur on remnants of sandy terrace deposits in the lower portion.

The alluvial flood plain soils were derived mainly from the surrounding upland Blackland Prairie soils. These productive clay and silty clay soils are mainly of the Trinity and Frio series and are used extensively for growing cultivated crops.

4/ Bureau of Economic Geology, The University of Texas at Austin, Geologic Atlas of Texas, Waco Sheet, Austin, Texas, June 1970.

5/ Texas Agricultural Experiment Station, Texas A&M University, in cooperation with U. S. Department of Agriculture, Soil Conservation Service, General Soil Map of Texas, College Station, Texas, 1973.

The land use in the watershed is as follows:

Land Use	Acres	Percent
Cropland	122,267	59
Pastureland	62,263	30
Rangeland	13,065	6
Miscellaneous	9,765	5
Total	207,360	100

1/ Roads, railroads, farmsteads, urban, and built-up areas.

Land use of the flood plain is 36 percent cropland, 62 percent pasture-land, and 2 percent miscellaneous.

The average annual rainfall is about 34 inches. The rainfall is fairly well distributed throughout the year; however, the months of April and May normally receive the greatest amounts. The average temperatures for January and July are 48° and 85° F., respectively. The average date of the last killing frost in the spring is March 10, and that of the first killing frost in the fall is November 22, resulting in an average growing season of 257 days.6/ The prevailing winds are southerly, ranging from the southeast to the south, southwest about 65 percent of the time. Velocities in excess of 12 miles per hour from southerly winds occur about 15 percent of the time.7/

Mineral resources in the watershed are of minor importance. Oil was produced from a small oilfield in the lower portion of the watershed. Gravel is being produced from pits in terrace deposits near Cameron and from localized small pits in remnants of terrace deposits extending from Cameron to Buckholts. Some soft to moderately hard limestone is utilized from the Austin Chalk formation which extends northward from Temple through the Troy area. Limestone from this formation and clay shale from the underlying South Bosque Formation are mined for cement production 14 miles north of the watershed near Waco.

Ground water occurs throughout the project area. The Travis Peak Formation of the Trinity Group is the most important of several underlying aquifers.8/ It occurs at depths of slightly less than 2,000 feet in the upper parts of the watershed to more than 3,000 feet in the lower part. The quality of the ground water is adequate for most uses in the upper portions of the watershed but becomes highly mineralized downdip (southeastward) in the lower portion of the watershed and is not generally suitable for domestic and household uses. Heavy

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6/ U. S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, Climatological Data, Texas, Annual Summary, Vol. 75, No. 13, Asheville, N. C., March 19, 1971.

7/ Wind Rose - Waco, Texas, National Weather Service, Climatography of Texas 552-3-15.

8/ Hunter Engineers, Engineers-Consultants, Part 1: Basic Studies of a Comprehensive Plan for Water and Sewerage Systems, Bell County, Texas, Austin, Texas, 1968.

usage of ground water by cities lying to the north of the watershed is causing a decline in the water table. Smaller quantities of ground water are also obtained from shallow, near surface sources and formations lying above the Travis Peak aquifer.

There are about 225 miles of streams having one square mile of drainage area or more within the watershed. In addition, there are many miles of intermittent channels which have less than one square mile of drainage area; however, these are not included in the following discussion of streams in the watershed. Elm Creek, the mainstem of the watershed, has a total length of about 50 miles. It heads near Moody in southwestern McLennan County and flows in a southeasterly direction across Bell County. It flows into the Little River near Cameron in Milam County. North Elm Creek, one of the larger tributaries, heads in western Falls County and flows into Elm Creek in the northern part of Milam County. Camp Creek and Cottonwood Branch lie within Bell County and flow into Elm Creek on the northeast side. Little Elm Creek heads north of Temple in Bell County and flows into Elm Creek on the southwest side. South Elm and Lipan Creeks head in Bell County and flow into Elm Creek in Milam County on the southwest side.

About 58 miles of the streams of the watershed have perennial flow or contain some permanent spring-fed water holes throughout the year during years of normal rainfall. Another 9 miles have permanent flow resulting from release of sewage effluent from the Temple treatment plant. The remaining 158 miles have flow ranging from less than 45 percent of the time to only short periods of time following runoff-producing rainfall.

Most of the streams are classified as natural, with man-made or altered channels limited to watercourses having less than one square mile drainage area.

Channel filling is presently causing major changes in the location and/or capacity of about 85 percent of the streams in the watershed. The capacities of the channels are being reduced and new channels are being formed in the flood plain (figure 3). During recent years, about 18 miles, or 8 percent, of the streams have been completely filled and new channels have been formed. Another 19 miles, or slightly over 8 percent, of the streams have lost more than one-half of their original capacities with much of the streamflow now being carried in newly developing channels. The streams in the upper portions of the watershed lying on or near the outcrops of the Austin Chalk bedrock have had little or no channel capacity loss due to sediment filling.

The concentration of total dissolved solids in runoff from the watershed is less than 500 parts per million. The prevalent chemical type is calcium carbonate and bicarbonate. Temperature measurements have not been made in the watershed; however, measurements made of runoff in an adjoining watershed showed a temperature range from 21° C. to 24° C. during the

months of April through June.[8] Year-round temperatures probably range from as low as 2° C. in January to as high as 34° C. in July and August. The estimated average annual sediment load in the runoff from the watershed is 3,600 milligrams per liter. Normally, the concentration of sediment is highest in flood runoff occurring during the winter and spring when the cropland is bare during preparation for planting.

Present and Projected Population

The population of the four-county watershed area has shown a steady growth of approximately 13 percent each decade since 1860, except for the decade from 1930 to 1940 when the population dropped by 4 percent. Based on OBERS BEA economic area projections, the population is expected to increase by 10 percent each decade to the year 2020.[9] This would result in an estimated population for the four-county watershed areaof approximately 498,000 in the year 2020.

Economic Resources

The economy generated within the watershed is based almost entirely on agriculture and associated agribusiness. Agriculture and associated agribusiness are expected to be of prime importance to the economy for the foreseeable future due to the basic demand for food and fiber.

All of the agricultural land in the watershed is privately owned. There are approximately 1,550 farms, which average about 125 acres in size, located wholly or partially within the watershed. Agricultural land values range from $300 to $600 per acre, depending upon soil capability and location. Urban land values range from a few thousand dollars for a city lot to many thousands of dollars for commercial property.

Almost half of the agricultural income of the watershed is derived from livestock and its associated products and the balance from crops. Principal crops grown and average yields per acre are: Cotton, 350 pounds of lint; grain sorghum, 3,500 pounds; oats, 30 bushels and 2 animal unit months of grazing; wheat, 20 bushels and 2 animal unit months of grazing; and forage sorghums, 2.5 tons of hay.

The latest statistics which are available show a labor force of 121,840, or 39 percent, from a total population of 309,364 for the four counties within which the watershed is located.[10] Approximately

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8/ U. S. Department of the Interior, Geological Survey, Water Resources Data for Texas, Part 2. Water Quality Records, 1969, page 474.

9/ U. S. Water Resources Council, OBERS Projections; Regional Economic Activity in the U. S., Volume 2, BEA Economic Areas, Washington, D. C., 1972.

10/ Texas Employment Commission, Work Force Estimated for Nonmetropolitan Counties in Texas for April 1973, Austin, Texas, July 1973.

2.4 percent (2,970 workers) are unemployed. This is below the state and national rate of unemployment. Approximately 7 percent (7,955 workers) are employed in the agricultural sector. The nonagricultural sector employs 110,910 workers: 21,270 workers in the manufacturing sector, and 89,640 workers in the nonmanufacturing sector.

The cities of Temple, Cameron, Moody, Troy, Rogers, and Buckholts are located within the watershed, either wholly or partially. Smaller communities located in the watershed and of importance to local residents are Oenaville, Ratibor, Seaton, Oscar, Zabcikville, Cyclone, Red Ranger, Meeks, Leedale, Yarrelton, Pettibone, Marak, and Splawn.

Temple and Cameron provide processing and marketing facilities for agricultural products and also provide schools, churches, excellent medical facilities, and most of the goods and services needed by watershed residents. The smaller cities and communities usually provide processing and marketing facilities for certain agricultural products, schools, churches, and goods and services needed by watershed residents in the immediate vicinity.

Good highways link these cities and communities with other population and marketing centers in all directions. Approximately 120 miles of paved roads and over 300 miles of all-weather roads serve the watershed residents. Also two railroads traverse the watershed, providing additional transportation facilities.

Plant and Animal Resources

The watershed occurs in the Blackland Prairies vegetational region. According to Dr. Frank Gould,[11/] in its pristine condition little bluestem (Andropogon scoparius) was the dominant grass. Other important grasses are big bluestem (Andropogon gerardi), yellow indiangrass (Sorghastrum nutans), switchgrass (Panicum virgatum), sideoats grama (Bouteloua curtipendula), hairy grama (Bouteloua hirsuta), tall dropseed (Sporobolus asper), silver bluestem (Andropogon saccharoides), and Texas wintergrass (Stipa leucotricha). Woody plants such as live oak (Quercus virginiana), pecan (Carya illinoensis), elm (Ulmus spp.), and sugar hackberry (Celtis laevigata) occurred in occasional mottes along well defined drainage ways and adjacent to significant streamways. Many forbs and legumes such as maximilian sunflower (Helianthus maximiliani), engelmanndaisy (Engelmannia pinnatifida), gayfeather (Liatris spp.), halfshrub sundrop (Oenothera serrulata), and prairieclover (Petalostemum spp.) added color to the region and variety to the diet of foraging animals and birds.

11/ Gould, F. W., Texas Plants, A Checklist and Ecological Summary, Texas A&M University, TAES, College Station, Texas 1962.

Around the turn of the century, most original plant ecosystems were destroyed by the conversion of these prairies to cropland. Intensive cotton production on the rolling uplands resulted in severe soil erosion. Fortunately, much of this land has since been converted to tame pasture grasses such as common and Coastal bermudagrass (Cynoden spp.), with this trend expected to continue into the future.

Very few remnants of climax ecotypes remain. Most of the 13,065 acres of rangeland contain less than 25 percent of its climax flora. Buffalograss (Buchloe dactyloides), threeawns (Aristida spp.), Texas wintergrass, silver bluestem, and small amounts of little bluestem, make up most of the currently existing range flora. Introduced tame pasture grasses such as common bermudagrass and Coastal bermudagrass currently occupy 62,263 acres of the watershed. Woody plants such as hackberry, elm spp., ash spp., oak spp., and bumelia (Bumelia spp.) occur as dominants on 14,000 acres.

Texas bluegrass (Poa arachnifera) is a threatened plant species as a result of close grazing and conversion of rangeland to cropland and pastureland.

The watershed lies almost totally within the Blackland Prairie Game Region.[12/] This area once supported an abundance of wildlife, including buffalo, antelope, deer, and turkey. Conversion of the native tall grass prairie to cropland drastically changed the habitat conditions for wildlife. Big game species no longer occur in this area. The present wildlife is limited to several species of small game, furbearers, and nongame animals.

The principal small game species of wildlife are mourning dove, bobwhite quail, and fox squirrel. The principal furbearers are raccoon, beaver, nutria, ring-tailed cat, skunk, opossum, red fox, gray fox, and mink. The principal nongame species include cottontail rabbit, swamp rabbit, jackrabbit, coyote, armadillo, herons, egrets, raptors, songbirds, and small reptiles and amphibians.

The watershed is located on the outer margin of a major flyway and thus receives only light use by migratory waterfowl.

The populations of wildlife species vary with the availability, interspersions, and quality of the habitat in the watershed. The overall habitat composition of the agricultural land for selected species of wildlife is as follows:

12/ Texas Game, Fish, and Oyster Commission, Principal Game Birds and Mammals of Texas, June 1945.

WILDLIFE HABITAT QUALITY AND QUANTITY

Wildlife Species	Good Habitat		Fair Habitat		Poor Habitat		None		Total	
	(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)	(Acres)	(Percent)
Mourning Dove	158,000	80	40,000	20	-	-	-	-	198,000	100
Bobwhite Quail	32,000	16	24,000	12	142,000	72	-	-	198,000	100
Fox Squirrel	1,200	1	12,800	6	184,000	93	-	-	198,000	100
Raccoon	1,200	1	38,800	19	-	-	158,000	80	198,000	100
Cottontail Rabbit	16,000	8	48,000	24	134,000	68	-	-	198,000	100

There is very little habitat for waterfowl in the watershed. Resting areas for migrating waterfowl are provided by 800 ponds and the 67 miles of perennial flow in Elm Creek and its tributaries. Probably a few waterfowl spend the winter at these water areas.

No threatened or endangered species of wildlife are known to inhabit the watershed. However, the watershed is located within the migration route of the American peregrine falcon. The American peregrine falcon is listed as endangered.

The Texas Parks and Wildlife Department indicated that the amount of hunting is light throughout the watershed. The principal game species hunted, listed in descending order of hunting days provided, are mourning dove, bobwhite quail, migratory waterfowl, and fox squirrel. It is estimated that the watershed provides an average of 2,800 man-days of hunting annually. Hunting is done by landowners and by invitation of the landowners.

The taking of furbearers is light in the watershed. It is estimated that an average of 3,200 man-days are spent in the hunting and taking of furbearers annually.

Two types of fisheries, pond and stream, exist in Elm Creek watershed. Out of approximately 225 miles of streams, only the lower 20 miles of Elm Creek contains the necessary deep pools to support a year-round fishery.

Approximately 800 ponds, totaling about 250 surface acres, provide good pond fisheries habitat. Ponds are normally stocked with black bass, hybrid sunfish and channel catfish.

Public access to fishing waters is limited to two fee catfish farms and nine public road crossings on the lower 20 miles of Elm Creek. The majority of fishing is done by landowners and their friends. Sport fishing is light. It is estimated that the watershed provides approximately 3,000 man-days of fishing annually. Commercial fishing is absent in the watershed.

Recreational Resources

Opportunities for outdoor and water-based recreation are limited to fishing along about 20 miles of spring-fed streams and in ponds, hunting of dove and quail, and other minor outdoor activities such as picnicking. Excellent facilities for water-based recreation and fishing are available at the nearby large reservoirs of Lake Belton and Stillhouse Hollow Reservoir and floodwater retarding structures in nearby watersheds.

Archeological and Historical Values and Unique Scenic Resources

An archeological reconnaissance of the watershed conducted by the Archeology Research Program, Southern Methodist University, for the Soil Conservation Service, indicated that numerous archeological sites occur along the mainstem of Elm Creek from the mouth into the general vicinity of Troy and on the lower reaches of North Elm, Camp, Cottonwood, and Little Elm Creeks. The watershed lies between the Grand Prairie and the East Texas Deciduous Forest and may have served as a route for movement of people between these areas. This area has had very little archeological study and its importance is unknown.

There are no known historic sites within the watershed listed in, or in process of nomination to, the National Register of Historic Places according to the Texas State Historical Commission.

Soil, Water, and Plant Management Status

Most of the native tall grass prairie which originally covered the watershed was converted to cropland prior to the turn of the century. The use of clean tillage methods, primarily for the production of cotton, allowed severe erosion to occur on steeply rolling lands and resulted in severe damage to large areas of these lands before the beginning of the conservation movement in the 1930's. The land is gradually being converted to pastureland by land users.

The Central Texas and the McLennan County Soil and Water Conservation Districts were organized in the early 1940's by interested landowners to encourage the application of needed conservation land treatment measures. Technical assistance is supplied to these districts by Soil Conservation Service personnel headquartered at Waco, Temple, Cameron, and Rosebud to aid land users of watershed lands in the development of soil and water conservation plans and the application of needed land treatment measures.

Soil and water conservation plans have been developed on 885 of the 1,550 operating units located wholly or partially within the watershed. Plans have been developed on 58 percent of the agricultural land in the watershed.

It is estimated that needed land treatment has been applied on about 40 percent of the agricultural land. The total cost of this application is estimated at $2,354,019.

Technical assistance to landowners for planning forestry measures such as tree plantings for recreational and aesthetic purposes, and wood products is available from the Texas Forest Service within the going Cooperative Forest Management Program.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land and Water Management

The broad concept of resource conservation has been accepted by many farmers and ranchers in the watershed as evidenced by their individual progress in applying conservation measures to their lands. From the average size of the farms in the watershed, it is apparent that some farms are marginal to submarginal as an economic unit. The rate of application of land treatment measures on these lands is often slow because many of the landowners lack the necessary capital and management skills for applying needed measures.

Soil erosion and reduced organic content of the soil are primary problems on cropland. Soil erosion is most severe on land having slopes greater than one percent, or one foot fall per 100 feet length of slope. The productivity of many of the steeper soils in the watershed has been severely damaged by excessive erosion. Cotton farming in a clean-tilled monoculture did not produce the needed crop residues for protecting the soil against erosion and for supplying the organic matter needed for biological activity.

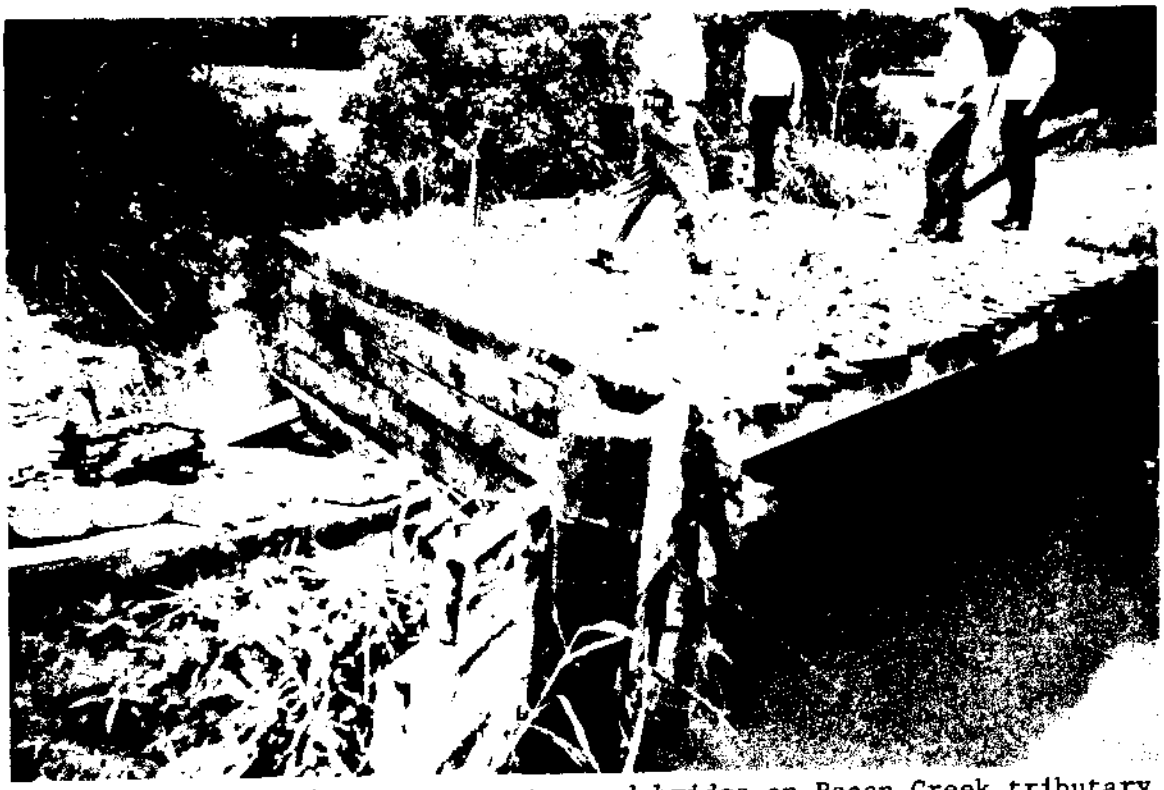
The trend has been to convert the severely eroded cropland to pastureland. However, the rate of conversion has slowed down in recent years. Approximately 17,000 acres of this marginal cropland is still in cultivation. About 40 percent of the land treatment measures on the land suited for future cropland use have not been applied.

The problems on pastureland and rangeland are poor cover and degraded plant composition. Most of the pastureland consists of eroded soils which are low in fertility and will not support the needed vegetation for erosion control or desired forage production. The natural thick cover of vegetation on the rangeland has been replaced by shorter, less productive and protective grasses and seasonal annual plants. More than 70 percent of the needed pastureland conservation measures and 60 percent of the rangeland conservation measures have not been installed.

Floodwater Damage

Damages to crops and pastures on flood plain lands are extensive throughout the watershed. Crops are often destroyed by floodwater, but a significant portion of the damages is related to delayed planting and harvesting with resultant increases in the cost of producing the crop and decreases in crop yields and quality of the product. These damages have forced operators to manage flood plain land well below the actual potential of the soils, resulting in reduced yields and incomes.

Floodwater damage occurs on about 22,900 acres of valuable agricultural floud plain land, excluding stream channels, along Elm Creek and its



Floodwater damage to county road bridge on Pecan Creek tributary following heavy spring rain of May 9, 1971.

Floodwater damage to fence and scour damage on cropland following storm of May 9, 1971.

4-34639 1-1975

tributaries (figure 3). This is the flood plain that would be inundated from a 100-year frequency event. At the present time, land use of the flood plain is about 12 percent cotton; 11 percent grain sorghum; 5 percent small grain; 8 percent forage sorghum; 12 percent improved pasture; 50 percent pasture; and 2 percent miscellaneous uses.

There are about 530 farm units that suffer floodwater damages. The average size farm unit is about 125 acres. There are no residences or businesses in the flood hazard area.

Other agricultural damages are extremely severe because of intensity of flood plain use. The conversion of areas of frequently damaged cropland to pastureland has resulted in a tremendous increase in livestock, fences, and other improvements being subject to damage by floodwater.

Private and public property, other than land, livestock and crops, subject to flood damage includes roads, bridges, fences, utilities, etc., and is valued at more than $2,000,000.

The flood plain was divided into 15 reaches (figure 3) because of the diversity of damageable values and characteristics. The extent of flooding and the damage therefrom is shown in the following tabulation:

Evaluation Reach (figure 3)	Total Flood Plain 1/ (acres)	Average Annual Area Inundated (acres)	Average Annual Damage (dollars)
1	1,121	712	15,090
1A	1,575	1,301	43,540
2	489	297	8,130
3	2,020	1,817	47,600
4	399	78	2,320
4A	661	656	18,580
5	2,790	1,648	55,730
6	65	28	1,740
7	2,540	950	40,050
7A	201	45	4,060
8	1,106	856	30,770
9	3,700	4,100	114,360
10	2,577	2,561	80,690
11	3,123	2,100	116,100
X	533	234	1,740
TOTAL	22,900	17,383	580,500

1/ Contains 1,419 acres which are located above and in floodwater retarding structures.

Most of the flooding results from high-intensity, short-duration thunderstorms that usually occur during the spring and summer. Flooding is also caused by rains of low intensity and long duration which occur during the fall and winter as a result of southward moving cold fronts and in late summer as a result of warm low pressure air masses moving inland from the Gulf of Mexico.

Minor flooding inundating less than half the flood plain occurs at some locations on an average of three to four times a year. Major floods inundating more than half the flood plain during recent years include those of 1957, 1959, 1965, and 1971.

The flood event of May 1965 was caused by a storm that produced rainfall of 6.3 inches at Temple, 6.8 inches at Troy, 3.9 inches at Burlington, and 3.7 inches at Cameron. In the vicinity of Temple, rainfall amounts of 8 to 9 inches were recorded by residents in the watershed. Rainfall amounts of 6.8 inches can be expected to occur about once each 10 years and 3.7 inches can be expected to occur about once each 2 years. Information obtained from residents of the watershed indicated that this storm inundated approximately 18,000 acres of the flood plain and produced damages in excess of $1,200,000 at current normalized prices.

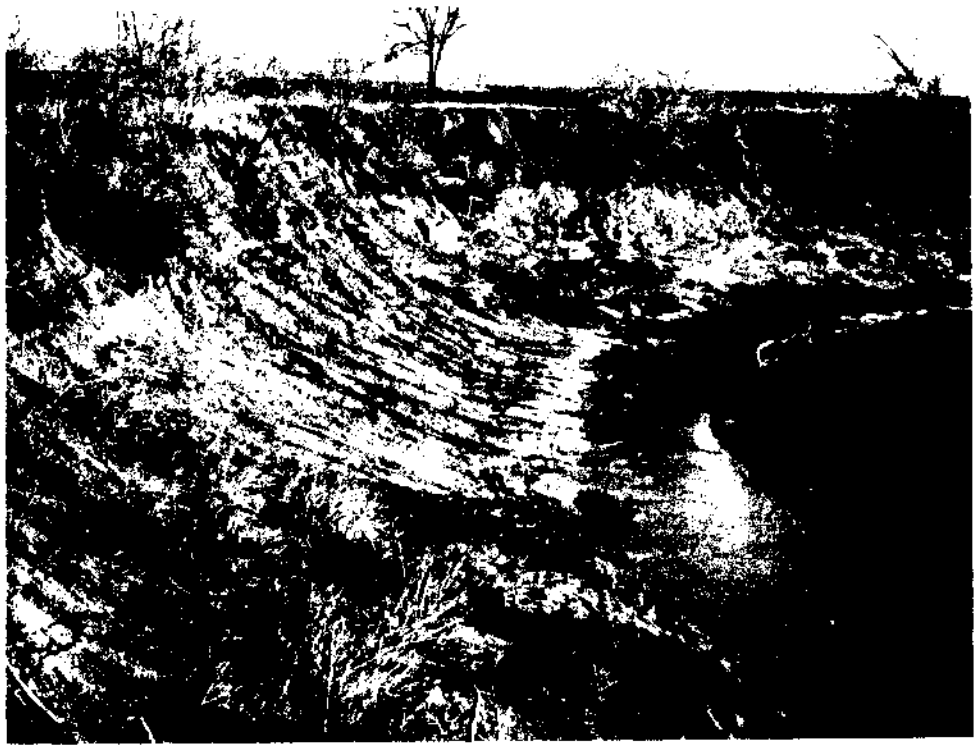
The total average annual floodwater damages under without project conditions are estimated to be $452,870. Of this amount, $241,410 is crop and pasture; $185,130 is other agricultural; and $26,330 is road and bridge (table 5).

Indirect damages, such as interruption of travel, re-routing of school buses and mail routes, interruption of livestock feeding and care, losses to local business, and other similar losses, are estimated at $53,970 annually.

Erosion Damage

The present annual gross erosion rate in the uplands ranges from an average of about 2.5 tons per acre on pastureland to 9 tons per acre on cropland. The rates are highest on the poorly vegetated pastureland and untreated cropland, which average about 5 tons per acre and 15 tons per acre, respectively. These erosion rates exceed the rate which would allow sustained use of the soil resource for agricultural production. These high rates create adverse problems downstream, such as streams filling with sediment and overbank deposition. The average annual permissible rate of soil loss ranges from 2 tons per acre to 5 tons per acre for the soils in the watershed. The average permissible rate of soil loss for the majority of soils being cultivated is 4 tons per acre annually.

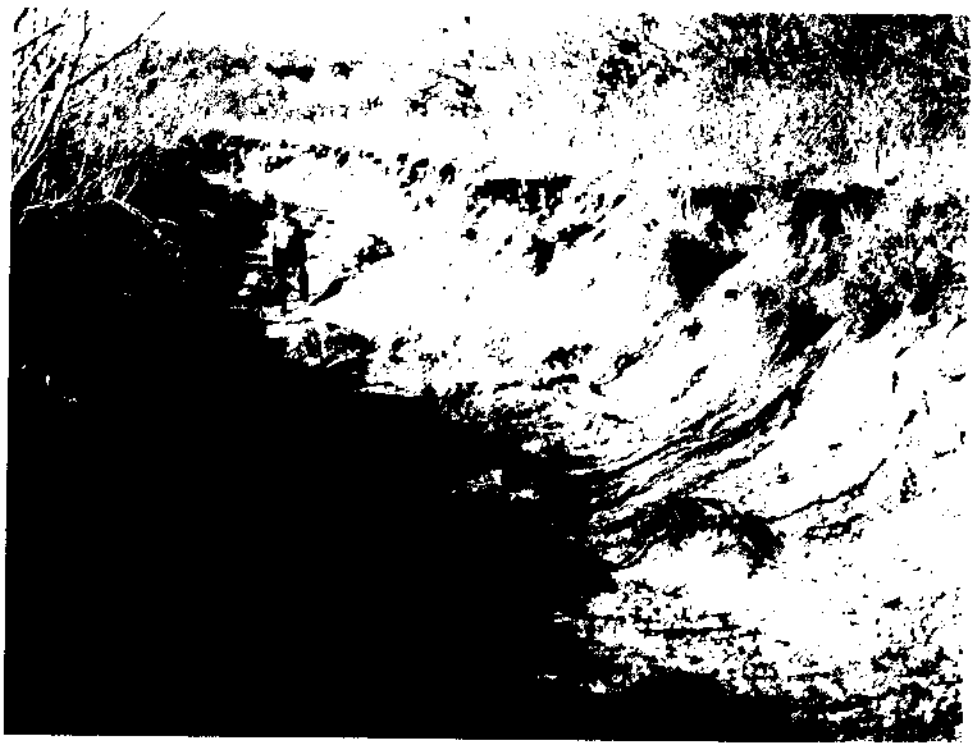
Flood plain scour, valley trenching, and streambank erosion are a serious problem on the flood plain lands (figure 3).



Active streambank erosion in lower reaches of mainstem of Elm Creek is destroying cropland.

4-34639

This tree-lined channel on North Elm Creek is almost completely filled with sediment. This channel is being abandoned through new channel formation processes or valley trenching on open areas of the flood plain.



Advancing valley trenching actively destroying flood plain land in the process of creating a new channel. This is nature's way of creating new channels in areas where the original channel has become filled with sediment.

Flood plain scour is damaging an average of 3,188 acres of cropland annually. Sheet scouring removes productive topsoil from broad areas of cropland and channel scouring concentrates soil removal in narrow, continually deepening areas. Channel scouring ultimately results in abandonment of the land from further agricultural use. Damage in terms of reduced productivity of the flood plain soils ranges from 5 to 20 percent by sheet scouring and 20 to 40 percent for channel scouring. The average annual value of this damage is $38,520.

Approximately 400 acres of once productive flood plain land have been destroyed by the valley trenching process. About 18 miles of new stream channels have developed in recent years. Another 19 miles of new stream channel formation are in advanced stages of development. Valley trenching is presently destroying an average of 6.9 acres of flood plain annually through new channel formation in the deepened scour channels. The average annual value of this damage is $4,380.

Streambank erosion is voiding an average of 1.4 acres of flood plain land annually. This problem is most serious on the raw banks of the newly formed channels and is also occurring in some of the sharp bends of Elm Creek near the Little River. Streambank erosion in the upland areas is generally low with severe erosion limited to isolated areas. The average annual value of damage by streambank erosion is $880.

Sediment Damage

Large volumes of clayey sediment derived from the intensively cultivated uplands and poorly vegetated pastureland have been deposited on the flood plain and in the stream channels. Sediment accumulations to depths of more than 3 feet have damaged the productivity of 3,737 acres of agricultural land from 10 to 20 percent in terms of reduced productivity. These materials consist of poorly aggregated clays which seal and impede moisture and air movement in the soil and silt and fine sand which are lower in fertility than the original soil. The average annual value of this damage is $29,880.

Deposition of clayey sediment in streams has reduced the flow carrying capacity for streamflow in about 85 percent of all streams in the watershed. Total filling, accompanied with abandonment of the channel, has occurred on 18 miles or 8 percent of the streams. In addition, 19 miles or slightly over 8 percent are in advanced stages of filling and abandonment. The filling of stream channels has increased the flooding problem and is one of the major causes of the valley trenching.

The amount of sediment carried out of the watershed is estimated to average 425,000 tons (238 acre-feet) annually. Eighty percent of thia volume is derived from sheet erosion, 11 percent from flood plain scour, 5 percent from valley trenching, and 4 percent from streambank erosion. This volume of sediment results in an estimated average sediment concentration

of 3,600 mg/l in the 86,600 acre-feet of average annual runoff at the mouth of the watershed.

Municipal and Industrial Water Problems

Rural water supply corporations and small towns in the watershed obtain their water supply from ground water sources. The decline of the water table and the increasingly lower quality of the ground water downdip in the aquifer are problems in developing and increasing needed rural supplies from this source. The cities of Temple and Cameron obtain their water supply from surface sources which are adequate for their present and foreseeable future needs.

Recreation Problems

The main problem relating to outdoor recreation is the lack of opportunity within the watershed. There are no parks or public lands where residents can picnic, fish, or hunt. The fish and wildlife resources are limited. High sediment loads and filling of streams which reduce fisheries habitat and quality of environment for fish also limit the desirability and use of the streams of the watershed for recreation. There is a definite need for additional recreational opportunities for watershed residents; however, the opportunities for development are limited.

Plant and Animal Problems

The major problem associated with most species of wildlife, except mourning dove, is that the watershed does not have significant quantities of good quality habitat. The major limiting factors are the quantity and quality of woody habitat and food producing plants, the interspersion of land uses, and the distribution of watering spots. The land users are primarily concerned with the production of crops and grasses which produce the greatest economic return from the land. There is little or no economic incentive for providing for the needs of the various species of wildlife. Consequently, the only species of wildlife that flourishes is the mourning dove, which is well adapted to the present environment.

The most significant limiting factor for all forms of wildlife except mourning dove is the general lack of suitable woody habitat. Most of the woody vegetation having the greatest potential for providing high quality habitat is located along the streams and on the flood plain. This habitat is presently being severely damaged by flooding, sediment deposition, erosion, and new channel formation.

The major problem associated with the existing stream fisheries is sediment filling of the streams and new channel formation. The major problem of the lake or pond fisheries is the high rate of sediment deposition in the ponds. The high concentrations of sediment in the runoff from the watershed reduce the quality of the aquatic environment in the ponds and streams.

New channel formed by nature in the flood plain of North Elm Creek. The abandoned tree-lined and sediment filled original channel is located in the background. Notice nature does not use spoil banks. The material moved from this section was transported downstream as sediment.

Economic and Social Problems

About 1,400 operating units in the watershed are family-type farm operations employing less than 1½ man-years of outside labor. About 450 of these units auffer damages from flooding. About 200 of these are low income producing units which require outside employment by their operators to maintain an adequate standard of living. The watershed economy is taxed approximately $580,500 annually in floodwater, sediment, and erosion damages alone. The small landowner can ill afford this added burden and continue a stable economic operation. There is a need for additional employment opportunities for the 2,970 unemployed in the four county watershed area. A concentrated effort in rural community development is needed to increase income and employment opportunities for local watershed residents.

Other

Other problems closely related to the agricultural flood damages include possible losses to local businesses; fears associated with poaaible future floods; and indirect losses such as the decline in property values, tax revenues, and community services.

PROJECTS OF OTHER AGENCIES

There are no known existing or soon to be constructed water resource development projects within the watershed which have a direct relationship to the works of improvement included in the plan.

Several of the communities within the watershed have developed water supplies with financial assistance from the Farmers Home Administration.

PROJECT FORMULATION

The application for assistance for the Elm Creek waterahed was submitted to the Secretary of Agriculture through the Texas State Soil and Water Conservation Board (designated state agency). A field examination was made by the Soil Conservation Service and representatives of appropriate state agencies to determine that, within the requirements of national standards, there were no apparent obstacles to planning and carrying out a watershed project. The Texaa State Soil and Water Conservation Board held a public hearing to solicit public reaction. The board then recommended that the Soil Conservation Service furnish planning asaistance.

The work plan was developed in full consultation and cooperation with all interested agencies and individuals. Written notification of initiation of work plan development was sent to all federal, state, and local agencies that might have an interest in the project, soliciting information and comments. The Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department,

made a reconnaissance survey of the fish and wildlife resources of the watershed. This report was used in plan formulation. The Corps of Engineers, U. S. Department of the Army, furnished survey information on the Little River which was used in evaluating the effects this project would have downstream from the project boundaries. The Texas Water Rights Commission furnished assistance to the sponsors concerning compliance with state laws in the storage and use of water. A study of the watershed was made by representatives of the U. S. Forest Service and the Texas Forest Service to determine if there were any forest management possibilities. The Texas Historical Commission determined if there were any known archeological or historical sites either listed in, or nominated to, the National Register of Historic Places that would be adversely affected by the installation of measures included in the project. The committee also furnished assistance by recommending a competent archeologist to make a reconnaissance study of the watershed.

The sponsors contacted the communities within the watershed to determine if there was any interest in adding storage capacity for municipal and/or recreational uses in any of the floodwater retarding structures. The cities of Troy and Cameron expressed an interest in developing a municipal water supply in conjunction with the project; however, after studying the possibilities, decided not to include additional storage capacity in any of the floodwater retarding structures.

Representatives of the sponsoring local organizations contacted landowners for permission to survey, and to explain how the program would affect their lands.

Owners of pipelines, utility lines, etc., were contacted to determine what modifications, if any, would be necessary to their improvements when the project was installed. The sponsors carried on an active public information program in an effort to keep the public informed as the project was formulated.

Objectives

Meetings were held with the sponsors to discuss their problems, possible solutions, watershed resource development needs, and the formulation of project objectives.

The objectives selected were those that would contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources so that the watershed residents can enjoy:

--QUALITY IN THE NATURAL RESOURCE BASE FOR SUSTAINED USE

--QUALITY IN THE ENVIRONMENT TO PROVIDE ATTRACTIVE, CONVENIENT, AND SATISFYING PLACES TO LIVE, WORK, AND PLAY

--QUALITY IN THE STANDARD OF LIVING BASED ON COMMUNITY IMPROVEMENT AND ADEQUATE INCOME

The goals for this project are:

1. Establishment and maintenance of necessary land treatment measures which will reduce soil loss to a rate thst will permit a high level of productivity to be sustained economically and indefinitely.

2. Provision of a level of protection which will reduce floodwater, sediment, and erosion damages to a rate which will allow the productivity of the land to be sustained economically and indefinitely. The landowners stated that they plan to maintain the present land use in the flood plain. They also indicated that they plan to manage the pastureland at a higher level, primarily by establishing and properly managing improved varieties of grasses.

3. Preservation and improvement of the fish and wildlife resources.

4. Stimulation of the economic development of the area as a result of project installation.

It was agreed that these objectives were reasonable and consistent with watershed resource conservation and development.

Environmental Considerations

The sponsors carefully considered the impacts, both favorable and adverse, in developing the plan for meeting the project objectives. Adverse effects were avoided when possible if the project objectives could be achieved. The sponsors recognized that a certain amount of land would need to be committed to the project. The structure sites were selected and structures were planned to minimize adverse effects to farming and ranching operations, transportation networks, utility lines, fish and wildlife habitat, etc., as much as was practical. The structure slopes, disturbed areas, and idle areas around the structures will be vegetated with adapted plant species for wildlife food, habitat improvement, and erosion control. Floodwater retarding structure No. 12 is located below the point where the city of Temple dishcarges the effluent from its sewage treatment plant. A regional sewage collection and treatment system is being planned and should be installed prior to the installation of the structure. This will prevent the possibility of the effluent from the sewage treatment plant contaminating the sediment pool. Based on experience on similar structures in nearby watersheds, it is not anticipated that any health or water quality problems will arise at any of the sediment pools of the floodwater retarding structures used for livestock water or lake fisheries. The sponsors do not plan to provide public access to any of the structural measures and will discourage landowners from using any waters created by the project for incidental recreation until sanitary facilities meeting local and state health requirements are installed.

Financial and relocation advisory assistance will be furnished to the people and farming operations displaced by installation of the project to assist in their being properly relocated.

Land treatment measures planned for the watershed are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the structural measures, reduce flooding, and preserve and improve the habitat for the existing fish and wildlife resources of the watershed.

The U. S. Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, made the following recommendations for consideration by the sponsors and the Service for installation of the project measures included in the work plan:

1. Landowners with farm ponds, located in the flood pools of floodwater retarding structures Nos. 3, 9, 17, 18, 19, 24, 27, and 31, should be encouraged to work with the Texas Parks and Wildlife Department in determining the presence of an undesirable fish population. Landowners should be encouraged to eradicate undesirable fish species and restock with desirable game fish prior to inundation of floodwater retarding structures.

2. Fish species selection for stocking and subsequent management of the reservoirs and farm ponds be conducted with the advice of the Texas Parks and Wildlife Department.

3. Landowners be encouraged to permit public fishing on project reservoirs and farm ponds.

4. Standing timber be permitted to remain in approximate areas designated as "uncleared areas" shown on Plates 2 through 21 which constitute area maps of structures Nos. 1, 2, 3, 5, 6, 7, 12, 26, 32, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, and 45.

5. All dams and spillways be seeded to a grass-legume mixture such as Dallisgrass, kleingrass, clovers, and vetches.

6. All other disturbed areas including borrow sites, odd areas, bases of dams and spillways, be planted to pecan, hackberry, wild plum, Englemanndaisy, Maximilian sunflower, shrub honeysuckle, red haw, switchgrass, lovegrass, and other plants desirable for wildlife.

7. The plant species included in recommendation No. 6 be planted around the edges of farm ponds and floodwater-retarding reservoirs to improve the practice of wildlife upland-habitat management.

The sponsoring local organizations and the Service considered the recommendations made by the Fish and Wildlife Service and the Texas Parks and Wildlife Department in formulating the land treatment and structural measures to be included in the work plan.

The recommendations contained in items Nos. 5, 6, and 7 for the enhancementment of wildlife habitat on the fenced and revegetated areas and around the dams, emergency spillways, and areas disturbed during construction have been included in the plans for the floodwater retarding structures. The recommendations in items 1 and 2 concerning fishpond management will be implemented through technical assistance to the concerned landowners. Special attention will be given to the affected ponds identified at floodwater retarding structures Nos. 3, 9, 17, 18, 19, 24, 27, and 31.

The standing timber in the upper reaches of the sediment pools of floodwater retarding structures Nos. 1, 2, 3, 5, 6, 7, 12, 26, 32, 34, 36, 37, 38, 39, 40, 41, 42, 43, 44, and 45 will be left uncut to the maximum extent consistent with the safe and normal functioning of the structures. This will probably involve lesser areas than those indicated in item No. 4. At some sites the recommended areas included deeper portions of the planned sediment pools. Timber left in these areas would be killed by inundation and pose a potential hazard to the safe and normal operation of the structures.

The problems, expenses, and liability associated with the landowners' opening their property to public use limit the acceptance of this activity and cast doubt on the rationale of the sponsors' encouraging landowners to become so burdened. The costs associated with land rights acquisition for this purpose by the sponsoring organizations exceed their financial ability. It was determined that the recommendation in item No. 3 could not be fully implemented. The sponsoring local organization and the Soil Conservation Service will, however, encourage landowners having particularly well-adapted sites to develop income-producing recreation facilities that meet local and state health standards. The Soil Conservation Service will provide technical assistance to interested landowners.

The minor reduction in streamflow of the Brazos River caused by evaporation and seepage losses in the sediment pools of the floodwater retarding structures was determined not be significant enough to consider initially storing a lesser amount of permanent water in the sediment pools. All of the structures will have provisions to release impounded floodwater if it becomes necessary to avoid encroachment upon prior downstream water rights.

Alternatives

The considered alternatives to the proposed action in planning for the development, conservation, and productive use of the soil, water, and related resources were:

1. An accelerated program of applying land treatment measures for watershed protection.

2. Changing the present use of the watershed lands which suffer severe floodwater and erosion damage to a use that is less susceptible to damage.

3. An accelerated program of applying land treatment measures, floodwater retarding structures, and channel work.

4. Foregoing the implementation of a project.

A discussion of each alternative follows:

Alternative No. 1 - Alternative No. 1 consisted of applying the land treatment measures as proposed in the project action. Most of the impacts of the application of land treatment measures are discussed under "Effects of Works of Improvement." Average annual monetary damages from floodwater, sediment, and erosion would be reduced by about 6 percent.

The favorable and adverse impacts that would be caused by installation of the structural measures would be foregone. The estimated cost of this alternative is $1,717,849.

Alternative No. 2 - Alternative No. 2 consisted of changing the present use of the watershed lands which suffer severe erosion and flood damage to a use less susceptible to damage.

The potential land uses in order from highest to lowest susceptibility to flood damage and erosion are urban and built-up, cropland, pastureland, and rangeland. Land used for other purposes, such as the transportation system and wildlife-recreation land, are damaged to varying degrees by flooding and erosion, depending upon the level of development.

This alternative would require changing the land use of the cropland located in the uplands that is being eroded at a rate which is destroying its productivity and the cropland located in the flood plain which is being severely damaged by flooding. The flood plain lands could be used for rangeland, pastureland, or wildlife-recreation land if extensive improvements were not installed. The uplands could be used for pastureland or wildlife-recreation land if proper cover were maintained.

This alternative would significantly reduce the actual monetary damage caused by floodwater, sediment, and erosion. It would significantly reduce the amount of sediment being carried out of the watershed. The damages to the transportation system would continue at about the same

rate. Damages to other agricultural property, livestock, etc., would increase as the land use changed. This alternative would reduce the annual net income on land changed from cropland to rangeland and pastureland by approximately $20 per acre. This alternative would cost about $5,250,000 to implement, and would create a whole new environment for the watershed. The number of businesses associated with a row-crop agriculture would be reduced. Many families that maintain an adequate level of income with a row-crop agriculture system would find it necessary to expand their farming operation to maintain the same level of income with the grassland.

The habitat for wildlife which depend upon a row-crop environment would be adversely impacted. However, the habitat for species of wildlife which depend on pastureland and rangeland would be improved.

Alternative No. 3 - Alternative No. 3 consisted of land treatment measures, floodwater retarding structures, and channel work.

The land treatment measures would be the same as in the proposed action. The location of the floodwater retarding structures would be the same as in the proposed action. However, only 22 floodwater retarding structures were considered. These were Nos. 1, 4, 5, 6, 7, 12, 13, 14, 15, 17, 18, 19, 21, 23, 26, 27, 32, 34, 39, 40, 42, and 44. These 22 structures would control runoff from 122 square miles, or 37.7 percent of the watershed. The channel work would consist of increasing the capacity of about 25 miles of the mainstem channel from where Little Elm Creek joins the mainstem to the point where the last county road crosses Elm Creek in the lower part of the watershed.

This alternative would cost an estimated $6,700,000 to install. This consists of $1,800,000 for land treatment, $3,400,000 for floodwater retarding structures, and $1,500,000 for the channel work.

The impacts of applying the land treatment measures would be the same as discussed under the environmental impacts of the proposed action.

Flood damages would be reduced by about 75 percent. This alternative would provide protection to 21,000 acres of flood plain. Installation of this system of structural measures would require the use of about 5,970 acres. The land would be used for the following purposes: Construction of dam and spillways, 300 acres; storage of sediment, 1,250 acres; temporary storage of floodwater, 3,520 acres; and 900 acres for channel work. The future use of this land would be restricted. A detailed study of the impacts of the channel work on the fish and wildlife resources was not made. However, some adverse impacts could be expected to the fish and wildlife resources due to altering of the channel unless careful consideration was given to the resources during planning, design, and construction.

Alternative No. 4 - Alternative No. 4 consisted of foregoing the implementation of the project.

This would delay the application of land treatment measures, which would delay the impact these measures have on reducing sediment production from

the watershed and would also delay the impact these measures have in reducing flood damage. However, it is reasonable to expect that the landowners and operators would eventually install the land treatment measures to maintain the productivity of their lands.

Flooding would continue, resulting in damage to the agricultural land and the transportation system.

The deterioration of the cultivated flood plain soils by scour would continue until the cumulative effect of this damage forced land use conversion to less productive uses.

Valley trenching and streambank erosion would continue to destroy an average of 8.3 acres of flood plain annually.

Areas subject to scour, valley trenching, and streambank erosion would continue to produce sediment.

The opportunity to store water for streamflow augmentation in two floodwater retarding structures would be foregone.

The need to use 6,534 acres of land to construct the structural measures and the resultant adverse impacts would be eliminated.

The creation of 1,776 acres of surface water which could be used for fish and wildlife would be foregone.

The opportunity to realize about $271,520 in average annual net benefits would be foregone.

The sponsors considered each alternative carefully before making a selection. Alternatives Nos. 1 and 4 were not selected because they did not meet the sponsors' objectives for watershed protection and reduction in flood damages. Alternative No. 2 was not selected because the sponsors did not have the financial or legal ability to carry it out. Also, the adverse economic impacts to the land users were considered too severe.

Alternative No. 3 was not selected because it provided flood protection to fewer acres of flood plain and the cost of operation and maintenance would have been slightly greater than the alternative selected. The sponsors chose the selected plan over alternative No. 3 in order to prevent the potential damage to bottomland wildlife habitat and the stream fishery even though it provides for a slightly lower level of protection.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Planned land treatment measures (conservation practices) will be applied on private lands in the watershed by land users on a voluntary basis. These measures are based upon a resource conservation plan developed by the land user in cooperation with the Central Texas and the McLennan County Soil and Water Conservation Districts. The Soil Conservation

Service will provide technical assistance to the land user in the planning and application of all soil, plant, and water conservation measures. This assistance is provided under working agreements involving the Soil Conservation Service and the Central Texas and the McLennan County Soil and Water Conservation Districts.

Land treatment measures are to be applied at an accelerated rate over a 10-year installation period. The conservation land treatment program is flexible for meeting the treatment needs of changing land uses in order to protect and improve the soil, water, and vegetative resources for the future. The goal is to complete the application of needed treatment measures on 24,600 acres of cropland, 33,500 acres of pastureland, and 5,400 acres of rangeland, in addition to maintaining those measures which have already been applied.

Land treatment measures expected to be installed on cropland include conservation cropping systems, crop residue management, diversions, terraces, contour farming, grassed waterways, and grade stabilization structures. Conservation cropping system consists of rotation systems which incorporate high residue crops and soil improving crops in the cropping pattern. The cropping pattern commonly used is 35 percent cotton, 50 percent grain sorghum, 10 percent small grain, and 5 percent hay and other crops. Crop residue management consists of leaving plant residues, including waste from grain crops, on or near the soil surface for protection against raindrop energy and the resultant erosion of the detached soil. The other cropland practices consist of water control measures designed to control erosion by disposing of runoff into stable outlets.

Land treatment measures which are expected to be applied on pastureland include pasture and hayland planting, pasture and hayland management, and critical area planting. Pasture and hayland planting consists of establishing adapted soil protecting forage plants on land formerly used as cropland for livestock grazing use. The plants most commonly chosen by the landusers are coastal bermudagrass and common bermudagrass on about 90 percent of the land and kleingrass and lovegrass on the remaining 10 percent. Pasture and hayland management consists of management practices designed to maintain an effective soil protecting cover of vegetation on the land throughout all seasons of the year. Practices used to achieve this objective include fertilization, control of grazing, control of undesirable plants, etc. Critical area treatment is applied to sediment producing, highly erosive areas. It consists of shaping, grading, filling, and establishment of permanent vegetation for erosion control, grazing, and wildlife.

Land treatment measures expected to be applied on rangeland include proper grazing use, deferred grazing, planned grazing systems, cross fences, and livestock water facilities such as ponds, wells, and storage facilities. These practices are designed to control grazing by livestock in order to maintain an effective soil protecting cover of vegetation on the land at all times and to maintain a variable plant community of the more desirable forage grasses and forb plants of the native prairie.

Measures which are expected to be applied to both pastureland and rangeland include ponds for livestock water supply and brush management to manipulate woody plant composition of lands used for grazing. Approximately 90 percent of the brush management consists of the control of invading mesquite and 10 percent consists of control of other invading low growth woody plants from land used for grazing. Land users are encouraged to apply this practice with consideration for needs of wildlife by leaving strips and mottes for cover and travel lanes.

Practices which are expected to be applied to all land uses for fish and wildlife resource conservation and development include wildlife upland habitat management and fishpond management. Wildlife upland habitat management includes the preservation of woody plant cover along watercourses and fence rows, special cover plantings, and seeding of food plants. Fishpond management consists of proper stocking after construction or renovation, proper fertilization, and harvesting of fish.

Structural Measures

A system of 45 floodwater retarding structures is planned for construction during the 10-year installation period. This system of structures will provide protection to the flood plain lands of the watershed. The location of the planned structural measures is shown on the project map (figure 4).

Runoff from 47 percent of the watershed will be retarded by the structural measures.

The total capacity allocated for the anticipated 100-year accumulation of sediment is 13,812 acre-feet. The principal spillway crest of all the structures will be set at the capacity of the 100-year sediment volume predicted to be deposited as submerged sediment. The inlets for structures Nos. 1, 4, 5, 6, 7, 12, 13, 19, 24, 25, 26, 27, 32, 34, 36, 37, 39, 40, 42, and 44 will be ported at the elevation which will limit initial impoundments to 200 acre-feet, including capacity of borrow. The sponsors have requested that the ports in the inlets of structures Nos. 1 and 40 be sized to limit the discharge of all sediment pool water impounded between 200 acre-feet and the principal spillway crest. It is planned to limit the discharge to about one cubic foot per second. The release of the sediment pool water at this rate will provide streamflow augmentation on Elm Creek and North Elm Creek. The principal spillways for all the structures will be the drop inlet type with cantilever outlets. Constriction plates will be used in 24 of the structures to limit the discharge capacity to less than the full pressurized pipe flow. All inlets will be ungated and will operate automatically. All of the structures will have provisions to release impounded floodwaters in order to perform maintenance and, if it becomes necessary, to avoid encroachment upon downstream water rights.

The total floodwater retarding capacity in the floodwater retarding structures is 48,040 acre-feet. This storage, combined with the principal spillway capacity for all structures, will provide protection to the emergency spillways. The emergency spillway of each structure will have a 4 percent or less chance of use at the end of 100 years after construction. The

emergency spillways of all structures will be an excavated channel around the end of the embankments. All structures except structures Nos. 2, 3, 8, 9, and 10 will have emergency spillways excavated in earthen material, Structures Nos. 2, 3, 8, 9, and 10 will have emergency spillways excavated partially in a moderately hard, shaly limestone. All emergency spillways, embankments, disturbed areas, and odd areas on or adjacent to the works of improvement will be vegetated to control erosion, provide wildlife food and cover, to minimize habitat loss resulting from construction, and to enhance the remaining habitat. Plant species will be selected, sited, and planted in accordance with SCS Technical Specifications for Establishment of Wildlife Habitat on or Adjacent to Watershed Works of Improvement. The type of vegetation to be used will include annual and perennial vegetation of native and introduced grasses, forbs, shrubs, snd trees. Sod forming vegetation such as bermudagrass will be used as the base vegetation on embankments and spillways. Bunchgrasses, forbs, and shrubs such as bluestem species, kleingrass, maximilian sunflower, bushsunflower, dewberry, bush honeysuckle, buttonbush, and indigobush will be planted on disturbed areas, odd areas, and overseeded or planted at some locations. Wood species such as crabapple, autumnolive, russianolive, mulberry, walnut, oaks, and pecan will also be planted in odd areas within the rights-of-way. These plantings will be sited and planned in detail during the final design stage in consideration of specific site conditions. The selection of exact species to be used will be from the adapted species of seed and plant stock available at the time of construction. Fences will be constructed around the embankment and emergency spillway of each structure to protect the vegetation from damage by grazing.

Most of the floodwater retarding structures are located on yielding materials. Sites which have yielding materials of 10-foot thicknesses or greater include Sites 1, 4, 6, 7, 12, 32, 34, 36, 37, 38, 39, 40, 42, 44, and 45. Non-yielding bedrock strata occur on the remaining sites at depths of less than 10 feet and are overlain by firm foundation material.

Preliminary site investigations indicate that all needed borrow for the embankments should be obtainable from the emergency spillway areas and from within the sediment pool areas. The fill materials consist mainly of residual and alluvial silty clay (CL), clay (CH), and some clayey gravel (GC).

Installation of the structural measures will require 6,534 acres of land. This area on which the dams will be constructed and on which sediment and floodwater will be impounded consists of 2,347 acres of cropland, 3,932 acres of pastureland and rangeland, and 255 acres (64 miles) of intermittent stream channels under present land use conditions. Construction of the dams and emergency spillways will require 428 acres of land, which includes 200 acres of cropland and 228 acres of pastureland and rangeland. The sediment pools, which will initially impound water, will inundate 1,776 acres of land, which includes 526 acres of cropland, 1,108 acres of pastureland and rangeland, and 142 acres (37 miles) of intermittent stream channels. The retarding pools will temporarily inundate 4,330 acres of land, which includes 1,621 acres of cropland, 2,596 acres of pastureland and rangeland, and 113 acres (27 miles) of intermittent stream channels.

The areas needed for construction of the dams and emergency spillways and borrow areas will be cleared of all existing vegetation. In addition, large woody vegetation within the sediment pool areas below the elevation of the lowest ungated outlet will be cleared to the amount needed for the adequate and safe performance and operation of the floodwater retarding structures and to create a practical and reasonable maintenance condition. It is planned to leave uncleared the fringes, coves, and upper portions of the sediment pools. The precise area to be cleared will be determined during the installation phase at each site. It is estimated that 560 acres of large woody vegetation will be cleared. The dams, emergency spillways, and all disturbed areas, except water impoundment areas, will be vegetated with adaptable multiuse plants for erosion control, wildlife use, and grazing of livestock.

The following alterations, modifications, or replacements of existing improvements will be necessary in order to install the floodwater retarding structures:

Floodwater Retarding Structure No.	Item
1	Close county road, reroute powerline
2	Reroute telephone line
3	Alter powerline
5	Reroute county road
6	Alter powerline
7	Reroute county road, alter powerline
14	Alter pipeline
17	Raise county road
18	Raise county road, alter powerline
19	Raise county road
24	Close county road, relocate powerlines
27	Alter powerline
31	Raise county road
33	Reroute county road, alter powerline
39	Close county road, alter powerline
40	Raise county roads, alter telephone line
41	Raise county road
44	Reroute county roads, alter powerline and telephone line

Under present conditions the acquisition of land rights needed for installation of structural measures will result in the following displacements:

Floodwater Retarding Structure No.	Item
1	One dwelling with two persons, contents of one barn
6	Contents of one barn
7	Contents of one barn
12	Contents of two barns
21	Contents of one barn
22	Contents of one barn
24	Contents of one barn
25	Contents of two barns
32	Contents of one barn
34	Contents of one barn
40	One owner-operated farm enterprise
44	One owner-operated farm enterprise and contents of one barn
45	Contents of one barn

No other displacements are apparent under present conditions.

The installation of the project will have insignificant effects on the mineral resources and related installations in the watershed.

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the works of improvement; to provide for flowage of water in or upon or through the structures; and to provide for the permanent storage and temporary detention, either or both, of any sediment or water.

The environment will be protected from soil erosion and water and air pollution during construction. Contractors will be required to adhere to strict guidelines set forth in each construction contract to minimize soil erosion and water and air pollution during construction. Excavation

and construction operations will be scheduled and controlled to prevent exposure of excessive amounts of unprotected soil to erosion and the resulting translocation of sediment. Measures to control erosion will be uniquely specified at each work site and will include, as applicable, use of temporary vegetation or mulches, diversions, mechanical retardation of runoff, and traps. Harmful dust and other pollutants inherent to the construction process will be held to minimum practical limits. Haul roads and excavation areas and other work sites will be sprinkled with water as needed to keep dust within tolerable limits. Contract specifications will require that fuel, lubricants, and chemicals be adequately labeled and stored safely in protected areas, and disposal at work sites will be by approved methods and procedures. All construction equipment will have safety and health features in compliance with the Safety and Health Act. Clearing and disposal of brush and vegetation will be carried out in accordance with applicable laws, ordinances, and regulations in respect to burning. Each contract will set forth specific stipulations to prevent uncontrolled grass or brush fires. Disposal of brush and vegetation will be by burying, hauling to approved off-site locations, or controlled burning, as applicable.

Necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such facilities being injuriously adjacent to live streams, wells, or springs in conformance with federal, state, and local water pollution control regulations. Conformance to all environmental control requirements will be monitored constantly by a construction inspector who will be on-site during all periods of construction operation.

The environment will continue to be protected from erosion and water pollution following completion of construction. Project sponsors will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution.

The sediment pools of all floodwater retarding structures are expected to hold water. The pools and surrounding areas have a good potential for incidental recreational use. However, the sponsors do not plan to assure public access to any of the structures; therefore, public recreation use will be prohibited at all sites. If at some future time public access is provided at any of the sites, the sponsors will assure that adequate sanitary facilities, in compliance with public health laws, are installed prior to making the areas available for public use.

Efforts will be made to avoid creating conditions which will increase population of vectors which affect public health conditions. Prevention and control measures will be implemented, if needed, in cooperation with appropriate federal, state, and local health agencies to suppress proliferation of vectors such as aquatic insects, terrestrial arthopods and rodents, etc., that could occur with the installation of floodwater retarding structures.

Figures 1, 2, and 2A show structures which are typical of those planned for the watershed. Table 3 shows details on quantities and design features of the structural measures.

All applicable state water laws will be complied with in the design and construction of the structural measures, as well as those pertaining to the storage, maintenance of quality, and use of water.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures listed in table 1 will be applied by local interests at an estimated cost of $1,717,849. This includes funds for Public Law 46 and Public Law 566 technical assistance to be provided by the Soil Conservation Service.

Included in the above sum is $214,910 of Public Law 566 funds to accelerate technical assistance in order that planning and application of needed land treatment measures included in this plan may be accomplished by the end of the 10-year installation period. The Public Law 566 funds include $2,750 for the completion of soil surveys during the first two years of project installation. The estimated cost of application of the various measures is based on current prices being paid by landowners and operators in the area.

The total installation cost of the structural measures is estimated to be $4,953,481, of which Public Law 566 costs are $3,985,538 and local costs are $967,943.

Public Law 566 costs include $3,183,700 for construction, $222,150 for engineering services, $571,440 for project administration, and $8,248 for relocation payments.

The local costs consist of $937,921 for land rights, $1,770 for water rights, $23,400 for project administration, and $4,852 for relocation payments. The estimated cost of land rights includes $13,500 for legal fees, $790,411 for value of easements, and $134,010 for modifications or replacements of existing improvements.

The local costs for project administration include sponsors' costs relative to contract administration, overhead and organizational costs, whatever construction inspections they desire to make at their own expense, incurred costs for administrative duties associated with relocation payments, and costs for relocation advisory assistance services. Estimated costs of $900 for providing relocation advisory assistance services will be borne entirely by the sponsors.

The construction cost includes the engineer's estimate and a 10 percent allowance for contingencies. The engineer's estimate was made by determining the amount or quantity of specific items that will be needed for construction of each individual structure. Such items include, but are not limited to, land clearing, embankment fill, excavation, concrete

pipe, concrete, fencing, and vegetation. The unit cost for the specific items was based on actual cost of structural measures in similar areas modified to conditions found in this watershed.

Engineering services and project administration costs are based on an analysis of previous work in similar areas. Engineering services costs include, but are not limited to, detailed surveys, geological investigations, laboratory reports, designs, and cartographic services.

Public Law 566 costs for project administration include the costs of construction inspection, contract administration, maintenance of Soil Conservation Service records and accounts, and administrative costs associated with relocation payments incurred by the Soil Conservation Service.

Value of land, easements, and rights-of-way was estimated by representatives of the local sponsors and concurred in by the Soil Conservation Service. The estimated costs for relocating or modifying the entities' powerlines, pipelines, and telephone lines were furnished by the respective companies servicing these lines. The Commissioners Courts of Bell, Falls, and Milam Counties, respectively, furnished the estimated costs for altering county roads in their counties.

The total costs for apparent eligible relocation payments resulting from displacements that are expected from installation of the project are estimated to be $13,100. All relocation costs will be shared, with Public Law 566 funds providing 62.96 percent and local funds providing 37.04 percent of the costs. Cost sharing percentages are based upon the ratio of Public Law 566 funds and other funds, less relocation payments, to the total project costs.

The estimated schedule of obligations for the 10-year installation period, covering installation of land treatment and structural measures, is as follows:

Schedule of Obligations

Fiscal Year	Measure	PL 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Land Treatment	22,591	150,294	172,885
2nd	Land Treatment	22,591	150,294	172,885
	Floodwater Retarding Structures Nos. 13, 14, 26, 30, 31, 41, and 43	399,276	87,164	486,440
3rd	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 3, 4, 5, and 42	407,230	77,558	484,788
4th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 1, 2, 35, and 36	707,228	147,757	854,985
5th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 8, 9, 10, 11, 19, 37, and 38	461,530	83,560	545,090
6th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 15, 16, 20, 21, 39, 17, and 18	383,371	123,399	506,770
7th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 6, 12, 22, 23, 24, and 25	539,222	109,848	649,070
8th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 7, 27, 28, 29, 32, 33, and 34	549,758	159,957	709,715
9th	Land Treatment	21,216	150,294	171,510
	Floodwater Retarding Structures Nos. 40, 44, and 45	537,923	178,700	716,623
10th	Land Treatment	21,216	150,293	171,509
TOTAL		4,200,448	2,470,882	6,671,330

EFFECTS OF WORKS OF IMPROVEMENT

Conservation Land Treatment

The accomplishment of the sponsors' goal of the installation of needed land treatment measures on about 64,000 acres of land will reduce soil erosion by 590,000 tons yearly and maintain and improve the productivity and tilth of the soil. These measures will also reduce downstream flood-water and sedimentation damages by 6 percent, reduce the sediment load carried out of the watershed by 32 percent, reduce the peak rate of run-off from the uplands, and assure the proper functioning of the structural measures.

The trend of conversion of marginal cropland to grassland is expected to reduce the acreage of cropland by about 17,000 acres during the 10-year installation period. The projected future land use at the end of the installation period will be as follows:

Land Use	Acres	Percent
Cropland	105,000	51
Pastureland	79,000	38
Rangeland	13,000	6
Miscellaneous1/	10,360	5
Total	207,360	100

1/ Roads, railroads, farmsteads, urban, built-up, etc.

Most of this change in land use is not project induced and is expected to occur even if the project is not installed. The only project induced land use change is that which will be required for the installation of floodwater retarding structures. The land use change will affect the needs, types, and amounts of the various measures that will be selected by the land users for installation on the land to reduce erosion and improve the soil resource while improving his economic return.

The application of additional land treatment measures will generally improve fish and wildlife resources in the watershed. The amount of improvement will vary from minor to significant, depending on the interests of the land users and the economic returns that can be anticipated.

The application of crop residue management will leave waste grain from grain sorghum and small grain crops on the surface of the soil for fall and winter food for dove and quail. Application of conservation cropping systems will improve food quality for dove and quail and improve the habitat for rabbit through the interspersion of crops. Grassed waterways, pasture and hayland planting, and critical area planting will be installed in accordance with appropriate SCS standards and specifications. These specifications include plant species that will improve the interspersion of plant cover on agricultural land

and provide needed travel lanes for quail and rabbit. The portions of these treated areas which are planted exclusively to non-seed producing plants will limit food production for dove as well as quail. The application of pasture and hayland management will improve the habitat value of areas planted with seed producing plants, but will lower the habitat value of the non-seed producing areas where weed control is practiced. The non-seed producing pastureland habitat could be improved through use of partial weed control methods. Proper grazing use, planned grazing systems, and deferred grazing on rangeland will improve the tall grasses and improve the numerous forbs which are associated with this native plant community.

Brush management of woody plants, mainly invading mesquite on grazing lands, would have some detrimental effects to furbearers where total clearing is done but would improve interspersion of cover for quail, dove, and rabbit where it is applied in patterns. Construction of ponds for livestock watering will also provide needed watering spots for dove and raccoon and water surface for waterfowl resting areas. The application of wildlife upland habitat management by land users who are concerned about the needs of wildlife will directly improve habitat for all wildlife.

The reduction of erosion by all land treatment measures will improve the quality of the aquatic environment for fish species by reducing sedimentation in the 20 miles of streams and the 800 farm ponds. Application of fish pond management will improve the fishery resources of the watershed.

Structural Measures

The installation of the floodwater retarding structures, will provide flood protection to 21,481 acres of the 22,900 acres of flood plain land.

Average annual flooding within the benefited area will be reduced from 17,149 acres to 7,155 acres, a reduction of 58 percent. Reduction in area inundated varies with respect to location within the watershed. The general locations and reduction in inundation are shown in the following tabulation:

Evaluation Reach (figure 3)	Total (acres)	Average Annual Area Inundated		
		Without Project (acres)	With Project (acres)	Reduction (percent)
1	795	712	205	71
1-A	1,360	1,301	160	88
2	290	297	37	88
3	2,020	1,817	1,005	45
4	363	78	56	28
4-A	661	656	327	50
5	2,790	1,648	524	68
6	53	28	0	100
7	2,490	950	286	70
7-A	195	45	3	93
8	1,106	856	324	62
9	3,700	4,100	2,060	50
10	2,535	2,561	1,280	50
11	3,123	2,100	888	58
TOTAL[1/]	21,481	17,149	7,155	58

1/ Excludes flood plain area in and above floodwater retarding structures which does not receive protection.

The installation of the planned structural measures will reduce flooding from a flood similar to that of May 1965 by approximately 5,700 acres on the benefited flood plain.

Although the planned structural measures will greatly reduce damages from flooding throughout the watershed, the threat of flooding remains. The level of protection provided to the flood plain of Elm Creek was considered adequate for the present agricultural use, but is not

considered adequate for the installation of improvements, such as buildings, which are subject to significant damage from flooding. The maximum protection will be provided to the flood plain immediately downstream of the planned structural measures. As watershed area controlled by structural measures decreases, a corresponding decrease in damage reduction will occur. The following tabulation shows the reduction of damages by reach:

Evaluation Reach (figure 3)	Direct Monetary Floodwater Damage: Total Average Annual Damage: Without Project (dollars)	With Project (dollars)	Benefits (dollars)	Reduction (percent)
1	15,090	3,150	11,940	79
1-A	43,540	4,080	39,460	91
2	8,130	740	7,390	91
3	47,600	17,440	30,160	63
4	2,320	1,110	1,210	52
4-A	18,580	7,420	11,160	60
5	55,730	15,030	40,700	73
6	1,740	90	1,650	95
7	40,050	8,350	31,700	79
7-A	4,060	370	3,690	91
8	30,770	9,090	21,680	70
9	114,360	47,990	66,370	58
10	80,690	31,910	48,780	60
11	116,100	37,100	79,000	68
SUBTOTAL	578,760	183,870	394,890	68
X[1/]	1,740	1,650	90	5
TOTAL	580,500	185,520	394.980	68

1/ No structural control planned for reach X; reduction due to land treatment.

It is expected that about 1,650 acres of pastureland, now producing a minimum of palatable forage, will be managed more intensively. The reduction in flooding will allow operators to establish an improved variety of grass and manage the improved pastureland to a level commensurate with the soil's capability. This higher level of management will provide a greater degree of economic stability and allow the operator to utilize his land, time, labor, and machinery more efficiently. It is not expected that there will be a net increase of flood plain cropland, nor is it expected that the project will cause an increase in the acreage of crops in surplus supply.

Impoundment of water in the sediment pools will take 526 acres of cropland and 1,108 acres of pastureland and rangeland out of further agricultural production. Another 200 acres of cropland and 228 acres of pastureland and rangeland will be converted to use for dams and emergency spillways and will have restricted agricultural use as pastureland. It is expected that most of the 1,621 acres of cropland in the detention pools will be converted to pastureland. The total net loss of agricultural production resulting from inundation and construction of the structural measures is about $21,000. No measurable effect is anticipated on the management operations of the individuals affected.

The annual volume of sediment produced by flood plain scour, streambank erosion, and valley trenching will be reduced from an estimated 332,000 tons to 85,000 tons with the project installed. This reduction in flood plain erosion combined with the expected reduction of erosion in the uplands by land treatment and the trapping of sediment in the floodwater retarding structures will reduce the annual sediment load carried out of the watershed from 425,000 tons under without project conditions to 124,000 tons with project installed. This load represents a sediment concentration of 3,600 mg/l in the estimated average annual runoff of 86,600 acre-feet under without project conditions and 1,100 mg/l in the 82,800 acre-feet of annual runoff initially after installation of the project.

The reduction of erosion in the uplands and flood plain and the resultant reduction in sediment load carried by streams of the watershed will effect similar reductions in stream filling and new channel formation by valley trenching. Valley trenching is not expected to be completely eliminated, however, and is expected to continue at a rate of about 27 percent of the present rate as the stream system continues to adjust to the effects of past damage by sedimentation.

The installation of all measures, both land treatment and structural, will benefit over 1,500 landowners and operators. About 530 farm units, of which about 450 are family-type operations, will have damages reduced as a result of the installation of structural measures.

The reduction in flooding and floodwater depths and velocities, sediment deposition, and erosion will reduce crop and pasture damages by 66 percent;

other agricultural damages, 66 percent; road and bridge damages, 85 percent; overbank deposition damages, 72 percent; flood plain scour, 75 percent; streambank erosion, 75 percent; valley trenching, 74 percent; and indirect damages by 68 percent.

The planned floodwater retarding structures will modify the peak discharges of flood flows entering the Little River from the watershed. The estimated peak discharge from various frequency flood events are:

Frequency (years)	Without Project (cfs)	With Project (cfs)
100	31,100	18,200
25	21,700	12,700
5	12,400	7,300
2	7,500	4,400
1	4,400	2,800

Initial filling of the sediment pools of the floodwater retarding structures up to the elevation of the lowest ungated outlet will require an estimated 6,671 acre-feet of water which will not be available as water yield from the watershed. This initial loss will be spread throughout the 10-year installation period and will average about 667 acre-feet per year. After complete installation of planned floodwater retarding structures, the average annual volume of streamflow from the watershed will be reduced about 4.4 percent as a result of evaporation and seepage losses from the sediment pools. However, as sediment accumulates in the sediment pools, the streamflow will again approach pre-project conditions.

The continuous release of water from the sediment pools of floodwater retarding structures Nos. 1 and 40 will prolong low flows in the downstream channels. This flow will create approximately 8 miles of additional permanent flowing streams for fisheries, waterfowl, and wildlife. These release flows are also expected to provide livestock water, which will enable land users to better manage their pastureland by the distribution of grazing on the bottomland.

The quality of the runoff from the agricultural lands after the installation of the project is not expected to be affected appreciably except for the reduction in the sediment load being transported. There have been no problems associated with water pollution from agricultural chemicals, fertilizers, or livestock watering use of the sediment pools in an adjoining watershed project which has similar soil and land use characteristics.

It is anticipated that pool areas of floodwater retarding structures will be used by landowners and operators for livestock water. The pool areas are expected to provide livestock water which will enable operators to manage their pastureland to a higher degree by the distribution of grazing on the upland.

The floodwater retarding structures will not detract from the rural pattern of intensive agricultural use of the watershed. The vegetated

embankments and emergency spillways will blend in with the existing pattern of cultivated lands intermixed with permanent grassland. Water stored in the sediment pools will create attractive bodies of water in this setting.

Floodwater damages on about 26,600 acres of flood plain land on the mainstem of the Little River between the watershed and the Brazos River will be reduced as a result of project installation. This project will control an average of about 2 percent of the drainage area contributing floodwater to this area.

Fish and Wildlife and Recreation

Installation of the 45 floodwater retarding structures will change 1,776 acres of small game habitat needed for sediment pools to a fisheries and waterfowl habitat. Construction of the dams and emergency spillways will temporarily destroy the small game habitat on another 428 acres. These areas will be revegetated with proper plants for erosion control and food and cover for wildlife. About 560 acres of these areas are woody habitat for fox squirrel and furbearers and represents about 4 percent of this type habitat in the watershed. The remainder is open rangeland, pastureland, and cropland habitat for dove and quail, which represents about 1 percent of this type habitat in the watershed. Also included are about 38 miles (140 acres) of intermittent streams which may have seasonal use by waterfowl and six existing farm ponds.

The detention pools will temporarily inundate 4,330 acres of small game habitat composed of 1,621 acres of cropland, 10 acres of pastureland, 2,586 acres of rangeland, and 113 acres (27 miles) of intermittent stream channels. The periodic flooding of this habitat will be a temporary nuisance to wildlife. Expected conversion of the cropland to pastureland may reduce wildlife food availability if non-seed producing plants are used by the land user.

The sediment pools of the floodwater retarding structures will initially create 1,776 acres of surface water for waterfowl resting habitat and occasionally up to 4,330 acres of temporary waterfowl resting habitat during periods of impoundment in the detention pools. Approximately 25 of these pools, with a total surface area of 640 acres, will have good fisheries potential; 19 pools, with a surface area of 1,114 acres, will have fair fisheries potential; and one pool, with a surface area of 22 acres, will have a poor fisheries potential.

The reduction of sedimentation in the uplands by land treatment measures will improve the quality of the pond and sediment pool fisheries habitat. The reduction of the sediment load carried into streams of the watershed by both land treatment measures and the floodwater retarding structures will improve the 20 miles of existing stream fisheries and the 8 additional miles expected to be created by streamflow augmentation.

The project will reduce flooding on 21,481 acres of flood plain habitat, which includes about 1,200 acres of woody habitat in the form of narrow bands along the streams. Reduced flood plain erosion by scouring and valley trenching will improve this resource and reduce woody habitat destruction associated with abandonment of existing tree-lined stream channels and formation of new channels in open land.

Installation of the project is not expected to have any effect on threatened or endangered species.

Access to watershed lands by the general public for fishing and hunting is not expected to change significantly with the project installed, as the sponsors do not intend to acquire any lands for recreational use.

Archeological, Historic, and Scientific

An archeological survey was made of the areas which will be affected by the floodwater retarding structures. One archeological site was found within the pool area of floodwater retarding structure No. 7. Study of this site by archeologists of the Archeology Research Program, Southern Methodist University, showed that the site has been disturbed by farming activity and that salvage is not warranted. The Interagency Archeological Services-Denver, National Park Service, will be kept informed of the progress of the plan. If any archeological sites are located during the construction of the structural measures, a trained archeologist will be notified in order that these resources can be salvaged.

Economic and Social Effects

The installation of structural measures will reduce substantially the direct income losses due to floodwater damage suffered by farm and ranch operators and associated agricultural businesses. This reduction in floodwater damage will result in greater agricultural efficiency and income stability for the small farmers of the area and strengthen the local agricultural economy. A strong local agricultural economy is essential in reducing the number of farmers and ranchers who are forced to the city in search of employment to maintain an adequate standard of living.

The reduction in sediment and erosion damages, the reduction in floodwater damages to crops and pastures, and the increased value of production due to the more intensive use of pastureland will result in new revenues in the local area. These revenues will result in a net expansion of the local economy by an additional $157,530 annually. This will also create a need for approximately 22 new jobs. In addition, the expenditure of funds for the construction of the works of improvement will create approximately 154 man-years of employment.

PROJECT BENEFITS

The estimated average annual monetary damages (table 5) will be reduced from $580,500 to $185,520, or 68 percent. Crop and pasture damages will be reduced from $241,410 to $81,960, or 66 percent. Other agricultural damages, such as loss of livestock, fences, stored grain and hay, and farming and ranching equipment and supplies, etc., will be reduced from $185,130 to $63,330, or 66 percent. Road and bridge damages will be reduced from $26,330 to $3,860, or 85 percent. Overbank deposition damages to fertile flood plain lands will be reduced from $29,880 to $8,510 or 72 percent. Flood plain scour damages will be reduced from $38,520 to $9,460, or 75 percent. Streambank erosion damages, now occurring at the rate of $880 annually, will be reduced to $220, or 75 percent. Valley trenching damages, now occurring at the rate of $4,380 annually, will be reduced to $1,140, or 74 percent. Indirect damages will be reduced from $53,970 to $17,040, or 68 percent.

Benefits from intensification of pastureland, primarily by the establishment and proper management of an improved variety of grass, are expected to accrue at the rate of $33,100 annually. These benefits were discounted to reflect an expected 5-year lag in accrual of full level benefits.

The installation of all structural measures in the Elm Creek watershed will also result in additional benefits downstream from the watershed. It is expected that benefits along the Little River will accrue to the aforementioned measures at the rate of $19,720 annually. Benefits from floodwater, sediment, and erosion to agricultural properties total $17,750, while nonagricultural properties receive benefits of $1,970.

Benefits from providing incidental sources of livestock water at the sediment pools of the floodwater retarding structures are expected to accrue at an average annual rate of $4,260.

Although not considered pertinent from a national viewpoint, net secondary benefits will result in an increase in disposable personal income for the four-county watershed of $157,530 annually.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation and project administration costs plus annual operation and maintenance costs) is $304,110. These measures are expected to produce average annual primary benefits of $418,100. The benefit-cost ratio, excluding secondary benefits, is 1.4 to 1.0. The ratio of total annual project benefits accruing to structural measures, $575,630, to the average annual cost of structural measures, $304,110, is 1.9 to 1.0 (table 6).

PROJECT INSTALLATION

The project installation period will be 10 years. The general sequence of installation is shown under the schedule of obligations, "Explanation of Installation Costs."

Planned land treatment (table 1) will be accomplished by farm and ranch operators in cooperation with the Central Texas and the McLennan County Soil and Water Conservation Districts during the 10-year installation period. The goal is the completion of the installation of adequate treatment measures on 24,600 additional acres of cropland, 5,400 additional acres of rangeland, and 33,500 additional acres of pastureland by the end of the installation period. The district directors of the soil and water conservation districts will assume aggressive leadership in accelerating the land treatment program now being applied.

The installation of land treatment measures which will benefit wildlife will be encouraged at every opportunity. Landowners will be encouraged to seek assistance from the Texas Parks and Wildlife Department in the management and stocking of their reservoirs and ponds for fish and the management of the water bodies for wildlife.

The Soil Conservation Service will provide additional technical assistance to the soil and water conservation districts to accelerate the planning and application of soil, plant, and water conservation measures.

Public Law 566 funds will supplement Public Law 46 funds in order that soil surveys on 16,200 acres in Milam County can be completed during the first two years. The Extension Service will assist in the educational phase of the program by holding local farm meetings, preparing press, radio, and television releases, and using other methods of getting information to landowners and operators in the watershed. Soil and water conservation loans available through the Farmers Home Administration will be given special emphasis. Present FHA clients in the watershed will be encouraged to cooperate in the program.

In designing floodwater retarding structure No. 6, structure No. 5 was assumed to be installed; in designing structure No. 7, structures Nos. 5 and 6 were assumed to be installed; and in designing structure No. 40, structure No. 39 was assumed to be installed. Therefore, structure No. 5 will be installed prior to structure No. 6, structure No. 6 will be installed prior to structure No. 7, and structure No. 39 will be installed prior to structure No. 40.

The Elm Creek Watershed Authority has the power of eminent domain under applicable state laws and will be responsible for the installation of the structural measures.

The authority will take the following actions pertaining to the structural measures:

1. Be responsible for working with the Service during construction of works of improvement. They will designate in writing an individual to serve as liaison between the authority and the Service.

2. Obtain all land and water rights needed legally for construction, operation and maintenance, and take related land rights action conforming to Service policy requirements and the requirements of Public Law 91-646, Uniform Relocation Assistance and Real Properties Acquisition Policies Act of 1970. The Elm Creek Watershed Authority, through its own facilities and staff or by contract with a fully qualified agency, will: (1) Provide personally, or by first class mail, written notice of displacement and appropriate application forms to each displaced person, business, or farming operation; (2) give displaced persons notice to vacate at least 90 days prior to the date they must move; (3) assist in filing applications; (4) review and take action on applications for relocation assistance; (5) review and process grievances in connection with displacements; and (6) make relocation payments.

   The authority will provide such measures, facilities, or services as may be necessary or appropriate in order to: (1) Determine the need, if any, of displaced persons for relocation assistance; (2) provide current and continuing information on the availability, prices, and rentals of comparable decent, safe, and sanitary sale and rental housing, and of comparable commercial properties and locations for displaced businesses and farm operations; (3) assure that within a reasonable period of time prior to displacement, replacement dwellings will be available; (4) assist a person displaced from his business or farm operation in obtaining and becoming established in a suitable replacement location; (5) supply information concerning housing programs, disaster loan programs, and other federal or state programs offering assistance to displaced persons; (6) provide other advisory services to displaced persons in order to minimize hardships to such persons in adjusting to relocations; (7) advise displaced persons that they should notify the displacing agency before they move; and (8) prior to initiation of acquisition, provide persons from whom it is planned to acquire land a brochure or pamphlet outlining the benefits to which they may be entitled.

   Construction of any floodwater retarding structure causing a displacement will not be initiated until decent, safe, and sanitary replacement housing is available for all displaced persons.

3. Determine the legal adequacy of land rights and use its power of eminent domain to obtain all land rights not donated or obtained through negotiation.

4. Provide for the modification of the utility lines, roads, pipelines, and privately owned improvements as may be necessary for the installation of structural measures.

Technical assistance will be provided by the Soil Conservation Service in the preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificates of completion, and related tasks necessary to install structural measures. The Soil Conservation Service will, as a part of project administration, assist the authority in fulfilling its responsibilities in carrying out the requirements of Public Law 91-646.

As required by Public Law 86-523, the Service will keep the Secretary of the Interior informed of the construction schedule so that the Secretary can cause a survey to be made of the sites to ascertain whether such sites contain historical and archeological data which should be preserved in the public interest. Further, if any archeological materials are found during construction, the Secretary will be similarly notified.

The Soil Conservation Service, in compliance with the request made by the sponsors, will provide the necessary administrative and clerical personnel, facilities, and supplies to advertise, award, and administer contracts, and will be the contracting agency.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

The cost of installing the needed land treatment measures during the 10-year installation period will be borne by the landowners and operators of the land on which these measures are installed. The Farmers Home Administration, local banks, and other lending institutions can arrange financing for the landowerns and operators' share of the cost.

The Soil Conservation Service will provide funds in the estimated amount of $433,050 to finance the cost of technical assistance in planning and application of the land treatment measures. This consists of $214,910 of Public Law 566 funds and $218,140 to be provided from Public Law 46 funds (table 1).

Funds for the local share of the cost of installing the structural measures will be provided by the Elm Creek Watershed Authority. The Elm Creek Watershed Authority plans on obtaining a loan from the Farmers Home Administration. Negotiations, including the filing of a preliminary application, are under way with the state director of the Farmers Home Administration. A $300,000 bond issue has been approved by the taxpaying voters of Improvement District Number 1 of the Elm Creek Watershed Authority. A tax is now being levied for the purpose of retiring this indebtedness. The area of Improvement District Number 1 is defined by the Elm Creek Watershed Authority as the area of flood plain and certain land

immediately adjoining the flood plain. In addition, another tax is being levied by the authority which can be used for the operation and maintenance of the project. These funds are adequate for financing the share of the project installation cost to be borne by the Authority.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent on the appropriation of funds for this purpose. In addition, the following prerequisite conditions will be met before federal funds will be made available for the installation of the structural measures:

1. The requirements for land treatment in the drainage areas above the floodwater retarding structures have been met.

2. All necessary land and water rights have been obtained for all structural measures, or the sponsors have furnished a written statement to the effect that they have the means of obtaining land rights and the exact date by which all land rights will have been obtained. Following is the proposed schedule, by 6-month periods, for obtaining needed land rights:

1st 6-month period	Floodwater retarding structures Nos. 13, 26, 30, 31, 41, and 43
2nd 6-month period	Floodwater retarding structures Nos. 1, 3, 4, 5, 14, and 25
3rd 6-month period	Floodwater retarding structures Nos. 10, 17, 18, 35, and 42
4th 6-month period	Floodwater retarding structures Nos. 8, 19, 20, 21, and 37
5th 6-month period	Floodwater retarding structures Nos. 2, 6, 36, and 38
6th 6-month period	Floodwater retarding structures Nos. 9, 16, 32, 33, and 39
7th 6-month period	Floodwater retarding structures Nos. 11, 27, 28, and 29
8th 6-month period	Floodwater retarding structures Nos. 22, 23, 44, and 45
9th 6-month period	Floodwater retarding structures Nos. 15, 24, and 34
10th 6-month period	Floodwater retarding structures Nos. 7, 12, and 40

3. County roads affected by floodwater retarding structures Nos. 1, 5, 7, 17, 18, 19, 24, 31, 33, 39, 40, 41, and 44 have been raised, moved, or closed.

4. Utilities such as power lines, telephone lines, and pipelines have been modified or permission has been granted to inundate the properties involved.

5. Relocation agreements have been executed.

6. Project agreements have been executed.

7. Operation and maintenance agreements have been executed.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the landowners and operators of farms and ranches on which the measures are installed under agreements with the Central Texas and McLennan County Soil and Water Conservation Districts. Representatives of the districts will encourage landowners to maintain land treatment measures.

The Elm Creek Watershed Authority will be responsible for the operation and maintenance of all structural measures. Maintenance will be performed by the commissioners court of the county in which the structural measures are located. Funds for this purpose will be provided by the county and by a tax levied by the authority. Floodwater retarding structures Nos. 1 through 24 and 26 through 31 are located in Bell County, floodwater retarding structure No. 39 is located in Falls County, and floodwater retarding structures Nos. 25, 32 through 38, and 40 through 45 are located in Milam County. The estimated average annual cost of operation and maintenance ia $12,100, based on current (1974) prices. The estimated average annual value of operation and maintenance is $7,700 for structural measures in Bell County, $4,000 for Milam County, and $400 for Falls County.

The Service and the sponsors will make a joint inspection annually or after unusually severe floods, or in the event of other unusual conditions that may adversely affect the works of improvement, for three years following installation of each structure. Inspection after the third year will be made annually by the sponsors. The Service will participate in annual inspections as often as it elects to do so after the third year. Inspection items are those items which may need maintenance. Items of inspection and maintenance will include, but will not be limited to, condition of principal spillways, earth fills, emergency spillways, vegetative cover, fences, gates, and vegetative growth in reservoirs. Also, the structures will be monitored to determine if there are any water pollution problems being created by livestock watering, etc.

Immediately following completion of the structures by the contractor, the sponsors will be responsible for and promptly perform, or have performed, without cost to the Service, all maintenance of the structural measures as determined to be needed by either the sponsors or the Service. The sponsors will be responsible for maintenance of vegetation associated with structural measures after the initial vegetation work is adequately completed, as determined by the Service, but no later than three years following completion of each structural measure. Maintenance of the floodwater retarding structures will consist of items such as controlling undesirable vegetation by mowing, hand cutting, or using herbicides; painting metal parts; and repairing eroded areas. The mowing operations for the most part will be done with a farm-type tractor and shredder. The method of application of herbicides will be in accordance with labeling, as required by the Federal Insecticide, Fungicide and Rodenticide Act, as amended (86 Stat. 995).

An operation and maintenance agreement will be executed by the parties hereto prior to the signing of the initial project agreement and the issuance of invitations to bid on construction of the structural measures. The operation and maintenance agreement will be in accordance with guidelines contained in the Texas Operation and Maintenance Handbook. An operation and maintenance plan will be developed for each structural measure. The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with financial assistance from Public Law 566 funds.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Elm Creek Watershed, Texas

Installation Cost Item	Unit	Number: Federal Land	Number: Non-Federal Land	Number: Total	Estimated Cost (Dollars) 1/: PL 566 Funds: Non-Federal Land: SCS 2/	Estimated Cost (Dollars) 1/: Other: Non-Federal Land: SCS 2/	Estimated Cost (Dollars) 1/: Total
LAND TREATMENT							
Land Areas 3/							
Cropland	Acres to be treated	-	24,600	24,600	-	245,389	245,389
Pastureland		-	33,500	33,500	-	1,028,562	1,028,562
Rangeland		-	5,400	5,400	-	10,848	10,848
Technical Assistance					214,910	218,140	433,050
TOTAL LAND TREATMENT	xxx	xxx	xxx	xxx	214,910	1,502,939	1,717,849
STRUCTURAL MEASURES							
Construction							
Floodwater Retarding Structures	No.	-	45	45	3,183,700	-	3,183,700
Subtotal - Construction					3,183,700	-	3,183,700
Engineering Services					222,150	-	222,150
Relocation Payments					8,248	4,852	13,100
Project Administration					292,060	-	292,060
Construction Inspection					279,380	22,500	301,880
Other					-	900	900
Relocation Assistance Advisory Services					571,440	73,400	594,840
Subtotal - Administration					-	937,921	937,921
Other Costs					-	1,770	1,770
Land Rights					-	939,691	939,691
Water Rights					3,985,538	967,943	4,953,481
Subtotal - Other					4,200,448	2,470,882	6,671,330
TOTAL STRUCTURAL MEASURES							
TOTAL PROJECT							

1/ Price Base: 1974

2/ Federal agency responsible for assisting in installation of works of improvement

3/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Elm Creek Watershed, Texas

Measure	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acres	53,372	53,372
Contour Farming	Acres	23,880	23,880
Crop Residue Management	Acres	64,968	194,904
Diversion	Feet	158,900	19,068
Terrace, Gradient	Feet	6,631,680	464,218
Grassed Waterway or Outlet	Acres	1,112	122,320
Grade Stabilization Structure	No.	3	6,000
Pasture and Hayland Planting	Acres	10,135	304,050
Pasture and Hayland Management	Acres	16,643	33,286
Critical Area Planting	Acres	374	41,140
Pond	No.	806	564,200
Brush Management	Acres	12,881	515,240
Fishpond Management	No.	226	1,130
Wildlife Upland Habitat Management	Acres	1,155	1,155
Proper Grazing Use	Acres	5,056	5,056
Deferred Grazing	Acres	5,000	5,000
TOTAL			2,354,019

Price Base: 1974

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Elm Creek Watershed, Texas

(Dollars) 1/

Item	Installation Cost - PL 566 Funds				Installation Cost - Other Funds				Total Installation Cost
	Construction	Engineering	Relocation Payments	Total PL 566	Land Rights 2/	Water Rights	Relocation Payments	Total Other	
Floodwater Retarding Structures									
1	427,300	18,360	3,778	449,438	111,375	900	2,222	114,497	563,935
2	41,200	3,300	-	44,500	14,560	-	-	14,560	59,060
3	48,600	3,890	-	52,490	7,940	-	-	7,940	60,430
4	77,100	5,400	-	82,500	18,080	-	-	18,080	100,580
5	96,200	6,730	-	102,930	21,908	-	-	21,908	124,838
6	90,600	6,340	79	97,019	21,950	-	46	21,996	119,015
7	93,300	6,530	47	99,877	52,870	-	28	52,898	152,775
8	48,400	3,870	-	52,270	5,710	-	-	5,710	57,980
9	55,400	4,430	-	59,830	10,100	-	-	10,100	69,930
10	55,500	4,440	-	59,940	6,010	-	-	6,010	65,950
11	32,900	3,290	-	36,190	7,980	-	-	7,980	44,170
12	136,800	8,210	47	145,057	24,990	-	28	25,018	170,075
13	48,200	3,860	-	52,060	10,610	-	-	10,610	62,670
14	43,300	3,460	-	46,760	24,180	-	-	24,180	70,940
15	36,100	3,610	-	39,710	16,770	-	-	16,770	56,480
16	26,100	2,870	-	28,970	9,800	-	-	9,800	38,770
17	34,800	3,480	-	38,280	20,050	-	-	20,050	58,330
18	34,100	3,410	-	37,510	14,410	-	-	14,410	51,920
19	66,100	4,630	-	70,730	34,690	-	-	34,690	105,420
20	25,400	2,790	-	28,190	7,460	-	-	7,460	35,650
21	41,300	3,300	31	44,631	13,830	-	19	13,849	58,480
22	38,500	3,850	79	42,429	11,320	-	46	11,366	53,795
23	47,500	3,800	-	51,300	16,800	-	-	16,800	68,100
24	70,300	4,920	31	75,251	18,360	-	19	18,379	93,630
25	45,300	3,620	236	49,156	12,900	-	139	13,039	62,195
26	54,500	4,360	-	58,860	17,470	-	-	17,470	76,330
27	37,200	3,720	-	40,920	37,060	-	-	37,060	77,980
28	24,100	2,650	-	26,750	3,080	-	-	3,080	29,830
29	28,300	3,110	-	31,410	2,630	-	-	2,630	34,040
30	40,500	4,050	-	44,550	10,460	-	-	10,460	55,010
31	28,500	3,140	126	31,766	4,630	-	74	4,704	36,470
32	66,000	4,620	158	70,778	20,270	-	92	20,362	91,140
33	31,700	3,170	-	34,870	9,340	-	-	9,340	44,210
34	154,800	8,060	283	163,143	30,770	-	167	30,937	194,080
35	32,600	3,260	-	35,860	3,030	-	-	3,030	38,890

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION - continued
Elm Creek Watershed, Texas

(Dollars) 1/

Item	Installation Cost - PL 566 Funds				Installation Cost - Other Funds				Total Installation Cost
	Construction	Engineering	Relocation Payments	Total PL 566	Land Rights 2/	Water Rights	Relocation Payments	Total Other	
Floodwater Retarding Structures									
36	86,900	6,080	-	92,980	13,420	-	-	13,420	106,400
37	50,200	4,020	-	54,220	8,770	-	-	8,770	62,990
38	52,300	4,180	-	56,480	6,800	-	-	6,800	63,280
39	97,300	6,810	-	104,110	37,510	-	-	37,510	141,620
40	264,700	13,240	1,590	279,530	105,565	870	935	107,370	386,900
41	46,100	3,690	-	49,790	9,640	-	-	9,640	59,430
42	104,700	6,280	-	110,980	27,630	-	-	27,630	138,610
43	47,400	3,790	-	51,190	6,550	-	-	6,550	57,740
44	125,600	7,530	1,732	134,862	55,563	-	1,018	56,581	191,443
45	50,000	4,000	31	54,031	13,080	-	19	13,099	67,130
Subtotal	3,183,700	222,150	8,248	3,414,098	937,921	1,770	4,852	944,543	4,358,641
Project Administration	xxx	xxx	xxx	571,440	xxx	xxx	xxx	23,400	594,840
GRAND TOTAL	3,183,700	222,150	8,248	3,985,538	937,921	1,770	4,852	967,943	4,953,481

1/ Price Base: 1974
2/ Includes $13,500 for legal fees and $134,010 for relocation or modification of fixed improvements

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TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY
Elm Creek Watershed, Texas

ITEM	UNIT	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10
Class of Structure		C	A	A	A	B	B	B	B	B	B
Drainage Area (Total)	Sq. Mi.	21.12	0.91	1.30	3.09	4.25	7.33	13.06	0.85	0.79	0.99
Controlled		-	-	-	-	-	4.25	7.33	-	-	-
Curve No. (1-Day)(AMC II)		57	81	81	81	81	81	81	81	81	81
TC	Hr.	2.80	0.83	0.68	1.28	2.25	1.05	1.65	0.72	0.51	0.92
Elevation Top of Dam	Ft.	677.8	667.6	609.1	643.6	623.8	558.1	517.1	758.9	731.4	719.6
Elevation Crest Emergency Spillway	Ft.	668.5	664.0	605.5	639.0	618.6	552.5	511.6	754.5	728.0	715.0
Elevation Crest Principal Spillway	Ft.	650.1	650.9	594.3	628.8	605.0	1/ 540.8 544.2	499.1	745.0	721.0	703.4
Elevation Crest Lowest Ungated Outlet	Ft.	636.8	650.9	594.3	624.8	599.6	1/ 538.8 541.3	494.6	765.0	721.0	703.4
Maximum Height of Dam	Ft.	65	44	42	35	41	35	38	30	27	39
Volume of Fill	Cu. Yds.	545,900	57,000	86,600	155,500	187,000	157,900	141,900	83,900	101,100	96,400
Total Capacity 2/	Ac. Ft.	9,777	372	544	1,236	1,791	1,299	2,246	376	421	496
Sediment (100 Years)	Ac. Ft.	1,870	89	162	348	390	294	452	75	130	132
Sediment Submerged 3/	Ac. Ft.	1,712	82	149	320	358	271	416	69	120	121
Sediment Aerated.	Ac. Ft.	4/ 158	7	13	4/ 28	4/ 32	6/ 23	4/ 36	6	10	11
Sediment Pool (Lowest Ungated Ouclet)	Ac. Ft.	4/ 200	82	149	4/ 200	4/ 200	6/ 200	4/ 200	69	120	121
Retarding 2/	Ac. Ft.	7,907	283	382	888	1,401	1,005	1,794	301	291	364
Surface Area											
Sediment Pool (Lowest Ungated Outlet)	Acre	32	13	21	31	28	37	39	16	27	19
Sediment Pool (Principal Spillway Crest)	Acre	227	13	21	56	56	55	78	16	27	19
Retarding Pool	Acre	681	34	51	127	160	167	227	50	60	49
Principal Spillway Design											
Rainfall Volume (Areal)(1-Day)	Inch	14.40	8.12	8.00	8.01	9.00	9.00	9.00	9.00	9.35	9.00
Rainfall Volume (Areal)(10-Day)	Inch	23.00	13.50	13.30	13.32	15.00	15.00	15.00	15.00	15.50	15.00
Runoff Volume (10-Day)	Inch	9.51	8.83	8.55	8.23	9.50	9.39	10.21	10.21	10.67	10.21
Capacity (Maximum)	C.F.S.	280	14	21	47	68	124	232	15	15	15
Frequency Operation - Emergency Spillway	% Chance	0.1	3.7	4.0	3.8	2.0	2.0	2.0	2.0	1.6	2.0
Size of Conduit	Inch	42	18	18	30	24	1/ 24 24	42	24	24	24
Emergency Spillway Design											
Rainfall Volume (ESH)(Areal) 5/	Inch	12.83	7.30	7.70	7.30	10.20	10.02	10.20	10.20	10.20	10.20
Runoff Volume (ESH)	Inch	6.79	5.08	5.08	5.08	7.84	7.84	7.66	7.84	7.84	7.84
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	450	60	80	120	180	180	200	100	100	130
Velocity of Flow (V_e)	Ft./Sec.	0	0	0	2.0	7.9	4.9	7.8	5.0	2.4	5.7
Slope of Exit Channel	Ft./Ft.	0.024	0.104	0.068	0.037	0.058	0.028	0.083	0.037	0.063	0.046
Maximum Reservoir Water Surface Elevation	Ft.	667.9	662.7	604.8	639.5	621.0	554.6	513.5	755.9	728.5	716.6
Freeboard Design											
Rainfall Volume (FH)(Areal) 5/	Inch	29.23	15.00	15.00	15.00	17.00	17.00	16.70	22.10	22.10	22.10
Runoff Volume (FH)	Inch	21.78	12.51	12.51	12.51	14.47	14.47	14.17	19.52	19.52	19.52
Maximum Reservoir Water Surface Elevation	Ft.	677.8	667.6	609.1	643.6	623.8	558.1	517.1	758.9	731.4	719.6
Capacity Equivalents											
Sediment Volume	Inch	1.66	1.84	2.34	2.11	1.72	1.79	1.48	1.66	1.09	2.49
Retarding Volume	Inch	7.02	5.82	5.51	5.39	6.18	6.12	5.87	6.64	6.90	6.88

(See footnotes at end of table.)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - Continued
Elm Creek Watershed, Texas

ITEM	UNIT	STRUCTURE NUMBER 11	12	13	14	15	16	17	18	19	20
Class of Structure		A	A	A	A	A	A	A	A	A	A
Drainage Area (Total)	Sq. Mi.	0.37	5.19	1.45	1.35	1.70	0.74	1.10	1.02	4.38	0.52
Controlled		-	-	-	-	-	-	-	-	-	-
Curve No. (1-Day)(AMC II)		81	82	82	82	82	82	82	82	82	82
TC	Hr.	0.46	3.00	0.91	0.90	0.98	0.74	0.92	0.98	1.71	0.57
Elevation Top of Dam	Ft.	676.2	524.2	515.5	507.0	545.4	548.0	538.6	549.3	519.9	539.0
Elevation Crest Emergency Spillway	Ft.	674.0	519.0	512.0	503.2	542.2	545.0	536.0	546.2	516.0	536.7
Elevation Crest Principal Spillway	Ft.	668.9	507.9	504.1	492.8	535.9	539.0	530.8	540.3	508.8	532.1
Elevation Crest Lowest Ungated Outlet	Ft.	668.9	502.3	503.9	492.8	535.9	539.0	530.8	540.3	506.0	532.1
Maximum Height of Dam	Ft.	24	33	27	27	21	18	18	21	24	15
Volume of Fill	Cu. Yds.	42,650	290,300	79,800	77,200	54,300	34,900	51,400	52,900	107,300	29,400
Total Capacity 2/	Ac. Ft.	168	1,882	674	585	687	292	461	386	1,635	191
Sediment (100 Years)	Ac. Ft.	70	487	206	172	188	87	146	108	432	46
Sediment Submerged 3/	Ac. Ft.	64	448	189	158	172	80	134	99	397	42
Sediment Aerated	Ac. Ft.	6	39	17	14	16	7	12	9	35	4
Sediment Pool (Lowest Ungated Outlet)	Ac. Ft.	64	4/ 200	189	158	172	80	134	99	4/ 200	42
Retarding 2/	Ac. Ft.	98	1,395	468	413	499	205	315	278	1,203	145
Surface Area											
Sediment Pool (Lowest Ungated Outlet)	Acre	15	38	36	26	54	23	40	28	67	22
Sediment Pool (Principal Spillway Crest)	Acre	15	76	37	26	54	23	40	28	98	22
Retarding Pool	Acre	26	192	86	60	114	49	91	71	245	43
Principal Spillway Design											
Rainfall Volume (Areal)(1-Day)	Inch	8.00	8.05	8.25	8.00	8.00	8.00	8.10	8.05	8.25	8.00
Rainfall Volume (Areal)(10-Day)	Inch	13.30	13.35	13.70	13.30	13.30	13.30	13.40	13.35	13.65	13.30
Runoff Volume (10-Day)	Inch	8.64	8.37	9.13	8.77	8.68	8.95	9.04	9.00	8.57	8.95
Capacity (Maximum)	C.F.S.	10	104	22	20	18	17	26	27	91	11
Frequency Operation - Emergency Spillway	% Chance	4.0	3.7	3.3	4.0	4.0	4.0	3.7	3.8	3.3	4.0
Size of Conduit	Inch	18	30	18	18	18	18	18	18	30	18
Emergency Spillway Design											
Rainfall Volume (ESH)(Areal) 5/	Inch	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30
Runoff Volume (ESH)	Inch	5.08	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	60	120	100	90	100	60	70	60	170	50
Velocity of Flow (Va)	Ft./Sec.	0	0	3.4	2.9	1.1	2.1	0	0	0	0
Slope of Exit Channel	Ft./Ft.	0.037	0.021	0.048	0.043	0.028	0.030	0.030	0.028	0.036	0.030
Maximum Reservoir Water Surface Elevation	Ft.	674.0	519.0	512.9	503.9	542.3	545.5	535.7	546.1	515.8	536.5
Freeboard Design											
Rainfall Volume (FH)(Areal) 5/	Inch	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Runoff Volume (FH)	Inch	12.51	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65	12.65
Maximum Reservoir Water Surface Elevation	Ft.	676.2	524.2	515.5	507.0	545.4	548.0	538.6	549.3	519.9	539.0
Capacity Equivalents											
Sediment Volume	Inch	3.52	1.36	2.66	2.39	2.07	2.20	2.49	1.99	1.85	1.64
Retarding Volume	Inch	4.98	5.04	6.06	5.74	5.51	5.20	5.37	5.10	5.15	5.26

(See footnoces ac end of table.)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - Continued
Elm Creek Watershed, Texas

ITEM	UNIT	STRUCTURE NUMBER 21	22	23	24	25	26	27	28	29	30
Class of Structure		A	A	A	A	A	A	A	A	A	A
Drainage Area (Total)	Sq. Mi.	1.47	1.18	1.79	3.00	2.15	2.93	1.82	0.45	0.44	1.33
Controlled		-	-	-	-	-	-	-	-	-	-
Curve No. (1-Day)(AMC II)		82	82	82	82	82	82	82	82	82	82
TC	Hr.	0.97	0.99	1.16	1.80	1.15	1.16	0.81	0.51	0.36	0.89
Elevation Top of Dam	Ft.	513.1	506.8	482.5	451.4	419.4	519.8	492.8	497.3	485.3	517.2
Elevation Crest Emergency Spillway	Ft.	509.7	503.2	479.0	447.5	415.7	516.0	489.1	494.5	482.5	513.5
Elevation Crest Principal Spillway	Ft.	503.5	495.2	472.1	438.0	405.8	507.8	481.4	487.0	472.7	505.0
Elevation Crest Lowest Ungated Outlet	Ft.	503.5	495.2	472.1	435.0	405.7	506.0	480.6	487.0	472.7	505.0
Maximum Height of Dam	Ft.	22	27	29	32	30	28	27	25	27	28
Volume of Fill	Cu. Yds.	59,100	60,500	70,800	127,700	74,000	77,200	56,700	31,800	42,500	66,900
Total Capacity 1/	Ac. Ft.	533	516	678	1,176	858	1,169	772	181	183	511
Sediment (100 Years)	Ac. Ft	157	151	200	323	205	330	241	53	54	119
Sediment Submerged 3/	Ac. Ft.	144	141	184	798	189	302	722	49	49	109
Sediment Aerated	Ac. Ft.	13	12	16	75	16	28	19	4	5	10
Sediment Pool (Lowest Ungated Outlet)	Ac. Ft.	144	141	184	4/ 200	189	4/ 200	4/ 200	49	49	109
Retarding 2/	Ac. Ft.	376	363	478	851	653	839	531	128	179	392
Surface Area											
Sediment Pool (Lowest Ungated Outlet)	Acre	37	30	46	38	36	50	41	10	9	28
Sediment Pool (Principal Spillway Crest)	Acre	37	30	46	56	37	65	46	10	9	28
Retarding Pool	Acre	88	72	101	128	102	149	94	26	25	70
Principal Spillway Design											
Rainfall Volume (Areal)(1-Day)	Inch	8.05	8.05	8.00	8.00	8.00	8.00	8.00	8.05	8.15	8.00
Rainfall Volume (Areal)(10-Day)	Inch	13.35	13.35	13.30	13.30	13.30	13.30	13.30	13.35	13.60	13.30
Runoff Volume (10-Day)	Inch	8.78	8.82	8.68	8.50	8.65	8.50	8.66	9.00	9.23	8.82
Capacity (Maximum)	C.F.S.	55	18	42	51	32	50	31	10	10	23
Frequency Operation - Emergency Spillway	% Chance	3.7	3.8	4.0	4.0	4.0	4.0	4.0	3.8	3.3	4.0
Size of Conduit	Inch	24	18	24	24	18	24	18	18	18	18
Emergency Spillway Design											
Rainfall Volume (ESH)(Areal) 5/	Inch	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30	7.30
Runoff Volume (ESH)	Inch	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	80	60	100	150	100	140	100	40	50	60
Velocity of Flow (V_e)	Ft./Sec.	0.9	2.0	0	1.3	0	0	1.2	0	0	0
Slope of Exit Channel	Ft./Ft.	0.033	0.037	0.043	0.026	0.068	0.029	0.058	0.053	0.071	0.037
Maximum Reservoir Water Surface Elevation	Ft.	509.8	503.7	479.0	447.7	415.0	516.0	489.2	494.2	481.9	513.1
Freeboard Design											
Rainfall Volume (FH)(Areal) 5/	Inch	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Runoff Volume (FH)	Inch	12.65	12.65	12.65	17.65	12.65	12.65	12.65	12.65	12.65	12.65
Maximum Reservoir Water Surface Elevation	Ft.	513.1	506.8	482.5	451.4	419.4	519.8	492.8	497.3	485.3	517.2
Capacity Equivalents											
Sediment Volume	Inch	2.00	2.43	2.10	2.02	1.79	2.11	2.49	2.22	2.28	1.68
Regarding Volume	Inch	4.80	5.77	5.00	5.33	5.70	5.37	5.46	5.33	5.50	5.52

(See footnotes at end of table.)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - Continued
Elm Creek Watershed, Texas

ITEM	UNIT	STRUCTURE NUMBER 31	32	33	34	35	36	37	38	39	40
Class of Structure		A	A	A	A	A	A	A	A	A	A
Drainage Area (Total)	Sq. Mi.	0.54	2.58	0.58	12.68	0.60	1.69	2.09	1.73	6.23	28.29
Controlled		-	-	-	-	-	-	-	-	-	6.21
Curve No. (1-Day)(AMC II)		82	82	82	83	82	82	82	82	82	82
TC	Hr.	0.47	0.91	0.51	3.86	0.86	1.24	0.95	0.96	1.73	4.90
Elevation Top of Dam	Ft.	491.2	423.1	429.6	410.8	398.2	393.4	386.1	377.2	516.5	410.2
Elevation Crest Emergency Spillway	Ft.	488.5	419.3	427.0	404.5	395.0	388.5	382.0	373.5	511.5	403.5
Elevation Crest Principal Spillway	Ft.	480.2	411.3	420.7	380.8	382.5	374.6	369.1	361.1	500.5	387.5
Elevation Crest Lowest Ungated Outlet	Ft.	480.2	408.2	420.7	375.7	382.5	369.4	368.6	361.1	494.8	377.2
Maximum Height of Dam	Ft.	26	27	24	50	32	43	37	35	11	44
Volume of Fill	Cu. Yds.	42,500	115,700	50,200	296,200	44,600	144,300	81,500	91,900	168,000	311,900
Total Capacity 2/	Ac. Ft.	214	1,121	274	4,666	228	1,467	860	665	2,689	9,126
Sediment (100 Years)	Ac. Ft.	53	354	100	446	55	406	225	176	570	1,802
Sediment Submerged 3/	Ac. Ft.	49	326	92	412	51	374	207	162	523	1,637
Sediment Aerated	Ac. Ft.	4	28	8	34	4	32	18	14	47	165
Sediment Pool (Lowest Ungated Outlet)	Ac. Ft.	49	4/ 200	92	4/ 200	51	4/ 200	4/ 200	162	4/ 200	4/ 200
Retarding 2/	Ac. Ft.	161	767	174	4,220	173	1,061	635	489	2,119	7,324
Surface Area											
Sediment Pool (Lowest Ungated Outlet)	Acre	12	42	19	37	9	32	31	24	42	62
Sediment Pool (Principal Spillway Crest)	Acre	12	64	19	72	9	49	12	24	95	248
Retarding Pool	Acre	28	140	39	316	20	109	72	61	310	754
Principal Spillway Design											
Rainfall Volume (Areal)(1-Day)	2neh	8.05	8.00	8.05	8.40	8.00	8.00	8.20	8.05	9.15	8.70
Rainfall Volume (Areal)(10-Day)	Inch	33.35	13.30	13.40	13.90	13.30	13.30	13.60	13.35	15.20	14.78
Runoff Volume (10-Day)	Inch	9.00	8.59	9.04	8.50	8.95	8.41	8.91	8.69	9.83	8.88
Capacity (Maximum)	C.F.S.	10	39	11	124	12	60	35	33	104	140
Frequency Operation - Emergency Spillway	% Chance	3.8	4.0	3.7	2.9	4.0	4.0	3.4	3.8	1.8	2.0
Size of Conduit	Inch	18	30	18	30	18	30	18	18	30	48
Emergency Spillway Design											
Rainfall Volume (ESH)(Areal) 5/	Inch	7.30	7.30	7.30	7.19	7.30	7.30	7.30	7.30	10.20	9.57
Runnfl Volume (ESH)	Inch	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	7.97	7.37
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	60	140	60	300	70	170	120	130	200	350
Velocity of Flow (Ve)	Ft./Sec.	0	2.2	0	5.7	0	2.5	0	0	5.9	8.0
Slope of Exit Channel	Ft./Ft.	0.045	0.044	0.042	0.043	0.115	0.100	0.089	0.111	0.041	0.050
Maximum Reservoir Water Surface Elevation	Ft.	488.0	419.8	427.0	406.1	394.4	388.9	381.8	373.1	513.4	406.3
Freeboard Design											
Rainfall Volume (FH)(Areal) 5/	Inch	15.00	35.00	15.00	14.78	15.00	15.00	15.00	15.00	17.00	15.98
Runoff Volume (FH)	Inch	12.65	12.65	12.65	12.58	12.65	12.65	12.65	32.65	14.62	13.61
Maximum Reservoir Water Surface Elevation	Ft.	491.2	423.1	429.6	410.8	398.2	393.4	386.1	377.2	516.5	410.2
Capacity Equivalents											
Sediment Volume	Inch	1.84	2.57	3.22	0.66	1.72	2.06	2.02	1.91	1.72	1.53
Retarding Volume	Inch	5.57	5.58	5.63	6.24	5.40	5.39	5.69	5.30	6.40	6.22

(See footnotes at end of table.)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - Continued
Elm Creek Watershed, Texas

ITEM	UNIT	STRUCTURE NUMBER 41	42	43	44	45	TOTAL
Class of Structure		A	A	A	A	B	xxx
Drainage Area (Total)	Sq. Mi.	1.25	7.48	1.18	9.59	2.20	150.97
Contcolled		-	-	-	-	-	xxx
Curve No. (1-Day)(AMC II)		82	82	82	82	82	xxx
TC	Hr.	1.44	2.16	1.01	3.40	0.83	xxx
Elevation Top of Dam	Ft.	377.6	401.3	373.0	360.9	355.0	xxx
Elevation Crest Emecgency Spillway	Ft.	374.0	396.0	369.3	354.5	350.0	xxx
Elevation Crest Principal Spillway	Ft.	364.3	384.2	358.7	340.8	337.8	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	364.3	378.3	358.7	332.2	337.8	xxx
Maximum Height of Dam	Ft.	26	35	33	35	32	xxx
Volume of Fill	Cu. Yds.	78,700	200,000	77,100	256,200	78,400	5,137,250
Total Capacity 2/	Ac. Ft.	456	2,761	505	3,867	857	61,852
Sediment (100 Years)	Ac. Ft.	110	574	140	926	156	13,812
Sediment Submerged 3/	Ac. Ft.	101	527	129	854	143	12,675
Sediment Aerated	Ac. Ft.	9	47	11	72	13	1,137
Sediment Pool (Lowest Uogated Outlet)	Ac. Ft.	101	4/ 200	129	4/ 200	143	6,671
Retarding 2/	Ac. Ft.	346	2,187	365	2,941	701	48,040
Surface Area							
Sediment Pool (Lowest Ungated Outlet)	Acre	20	37	21	44	30	6/ 1,395
Sediment Pool (Principal Spillway Crest)	Acre	20	98	21	130	30	2,274
Retarding Pool	Acre	55	298	55	321	95	6,106
Principal Spillway Design							
Rainfall Volume (Areal)(1-Day)	Inch	8.15	8.20	8.00	8.05	9.20	xxx
Rainfall Volume (Areal)(10-Day)	Inch	13.50	13.55	13.30	13.35	15.20	xxx
Runoff Volume (10-Day)	Inch	8.96	8.36	8.86	8.19	10.29	xxx
Capacity (Maximum)	C.F.S.	30	108	18	107	61	xxx
Frequency Operation - Emergency Spillway	% Chance	3.6	3.4	4.0	3.8	1.8	xxx
Size of Conduit	Inch	18	30	18	30	24	xxx
Emergency Spillway Design							
Rainfall Volume (ESH)(Areal) 5/	Inch	7.30	7.30	7.30	7.30	10.20	xxx
Runoff Volume (ESH)	Inch	5.20	5.20	5.20	5.20	7.97	xxx
Type		Veg.	Veg.	Veg.	Veg.	Vog.	Vag.
Bottom Width	Ft.	80	200	80	200	170	xxx
Velocity of Flow (Ve)	Ft./Sec.	0	2.9	3.2	6.8	5.3	xxx
Slope of Exit Channel	Ft./Ft.	0.063	0.049	0.086	0.056	0.044	xxx
Maximum Reservoir Water Surface Elevation	Ft.	373.7	396.7	369.9	356.4	351.4	xxx
Freeboard Design							
Rainfall Volume (FH)(Areal) 5/	Inch	15.00	15.00	15.00	15.00	22.10	xxx
Runoff Volume (FH)	Inch	12.65	12.65	12.65	12.65	19.67	xxx
Maximum Reservoir Water Surface Elevation	Ft.	377.6	401.3	373.0	360.9	355.0	xxx
Capacity Equivalents							
Sediment Volume	Inch	1.64	1.44	2.23	1.81	1.33	xxx
Retarding Volume	Inch	5.19	5.48	5.80	5.75	5.97	xxx

1/ Two separate principal spillways are required.
2/ Crest of emergency spillway.
3/ Includes volume in sediment pool (lowest ungated outlet).
4/ Volume includes antitipated borrow to be excavated below lowest ungated outlet elevation. This borrow volume is not included in the submerged sediment.
5/ Storm duration in six hours.
6/ The use of the sediment atocago in floodwater retarding structures Nos. 1 and 40 to augment the downstrexm low flows will crcate an additional 381 acres of surface watet for a total of 1,776 acres.

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TABLE 4 - ANNUAL COST

Elm Creek Watershed, Texas

(Dollars)[1/]

Evaluation Unit	Amortization of Installation Cost[2/]	Operation and Maintenance Cost	Total
45 Floodwater Retarding Structures	256,940	12,100	269,040
Project Administration	35,070	xxx	35,070
GRAND TOTAL	292,010	12,100	304,110

1/ Price Base: 1974
2/ 100 years at 5.875 percent interest

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Elm Creek Watershed, Texas
(Dollars)[1/]

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefit
Floodwater			
Crop and Pasture	241,410	81,960	159,450
Other Agricultural	185,130	63,330	121,800
Nonagricultural			
Road and Bridge	26,330	3,860	22,470
Subtotal	452,870	149,150	303,720
Sediment			
Overbank Deposition	29,880	8,510	21,370
Erosion			
Flood Plain Scour	38,520	9,460	29,060
Streambank	880	220	660
Valley Trenching	4,380	1,140	3,240
Subtotal	43,780	10,820	32,960
Indirect	53,970	17,040	36,930
TOTAL	580,500	185,520	394,980

1/ Price Base: Current normalized prices for agricultural damages and 1974 prices for nonagricultural damages.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Elm Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS[1]						Average Annual Cost[3]	Benefit-Cost Ratio
	Damage Reduction	More Intensive Land Use	Incidental Livestock Water	Other[2]	Secondary	Total		
45 Floodwater Retarding Structures	361,020	33,100	4,260	19,720	157,530	575,630	269,040	2.1:1.0
Project Administration	xxx	xxx	xxx	xxx	xxx	xxx	35,070	xxx
GRAND TOTAL	[4] 361,020	33,100	4,260	19,720	157,530	575,630	304,110	1.9:1.0

1/ Price Base: Current normalized prices for agricultural damages and 1974 prices for nonagricultural damages.
2/ Benefits accruing to structural measures outside project area on Little River.
3/ From table 4
4/ In addition, it is estimated that planned land treatment measures will provide flood damage reduction benefits of $33,960 annually.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment measures for the watershed was developed by directors of the Central Texas and the McLennan County Soil and Water Conservation Districts, with the assistance of Soil Conservation Service personnel headquartered at Waco, Temple, Rosebud, snd Cameron, Texas. Representative soil and water conservation plans were analysed both in the office and on the land. The findings were expanded for the entire watershed.

This analysis provided pertinent data on total conservation needs, accomplishments to date, and remaining needs, and was used in the establishment of priorities for planning, application, and maintenance of needed land treatment measures.

The funds for accelerated technical assistance represent the difference in the amount of funds now being expended and those which will be required to meet the project goal of the application of 80 percent of all needed land treatment by the end of the 10-year installation period.

Engineering Investigations

The procedures used to develop the most feasible plan of structural measures to meet the objectives of the sponsoring local organizations that could not be accomplished by land treatment measures were as follows:

1. Possible sites for structural measures that would accomplish project objectives were found by use of topographic maps and aerial photographs, supplemented with field investigations. Preliminary studies were made to determine the physical feasibility and involvement of land and improvements and to provide data for laying out field surveys.

2. Surveys - Engineering surveys were made after preliminary agreement was reached with the sponsoring local organizations on the sites to be studied for potential structural measures. Property lines and ownership of the land involved were furnished by the sponsors.

    a. Vertical control - Existing U. S. Geological Survey and U. S. Coast & Geodetic Survey bench marks were supplemented with temporary bench marks set at atrategic locations for use in making surveys.

    b. Floodwater retarding structures - Field surveys were made in two stages. First, topographic maps of possible sites

were prepared. Roads, utility lines, and miscellaneous improvements located within the reservoir areas were surveyed. Second, after preliminary designs and layouts of the floodwater retarding structures that would be feasible to install were reviewed and accepted by the sponsors, detailed topographic surveys of the emergency spillway areas were made. A profile survey of the centerline of each dam site was made. These surveys provided the data necessary to determine the most economical and feasible design, to make estimates of the installation cost, and to prepare the land rights work maps. Procedures outlined in current Soil Conservation Service watersheds memoranda were used in making all surveys.

3. Designs - Design of structural measures was a continuous process during work plan development. Designs were made of individual or related groups of structures as information was collected and surveys were completed. Classification for limiting design criteria of the potential sites for floodwater retarding structures was made considering the damages that might result from a sudden breach of the earth embankment. Site 1 was given a "c" classification due to the proximity of Interstate Highway 35. Sites 5, 6, and 7 were given a "b" classification due to the proximity of State Highway 53. A breach of these structures could pose a potential flood hazard to this road. Sites 8 and 9 were given a "b" classification due to the proximity of the Atchison, Topeka, and Santa Fe Railway. A breach of either of the embankments might cause damage to the railroad tracks. Site 10 was given a "b" classification because a breach of the embankment could cause minor flooding of a house. Site 45 was given a "b" classification because a breach of the structure could cause flooding of U. S. Highway 190. The remaining structure sites were given an "a" classification because damages would be limited to agricultural lands, county roads, and farm-to-market roads in the event of a structural failure.

Hydrologic criteria used in design of the floodwater retarding structures equal or exceed the criteria specified in Engineering Memorandum-27 (Revised), Earth Dams, UDSA, SCS, March 1965. Procedures outlined in chapter 21, National Engineering Handbook, Section 4, Hydrology, USDA, SCS, August 24, 1972, and Technical Release No. 33, Simplified Method for Determining Floodwater Retarding Storage, USDA, SCS, August 1966, were used to determine floodwater retarding capacity requirements and hydrograph development. For each structure, the appropriate spillway design and freeboard storms were flood routed to determine the elevation of the emergency spillway, dimensions of the emergency spillway, and elevation of the top of dam.

The cost of class "a" structures 12, 34, 40, and 44 exceeds $110,000. Hydrologic criteria approaching that required for

class "b" structures were used. The freeboard hydrograph storm was increased from 10.00 inches to 15.00 inches for Sites 12 and 44, to 14.78 inches for Site 34, and to 15.98 inches for Site 40. The emergency spillways were proportioned so that they will pass the emergency spillway hydrograph storm runoff at less than permissible velocity, thus approaching class "b" structure requirements.

A detailed study was made to determine the most feasible and economical means to evacuate the floodwater retarding pools. The basic objective was to evacuate the pools as soon as possible without the principal spillway discharges causing adverse impacts downstream. Three principal spillway flow conditions were considered. One was full pipe flow from the principal spillways. The second was modifying principal spillway discharges by use of two stage inlets with the higher stage above the sediment pool elevation. The third condition considered was limiting principal spillway discharges by use of constriction plates. Both full pipe flow and the use of two stage inlets with the higher stage above the sediment pool elevation produced discharges that would cause out-of-bank flow downstream and result in significant damages to cropland. The use of constriction plates to limit principal spillway discharges at specific sites and allowing full pipe flow at the remaining sites was determined to be the most feasible and economical combination for evacuating the retarding pools.

The emergency spillways for Sites 1, 7, 34, and 40 were also designed to meet the requirements presented in Technical Release No. 52, A Guide for Design and Layout of Earth Emergency Spillways As Part of Emergency Spillway Systems for Earth Dams, USDA, SCS, February 1973. The drainage area for each of these sites exceeds 10 square miles. The topography at Site 1 is such that a single spillway located on either abutment would not have sufficient longitudinal bulk to meet the requirements. An erosion control barrier built into the exit channel of the one spillway or two spillways, one on each abutment, would be required. It was decided to design the emergency spillway with the barrier since this achieved a more feasible and economical design and layout.

4. Construction costs for the structural measures were based on current unit prices being expended at similar sites, experience, and values furnished by local organizations and utility companies.

   Annual operation and maintenance costs were estimated considering such costs as fertilization, reestablishment and maintenance of vegetation, weed control, and frequency of use of the emergency spillways. Current (1974) prices were used.

Hydraulic and Hydrologic Investigations

Rainfall frequency data were obtained from Rainfall Frequency Atlas for the United States.[1/]

The present hydrologic conditions were determined from an 8 percent sampling of soil and cover complex conditions. The antecedent moisture condition II curve number for the watershed was computed to be 82.

The area subject to damage from flooding was determined by studies of aerial photographs, U. S. Geological Survey quadrangle sheets, and field interviews with local residents.

Engineering surveys were made of 169 valley cross sections, to represent stream hydraulics and flood plain area. The needs of the economist and the geologist were considered in the selection of these sections.

Rating curves were developed for each valley cross section to show the relation between area inundated and stage, discharge, and frequency. Water surface profiles were developed by using the Water Surface Profile Program, Automatic Data Processing Unit, South Regional Technical Service Center.

Flood routing for evaluation of damages were determined by use of the computer, using the project formulation program outlined in Technical Release No. 20, Computer Program for Project Formulation - Hydrology, USDA, SCS, May 1965. The relationship of peak discharge was determined at each proposed floodwater retarding structure site and at each valley cross section by routing the runoff of the 24-hour, 5-year frequency rainfall, using antecedent moisture condition II. A study of the rainfall runoff relationship indicates that the discharges resulting from these flood routings should be adjusted for areal rainfall and an average antecedent moisture condition less than II. The average condition curve number for the watershed area should be about 76. From a relationship of runoff to discharge at each section, the discharge associated with various frequency floods was determined.

Reservoir operation studies were made to determine the effects of evaporation, seepage, and demand. Basis for input data used in water budget studies were:

1. RAINFALL - Cameron and Temple U. S. Weather Bureau monthly rainfall records.[2/]

1/ U. S. Department of Commerce, Rainfall Frequency Atlas for the United States, U. S. Weather Bureau Technical Paper No. 40, Washington, D. C., May 1961.

2/ U. S. Department of Commerce, Environmental Science Service Administration, Climatological Data, Washington, D. C.

2. RUNOFF - U. S. Geological Survey Gage Data for Aquilla Creek near Aquilla, Texas.3/

3. EVAPORATION - Texas Board of Water Engineers' Bulletin 6006, with adjustments for effects of solar radiation, wind, dew point, and air temperature.4/

Sedimentation Investigations

Sedimentation investigations were made as follows:

1. The 100-year sediment storage requirements for all floodwater retarding structures were made according to procedures outlined in Technical Release No. 12 (Revised), Sediment Storage Requirements for Reservoirs, USDA, SCS, January 1968. The following field and office studies were made:

   a. Erosion rates for the watershed were developed from an 8 percent sampling of the uplands. Sampled data on soil, slope, cover, and treatment conditions were tabulated and summarized within topographically similar soils areas. The Musgrave soil loss equation was used to arrive at estimated gross sheet erosion rates within each of these areas. Streambank erosion rates were calculated from data obtained in field and aerial photograph study.

   b. The estimated gross erosion occurring within the drainage area of each structure was adjusted to reflect the estimated delivery ratio and the trap efficiency of each reservoir. Sediment delivery ratios determined from sediment surveys of existing reservoirs in the Blackland Prairies Land Resource Area were used to estimate the sediment delivery relation for each of the planned structures. The trap efficiency was estimated to be 90 percent for the dominantly clayey sediment.

   c. Allowances for differences in density of aerated and submerged sediment are based on an average weight of 82 pounds per cubic foot for completely aerated sediment to 51 pounds per cubic foot for submerged sediment.

   d. Allocation of sediment in the structure pools for 100 years is as follows:

3/ U. S. Department of the Interior, Geological Survey, Water Resources Data for Texas, Part 1, Surface Water Records, Austin, Texas.

4/ Texas Board of Water Engineers, Monthly Reservoir Evaporation Rates Rates for Texas, Austin, Texas, May 1960.

Pool	Condition	Percent by Weight
Sediment	Submerged	87.5
Detention	Aerated	12.5

2. Sediment and erosion damage investigations on the flood plain were made by the valley cross section sampling method. Information pertaining to changes in the stream channel system caused by filling of the old channels and new channel formation caused by valley trenching was obtained by comparing photographs of the same area taken at different dates. Streambank erosion damage was investigated by field study supplemented by study of aerial photographs.

   All sources of material causing or contributing to the sediment damages on the flood plain and their damage potential were weighted to establish the relative importance of each of these sources. This information served as a guide in evaluating the effects of the project on damage reduction.

3. The sediment load carried out of the watershed was estimated by applying a delivery ratio of 24 percent to the gross erosion under existing conditions and with applied additional land treatment. A delivery ratio of 28 percent was used to estimate the sediment load which will be carried out of the watershed under with project conditions from the uncontrolled watershed area after installation of the floodwater retarding structures.

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the floodwater retarding structure sites. These investigations included studies of valley slopes, alluvium, and exposed geologic formations.

Sites 2, 3, 8, 9, 10, and 11 are located on moderately soft to moderately hard shaly limestone of the Austin Chalk formation of upper Cretaceous age. All other planned floodwater retarding structure sites are located on soft shale bedrock of the Upper Cretaceous and Eocene ages.

The location of all sites in relation to geologic unit(s) is as follows:

Stratigraphic Location of Floodwater Retarding Structures

UPPER CRETACEOUS						EOCENE
		("lower Taylor marl")		("upper Taylor marl")		
South Bosque Formation	Austin Chalk	Ozan Formation	Pecan Gap Chalk	Marlbrook Marl	Neylandville Formation	Midway Group
1	2	4	23	24	37	45
	3	6	25	28	38	
	5	7	26	29	43	
	8	12	27	32	44	
	9	13	30	33		
	10	14	31	34		
	11	15	39	35		
		16		36		
		17		40		
		18		41		
		19		42		
		20				
		21				
		22				

The structure of the formation is simple with dip to the southeast of less than 100 feet per mile. Faulting associated with the inactive Balcones Fault System occurs within the project area. Faults lying at right angles to the trends of the valleys occur either immediately upstream or downstream or both upstream and downstream from Sites 1, 3, 4, and 14. Faults lying parallel with the trend of the valleys occur at Sites 14 and 32.

Detailed investigations, including exploration with core drilling equipment, will be made at each floodwater retarding structure site prior to construction to determine the suitability and methods of handling foundation and embankment materials.

Economic Investigations

Basic methods used in economic investigations and analyses are outlined in the Economics Guide for Watershed Protection and Flood Prevention, U. S. Department of Agriculture, Soil Conservation Service, March 1964.

Selection of Evaluation Reaches

Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into 15 reaches. Agricultural damages occur in all the reaches, while 13 reaches austain road and bridge damages.

Determination of Damages

All damages were calculated by using the frequency method. Owners and operators of flood plain lands were interviewed to obtain information relative to past, present, and future land use; crop distribution under normal conditions; planting dates, harvesting dates, and yields; and historical data on flooding and resultant damages to crops and pastures, as well as to other agricultural property. The land use of the entire flood plain was obtained by field mapping.

Crop and pasture damages were determined by applying damage rates by depth and season to the acres inundated by selected frequency storms to obtain an average annual damage for each reach. This computed damage was discounted for recurrent flooding with allowance for partial recovery of crops between floods.

Other agricultural damages to fences and farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected in the field and correlated with area and depth of flooding.

Road and bridge damages were based on information obtained from county commissioners and state highway department officials, supplemented by information gathered from local residents.

The monetary value of the physical damage from overbank deposition and flood plain scouring was based on the loss in productivity for various degrees of damage as determined by field sedimentation and scouring studies.

The monetary value of damage from streambank erosion and valley trenching was based on the expected net returns per acre foregone as a result of the land being permanently damaged and the depreciation of adjacent lands.

Indirect damages were estimated to amount to 10 percent of direct damages in all categories except for road and bridge damages which were estimated at 15 percent of direct damages.

More Intensive Land Use Benefits

More intensive management is expected on about 1,650 acres of pasture-land as the result of reduced flooding following project inatallation. The net benefits, after deducting associated costs and additional damage to higher values, will result from the production of a greater amount of palatable forage. The expected monetary benefits were discounted to allow for a lag in accrual of full level benefits.

Benefits Outside Project Area

Benefits will accrue to the structural measures in the watershed from reduced flooding along the Little River between the watershed and the Brazos River. Average annual damages along the Little River were obtained from "Flood Damage Study (Work Assignment 11.2)" by the Corps of Engineers, April 1961. Agricultural damages were converted to current normalized prices and nonagricultural damages were up-dated to current prices. The reduction of remaining damages was based on percentage of total drainage area controlled by the planned structural measures.

Livestock Water Benefits

Livestock water benefits are expected to accrue to landowners with access to pools of floodwater retarding structures. These benefits were calculated to be equivalent to the cost of a farm pond amortized for 20 years plus an operation and maintenance cost. These benefits were discounted to allow for full level of use during the firat 40 years with a gradual diminishing of use during the next 10 years to zero at the end of 50 years and thereafter.

Secondary Benefits

Secondary benefits were estimated by an adaptation of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in the "Input-Output Model of the North Central Region of Texas," which was developed as part of the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, April, 1972.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. A comparison of the net value of agricultural production loat in the sites and pool areas as a result of the project to the amortized value of the

easements, determined by local appraisal giving full consideration to current real estate market values, showed the latter to be greater. The value of the easements was, therefore, used in the economic investigations. The value of production lost in the sites and pool areas was used in the calculation of secondary losses.

Archeological and Historical Investigations

A survey of the prehistoric and historic archeological resources was carried out by the Archeology Research Program of Southern Methodist University under funding by the Soil Conservation Service. The National Park Service, the agency which is responsible for archeological resources, was unable to make this reconnaissance.

The survey consisted of gathering together information on known prehistoric Indian sites within the watershed and the recording of previously unrecorded prehistoric sites. The areas to be affected by the floodwater retarding structure sites were visited and examined during the course of making this survey. As a result of this survey, six previously unrecorded archeological sites were discovered but only one site was found to occur within the areas to be affected by floodwater retarding structures. A detailed study of this site showed that it had been disturbed by farming operations and that salvage of archeological materials was not warranted.

Fish and Wildlife Resource Investigations

The Fish and Wildlife Service, USDI, in cooperation with the Texas Parks and Wildlife Department and the Soil Conservation Service, made a reconnaissance study of Elm Creek watershed. This report, along with a detailed biological study conducted by a Soil Conservation Service biologist during the development of the project plan, was used in an interdisciplinary approach to planning for the conservation and development of the fish and wildlife resources in the watershed.

Detailed data on fish and wildlife habitat conditions on the agricultural lands in the watershed were developed by making a detailed study on an 8 percent sample of the uplands. A less detailed, reconnaissance-type survey of the flood plain was made to determine vegetative composition. Results from these studies were summarized for the watershed to arrive at acreages and quality of the various types of wildlife habitat, major factors limiting the agricultural land for wildlife habitat, and the miles of stream fisheries.

The following table outlines optimum land use composition ratings for six indicator wildlife species:

Wildlife Species	Land Use (Percent)			
	Cropland	Pastureland	Rangeland	Woody Canopy
Quail	30-55	0-25	25-50	20
Dove	50-100	0-25	0-30	0-10
Rabbit	10-25	------ 50-65 ------		25
Raccoon	10-50			50-90
Squirrel	------- 0-5 --------			95-100

Obvious factors limiting wildlife increases that were evaluated included food and cover quality, interspersion, water, travel lanes, and lack of adequate vegetative types. Land use composition was rated good if each of the types indicated in the table were present within 75 to 100 percent of the proportions given. Fair ratings were given where one or more of the types were present within 25 to 74 percent of the proportions given and the others were 75 to 100 percent. Poor ratings were given where one or more of the types were present within 1 to 24 percent of the proportions given. The rating of squirrel habitat was restricted to that portion of the watershed which is wooded.

Data on wildlife populations were obtained from biologists of the Texas Parks and Wildlife Department.

A field reconnaissance survey of each floodwater retarding structure site was made to determine vegetative composition. The information was recorded on aerial photographs and overlays.

Each floodwater retarding structure sediment pool was checked for average depth and presence of woody vegetation. Each site was rated according to this criteria as potential fisheries habitat. Good ratings were given to those sites having an average depth of three feet or greater and trees present. Fair ratings were given to those sites having an average depth of three feet or greater and having no trees present. Poor ratings were given to those sites having an average depth of less than three feet.

The Fish and Wildlife Service made seven recommendations for enhancing the fishery resources and minimizing the losses of wildlife habitat. These recommendations have been incorporated into the plans for the project as far as practicable and the sponsors had the legal authority to implement.

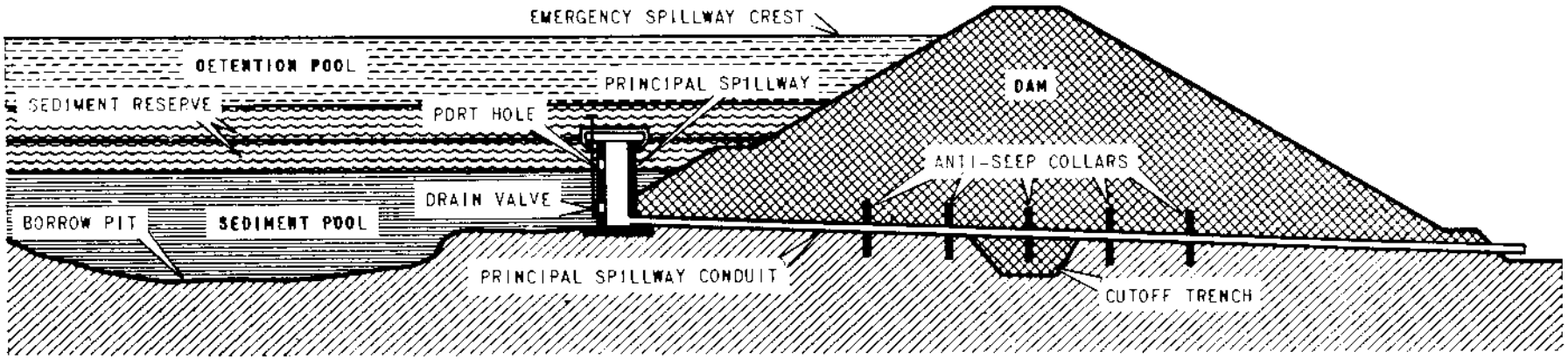
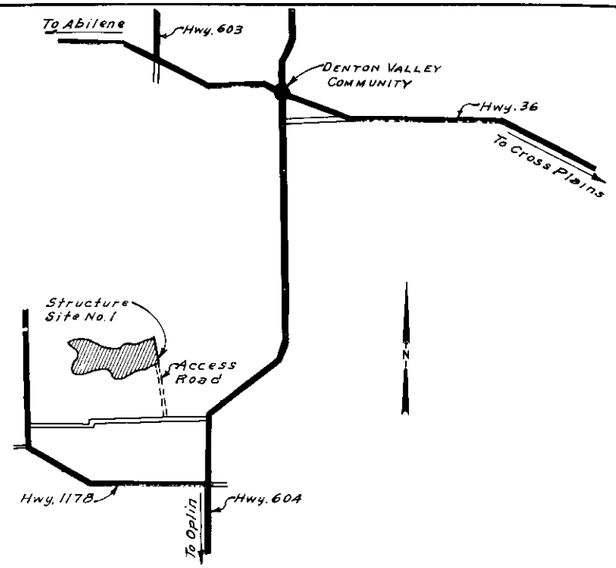


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

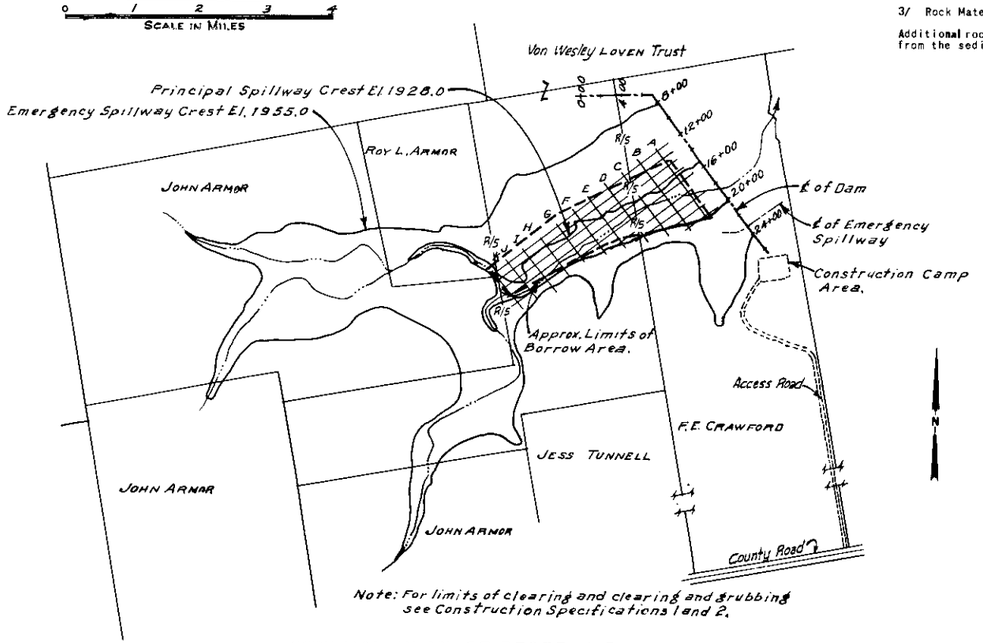


Structure site is located approx. 7 miles southwest of Denton Valley Community, Callahan County, Texas.

VICINITY MAP

0 1 2 3 4

SCALE IN MILES

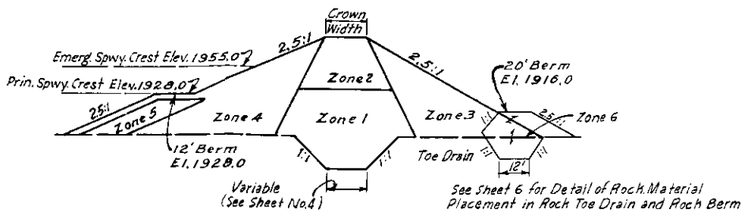


Note: For limits of clearing and clearing and grubbing see Construction Specifications 1 and 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET



See Sheet 6 for Detail of Rock Material Placement in Rock Toe Drain and Rock Berm

TYPICAL SECTION - ZONED EMBANKMENT

MATERIALS PLACEMENT DATA

Embankment Zone No. 1/	Source of Fill Materials: Material Location 2/	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test: Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test: Number	Method	Curue No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow	0	3	CL	D698	A or B	6"	9"	A	95	-2	+4	D698	A	5	101.5	20.5
	Borrow	0	6	CL	D698	A or B	6"	9"	A	95	-2	+3	D698	A	6	113.0	14.0
	Borrow	0	4	SC	D698	A or B	6"	9"	A	95	-1	+3	D698	A	3	116.5	13.0
2 & 3	Borrow	4	12	GC	D698	D	6"	9"	A	95	Opt.	+4	D698	C	2	130.0	7.0
4	Borrow	0	7	SM	D698	A or B	6"	9"	A	95	-1	+4	D698	A	4	121.5	11.0
5	Borrow	0	4	SM	D698	A or B	6"	9"	A	95	Opt.	+4	D698	A	1	116.0	11.5
2 B 3	Emerg. Spwy.	0	Grade	GC	D698	0	6"	9"	A	95	Opt.	4	Not Testad				
6	3/	Durable Rock					24"	36"									

1/ The zone boundaries shown in the typical section are approximate. Adjustments will be made by the Engineer to permit the use, within the neat lines of the embankment, of all suitable materials from the required excavations.

2/ Materials from the required excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials under Materials Placement Data.

3/ Rock Material to be used for the Rock Toe Drain, Berm, and Channel linar shall be procured from required excavations.

Additional rock materials required in excess of that obtained from specified excavations shall be combed, raked or otherwise haruested from the sediment pool, detention pool, or surrounding areas. (See Construction Specification 51.

ZONED EMBANKMENT DATA

All usable material from within the sediment pool shall be used prior to enlarging borrow area outside these limits. Borrow from outside the sediment pool shall be obtained only as directed by the Engineer.

Elevation	Surface Acres	Storage: Acre Feet	Inches
1918	1	3	.0
1920	3	11	.02
1924	9	35	.05
1928	13	79	.12
1932	22	149	.23
1934.1	27	207	.32
1936	32	257	.40
1940	47	415	.65
1944	71	651	1.01
1948	96	985	1.53
1952	130	1437	2.24
1955	155	1864	2.90
1956	163	2023	3.15
1960	197	2743	4.27
1962.1	221	3182	4.95
1964	243	3623	5.64

Top of Dam (Effective) Elev.	1962.1
Emergency Spillway Crest Elev.	1955.0
Principal Spillway Crest Elev.	1928.0
Sediment Pool Elev.	1928.0
Drainage Area, Acres	7706.
Sediment Storage, Acre Feet	207.
Floodwater Storage, Acre Feet	1657.
Max. Emergency Spillway Cap., c.f.s.	10,820.

Figure 2

TYPICAL

FLOODWATER RETARDING STRUCTURE

GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

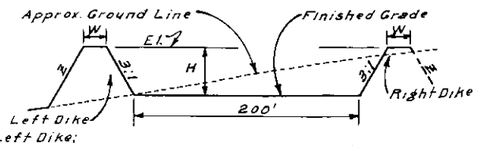
		Date
Designed	G.C.S.	4-66
Drawn	G.C.S.	4-66
Traced	T.F.R.	5-66
Checked	G.C.S.	5-66

Approved by: HEAD, ENGINEERING BRANCH, SCS, USDA, FORT WORTH, TEXAS

SCS, CONSERVATION ENGINEER, TEMPLE, TEXAS

Sheet No. 3 of 13

Drawing No. 4-E-21,594



Left Dike:
From Sta. 4+30 to Sta. 5+00-El.= 1962.2, W=16.0', Z= 2.5:1
From Sta 5+00 to Sta. 5+50 - a transition section.
From Sta. 5+50 to approx. Sta. 6+30-W=10.0', Z=3:1, H=4.5'.
Right Dike:
From Sta. 4+30 to Sta 5+00-El.= 1962.2, W=16.0', Z= 2.5:1
From Sta. 5+00 to Sta. 5+50 - transition to W=10.0', Z=3:1, H=4.5'.
Material forming dikes shall be placed and paid as "Earth Fill, Embankment".

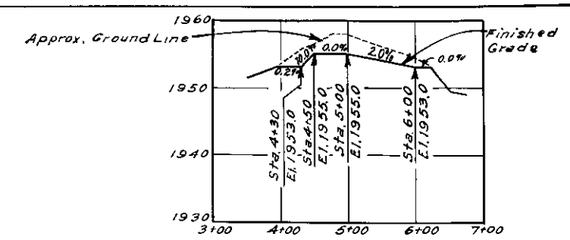
TYPICAL SECTION — EMERGENCY SPILLWAY

Emergency Spillway Diversions and Stub Diversions (S.D.): 18" effective height, 3:1 side slopes and 13 ft., minimum base, shall be constructed at the approximate locations shown on the plans. Final locations of the Stub Diversions shall be determined by the Engineer (See Construction Specification 5).

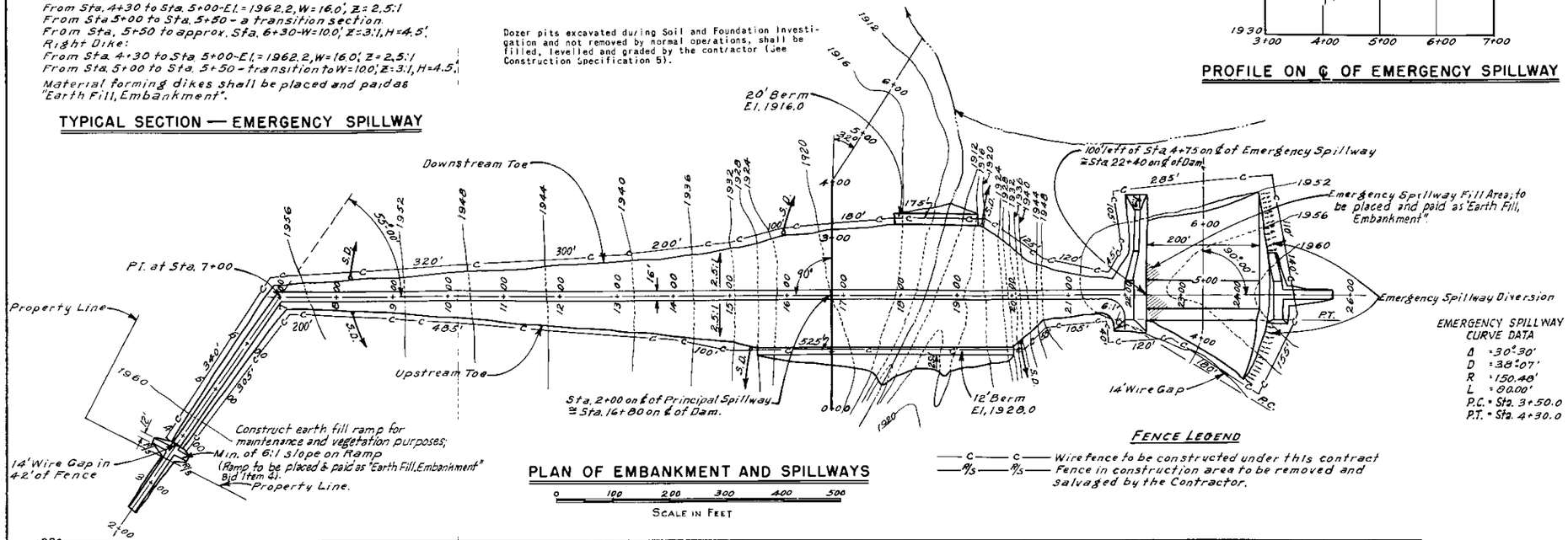
A minimum of 6" topsoil shall be placed in Emergency Spillway and on all Earth Fill Areas (See Construction Specification 20C).

Stream Channel within embankment area shall be shaped and cleared of objectionable material (see sheet 12 and Construction Specification 4).

Dozer pits excavated during Soil and Foundation Investigation and not removed by normal operations, shall be filled, levelled and graded by the contractor (See Construction Specification 5).



PROFILE ON ℄ OF EMERGENCY SPILLWAY



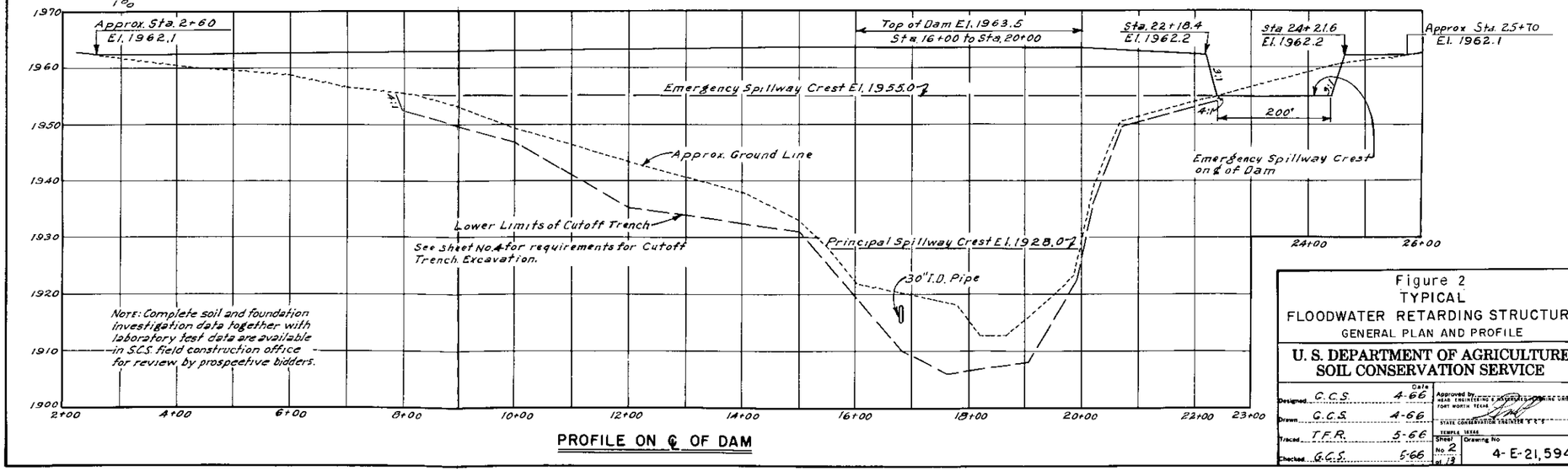
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

EMERGENCY SPILLWAY CURVE DATA
Δ = 30°30'
D = 38°07'
R = 150.48'
L = 80.00'
P.C. = Sta. 3+50.0
P.T. = Sta. 4+30.0

FENCE LEGEND

—C—C— Wire fence to be constructed under this contract
—R/S—R/S— Fence in construction area to be removed and salvaged by the Contractor.



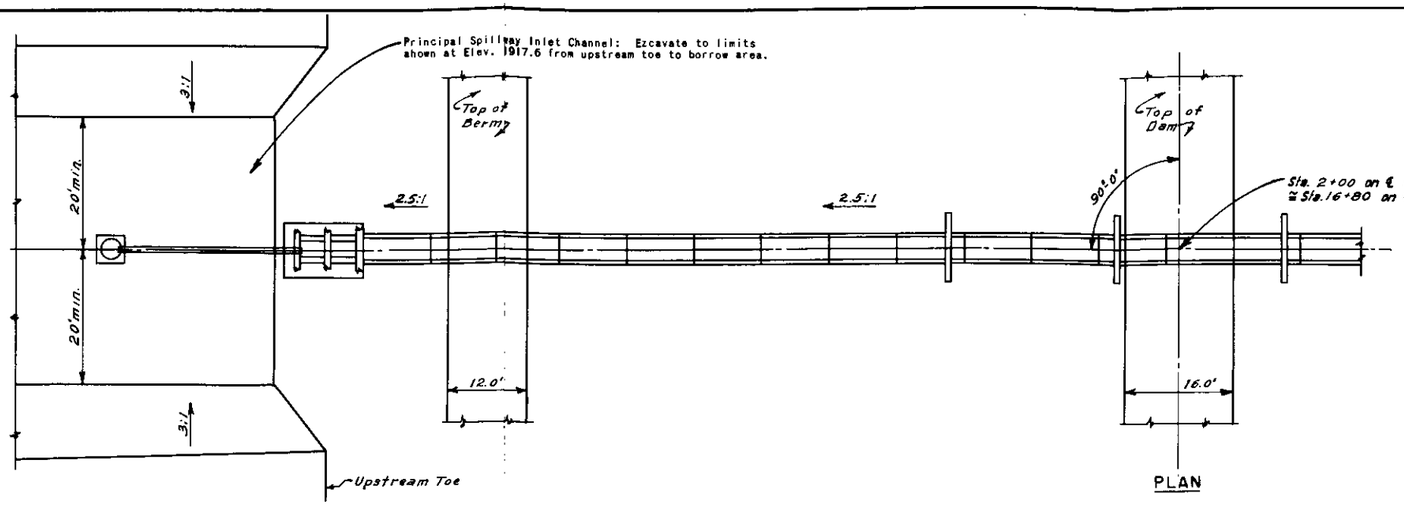
PROFILE ON ℄ OF DAM

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

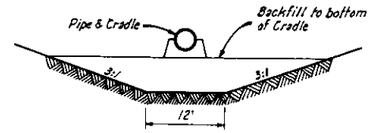
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	C.C.S.	4-66
Drawn	C.C.S.	4-66
Traced	T.F.R.	5-66
Checked	C.C.S.	5-66

Approved by: HEAD, ENGINEERING STANDARDS UNIT, FORT WORTH, TEXAS
STATE CONSERVATIONIST, TEMPLE, TEXAS
Sheet No. 2 of 13
Drawing No. 4-E-21,594



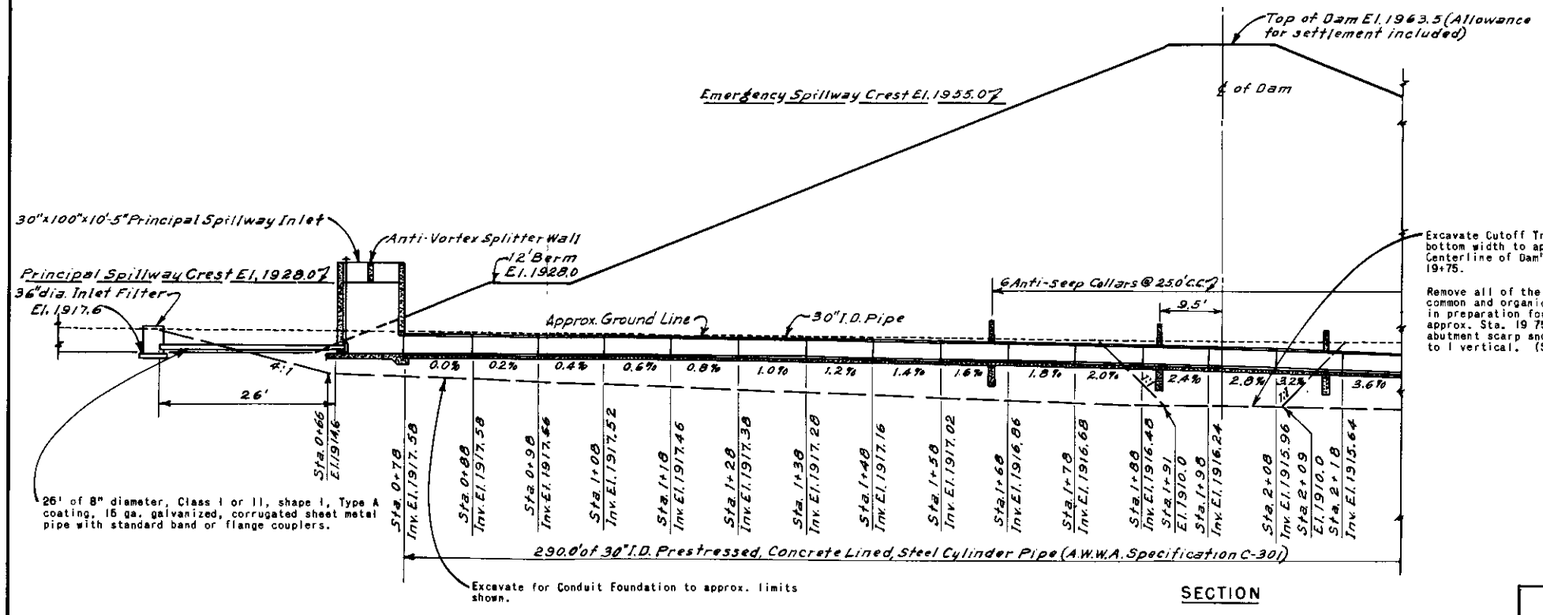
PLAN



Excavation to be paid as "Excavation, Unclassified".

Prior to placing backfill around the structure, the surface layer of the in-place fill material shall be reworked as necessary, and to the depth necessary, to restore and satisfy the density and moisture requirements specified for that fill material.

TYPICAL CONDUIT FOUNDATION EXCAVATION



SECTION

PRINCIPAL SPILLWAY

Excavate Cutoff Trench with 1:1 side slopes and 18 ft. bottom width to approximata limit shown on "Profile on Centerline of Dam" from Sta. 8+00 to approximate sta. 19+75.

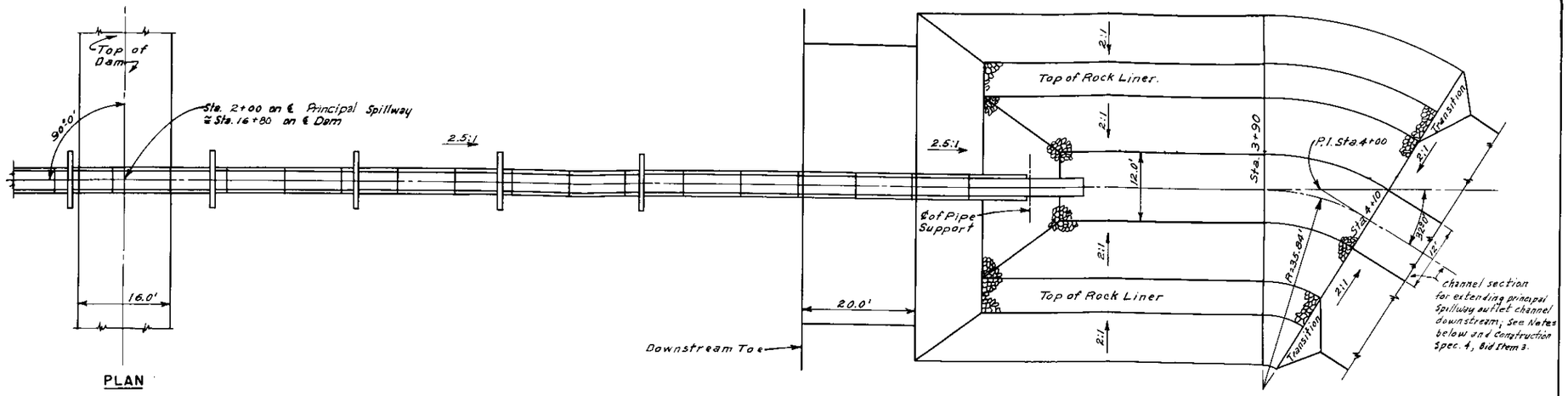
Remove all of the slide rock, boulders, flags, cobbles, common and organic material to hard unfragmented rock in preparation for base of dam on the right abutment, approx. Sta. 19 75 to Sta. 22 40. Remove the right abutment scarp and slope to not steeper than 2 horizontal to 1 vertical. (See Construction Spec. 4).

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

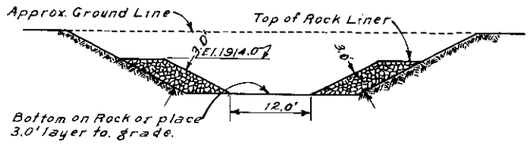
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	G. C. S.	4-66
Drawn	G. C. S.	4-66
Traced	T. F. R.	5-66
Checked	G. C. S.	5-66

Approved by
HDQS. ENGINEERING & SURVEYS TRAINING UNIT
FORT WORTH, TEXAS
STATE CONSERVATIONIST
TEMPLE, TEXAS
Sheet No. 4 of 13
Drawing No. 4-E-21,594



PLAN



SECTION

NOTE: Excavation for the Rock lined Channel shall be paid as "Excavation, Unclassified". Place a 3.0 ft. thickness of dumped rock to dimensions shown in the drawings with rock size grading from small at subgrade to large at finished grade. Placement of spalls and cobbles shall precede dumping of boulders. Rock material shall be placed to reasonably neat lines of the finished grade. Payment for placing rock fill in channel is not a separate item; such cost shall be considered "Earth Fill, Embankment" and paid for as such. Rock against Principal Spillway shall be placed so as to avoid damage to pipe and other structural works. See sheet 3 for sources of Rock Material.

SECTION

PRINCIPAL SPILLWAY

Figure 2A :
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.C.S.	Date 4-66	Approved by ... HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS	
Drawn G.C.S.	4-66		
Traced T.F.R.	5-66	TEMPLE, TEXAS	
Checked G.C.S.	5-66	Sheet No. 5 of 13	Drawing No. 4-E-21,594

Figure 3

PROBLEM LOCATION MAP

ELM CREEK WATERSHED

BELL, MILAM, FALLS, McLENNAN COUNTIES

TEXAS

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

Compiled from uncontrolled mosaic 4-R-13787

Approximate scale in miles 1:126,720

Approximate Area 207,360 Acres

PROJECTION UNKNOWN

LATITUDE AND LONGITUDE LINES ARE APPROX.

9-72

4-R-29943

Oct 27, 1959 Rev. 1-71

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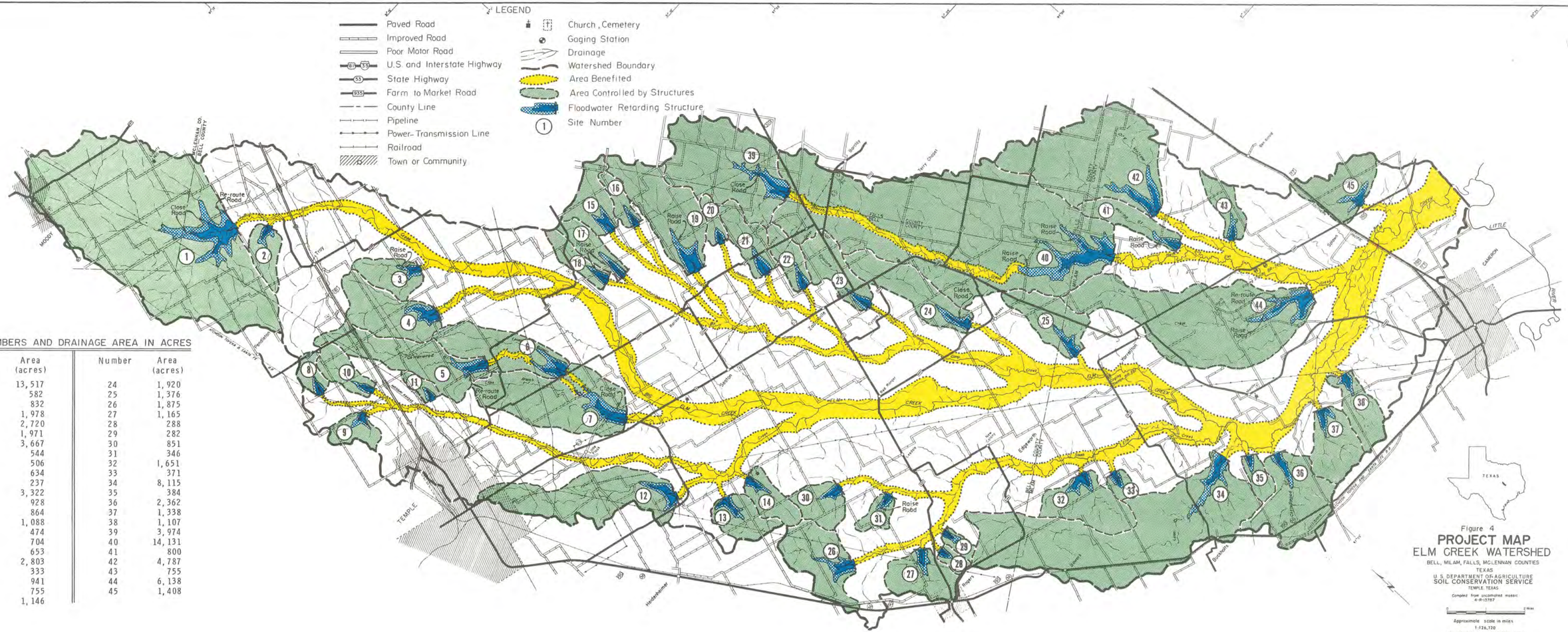

SITE NUMBERS AND DRAINAGE AREA IN ACRES

Number	Area (acres)	Number	Area (acres)
1	13,517	24	1,920
2	582	25	1,376
3	832	26	1,875
4	1,978	27	1,165
5	2,720	28	288
6	1,971	29	282
7	3,667	30	851
8	544	31	346
9	506	32	1,651
10	634	33	371
11	237	34	8,115
12	3,322	35	384
13	928	36	2,362
14	864	37	1,338
15	1,088	38	1,107
16	474	39	3,974
17	704	40	14,131
18	653	41	800
19	2,803	42	4,787
20	333	43	755
21	941	44	6,138
22	755	45	1,408
23	1,146		

Figure 4

PROJECT MAP

ELM CREEK WATERSHED

BELL, MILAM, FALLS, MCLENNAN COUNTIES
TEXAS

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

Compiled from uncontrolled mosaic
4-R-13787

0 2 Miles

Approximate scale in miles
1:126,720

Approximate Area 207,360 Acres

PROJECTION UNKNOWN

LATITUDE AND LONGITUDE LINES ARE APPROX.

9-72

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USDA-SCS-FT. WORTH, TEXAS 1972