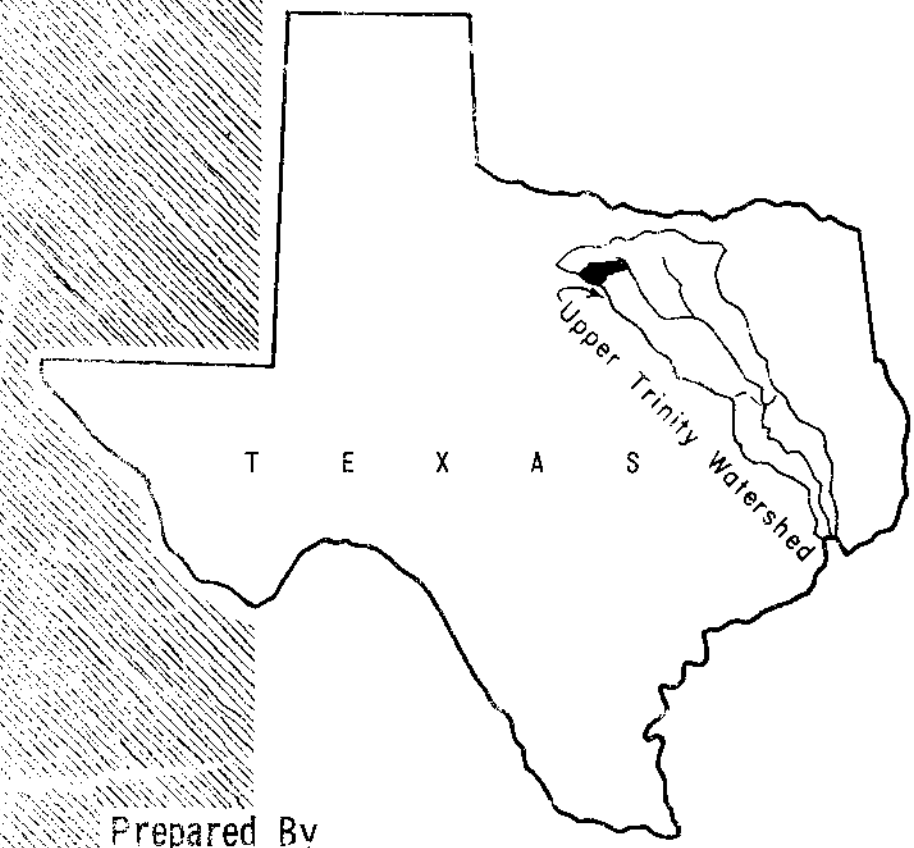
WORK PLAN

NORTH CREEK WEST FORK ABOVE BRIDGEPO WATERSHED

OF THE TRINITY RIVER WATERSHED
JACK COUNTY, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
February 1960

MINOR WORK PLAN REVISIONS

Watershed Name	Date Approved
North Creek	
1. Proposed Work Plan Revision - Deletion of original Sites 27,28,& 29, and the addition of the new Site 28A.	10-20-65
2. Relocation of Structure Site No. 25 - Relocation of structure Site No. 25 upstream.	7-14-66
3. Add HSS 28A-1 & 28A-2	1-12-76

WATERSHED WORK PLAN AGREEMENT

between the

Upper West Fork Soil Conservation District
Local Organization

(Hereinafter referred to as the District)

Jack County Commissioners Court
Local Organization

(Hereinafter referred to as the County)

In the State of Texas

and the

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

Whereas, the District has heretofore entered into a Flood Control Supplemental Memorandum of Understanding with the Soil Conservation Service for assistance in constructing Works of Improvement for the prevention of floods in the North Creek Watershed, State of Texas, under the authority of the Flood Control Act of 1944 (58 Stat. 887).

Whereas, the responsibility for carrying out all or a portion of the work of the Department on the Watershed has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the District and the Service a mutually satisfactory plan for Works of Improvement for the North Creek Watershed, State of Texas, hereinafter referred to as the Watershed Work Plan;

Whereas, the County will benefit from the carrying out of the plan for Works of Improvement through the reduction of damages to property, including County Roads and bridges in the County that are located within the flood plain of the watershed;

It is mutually agreed that in installing and operating and maintaining the Works of Improvement described in the Watershed Work Plan:

1. The District 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.

2. The District 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 Service will provide all construction costs and installation services applicable to Works of Improvement for flood prevention.

4. The District 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.

5. The District will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the Watershed Work Plan.

6. The District will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

7. The District and the County 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 an Operation and Maintenance Agreement which is to be entered into.

8. 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.

9. 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.

Upper West Fork Soil Conservation District
Local Organization

By Geo Cunningham

Title Chairman

Date April 6, 1961

The signing of this agreement was authorized by a resolution of the governing body of the Upper West Fork Soil Conservation District
Local Organization

adopted at a meeting held on April 6, 1961

J B Bruce Jr
(Secretary, Local Organization)

Date April 6, 1961

Commissioners Court of Jack County
Local Organization

By Harold J. Chambers

Title County Judge

Date May 8, 1961

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

adopted at a meeting held on May 8, 1961

Marvin Tilghman
(Secretary, Local Organization)
County Clerk

Date May 8, 1961

United States Department of Agriculture
Soil Conservation Service

By _____
State Conservationist

Date _____

4-14821 9-60

WORK PLAN

NORTH CREEK
WEST FORK ABOVE BRIDGEPORT WATERSHED
Of the Trinity River Watershed
Jack County, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority of
the Flood Control Act of 1936 as Amended
and Supplemented.

Participating Agencies

Upper West Fork Soil Conservation District
Jack County Commissioners Court

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture
February 1960

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

List of Tables and Figures

SECTION 1

WORK PLAN

NORTH CREEK
WEST FORK ABOVE BRIDGEPORT WATERSHED
Of the Trinity River Watershed
Jack County, Texas
February 1960

SUMMARY OF PLAN

Description

Size: 64,136 acres - 100.2 square miles

Land Use:

Cropland	6,590 acres
Rangeland and Pasture	50,810 acres
Wooded Pasture	5,936 acres
Miscellaneous (roads, urban, etc.)	800 acres

Flood Plain Area,Total: 5,327 acres
Flood Plain Area, Below floodwater retarding structures: 4,973 acres
(Excludes area in stream channels, 657 acres)

Soil Conservation District: Upper West Fork

No Federal lands involved.

Flood Frequency:

Total of 122 floods during 44-year period of study (1915 through 1958), of which 42 inundated more than half the flood plain area.

Land Treatment:

Practice	Unit	Applied to Date	Remaining to be Done
Conservation Cropping Systems	Acre	3,586	2,314
Contour Farming	Acre	1,301	1,079
Cover Cropping	Acre	3,128	2,572
Crop Residue Use	Acre	3,586	2,314
Rotation Hay and Pasture	Acre	1,287	593
Grassland Renovation	Acre	0	160
Pasture Improvement	Acre	371	509
Pasture Planting	Acre	371	339

Land Treatment - Continued

Practice	Unit	Applied to Date	Remaining to be Done
Proper Range Use	Acre	39,776	7,711
Range Seeding	Acre	2,081	2,049
Wildlife Area Treatment	Acre	524	1,043
Brush Control	Acre	19,900	12,900
Diversion Construction	Mile	4	4
Grassed Waterways	Acre	42	18
Pond Construction	No.	58	158
Terracing	Mile	23	51

Structural Measures:

Floodwater retarding structures - 19

Sediment Storage	-	1,916 acre-feet
Detention Capacity	-	12,450 acre-feet
Total		14,366 acre-feet

Stream channel improvement - 6.45 miles

Cost Installation Period:

Item	Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment	14,250	238,657	252,907
Structural Measures	838,682	55,355	894,037
Work Plan Preparation	24,300	-	24,300
Total	877,232	294,012	1,171,244

Average Annual Damages and Benefits:

Item	Damage			Benefit
	Without Project	With Land Treatment	With Project	Structural Measures
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater	54,572	52,977	10,585	42,392
Sediment	4,193	3,796	1,943	1,853
Erosion	621	569	171	398
Indirect	4,312	4,107	1,270	2,837
Total	63,698	61,449	13,969	47,480

Benefit-Cost Ratio - Structural Measures:

Average Annual Cost	-	$39,279
Average Annual Benefit	-	47,480
Benefit-Cost Ratio	-	1.2:1

Operation and Maintenance:

Land Treatment Measures - Landowners and Operators Under Agreement With:

Upper West Fork Soil Conservation District

Structural Measures: - Upper West Fork Soil Conservation District

Jack County Commissioners Court

Annual Cost - $2,443

DESCRIPTION OF WATERSHED

Physical Data

North Creek (Figure 1) rises in the western part of Jack County, approximately 1.5 miles south of Jermyn, Texas, and flows in a northeasterly direction through Jack County for about 22 miles. It flows into West Fork of the Trinity River about 8.5 miles north of the town of Jacksboro, Texas. The largest tributaries are Big Cleveland and Little Cleveland Creeks. The watershed ranges from 3 to 11 miles in width and has an area of 64,136 acres (100.2 square miles), nearly all of which is in farms and ranches.

The alluvial valley of the mainstem ranges in width from 4,000 feet at valley section 3 (VS-3, Problem Location, Figure 1) to 1,200 feet near its headwaters. Valley Widths of the two principal tributaries range from 4,300 feet at VS-11A to 550 feet near the headwaters of Little Cleveland Creek. Mean sea level elevation of the valley ranges from 1,199 to 902 feet.

The topography of the watershed ranges from steep escarpments to a gently rolling plain. Underlying rocks are limestone, shale, and sandstone members of the Graham and Thrifty formations of the Cisco group, which is late Pennsylvanian in age. The Thrifty formation occurs only in the extreme western area of the watershed. The harder sandstones and limestones form the ridges, and deep valleys have been incised in the shale.

The watershed lies in the North Central Prairie Land Resource Area. The soils are fine to medium textured, very slowly to moderately permeable, and deep to very shallow. The principal soil series are: Darnell, Owens, Renfrow, Byrds, and Chickasha. The dominant land use is range, with some cropland, principally in forage crops.

The soils are generally in fair condition. Legumes, mostly vetch, are interplanted with a high percentage of the small grains grown in the watershed. Crop residue use is practiced on more than one-half the cropland.

The watershed lies within the mixed prairie and post oak savannah plant groups. Range cover is mostly in fair condition, with some severely eroded areas in poor condition. Natural recovery on these areas has been slow due to the loss of topsoil and the lack of seed source of higher type plants. There are six range sites in the watershed: Bottomland, Mixland Savannah, Mixland, Tightland, Sandy Rough, and Tight Rough. The predominant vegetation at the present time consists of: little bluestem, big bluestem, switchgrass, Indiangrass, sideoats grama, blue grama, hairy grama, buffalograss, tall dropseeds, meadow dropseeds, sand dropseeds, mesquite, post oak, and annual weeds and grasses. The range condition classes of the watershed are as follows: 5 percent, excellent; 20 percent, good; 50 percent, fair; and 25 percent, poor.

The over-all land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cropland	6,590	10.3
Rangeland and Pasture	50,810	79.2
Wooded Pasture	5,936	9.3
Miscellaneous 1/	800	1.2
Total	64,136	100.0

1/ Includes roads, highways, towns, etc.

The flood plain 5,327 acres, exclusive of 657 acres in stream channels, is that area that will be inundated by the runoff of 4.30 inches that can be expected to occur on an average of once in 25 years from a single storm event. The principal soils of the flood plain are: Gowen fine sandy loam, 30 percent; Gowen silty clay, 50 percent; and mixed alluvial, 20 percent. At the present time about 28 percent of the flood plain is in cultivation, 67 percent is in pasture, and 5 percent is in miscellaneous uses.

The mean annual weighted rainfall for the watershed is 26.55 inches. It is well distributed, with the wettest months being April, May, June, and October. Individual rains causing serious erosion and flood damage may occur in any season, but are most frequent in the spring and fall months. The minimum recorded annual rainfall was 12.50 inches in 1925, and the maximum was 52.16 inches in 1957.

Average temperatures range from 84 degrees Fahrenheit in the summer to 41 degrees in the winter. The normal frost-free season of 233 days extends from March 28 to November 16.

Water for livestock and domestic use in the watershed area is obtained from shallow wells and small farm ponds. These wells and ponds provide an adequate water supply. The town of Jacksboro obtains its water supply from wells and a city lake. These are adequate for present needs and anticipated future needs can be met by increasing the storage capacity of the city lake.

Economic Data

The economy of the watershed is basically agricultural. Livestock production, chiefly beef cattle and goats, dominates the agricultural output of the watershed. The majority of the upland area is used for range, while the predominant crops found in the watershed are oats, wheat, and Johnsongrass. In this area oats and wheat are grazed during the winter months and harvested for grain in June.

Crude oil production is important to the economy of the watershed. Oil leases and royalties furnish income to supplement that from agriculture, and many local residents are employed by oil companies operating in the area.

The average-size farm in the watershed is 410 acres, with an average value of $16,096 for land and buildings (1954 agricultural census).

The average annual gross value of production on the flood plain at 1957 prices, is about $15.40 per acre in flood-free condition. This value ranges from about $5.20 in evaluation reach 1 to $22.30 in evaluation reach 2. Typical flood-free yields are 45 bushels for oats and 2 tons for hay crops. More details are shown in table 8. The estimated market value of land in the benefited area is $105 per acre.

Jacksboro, with an estimated population of 4,167, is the initial marketing point for most of the locally produced crops and is the center of considerable oil activity. The principal livestock market is Fort Worth, 63 miles southeast of Jacksboro.

The watershed is adequately served by approximately 83 miles of roads, of which 31 miles are paved. Floods frequently make most of the county roads impassable from a few hours to several days. The detours thus occasioned cause delay and extra travel distance to and from markets. Adequate rail facilities are available at Jacksboro.

Status of Conservation Work in the Watershed

The watershed is served by the Soil Conservation Service work unit at Jacksboro, which is assisting the Upper West Fork Soil Conservation District. This work unit has assisted farmers and ranchers in preparing 125 soil and water conservation plans on 56,340 acres (88 percent of the agricultural land) within the watershed and in giving technical guidance in establishing and maintaining planned measures. Forty percent of the needed land treatment measures have been applied. Where land treatment measures have been applied and maintained as long as 3 years, average crop and pasture yields have increased by about 20 percent.

WATERSHED PROBLEMS

Floodwater Damage

Floods occur frequently on North Creek and cause severe damage (Figure 1). Major floods (floods covering more than one-half of the flood plain) have occurred on an average of about once a year, the latest one being in August 1958. During the 44-year evaluation period, 1915-1958, there were 42 major floods and 80 minor floods. Forty-nine percent of the floods occurred in the spring - March, April, May and June - causing severe damage to growing crops and delaying planting operations until after the optimum planting dates. The largest storm in the 44-year period occurred on April 26-27, 1957. This flood inundated approximately 5,567 acres.

It is estimated that the average annual direct monetary floodwater damage is $54,572 under existing conditions, based on long-term price levels. This includes $35,196 crop and pasture damage; $13,680 other agricultural damage, such as damage to fences, farm equipment, livestock, and farm levees; and $5,696 nonagricultural damage, such as damage to roads, bridges and railroads. In addition, there are numerous indirect damages, such as interruption of

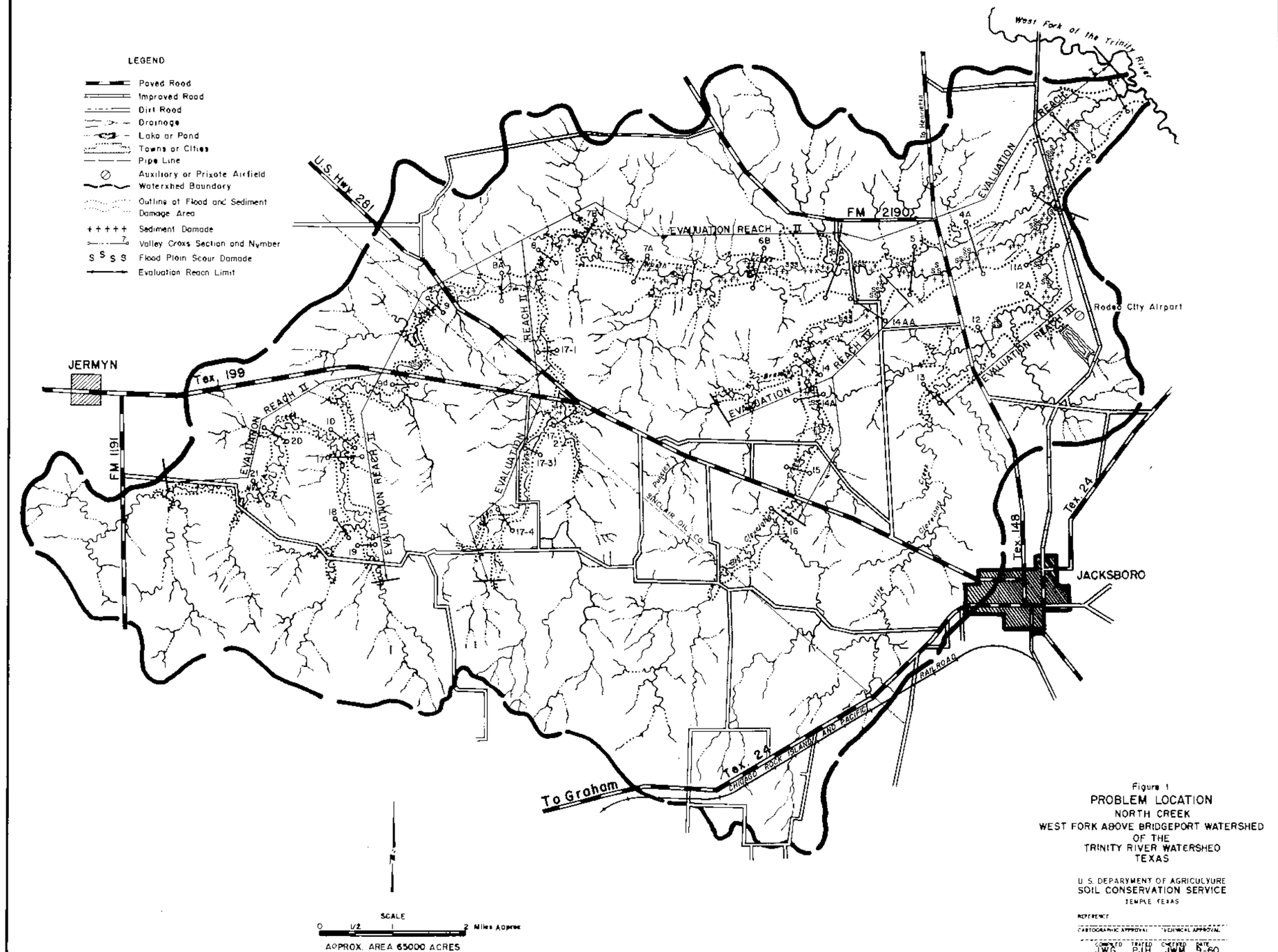


Figure 1

PROBLEM LOCATION
NORTH CREEK
WEST FORK ABOVE BRIDGEPORT WATERSHED
OF THE
TRINITY RIVER WATERSHED
TEXAS

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

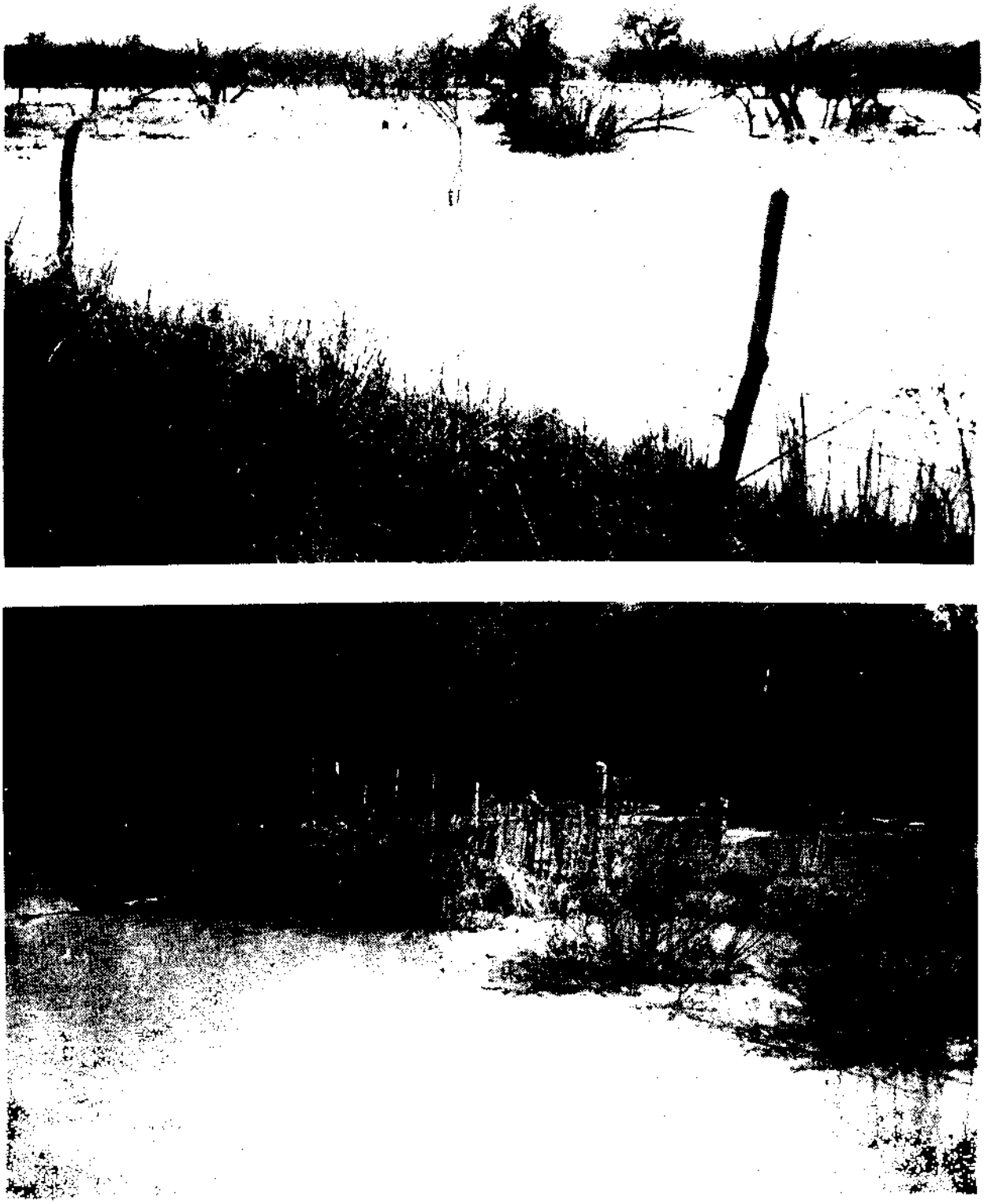
REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	INITIAL
JWG	PJH	JWM	8-60

Rev. 9-60

4-R-14246



North Creek flood plain inundation and fence damage resulting from 1.31 inches of rain, April 19, 1950. Approximately 2,200 acres of flood plain ware inundated and 4 roads closed to traffic.

travel, losses in business sustained by dealers and industries in the area, and other losses, estimated to average $4,312 annually.

Upland Erosion Damage

The erosion rates are low to moderate, ranging from 0.59 acre-foot to 1.51 acre-feet per square mile annually. In the upland areas, sheet erosion represents 73 percent and gully and streambank erosion 27 percent of the annual gross erosion.

Flood Plain Erosion Damage

Damage due to flood plain scour is moderately low. It is estimated that an average of 161 acres is being damaged annually by this process. The productive capacity of 60 acres has been reduced 20 percent and of 101 acres, 40 percent. Examination of the scoured areas and interviews with flood plain owners and operators indicate that this type damage is in equilibrium, that is, new damage occurring each year is balanced by recovery of other damaged areas. The estimated average annual monetary damage by flood plain scour is $621 at long-term price levels.

Streambank erosion and channel entrenchment are generally moderate in the upper part of the watershed and minor in the lower part. The average annual land loss due to streambank erosion is 0.60 acre.

Sediment Damage

Sediment damage consists primarily of flood plain deposition and the contribution of sediment to Bridgeport Reservoir located on the West Fork of the Trinity River, about 16 miles below the mouth of North Creek.

Erosion in the upland area has resulted in the deposition of silty sands, sandy clays, and clayey sands on the flood plain. The productive capacity of 1,305 acres has been reduced as follows: 900 acres damaged 10 percent; 269 acres damaged 20 percent; and 136 acres damaged 30 percent. These deposits are low in organic matter and fertility; however, productivity of these areas can be restored through intensive treatment in a short period of time, or through natural recovery over a longer period if flooding is eliminated or greatly reduced. As in the case of scour damage, indications are that damage due to deposition of sediment are approximately in equilibrium. The estimated average annual monetary damage by overbank deposition is $2,128 at long-term price levels. Deposition in the channels in the lower parts of the watershed has reduced their capacities. This has resulted in increased flood frequencies, depths, and damages.

An estimated 65 acre-feet of sediment from the North Creek watershed is being deposited annually in Bridgeport Reservoir. The estimated annual damage to this reservoir by depletion of its sediment capacity is $2,065.

Problems Relating to Water Management

There is no local interest in incorporating additional storage for irrigation, municipal water supply or recreation. There is no need for drainage to be included as a project purpose. Needs for water management for fish and wildlife resources and pollution abatement are minor and do not warrant a study at this time.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Other efforts to prevent or to control flooding on agricultural lands in the watershed have been minor. Some attempts at leveeing by individual farmers have been made, with very little effect on the reduction of flood damages.

Bridgeport Reservoir, located on the West Fork of the Trinity River with the upper extremity about 16 miles below the mouth of North Creek, was constructed in 1931 by the Tarrant County Water Control and Improvement District No. 1 as a part of the Fort Worth water supply.

The Upper West Fork Soil Conservation District has been very active in establishing land treatment measures and in initiating flood prevention work. Through these efforts, a high degree of participation in this program by the farmers, ranchers, and other interested parties in the watershed has been achieved. Land treatment measures installed before the development of this flood prevention work plan are listed in Table 1.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the Upper West Fork 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 those land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

Of the 64,136 acres in the watershed, 32,090 acres, or 50 percent, lie above the 19 floodwater retarding structures. It is especially important that land treatment be planned and applied to assure full effectiveness and proper functioning of the floodwater retarding structures.

Land treatment measures at an estimated non-Federal cost of $392,362, exclusive of Agricultural Conservation Program Service reimbursements, and a Federal expenditure of $6,500 of flood prevention funds have been established by landowners in the watershed prior to work plan development (Table 1). The Federal funds expended for this work were for technical assistance in helping

landowners to accelerate planning and applying land treatment measures. During the project installation period, additional land treatment measures are to be established at an estimated non-Federal cost of $238,657 and a Federal expenditure of $14,250 (Table 1).

Land treatment measures will serve principally to improve soil and cover conditions, thereby decreasing erosion damage to cropland, pasture, and rangeland. Such measures for cropland include conservation cropping systems, cover cropping, rotation hay and pasture, and crop residue use. Measures such as range seeding, pasture planting, pasture improvement, rotation grazing, deferred grazing, proper range use, and brush control will be used on the grassland. These measures, properly managed, will increase infiltration rates of soils, permitting larger amounts of rainfall to be stored in the soils, thereby reducing runoff. The estimated quantities of land treatment measures that will be applied during the project period are shown on Table 1.

In addition to the measures related directly to soil improvement and cover conditions, other land treatment practices include contour farming, terracing, diversion construction, pond construction, and grassed waterway development. These practices, properly applied and maintained, have a measurable effect in reducing peak discharge by extending the course of runoff water. These conservation practices also supplement and support the soil improvement and cover measures to reduce erosion damage and sediment production.

Structural Measures

Two of the floodwater retarding structures included in this plan, Sites 13 and 18, have been constructed. These structures were included in the West Fork Above Bridgeport Work Plan, dated July 19, 1950. This work plan is a revision of the North Creek portion of the West Fork Above Bridgeport Work Plan. The actual costs of these structures are included in Tables 1 and 2.

A system of 17 floodwater retarding structures and 6.45 miles of stream channel improvement will be installed in the watershed to afford with the 2 existing structures the desired degree of protection to flood plain lands that cannot be provided by land treatment measures alone.

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

The location of the planned floodwater retarding structures and stream channel improvement is shown on Figure 3, Planned Structural Measures, with supporting data in Tables 3 and 3A.

The floodwater retarding structures will temporarily detain the runoff from a storm that can be expected to occur on an average of once in 25 years. Detention capacity in individual sites will range from 4.08 to 4.79 inches of runoff from their watersheds. The total of 12,450 acre-feet of detention capacity provided by the 19 structures is sufficient to detain the equivalent of 4.66 inches of runoff from the area above structures, or the equivalent of 2.33 inches from the entire watershed.

Floodwater Retarding Structure 18 on Little Cleveland Creek, North Creek watershed, detaining floodwaters from 8.79 inches of rain, April 27, 1957, thereby protecting flood plain land and improvements.

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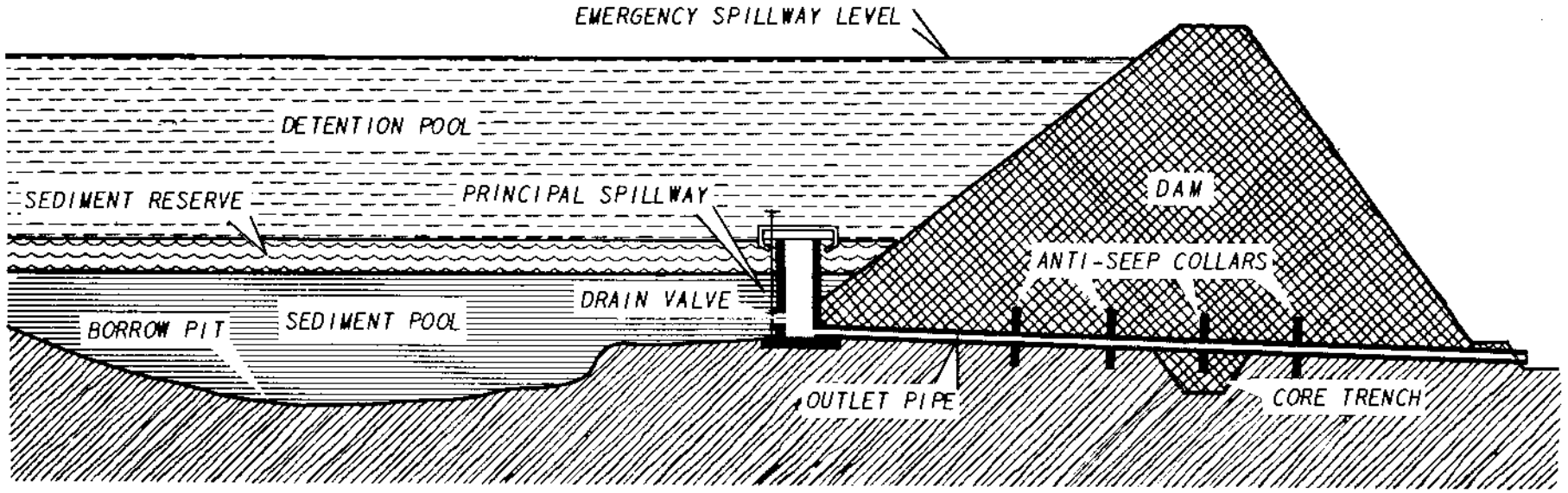


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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

LEGEND

- Paved Road
- Improved Road
- Dirt Road
- Drainage
- Lake or Pond
- Towns or Cities
- Pipe Line
- Auxiliary or Private Airfield
- Watershed Boundary
- Outline of Flood and Sediment Damage Area
- Floodwater Retarding Structure
- Drainage Area Boundary
- Channel Improvement
- (21) Structure Site Number

West Fork of the Trinity River

U.S. HWY 281

FM 2190

North Creek

JERMYN

Tex. 199

FM 1191

Rodeo City Airport

Tex. 24

Tex. 148

JACKSBORO

To Graham

Tex. 24

CHICAGO ROCK ISLAND AND PACIFIC RAILROAD

SITE NUMBERS	DRAINAGE AREA ACRES	SITE NUMBERS	DRAINAGE AREA ACRES
13	992	23	3136
14	519	24	3501
15	960	25	902
16	4006	26	903
17	896	27	781
18	4704	28	1685
19	1965	29	1103
20	2643	30	768
21	1178	31	672
22	717		

SCALE 0 1/2 1 2 Miles Approx

APPROX. AREA 65000 ACRES

Figure 3

PLANNED STRUCTURAL MEASURES

NORTH CREEK
WEST FORK ABOVE BRIDGEPORT WATERSHED
OF THE
TRINITY RIVER WATERSHED
TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE
JWS	JEL	JWM	9-8-60

Revised 9-60

4-R-14247

Land easements, rights-of-way, necessary road and utility changes, and legal fees --estimated cost $65,645--will be provided by the sponsoring local organizations at no cost to the Federal Government. The land easement cost of $54,000 was determined through local appraisal, giving full consideration to the real-estate values involved. The road, utility and improvement changes, which will cost $9,875, include the removal and rebuilding of two bridges and improvement of one low-water crossing as a part of the stream channel improvement (Figure 3), and the relocation of an oil pipeline at Site 31. The legal fees are estimated to be $1,770.

After the proposed stream channel improvement is installed, all stream channels and bridges will have sufficient capacity to carry the release flow from the floodwater retarding structures.

The sediment pools of the 19 structures will inundate 90 acres of flood plain and 275 acres of upland. The detention pools will temporarily inundate an additional 264 acres of flood plain and 801 acres of upland.

The estimated total Federal cost of installing the 19 floodwater retarding structures and 6.45 miles of channel improvement is $958,618 and the total non-Federal cost is $65,645, for a total of $1,024,263. The total annual equivalent cost, including operation and maintenance, is $39,279. The estimated Federal cost of installing the 17 proposed floodwater retarding structures and 6.45 miles of channel improvement is $838,682 and the non-Federal cost is $55,355, a total of $894,037.

Sufficient detention capacity has been provided in all floodwater retarding structures to assure a 4 percent or less chance of use of the emergency spillway. This will permit the use of vegetative spillways, thereby effecting a substantial reduction in cost over the use of concrete spillways.

The total cost of installing all works of improvement is $1,700,332, of which $529,088 was expended prior to work plan revision.

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures will prevent flood damages from 14 of the 122 floods such as occurred in the watershed during the 44-year evaluation period. In addition, 40 of the 42 major floods (one-half or more of the flood plain inundated) would have been reduced to minor floods.

The largest runoff-producing rain during the 44-year series occurred over a 2-day period, April 26 and 27, 1957. This storm, slightly exceeding a 100-year frequency event, was noted merely for purposes of comparison and was not considered in the study of the watershed. An average storm of this magnitude, under antecedent Moisture Condition III, would produce a runoff, under present conditions, of 7.95 inches and would inundate 5,567 acres. Runoff from such a storm, after complete conservation and structural treatment, would be reduced so as to cause flooding on 3,920 acres.

For the study of this watershed, the area inundated by the runoff from a 24-hour, 25-year frequency storm was considered to be the flood plain. A rain of this magnitude would total 6.69 inches and produce a runoff of 4.30 inches under antecedent Moisture Condition II. This amount of runoff would cause a peak discharge of 24,279 cubic feet per second at VS-1, located 0.25 mile west of the confluence of North Creek and West Fork of the Trinity River (Figure 1). This same storm, with conservation treatment and after installation of structural measures, would produce a flow of 13,279 cubic feet per second at VS-1. The runoff would inundate 5,327 acres of flood plain under present conditions and an estimated 5,300 acres after conservation treatment measures had been applied. With conservation treatment measures and structural measures in operation, 3,108 acres of the flood plain would be inundated, excluding the area affected by the floodwater retarding structures.

It was determined that 0.10 inch of runoff was the minimum volume that would cause flooding to a depth of 6 inches. Therefore, no storms producing less than 0.10 inch of runoff were considered for flood routing purposes. This amount of runoff would be produced by 2.05 inches of rainfall under Moisture Condition I, 1.09 inches under Moisture Condition II, and 0.48 inch under Moisture Condition III. Runoff of 0.10 inch would produce a discharge of 575 cubic feet per second at the reference section (VS-1) where the stream channel has a capacity of 1,862 cubic feet per second.

The area on which sediment damage from overbank deposition will occur is expected to be reduced from an average of 1,305 acres annually to 509 acres, a reduction of 62 percent. A reduction of 10 percent will result from land treatment and 52 percent from the structural measures. The average annual monetary value of this reduction from land treatment measures is $213 and from structural measures $1,028. The area on which flood plain scour damage will occur is expected to be reduced from 161 acres to 49 acres, a reduction of 70 percent.

It is estimated that the present annual rate of sediment contribution from North Creek watershed to Bridgeport Reservoir will be reduced from 65 acre-feet to 33 acre-feet with land treatment and structural measures installed.

Land treatment measures will reduce the annual gross erosion in the watershed from 113 to 98 acre-feet.

Some formerly cultivated lands now in open pasture, 770 acres, are expected to be returned to higher value crop production. In addition, it is expected that some wooded areas, 590 acres, will be restored to former levels of productivity as pasture. This restoration of a portion of the flood plain land, 1,360 acres, to its former level of production will be made possible by the reduced frequency, area and depth of flooding, and by the reduction of sediment deposition. The benefits allocable to the structural measures from the restoration of these flood plain lands are estimated to average $16,265 annually. The loss in original production has been considered a crop and pasture damage and the increased net income from restoration a benefit in

Table 6. There will be no increased acreage of crops under acreage allotment restrictions as a result of the project.

Analysis of the flood plain potential and the degree of protection provided indicated that the average gross value of the agricultural production on the benefited area would be increased from about $15.40 to approximately $29 per acre in the area benefited by the project. The estimated changes in the use of the benefited area of the flood plain are shown in the following tabulation:

Land Use	Without Project			With Project	
	Percent in Use	Unit	Yield	Percent in Use	Yield
Oats	18.6	Bu.	45.0	24.6	45.0
Forage Crops	11.7	Ton	2.0	30.5	2.0
Wheat	3.2	Bu.	20.0	5.7	20.0
Pasture	34.1	AUM	1.2	27.7	1.2
Wooded Pasture	28.7	AUM	0.8	7.8	0.8
Miscellaneous	3.7	-	-	3.7	-

Annual damage reductions resulting from structural measures average $29,446 in crop and pasture damage, $8,527 in other agricultural damage, $4,419 in road and bridge damage, $398 in damage from flood plain scour, $1,028 in damage from overbank deposition, $825 in damage from sediment to Bridgeport Reservoir, and $2,837 in indirect damage.

The estimated average annual floodwater, erosion, sediment, and indirect damage in the watershed will be reduced from $63,698 to $13,969, a reduction of 78 percent. About 96 percent of the expected reduction would result from the structural measures.

The total flood prevention benefits, including reduction of sediment deposition on flood plain lands and in Bridgeport Reservoir; the reduction in flood plain scour damage; and the reduction of indirect damages, are estimated to average $49,729 annually, of which $47,480 will be the result of structural measures.

The general location of the benefits from the combined program of land treatment and structural measures is presented in Table A.

TABLE A - GENERAL LOCATION OF BENEFITS

	Evaluation Reach (Figure 1)				
	1	2	3	4	Total
Average Annual Acres Flooded:					
Without Project - Acres	1,932	1,221	845	958	4,956
With Project - Acres	1,043	372	133	151	1,699
Percent Reduction	46	70	84	84	66
Average Annual Damages: 1/					
Without Project - Dollars	10,255	22,468	7,484	7,226	47,433
With Project - Dollars	4,720	5,852	1,213	1,184	12,969
Percent Reduction	54	74	84	84	73
Number of Major Floods in Evaluation Series: 2/					
Without Project	61	21	59	43	
With Project	26	1	5	0	
Area Flooded by 2-Day, 25-Year Frequency Storm : 3/					
Without Project - Acres	1,496	1,829	651	997	4,973
With Project - Acres	1,338	842	463	465	3,108
Percent Reduction	11	54	29	53	38
Floodwater Damage by 2-Day, 25-year Frequency Storm					
Without Project - Dollars	299	789	162	215	1,465
With Project - Dollars	191	284	63	86	624
Percent Reduction	36	64	61	60	57
Area Flooded by 2-Day, 5-Year Frequency Storm 4/					
Without Project - Acres	1,330	1,335	568	832	4,070
With Project - Acres	1,070	453	288	295	2,080
Percent Reduction	20	66	49	65	49
Floodwater Damage by 2-Day, 5-Year Frequency Storm 4/					
Without Project	191	499	121	141	952
With Project	114	155	44	37	350
Percent Reduction	40	69	64	74	63

1/ Excludes restoration.
2/ Inundates more than 50 percent of the flood plain area in the evaluation reach.
3/ Excludes areas in stream channels and proposed floodwater retarding structures.
4/ Storm of June 4 and 5, 1957.

February 1960

COMPARISON OF BENEFITS AND COSTS

The average annual equivalent cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be $39,279. When the structures are installed, they are expected to produce average annual benefits of $47,480, a benefit of $1.21 for each dollar of cost. There are other substantial values which will accrue from structural measures, such as increased opportunity for recreation, improved wildlife conditions, and a sense of security, which have not been used for project justification.

ACCOMPLISHING THE PLAN

Federal assistance for carrying out the works of improvement, as described in this work plan, will be provided under the authority of the Flood Control Act of June 22, 1936, as amended and supplemented.

Land Treatment Measures

Land treatment measures itemized in Table 1 will be established by farmers and ranchers in cooperation with the Upper West Fork Soil Conservation District during the 5-year project installation period. The cost of applying these measures will be borne by the owners and operators of the land. It is expected that the owners and operators will be reimbursed for a portion of this cost through the existing Agricultural Conservation Program Service, the Great Plains Conservation Program, or other Federal programs. The amount of reimbursement to be expected has been estimated, based on current program criteria, and this amount has not been included in the total estimated non-Federal cost for land treatment listed in Table 1. The soil conservation district is giving assistance in the planning and application of these measures under its going program. This assistance will be continued to assure application of the planned measures within the 5-year installation period of the project.

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

The Soil Conservation Service work unit at Jacksboro will assist landowners and operators cooperating with the district in accelerating the preparation of soil and water conservation plans and the application of conservation practices.

The Extension Service will assist with the educational phase of the program by conducting general information and local meetings, preparing radio and

press releases, and using other methods of getting information to landowners and operators in the watershed. This activity will help to get the land treatment practices and the structural measures for flood prevention carried out.

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 project.

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

Structural Measures for Flood Prevention

The Soil Conservation Service will contract for the construction of the 17 floodwater retarding structures and 6.45 miles of stream channel improvement, as shown on Figure 3. It will also prepare plans and specifications, supervise construction, prepare contract payment estimates, make contract payments, make final inspections, certify completion, and perform related duties for the installation of these structural measures.

The Upper West Fork Soil Conservation District will furnish the land, easements and rights-of-way and arrange for road, utility and improvement changes, including two bridges and one low-water crossing, for all the structural measures at no cost to the Federal Government (Figure 3).

Since the entire watershed is one hydrologic unit and all structures are needed to secure the desired reduction in damages, no attempt was made to separate the watershed into construction units. This will necessitate securing all necessary easements and rights-of-way prior to the expenditure of Federal funds for construction in the watershed.

The cooperating parties have agreed on a 3-year installation period for the structural measures. The estimated schedule of obligation for the complete 5-year project installation period, including installation of both land treatment and structural measures, is as follows:

Fiscal Year	Measures	Federal Funds (dollars)	Non-Federal Funds (dollars)	Total (dollars)
1st	Floodwater Retarding Structure Sites 15, 16, 22, 23, 24, 25, and 26; and Land Treatment	343,986	71,341	415,327
2nd	Floodwater Retarding Structure Sites 14, 17, 19, 20, 21, 27, 28, and 31; and Land Treatment	331,188	66,831	398,019
3rd	Floodwater Retarding Structure Sites 29 and 30; Stream Channel Improvement; and Land Treatment	172,058	60,376	232,434
4th	Land Treatment	2,850	47,732	50,582
5th	Land Treatment	2,850	47,732	50,582
	Total	852,932	294,012	1,146,944

This schedule may be adjusted if mutually desirable and in view of appropriations and accomplishments.

The structural measures will be installed pursuant to the following conditions:

1. Flood prevention funds are available.
2. The required land treatment in drainage area above structure has been installed or is in the process of being installed.
3. All land easements and rights-of-way have been secured.
4. Operation and maintenance agreements have been executed.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by farmers and ranchers as cooperators with the soil conservation district. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine the need for and encourage the performance of maintenance. District-owned equipment will be made available for use in maintaining land treatment measures.

Structural Measures

The 19 floodwater retarding structures and 6.45 miles of stream channel improvement will be operated and maintained jointly by the Upper West Fork Soil Conservation District and the Jack County Commissioners Court. The district will have the responsibility of the operation of the structures in the North Creek watershed. Maintenance will be the responsibility of the Jack County Commissioners Court.

All floodwater retarding structures and stream channel improvement will be inspected by representatives of all cosponsoring organizations at least annually and after each heavy rain or streamflow. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the emergency spillway, the earthfill, the vegetative cover of the earthfill and emergency spillway, fences and wire gaps installed as a part of the floodwater retarding structures, and the condition of the improved stream channel. The sponsoring local organizations will maintain a record of the inspections and maintenance work performed and have it available for review by Soil Conservation Service personnel.

Maintenance work generally will be performed by contract or force account. Funds for this work will be provided by the Jack County Commissioners Court, which has legal authority to raise funds, as set forth in maintenance agreements executed prior to the letting of contracts for construction of the structural works of improvement. The estimated annual operation and maintenance cost is $2,443 (Based on long-term price levels). Provisions will be made for free access of representatives of the cosponsoring organizations and the Federal Government to inspect the 19 floodwater retarding structures and their appurtenances and the improved stream channel at any time.

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

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the watershed protection and flood prevention project on the North Creek watershed will make a substantial contribution to the overall development of West Fork of the Trinity River.

This project plan conforms to all Federal laws and regulations and will have no known detrimental effects on existing downstream projects or any that might be constructed in the future.

SECTION 2

WORK PLAN DEVELOPMENT

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

Project Objectives

A reconnaissance survey of the watershed was made by specialists of the Planning Party and representatives of the State, Area and Work Unit offices. The purpose was to obtain sufficient information to estimate planning requirements and to furnish the local people with technical information needed for their determination of project objectives.

At a series of meetings with the local people, the flood prevention program and reconnaissance survey data were discussed. Considering this information, together with their needs and desires, it was found that a complete watershed program on North Creek was desired.

The over-all objective of the people of the watershed is to establish and maintain a complete conservation program on all their land and to reduce floodwater, sediment and erosion damage to the extent feasible on flood plain land and improvements in the flood plain. Specific objectives of the local people are as follows:

1. Attain a reduction of at least 70 percent of average annual floodwater and sediment damage.

2. Establish remaining land treatment measures which contribute directly to flood prevention.

Land Treatment

The status of land treatment measures for the North Creek watershed was secured from the records of the Upper West Fork Soil Conservation District. This information was expanded with assistance from personnel of the Soil Conservation Service Work Unit at Jacksboro to represent the needed land treatment measures for the watershed. Estimates were made of the amounts of practices that will be applied during the 5-year project installation period for the entire watershed (Table 1). Trends in ranching and farming operations, amounts of land treatment practices already applied, soil conditions, grassland cover conditions, and other pertinent data were used in estimating these future land treatment needs. The cost of applying the land treatment measures was based on current costs and going program criteria.

Project Formulation

Land treatment measures which contribute directly to flood prevention remaining to be applied in the watershed were determined. The hydraulic,

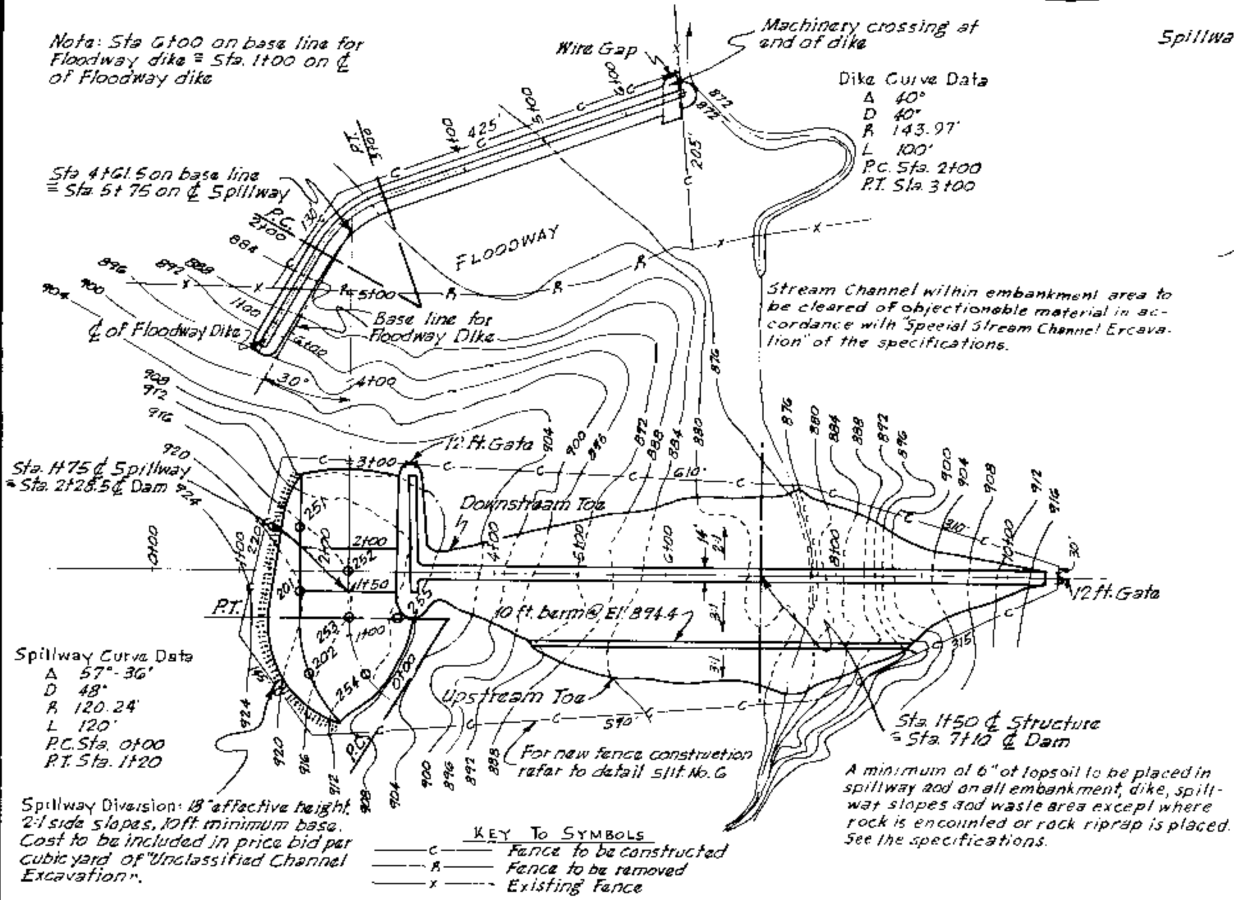
hydrologic, geologic, sedimentation, and economic investigations provided data on the effect these measures would have on the reduction of sediment, erosion, and floodwater damages. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

Structural measures for flood prevention which would be feasible to install and required to meet the objectives of the sponsoring local organizations were then determined. The procedures used in that determination were as follows:

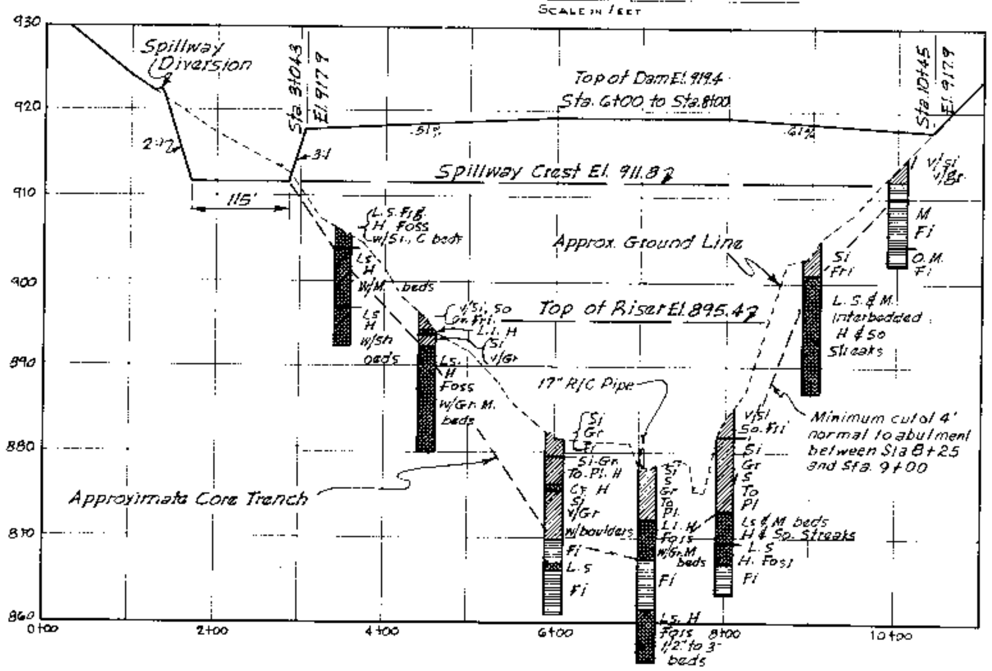
1. A base map of the watershed was prepared, showing the watershed boundary, drainage pattern, system of roads and other pertinent information. By means of a stereoscopic study of 4-inch photographs of the watershed, all probable floodwater retarding structure sites were selected. This information was recorded on the watershed base map for use in field surveys.

2. A field study was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not appear to have adequate storage possibilities and those which would inundate highways and other expensive improvements were carefully studied to determine feasibility of relocation. Those considered not to be economically feasible to relocate were dropped from the proposed plan. From the remaining sites, a system of floodwater retarding structures was selected for detailed survey and further consideration. Plans for a floodwater retarding structure, typical for this watershed, are illustrated by Figures 4 and 4A.

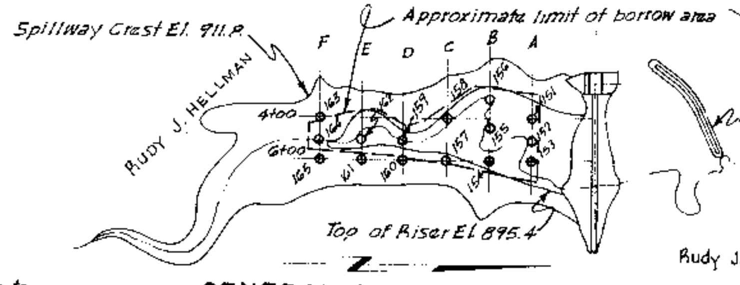
3. A topographic map was made of the pool area of each of the proposed sites and a grid was made of the area to be occupied by the emergency spillway. These data were used to determine the storage capacities of the sites, the estimated cost of the structures and the areas to be inundated by the sediment and detention pools. The heights of the dams and the sizes of the pools were determined by the capacity needed to temporarily detain the runoff from the design storm and to provide the storage needed for sediment. In these determinations, full consideration was given to site obstacles and to minimization of costs. Locations of all selected sites and the flood plain were transposed, approximately to scale, on a copy of the base map (Figure 3). A structure data table was developed to show for each structure: drainage area, storage capacity needed for floodwater detention and for sediment storage



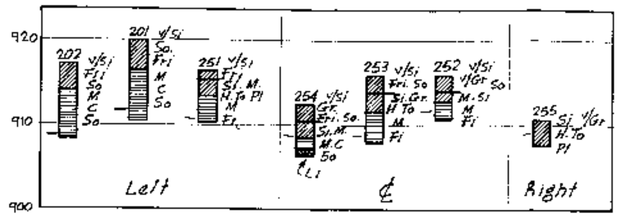
PLAN OF EMBANKMENT AND SPILLWAY



PROFILE ON ℄ OF DAM



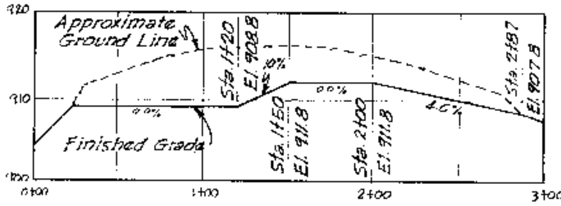
GENERAL PLAN OF RESERVOIR



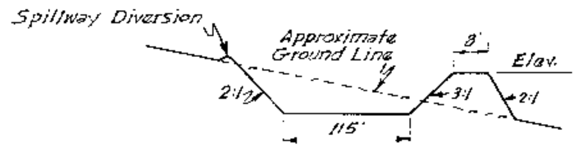
Note: Bar at left of boring is at spillway grade.

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY



PROFILE ON ℄ OF SPILLWAY

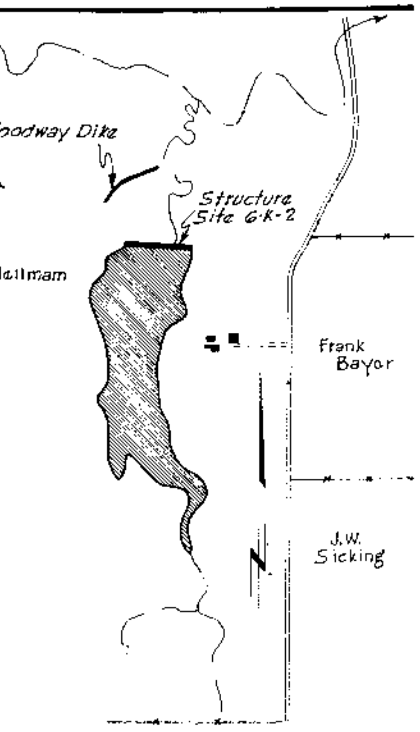


Top of Dike El. 917.9 from Sta. 1+50 to Sta. 2+00 (Crest Section)
Top of Dike El. 911.8 @ Sta. 2+87. Grade top of dike between Sta. 2+00 and Sta. 2+87.

TYPICAL SPILLWAY SECTION

Clay	S	Sandy - Sandy	H	Hard
	Si	Silt - Silty	Foss	Fossiliferous
	C	Clay - Clayey	W/	With
	Gr	Gravel - Gravelly	V	Very
Rock	Sh	Shale - Shaley	So	Soft
	M	Marl - Marly	Fri	Friable
	O.M.	Organic Matter	Fi	Firm
	L.S.	Limestone	To	Tough
Shale	Fg	Fragments	Pl	Plastic

LEGEND OF BORINGS



Located 1 mile west and 1.7 miles south of Myra, Cooke County, Texas

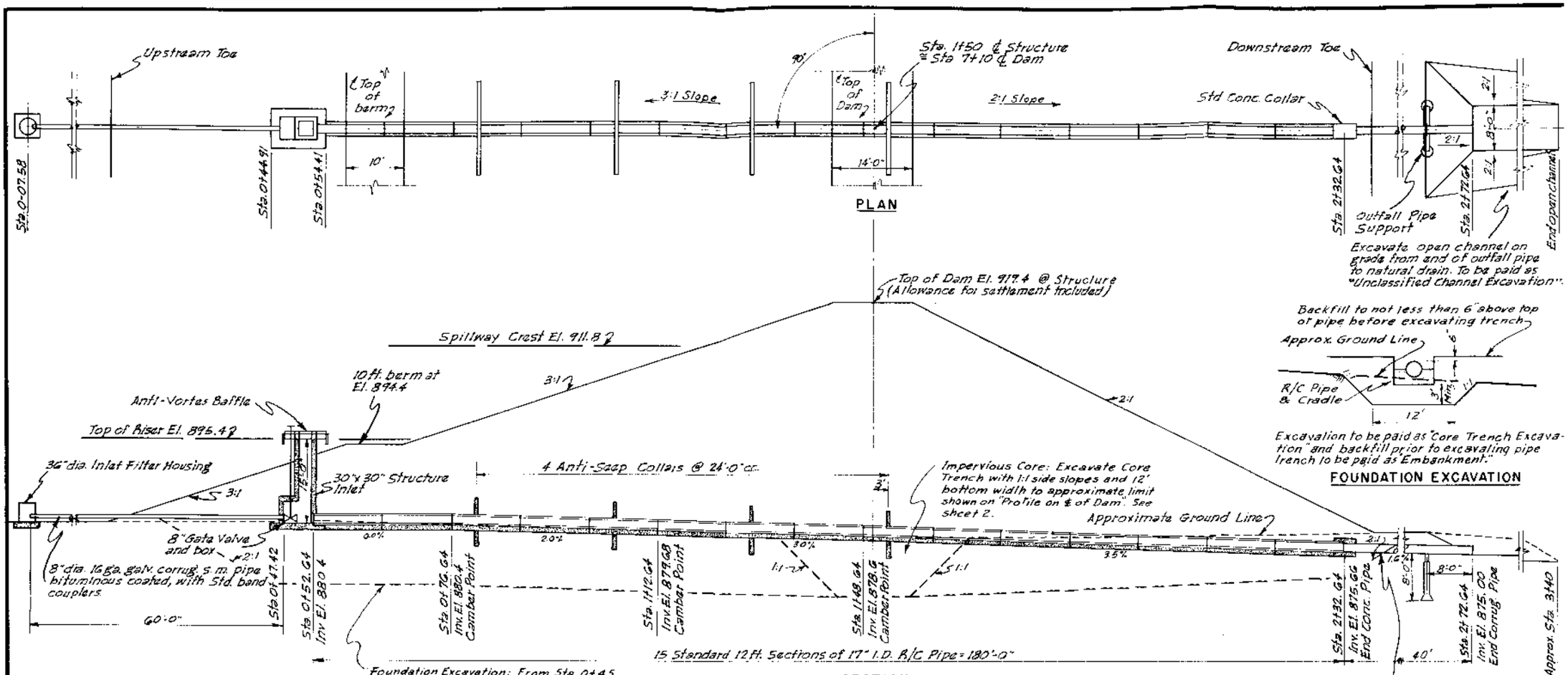
VICINITY MAP

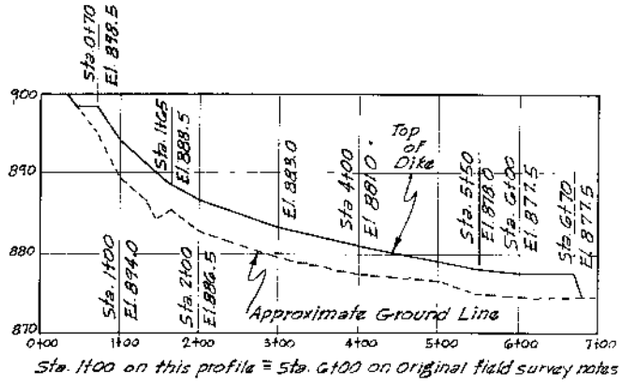
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
895.4	7.5	64.0	1.31
898	10.0	86.5	1.78
902	13.7	132.9	2.73
906	17.5	174.3	3.97
910	22.1	273.5	5.62
911.8	24.3	315.2	6.47
914	27.0	371.7	7.64
918	33.7	473.1	10.13
Top of Dam (Effective) Elev.			917.9
Spillway Crest Elev.			911.8
Top of Riser Elev.			895.4
Sediment Pool Elev.			895.4
Drainage Area, Acres			584
Sediment Storage, Ac. Ft.			73
Floodwater Storage, Ac. Ft.			251

Figure 9
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

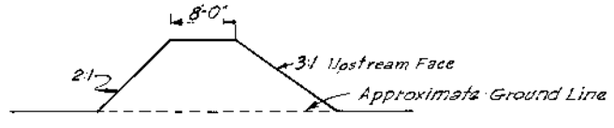
Designed G.W.T. Date 11/54
Drawn G.W.T. & D.S.
Traced D.S. 12/55
Checked G.W.T. 4/56
Approved by H.M.
Head, Engineering & Watershed Planning Unit, Fort Worth, Texas
State Conservation Engineer, S.C.S., Temple, Texas
Sheet No. 2 of 6
Drawing No. 4-E-10,184





Sta. 1+00 on this profile = Sta. 6+00 on original field survey notes

PROFILE ON ℄



Extend top of dike on level grade from Sta. 0+70 to natural ground.
End slope of dike to extend to creek bank from Sta. 6+70
To be placed and paid for as "Embankment"

TYPICAL SECTION

FLOODWAY DIKE

Figure 4a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.W.T.	Date 11/54	Approved by H. Zn	HEAD ENGINEERING & WATERSHED PLANNING BY FORT WORTH, TEXAS
Drawn G.W.T. & D.S.			STATE CONSERVATION ENGINEER TEMPLE, TEXAS
Traced D.S.	12/65	Sheet No. 3 of 6	Drawing No. 4-E-10,184
Checked G.W.T.	5/56		

in acre-feet and in inches of runoff, release rate of the principal spillway, acres inundated by the sediment and detention pools, volume of fill, width and depth of flow in the emergency spillway, and the estimated cost of the structure (Tables 2 and 3).

4. Damages resulting from floodwater, sediment and flood plain erosion were determined from damage schedules and field surveys of flood plain areas. Reductions in these damages were estimated on the basis of reduction of area and depth of inundation and reduction of sediment yield. This was determined by flood routing under future conditions, assuming that the works of improvement had been installed. Benefits so determined were allocated to individual or groups of interrelated floodwater retarding structures on the basis of respective effects of each on reduction of damages. In this manner, it was found that the system of all feasible floodwater retarding structures would reduce average annual flood damage only 61 percent. Since this did not meet the objective of the local people, it was necessary to include stream channel improvement.

   Alternate combinations of stream channel improvement with the system of floodwater retarding structures were studied to develop the least costly system of structural measures that would secure the desired degree of protection.

   Stream channel improvement which would protect the entire flood plain from a 3-year frequency flood was considered. This produced the desired degree of reduction of damages, but the costs were prohibitive. This study revealed that the majority of benefits accruing to stream channel improvement are located in Evaluation Reach III (Little Cleveland Creek) and Evaluation Reach IV (Big Cleveland Creek).

   Stream channel improvement was considered for Evaluation Reach III only and for reaches III and IV together. In both of these cases a favorable benefit-cost ratio was obtained but did not produce the over-all desired reduction in damages for the watershed. Consideration was given to improving the channel through Reach I (the mainstem) to its confluence with the West Fork of the Trinity River to carry the 3-year frequency runoff from reaches III and IV in addition to channel improvement in reaches III and IV.

   A comprehensive study was made of the capacity of the natural channels with the purpose of making use of the existing channel wherever feasible. The final channel design and alignment utilizes the existing channel with no improvement from Valley Section 2, approximately 1,400 feet below the county road, to the confluence with the West Fork of the Trinity River. The

channel will be improved upstream from Valley Section 2 through reaches I, III, and IV. The existing channel will provide approximately 50 percent of the channel capacity required in the improved section in Reach I, resulting in reduced construction costs. Sufficient additional benefits were produced in Reach I to secure the desired over-all reduction in damages and maintain a favorable benefit-cost ratio.

After land treatment and structural measures had been determined, a table was prepared to show the cost of each type of measures. The summation of the total costs for all the needed measures is the estimated cost of the planned flood prevention project (Tables 1 and 2). Table 5 shows separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures.

Hydraulic and Hydrologic Investigations

Hydraulic and hydrologic investigations and determinations included steps and procedures as follows:

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, United States Weather Bureau and Water Supply Papers, United States Geological Survey, and locally recorded records and analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, the frequency of occurrence of meteorologic events to be used in the evaluation of the project, rainfall-runoff relationships, runoff-peak discharge relationships, and the relationship of geology, soils and climate to runoff depth frequency for single storm events.

2. The cross sections of the flood plain, previously located stereoscopically, were examined in the field, adjusted to give the best representation of hydraulic characteristics and surveyed at the selected locations. Data developed from these cross sections permitted computation of peak discharge-stage-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 was recorded.

3. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities, high water elevations of selected storms, bridge capacities, and other hydraulic characteristics, and on proposed floodwater retarding structure sites to collect data used in design. These cross sections and evaluation reaches were selected on the ground in conference with the other members of the Planning Party.

4. The present hydrologic condition of the watershed was determined from a 28 percent sample. This sample included existing land treatment, cover conditions, hydrologic soil groups and crop distribution. The future hydrologic condition was determined by obtaining from the Work Unit Conservationist the changes in land use and treatment that could be expected with an accelerated land treatment program during the project 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.

5. Determination was made of the rainfall-runoff relationship. The frequency of meteorologic events was determined by computing the plotting positions of historical series taken from climatological papers and water supply bulletins, and plotting runoff and peak discharges against their respective plotting positions on Hazen probability paper. The relationships of runoff, peak discharges and damages were determined for various frequencies. (Pages 3.18-1-24, National Engineering Handbook, Section 4, Supplement A).

   Stage-area inundated curves were developed for each cross section.

6. Determination was made of peak discharges, area inundated and damages caused by various amounts of runoff which would exist due to:

   a. Present conditions.

   b. Effect of land treatment measures.

   c. Effect of land treatment measures and floodwater retarding structures.

   d. Effect of land treatment measures, floodwater retarding structures, and stream channel improvement.

   e. Consideration of alternative programs and measures.

7. All floodwater retarding structures planned for this watershed are classified as Class A structures. In accordance with the criteria set forth in Washington Engineering Memorandum SCS-27, the minimum floodwater detention volume was determined using Yarnell's 6-hour, 25-year rainfall.

   The expected runoff from this rainfall ranged from 2.61 inches to 3.26 inches, depending on the soil-cover complex and the size of the drainage area of each structure.

The minimum floodwater detention volume as specified in the Texas State Mannual Supplement 2441 and determined by the method set up in the Fort Worth Engineering and Watershed Planning Unit Hydrology Memorandum EWP-2 ranges from 3.21 inches to 4.06 inches for Class A structures, depending on the soil-cover complex and the size of the drainage area of each structure.

The detention volume used in all structures equaled or exceeded the minimum requirements of Texas State Manual Supplement 2441 and Washington Engineering Memorandum SCS-27.

Percent chance of use of the emergency spillway was based on regional stream gage analysis and soil-cover complex of the watershed.

8. Point rainfall for the emergency spillway design and freeboard determination was selected from Figures 3.21-1 and 3.21-4 of the National Engineering Handbook, Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum SCS-27, Texas State Manual Supplement 2441, and Fort Worth Engineering and Watershed Planning Unit Hydrology Memorandum EWP-3, dated June 8, 1959. After making area adjustment of the point rainfall as prescribed in the references above, the expected runoff from the design storms was determined by using the Moisture Condition II and proper curve number, as was determined in Item No. 4 above, for each individual site.

   Inflow hydrographs of the runoff from the design storms were developed for each structure using the distribution graph method. In all cases, routing of the emergency spillway hydrograph produced no outflow with which to proportion the emergency spillway. Therefore, the dimensions of the emergency spillway were determined by using the outflow produced by routing of the freeboard hydrograph.

   Where alternate designs were used to determine the most economical combination of spillway width, depth, and elevation of the top of the dam, spillway dimensions were estimated by using an empirical formula. Final design of all structures was determined by using the graphical flood routing method described on page 5.8-12 of Section 5 of the National Engineering Handbook.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance with procedures as outlined in Watershed Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", August 21, 1959, Fort Worth, Texas.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 17 planned floodwater retarding structures according to the following procedures:

1. Detailed investigations were made in the drainage area above 12 of the floodwater retarding structures. Semidetailed studies of sediment sources were made for the remaining five planned floodwater retarding structures.

2. Detailed field surveys included: mapping soil units by slope in percent; slope length in feet; present land use; present land treatment on cultivated land; present cover condition classes on pasture and woodland; land capability classes; lengths, widths, and depths of all gullies; lengths, widths, and depths of all stream channels affected by erosion; the estimated annual lateral erosion of stream channels and gullies in feet; and the estimated annual headward erosion of gullies.

   The annual gross erosion, in acre-feet, by sources (sheet, gully and streambank erosion) was computed by the use of formulas in accordance with the criteria set forth in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Problem Area in Soil Conservation," Soil Conservation Service, Fort Worth, Texas, February 1953. The delivery rate curves as shown in the above guide was used to determine the volume of sediment deposited in structures.

3. Semidetailed field surveys to determine the sediment rates for structures under present conditions consisted of mapping the land use and grouping the sites according to similar watershed characteristics. Computations consisted of preparation of sediment source summary sheets based on the homogeneous grouping of the sites and the detailed investigations.

4. The sediment rates were then adjusted to reflect the effect of expected land treatment above the planned floodwater retarding structures. The computed sediment storage requirement for each floodwater retarding structure is based on a gradual improvement of watershed conditions as a result of the installation of needed land treatment measures expected to be installed during the first 5 years and maintaining these measures at 75 percent effectiveness during the next 45 years.

5. The ratio of sediment storage volume in the pools to soil

in place ranged from 1.2 to 1.4 for all structures in the watershed.

6. The allocation of sediment to the floodwater retarding structure pools was based on 20 percent deposition in the detention pool and 80 percent in the sediment pool, as shown for the North Central Prairie Land Resource Area in Fort Worth Engineering and Watershed Planning Unit Watersheds Memorandum EWP-5, "Sediment Storage Requirements and Allocation of Sediment in Floodwater Retarding Structures", dated July 7, 1959.

The average annual rate of sediment deposition in all structures is 0.63 acre-foot per square mile of drainage area.

Flood Plain Sedimentation and Scour Damages

The following sedimentation and scour damage investigations were made to determine the nature and extent of physical damage to the flood plain land, giving due consideration to agronomic and other land treatment practices, soils, crop yields and land capabilities:

1. Borings were made with a hand auger along each of the valley cross sections (Figure 1), making note of the depth and texture of the deposit, soil conditions, scour channels, stream channel aggradation or degradation and other pertinent factors contributing to flood plain damage.

2. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators and by comparing crops on damaged and undamaged land.

3. A damage table was developed to show percent of damage by texture and depth increments for deposition and percent of damage by depth and width for scour channels.

4. The depth and width of the damaging sediment deposits and scour areas were measured, tabulated and converted into acres.

5. The damage to the productive capacity of the flood plain was assessed by percent for each type of damage.

6. The sedimentation and scour damages were summarized by evaluation reaches for the entire flood plain. Estimates of recoverability of productive capacity were developed as a result of field studies and interviews with farmers.

7. Using the average annual erosion rates as a basis, the average annual sediment yields to selected reaches of the

flood plain were estimated for present conditions, with land treatment, and with structural measures installed. The results were compared to show the average annual reduction of overbank deposition. The reduction of scour damage due to the installation of the complete project is based on a reduction of depth and area inundated.

Sedimentation in Bridgeport Reservoir

The estimate of the present annual sediment yield to Bridgeport Reservoir from North Creek watershed is based on (1) a sedimentation survey of Bridgeport Reservoir by the Soil Conservation Service in 1943, (2) United States Geological Survey Water Supply Paper 1512 for the year 1957, and (3) a detailed study of sediment sources in North Creek watershed and the use of delivery rate curves developed by the Soil Conservation Service. The 1943 sedimentation survey showed an annual rate of deposition of 0.80 acre-foot per square mile. U. S. Geological Survey Water Supply Paper 1512 showed a 1952 capacity of 270,400 acre-feet which indicates an annual rate of 0.92 acre-foot per square mile for the period 1943 to 1952. However, proper land use and cover conditions in the North Creek watershed are considerably better than the average of the remaining watershed area above Bridgeport Reservoir. Therefore, it is estimated that the present annual rate of sediment contribution to Bridgeport Reservoir from the North Creek watershed is 0.65 acre-foot per square mile, and that the annual contribution with the complete watershed project installed and functioning effectively will be 0.33 acre-foot per square mile, a reduction of 53 percent.

Geological Investigations

Preliminary geologic dam site investigations were made at each of the planned floodwater retarding structure sites. These included studies of valley slopes, alluvium, channel banks and exposed geologic formationa. Borings with a hand auger were made to obtain preliminary information on the nature and extent of embankment material and emergency spillway excavation that might be encountered in construction.

All sites are located in the Graham formation, which represents the Cisco group of the Pennsylvanian period. This formation consists of shale, sandy shale, sandstone, and limestone members.

Some rock excavation will be encountered in the emergency spillway areas. Since continuous outcrops do not occur at several of the sites, accurate estimates of the percentage of rock excavation could not be made during the usual type of preliminary geologic investigation. Therefore, the emergency spillway areaa on Sites 15, 16, 17, 23, 24 and 30 were investigated with core drilling equipment to provide a realistic eatimate of rock excavation. Relatively high percentages of the required excavation will be rock. Bulldozer pits were excavated in the emergency spillway area of Sites 16 and 23 to provide information on the removability of the rock. All of the material required to be excavated will be useable in construction.

All the sites have adequate borrow material in the sediment pool areas. This material appears to be suitable for embankment construction and is classified as CL, SC, SM and SP-SM by the Unified Soil Classification system. High water tables are not a problem in these borrow areas.

Critically dispersed soils were found in samples taken from Sites 16, 19, and 27. These sites will require special drilling and sampling procedures during detailed dam site investigations, and special design and construction measures.

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 suitability and handling of the available embankment, cutoff wall, and foundation materials.

Economic Investigations

Basic methods used in the economic investigation and analysis are outlined in the Economics Guide issued December 1958.

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based upon schedules obtained in the field covering approximately 65 percent of the flood plain of North Creek and its tributaries. These schedules covered land use, crop distribution under normal conditions, crop yields and historical data on flooding and flood damage.

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 1915-1958, 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. Estimates of 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 are sufficient to divide the flood plain into four evaluation reaches. A different damageable value was used for each reach.

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

Reach I - From confluence of North Creek and West Fork of Trinity River to valley cross section 6A.

Reach II - From valley cross section 6A to structure sites Nos. 13, 14, 15, 16, 17, 22, 23, 24, 25, 26, 27, 28, 29, 30, and 31.

Reach III - From confluence of Little Cleveland Creek and North Creek to structure Site No. 18.

Reach IV - From confluence of Big Cleveland Creek and North Creek to structure sites Nos. 19, 20, and 21.

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

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

Estimates of damage 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 all evaluation reaches.

Farmers and ranchers in the flood plain were asked to state changes made in land use as a result of past flooding. They estimated future changes in crop distribution and major land use which would result due to a reduction in flood extent and frequency. This was the basis for estimating benefits from restoration of productivity. Consideration was given to increased damage after restoration of productivity and the added damage was deducted. Among the factors considered in this analysis were the size and location of the areas affected, land capability, acreage allotment restrictions, existence of available markets and reduction in frequency of flooding. It is not expected that acreages of crops subject to acreage allotments will be increased as a result of the project. Benefits from restoration of productivity are included as crop and pasture benefits.

All benefits from flood plain 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 were discounted to provide for a 7-year lag in accomplishment.

The value of easements was determined through local appraisal giving full consideration to the real estate values involved. Flood plain areas which will be inundated by the sediment and detention pools were excluded from the damage and benefit calculations. An estimate was made, however, of the value of the production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pools, and that the land covered by the detention pools would continue to be used as pasture after installation of the program.

The average annual loss in production within the structure sites was compared with 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.

Determination of Benefits Outside the Watershed

No benefits from the reduction of damage on the mainstem of the West Fork of the Trinity River were used. The straight-line depreciation method was used in evaluating the benefits that are derived from reduction of sediment damage to the Bridgeport Reservoir.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)
Price Base: 1957

Applied Prior to February 1960

Item	Unit	Number Applied	Estimated Cost 1/ Federal (dollars)	Non-Federal 2/ (dollars)	Total (dollars)
LAND TREATMENT FOR:					
Watershed Protection					
Soil Conservation Service					
Conservation Cropping Systems	Acre	3,586	-	-	-
Contour Farming	Acre	1,301	-	651	651
Cover Cropping	Acre	3,128	-	40,946	40,946
Crop Residue Use	Acre	3,586	-	14,344	14,344
Rotation Hay and Pasture	Acre	1,287	-	8,494	8,494
Grassland Renovation	Acre	0	-	-	-
Pasture Improvement	Acre	371	-	2,084	2,084
Pasture Planting	Acre	371	-	4,000	4,000
Proper Range Use	Acre	39,776	-	119,328	119,328
Range Seeding	Acre	2,081	-	24,868	24,868
Wildlife Area Treatment	Acre	524	-	524	524
Brush Control	Acre	19,900	-	159,001	159,001
Diversion Construction	Mile	4	-	480	480
Grassed Waterways	Acre	42	-	353	353
Pond Construction	No.	58	-	15,225	15,225
Terracing	Mile	23	-	2,064	2,064
Technical Assistance (Accel.)			6,500	-	6,500
SCS Subtotal			6,500	392,362	398,862
TOTAL LAND TREATMENT			6,500	392,362	398,862
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Strucs.	No.	2	88,383	-	88,383
Stream Channel Improvement	Mile		-	-	-
Subtotal - Construction			88,383	-	88,383
Installation Services					
Soil Conservation Service					
Engineering Services			22,806	-	22,806
Other			8,747	-	8,747
Subtotal - Installation Services			31,553	-	31,553
Other Costs					
Land, Easements, and R/W			-	10,230	10,230
Legal Fees			-	60	60
Subtotal - Other			-	10,290	10,290
TOTAL STRUCTURAL MEASURES			119,936	10,290	130,226
Work Plan Preparation Cost			-	-	-
TOTAL PROJECT			126,436	402,652	529,088
SUMMARY					
Subtotal SCS			126,436	402,652	529,088
TOTAL PROJECT			126,436	402,652	529,088

1/ Flood Prevention funds, including accelerated funds.
2/ Excludes $136,483 that was reimbursed from other Federal Funds to private interest.

February 1960

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Price Base: 1957 Installation Period 1/ February 1960 - February 1965

Item	Unit	Number to be Applied	Estimated Cost 2/ Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT FOR:					
Watershed Protection					
Soil Conservation Service					
Conservation Cropping Systems	Acre	2,314	-	-	-
Contour Farming	Acre	1,079	-	540	540
Cover Cropping	Acre	2,572	-	33,667	33,667
Crop Residue Use	Acre	2,314	-	9,256	9,256
Rotation Hay and Pasture	Acre	593	-	3,914	3,914
Grassland Renovation	Acre	160	-	682	682
Pasture Improvement	Acre	509	-	1,018	1,018
Pasture Planting	Acre	339	-	3,390	3,390
Proper Range Use	Acre	7,711	-	23,133	23,133
Range Seeding	Acre	2,049	-	22,129	22,129
Wildlife Area Treatment	Acre	1,043	-	1,043	1,043
Brush Control	Acre	12,900	-	93,525	93,525
Diversion Construction	Mile	4	-	480	480
Grassed Waterways	Acre	18	-	151	151
Pond Construction	No.	158	-	41,475	41,475
Terracing	Mile	51	-	4,254	4,254
Technical Assistance (Accel.)			14,250	-	14,250
SCS Subtotal			14,250	238,657	252,907
TOTAL LAND TREATMENT			14,250	238,657	252,907
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Strucs.	No.	17	587,151	-	587,151
Stream Channel Improvement	Mile	6.45	80,677	-	80,677
Subtotal - Construction			667,828	-	667,828
Installation Services					
Soil Conservation Service					
Engineering Services			110,766	-	110,766
Other			60,088	-	60,088
Subtotal - Installation Services			170,854	-	170,854
Other Costs					
Land, Easements, and R/W			-	53,645	53,645
Legal Fees			-	1,710	1,710
Subtotal - Other			-	55,355	55,355
TOTAL STRUCTURAL MEASURES			838,682	55,355	894,037
Work Plan Preparation Cost			24,300	-	24,300
TOTAL PROJECT			877,232	294,012	1,171,244
SUMMARY					
Subtotal SCS			877,232	294,012	1,171,244
TOTAL PROJECT			877,232	294,012	1,171,244

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

2/ Excludes $145,045 that may be available from other Federal funds to reimburse private interest.

NOTE: There are no Federal lands in this watershed. February 1960

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)
Price Base: 1957

Item	Unit	Number Applied and to be Applied	Estimated Cost Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total 1/ (dollars)
LAND TREATMENT FOR:					
Watershed Protection					
Soil Conservation Service					
Conservation Cropping Systems	Acre	5,900	-	-	-
Contour Farming	Acre	2,380	-	1,191	1,191
Cover Cropping	Acre	5,700	-	74,613	74,613
Crop Residue Use	Acre	5,900	-	23,600	23,600
Rotation Hay and Pasture	Acre	1,880	-	12,408	12,408
Grassland Renovation	Acre	160	-	682	682
Pasture Improvement	Acre	880	-	3,102	3,102
Pasture Planting	Acre	710	-	7,390	7,390
Proper Range Use	Acre	47,487	-	142,461	142,461
Range Seeding	Acre	4,130	-	46,997	46,997
Wildlife Area Treatment	Acre	1,567	-	1,567	1,567
Brush Control	Acre	32,800	-	252,526	252,526
Diversion Construction	Mile	8	-	960	960
Grassed Waterways	Acre	60	-	504	504
Pond Construction	No.	216	-	56,700	56,700
Terracing	Mile	74	-	6,318	6,318
Technical Assistance (Accel.)			20,750	-	20,750
SCS Subtotal			20,750	631,019	651,769
TOTAL LAND TREATMENT			20,750	631,019	651,769
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	19	675,534	-	675,534
Stream Channel Improvement	Mile	6.45	80,677	-	80,677
Subtotal - Construction			756,211	-	756,211
Installation Services					
Soil Conservation Service					
Engineering Services			133,572	-	133,572
Other			68,835	-	68,835
Subtotal - Installation Services			202,407	-	202,407
Other Costs					
Land, Easements and R/W			-	63,875	63,875
Legal Fees			-	1,770	1,770
Subtotal - Other			-	65,645	65,645
TOTAL STRUCTURAL MEASURES			958,618	65,645	1,024,263
Work Plan Preparation Cost			24,300	-	24,300
TOTAL PROJECT			1,003,668	696,664	1,700,332
SUMMARY					
Subtotal SCS			1,003,668	696,664	1,700,332
TOTAL PROJECT			1,003,668	696,664	1,700,332

1/ Includes total watershed needs.
2/ Flood Prevention funds, including acceleration funds.
3/ Excludes $281,528 that will be reimbursed from other Federal funds.

February 1960

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)
Price Base: 1957

Structure Site Number	Federal Installation Cost					Total Non-Federal Installation Cost 2/	Estimated Total Cost
	Construction		Installation Services		Total Federal		
	Engineer's Estimates	Contingencies	Engineering	Other			
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
13 3/	39,749	-	10,341	3,934	54,024	1,770	55,794
14	13,798	1,380	2,760	1,366	19,304	870	20,174
15	35,882	3,588	7,176	3,551	50,197	1,770	51,967
16	57,712	5,771	11,542	5,712	80,737	8,490	89,227
17	23,920	2,392	4,784	2,367	33,463	1,560	35,023
18 3/	48,634	-	12,465	4,813	65,912	8,520	74,432
19	30,565	3,056	6,113	3,025	42,759	3,900	46,659
20	37,715	3,772	7,543	3,733	52,763	4,110	56,873
21	41,632	4,163	8,326	4,120	58,241	2,760	61,001
22	16,505	1,650	3,301	1,633	23,089	1,470	24,559
23	26,098	2,610	5,220	2,583	36,511	5,340	41,851
24	59,207	5,921	1,184	5,860	72,172	3,720	75,892
25	25,694	2,569	5,139	2,543	35,945	1,590	37,535
26	30,368	3,037	6,074	3,006	42,485	1,230	43,715
27	40,994	4,099	8,199	4,057	57,349	1,380	58,729
28	26,751	2,675	5,350	2,648	37,424	2,730	40,154
29	25,572	2,557	5,114	2,531	35,774	1,980	37,754
30	22,037	2,204	4,407	2,181	30,829	900	31,729
31	19,325	1,932	3,865	1,913	27,035	1,790	28,825
Subtotal	622,158	53,376	118,903	61,576	856,013	55,880	911,893
Stream Channel Improvement							
Reach I	38,645	3,864	7,729	3,825	54,063	6,960	61,023
Reach III	20,693	2,069	4,139	2,048	28,949	60	29,009
Reach IV	14,005	1,401	2,801	1,386	19,593	2,745	22,338
Subtotal	73,343	7,334	14,669	7,259	102,605	9,765	112,370
GRAND TOTAL	695,501	60,710	133,572	68,835	958,618	65,645	1,024,263

1/ Does not include work plan preparation cost.
2/ Includes easements, rights-of-way, legal fees, and removing obstacles.
3/ Constructed.

February 1960

TABLE 3 - STRVCTURE DATA - FLOODWATER RETARDING STRUCTURES

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER									
		13 8/	14	15	16	17	18 8/	19	20	21	22
Drainage Area	Sq.Mi.	1.55	0.81	1.50	6.26 1/	1.40	7.35	3.07	4.13	1.84	1.12
Storage Capacity											
Sediment Pool	Ac.Ft.	184	24	54	200	56	467	69	90	57	26
Sediment in Detention Pool	Ac.Ft.	0	5	11	40	11	-	15	18	12	5
Floodwater Detention	Ac.Ft.	595	189	342	1,589	329	1,878	719	899	456	268
Total	Ac.Ft.	779	218	407	1,829	396	2,345	803	1,007	525	299
Surface Area											
Sediment Pool 2/	Acre	16	6	13	60	12	62	18	26	17	9
Floodwater Detention Pool	Acre	42	20	44	219	38	221	110	88	69	38
Volume of Fill	Cu. Yd.	104,823	33,420	72,280	80,030	62,520	131,662	70,760	86,890	108,580	43,030
Elevation Top of Dam	Foot	1,041.0	1,040.6	1,049.5	1,033.8	1,031.2	1,005.0	1,074.5	1,048.0	1,028.3	1,149.1
Maximum Height of Dam	Foot	35	35	38	40	36	24	34	39	27	22
Emergency Spillway											
Crest Elevation	Foot	1,036.0	1,036.5	1,045.5	1,028.0	1,026.5	1,000.0	1,070.5	1,044.0	1,024.5	1,146.0
Bottom Width	Foot	50	60	90	100	50	250	120	220	80	90
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 3/	-	1.0	2.9	3.0	2.0	2.6	2.9	2.6	2.9	2.3	2.5
Average Curve No. - Condition II	-	77	78	78	76	76	80	77	77	76	76
Emergency Spillway Hydrograph											
Storm Rainfall (6-hour) 4/	Inch	-	6.50	6.43	6.00	6.44	-	6.21	6.12	6.38	6.48
Storm Runoff	Inch	-	4.03	3.97	3.40	3.76	-	3.66	3.58	3.71	3.80
Velocity of Flow (Vc) 5/	Ft./Sec.	-	0	0	0	0	-	0	0	0	0
Discharge Rate 5/	c.f.s.	-	0	0	0	0	-	0	0	0	0
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	-	-
Freeboard Hydrograph											
Storm Rainfall (6-hour) 6/	Inch	-	15.20	15.03	14.00	15.07	-	14.54	14.42	14.92	15.17
Storm Runoff	Inch	-	12.28	12.12	10.80	10.85	-	11.48	11.37	11.70	11.95
Velocity of Flow (Vc) 5/	Ft./Sec.	-	8.7	8.6	10.5	9.4	-	8.6	8.6	8.4	7.6
Discharge Rate 5/	c.f.s.	1,000	1,290	1,850	3,855	1,350	5,000	2,362	4,448	1,513	1,175
Maximum Water Surface Elev. 5/	Foot	-	1,040.6	1,049.5	1,033.8	1,031.2	-	1,074.5	1,048.0	1,028.3	1,149.1
Principal Spillway Capacity (Maximum)	c.f.s.	16	10	19	153	18	74	38	52	23	14
Capacity Equivalents											
Sediment Below Riser	Inch	2.20	0.55	0.68	0.60	0.75	1.19	0.42	0.41	0.58	0.44
Sediment in Detention Pool	Inch	-	0.12	0.14	0.12	0.15	-	0.09	0.08	0.12	0.08
Floodwater Detention	Inch	7.20	4.38	4.28	4.76	4.40	4.79	4.39	4.08	4.65	4.50
Spillway Storage 7/	Inch	3.20	2.05	2.47	4.34	2.70	3.26	3.10	1.85	3.05	2.80
Class of Structure		A	A	A	A	A	A	A	A	A	A

(Footnotes next page)

TABLE 3 - STRVCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRVCTURE NUMBER 23	24	25	26	27	28	29	30	31	Total
Drainage Area	Sq.Mi.	4.90	5.47	1.41	1.41	1.22	2.63	1.82	1.20	1.05	50.14
Storage Capacity											
Sediment Pool	Ac.Ft.	110	111	24	36	29	60	47	33	29	1,706
Sediment in Oetention Pool	Ac.Ft.	21	20	6	7	6	13	10	4	6	210
Floodwater Detention	Ac.Ft.	1,228	1,283	335	335	288	628	461	392	236	12,450
Total	Ac.Ft.	1,359	1,414	365	378	323	701	518	429	271	14,366
Surface Area											
Sediment Pool 2/	Acre	31	24	11	7	7	17	14	7	8	365
Floodwater Dctention Pool	Acre	145	113	40	32	37	71	50	21	32	1,430
Volume of Fill	Cu.Yd.	53,420	154,540	63,270	77,720	98,780	67,810	64,580	52,840	52,950	1,479,905
Elevation Top of Oam	Foot	1,080.6	1,229.0	1,199.3	1,166.6	1,192.8	1,170.0	1,096.8	1,083.5	1,015.5	xxx
Maximum Height of Dam	Foot	43	40	30	35	24	33	33	44	19	xxx
Emergency Spillway											
Crest Elevation	Foot	1,075.5	1,224.0	1,195.0	1,162.5	1,188.5	1,166.0	1,092.0	1,078.5	1,011.5	xxx
8ottom Width	Foot	70	210	80	100	60	150	60	60	64	xxx
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 3/	-	2.2	3.1	2.3	2.6	2.4	2.7	2.3	3.3	3.0	xxx
Average Curve No. - Condition II	-	77	82	75	77	75	78	77	82	77	xxx
Emergency Spillway Hydrograph											
Storm Rainfall (6-hour) 4/	Inch	6.80	6.08	6.44	6.43	6.42	6.30	6.34	6.43	6.85	xxx
Storm Runoff	Inch	4.18	4.05	3.66	3.86	3.64	3.85	3.78	4.38	3.93	xxx
Velocity of Flow (Vc) 5/	Ft./Sec.	0	0	0	0	0	0	0	0	0	xxx
Oischarge Rate 5/	c.f.s.	0	0	0	0	0	0	0	0	0	xxx
Maximum Water Surface Eleu. 5/	Foot	-	-	-	-	-	-	-	-	-	xxx
Freeboard Hydrugraph											
Storm Rainfall (6-hour) 6/	Inch	15.91	14.24	15.07	15.04	15.02	14.74	14.84	15.03	15.23	xxx
Storm Runoff	Inch	11.19	11.90	11.70	11.97	11.65	11.84	11.77	12.68	12.15	xxx
Velocity of Flow (Vc) 5/	Ft./Sec.	9.9	9.8	8.9	8.7	9.0	8.6	9.6	9.8	8.6	xxx
Oischarge Rate 5/	c.f.s.	2,111	6,220	1,825	2,132	1,335	3,067	1,675	1,767	1,310	xxx
Maximum Water Surface Elev. 5/	Poot	1,080.6	1,224.0	1,199.3	1,166.6	1,192.8	1,170.0	1,096.8	1,083.5	1,015.5	xxx
Principal Spillway Capacity (Maximum)	c.f.s.	61	68	18	18	15	33	23	15	13	xxx
Capacity Equivalents											
Sediment Below Riser	Inch	0.42	0.38	0.32	0.48	0.44	0.43	0.49	0.52	0.52	xxx
Sediment in Detention Pool	Inch	0.08	0.07	0.07	0.09	0.09	0.09	0.10	0.06	0.11	xxx
Floodwater Detention	Inch	4.70	4.40	4.46	4.46	4.44	4.48	4.75	4.57	4.22	xxx
Spillway Storage 7/	Inch	3.20	2.38	2.40	1.92	2.93	2.40	2.96	2.30	2.60	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	xxx

1/ Excludes area from which runoff is controlled by other structures.
2/ Surface area at top of riser.
3/ 8ased on regional stream gage analysis and soil-cover complex characteristics of the watershed of the individual structure.
4/ Class A structures - 0.5P adjusted to drainage area; value of P from Figure 3.21-1, Supplement A, Section 4, National Engineering Handbook.
5/ Maximum during passage of hydrograph.
6/ 1.17 P adjusted to drainage area. Reference: Figure 3.21-1, Supplement A, Section 4, NEH, as modified by Hydrology Memorandum EWP-3, dated June 8, 1959.
7/ Storage from emergency spillway crest to top of dam.
8/ Constructed in 1951 under design criteria current at that time.

February 1960

TABLE 3A - STRUCTURE DATA

STREAM CHANNEL IMPROVEMENT

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Station Numbering For Reach		Watershed Area 1/	Planned Channel Capacity 2/	Bottom Width	Side Slope	Depth	Fall	Velocity at Design Depth	Volume of Excavation
Station	Station	(sq.mi.)	(c.f.s.)	(feet)		(feet)	(ft./ft.)	(ft./sec.)	(1000 cu.yd.)
Mainstem - Reach I									
0+00	16+38	20.00 3/	1,795 3/	62	2.5:1	5.0	.0025	4.82	22.63
16+38	58+95	50.01	2,986	70	2.5:1	6.9	.0018	4.96	82.58
58+95	80+45	38.14	2,986	50	2.5:1	6.0	.0017	4.96	7.76
113+95	128+15	36.46	1,685	50	2.5:1	6.0	.0017	4.32	11.28
128+15	153+95	36.07	1,688	50	2.0:1	5.6	.0020	3.12	37.27
161+15	194+05	24.06	345 4/	16	2.0:1	4.6	.0014	2.98	14.14
								Subtotal	175.66
Little Cleveland Creek - Reach III									
58+95	86+95	8.29	1,328	60	2.0:1	4.1	.0030	4.75	29.00
86+95	125+95	6.66	1,165	50	2.0:1	4.2	.0030	4.75	35.43
125+95	171+95	3.43	685	28	2.0:1	4.2	.0030	4.48	26.05
171+95	183+45	1.18	304	22	2.0:1	3.0	.0030	3.62	3.58
								Subtotal	94.06
Big Cleveland Creek - Reach IV									
153+95	216+45	9.38	1,353	45	2.0:1	5.0	.0027	4.92	63.66
								Subtotal	63.66
								GRAND TOTAL	333.38

1/ Uncontrolled area below floodwater retarding structures.
2/ From uncontrolled drainage area.
3/ Flow divided; capacity of existing stream channel is 1,172 c.f.s.
4/ Release rates only.

NOTE: Capacity of existing channel is adequate at and between stations 80 + 45 and 113 + 95 and at and between stations 153 + 95 and 161 + 15.

February 1960

TABLE 4 - SUMMARY OF PHYSICAL DATA

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	100.2	-
Watershed Area	Acre	64,136	-
Area of Cropland	Acre	6,590	6,590
Area of Rangeland and Pasture	Acre	50,810	50,668
Area of Wooded Pasture	Acre	5,936	5,713
Area of Miscellaneous Use	Acre	800	1,165
Overflow Area Subject to Damage 1/	Acre	5,327	3,068 2/
Overflow Area Damaged Annually by:			
Sediment	Acre	1,305 3/	509 4/
Flood Plain Scour	Acre	161 3/	49 4/
Streambank Erosion	Acre	0.60	0.60
Annual Rate of Erosion:			
Sheet	Ac.Ft.	73.33	60.09
Gully	Ac.Ft.	12.48	11.23
Streambank	Ac.Ft.	20.91	20.91
Scour	Ac.Ft.	6.26	2.68
Average Annual Rainfall	Inch	26.55	-

1/ Area inundated by the runoff from a 25-year frequency storm.
2/ Excludes 354 acres of flood plain within structure sites.
3/ Acres on which some loss of production is occurring each year.
4/ Area on which production loss will occur each year after all recovery has taken place and equilibrium has been reached. This applies to all flooding up to the area inundated by the runoff from a 25-year frequency design storm.

February 1960

TABLE 5 - ANNUAL COSTS 1/

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Measures	Amortization of Installation Costs 2/			Operation & Maintenance Costs 3/	Total
	Federal	Non-Federal	Total	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures 13 through 31;4/ and 6.45 Miles of Stream Channel Improvement	33,799	3,037	36,836	2,443	39,279
Total	33,799	3,037	36,836	2,443	39,279

1/ Does not include work plan preparation costs.

2/ Amortization period, 50 years; Federal interest rate, 2½ percent; non-Federal interest rate, 4 percent; based on 1957 prices.

3/ Based on long-term price levels as projected by ARS, September 1957.

4/ Interdependent measures.

February 1960

TABLE 6 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits
	Without Project	After Land Treatment For W/S Protection	With Project	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	35,196	34,472	5,026	29,446
Other Agricultural	13,680	13,124	4,597	8,527
Nonagricultural	5,696	5,381	962	4,419
Subtotal	54,572	52,977	10,585	42,392
Sediment Damage				
Overbank Deposition	2,128	1,915	887	1,028
Bridgeport Reservoir	2,065	1,881	1,056	825
Subtotal	4,193	3,796	1,943	1,853
Erosion Damage				
Flood Plain Scour	621	569	171	398
Subtotal	621	569	171	398
Indirect Damage	4,312	4,107	1,270	2,837
Total, All Damage	63,698	61,449	13,969	47,480
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	47,480
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	47,480
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	47,480

1/ USDA, ARS, September 1957.

February 1960

TABLE 7 - BENEFIT-COST ANALYSIS

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Measures	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit-Cost Ratio
	Flood Prevention						
	Flood-water	Sediment	Erosion	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 3/ Nos. 13 through 31; and 6.45 Miles of Stream Channel Improvement	42,392	1,853	398	2,837	47,480	39,279	1.2:1
TOTAL	42,392	1,853	398	2,837	47,480	39,279	1.2:1

1/ Long-term price levels, as projected by ARS, September 1957.

2/ Installation costs based on 1957 prices; operations and maintenance costs on long-term prices as projected by ARS, September 1957.

3/ Interdependent measures.

February 1960

ADDENDUM

TABLE 7 - BENEFIT-COST ANALYSIS 1/

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Measures	AVERAGE ANNUAL BENEFITS 2/					Average Annual Cost 3/	Benefit-Cost Ratio
	Flood Prevention						
	Flood-water	Sediment	Erosion	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 4/ Nos. 13 through 31; and 6.45 Miles of Stream Channel Improvement	42,392	1,853	398	2,837	47,480	39,460	1.2:1
TOTAL	42,392	1,853	398	2,837	47,480	39,460	1.2:1

1/ Revised to show benefit-cost comparison based on 2-5/8 percent interest rate for amortization of both Federal and non-Federal costs.

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

3/ Installation costs based on 1957 prices; operations and maintenance costs on long-term prices as projected by ARS, September 1957.

4/ Interdependent measures.

February 1960

TABLE 8 - SUMMARY OF BENEFITS FROM RESTORATION

North Creek - West Fork Above Bridgeport Watershed, Texas
(Trinity River Watershed)

Land Use	Unit of Production	Without Project 1/ Acres	Yield Per Acre	Gross Income (dollars)	Production Cost (dollars)	Net Return (dollars)	With Project 1/ Acres	Yield Per Acre	Gross Income (dollars)	Production Cost (dollars)	Net Return (dollars)
Oats	Bu.	524	45.0	18,393	10,968	7,425	694	45.0	24,360	14,527	9,833
Oats (Temporary Pasture) 3/	AUM	(524)	2.0	2,002	132	1,870	(694)	2.0	2,651	175	2,476
Wheat	Bu.	91	20.0	3,549	1,833	1,716	161	20.0	6,279	3,243	3,036
Wheat (Temporary Pasture) 3/	AUM	(91)	2.0	351	23	328	(161)	2.0	615	48	567
Forage Crops	Ton	329	2.0	17,523	6,624	10,899	859	2.0	45,750	17,383	28,367
Pasture	AUM	961	1.2	2,202	240	1,962	781	1.2	1,791	195	1,596
Wooded Pasture	AUM	810	0.8	1,240	202	1,038	220	0.8	340	259	81
Miscellaneous Land Use	-	104	-	-	-	-	104	-	-	-	-
Total		2,819		45,260	20,022	25,238	2,819		81,786	35,830	45,956

1/ Based on flood-free yields.
2/ Discounted for expected lag in conversion.
3/ Grazing received from oats and wheat which will be harvested for seed.

Increased Net Return with Project	$20,718
Less Associated Cost	3,265
Discounted Increased Net Return 2/	15,289
Average Annual Benefits From Restoration (Long-Term Price)	16,265

February 1960