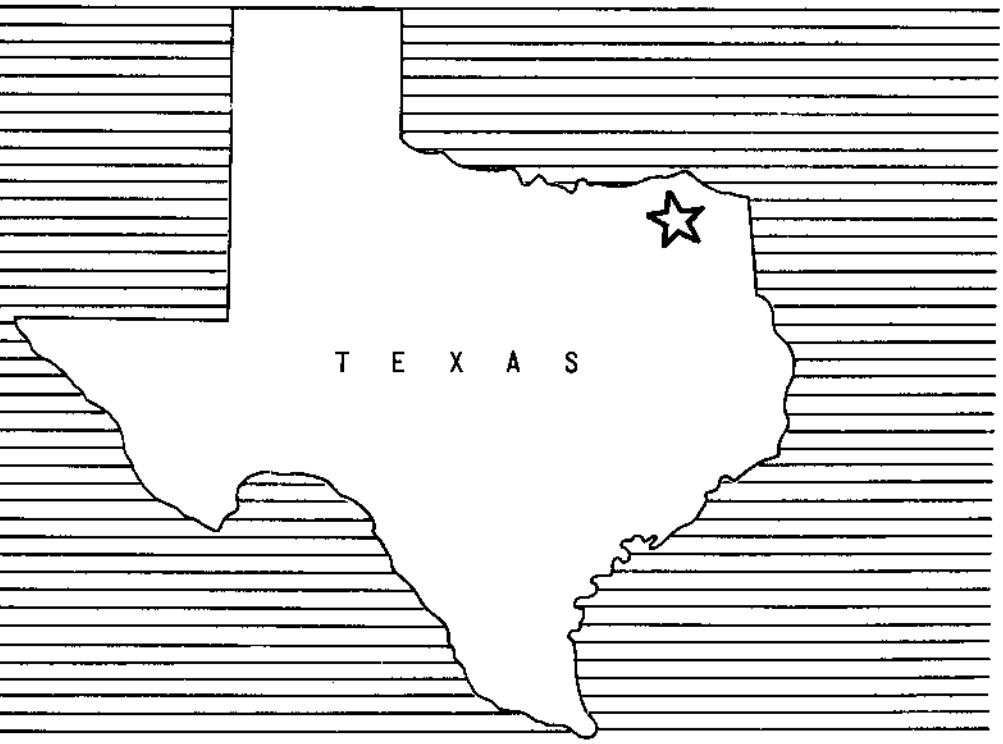
WORK PLAN

For Watershed Protection, Flood Prevention
and Nonagricultural Water Management

LANGFORD CREEK WATERSHED

RED RIVER COUNTY, TEXAS



April, 1958

USDA-SCS-FORT WORTH, TEX. 1958

WATERSHED WORK PLAN AGREEMENT

between the

Red River County Soil Conservation District
Local Organization

Red River County Water Control and Improvement District No. 1, Langford Creek
Local Organization

Red River County Commissioners Court
Local Organization

Clarksville City Council

In the State of Texas
(hereinafter referred to as the Sponsoring Local Organization)

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 Langford Creek Watershed, State of Texas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress; 70 Stat. 1088); 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 Langford Creek 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 will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

It is mutually agreed that in installing and operating and maintaining the works of improvement described in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 71,279 .)

2. 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.

3. The percentages of construction costs of structural measures and land treatment measures for flood prevention 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 Structure No. 1	52.98	47.02	78,353
Floodwater Retarding Structures 2 through 12	0	100	211,327

The Sponsoring Local Organization will pay all of the costs allocated to purposes other than flood prevention, and irrigation, drainage, and other agricultural water management.

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention. (Estimated cost $ 82,392 .)

   The Service will bear _____ percent of the cost of installation services applicable to works of improvement for agricultural water management and the Sponsoring Local Organization will bear _____ percent of the cost of such services. (Estimated cost $ None .)

   The Sponsoring Local Organization will bear the cost of all installation services spplicable to works of improvement for nonagricultural water management. (Estimated cost $ 13,782 .)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 6,000 .)

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

7. 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.

8. 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.

9. 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.

10. 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.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. 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.

13. 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.

Red River County Soil Conservation District
Local Organization

By Luther Rogers

Title Chmn

Date 4-28-58

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

adopted at a meeting held on 4-28-58

D. J. Jackson
(Secretary, Local Organization)

Date 4-28-58

Red River County Water Control and Improvement District No. 1, Langford Creek
Local Organization

By [signature]

Title President

Date 4-28-58

The signing of this agreement was authorized by a resolution of the governing body of the Red River County Water Control and Improvement District No.1, Langford Creek
Local Organization

adopted at a meeting held on 4-28-58.

[signature]
(Secretary, Local Organization)

Date 4-28-58

Red River County Commissioners Court
Local Organization

By [signature]

Title County Judge

Date April 28, 1958

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

adopted at a meeting held on April 25, 1958

[signature]
(Secretary, Local Organization)

Date April 28, 1958

Clarksville City Council
Local Organization

By W. Bonham

Title Mayor

Date Apr 28 1958

The signing of this agreement was authorized by a resolution of the governing body of the Clarksville City Council
Local Organization

adopted at a meeting held on April 28 1958

Mrs. Ruth Owen
(Secretary, Local Organization)

Date Apr. 28, 1958

_____
Local Organization

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the _____
Local Organization

adopted at a meeting held on _____

_____
(Secretary, Local Organization)

Date _____

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION AND NONAGRICULTURAL WATER MANAGEMENT

LANGFORD CREEK WATERSHED
Red River County, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act. (Public Law 566, 83rd Congress; 68 Stat. 666 as Amended by Public Law 1018, 84th Congress; 70 Stat. 1088)

Prepared By: Red River County Soil Conservation District
(Cosponsor)

Red River County Water Control and Improvement District No. 1, Langford Creek
(Cosponsor)

Red River County Commissioners Court
(Cosponsor)

Clarksville City Council
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
April 1958

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

List of Tables and Figures

SECTION 1

WATERSHED WORK PLAN

LANGFORD CREEK WATERSHED
Red River County, Texas
April 1958

SUMMARY OF PLAN

General Summary

The work plan for Langford Creek watershed, Texas, was prepared by the Red River County Soil Conservation District; the Red River County Water Control and Improvement District No. 1, Langford Creek; the Red River County Commissioners Court, and the Clarksville City Council as the local cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture.

The watershed work plan covers an area of approximately 39.11 square miles, or 25,030 acres, in Red River County, Texas. Approximately 16 percent of the watershed is cropland, 73 percent is grassland, 5 percent is wooded range, and 6 percent is in miscellaneous uses such as stream channels, towns, roads, etc.

There is no Federally-owned land in the watershed.

The work plan proposes installing during a five-year period a project for the protection and development of the watershed at a total estimated installation cost of $614,618. The share of this cost to be borne by Public Law 566 funds will be $346,111. The remaining $268,507 will be borne by local and other funds. In addition, local interests will bear the entire cost of operation and maintenance, with a capitalized value of $55,789. Of the total project cost of $670,407, Public Law 566 funds will bear $346,111 and local and other funds will bear $324,296.

Land Treatment Measures

The cost for land treatment measures is estimated to be $151,235, of which the share to be borne by other than P. L. 566 funds is $135,685. It is estimated that $5,915 will be available from the Public Law 46 going program for technical assistance. The share to be borne by P. L. 566 funds, consisting entirely of accelerated technical assistance, is $15,550. The land treatment program will be installed over a five-year period.

Structural Measures

The structural measures included in the plan consist of 12 floodwater retarding structures. The 12 structures will have a total capacity of

5,876 acre-feet of floodwater detention and sediment storage. In addition, 1,118 acre-feet of nonagricultural water storage will be provided in Site 1, on a cost-sharing basis, for recreational and standby municipal and/or industrial uses. The total cost of these measures, including the capitalized value of operation and maintenance, is $519,172, of which $188,611 will be borne by local interests. The non-Federal share of the cost of structural measures includes land, easements, and rights-of-way, 38 percent; nonagricultural water management, 29 percent; operation and maintenance, 30 percent; and administering contracts, 3 percent. The floodwater retarding structures will be installed over a 3-year period.

Damages and Benefits

The estimated average annual floodwater, sediment, erosion and indirect damage without the project is $44,354, computed at long-term price levels. The estimated average annual damage with the project installed, including reductions accruing to both land treatment and structural measures, is $7,294, a reduction of 84 percent.

The average annual primary benefits accruing to structural measures are $34,780, which are distributed as follows:

Floodwater damage reduction	$28,883
Sediment damage reduction	864
Erosion damage reduction (flood plain)	237
Indirect damage reduction	3,025
Nonagricultural water management	1,771

The ratio of the average annual benefit ($34,780) to the average annual cost of structural measures ($18,305) is 1.90 to 1.

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

Provisions for Financing Construction

The Red River County Water Control and Improvement District No. 1, Langford Creek has powers of taxation and eminent domain under applicable State laws. This district will administer the contracts for the structural measures listed in the plan. Funds for financing the local share of the project will be raised by a district-wide tax.

Operation and Maintenance

Land treatment measures will be installed, operated, and maintained by the landowners or operators of the farms under agreement with the Red River County Soil Conservation District.

Under terms of an operation and maintenance agreement to be executed, the 12 floodwater retarding structures will be operated and maintained by the Red River County Water Control and Improvement District No. 1,Langford Creek.

DESCRIPTION OF THE WATERSHED

Physical Data

Langford Creek heads approximately 3 miles north of the city of Clarksville, Texas, and enters Cuthand Creek approximately 8.5 miles south of Clarksville, in Red River County, Texas. The principal tributaries are Boggy and Delaware Creeks and East Branch. The area of the watershed is 39.11 square miles (25,030 acres).

The topography ranges from nearly level along the alluvial valley to gently rolling in the upland areas. Elevations range from 315 feet to 510 feet above mean sea level. The main alluvial valley of Langford Creek is well defined and consists of 2,452 acres.

The watershed lies entirely within the Blackland Prairies Land Resource Area. The soils consist of dark-gray to light-gray clays and clay loams of the Houston, Wilson and Crockett series. They are slowly to very slowly permeable and are usually deep, with some isolated areas of shallow soils. The soils are in fair physical condition. Grassland occupies approximately 74 percent of the watershed, with the major portion of this area being formerly cultivated land that has been changed to pasture use.

The overall land use for the watershed is as follows:

Land Use	Acres	Percent
Cropland	4,095	16.36
Grassland	18,387	73.46
Wooded Range	1,170	4.67
Miscellaneous 1/	1,378	5.51
Total	25,030	100.00

1/ Includes roads, highways, railroad rights-of-way, urban areas, etc.

Land use in the flood plain is as follows: 32 percent in cultivation; 61 percent in pasture; 4 percent in wooded range; and 3 percent in miscellaneous uses.

The mean annual rainfall is 44.46 inches as recorded at U. S. Weather Bureau gage at Clarksville, Texas, over the 20-year period, 1923 through 1942. The monthly average ranges from 2.73 inches in September to 5.01 inches in May. Average temperatures range from 83.5 degrees Fahrenheit in the summer to 45 degrees in the winter. The normal frost-free period of 234 days extends from March 20 to November 9.

Water for livestock and rural domestic use is obtained from surface ponds and wells. The city of Clarksville obtains its water from two wells in

the Blossom sand. The high annual rainfall causes streamflow most of the time.

Economic Data

Red River County, in which this watershed is located, has a unique historical background. After the consummation of the Louisiana Purchase in 1803, many people from the United States believing the Sulphur River rather than Red River to be the boundary settled in the area. Consequently, this is one of the oldest areas of Texas from the standpoint of settlement. County government was organized in 1837.

For many years the agriculture of the county was based on cotton. Farms were small, ranging from 60 to 80 acres in size. For many years Clarksville was the leading cotton market in northeast Texas. Cotton production declined rapidly in the twenties and the local cotton market center became a casualty because of the 1929 crash and the greatly reduced volume of cotton produced in the area.

At the present time cotton production is at about one-third of the former level. Although it is still important to the economy of the area, livestock and dairy production are now of major importance.

There is no commercial timber production in the watershed although it is of considerable importance elsewhere in Red River County.

In the period 1950 to 1954 the number of farms decreased 19 percent and farms increased in size from 159 to 194 acres. Approximately 50 percent of the farms are owner operated.

Livestock is trucked to Fort Worth and Texarkana. Cotton is sold to local buyers or placed in government loan. Most of the hay and feed crops are consumed locally.

There is no production of oil, gas, or other minerals in the watershed.

Clarksville, estimated to have a 1957 population of 5,500, is the market and supply center for the project area as well as the county seat of Red River County.

The Langford Creek watershed is served by the Clarksville Soil Conservation Service Work Unit through the Red River County Soil Conservation District. This work unit has assisted farmers in preparing 70 initial and basic soil and water conservation plans on 13,512 acres, representing 58 percent of the agricultural land within the watershed, and giving technical guidance in establishing and maintaining planned measures.

The watershed is served by 46 miles of roads, of which 22 are paved (State Highway No. 37, U. S. Highway 82, Farm to Market Roads 114, 909, 910, and 1159). Langford Creek is crossed by two county roads and by

U. S. Highway 82. The county roads frequently become impassable during floods and thus extra travel distance is required for travel between points on opposite sides of the creek. Loading facilities and rail transportation over the Texas and Pacific Railroad are available in Clarksville.

WATERSHED PROBLEMS

Floodwater Damage

Floods occur frequently on Langford Creek and cause severe damage. During the 20-year period 1923 - 1942, there were 22 major floods and 58 minor floods. Many of the floods occur in the spring and delay planting of crops until after the optimum dates. Damaging floods also have occurred in other seasons of the year.

The flood plain area, 2,452 acres (figure 1) is the portion of the bottom land, not within the city of Clarksville, that is inundated by the runoff from an 18-hour 25-year frequency storm. A major flood is defined as one producing sufficient runoff to inundate more than one-half of the flood plain area and a minor flood less than one-half.

For the floods experienced during the period studied, the total direct agricultural and nonagricultural damages under present conditions were estimated to average $40,286 annually at long-term price levels, of which $24,509 is crop and pasture damage, $6,904 is other agricultural damage, and $5,805 is nonagricultural such as damage to roads, bridges and urban property. Indirect damages such as interruption of travel, extra travel over re-routed school bus and mail routes, losses sustained by dealers and industries in the area, and similar losses are estimated to average $4,068 per year.

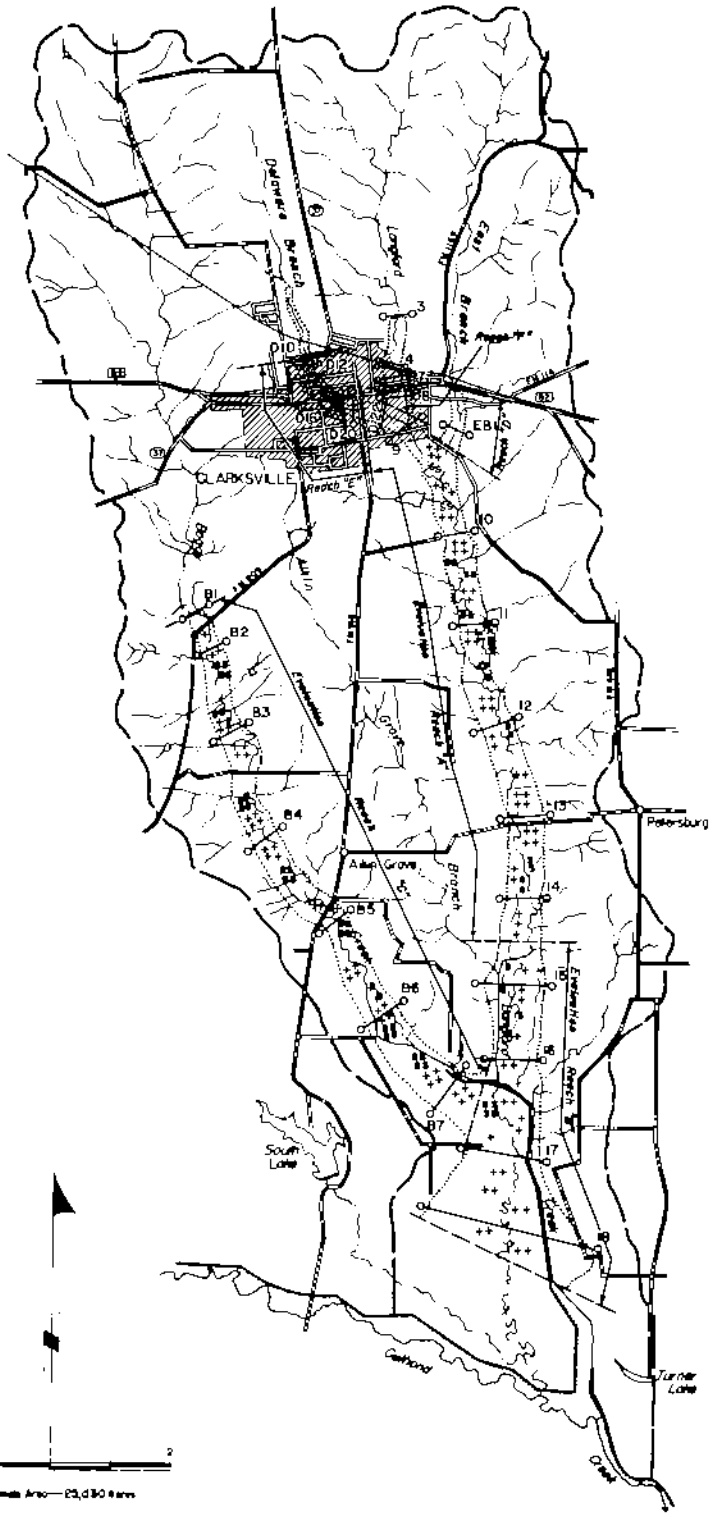
On September 30, 1955, floodwater from Delaware and Langford Creeks caused an estimated $180,640 in damage in the city of Clarksville. Of this amount, $146,150 was caused by flooding from Delaware Creek and $34,490 from Langford Creek. This peak flow from this storm was considerably more than that which could be expected to occur on an average of once in 100-years. For the purposes of this evaluation, it was assumed that it was of a magnitude that could be expected once in 200 years, and the above damages were divided by 200 to convert them to an average annual value of $903.

Sediment Damage

Overbank deposition in the flood plain has declined since the early twenties when a majority of the land was in row crop cultivation. With only 16 percent of the watershed now in cultivation, it is estimated that 1,031 acres of flood plain land have been damaged by sediment. This damage is estimated to have reduced crop and pasture production on 555 acres by 10 percent, on 401 acres by 20 percent, and on 75 acres

Floodwater damage to cropland in Langford Creek flood plain.
The complete program will reduce annual damages by 72 percent.

M-11-Ft.W.-58



LEGEND

- Hard Surface Road
- Unimprove Road
- Semi-hard Surface Road
- Railroad
- Creeks
- Pond or Lake - Existing
- Community
- Dike or Levee
- Watershed Boundary
- Outline of Flood and Sediment Damage Areas
- Sedimentation Damage
- Flood Plain Scour Damage
- Hydrologic Cross Section
- Evaluation Reach

0 2

Approximate Area—23,030 acres

Figure 1

PROBLEM LOCATION MAP

LANGFORD CREEK WATERSHED

RED RIVER COUNTY, TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

COMPILED | TRACED | CHECKED | DATE

4-A-12,844

Revised 3-16-84 | 11/23/83 | 4-A-11,984

by 30 percent, with an average annual monetary damage of $2,703, at long-term price levels.

The most severely damaged area is downstream from the confluence of Langford and Boggy Creeks, with all of the damage occurring below the planned floodwater retarding structures.

The damaging sediment consists of silty clays, clays, and gravelly clays which are low in organic matter and puddle and crust readily. There are no large reservoirs in the watershed but the numerous farm ponds (locally known as pools) have suffered moderate damage due to sedimentation.

Erosion Damage

Sparsely covered upland soils in the watershed have relatively high erosion rates, but when a protective vegetative cover is established erosion rates become moderate to low. Sheet erosion is the major process in the watershed, accounting for 91 percent of the annual gross erosion. Gully and streambank erosion account for 8 percent, with the remaining 1 percent attributed to flood plain scour. The average annual rate of upland gross erosion is 1.43 acre-feet per square mile. Approximately 176 acres are damaged annually by flood plain scour ranging from 10 to 30 percent of the productive capacity of the soils. This represents an average annual monetary damage of $365 at long-term price levels.

Problems Relating to Water Management

Problems relating to methods now used in the conservation, development, utilization, and disposal of water are of a minor nature in the Langford Creek watershed.

The citizens of the Red River County Water Control and Improvement District No. 1, Langford Creek, state that they have lost the opportunity to secure small industries because the town of Clarksville, located in the district, depends upon a ground water supply which is not adequate for industrial use. They feel that the storage of water for recreational and standby municipal and industrial use will benefit the people of Clarksville, enable small industries to locate there, and provide additional employment opportunities.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Prior to 1920 private interests began to try to solve some of their flood problems by constructing diversion levees, and associated channel realignment and enlargement, in the lower reaches of Boggy and Langford Creeks. During the twenties two levee districts were organized near the confluence of Langford and Cuthand Creeks and additional levees were constructed. Minor damages in the form of washouts occur about once every two years and major repairs are required about once every five years. The installation of land treatment measures and the 12 floodwater retarding structures

will supplement these existing works of improvement by making them more effective as a result of reduction in peak flows.

A system of concrete lined channels was installed on Delaware Creek and its tributaries in the city of Clarksville prior to 1940 as a part of a mosquito control program under the Works Progress Administration. Only one damaging flood has occurred since the installation of this work. The installation of Site 2 on Delaware Creek above Clarksville will make the existing improvements more effective in reduction of urban damages.

As a part of the authorized Cooper Reservoir and Channels Project, the Corps of Engineers is developing plans for channel clearing, enlargement, and realignment, and levee enlargement on Cuthand Creek a portion of which is near the confluence of Langford Creek. This Public Law 566 project will complement the Corps of Engineers project by providing needed protection to flood plain lands on Langford Creek which would not be provided by the Corps' project. The installation of the 12 floodwater retarding structures also will result in a reduction of peak flows and sediment delivery from Langford Creek, thus increasing the effectiveness of the proposed works on Cuthand Creek.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

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

Approximately 10,829 acres of the total watershed area of 25,030 acres lie above the planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. Land treatment constitutes the only planned measures for the remaining upland area. Land treatment measures on the 2,452 acres of flood plain are also important in reducing floodwater and erosion damages.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing these measures is $151,235, including $15,550 for the acceleration of technical assistance during the 5-year installation period to help owners and operators to plan and speed up the application of conservation practices. Landowners and

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS
Langford Creek Watershed, Texas

Installation Cost Item	Unit	No. to be Applied Non-Federal Land	Estimated Cost 1/ P.L. 566 Funds (dollars)	Other (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	792	-	N.C.	N.C.
Cover Cropping	Acre	1,160	-	10,440	10,440
Crop Residue Utilization	Acre	908	-	N.C.	N.C.
Rotation Hay & Pasture	Acre	300	-	2,700	2,700
Pasture Planting	Acre	5,000	-	60,000	60,000
Proper Use, Pasture	Acre	5,300	-	10,600	10,600
Rotation Grazing	Acre	7,540	-	15,080	15,080
Pond Construction	Each	43	-	11,180	11,180
Brush Control	Acre	940	-	7,050	7,050
Diversion Construction	Mile	2	-	1,000	1,000
Terracing	Mile	43	-	11,180	11,180
Waterway Development	Acre	18	-	540	540
Technical Assistance			15,550	5,915	21,465
SCS Subtotal			15,550	135,685	151,235
TOTAL LAND TREATMENT			15,550	135,685	151,235
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	12	248,169	41,511	289,680
SCS Subtotal			248,169	41,511	289,680
Subtotal - Construction			248,169	41,511	289,680
Installation Services					
Soil Conservation Service					
Engineering Services			49,633	8,302	57,935
Other			32,759	5,480	38,239
SCS Subtotal			82,392	13,782	96,174
Subtotal - Installation Services			82,392	13,782	96,174
Other Costs					
Land, Easements and R/W			-	71,279	71,279
Administration of Contracts			-	6,000	6,000
Water Rights			-	250	250
Subtotal - Other			-	77,529	77,529
TOTAL STRUCTURAL MEASURES			330,561	132,822	463,383
TOTAL PROJECT			346,111	268,507	614,618
SUMMARY					
Subtotal SCS			346,111	268,507	614,618
TOTAL PROJECT			346,111	268,507	614,618

1/ Price base: Current price levels.

April 1958

operators will maintain these measures in accordance with provisions of the farmer-district cooperative agreements with the Red River County Soil Conservation District.

Land treatment measures will decrease erosion damage and sediment production from fields and pastures by providing improved soil-cover conditions. These measures include cover cropping, use of rotation hay and pasture, crop residue utilization for cropland, and pasture planting to establish good cover on grassland and formerly cultivated lands. They also include brush control to allow grass to improve and replace the poor brushy cover; construction of farm ponds to provide watering places to prevent cover destroying seasonal concentrations of livestock; and proper use of grassland to provide improvement, protection and maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

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

Structural Measures

A system of 12 floodwater retarding structures will be installed in the Langford Creek watershed to provide needed protection for flood plain land and urban protection for the city of Clarksville that cannot be attained by the land treatment measures described above.

This system of structures, when installed, will temporarily detain runoff from 43.3 percent of the total watershed. The 12 floodwater retarding structures have floodwater detention capacity to detain an average of 5.78 inches of runoff from the watershed area above the planned structures. This is the equivalent of 2.50 inches of runoff from the entire 25,030-acre watershed.

Figure 2 shows a section of a typical floodwater retarding structure.

The location of the structural measures are shown on the Planned Structural Measures map, figure 3. In addition to floodwater detention, Site 1 will provide 1,118 acre-feet of storage to be used for recreational purposes as well as a standby reserve for municipal and industrial uses by the city of Clarksville. This additional storage will provide a firm yield of 1,000,000 gallons daily and in most years 2,000,000 gallons. The quality of the water is much better than can be obtained from wells. The determination of yield and quality was made by a private engineering firm employed by the Red River County Water Control and Improvement District No. 1, Langford Creek, to assist in developing the nonagricultural water management phases of this plan. The total estimated cost of

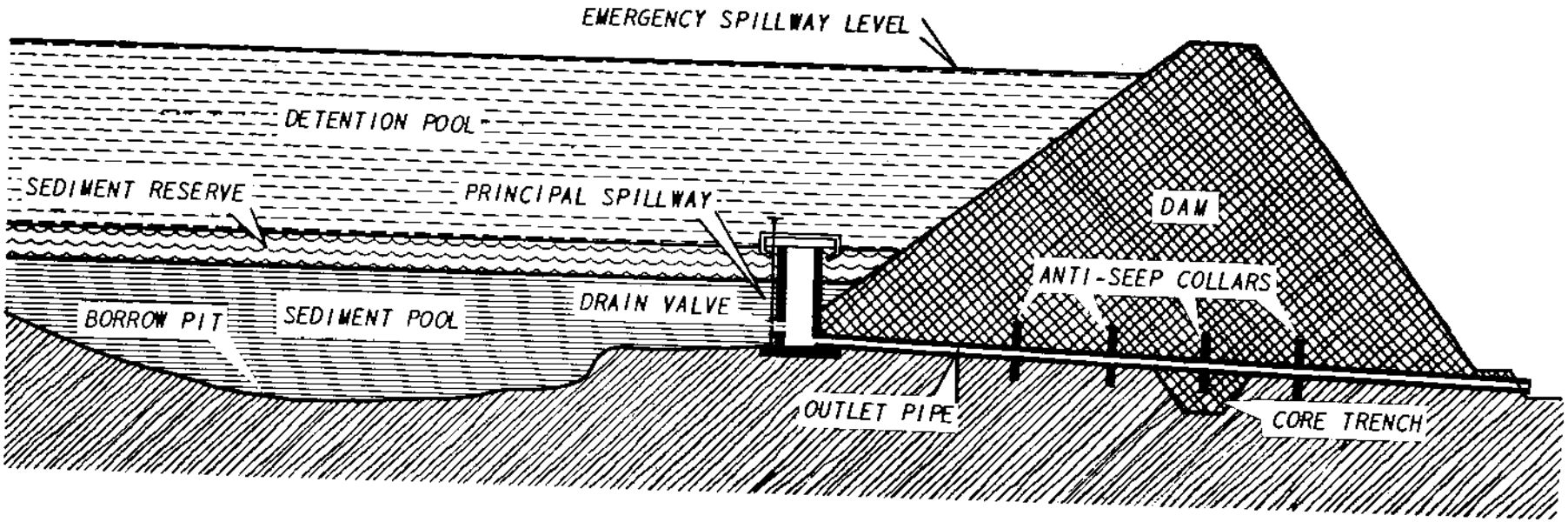
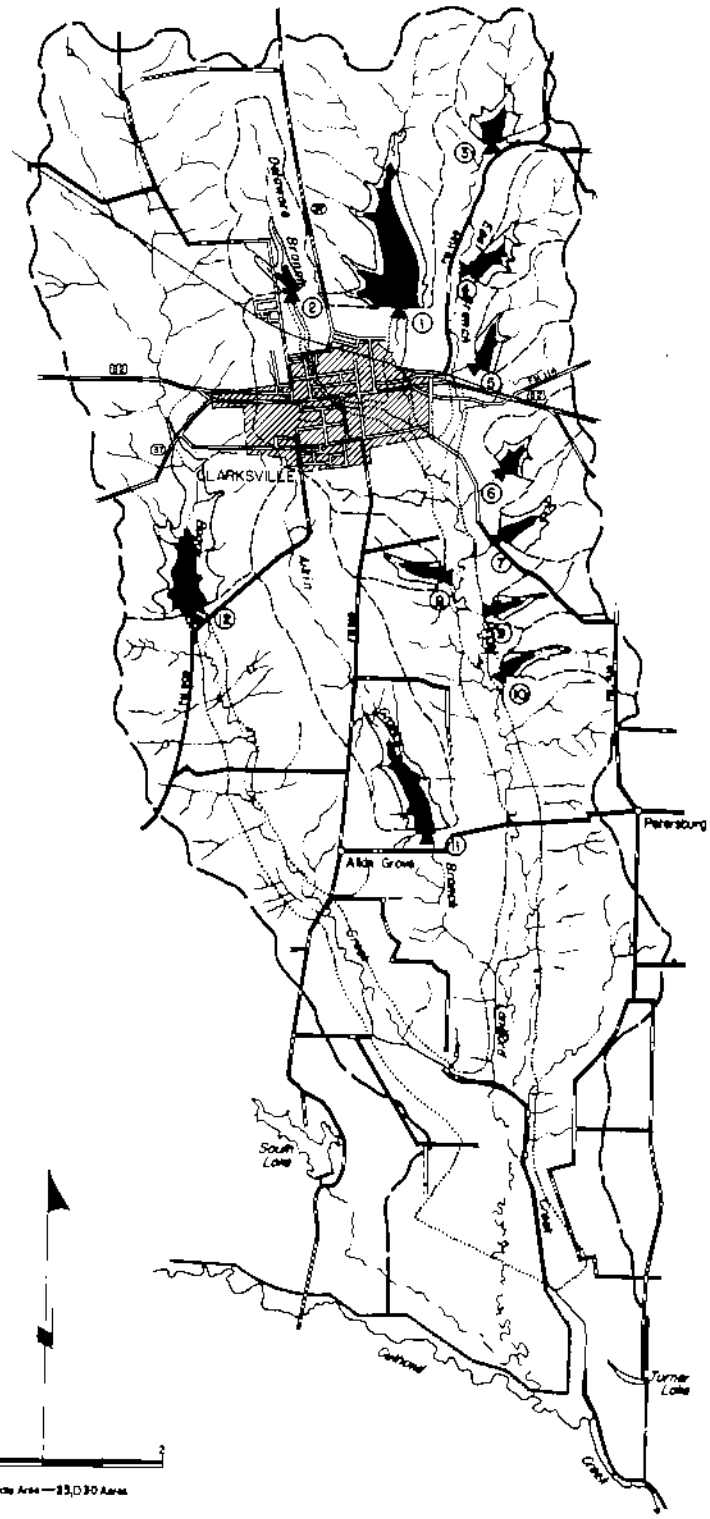


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-24-57 4-L-10,071



SITE NUMBER AND ACRES DRAINAGE AREA

①	1893 Acres	⑦	368 Acres
②	490 Acres	⑧	247 Acres
③	407 Acres	⑨	229 Acres
④	370 Acres	⑩	312 Acres
⑤	331 Acres	⑪	1376 Acres
⑥	209 Acres	⑫	4606 Acres

LEGEND

- Hard Surface Road
- Unimprove Road
- Semi-hard Surface Road
- Railroad
- Creeks
- Pond or Lake-Existing
- Community
- Dike or Levee
- Flood Pool / Sediment Pool — Floodwater Retarding Structure
- Drainage Area Boundary-Special Structure
- Watershed Boundary
- Outline of Flood and Sediment Damage Areas

Figure 3

PLANNED STRUCTURAL MEASURES MAP
LANGFORD CREEK WATERSHED
RED RIVER COUNTY, TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

COMPILED | TRACED | CHECKED | DATE
DHR | JRL | ALB | 6-16-58

4-R-16,896

Revised 3-IV-58 11-23-57 4-R-11,964

establishing these works of improvement is $463,383, of which $132,822 will be borne by local interests and $330,561 will be borne by Public Law 566 funds (table 1).

The estimated annual equivalent cost of installation, $16,338, with an estimated annual operation and maintenance cost of $1,967 makes a total annual cost of $18,305.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or a similar type of spillway. The multiple purpose features incorporated in Site 1 will result in an estimated saving of $1,783 to Public Law 566 funds for flood prevention as a result of allocation of costs to the two purposes to be served. All applicable State water laws will be complied with in the design and construction of the floodwater retarding structures, and in the use of water stored for beneficial purposes.

BENEFITS FROM WORKS OF IMPROVEMENT

The general locations of the benefits from the combined program of land treatment and structural measures are presented in the following table:

	Evaluation Reach (Figure 1)						
	A	B	C	D	E	F	Total
Average Annual Area Flooded							
Without Project - Acres	1,519	1,139	875	35	-	-	3,568
With Project - Acres	537	471	60	6	-	-	1,074
Percent Reduction	64.65	58.65	93.14	82.86	-	-	69.90
Area Subject to Recurrent Annual Flooding							
With Project - Acres	209	222	7	0	-	-	438
Area Flooded by Largest Storm							
Without Project - Acres	735	1,220	700	62	-	-	2,717
With Project - Acres	638	632	240	34	-	-	1,544
Percent Reduction	13.20	48.20	65.57	45.16	-	-	44.18
Average Annual Damages							
Without Project - Dollars	11,638	21,573	8,895	1,345	730	173	44,354
With Project - Dollars	2,306	3,960	687	152	175	14	7,294
Percent Reduction	80.19	81.65	92.28	88.70	76.03	91.91	83.56

The evaluation storm series for the period 1923 through 1942 contained 80 storms which would cause inundation of flood plain under present conditions at the smallest valley cross section. The following table shows a comparison with and without the project for each evaluation reach, the inches of runoff when

damage starts, the number of storms in the evaluation series which caused floodwater damage, and the number which inundated more than half of the flood plain in each reach.

	Evaluation Reach (Figure 1)					
	A	B	C	D	E	F
Inches of Runoff When Damage Starts						
Without Project	.45	.33	.42	1.39	1.63	2.18
With Project	.93	.51	1.59	2.74	4.13	5.00
Number of Floods in Evaluation Series						
Without Project	76	80	78	33	-	-
With Project	55	68	24	7	-	-
Number of Major Floods in Evaluation Series						
Without Project	41	7	17	7	-	-
With Project	14	5	5	5	-	-

The area on which some annual crop loss will occur due to overbank deposition of sediment will be reduced from 1,031 acres to 382, a reduction of 63 percent. Land treatment will effect 30 percent of this reduction and structural measures 33 percent.

The area on which annual crop loss occurs due to flood plain scour will be reduced from 176 acres to 107, a reduction of 39 percent. The planned land treatment program can be expected to reduce the total annual gross erosion from the watershed from 56.39 acre-feet to 39.40 acre-feet. The estimated average annual floodwater, sediment, erosion and indirect damages within the watershed will be reduced from $44,354 to $7,294, a reduction of 86 percent.

Approximately 89 percent, $33,009, of the expected reduction in the average annual damage would result from the system of floodwater retarding structures.

By type of damage for each Evaluation Reach (figure 1) these reductions will be:

BENEFIT FROM REDUCTION IN DAMAGE

Type of Damage	Evaluation Reach					
	A		B		C	
	Total Project	Structures Only	Total Project	Struc. Only	Total Project	Struc. Only
	(dollar)		(dollar)		(dollar)	
Crop and Pasture	3,260	2,894	12,327	11,510	4,931	4,573
Other Agricultural	1,609	1,398	2,671	2,319	1,532	1,330
Nonagricultural	3,139	2,594	-	-	528	432
Overbank Deposition	421	223	952	476	306	165
Flood Plain Scour	55	46	62	49	164	142
Indirect	848	724	1,601	1,435	747	683
Total	9,332	7,969	17,613	15,789	8,208	7,505

BENEFIT FROM REDUCTION IN DAMAGE

Type of Damage	Evaluation Reach D		Evaluation Reach E		Evaluation Reach F	
	Total Project	Struc. Only	Total Project	Struc. Only	Total Project	Struc. Only
	(dollar)		(dollar)		(dollar)	
Crop and Pasture	421	404	-	-	-	-
Other Agricultural	136	118	-	-	-	-
Nonagricultural	528	433	485	473	138	135
Overbank Deposition	-	-	-	-	-	-
Flood Plain Scour	-	-	-	-	-	-
Indirect	108	95	70	68	21	20
Total	1,193	1,050	555	541	159	155

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore land now in Johnsongrass meadow or pasture to cotton, corn and alfalfa. All of this land was in cultivation at one time but is now chiefly used for hay or pasture because of the frequency of flooding. It is estimated that net income from such restoration of land to former productivity will amount to $13,504 (long-term price levels) annually. This loss from the original production has been considered a crop and pasture damage and its restoration a benefit in table 7. The total flood prevention benefits as a result of structural measures, are estimated to be $33,009 annually.

Water supply provided in structure site 1 would provide recreational opportunities to the people of Red River County which had a population of 21,851 in 1950. Standby municipal and industrial water supply would be available to meet future needs of the city of Clarksville, which had a population estimated to total 5,500 in 1957.

Benefits from the nonagricultural water supply were assumed to be at least equal to the allocated costs, $88,528. Projected on an annual basis for the 50-year project period, these benefits would be at least $1,771.

Damage from a storm equal in magnitude to the September 30, 1955 event would be reduced from $180,640 to approximately $37,749, a reduction of 79 percent. Projected to an annual basis this would reduce damages from $903 to $189.

The following table shows the effect the project will have in reducing depth and width of flow of runoff from a storm of the same magnitude as the one of September 30, 1955 through the city of Clarksville. This storm greatly exceeded the 100-year frequency storm and was assumed to be a 200-year frequency storm for purposes of economic evaluation:

Valley Cross Section (Figure 4)	Elevation Where Damage Begins (Ft.M.S.L.)	September 30, 1955 Storm: High Water Elevation: Without Project (Ft.M.S.L.)	High Water Elevation: With Project (Ft. M.S.L.)	Width of Flooded Area: Without Project (Ft.)	Width of Flooded Area: With Project (Ft.)
D-10	421.30	420.20	416.50	350	110
D-11	416.50	418.15	414.70	440	155
D-12	413.30	416.40	413.70	395	255
D-13	412.00	415.70	413.05	425	265
D-14	410.70	415.00	412.50	550	75
D-15	409.90	413.55	410.70	580	295
D-16	408.10	411.00	408.60	350	200
D-17	407.10	409.35	407.25	410	230
D-18	406.60	408.90	406.95	455	350
D-19	404.60	407.20	405.65	535	340
D-20	402.20	405.30	403.70	495	385
D-21	399.60	404.30	402.90	510	390
D-22	396.50	400.50	399.45	780	670
6	397.70	401.70	397.50	735	35
7	399.00	400.85	397.25	920	55
8	398.00	399.60	397.15	1,000	830
9	392.30	396.90	395.05	980	865

With the project installed depth of flow would be reduced to less than one foot above the point where damage begins except at valley cross sections D-14, D-19, D-20, D-21 and 9. The areas at these valley cross sections are largely undeveloped except at D-14 (figure 4). The local people should recognize the limitations of the project when planning future developments in the presently undeveloped area.

Investigations revealed that the small remaining damages were not sufficient to economically justify the cost of additional works of improvement, such as further channel improvement.

COMPARISON OF BENEFITS AND COSTS

The annual equivalent cost of structural measures (converted from total installation cost plus operation and maintenance) is estimated to be $18,305. When the project is completely installed it is expected to produce average annual benefits of $34,780. Therefore, the project will produce benefits of $1.90 for each dollar of cost. Other substantial values will accrue from the project, such as improved wildlife habitat and a sense of security, which have not been used for project justification.

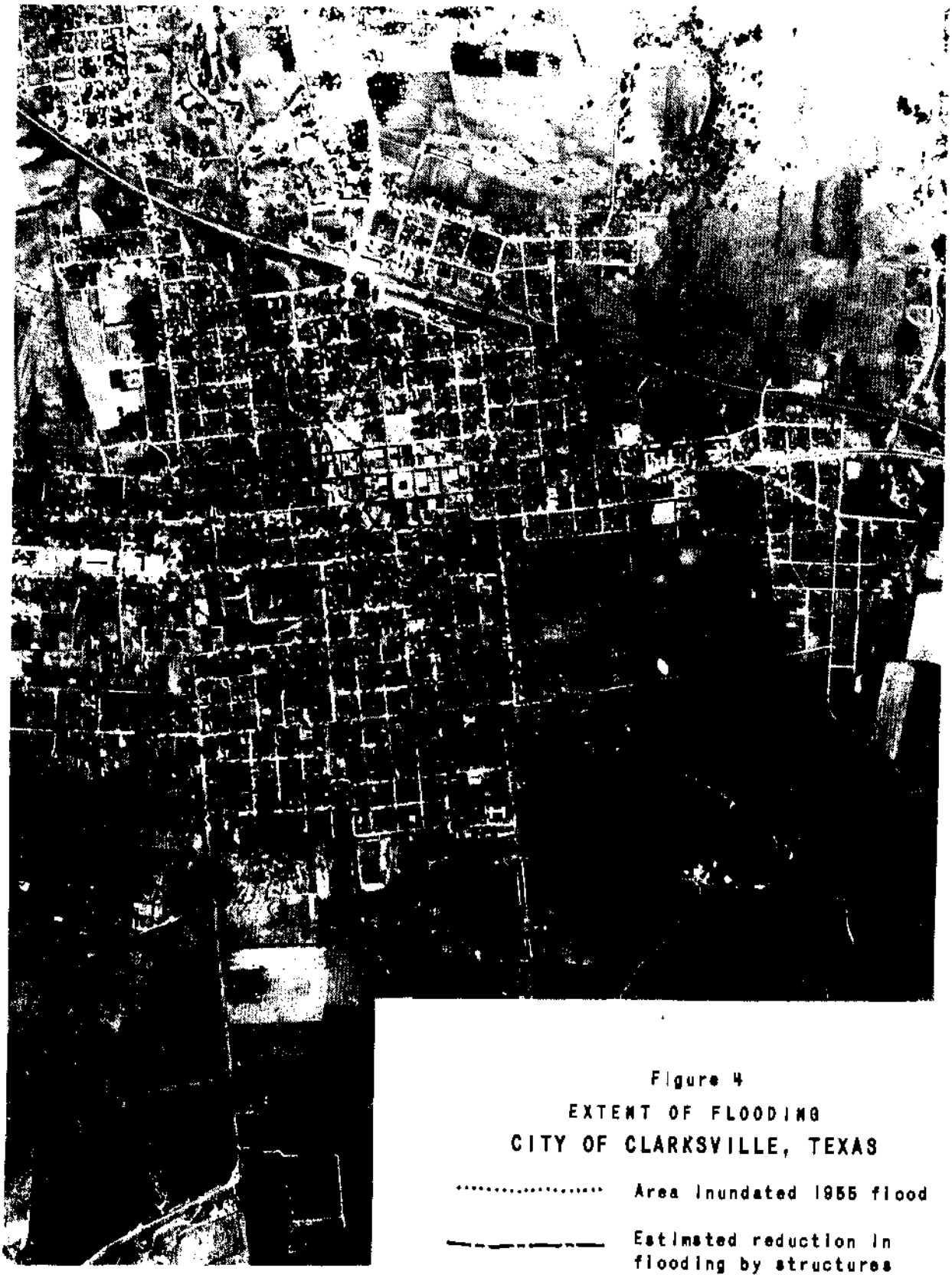


Figure 4

EXTENT OF FLOODING

CITY OF CLARKSVILLE, TEXAS

..... Area inundated 1955 flood

— — — — Estimated reduction in flooding by structures

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

SCS-FCS-FORT WORTH, TEX. 1958

4-12-58 4-L-12293

ACCOMPLISHING THE PLAN

Federal assistance for carrying out the works of improvement on non-Federal land, as 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 by Public Law 1018; 84th Congress; 70 Stat. 1088).

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

Land Treatment Measures

The land treatment measures, itemized in table 1, will be established by farmers over a 5-year period in cooperation with the Red River County Soil Conservation Diatrict which is giving assistance in the planning and application of these measures under its going program. This assistance will be accelerated with Public Law 566 funds to assure application of the planned measures within the 5-year installation period for the project.

The governing body of the Red River County Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program under way,with the assistance of the Red River County Water Control and Improvement District No. 1, Langford Creek, in arranging for meetings according to a definite schedule. By this means and by individual contacts, the landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the districts. The soil conservation district governing body will make or cause to be made, periodic inspections of the completed conservation measures within the watershed. The Soil Conservation Service will assign additional technicians and aids to the Red River County Soil Conservation District to assist landowners and operators cooperating with the district in accelerating the preparation and application of soil, plant, and water conservation plans.

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

The County ASC Committee will cooperate with the governing body of the Soil Conservation District by selecting and providing financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

Structural Measures for Flood Prevention

The Red River County Water Control and Improvement District No. 1, Langford Creek, will obtain the necessary land, easements, and rights-of-way and will provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts and to determine legal adequacy of easements, permits, etc., for the construction of the 12 floodwater retarding structures listed in the plan. Funds for the local share of the project costs including land, easements, rights-of-way, all costs allocated to nonagricultural water management and administration of contracts, will be raised through a district-wide tax.

This project was determined to be one construction unit. All necessary land, easements, and rights-of-way will be obtained for this construction unit before Federal financial assistance is made available for construction. The structural measures will be scheduled for construction within a three-year period as follows:

Sites 1 through 5, first year; Sites 6 through 10, second year; and Sites 11 and 12, third year, pursuant to the following conditions:

1. The required land treatment in the drainage area above structures has been installed or is in the process of being installed.

2. The necessary land, easements, and rights-of-way have been obtained.

3. Court orders have been obtained from the Commissioners Court showing that county roads affected by structural works of improvement will either be closed, raised two feet above emergency spillway crest elevation at no cost to the Federal Government, relocated, or permission granted to temporarily inundate the road provided equal alternate routes will be provided.

4. The contracting agency is equipped to handle its responsibilities.

5. The local share of the cost for the nonagricultural water management structure is available.

6. Operation and maintenance agreements have been executed.

7. Water rights have been obtained.

8. Federal funds are available.

Technical assistance will be provided by the Soil Conservation Service to assist in planning, designing, preparation of specifications,

supervision of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion and related tasks necessary to establish the planned structural measures for flood prevention.

The Red River County Commissioners Court will relocate roads and bridges which are involved in the floodwater retarding structure sites snd will provide access roads to the sites as requested by the Red River County Water Control and Improvement District No. 1, Langford Creek.

The Red River County Water Control and Improvement District No. 1, Langford Creek, will provide without reimbursement professional engineers to work with the Service in developing and installing the features of the plan relating to storage of water for recreational uses and standby reserve for municipal and industrial supply in Site 1.

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

PROVISIONS FOR OPERATIONS AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners and operators of the farms on which the measures are applied, under agreements with the Red River County Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform the management practices and maintenance needs. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The estimated annual operation and maintenance cost is $1,967, based on long-term price levels. The Red River County Water Control and Improvement District No. 1, Langford Creek, will be responsible for operation and maintenance of the 12 floodwater retarding structures. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. The Red River County Water Control and Improvement District No. 1, Langford Creek, will establish a permanent reserve fund for this purpose in the following manner and amounts:

> As structures are completed, $200 per year per structure will be placed in a reserve for operations and maintenance until the sum of $1,000 per structure for the first ten and $750 per structure for the remaining two is established. This will amount to $11,500 when all 12 floodwater retarding structures are built and the reserve fund will be maintained at this level.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or stream flow by representatives of the Red River County Water Control and Improvement District No. 1, Langford Creek, and the Red River County Soil Conservation District. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as a part of the structure. The Soil Conservation Service, through the Red River County Soil Conservation District, will participate in operation and maintenance only to the extant of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the cosponsoring organizations and Federal representatives to inspect and provide maintenance for all structural measures and their appurtenances at any time.

The cosponsoring local organizations will maintain a record of and report to the Soil Conservation Service all maintenance inspections made and all maintenance work done.

The city of Clarksville will maintain the existing channels of Delaware and Langford Creeks within the city limits by removing brush, debris and woody vegetation from within the stream channels.

The cosponsoring local organizations fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of invitation to bid on construction of the structural measures.

COST SHARING

Public Law 566 funds are expected to provide technical assistance in the amount of $15,550 during the 5-year installation period to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. Private interests will install these measures at an estimated cost of $129,770, which includes ACPS payments based on present program criteria (table 1).

The required local cost for structural measures consists of the value of land, easements, and rights-of-way, the capitalized value of operation and maintenance of works of improvement, allocated costs for nonagricultural water supply, and the costs of administering contracts. These costs are estimated to be $188,611.

The entire cost of constructing the structural measures, except that

portion allocated to nonagricultural water management, will be borne by the Federal Government. Public Law 566 construction costs will be $248,169. In addition $82,392 of the installation services cost will be borne by Public Law 566 funds. This is a total Federal cost of $330,561 for the installation of structural measures to be borne by Public Law 566 funds.

Floodwater retarding structure No. 1 will be a multiple-purpose structure for flood prevention and nonagricultural water management. The other 11 floodwater retarding structures will be constructed for flood prevention only.

The Separable Costs - Remaining Benefits Method of Cost Allocation described in the Watershed Protection Handbook, Section 6, V, B, was used in allocating the $128,066 installation cost of structure No. 1 among purposes. Consideration was given to providing an alternate standby municipal and industrial water supply from wells. However, the recreational purposes requested by local interests could not be served by such a system, so it was not evaluated. The installation and capitalized operation and maintenance cost of a structure in place of No. 1 designed for flood prevention alone would be $67,426. The engineering firm's estimate of the installation and capitalized operation and maintenance of a structure designed for the storage of 1,118 acre-feet of water was $88,528. Analysis of the savings from the multiple-purpose structure showed that $55,820, or 43.50 percent of the total installation cost should be allocated to flood prevention. The remaining $72,246, (56.41 percent) was allocated to nonagricultural water management. Details of this analysis are shown in Section 2 of this work plan under "Economic Investigations". It should be noted in this analysis that nonagricultural water management will bear $16,438, or almost 72 percent, of the $22,950 cost of land, easements and rights-of-way and somewhat less than 52.98 percent of the construction costs. This arises becauee storage of water will cause lands to be inundated permanently, whereas floodwater detention normally permits considerable use of the land.

The total project cost, $670,407, including the capitalized value of structure operation and maintenance, will be shared 51.6 percent ($346,111) by Public Law 566 funds, and 48.4 percent ($324,296) by other than Public Law 566 funda.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

This project conforms to all Federal laws and regulations and will have no known detrimental effects on any downatream projects which are now in existence or might be constructed in the future.

For a period of three years from May 28, 1956, surplus crops grown on lands reclaimed by flood prevention and the lands so reclaimed, shall be ineligible for any benefits under the soil bank provisions of the Soil Bank Act and under price support legislation.

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

The physical condition of the soil in the Langford Creek watershed is fair. The areas where row crops are grown continuously have poor soil conditions, while in the areas where legumes or other soil building crops and grasses are grown in rotations, the soil is in fair physical condition, with a few isolated areas in good condition. The soils, all of which are in the Blackland Prairies Land Resource Area, are dark gray to light gray or buff clays, silty clays, and sandy clay loams of the Houston, Wilson, and Crockett series; slowly to very slowly permeable; and usually deep, with some isolated shallow areas.

Cover Conditions

Sample areas, consisting of approximately 37 percent of the area, were selected and mapped to show hydrologic soil group, cover condition, land use, crop distribution, and land treatment. The information was expanded to represent the present soil-cover complex condition of the watershed. Land treatment needs were projected from present conditions to determine the expected future soil-cover complex conditions with expected land treatment measures applied. These studies indicate that approximately 16 percent of the watershed is in cultivation, 73 percent in pasture, 5 percent in wooded range, and 6 percent in urban and other miscellaneous uses.

The hydrologic cover condition of the pastureland is as follows: 41 percent fair condition and 59 percent poor condition. The existing predominant grasses are Bermudagrass, Johnsongrass, and annual grasses.

Land Use and Treatment Needs

The needed land treatment for the watershed was developed by the Soil Conservation Service work unit at Clarksville. That portion of these needs that will be applied during the five-year installation period are included in table 1.

Program Determination

Flood problems and program objectives were reviewed with representatives of the Red River County Soil Conservation District; Red River County Water Control and Improvement District No. 1, Langford Creek; Red River County Commissioner's Court; and the Clarksville City Council.

Determination was made of the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to flood prevention. The hydraulic, hydrologic, sedimentation, and economic investigations provided data on the effects of these measures in terms of the reduction of flood damages resulting from such treatment. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection desired by the local people.

The second determination consisted of a structural program, that when combined with the land treatment program would give the degree of flood protection desired by the local people, and would also have a favorable benefit-cost ratio. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. Using consecutive 4-inch aerial photographs and a stereoscope, all probable floodwater retarding structure sites were located, the limits and the area of the flood plain delineated, and points marked where valley cross sections should be surveyed for the determination of hydraulic characteristics of the stream channel and valley for flood routing purposes and for making borings to determine scour and sediment damages. Cross sections of the flood plain were surveyed at the selected locations (figure 1). Data developed from these cross sections permitted the computation of peak discharge-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations, and other pertinent information were recorded.

2. A field examination was made of all probable floodwater retarding structure sites previously located on the watershed base map. Sites which did not show good storage possibilities or which would inundate highways, railroads, or valuable improvements, the relocation of which could not be economically justified, were dropped from further consideration. From the remaining sites, a system of 12 floodwater retarding structures was selected for further consideration and detailed survey. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 5 and 5A.

3. A topographic map was made of the reservoir area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the dam, and the area of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the criteria outlined in Washington Engineering Memorandum No. 3 (Revised 1956). The limits of the flood

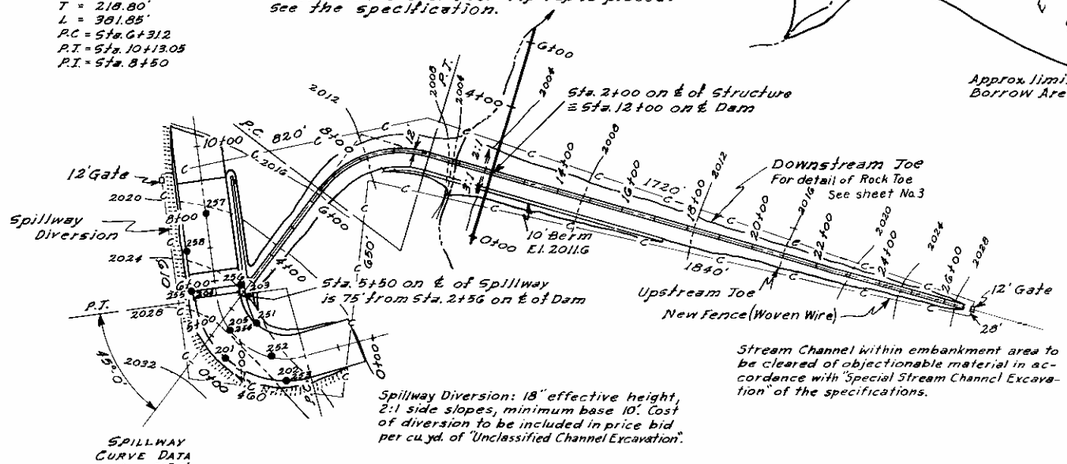
Clay
Silt
Limestone
Flagstone & Cobbles
Lime

C.	Clay	Clayey	Cal.	Calcareous
Si.	Silt	Silty	Vug.	Vugular
Ch.	Chalk	Chalky	Fc.	Fractured
S.	Sandy	Sandy	Fri.	Friable
Gr.	Gravel	Gravelly	Fi.	Firm
M.	Marl	Marly	Vl.	Very
Ls.	Limestone		So.	Soft
Flg.	Flagstone		H.	Hard
Mas.	Massive		Cob	Cobbles
Mat	Matrix			

LEGEND OF BORINGS

EMBANKMENT CURVE DATA
Δ = 69°-0'
D = 18°-04.3'
R = 318.36'
T = 218.80'
L = 381.85'
P.C. = Sta. 6+31.2
P.I. = Sta. 10+13.05
P.I. = Sta. 8+50

A minimum of 6" of topsoil to be placed in spillway and on all embankment, dike, spillway slopes and waste area except where rock is encountered or rock rip rap is placed. See the specification.



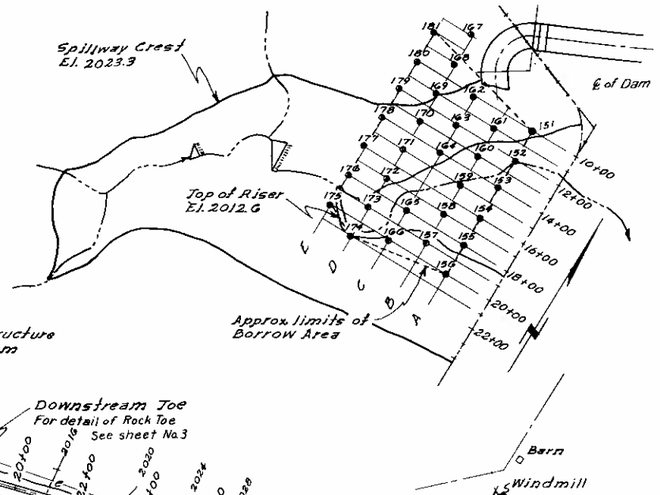
Spillway Diversion: 18" effective height, 2:1 side slopes, minimum base 10'. Cost of diversion to be included in price bid per cu yd. of "Unclassified Channel Excavation".

Stream Channel within embankment area to be cleared of objectionable material in accordance with "Special Stream Channel Excavation" of the specifications.

SPILLWAY CURVE DATA
Δ = 98°-0'
D = 28°-0'
R = 204.68'
L = 350.0'
P.C. = Sta. 2+00
P.I. = Sta. 5+50

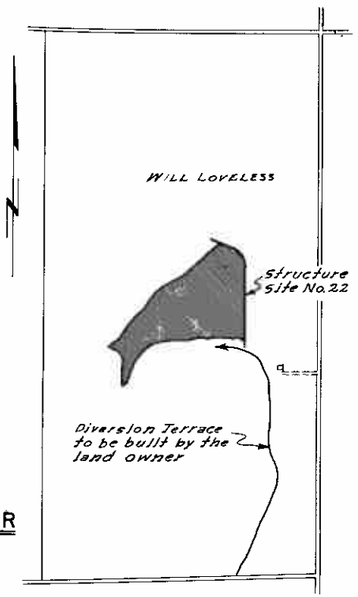
PLAN OF EMBANKMENT AND SPILLWAY

0 200 400 1000
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

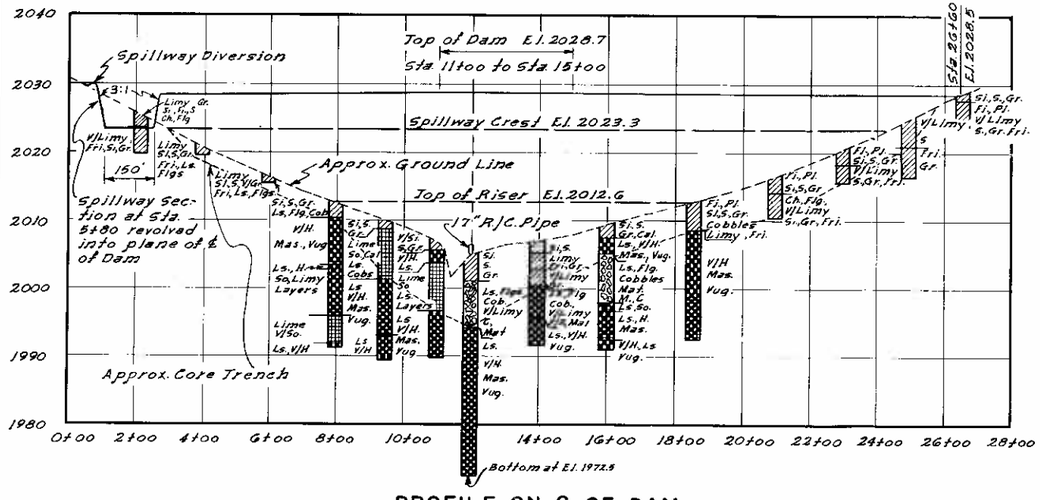
0 400 800 1600
SCALE IN FEET



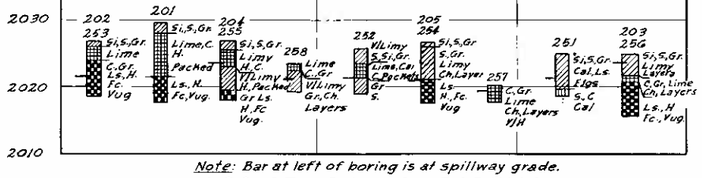
Located 5½ mi. East and 4 mi. South of Eden, Concho County, Texas

VICINITY MAP

0 ¼ ½ 1
SCALE IN MILES



PROFILE ON ℄ OF DAM



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

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

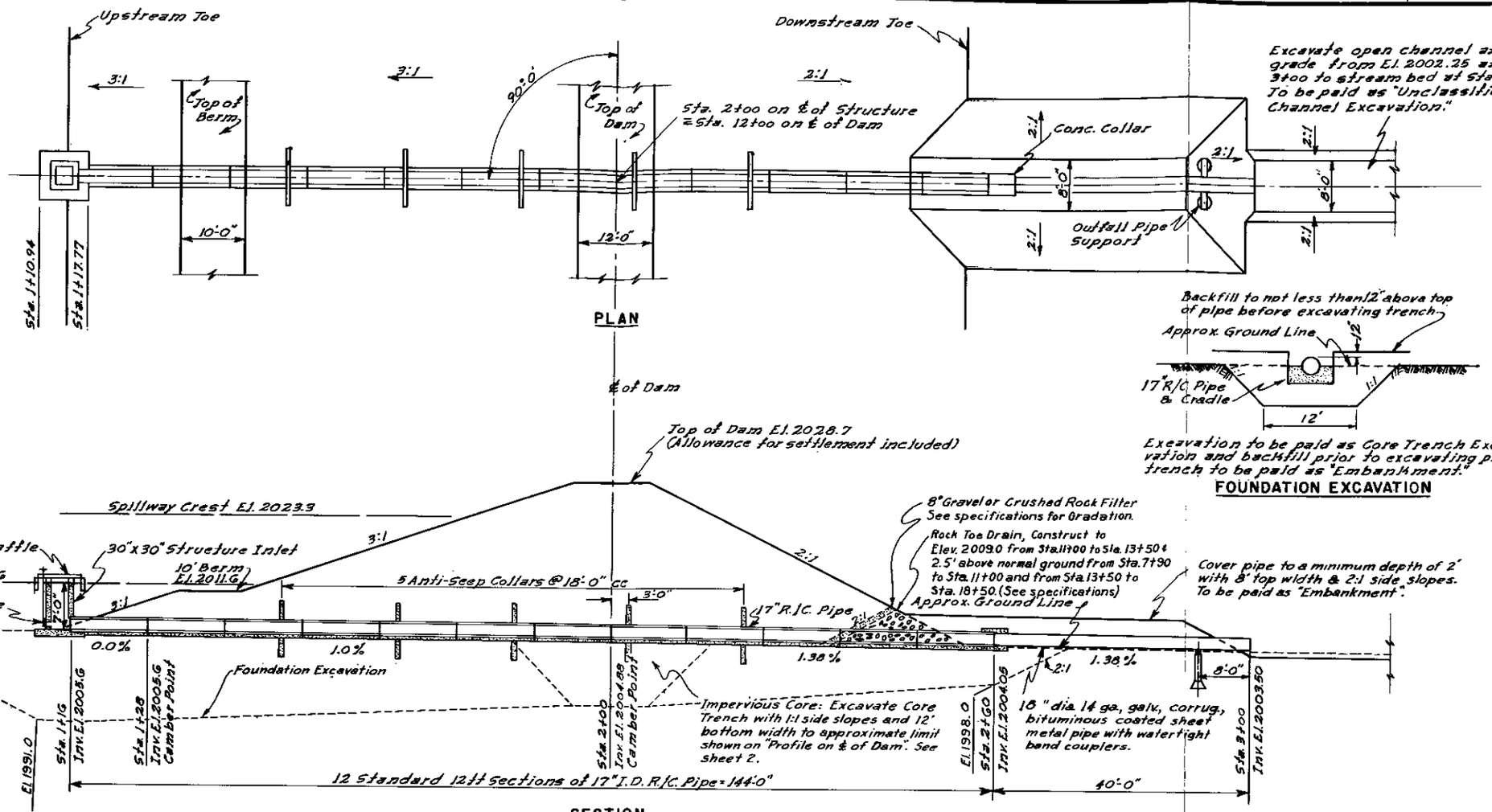
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
2012.6	16.84	51.70	0.50
2016.0	30.76	132.66	1.28
2020.0	54.21	302.60	2.92
2023.3	74.94	515.68	5.00
2024.0	79.33	569.68	5.50
2028.0	108.17	944.68	9.13

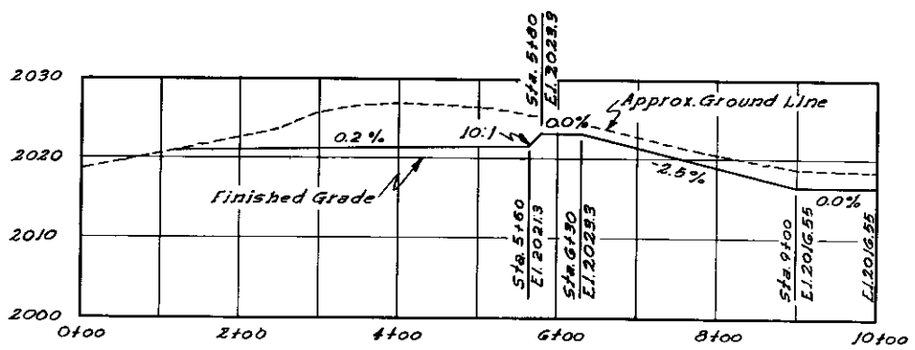
Top of Dam (Effective) Elev.	2028.5
Spillway Crest Elev.	2023.3
Top of Riser Elev.	2012.6
Sediment Pool Elev.	2012.6
Drainage Area, Acres	1262.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	464.0

Figure 5
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND PROFILE

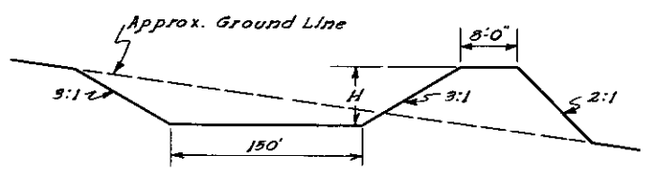
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	H.C.N.	Date 8-56	Approved by ____ HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	H.C.N. & G.R.	8-56	SOIL CONSERVATION ENGINEER, S.C.S. TEMPLE, TEXAS
Traced	G.R.	8-56	Sheet No. 2 of 7
Checked	H.C.N. & H.H.I.	9/56	Drawing No. 4-E-10,760





PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.55 from Sta. 5+00 to Sta. 6+30 12 ft. top width with 10:1 end slope. Transition from El. 2028.55 at Sta. 6+30 to 4 ft. height at Sta. 7+00, top width 8 ft. H = 4 ft. from Sta. 7+00 to Sta. 9+00, top width 8 ft. with 10:1 end slope.

TYPICAL SPILLWAY SECTION

Figure 5A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	H.C.N.	8-56	Approved by: W. M. Area Engineering & Watershed Planning Engr. Fort Worth, Texas
Drawn	H.C.N. & G.R.	8-56	State Conservationist, S.C.S. Temple, Texas
Traced	G.R.	8-56	Sheet No. 3 of 7
Checked	H.C.N & H.H.L.	9/56	Drawing No. 4-E-10,760

pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map (figure 3). Structure data tables were developed from engineering surveys to show for each structure the drainage area, the capacity needed for floodwater detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the acres of flood plain inundated by the sediment and detention pools, the volume of fill in the dams, the estimated cost of the structures, and other pertinent data (tables 2 and 3).

4. Damages resulting from floodwater, sediment, and flood plain erosion were determined from damage schedules, surveys of sample areas, and flood routing under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of peak discharges as determined by flood routing under future conditions, for which it was assumed that the proposed works of improvement had been installed. Benefits so determined were allocated to individual structures or groups of interrelated structures on the basis of the effect of each on reduction of damages. In this manner it was determined that a system of 12 floodwater retarding structures could be economically justified.

5. After analysis of agricultural damages and benefits it was found that all structures were economically feasible. The peak flow from the storm of September 30, 1955, was considerably in excess of that which could be expected to occur on an average of once in 100 years. For the purpose of damage evaluation, it was assumed that the storm was of a magnitude which could be expected once in 200 years, and the urban damages in Clarksville were divided by 200 to convert them to an annual basis.

Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau and Water Supply Papers, U. S. Geological Survey, and analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, the historical flood series to be used in the evaluation of the program, rainfall-runoff relationship of geology, soils and climate to runoff depth-frequency for single storm events.

2. Engineering surveys were made of channel and valley cross sections selected to adequately represent the stream

hydraulics and flood plain area. Preliminary locations for cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground, giving due consideration to the needs of the economist and the geologist. The evaluation reaches were delineated in conference with the economist and sedimentation specialists. The composite acre damageable values are homogeneous within each evaluation reach.

3. The present hydrologic condition of the watershed was determined by surveying the soil-cover condition of a 37 percent sample of the watershed and expanding this data to the entire watershed. The future hydrologic condition of the watershed was determined by obtaining from the Work Unit Conservationist the changes in land use that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were computed from the soil-cover complex data and used with figure 3.10 - 1, National Engineering Handbook Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series. Monthly soil moisture indices were used. Adjustments were made in the computed runoff curve numbers to make the computed average annual runoff compare favorably with the records from stream gages on similar watersheds in the area.

4. Cross section rating curves were computed from field survey data listed in item 2, above, by solving water surface profiles for various discharges, using a variation of Leache's method as described on page 4.1-1 to 4.1-5 of the National Engineering Handbook Section 4, Supplement A.

5. The theory of concordant flow was used to determine the relationship of peak discharge and drainage area. The exponent of the concordant flow equation was determined from good high water marks left by two recent floods and from the runoff computed from available records of rainfall that preceded these floods.

6. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Composite runoff area inundation curves were developed for each evaluation reach by routing selected volumes of runoff downstream by concordant flow procedures and summating the area flooded for each portion of the valley represented by a cross section in the evaluation reach. Similarly a family of runoff-area inundation curves were developed to reflect the effect of the system of floodwater retarding structures.

7. The period 1923 to 1942 inclusive was selected as the most representative of normal precipitation on the watershed, and

is the period from which the historical evaluation flood series was developed.

8. Determinations were made of the area that would have been inundated by each storm in the evaluation series under conditions that would exist due to:

   a. The present conditions of the watershed remaining static.

   b. The installation of land treatment measures for watershed protection.

   c. The installation of land treatment measures and floodwater retarding structures.

9. Runoff computations were made, giving due consideration to antecedent moisture conditions, for each runoff-producing 24-hour storm that occurred during the evaluation period. The Hazen method of analysis was used to develop a runoff frequency curve of the maximum annual runoff values. This runoff frequency curve was used to compare values of runoff computed from stream gage records and to determine the frequency of flooding in each evaluation reach. (See table in item 10).

10. The largest rain which occurred during the 20-year period was a storm of 8.38 inches on May 21 and 22, 1933.

    If soil moisture condition II is assumed, the computed runoff from a storm of this size is 6.93 inches. The annual flood frequency line developed by means of the computed runoff for the 20-year period indicates a frequency of once in 87 years for this storm. The following table indicates the flows and frequencies at which flood damages begin in the various evaluation reaches. The section referred to as the reference section is valley section number 18 which is near the downstream boundary of the watershed (figure 1).

Evaluation Reach (Figure 1)	Valley Cross Sections	Discharge at Smallest Section in Reach (c.f.s.)	Discharge at Reference Section (18) (c.f.s.)	Frequency of Occurrence (year)
A	9 thru 14, D21, D22	1,075	1,760	1*
B	15 thru 18	1,305	1,305	1*
C	B1 thru B7	810	1,642	1*
D	EB1	1,680	5,435	1
E	D14	1,500	6,373	1.2
F	7	2,650	8,524	1.5

* More than once per year.

11. It has been determined that the most desirable floodwater detention capacity for this watershed is the approximate runoff resulting from Yarnell's (U.S.D.A. Miscellaneous Publication No. 204) 18-hour storm of 25- and 100-year frequency for Class A and C structures, respectively. Additional capacity was planned in some of the structures to obtain a more economical or desirable emergency spillway or structure design.

    Frequency of use of emergency spillways was determined by adding to the actual detention storage, the volume which would be released by the principal spillways during a 12-hour period.

12. The average principal spillway release rates will range from 10 to 20 c.s.m. The capacity of the smallest channel section through which the release waters will pass is considerably more than adequate to carry the average release. The average release rate of each of the three class C structures (Sites 1 2, and 5) will be 20 c.s.m. This higher release rate will insure available floodwater storage for runoff from flood-producing storms following in close succession.

13. The appropriate spillway design storm, freeboard design storm and storm pattern was selected from figures 3.21 and 3.25 of National Engineering Handbook, Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum No. 3 (Revised 1956).

14. Spillway design storm hydrographs were developed for each of the floodwater retarding structures by the distribution graph method. The combination of emergency spillway width, depth, and elevation for the most economical structure was determined by an empirical equation. The final preliminary design was obtained on a representative number of sites by the Goodrich flood routing method described on page 5.8-12 of National Engineering Handbook, Section 5.

Sedimentation Investigation

The field surveys of the sedimentation problems in the watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans". Water Conservation 6, SCS, Region 4, revised February 1954. Field studies of overbank deposits, flood plain scour, streambank erosion, and the nature of the channels and valley were made near all the valley cross sections. Borings were made near all cross sections to determine the nature and thickness of sediment deposits. In the preparation of the work plan, tabular summaries of all the above findings, with explanatory texts, were prepared. These were used by the economist as a basis for calculating monetary damages.

Sediment Source Studies

Investigations of sediment sources in the drainage areas above floodwater retarding structures were made according to standard procedures. Estimates were then made for future sediment production in the drainage areas. The sediment production derived from sheet erosion was estimated by the use of a formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairies Problem Area in Soil Conservation," Soil Conservation Service, Region 4, February 1953. The formula is based on data obtained by watershed surveys, including the following:

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

2. Cover condition classes on pasture and woods.

3. Past history of land use.

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

The amount of sediment derived from gully and streambank erosion was estimated by field studies, use of aerial photographs, and by interviews with landowners in the watershed who were able to give information on the history of gully development and channel enlargement.

The total annual sediment yield above the 12 floodwater retarding structures was calculated to be 10.59 acre-feet. The average rate of sediment deposition per square mile is 0.76 acre-foot annually. It is estimated that 91 percent of the gross erosion in the upland areas of the watershed results from sheet erosion and 8 percent from modern gully and streambank erosion.

Effect of Watershed Treatment on Sediment Yield

The 1,031 acres damaged by overbank deposition and the 176 acres damaged by flood plain scour should be rendered productive again after they have been protected from flooding,and adapted soil improving crop rotations have been put into effect. With the installation of the complete program the present area of sediment damage (overbank deposition) will be reduced 63 percent.

Analysis of present watershed conditions indicate that the major portion of the annual sediment production results from sheet erosion of cultivated land. The proper application of the needed land treatment measures will reduce sediment production from the upland areas approximately 31 percent.

The installation of the complete program will have a measurable effect on the reduction of flood plain scour damage. The present area damaged by

this process will be reduced approximately 40 percent. The future area of damage will be confined to that portion of the flood plain inundated to depths of one foot or more.

Geological Investigations

Preliminary geologic dam site investigations were made at each of the planned floodwater retarding structure sites. These studies included valley slopes, alluvium, channel banks, and exposed geologic formations. Borings, with a hand auger, were made at representative sites to determine the nature and extent of fill material, that might be encountered in construction.

Description of Problems

Formations of the Taylor and Navarro Groups, of Upper Cretaceous Age, outcrop in the watershed. The Taylor (undivided)Group outcrops in the northwest corner of the watershed and again in a belt some two and one-half miles wide just south of Clarksville. Between these two outcrops is a tongue of the Annona Chalk formation, also of the Taylor Group. South of the Taylor Group is the Navarro (undivided) Group, which underlies the remainder of the watershed. There are recent alluvial deposits of silts and clays along the flood plain of the watershed.

Sites 1, 2, 3, 4, 5, and 12 are located within the outcrop of the Annona formation. This formation consists of approximately 50 feet of bluish gray, sandy chalk that weathers light gray and white. The formation is fine grained and in some instances resembles claystone. The Annona is massively bedded and does not appear to be fractured. It will not be necessary to make any emergency spillway excavation into this chalk, and it will be encountered only in the keying in of the core trench. No major problems are anticipated from construction in the Annona formation.

Sites 6, 7, 8, 9, and 10 are located within the outcrop of the Taylor (Undivided) group. This formation is characterized by clays, silty clays, and some soft shale, which is somewhat sandy and contains some shert gravel. There should be no major problems encountered in construction at these sites. Site No. 11 is located within the outcrop of the Navarro (undivided) group, which consists of dark colored clays and soft shales. Construction in this location should not encounter any major problems.

Soil material for embankment purposes is ample at each site location in the watershed. Compaction, strength, and shear resistance will be good to excellent at all sites.

The formations in the watershed when stripped of vegetative cover are very susceptible to erosion and will be revegetated as soon as possible after construction. Maximum permissible velocities in the emergency spillways of the sites will be 8 feet per second or less.

Detailed investigations, including exploration with core-drilling equipment, will be made at all floodwater retarding structure sites prior to their construction. Laboratory tests will be made to determine the suitability and handling of the available embankment, cutoff wall, and foundation material.

Economic Investigation

Basic methods used in the economic investigation and analysis are outlined in the Interim Economics Guide issued May 14, 1956.

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based upon schedules obtained in the field covering approximately 85 percent of the flood plain of Langford Creek and its tributaries. These schedules covered land use, crop distribution under normal conditions, crop yields and historical data on flooding and flood damage.

Most of the flood damage information obtained was for floods which occurred in 1955 and 1957.

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

The proper rates of damages were applied, flood by flood, to the floods covering the historical period 1923 to 1942, and an adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year. The flood plain land use was mapped in the field. Normal yields were based on data obtained from the schedules supplemented by information obtained from agricultural workers in the area.

It was found that significant differences in land use, yields, frequency of flooding, and degree of future use were sufficient to divide the flood plain into four evaluation reaches.

Identical damageable values were used for Reaches A, C, and D and a different value for Reach B.

The locations of the evaluation reaches are (figure 1):

Reach A - from confluence of Delaware and Langford to a point half way between valley cross sections 14 and 15.

Reach B - from a point halfway between valley cross sections 14 and 15 to the confluence of Langford and Cuthand Creeks.

Reach C - Boggy Creek.

Reach D - East Branch.

Reach E - Delaware Creek urban area.

Reach F - Langford Creek urban area.

Estimates of damages to other agricultural property such as fences, livestock, and farm equipment were made from analysis of flood damage schedules and correlated with size of floods.

Benefits on each tributary flood plain were allocated to the structures on that tributary on the basis of drainage area controlled. Benefits on the common flood plain below the confluence of each tributary with the mainstem were allocated to the structures producing the benefits on the basis of drainage area controlled by each structure.

The monetary value of the physical damage to the flood plain from erosion and from deposition of sediment was based on the net value of the production lost, taking into account any lag in recovery and/or the cost of farm operations to speed recovery. Damage from erosion was related to depth of flooding, giving greater weight to deeper flows.

Estimates of damages to roads and bridges in the flood plain were obtained from county commissioners and from the state highway district maintenance engineers. These estimates were supplemented by information obtained from local farmers.

Indirect damages in this watershed primarily involve extra farming expense, such as, additional travel time for farmers and costs for extra feed; rerouting school bus transportation, and mail delivery; and interruption of utility service. Upon analysis, it appeared that these damages are about 10 percent of the direct damage for Evaluation Reaches A, B, C, and D and 15 percent for Reaches E and F.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. This information, together with landowner's and operator's estimates of changes in land use and crop distribution as a result of reduction in flood extent and frequency, was the basis for estimating benefits from restoration of productivity. No benefits were projected for changed land use since it appears upon analysis that no new land will be placed in cultivation.

Benefits from restoration of productivity are included as crop and pasture benefits. They involve changes in crop distribution, increased yields due to earlier dates of planting and lower costs of tillage. Consideration was given to increased damage after restoration of productivity and the added damage was deducted. All benefits from restoration of productivity are net benefits remaining after production and harvest costs,

additional costs for taxes, and overhead, and clearing costs where applicable. All benefits from restoration of productivity were discounted to provide for a 10-year lag in accomplishment. They total about $13,500 annually at long-term price levels, ARS projection of September 1957.

Flood plain areas which will be inundated by the sediment, sediment reserve and detention pools were excluded from the damage calculations. An estimate was made, however, of the value of the production lost in these areas after installation of the project. In this appraisal it was considered that there would be no production in the sediment pools, and that the land covered by the detention pools would continue to be used as pasture after installation of the project.

The cost of land, easements, and rights-of-way for the 12 floodwater retarding structures was determined by individual appraisal in conjunction with directors of the Red River County Water Control and Improvement District No. 1, Langford Creek. This evaluation was based on full value for the sediment pools and half value for the detention pools, since the latter will remain in use as pasture.

The average annual loss in production within the structure sites was compared with the amortized value of easements. The easement value was found to be the greater and therefore was used in economic justification to assure a conservative benefit-cost analysis.

Investigation was made of the possibility of dividing the structures into construction units. Only one site, No. 12, was found to be economically justifiable as a construction unit. After consultation with the officials of the water control and improvement district it was determined that all structures would be included in a single unit.

Costs for structure site 1 were allocated between purposes using the separable cost-remaining benefits method. The actual allocation is shown in the following tables:

Allocation of Costs Between Purposes 1/

Structure Site 1

Item	Flood Prevention	Municipal Water Supply	Total
	(dollars)	(dollars)	(dollars)
Step A			
1. Benefits	328,473	88,528 2/	417,001
2. Alternate Costs Installation	63,456	79,882	143,338
3. Lesser of 1 or 2	63,456	79,882	143,338
4. Separable Costs Installation	48,184	64,610	112,794
5. Remaining Benefits	15,272	15,272	30,544
6. Allocated Joint Costs Installation	7,636	7,636	15,272
7. Total Allocated Cost Installation	55,820	72,246	128,066
Land, Easements & R.O.W.	6,512	16,688	23,200
Remainder	49,308	55,558	104,866
Percent for Allocation	47.02	52.98	100.0

1/ Current price levels.

2/ It is assumed that benefits from nonagricultural water management are at least equal to the cost.

Allocation of Costs Between Funds

Structure Site 1

Item	Flood Prevention			Water Supply	Total All Cost
	P.L. 566 Funds	Other	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Step B					
1. Engineering Estimate	33,492	-	33,492	37,738	71,230
2. Contingencies	3,350	-	3,350	3,773	7,123
3. Total Construction	36,842	-	36,842	41,511	78,353
Installation Service					
4. Engineering Service	7,368	-	7,368	8,302	15,670
5. Other	4,863	-	4,863	5,480	10,343
6. Total Installation Service	12,231	-	12,231	13,782	26,013
7. Adm. of Contracts	-	235	235	265	500
8. Easements and Water Rights	-	6,512	6,512	16,688	23,200
9. Total Installation Cost	49,073	6,747	55,820	72,246	128,066
10. Percent of Total	38.32	5.27	43.59	56.41	100.0

Percent for Allocation See Step A

Flood Prevention	47.02
Water Supply	52.98

Benefits Outside the Watershed

No determination was made of benefits outside of the watershed.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Langford Creek Watershed, Texas
Price Base: Current Price Levels

Structure Number	Public Law 566 Installation Cost					Other Installation Cost							Estimated Total Cost
	Construction		Installation Services			Construction		Installation Services	Other				
	Engineer's Estimate	Contingencies	Engineering	Other	Total P.L. 566	Engineer's Estimate	Contingencies		Adm. of Contract	Easement & R/W	Water Rights	Total Other	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	33,492	3,350	7,368	4,863	49,073	37,738	3,773	13,782	500	22,950	250	78,993	128,066
2	19,460	1,946	4,281	2,826	28,513	-	-	-	500	9,550	-	10,050	38,563
3	16,041	1,604	3,529	2,329	23,503	-	-	-	500	3,925	-	4,425	27,928
4	16,036	1,603	3,528	2,328	23,495	-	-	-	500	2,400	-	2,900	26,395
5	23,170	2,317	5,097	3,364	33,948	-	-	-	500	3,350	-	3,850	37,798
6	10,045	1,005	2,210	1,459	14,719	-	-	-	500	1,925	-	2,425	17,144
7	11,554	1,155	2,542	1,678	16,929	-	-	-	500	2,600	-	3,100	20,029
8	9,829	983	2,163	1,427	14,402	-	-	-	500	1,305	-	1,805	16,207
9	9,796	980	2,155	1,422	14,353	-	-	-	500	1,018	-	1,518	15,871
10	11,306	1,131	2,487	1,642	16,566	-	-	-	500	1,363	-	1,863	18,429
11	21,987	2,199	4,837	3,193	32,216	-	-	-	500	5,205	-	5,705	37,921
12	42,891	4,289	9,436	6,228	62,844	-	-	-	500	15,688	-	16,188	79,032
GRAND TOTAL	225,607	22,562	49,633	32,759	330,561	37,738	3,773	13,782	6,000	71,279	250	132,822	463,383

W-11-Ft.W.-58

April 1958

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES AND WATER SUPPLY RESERVOIRS

Langford Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7
Drainage Area	Sq.Mi.	2.96	0.75	0.63	0.58	0.52	0.33	0.57
Storage Capacity								
Sediment	Ac.Ft.	79	20	27	31	25	17	28
Sediment in detention pool	Ac.Ft.	16	4	3	3	3	2	3
Floodwater detention	Ac.Ft.	1,120	286	190	165	201	95	162
Subtotal	Ac.Ft.	1,215	310	220	199	229	114	193
Water Supply 1/	Ac.Ft.	1,118	-	-	-	-	-	-
Total	Ac.Ft.	2,333	310	220	199	229	114	193
Surface Area								
Sediment pool (top of riser)	Acre	26	8	9	11	9	7	9
Floodwater detention pool	Acre	250	48	38	34	36	27	37
Water supply pool	Acre	160	-	-	-	-	-	-
Maximum Height of Dam	Foot	30	22	20	19	21	15	17
Volume of Fill	Cu.Yd.	166,840	50,770	40,760	41,800	60,440	25,690	27,400
Emergency Spillway								
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of use	Year	100	130	35	25	140	30	30
Design storm rainfall								
Duration	Hour	6	6	6	6	6	6	6
Total	Inch	33.4	35.0	14.0	14.0	35.2	14.2	14.1
Bottom width	Foot	250	160	130	120	120	60	100
Design depth	Foot	4.0	3.0	2.0	2.0	2.0	2.0	2.0
Design capacity	c.f.s.	5,000	2,129	845	780	1,596	390	650
Freeboard	Foot	2.0	2.0	1.0	1.0	2.0	1.0	1.0
Total capacity	c.f.s.	9,500	4,880	1,729	1,596	3,660	798	1,330
Principal Spillway								
Capacity (Maximum)	c.f.s.	75	20	10	10	15	5	10
Capacity Equivalents								
Sediment volume	Inch	0.50	0.50	0.80	1.00	0.90	1.00	0.90
Sediment volume in detention pool	Inch	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Detention volume	Inch	7.10	7.15	5.60	5.35	7.32	5.50	5.30
Spillway storage	Inch	11.91	7.35	4.14	3.98	8.58	6.10	4.50
Class of Structure		C	C	A	A	C	A	A

1/ To be used for recreation and standby municipal and industrial water supply.

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES AND WATER SUPPLY RESERVOIRS Continued

Langford Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 8	9	10	11	12	Total
Drainage Area	Sq.Mi.	0.39	0.36	0.49	2.15	7.19	16.92
Storage Capacity							
Sediment	Ac.Ft.	21	19	34	115	154	570
Sediment in detention pool	Ac.Ft.	2	2	5	11	38	92
Floodwater detention	Ac.Ft.	109	103	147	608	2,028	5,214
Subtotal	Ac.Ft.	132	124	186	734	2,220	5,876
Water Supply 1/	Ac.Ft.	-	-	-	-	-	1,118
Total	Ac.Ft.	132	124	186	734	2,220	6,994
Surface Area							
Sediment pool (top of riser)	Acre	6	7	8	30	50	180
Floodwater detention pool	Acre	21	22	27	103	287	930
Water supply pool	Acre	-	-	-	-	-	160
Maximum Height of Dam	Foot	21	17	21	24	27	xxx
Volume of Fill	Cu.Yd.	24,780	25,340	29,260	56,830	111,340	661,250
Emergency Spillway							
Type		Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Frequency of use	Year	25	25	35	25	25	xxx
Design storm rainfall							
Duration	Hour	6	6	6	6	6	xxx
Total	Inch	14.2	14.2	14.1	13.5	12.8	xxx
Bottom width	Foot	100	90	100	140	170	xxx
Design depth	Foot	2.0	2.0	2.0	3.0	4.0	xxx
Design capacity	c.f.s.	650	585	650	1,862	3,638	xxx
Freeboard	Foot	1.0	1.0	1.0	1.0	1.0	xxx
Total capacity	c.f.s.	1,330	1,197	1,330	2,996	5,185	xxx
Principal Spillway							
Capacity (Maximum)	c.f.s.	5	5	10	30	135	xxx
Capacity Equivalents							
Sediment volume	Inch	1.00	1.00	1.30	1.00	0.40	xxx
Sediment volume in detention pool	Inch	0.10	0.10	0.20	0.10	0.10	xxx
Detention volume	Inch	5.32	5.40	5.65	5.30	5.28	xxx
Spillway storage	Inch	3.68	4.00	3.65	4.50	4.47	xxx
Class of Structure		A	A	A	A	A	xxx

1/ To be used for recreation, and standby municipal and industrial water supply.

April 1958

TABLE 4 - SUMMARY OF PHYSICAL DATA

Langford Creek Watershed, Texas

Item	Unit	Quantity Without Program	Quantity With Program
Watershed area	Sq.Mi.	39.11	xxx
Watershed area	Acre	25,030	xxx
Area of cropland	Acre	4,095	4,823
Area of grassland	Acre	18,387	17,659
Area of wooded range	Acre	1,170	1,170
Miscellaneous area	Acre	1,378	1,378
Overflow area subject to damage	Acre	2,452 1/	1,485 1/
Area Damaged Annually By:			
Overbank deposition	Acre	1,031 2/	382 3/
Flood plain scour	Acre	176 2/	107 3/
Annual Rate of Erosion			
Sheet	Acre-Foot	51.24	35.20
Gully	Acre-Foot	3.12	2.35
Streambank	Acre-Foot	1.57	1.57
Scour	Acre-Foot	0.46	0.28
Average annual rainfall	Inch	44.46	xxx
Additional water available for beneficial use	Acre-Foot	xxx	1,118

1/ Detention Design Storm.
2/ Acreage on which some production loss occurs each year.
3/ The acreage on which production loss will occur each year after all recovery has taken place. Applies to all flooding up to the area inundated by the largest storm in the 20-year series.

April 1958

TABLE 5 - SUMMARY OF PLAN DATA

Langford Creek Watershed, Texas

Item	Unit	Quantity
Years to complete project	Year	5
Total installation cost		
Public Law 566 funds	Dollar	346,111
Other	Dollar	268,507
Annual O & M cost		
Public Law 566 funds	Dollar	-
Other	Dollar	1,967
Average annual monetary benefits 1/	Dollar	34,780
Agricultural	Percent	72
Nonagricultural	Percent	18
Structural Measures		
Floodwater retarding structures 2/	Each	12
Area inundated by structures		
Flood plain		
Sediment pool	Acre	18
Detention pool	Acre	-
Water supply pool	Acre	-
Upland		
Sediment pool	Acre	162
Detention pool	Acre	616
Water supply pool	Acre	134
Watershed area above structures	Acre	10,829
Reduction of floodwater damage	Dollar	31,705
By Land Treatment Measures		
Watershed Protection	Percent	8
By Structural Measures	Percent	78
Reduction of sediment damage	Dollar	864
By Land Treatment Measures		
Watershed Protection	Percent	30
By Structural Measures	Percent	32
Reduction of erosion damage	Dollar	237
By Land Treatment Measures		
Watershed Protection	Percent	12
By Structural Measures	Percent	65
Nonagricultural Water Management	Dollar	1,771

1/ From Structural Measures.
2/ Includes Site 1, a multiple purpose structure.

April 1958

M-11-Ft.W.-58

TABLE 6 - ANNUAL COSTS

Langford Creek Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Other Economic 1/	Total
		Public Law 566	Other	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures						
1	4,515	-	500	500	-	5,015
2	1,359	-	85	85	-	1,444
3, 4, & 5	3,248	-	302	302	-	3,550
6	605	-	85	85	-	690
7	706	-	110	110	-	816
8	571	-	90	90	-	661
9	560	-	90	90	-	650
10	650	-	105	105	-	755
11	1,337	-	300	300	-	1,637
12	2,787	-	300	300	-	3,087
TOTAL	16,338	-	1,967	1,967	-	18,305

1/ Price Base: Current prices, amortized for 50 years at 2.5 percent.

2/ Long-term price levels, September 1957, Price Projection ARS.

April 1958

TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES AND LAND TREATMENT

Langford Creek Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project (dollars)	After All: Land Treatment (dollars)	With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	24,509	23,221	3,570	19,651
Other Agricultural	6,904	6,121	956	5,165
Nonagricultural, Road and Bridge	5,020	4,284	825	3,459
Urban	785	770	162	608
Subtotal	37,218	34,396	5,513	28,883
Sediment Damage				
Overbank deposition	2,703	1,888	1,024	864
Subtotal	2,703	1,888	1,024	864
Erosion Damage				
Flood plain scour	365	321	84	237
Subtotal	365	321	84	237
Indirect Damage	4,068	3,698	673	3,025
Total, All Damage	44,354	40,303	7,294	33,009
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	33,009
Municipal or Industrial Water Supply	xxx	xxx	xxx	1,771
TOTAL NONAGRICULTURAL WATER MANAGEMENT BENEFITS	xxx	xxx	xxx	1,771
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	34,780
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	34,780

1/ As projected by ARS, September, 1957.

April 1958

TABLE 8 - BENEFIT COST ANALYSIS

Langford Creek Watershed, Texas
Price Base: Long-Term 1/

Measures	AVERAGE ANNUAL BENEFITS						Average Annual Cost (dollars)	Benefit Cost Ratio
	Flood Prevention				Nonagricultural Water Management (dollars)	Total (dollars)		
	Floodwater (dollars)	Sediment (dollars)	Erosion (dollars)	Indirect (dollars)				
Floodwater Retarding Structures								
1 2/	5,259	170	26	555	1,771	7,781	5,105	1.52:1
2	1,771	44	7	202	-	2,024	1,444	1.40:1
3, 4, and 5 3/	3,656	99	16	721	-	4,492	3,550	1.27:1
6	507	20	3	163	-	693	690	1.01:1
7	1,004	34	5	85	-	1,128	816	1.38:1
8	660	21	3	87	-	771	686	1.12:1
9	623	22	3	64	-	712	675	1.03:1
10	848	28	5	88	-	969	755	1.28:1
11	1,756	60	6	180	-	2,002	1,637	1.22:1
12	12,799	366	163	880	-	14,208	3,087	4.68:1
TOTAL	28,883	864	237	3,025	1,771	34,780	18,305	1.90:1

1/ September 1957 price projections ARS.
2/ Multi-purpose structure.
3/ Sites 3, 4, and 5 are interdependent.

April 1958

TABLE 9 - COST-SHARING SUMMARY

Langford Creek Watershed, Texas

Type of Cost	P.L. 566 Funds		Other Funds		Totel Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment						
Non-Federal Land For Watershed Protection	15,550	10.3	135,685	89.7	151,235	22.6
Subtotal	15,550	10.3	135,685	89.7	151,235	22.6
Structural Measures						
Installation						
Flood Prevention	330,561	84.5	60,576	15.5	391,137	58.3
Nonagricultural Water Management	-	-	72,246	100.0	72,246	10.8
Subtotal	330,561	71.3	132,822	28.7	463,383	69.1
Total Installation Cost	346,111	56.3	268,507	43.7	614,618	91.7
Operation & Maintenance	xxx	xxx	55,789	100.0	55,789	8.3
Total Structural Cost	330,561	63.7	188,611	36.3	519,172	77.4
TOTAL PROJECT COST	346,111	51.6	324,296	48.4	670,407	100.0

April 1958

TABLE 9A - ALLOCATION OF INSTALLATION COSTS OF STRUCTURAL MEASURES

Langford Creek Watershed, Texas
Price Base: Current Price Levels

Item	Flood Prevention (dollar)	Nonagricultural Water Management (dollar)	Total (dollar)
STEP A			
Single Purpose			
Sites 2 through 12	335,317	xxx	335,317
Multiple Purpose			
Site No. 1	55,820	72,246	128,066
Total	391,137	72,246	463,383
STEP B			
P. L. 566	330,561	xxx	330,561
Other	60,576	72,246	132,822
Total	391,137	72,246	463,383

April 1958