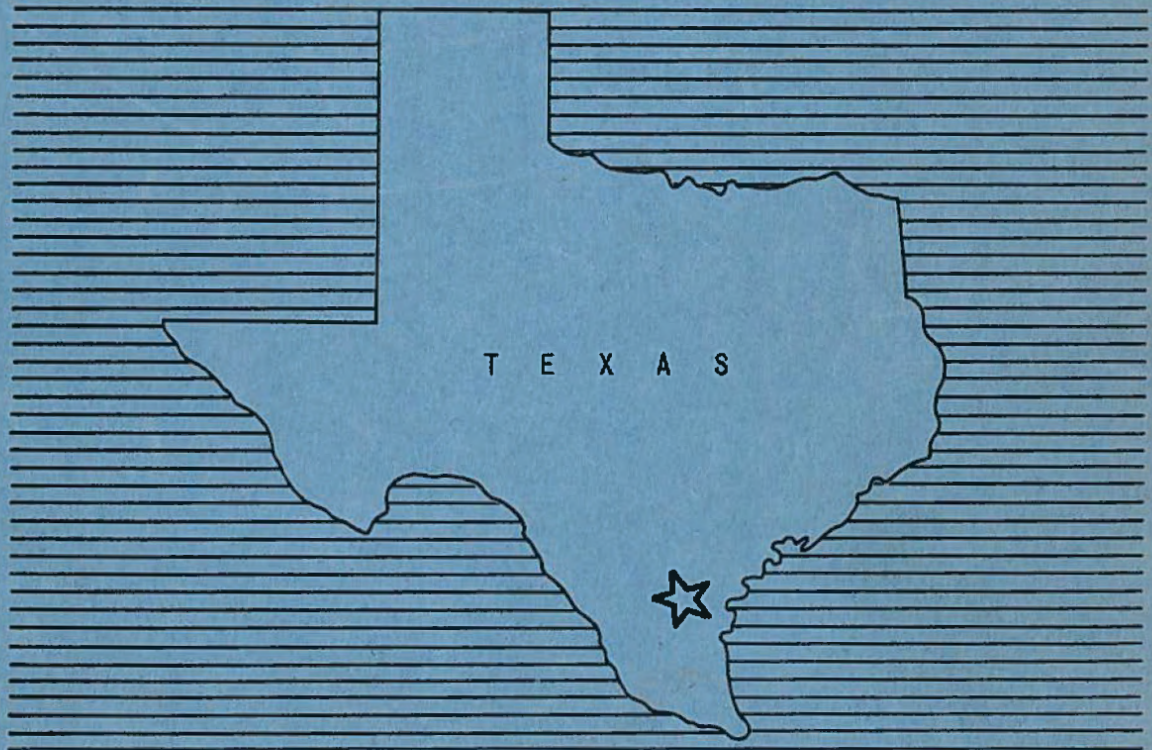
OFFICIAL COPY

WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

CHILTIPIN-SAN FERNANDO CREEKS WATERSHED

DUVAL, JIM WELLS, NUECES and KLEBERG COUNTIES, TEXAS



MAY 1958

USDA-SCS-FORT WORTH, TEX 1958

WATERSHED WORK PLAN AGREEMENT

between the

San Diego-Agua Dulce Soil Conservation District
Local Organization

Duval County Commissioners Court
Local Organization

Jim Wells County Commissioners Court
Local Organization

Nueces County Commissioners Court

City of Bishop

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

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Chiltipin-San Fernando Creek Watershed, State of Texas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress; 70 Stat. 1088); and

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

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

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 219,813 .)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The percentages of construction costs of structural measures and land treatment measures for flood prevention to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
9 Floodwater Retarding Structures	0	100	876,683
20.35 Miles Channel Improvement	0	100	173,946
5.7 Miles Levee	0	100	15,030
3.5 Miles Levee and Channel Improvement	0	100	84,302
			1,149,961

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

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention. (Estimated cost $ 358,575 .)

   The Service will bear _____ percent of the cost of installation services applicable to works of improvement for agricultural water management and the Sponsoring Local Organization will bear _____ percent of the cost of such services. (Estimated cost $_____.)

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

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 6,500 .)

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

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

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

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

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

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

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

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

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

San Diego-Agua Dulce Soil Conservation District
Local Organization

By W T Bolard

Title Chairman

Date July 24, 1958

The signing of this agreement was authorized by a resolution of the governing body of the San Diego-Agua Dulce Soil Conservation District
Local Organization

adopted at a meeting held on July 24, 1958

Geo O Hoffman
acting Secretary, Local Organization)

Date July 24, 1958

Duval County Commissioners Court
~~Local~~ Organization

By Daniel O'Kiel Jr.

Title County Judge

Date July 24, 1958

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

adopted at a meeting held on July 24, 1958.

J. W. Dolina Comm. #1
(Secretary, Local Organization)

Date July 24, 1958

Jim Wells County Commissioners Court
Local Organization

By Wash Storm Jr.

Title County Judge

Date July 24, 1958

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

adopted at a meeting held on July 24, 1958

Watmore County Clerk
(Secretary, Local Organization)

Date July 24, 1958

Nueces County Commissioners Court
Local Organization

By [signature]

Title [signature]

Date July 24, 1958

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

adopted at a meeting held on October 14, 1957

Mrs. Henry E. Geuger
County Clerk, Nueces Co. Tex
By Marion Geuger, Deputy
(Secretary, Local Organization)

Date July 24, 1958

City of Bishop
Local Organization

By [signature]

Title Mayor

Date July 24, 1958

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

adopted at a meeting held on July 24, 1958

J. B. Jones
(Secretary, Local Organization)

Date July 24, 1958

Soil Conservation Service
United States Department of Agriculture

By [signature]
Acting Administrator

Date 11/20/58

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

CHILTIPIN-SAN FERNANDO CREEKS WATERSHED
Duval, Jim Wells, Nueces and Kleberg Counties, Texas

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

Prepared By: San Diego-Agua Dulce Soil Conservation District
(Cosponsor)

Duval County Commissioners Court
(Cosponsor)

Jim Wells County Commissioners Court
(Cosponsor)

Nueces County Commissioners Court
(Cosponsor)

City of Bishop
(Cosponsor)

With Assistance By:

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

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SECTION 1

WATERSHED WORK PLAN

CHILTIPIN-SAN FERNANDO WATERSHED
Duval, Jim Wells, Nueces and Kleberg Counties, Texas
May 1958

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Chiltipin-San Fernando Creeks watershed was prepared by the San Diego-Agua Dulce Soil Conservation District and the Commissioners Courts of Duval, Jim Wells and Nueces Counties and the city of Bishop as cosponsoring organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

The work plan covers an area of approximately 337 square miles, or 215,740 acres, in Duval, Jim Wells, Nueces, and Kleberg Counties. Approximately 38.7 percent of the watershed is cropland, 58.4 percent is grassland and 2.9 percent is in miscellaneous uses, such as towns, industrial areas, roads, stream channels, and railroads.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $2,871,640. The share of this cost to be borne by other than Public Law 566 funds is $1,338,104. In addition, local interest will bear the entire cost of operation and maintenance, with a capitalized value of $242,186. Of the total project cost of $3,113,826, the other than Public Law 566 share will be $1,580,290, and the Public Law 566 share will be $1,533,536.

Land Treatment Measures

The cost for land treatment measures is estimated to be $1,136,791, of which the other than Public Law 566 share is $1,111,791, including $34,175 to be spent by the Soil Conservation Service under its going program for technical assistance during the project period. The Public Law 566 share, consisting entirely of accelerated technical assistance is $25,000. The work plan includes only the land treatment measures that will be installed during the 5-year project period.

Structural Measures

The structural measures included in the plan consist of 9 floodwater retarding structures, 20.35 miles of channel improvement, 5.7 miles of levee, and

3.5 miles of levee in combination with channel improvement for urban protection for the city of Bishop. The 9 structures will have a total sediment storage and floodwater detention capacity of 27,929 acre-feet. The total cost of these measures, including the capitalized value of operation and maintenance, is $1,977,035, of which the local share is $468,499, and the Public Law 566 share $1,508,536. The local share of the cost of structural measures includes: land, easements, and rights-of-way, 46.9 percent; operation and maintenance, 51.7 percent; and administering contracts, 1.4 percent. The project will be installed during a 5-year period.

Damages and Benefits

The estimated average annual floodwater, sediment, erosion and indirect damage without the project is $116,880. The estimated average annual damage with the project, including land treatment and structural measures, is $23,049. The average annual primary benefits accruing to structural measures in this watershed are $75,893 (table 7). Structural measures in the San Diego-Rosita Creeks watershed (figure 1) account for $33,980 of the reduction in damage occurring in the Chiltipin-San Fernando Creeks watershed (item 6, below) and are not credited to the structural measures in this watershed. On the other hand, structural measures in the Chiltipin-San Fernando Creeks watersheds reduce damages in other interrelated watersheds by $23,395 (item 5). Benefits are distributed as follows:

1.	Floodwater damage reduction	$ 51,999
2.	Sediment damage reduction	901
3.	Erosion damage reduction	23,352
4.	Indirect damage reduction	10,226
5.	Add benefits from outside project area:	
	Agua Dulce Creek watershed	12,195
	Agua Dulce Laterals Watershed	11,200
6.	Deduct benefits accruing to Chiltipin-San Fernando Creek watershed but creditable to works of improvement in San Diego-Rosita Creeks watershed	33,980
	Total	$ 75,893

The ratio of the average annual benefits creditable to works of improvements in this watershed ($75,893) to the average annual cost of structural measures in this watershed($69,704) is 1.1 to 1.

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

Provisions for Financing Construction

The Commissioners Courts of Duval, Jim Wells and Nueces Counties have powers of taxation and eminent domain under applicable State laws. An ad valorem tax has been voted in these counties for the purpose of flood control and is presently being collected. This revenue is adequate and will be available for financing the local share of the structural cost.

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the landowners or operators of the farms under agreement with the San Diego-Agua Dulce Soil Conservation District. The 9 floodwater retarding structures, 20.35 miles of channel improvement and 5.7 miles of levee will be operated and maintained jointly by the Commissioners Courts of Duval, Jim Wells, and Nueces Counties, which have legal authority to raise and expend funds for this purpose. The 3.5 miles of levee and channel improvement for urban protection will be operated and maintained jointly by the Commissioners Court of Nueces County and the city of Bishop. The city of Bishop also has legal authority to raise and expend funds for this purpose. The estimated average annual cost of operation and maintenance of all works of improvement is $8,539.

DESCRIPTION OF WATERSHED

Physical Data

Chiltipin Creek (figure 1) heads approximately 16 miles northeast of Freer, Texas and flows in a southeasterly direction to a point approximately one mile northeast of Alice, Texas where it is joined by San Diego Creek to form San Fernando Creek.

San Fernando Creek flows in a southeasterly direction from the confluence of Chiltipin and San Diego Creeks for approximately three miles. At a point approximately three miles east of Alice, the stream flow divides. A portion of the flow continues down San Fernando Creek in a southeasterly direction for about 21 miles where it discharges into an arm of Baffins Bay approximately 7 miles southeast of Kingsville, Texas. The remainder flows down Pintas Creek in an easterly direction for approximately 20 miles to the confluence with Agua Dulce Creek.

Agua Dulce Creek heads approximately 18 miles north of Alice and flows in a southeasterly direction for about 46 miles where it discharges into an arm of Baffins Bay, 16 miles east of Kingsville, Texas.

This complex and interrelated drainage area has been divided into four watersheds to obtain workable units for the planning and application of works of improvement. The local sponsoring organizations have requested that these four watersheds be planned together, since they are component parts of the larger watershed. The four watersheds, San Diego-Rosita Creeks, Chiltipin-San Fernando Creeks, Agua Dulce Creek, and Agua Dulce Laterals are shown on figure 1.

This work plan for watershed protection and flood prevention comprises the Chiltipin-San Fernando Creeks portion of the interrelated watershed. Chiltipin Creek, as pointed out above, heads in Duval County, approximately 16 miles northeast of Freer and flows in a southeasterly direction to its confluence with San Diego Creek one mile northeast of Alice, in Jim Wells County. Below this confluence it is known as San Fernando Creek which flows in a southeasterly direction through Nueces and Kleberg Counties for approximately 21 miles where it discharges into an arm of Baffin Bay about 7 miles southeast of Kingsville. Armagosa Creek joins Chiltipin Creek approximately 12 miles northwest of Alice. Turo Creek joins Chiltipin Creek about 5 miles north of Alice. Lattas Creek, which serves as drainage for most of the city of Alice, joins San Fernando Creek about 5 miles southeast of Alice. Coreta Creek, which serves as the drainage outlet for Bishop, joins San Fernando Creek approximately 5 miles south of Bishop.

The topography of the watershed ranges from moderately sloping and gently rolling in the upper portion to nearly flat in the lower portion. Elevations range from 520 feet to 20 feet above mean sea level. In the upper reaches of Chiltipin Creek the flood plain averages about 200 feet in width and increases to over 5,000 feet wide west of Bishop.

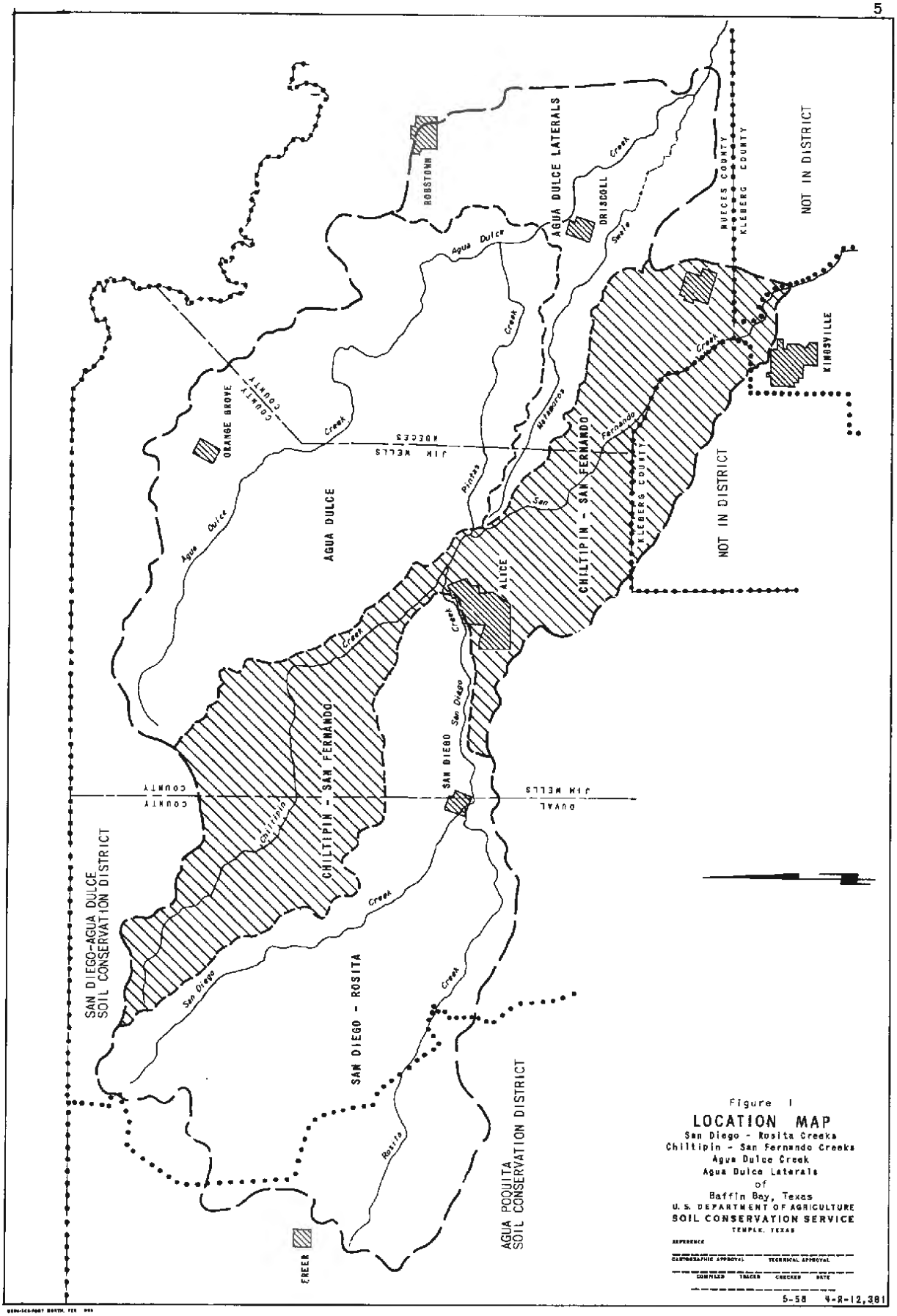

Figure 1

LOCATION MAP

San Diego - Rosita Creeks
Chiltipin - San Fernando Creeks
Agua Dulce Creek
Agua Dulce Laterals
of
Baffin Bay, Texas

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

REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

DRAWN | TRACED | CHECKED | DATE

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The watershed lies within the Rio Grande Plain Land Resource Area.

Physiographically, the western part of the watershed is known as the South Texas Coastal Plain, while the eastern part is within the Coastal Prairie. Formations outcropping within the watershed from oldest to youngest are the Goliad, Lissie, and Beaumont. The Goliad is Tertiary in age while the Lissie and Beaumont are classified as Quaternary in age. They dip from 20 to 80 feet per mile toward the Gulf of Mexico to the southeast. Surface faults in the upland areas within the upper portion of the watershed have determined the drainage of water to the creeks in many cases.

Medium textured soils predominate in the western half of the watershed. Soft to hard caliche generally underlies the soils at a shallow depth. The eastern half of the watershed consist primarily of deep fine textured soils. Grassland occupies approximately 58.4 percent of the watershed with 93.9 percent in poor cover condition, 5.1 percent in fair cover condition, and 1.0 percent in good cover condition. Shallow soils, drouth, and some cases of overgrazing have greatly influenced these conditions, however, under normal rainfall and with more land treatment practices applied, the condition of the cover should improve.

The overall land use for the watershed is as follows:

Land Use	Acres	Percent
Cultivation	83,477	38.7
Grassland	125,965	58.4
Miscellaneous 1/	6,298	2.9
Total	215,740	100.0

1/ Includes urban areas, industrial area, highways, roads, railroads, stream channels, etc.

Principal scour damages have occurred below U. S. Highway 281 north of Alice, to F. M. Highway 665 southeast of Alice. About 13,233 acres of the watershed are flood plain which will be benefited by the project. The flood plain considered in this plan is the area inundated by the 25-year frequency storm runoff. Land use in the flood plain is: 53 percent cultivation; 41 percent range, brush, or pasture; and 6 percent miscellaneous.

The average annual rainfall at the Alice, Texas gage is 26 inches according to U. S. Weather Bureau records over a period of 30 years. The monthly average ranges from 1.27 inches in February to 3.57 inches in September.

Average temperatures range from 83 degrees Fahrenheit in the summer to 56 degrees in the winter. The normal frost-free season of 294 days extends from February 23rd to December 12th.

Water for livestock and domestic use is supplied from wells. Stock ponds also furnish water for livestock, however, this source is not always dependable during periods of drought.

Economic Data

The economy of the watershed is based on both agricultural production and the production of petroleum products. In the Bishop area, production of chemicals are important and materially effects the economy of the lower portion of the watershed. Production of beef cattle is the major agricultural enterprise in the upper half of the watershed. In the lower half, production of cash crops predominates, with cotton and maize being the most important crops. In this area, however, beef cattle production is significant, influenced to a considerable extent by the large acreage of the King ranch located in the watershed.

The average size agricultural unit in the watershed is approximately 450 acres, an area sufficient for an economic unit. Almost all of the land in the watershed is leased for mineral production, which furnishes additional income to farm operators. Production of oil and gas is widespread throughout the watershed, and income from this source provides a significant part of the income of many farm operators.

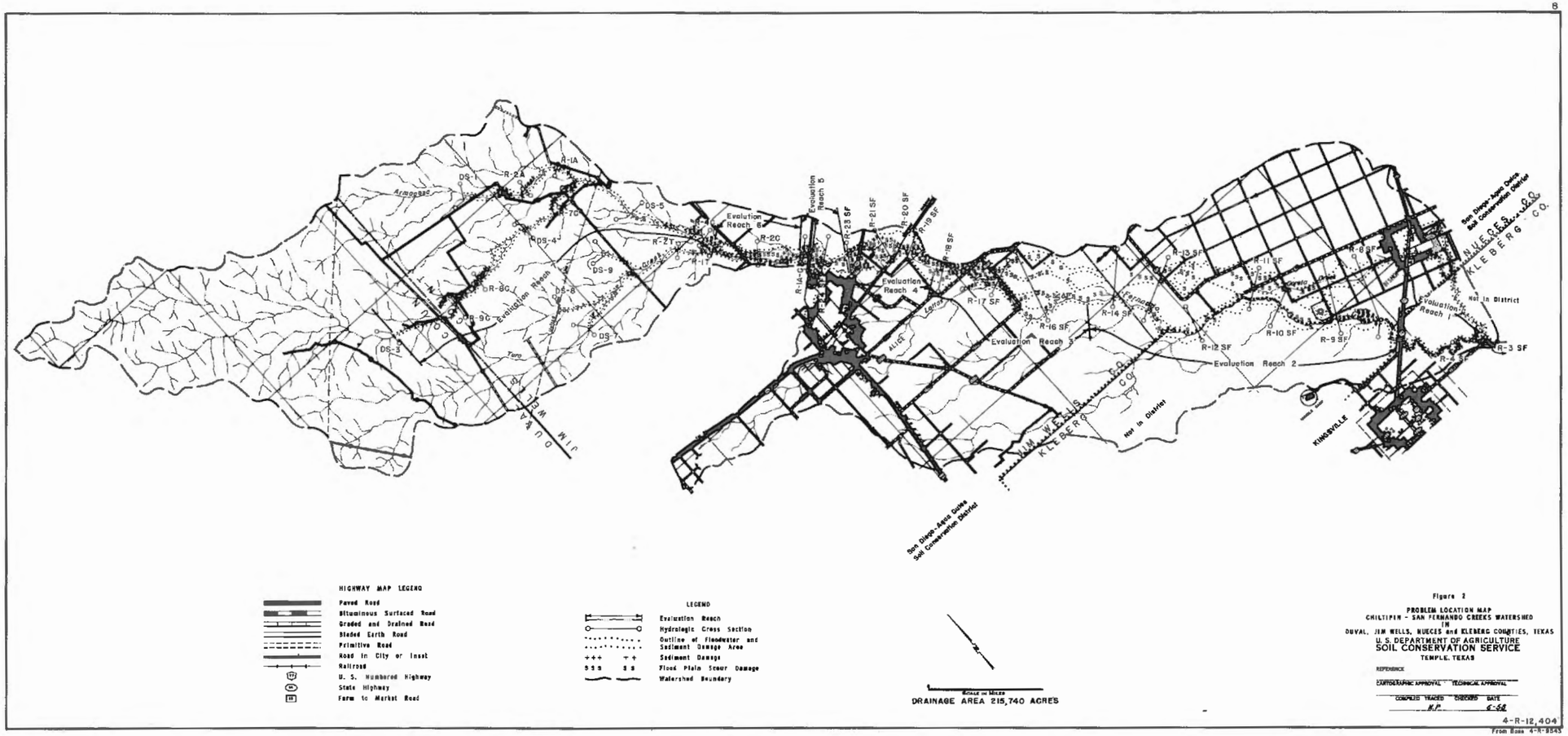
Alice, population 23,000, is partly in the watershed and partly in the San Diego-Rosita watershed. Bishop, population 4,000, is the only other city located in the watershed. Kingsville, population 25,000, adjoins the southern boundary of the watershed. These cities provide adequate marketing, ginning, grain storage, and educational and medical facilities for the people in this area.

The area is adequately served by approximately 203 miles of Federal, State and County roads, of which 106 miles are hard surfaced. In addition, there are numerous private farm, ranch and oil field roads serving the area. Adequate rail service is provided by three railroads with good loading and shipping facilities at Alice, Bishop, and Kingsville.

WATERSHED PROBLEMS

Floodwater Damage

Flooding occurs frequently in the Chiltipin-San Fernando Creeks watershed and causes severe damage. Large storms have occurred on the average of once every three to four years. During the 30-year period studied, 1924 to 1953, which is representative of normal rainfall in this area, there were eight major floods that inundated more than half of the flood plain (figure 2), as well as 46 smaller floods. In addition to flooding on Chiltipin and San Fernando Creeks, the town of Bishop experiences severe floodwater damage from excessive runoff from the relatively flat area of agricultural land north and west of town.



HIGHWAY MAP LEGEND

- Paved Road
- Bituminous Surfaced Road
- Graded and Drained Road
- Bladed Earth Road
- Primitive Road
- Road in City or Inset
- Railroad
- U. S. Numbered Highway
- State Highway
- Farm to Market Road

LEGEND

- Evaluation Reach
- Hydrologic Cross Section
- Outline of Floodwater and Sediment Damage Area
- Sediment Damage
- Flood Plain Scour Damage
- Watershed Boundary

SCALE IN MILES

DRAINAGE AREA 215,740 ACRES

Figure 2

PROBLEM LOCATION MAP
CHILTIPIN - SAN FERNANDO CREEKS WATERSHED
IN
DUVAL, JIM WELLS, NUECES and KLEBERG COUNTIES, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

COMPILED TRACED | CHECKED | DATE
H.P. | | 6-58

4-R-12,404
From Base 4-R-8545

During recent years unusually severe flooding has occurred in the Chiltipin-San Fernando Creeks watershed. Major floods were experienced in 1949, 1951, 1953, 1955, 1957, and 1958. All of these except the April 1949 flood occurred in the fall or winter months. Consequently the floodwater damage was somewhat less than would have been sustained had they occurred during the growing season.

The flood of September 1951 resulted from a general storm over all four interrelated watersheds, with precipitation ranging up to about 19 inches in places. Widespread flooding, covering about 16,200 acres in the watershed, resulted. Although many of the crops were harvested at the time this flood occurred, it is estimated that the direct floodwater damage was in excess of $350,000.

The floods of 1953 and 1955 were smaller than the flood of 1951. However, the 1955 flood followed a series of three severe floods at two-year intervals and discouraged many farmers. Moreover, it caused unusually severe scour damage which induced many farmers to convert flood plain land from crop production to pasture.

During the winter of 1957-1958 three floods occurred which caused severe scour damage throughout the flood plain. As a result of excessive runoff from the relatively flat agricultural lands north and west of town, Bishop suffered severe damage on two occasions during this period. The flood of January 4 - 5, 1958 was the most damaging to ever occur and resulted in a direct floodwater

Flood damages from storm of January 4 - 5, 1958. Commissioner inspecting Gibson Road west of Bishop.

(Photo by Grady Stiles, Caller-Times, Corpus Christi, Texas)

M-18-Ft.W.-58

damage in excess of $77,000. In addition, approximately 750 people were forced to evacuate their homes for periods of time ranging from 12 hours to several days. Exposure, brought about by evacuation, caused the death of one person.

It is estimated that the average annual direct floodwater damage in the watershed under existing conditions is $66,582, of which $39,586 is crop and pasture damage, $7,792 is other agricultural damages, $13,816 is nonagricultural damage to railroads, roads, bridges, industrial developments and recreational facilities etc, and $5,388 is damage to the urban area of Bishop. In addition, there are numerous indirect damages, such as interruption of travel, initial losses sustained by dealers and industries in the area and dislocation of persons from homes and work, which are estimated to average $13,269 per year.

Sediment Damage

Sediment damage to the flood plain lands has not been severe in this watershed. Approximately 178 acres have suffered some degree of damage causing varying amounts of loss of production. Some of the scour channels are being filled with sediment. This sediment consists primarily of fine sand washed clean of organic matter. Crop production has been reduced approximately 10 percent on 23 acres, 20 percent on 137 acres, and 40 percent on 18 acres. This amounts to an average annual monetary damage of $1,747.

There are no large reservoirs within the watershed. Stock ponds within the area have suffered moderate damage due to sedimentation.

Erosion Damage

Erosion rates are low to moderate within this watershed. This is due primarily to slopes ranging from moderate to nearly flat and to only 38.7 percent of the land being in cultivation. Sheet erosion accounts for 82.2 percent of the total gross erosion. Scour channels in the flood plain produced 15.0 percent, with erosion from streambanks, gullies, and dirt roads accounting for 1.8, 0.5, and 0.5 percent, respectively, of the total gross erosion.

Flood plain scour has damaged 4,734 acres, or 35.8 percent of the flood plain. The number of acres of scour damage is expected to increase in the future for an estimated period of five to ten years before a state of equilbrium will be reached. With long growing seasons in the watershed, cultivated lands in the flood plain have longer periods during which they are bedded and without cover. While in this state they are more subject to severe erosion by scour. Removal of surface soil ranges from 0.3 to 2.7 feet in depth and has damaged 2,731 acres, 10 percent; 1,378 acres, 20 percent; 368 acres, 30 percent; 207 acres, 40 percent; 35 acres, 50 percent; and 15 acres, 70 percent, in terms of reduced productivity. The estimated average annual damage by scour is $35,282.

Problems Relating to Water Management

There is very little activity relative to drainage or irrigation in the

watershed. No individual landowner or group of landowners has indicated an interest in providing additional storage in any of the floodwater retarding structures for irrigation purposes. The city of Alice, however, indicated interest in providing additional storage for municipal water supply. City officials, after study of engineering and hydrologic data and inspection of the proposed floodwater retarding structure sites, determined that one site on Chiltipin Creek warranted additional investigation. They engaged private consulting engineers to carry the investigations further and to prepare a feasibility report. These investigations indicated that additional storage satisfactory to the needs of the city in the floodwater retarding structure was not physically or economically feasible. Details of investigation and recommendations are contained in "Investigations of a Reservoir on Chiltipin Creek as a Possible Water Supply for the City of Alice, Texas" dated November, 1957 by Reagan & McCaughan Consulting Engineers, Corpus Christi, Texas.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The Chiltipin-San Fernando Creeks watershed is served by Soil Conservation Service Work Units at Alice and Robstown which are assisting the San Diego-Agua Dulce Soil Conservation District. These work units have assisted farmers and ranchers in preparing 291 soil and water conservation plans on 125,096 acres (60 percent of the agricultural land) within the watershed and in giving technical assistance in establishing and maintaining planned measures. Approximately 22,260 acres of the watershed, that portion of the King ranch in Kleberg County within the watershed, is not in a soil conservation district. This area is entirely in range under good management. No additional land treatment measures are needed or planned for this portion of the watershed.

Only minor efforts have been made to prevent or control flooding in the Chiltipin-San Fernando Creeks watershed. Attempts made by Jim Wells County to clean the channel of San Fernando Creek have had minor effect on the overall reduction of flood damages. The only existing works of improvement in the watershed are located on San Fernando Creek, in Nueces County. These works consist of approximately 1.5 miles of levee constructed to prevent San Fernando Creek from overflowing into the head of Coreta Creek. The channel improvement and levee measures included in this plan have been planned and designed on the basis of the present condition of the existing levee. To this extent the existing levee is considered an integral part of the plan. There are no other existing or proposed works of improvement in the watershed.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the San Diego-Agua Dulce Soil Conservation District is necessary for a sound flood prevention program on the watershed. Basic to reaching this objective is the

establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on accelerating the establishment of land treatment practices which have a measurable effect on the reduction of floodwater, sediment and erosion damages.

Of the total watershed area of 215,740 acres, 84,109 acres lie above planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. There are another 118,398 acres of upland in the watershed for which no structural control has been planned and for which establishment of land treatment constitute the only planned measures in this plan. Land treatment measures on the 13,233 acres of flood plain are also important in reducing floodwater and flood plain scour damages.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing these measures is $1,136,791, including $25,000 from Public Law 566 funds during the 5-year installation period for technical assistance to landowners and operators to speed up the planning and application of conservation practices. Landowners and operators will maintain these measures in accordance with provisions of the farmer-district cooperative agreements with the San Diego-Agua Dulce Soil Conservation District.

Land treatment measures will decrease erosion damage and sediment production from fields and pastures by providing improved soil cover conditions. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

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

Structural Measures

A system of 9 floodwater retarding structures, 20.35 miles of channel improvement and 5.7 miles of levee will be installed in the Chiltipin-San Fernando Creeks watershed in conjunction with 11 floodwater retarding structures in the San Diego-Rosita Creeks watershed to afford the needed protection to flood plain lands which cannot be provided by land treatment measures alone.

Urban protection for the prevention of flooding in Bishop, Texas will be provided by 3.5 miles of a combination of levee and channel improvement.

The 9 structures will detain temporarily the runoff from 84 percent of the

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Chiltipin-San Fernando Creeks Watershed, Texas
Price Base: 1957

Installation Cost Item	Unit	No. to be Applied Non-Federal Land	Estimated Cost P. L. 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	11,635	-	8,339	8,339
Cover Cropping	Acre	13,101	-	93,680	93,680
Crop Residue Utilization	Acre	28,194	-	56,388	56,388
Rotation Hay & Pasture	Acre	4,837	-	28,803	28,803
Brush Control	Acre	48,130	-	500,340	500,340
Proper Use	Acre	58,111	-	145,278	145,278
Range Seeding	Acre	46,508	-	209,281	209,281
Pasture Planting	Acre	923	-	5,880	5,880
Diversion Construction	Mile	2.1	-	1,497	1,497
Pond Construction	Each	14	-	10,800	10,800
Terraces	Mile	80	-	15,790	15,790
Waterway Development	Acre	77	-	1,540	1,540
Technical Assistance			25,000	34,175	59,175
SCS Subtotal			25,000	1,111,791	1,136,791
TOTAL LAND TREATMENT			25,000	1,111,791	1,136,791
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	9	876,683	-	876,683
Channel Improvement	Mile	20.35	173,946	-	173,946
Levee	Mile	5.7	15,030	-	15,030
Urban Protection					
Levee and Channel Improvement	Mile	3.5	84,302	-	84,302
SCS Subtotal			1,149,961	-	1,149,961
Subtotal - Construction			1,149,961	-	1,149,961
Installation Services					
Soil Conservation Service					
Engineering Services			209,082	-	209,082
Other			149,493	-	149,493
SCS Subtotal			358,575	-	358,575
Subtotal - Installation Services			358,575	-	358,575
Other Costs					
Land, Easements & R/W			-	219,813	219,813
Administration of Contracts			-	6,500	6,500
Subtotal - Other			-	226,313	226,313
TOTAL STRUCTURAL MEASURES			1,508,536	226,313	1,734,849
TOTAL PROJECT			1,533,536	1,338,104	2,871,640
SUMMARY					
Subtotal SCS			1,533,536	1,338,104	2,871,640
TOTAL PROJECT			1,533,536	1,338,104	2,871,640

1/ No Federal lands involved.

May 1958

M-18-Ft.W.-58

Hubam clover used for winter cover crop being grazed in the spring.

Bufflegrass seeding following brush clearing.

Chiltipin portion of the watershed at hydrologic cross section No. 2 C (figure 2). Storage in the individual sites in this watershed will range from 3.09 to 4.19 inches of runoff from their watersheds. The total of 25,289 acre-feet of floodwater detention provided by the 9 structures is sufficient to detain an average of 3.56 inches of runoff for the area above structures. These structures in combination with the structures in the San Diego-Rosita Creeks watershed will detain the runoff from 61.4 percent of the total contributing area above cross section SF 19, which is immediately above the division of streamflow of San Fernando and Pintas Creeks.

Figure 3 shows a section of a typical floodwater retarding structure.

The 20.35 miles of channel improvement will provide adequate channel capacity for release flows from the floodwater retarding structures, plus capacity to afford additional protection from runoff from the uncontrolled area.

The 5.7 miles of levee will be installed to prevent overland flow from San Fernando Creek during flood conditions. This measure was planned in lieu of the more expensive channel improvement.

There are 6 low-water crossings on Turo Creek, a tributary to Chiltipin Creek, and 4 on Chiltipin Creek above cross section 2 C that will be affected by the release flow from the floodwater retarding structures. Under present conditions these crossings are inundated during flood flows and for short periods following all rains. After the structures are in operation the flow peaks will be reduced but the flow will be greatly prolonged. The Commissioners Courts of Duval and Jim Wells Counties will provide the improvements needed to keep these crossings passable during periods of floodwater release where there are no equal alternate routes for travel.

The 3.5 miles of combination levee and channel improvement for the protection of urban property in Bishop will provide protection from floodwaters caused by the runoff from a 6-hour 50-year frequency storm. Freeboard provided by the levees, which are in combination with the channel improvement will eliminate all but minor damages from the 100-year frequency runoff.

The location of the floodwater retarding structures, channel improvement, levee and the works of improvement for protection of urban property in Bishop are shown on the Planned Structural Measures map, figure 4.

The total estimated cost of establishing these works of improvement is $1,734,849, of which $226,313 will be borne by local interest and $1,508,536 by Public Law 566 funds. The estimated annual equivalent cost for installation is $61,165 and the estimated annual operations and maintenance cost is $8,539, making a total annual cost of $69,704.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete on similar types of spillways.

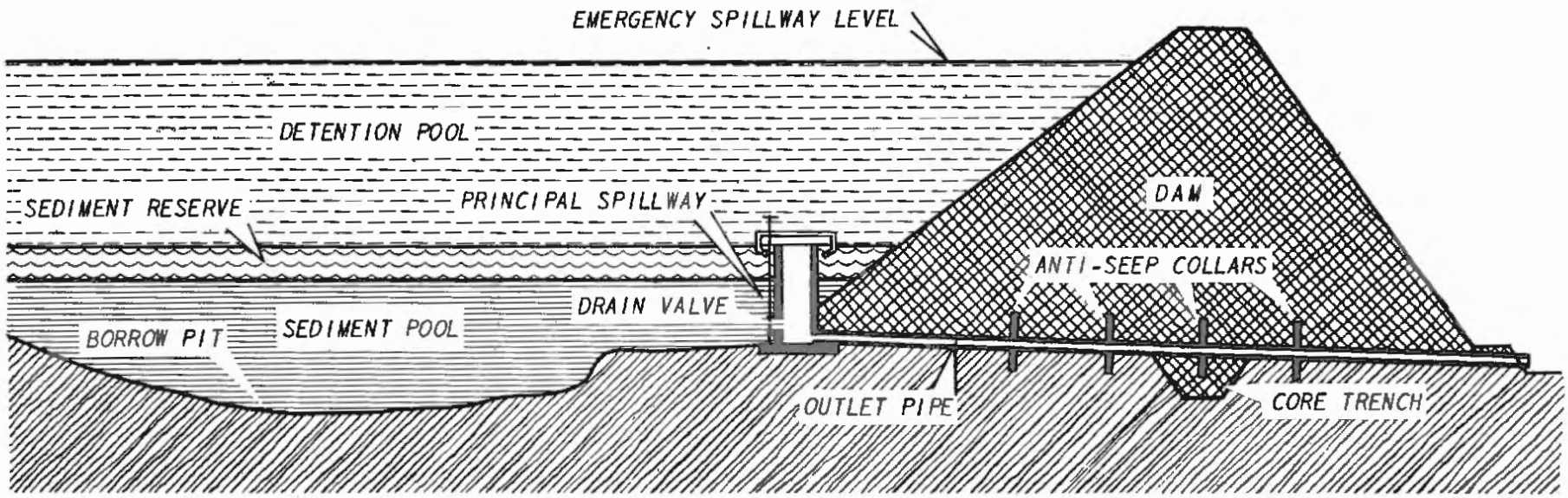
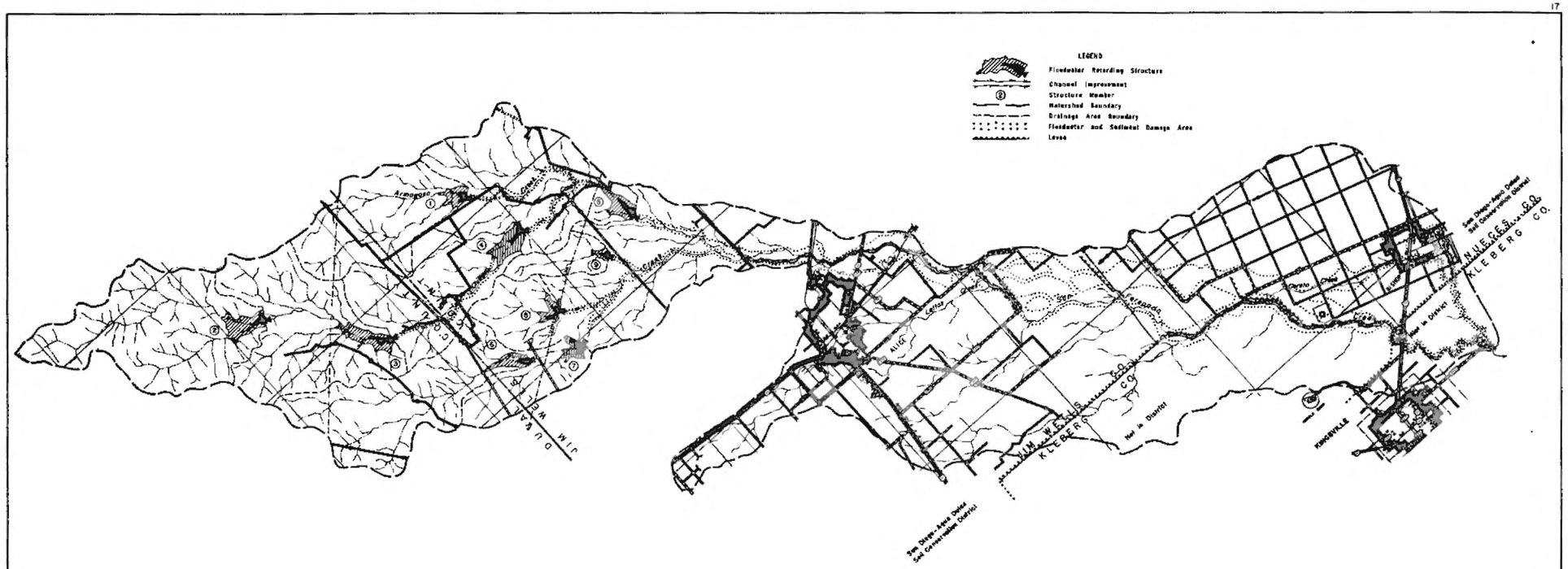


Figure 3

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



SITE NO.	DRAINAGE AREA ACRES
1	9,280
2	14,061
3	11,264
4	12,500
5	13,055
6	12,512
7	5,184
8	3,136
9	2,016

HIGHWAY MAP LEGEND

- Paved Road
- Bituminous Surfaced Road
- Graded and Drained Road
- Bladed Earth Road
- Road in City or Town
- Railroad
- U. S. Numbered Highway
- State Highway
- Farm to Market Road

DRAINAGE AREA 215,740 ACRES

Figure 4
PLANNED STRUCTURAL MEASURES MAP
CHULTPIN - SAN FERNANDO CREEKS WATERSHED
IN
DUVAL, JIM WELLS, NUECES and KLEBERG COUNTIES, TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE	
CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL
DRAWN BY / TRACED	CHECKED / DATE
W.P.	6-58

4-R-12,378
From Base 4-R 8642

All applicable state water laws will be complied with in the design and construction of the floodwater retarding structures.

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures described above, in conjunction with works of improvement in San Diego-Rosita Creeks watershed, would prevent flood damages from 27 of the 59 floods, such as occurred in the watershed from 1924 to 1953, inclusive. Of the 8 major floods that inundated more than one-half of the flood plain, all but one would be reduced to minor floods, each inundating less than one-half of the flood plain. Average annual flooding throughout the watershed will be reduced from 4,895 acres to about 1,246 acres.

The area on which sediment damage from overbank deposition will occur annually can be expected to be reduced from 178 acres to 14 acres, a reduction of 92 percent. About 46 percent of the expected reduction will result from land treatment and 54 percent from the structural measures.

The area on which flood plain scour damage will occur can be expected to be reduced from 4,734 acres to 949 acres, a reduction of 80 percent.

With the planned land treatment program, total gross erosion from the watershed will be reduced from 453 acre-feet to 346 acre-feet annually.

The estimated average annual flood, erosion, sediment, and indirect damages within the watershed will be reduced from $116,880 to $23,049, an 80 percent reduction. About 92 percent of the expected reduction in the average annual damage will result from the structural measures in this watershed and the system of floodwater retarding structures in San Diego-Rosita Creeks watershed. With the planned project installed in this and the San Diego-Rosita Creeks watershed, the flood plains of Chiltipin Creek and San Fernando Creek will be flood-free from all storms expected to occur no more frequently than once in two years. Flooding will be limited to approximately one-tenth of the flood plain for storms expected to occur no more frequently than once in four years. The proposed works of improvement for the protection of Bishop will eliminate damage to this urban area from all storms expected to occur no more frequently than once in 50 years.

Evaluation 1/ Reach No.	Average Annual Area Inundated			Flood-Free Frequency With Program
	Present	Future	Percent Reduction	
1	65	40	33	2 year
2	2,515	863	66	3 year
3	319	37	88	3 year
4	701	128	82	3 year
5	588	153	74	3 year
6	127	10	92	4 year
7	580	15	97	2 year
Bishop Urban Area	N.A.	N.A.	N.A.	50 year

1/ See figure 2 for location of evaluation reaches.

Evaluation Reach No.	Average Annual Damages: Present	Future	Percent Reduction
1	$ 47	$ 20	57
2	38,428	10,571	72
3	16,995	2,661	84
4	24,132	2,724	89
5	19,468	5,968	69
6	5,440	695	87
7	4,917	376	92
Bishop Urban Area	7,453	34	99
Total	$116,880	$23,049	80

Benefits of $12,195 annually will accrue to the planned structural measures in the Chiltipin-San Fernando Creeks watershed from reduction of damages on Pintas Creek and on Agua Dulce Creek below the confluence of Agua Dulce Creek and Pintas Creek. Additional benefits of $11,200 annually will be derived from reduction of damages in the Agua Dulce Laterals watershed. Benefits from Agua Dulce Laterals watershed will be from: (1) the mainstem of Agua Dulce Creek below the lower limits of Agua Dulce Creek watershed, and (2) the flood plain of Matamoros Swale from a point where it receives overflow from San Fernando Creek to where it joins the flood plain of Agua Dulce Creek. (See figure 1).

Operators of flood plain land say that if adequate flood protection is provided, they will restore land now in buffelgrass pasture and temporary pasture to cotton and grain sorghum. All of this land was in production of cotton and grain sorghum until 1955, but is now used for pasture because of excessive floodwater damage. It is estimated that the net increase in income from such restoration will amount to $9,712 (long-term price levels) annually. This loss from the original production has been considered a crop and pasture damage and its restoration a benefit in table 7.

Benefits of $33,980 annually, from reduction of damages to the flood plain of San Fernando Creek below its confluence with San Diego Creek, accrue to the system of floodwater retarding structures in San Diego-Rosita Creeks watershed. These benefits have been credited to the works of improvement planned in the San Diego-Rosita Creeks watershed.

The total flood prevention benefits creditable to structural works of improvement in Chiltipin-San Fernando Creeks watershed from reduction of damages are estimated to be $75,893 annually.

COMPARISON OF BENEFITS AND COST

The average annual cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be

$69,704. When the project is installed, it is expected to produce average annual benefits of $75,893. The project, therefore, will produce benefits of $1.09 for each dollar of cost. In addition to the direct monetary benefits, there are other substantial values which will accrue from the project, such as an increased sense of security, opportunity for recreation, improved wildlife conditions, better living conditions, and an indeterminable benefit from ground-water recharge, none of which have been used for project justification.

ACCOMPLISHING THE PLAN

Federal assistance for carrying out the works of improvement on non-Federal land, as described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666, as amended by Public Law 1018, 84th Congress; 70 Stat., 1088).

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by farmers and ranchers over a 5-year period in cooperation with the San Diego-Agua Dulce Soil Conservation District, which is giving assistance in the planning and application of these measures under its going program. This assistance will be accelerated to assure application of the planned measures within the 5-year project installation period.

The governing body of the San Diego-Agua Dulce Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program underway, with the assistance of the San Diego-San Fernando and Agua Dulce Creeks Watershed Association in arranging for meetings according to a definite schedule. By this means and by individual contacts the landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the district. The soil conservation district governing body will make, or cause to be made, periodic inspections of the completed conservation measures within the watershed. The Soil Conservation Service will provide additional technical assistance to the San Diego-Agua Dulce Soil Conservation District to assist landowners and operators cooperating with the district in accelerating the preparation and application of soil, plant, and water conservation plans.

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

The county ASC Committee will cooperate with the governing body of the soil conservation district by selecting and providing financial assistance for those ACPS practices which will accomplish the conservation objectives

in the shortest possible time.

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

Structural Measures for Flood Prevention

Land, easements, rights-of-way, and road and utility changes necessary for the construction of 9 floodwater retarding structures, 20.35 miles of channel improvement, 5.7 miles of levee, and the necessary improvement of low water road crossings to make them passable during prolonged structural release will be provided by the County Commissioners Courts of Duval, Jim Wells and Nueces Counties. Nueces County has adequate authority to install the planned channel improvement on that portion of San Fernando Creek forming the boundary between Nueces and Kleberg Counties. Revenue from an ad valorem tax, which has heretofore been voted in these counties for flood control, shall be available for these costs. The easements will be dedicated jointly to Duval or Jim Wells or Nueces County and the San Diego-Agua Dulce Soil Conservation District.

Land, easements, rights-of-way, road, bridge, street and utility changes necessary for the construction of 3.5 miles of levee and channel improvement for urban protection for the city of Bishop will be provided by the Commissioners Court of Nueces County and the city of Bishop. Revenue from the general fund will be available for the city of Bishop's share of these costs. The easements will be dedicated jointly to Nueces County or the city of Bishop and the San Diego-Agua Dulce Soil Conservation District.

Under an agreement that has been executed by the Commissioners Courts of Nueces, Jim Wells and Duval Counties, the Nueces County Commissioners Court will be the contracting agency and will let and service all contracts for the 9 floodwater retarding structures, 20.35 miles of channel improvement, and 5.7 miles of levee included in this work plan. The cost of administering contracts will be shared as follows: Nueces County, 50 percent; Jim Wells County, 30 percent; and Duval County, 20 percent. These costs will be paid from revenue from the ad valorem tax, which has been voted in each county for the purpose of flood control. Under an agreement that has been executed by the Commissioners Court of Nueces County and the city of Bishop, the Nueces County Commissioners Court will be the contracting agency and will let and service the contracts for the 3.5 miles of levee and channel improvement included in this work plan for urban protection for the city of Bishop. The costs of administering these contracts will be shared equally by Nueces County and the city of Bishop. These costs will be paid from the Bishop general fund and the Nueces County ad valorem tax fund.

All necessary land, easements, and rights-of-way will be obtained for the levee and channel improvement for the urban protection of Bishop before Public Law 566 financial assistance is made available for installation of any part of this project.

The release flow from the floodwater retarding structures planned in this watershed is sufficient to cause prolonged flooding in many sections of the flood plain where present channel capacities are extremely small. The capacity of Chiltipin Creek channel below Highway 81 must be enlarged prior to the construction of any of the floodwater retarding structures in this watershed to avoid prolonged flooding by structure release. San Fernando Creek has sufficient channel capacity to carry the release from proposed floodwater retarding structures 1 through 8 in the San Diego-Rosita watershed; or the 9 structures in the Chiltipin-San Fernando Creeks watershed; or combinations of structures from the two watersheds that will not produce releases in excess of 1,000 cubic feet per second. Additional structures will not be constructed until the channel improvement planned on San Fernando Creek and Pintas Creek in the Agua Dulce Creek watershed is installed.

The estimated schedule of obligation for the complete 5-year installation period, covering installation of both land treatment and structural measures, is as follows:

Fiscal Year	Measure	P.L. 566 Funds	Other Funds	Total
1st	Urban Protection-Bishop Levee-Channel Improvement	$ 110,585	$ 53,946	$ 164,531
	Land Treatment	5,000	222,359	227,359
2nd	Land Treatment	5,000	222,358	227,358
3rd	Sites 1 and 2	318,683	26,857	345,540
	Channel Improvement and Levee	247,902	45,380	293,282
	Land Treatment	5,000	222,358	227,358
4th	Sites 3, 4, 5, and 6	623,363	75,170	698,533
	Land Treatment	5,000	222,358	227,358
5th	Sites 7, 8, and 9	208,003	24,960	232,963
	Land Treatment	5,000	222,358	227,358
	Total	$1,533,536	$1,338,104	$2,871,640

This schedule will be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desired, and in the light of appropriations and accomplishments actually made.

The structural measures will be constructed during a 5-year installation period pursuant to the following conditions:

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

2. The necessary easements have been obtained.

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

4. Court orders have been obtained from the appropriate Commissioners Court showing that they will designate equal alternate routes, if available, for use during periods when low water road crossings are impassable due to prolonged flow from the principal outlets of floodwater retarding structures. If equal alternate routes are not available, the court order will specify that necessary improvements will be made, at no cost to the Federal Government, to make the crossings passable during prolonged periods of release flows from the structures.

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

6. Operation and maintenance agreements have been executed.

7. Public Law 566 funds are available.

Technical assistance will be provided by the Soil Conservation Service to assist in planning, design, preparation of specifications, supervision of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion and related tasks necessary to establish the planned structural measures for flood prevention.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

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

Structural Measures for Flood Prevention

The 9 floodwater retarding structures, 20.35 miles of channel improvement and 5.7 miles of levee will be operated and maintained by the Commissioners Courts of Duval, Jim Wells and Nueces Counties, since the works of improvements in the three counties are interdependent and benefits from this project will accrue to all counties. Each County Commissioners Court will be responsible for the performance of proper maintenance on structural works of improvement located within that county. The cost of operations and maintenance will be borne by the three counties in these proportions: Nueces County, 50 percent; Jim wells County, 30 percent; and Duval County, 20 percent. Funds for this purpose will come from an ad valorem tax which has heretofore been voted in each county for the purpose of flood control. The 3.5 miles of levee and channel improvement for urban protection for Bishop will be operated and maintained by the Commissioners Court of Nueces County and the city of Bishop.

A maintenance fund will be kept available by the Commissioners Courts of Nueces, Jim Wells and Duval counties consisting of $1,000 per structure for each of the 9 floodwater retarding structures and $1,000 per mile of channel improvement for the first ten miles, $750 per mile for the remaining 10.35 miles, and $500 per mile for the 5.7 miles of levee. This will amount to $29,612.

A maintenance fund will be kept available by the Nueces County Commissioners Court and the city of Bishop consisting of $1,000 per mile for the 3.5 miles of levee and channel improvement. This will amount to $3,500.

All structural measures will be inspected at least annually and after each heavy rain by representatives of the Commissioners Court of Duval, Jim Wells and Nueces Counties, and the San Diego-Agua Dulce Soil Conservation District. The city of Bishop will be a participating party in the inspection of the structural measures for urban protection.

A Soil Conservation Service representative will participate in these inspections at least annually. For the floodwater retarding structures, items of inspection will include, but not be limited to, the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as a part of the structures.

For channel improvement and levee works, items of inspection will include, but not be limited to the degree of scour, silting, bank erosion, the degree of obstruction to flow caused by debris lodged against bridges, fences and watergates, and excessive brush and tree growth within the open channel, and any repairs necessary to the levee.

The Soil Conservation Service, through the San Diego-Agua Dulce Soil Conservation District, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspection and furnishing technical guidance and information necessary for the operation and

maintenance program.

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

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

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

The estimated annual operation and maintenance cost of all structural measures is $8,539, based on long-term prices. The necessary maintenance work will be accomplished either by contract or force account.

COST SHARING

Public Law 566 funds will provide technical assistance in the amount of $25,000 during the 5-year installation period to accelerate the installation of land treatment measures included in the plan for watershed protection. These measures will be installed through funds other than Public Law 566 at an estimated cost of $1,111,791 (table 1). This cost includes ACPS payments based on present program criteria, and technical assistance under the going district program.

The required local costs for structural measures consisting of the value of land, easements and rights-of-way, ($219,813), the capitalized value of operation and maintenance of works of improvement ($242,186), and the cost of administering contracts ($6,500), are estimated at $468,499.

The entire cost of constructing structural measures, amounting to $1,149,961 will be borne by Public Law 566 funds. In addition, the installation services cost of $358,575 will be a Public Law 566 expense. This is a total Public Law 566 cost of $1,508,536 for the installation of structural measures.

The total project cost of $3,113,826, including capitalized value of structure operation and maintenance will be shared 49.2 percent ($1,533,536) by Public Law 566 funds and 50.8 percent ($1,580,290) by other than Public Law 566 funds.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

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

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

The physical condition of the soils in the Chiltipin-San Fernando Creeks watershed ranges from good to very poor. The areas where row crops are grown continuously have very poor soil conditions, while the soils are generally good, in the areas where clover or other soil building legumes and grasses are grown in rotations. The upper portion of the watershed generally is composed of medium textured soils which are quite often shallow or very shallow. In sharp contrast, the lower portion has primarily deep fine textured, slowly to very slowly permeable soils.

Cover Conditions and Range Sites

The watershed was divided into three segments, range, transitional and Coastal Prairie for sampling of cover conditions and range sites. Each segment was relatively homogeneous in land use, topography and soils. Approximately 43 percent of the watershed is in the Range area, of which 8.6 percent was sampled. The transitional area makes up 25 percent of the watershed and 11 percent was sampled. The Coastal Prairie represents 32 percent of the watershed, of which 5.8 percent was sampled.

Samples were selected at random within each segment and mapped to show land use, cover condition, crop distribution, land treatment, and hydrologic soil groups and conditions. This information was used to develop the soil-cover complex conditions in the watershed. The needed land treatment was projected to develop the expected future soil-cover complex condition. Five range sites were mapped and are described as follows:

Deep Sand Site (0.2 percent of range land)

The soils are deep sands and loamy sands that take water readily, on very gently sloping to low rolling terrain. Movement of air and root penetration and water are fair to good. These soils have little tendency to crust, consequently runoff and erosion susceptibility is less than on other sites. Some of the better grasses found on this site are Seacoast bluestem, Tanglehead, Switchgrass, and Crinkleawn.

Mixed Sandyland Site (12.8 percent of range land)

Deep, medium textured soils on very gently sloping to low rolling terrain comprise this site. These soils absorb water readily, root penetration and movement of air and water are good. Some of the better grasses found

on this site are Trichloris, Cottontop, Tall bristlegrass, and Lovegrass tridens.

Hardland Site (40.8 percent of range land)

This site includes deep clay and clay loam soils that take water slowly to very slowly, usually occurring as broad flats or on very gently sloping to low rolling terrain. Movement of air and water and root penetration is moderate to poor. Drouthy characteristic of this site may be offset by runoff water from adjacent hill land. Some of the better grasses found on this site are Trichloris, Lovegrass tridens, Tall bristlegrass, Vine mesquite, Green sprangletop, Cottontop, and Pinholed bluestem.

Shallow Ridge Site (25.4 percent of range land)

The soils are less than 20 inches deep, underlain with caliche and drouthy and occur on rolling to steep slopes. They take water moderately fast but hold very little water because of their shallow depth. Movement of air and water, and root penetration are poor. Some of the better grasses found on this site are Cottontop, Plains bristlegrass, Lovegrass tridens, and Sideoats grama.

Mixed Land Lime Site (20.8 percent of range land)

Crumbly loam or clay loam soils, usually occurring on very gently sloping to low rolling terrain, characterize this site. The surface soils, when dry, is light gray in color and markedly powdery and fluffy. The structure of the top soil, immediately below the powdery surface, is of fine, hard, blocky peds. The subsoil is characteristically very powdery to floury, is very strongly calcareous, contains soft lumps of calicium carbonate, and is quite subject to erosion when exposed. This site is inclined to be drouthy due to permeability and high lime content. Some of the better grasses found on this site are Trichloris, Lovegrass tridens, Tall bristlegrass, Green sprangletop, and Cottontop.

The range condition of these areas is shown on the following table:

Range Site and Condition Class

Condition Class	Acres	Percent For Site
	Deep Sand Site	
Good	0	0.0
Fair	0	0.0
Poor	218	100.0
Total	218	100.0
	Mixed Sandyland Site	
Good	1,296	8.0
Fair	871	5.4
Poor	13,986	86.6
Total	16,153	100.0

	Hardland Site	
Good	0	0.0
Fair	4,598	8.9
Poor	46,787	91.1
Total	51,385	100.0
	Shallow Ridge Site	
Good	0	0.0
Fair	253	0.8
Poor	31,722	99.2
Total	31,975	100.0
	Mixed Land Lime Site	
Good	0	0.0
Fair	694	2.6
Poor	25,540	97.4
Total	26,234	100.0
	All Sites	
Good	1,296	1.0
Fair	6,416	5.1
Poor	118,253	93.9
Total	125,965	100.0

Land Use and Treatment Needs

The needed land treatment for the watershed, as shown in table 1, was developed by the Soil Conservation Service work units in Alice and Robstown. Conservation needs data were compiled for the entire watershed and computed for each land treatment practice to be applied during the 5-year installation period.

Program Determination

Flood problems and program objectives were reviewed with representatives of the San Diego-Agua Dulce Soil Conservation District, the Commissioners Courts of Duval, Jim Wells and Nueces Counties, and the city of Bishop.

Determination was made, first of the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to flood prevention. The hydraulic, hydrologic, sedimentation and economic investigations provided data as to the effects of these measures in terms of the reduction of flood damages resulting from such treatment. Although significant benefits would result from application

of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

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

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

2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not have sufficient storage capacities were dropped from further consideration. From the remaining sites, a system of floodwater retarding structures was selected for further consideration and detailed survey. Site 1 is in series with site 5, also sites 2, 3, and 4 are in series with site 5. Sites 6 and 7 also are in series. These series are necessary because no other sites are available to give the needed degree of control and because of the very limited storage possibilities of sites 3, 4, 5, and 7. The sites in series with site 5 will prevent the inundation of a cemetery which would otherwise be within the detention pool area at site 5. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 5 and 5A.

3. A topographic map was made of the pool area of each of the proposed structures to determine the storage capacity, the estimated cost of the dam and the area of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the criteria outlined in Soil Conservation Service, Washington Engineering Memorandum No. 3, Revised. The limits of the flood pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed from engineering surveys to show for each structure the

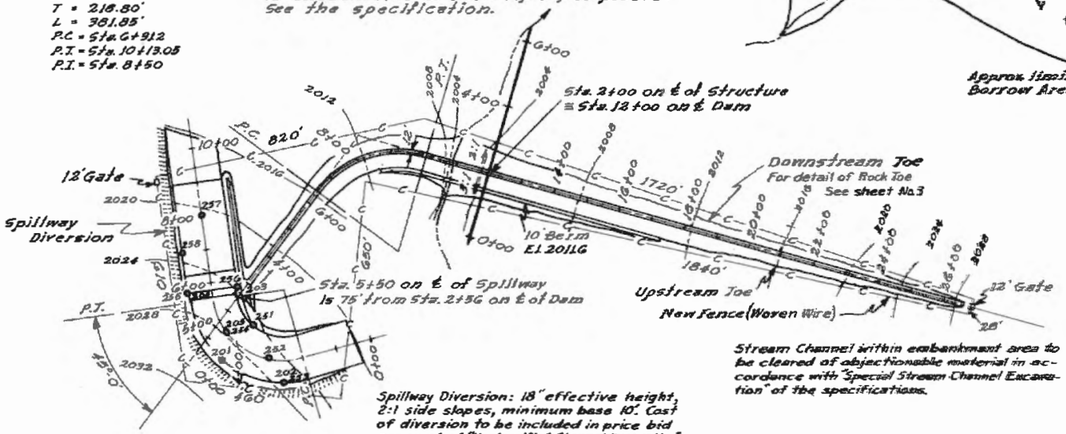
Clay
Silt
Limestone
Flagstone & Cobbles
Lime

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

LEGEND OF BORINGS

EMBANKMENT CURVE DATA
Δ = 69°-0'
D = 18°-04.3'
R = 318.36'
T = 218.80'
L = 381.85'
P.C. = Sta. 6+91.2
P.I. = Sta. 10+13.05
P.I. = Sta. 8+50

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

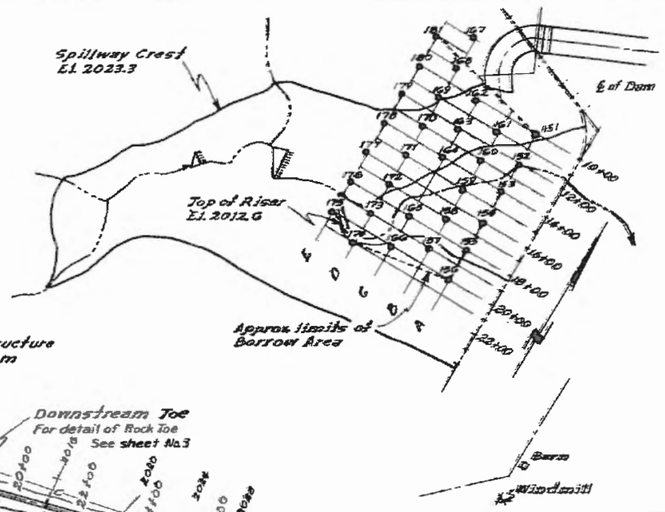


SPILLWAY CURVE DATA
Δ = 98°-0'
D = 28°-0'
R = 206.68'
L = 390.0'
P.C. = Sta. 2+00
P.I. = Sta. 5+50

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

PLAN OF EMBANKMENT AND SPILLWAY

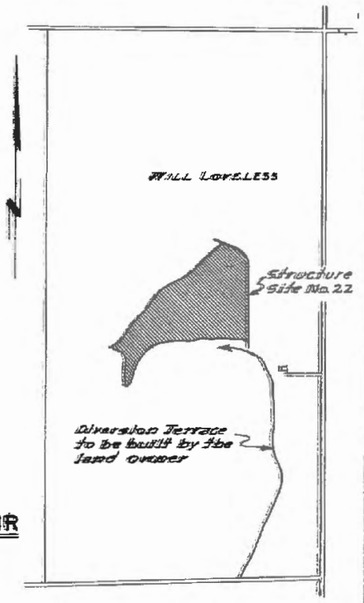
0 200 400 1000
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

0 400 800 1600
SCALE IN FEET

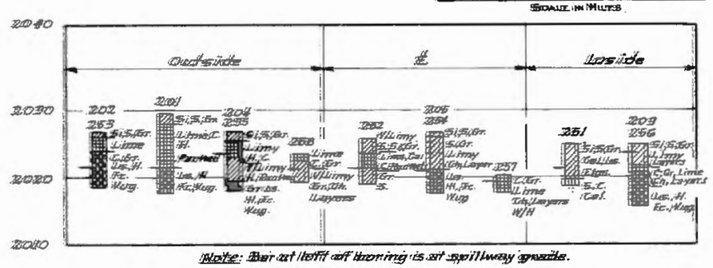
Stream Channel within embankment area to be cleared of objectionable material in accordance with "Special Stream Channel Excavation" of the specifications.



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

VICINITY MAP

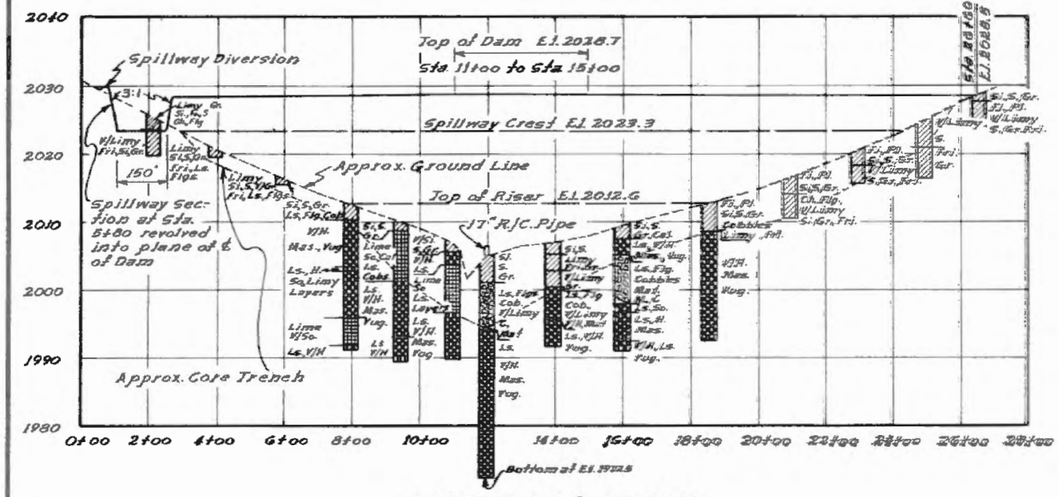
0 ½ 1
SCALE IN MILES



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

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY



PROFILE ON ℄ OF DAM

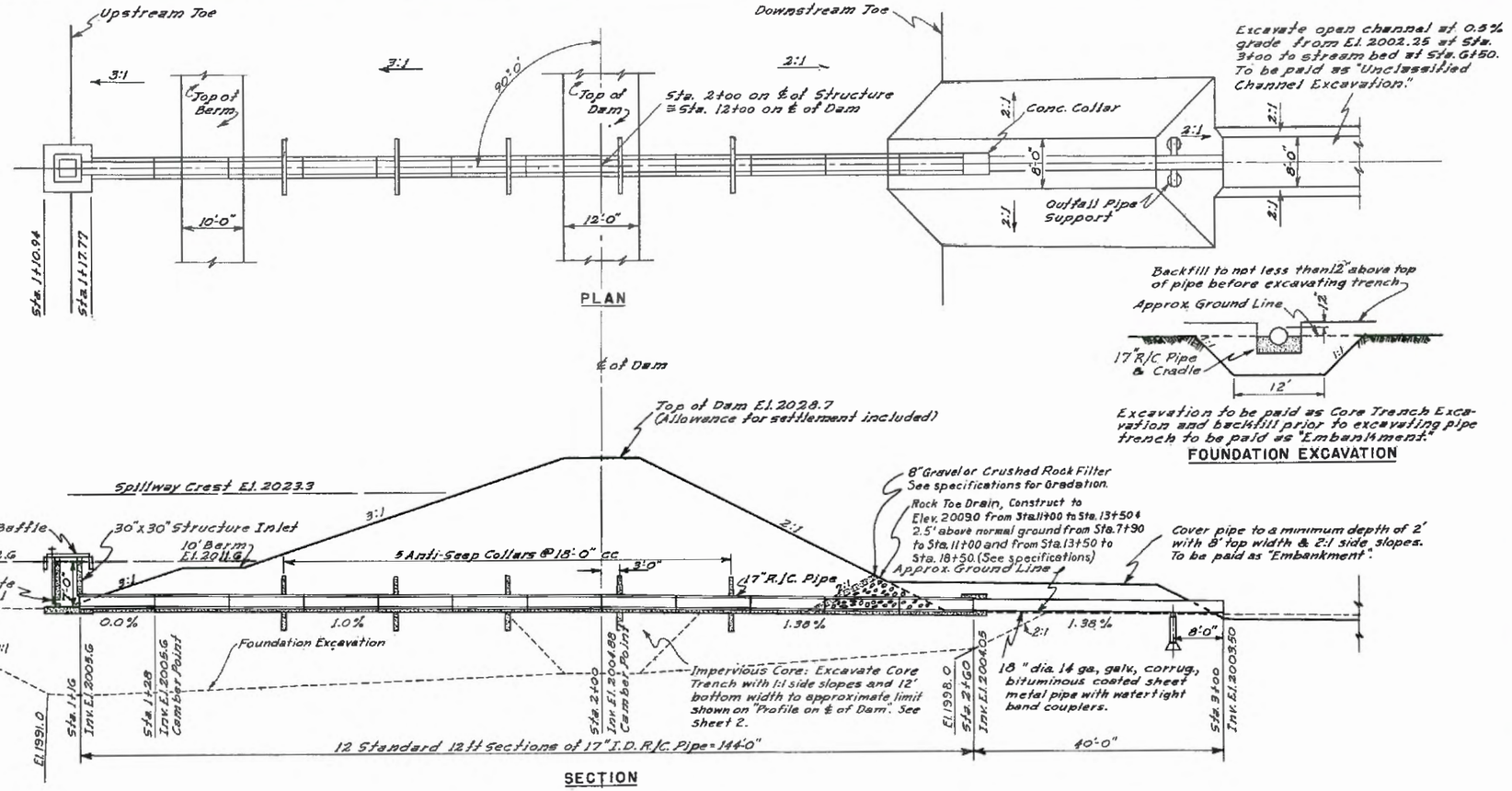
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
2012.6	1.16 .84	51.720	20.350
2016.10	30.76	132.56	1.208
2020.10	54.21	302.60	22.922
2023.3	74.94	513 (68)	15.000
2024.10	79.33	569 (68)	12.150
2028.10	108.17	944 (68)	19.128

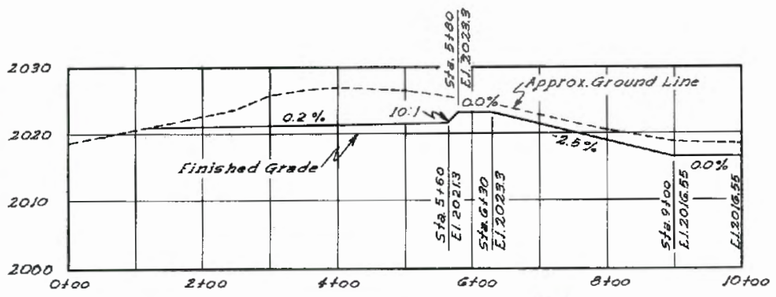
Top of Dam Effective Elev.	2028.15
Spillway Crest Elev.	2023.3
Top of Riser Elev.	2012.6
Sediment Pool Elev.	2012.6
Drainage Area, Acres	1292.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	462.0

Figure 5
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND PROFILE

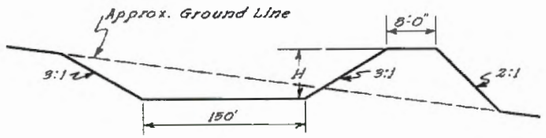
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	H.C.N.	8-56	Approved R.M.
Drawn	H.C.N. & G.R.	8-56	Date Sept. 1956
Traced	G.R.	8-56	Sheet No. 2 of 7 sheets
Checked	H.C.N. & H.H.L.	9-56	Drawing No. 4-TE-10,780





PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.55 from Sta. 5+00 to Sta. 6+90 12 ft. top width with 10:1 end slope. Transition from El. 2028.55 at Sta. 6+90 to 4 ft. height at Sta. 7+00, top width 8 ft. H = 4 ft. from Sta. 7+00 to Sta. 9+00, top width 8 ft. with 10:1 end slope.

TYPICAL SPILLWAY SECTION

Figure 5A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	H.C.N.	8-56	Approved by
Drawn	H.C.N. & G.R.	8-56	
Traced	G.R.	8-56	
Checked	H.C.N. & H.H.L.	9/56	

Sheet No. 3 of 7
Drawing No. 4-E-10,760

drainage area, the storage capacity needed for detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the acres of flood plain and upland inundated by the sediment and detention pools, the volume of fill in the dams, the estimated cost of the structures, and other pertinent data (tables 2 and 3).

4. A detailed analysis was made of county, private, and ranch roads, that cross the streams below the floodwater retarding structures, and which have low-water crossings as the only access across the streams. Where there are no other equal alternate routes and undue hardships would be caused by the inability to cross the streams, as a result of the release flows from the structures, determinations were made of the requirements to provide passage during periods of prolonged releases.

5. Additional representative cross sections of Chiltipin Creek below hydrologic section No. 2C to the confluence with San Diego Creek, and of San Fernando Creek to Highway 77 were selected and surveyed to aid in determining the size and cost of improving the channel to provide capacity for the release flows from all floodwater retarding structures upstream. A survey was made to determine the locations where additional channel capacities or levee were needed to prevent flood flows from diverting into overland flow and flooding areas many miles distant from the creek channel.

6. In designing the channel improvement on San Fernando Creek at the point where the stream flow divides between this creek and Pintas Creek, the present proportion of division of channel flow will be maintained. Due to the problems that may arise in determining and maintaining the division of stream flow to the satisfaction of all concerned, an alternate plan is possible.

7. The alternate plan, if it is determined to be more desirable, will eliminate all channel improvement in the area of division of flow between San Fernando and Pintas Creeks. In lieu of channel improvement, a small levee on the east side of San Fernando Creek upstream from the division of flow and a floodwater diversion downstream and between the creeks to prevent overland flows could be installed. Flooding would occur from the release flow from the structures, but the area involved is of fairly low damageable value. A flowage easement would be required for this area. This alternate plan is the less expensive of the two plans, but the division of the water is less positive. The channel improvement would begin at the extremities of the floodwater diversion on San Fernando

and Pintas Creeks.

8. An evaluation of damages to the urban area of Bishop was made and it was determined that the proposed structural works of improvement for flood plain protection would not reduce or eliminate these damages. Therefore, additional flood prevention measures for urban protection were deemed necessary. A survey was made of the area subject to flooding and determinations were made of the contributing drainage area, protection needed and the most economical and practical plan to be used. It was determined that combined levee and channel would be necessary to intercept floodwaters and channel them safely to Coreta Creek approximately two miles southeast of Bishop. The capacity needed to carry the peak discharge, was determined by flood routing the 6-hour, 50-year frequency storm runoff from the contributing area.

9. Damages resulting from floodwater, sediment and erosion were determined from damage schedules, surveys of sample areas and observations of actual flood events. Reduction in the damages resulting from the proposed works of improvements were estimated on the basis of reduction of area inundated and depth of inundation by various runoff depths, or peak discharges as determined by flood routings. These flood routings were made for conditions without the project and for future conditions assuming that the proposed works of improvement had been installed. Benefits so determined were allocated to individual measures, or groups of interrelated measures, on the basis of the effects of each on reduction of damages. Benefits from outside the project area were calculated and those benefits accruing to structural works in this watershed were assigned to these structures. Further analysis indicated that, due to distance of benefits outside the project area in relation to the structures, and residual flooding from release rates, it would not be feasible to allocate benefits to individual structures or to channel improvement as an independent measure. Therefore all structures considered and evaluated, including channel improvement and levees, were considered as a system of interdependent measures, except for the improvements designed for the protection of Bishop. Alternate sites and groups of sites were investigated until a system of floodwater retarding structures, in combination with channel improvement to handle release rates and levees which would give a desirable degree of control, was developed which would maximize net benefits and provide flood plain protection. Alternate works of improvement were investigated for the protection of Bishop until a combination system of levee and channel improvement was developed which would give the desired degree of protection to urban property.

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

Hydraulic and Hydrologic Investigations

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

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

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

3. The present hydrologic condition of the watershed was determined by surveying the soil-cover condition of approximately a ten percent random sample of the watershed. The future hydrologic condition of the watershed was determined by obtaining from the work unit conservationists the changes in cover conditions that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were computed from the soil-cover complex data and used with figure 3.10-1, National Engineering Handbook, Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series. Seasonal soil moisture indices were used. The computed average annual runoff compared favorably with the best available gage runoff data. Furthermore, computed peak discharges, at various hydrologic cross sections, compared favorably with actual peak

discharges at these same sections for weighted rainfall for seven storms observed during the work plan development.

4. Cross section rating curves were computed from field survey data collected in Item 2 by solving water surface profiles for various discharges. The water surface profiles were computed by the Doubt method described on pages 3.14-7-13, NEH Section 4, Supplement A.

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

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

7. The 30 years of precipitation records collected by the U. S. Weather Bureau at Alice, Bishop and Freer, supplemented by unofficial records in the watershed, were used to prepare a cumulative departure from normal precipitation graph. From this graph the period 1924 to 1953, inclusive, was selected as the most representative of normal precipitation on the Chiltipin-San Fernando Creeks watershed and was the period from which the historical evaluation flood series was developed.

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

   a. The present conditions of the watershed remaining static.

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

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

   d. The installation of land treatment measures, floodwater retarding structures, channel improvement and levee.

9. The appropriate spillway design storm and storm pattern was selected from figures 3.21-1 and 3.21-4 of NEH, Section 4, Supplement A in accordance with criteria contained in Engineering Memorandum No. 3, Revised.

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

The largest rain recorded in the 30-year period was 12.05 inches on September 14-15, 1951. It produced a runoff of 6.61 inches. The annual flood frequency line developed from a 30-year record indicates a frequency of 100 years for the above mentioned storm. The next largest rain and the largest one normally expected to occur in the evaluating series was 8.50 inches on June 28-29, 1931. With Moisture Condition No. I, it produced a calculated runoff of 3.72 inches. Under present conditions this storm would inundate the entire 13,569 acres of flood plain. If such a rain were to occur after land treatment measures are applied, it is estimated that the area inundated would be reduced to 13,255 acres. With land treatment measures and the planned system of structural measures and channel improvement in operation, 4,862 acres of flood plain would be inundated.

The minimum detention volume in the floodwater retarding structures was determined in accordance with Washington Engineering Memorandum No. 3, Revised, using Yarnell's 6-hour, 25-year frequency rainfall amount. The following table shows the minimum detention required and the actual detention planned for each structure.

Site No.	Structure Classification	Minimum Floodwater Detention Required	Actual Floodwater Detention Planned
1	A	2.96	3.69
2	A	2.96	3.79
3	A	2.96	4.19
4	A	2.96	3.60
5	A	2.96	3.09
6	A	3.44	3.50
7	A	3.34	3.44
8	A	3.54	3.61
9	A	3.15	3.15

Emergency spillway capacities were designed in accordance with Washington Engineering Memorandum No. 3, Revised, and Section 3.21 of the Hydrology Guide. Runoff from the maximum recorded 6-hour storm used for structure spillway design ranged from 7.48 to 9.36 inches.

In determining protection needed for the urban area of Bishop, the 6-hour, 50-year frequency rainfall of 4.90 inches was used. With a Moisture Condition No. II, this rainfall would produce a runoff of 3.18 inches. Inflow hydrographs were developed from these data and it was found that a peak of 4,547 c.f.s. would be produced. This peak was used in the design of the works of improvement for the protection of Bishop. Observations made during the 24-hour storm of January 4-5, 1958, revealed that a weighted rainfall of 8.00 inches fell over the area draining into Bishop. With a Moisture Condition No. II, this storm produced 6.10 inches of runoff. The flood frequency line developed for the Bishop drainage area from the 30 years rainfall record indicates this storm would be of a 44-year frequency. From comparisons of the peak discharge of this observed storm and that of the design storm at Section No. 3, East Coreta Creek, the design storm would exceed the 50-year frequency.

Average release rates for the principal spillways of the floodwater retarding structures were determined by a thorough study of the channel, amount of channel improvement required to carry the release, and the effect of release rates on the design of structures and emergency spillways. The release rates for sites 1 to 5, inclusive, and 8 and 9 will be 5 c.s.m. Because the storage capacities of sites 6 and 7 were limited, and in order to decrease the frequency of use of the emergency spillway, average release rates were increased to 10 c.s.m.

Sedimentation Investigation

The field surveys of the sedimentation problems of the Chiltipin-San Fernando Creeks watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans", Water Conservation-6, SCS, Region 4, Revised, February 1954. Field studies of overbank deposits, flood plain scour, streambank erosion and the nature of the channel and valleys were made. Above U. S. Highway 281 on Chiltipin Creek, all cross sections were studied to determine damages by overbank deposition of sediment and flood plain scour. Cultivated fields between the cross sections were investigated also for scour and sediment damages. This portion of the watershed has a narrow flood plain and a rather high percentage of rangeland. Physical damages to sample sections were determined by areal mapping and expanded to the total number of acres in the flood plain from U. S. Highway 281 to the mouth of the watershed. Approximately 35 percent of the flood plain area was represented by the samples. The nature and thickness of the sediment deposits were studied and classified as to percent loss of agricultural production. These figures were tabulated and used by the economist as the basis for calculating monetary damages.

Sediment Source Studies

The sediment derived from sheet erosion was estimated by the use of a formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation", Soil Conservation Service, Region 4, February, 1953.

The sediment derived from gullies, streambanks, dirt roads, and flood plain scour was estimated by field studies, use of aerial photographs, and interviews with local people. These estimates were based on studies made in the drainage areas of four of the nine proposed floodwater retarding structures. These figures were expanded to that portion of the watershed which is designated as the "Range" area. Typical drainage areas of the "Transitional" and "Coastal Prairie" were sampled also and expanded to their respective portions of the watershed. The average annual rate of gross erosion from all sources is 1.34 acre-feet per square mile.

No allocation of sediment in the detention pool is ordinarily recommended when sediment yields are less than 0.5 inch (see table 3). However, since the drainage areas of most of the proposed structures are unusually large, a 30 percent allocation was made when more than 200 acre-feet of sediment storage was required. Land treatment practices to be applied above the floodwater retarding structures during the 5-year installation period were estimated in determining the sediment storage required.

Effect of Watershed Treatment on Sediment Yield

Areas damaged by overbank deposition and flood plain scour should regain full productivity after installation of works of improvement if damage has not exceeded 30 percent. After installation of the land treatment measures shown in table 1, the total gross erosion will be reduced approximately 38 percent. With installation of both land treatment practices and structural measures the estimated reduction in gross erosion is 66 percent.

Geologic Investigations

Reconnaissance geologic investigations were made at all of the planned floodwater retarding structure sites. These investigations included brief lithologic and stratigraphic studies of the valley slopes, alluvium, channel banks, and exposed geological formations. Borings with a hand auger were made in the spillways, channel beds and representative areas of the borrow and foundation of the dam.

Description of Problems

The watershed is underlain by the Goliad, Lissie, and Beaumont formations. The Goliad is in the Tertiary System while the younger Lissie and Beaumont formations have been classified as Quaternary. The regional dip, between 20 and 80 feet per mile, is east and southeast towards the Gulf of Mexico.

Seven of the floodwater retarding structures, 1 to 4, inclusive, and 6 to 8, inclusive, will be located within the Goliad formation. The remaining two sites, 5 and 9, will be within the Lissie formation. No sites could be located in the Beaumont formation due to the flat topography.

The Goliad formation is characterized by caliche at or near the surface.

This is a secondary deposit and is thought to have occurred by perculating water, high in calcium carbonate, evaporating near the surface and leaving the evaporite to harden from heat and age. Generally the hard caliche is in the form of a hard resistive caprock from one to two feet in thickness. Occasionally the caprock is as thick as four or more feet. Therefore, it has greatly influenced the topography which is gently undulating and in places shows pot hole like depressions. Surface faults cutting across the upland in a blocky fashion have often determined the pattern of drainage to the creeks. The caprock in most places is found only at the higher elevations while the flood plain and other low areas have clays and fine sands at the surface. These are underlain by unweathered Goliad sands. Foundation drains and relief wells will be required on most of the sites.

The caprock to be removed from the spillways can be used as rip rap or for toe drains where sufficient quantities are available. The underlying material in the spillway is hard calcareous fine sand and calcareous sandy clay. Mud balls are often present to give the formation a motley or conglomerate appearance.

Numerous rock quarries and roadside cuts were useful in determining the geology of the sites. Before construction, detailed investigations with core drilling equipment on all sites will be made. Laboratory tests will be made to determine stability of foundation strata and the suitability and methods of handling the materials to be used in the embankment.

Ground-Water Recharge Investigations

Nonagricultural water management, such as ground-water recharge due to construction of the proposed floodwater retarding structures, was considered and investigated in the planning stages. Seven of the planned floodwater retarding structures will be located within the outcrop of the Goliad formation. Caliche caprock at or near the surface on much of the uplands is impervious. The valley alluvium soils are underlain by medium to fine-grained sandstone and are high in clay content and very calcareous. Clay members are quite common. Anticipated recharge from structural measures in this formation is low. The sandy water carrying members often are pinched out by impervious material.

The remaining two floodwater retarding structures are located within the Lissie formation near its contact with the Goliad. Gravels and sands are typical in this formation with some clays; however, valley borings at these two sites revealed mostly clays which greatly reduce ground-water recharge possibilities.

Although some ground-water recharge will occur, the total volumes will be small. Also, it is impossible to determine the locations and quantities of recovery. Therefore no credit was claimed for benefits arising from any ground-water recharge due to construction of structural measures.

Economic Investigations

Determination of Annual Benefits from Reduction in Damages

Damage schedules covering approximately 56 percent of the flood plain area of Chiltipin Creek and San Fernando Creek and their major tributaries were obtained from landowners or operators. These schedules covered land use and crop distribution, yields and historical data on flooding and flood damages. Analysis of the information contained therein formed the basis for determining damage rates for various depths and seasons of flooding. In the calculation of crop and pasture damage, expenses saved, such as cost of harvesting, were deducted from the gross value of the damage. Information was obtained from county and state highway officials and others on nonagricultural damages. Points of damage were visited and where information indicated improvements, such as increased bridge openings, had been made to reduce damage from future floods, allowances were made in projecting estimated future damage.

In addition to the above information obtained, seven actual flood events were observed during the work plan development. These flood events range from very minor floods to floods of considerable magnitude. During observation of actual flood events, rainfall, runoff, and peak flows were obtained and correlated; areas actually flooded were delineated and referenced to hydraulic cross sections and damages of all types were observed and calculated under actual conditions. This data was correlated with information obtained by the normal procedures and adjustments were made as needs indicated to obtain representative damage rates to be applied. Factual information was obtained on types of damage other than crop and pasture. These damages were correlated with size of flood and, in conjunction with data obtained from damage schedules, formed the basis for estimating other agricultural and nonagricultural damages from flood events in the storm series.

The basic information on urban damages in the town of Bishop was derived from observation of three damage producing floods which occurred in January and February, 1958. During observation of these flood events, area inundated and depth of inundation were noted. Schedules of damages were obtained from occupants of dwellings, business operators in the areas inundated, and city officials to arrive at estimates of both direct and indirect damages from these flood events.

For types of damage other than urban, the proper rates of damage were applied, flood by flood, to the floods covering the historical period, 1924 to 1953, inclusive, and adjustments were made to take into account the effect of recurrent flooding when more than one flood occurred within the same year. The flood plain land use was mapped in the field. Estimates of normal, flood free, yields were based on data obtained from schedules, supplemented by information obtained from other agricultural workers in the area.

Because of the low frequency of flooding and the high value of damage to residential, business and other urban property, the frequency method instead of the historical method of analysis was used in the evaluation of urban damages at Bishop.

In analyzing flood plain land use and yields, it was found that significant variations existed with respect to location within the flood plain. Therefore the flood plain was divided into eight evaluation reaches, each with its own damageable value.

Evaluation Reach No. 1 - From bottom of watershed upstream to cross section 7 SF.

Evaluation Reach No. 2 - From cross section 7 SF upstream to cross section 14 SF.

Evaluation Reach No. 3 - From cross section 14 SF upstream to cross section 19 SF.

Evaluation Reach No. 4 - From cross section 19 SF upstream to cross section 24 SF.

Evaluation Reach No. 5 - From cross section 24 SF upstream on Chiltipin Creek to cross section 2 C.

Evaluation Reach No. 6 - From cross section 2 C upstream to cross section 4 C.

Evaluation Reach No. 7 - From cross section 4 C upstream and includes the flood plains of Turo Creek and Armagosa Creek.

The Bishop project area was considered a separate evaluation reach and encompasses that portion of Bishop subject to damage by floodwaters from overland flow.

The monetary value of the physical damage to the flood plain from erosion and overbank deposition of sediment was based on the value of the production loss, taking into account the time lag for recovery and the cost of operations necessary to speed recovery.

As the economy of the watershed is based on both agricultural production and the production of petroleum products, indirect damages are somewhat higher than those encountered in a primarily agricultural area. Indirect damages in this watershed involve extra farming expenses, such as additional travel time for farmers and extra costs of purchasing additional feed for livestock, high cost delays in oil well drilling, and additional travel and time lost by those engaged in petroleum production. In addition, there are extremely high indirect damages sustained by urban residents and business operators

in Bishop as a result of dislocation of persons and loss of employment. Information regarding damages of this type was obtained from local residents, farm and ranch operators, business operators and persons engaged in the petroleum industry. Curves relating indirect damage to size of flood were developed from information obtained at Bishop. Other estimates of indirect damage were based upon the apparent relationship of indirect to direct damage.

Floodwater, scour and sediment damages were calculated under present conditions and under conditions that will prevail after completion of each class of measures to be installed, including those measures planned in San Diego-Rosita Creeks watershed. The difference between average annual damages at the time of initiation of each class of measures and those expected after its installation constitutes the benefit brought about by that group through reduction of damages. Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effects of reduction in area inundated and reduced depth of inundation. Benefits from reduction of valley sediment damages derived from each class of measures were determined on the basis of estimated reduction in rate of sediment production and in area flooded after installation of each class of measure.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. Operators were also asked what changes they would make in their use of flood plain lands if flooding were reduced. Analysis of these responses provided the basis for estimating benefits from restoration of lands to their former use. Additional factors considered in this analysis were the size and location of the area affected, land capability, reduction in frequency of flooding and similar factors. All benefits from restoration of production are net benefits remaining after production, harvesting and all other allied costs were considered. These benefits are included as crop and pasture benefits after appropriate adjustment for increased damage as a result of the remaining floods on higher damageable values and discounted for an expected five-year lag in conversion. No benefits were evaluated from changed use of agricultural lands or enhancement of urban areas as a result of the program. However, it appeared that normal development in Bishop in the absence of the project would continue. This development, discounted, was considered.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of production lost in these areas after the installation of the program. In this appraisal it was considered that there would be no production in the sediment pools. The land covered by the detention pools was assumed to be converted to grassland under project conditions. The costs of land, easements, and rights-of-way for the nine floodwater retarding structures, channel improvement and levee construction were determined by individual appraisal in conjunction with representatives of the sponsoring organizations. Floodwater retarding structure site costs were based on full land value for the sediment pools and one-half value for the detention pools, since the latter will remain

in use as grazing land. The average annual net loss in production, based on long-term prices, within the sites and land needed for channel improvement was calculated and this value was compared with the amortized cost of the structure sites and rights-of-way for channel improvement. The larger amount was used in the economic evaluation to the program to assure a conservative appraisal.

Determination of Annual Benefits Outside Watershed Resulting from Project

Benefits from reduction in damages in Agua Dulce Creek watershed and Agua Dulce Laterals watershed accrue to works of improvements in this watershed. In determining benefits from outside the project area, creditable to works in this project, complete hydraulic, hydrologic and economic evaluations were made for each watershed affected by works of improvement in this project area. Standard procedures as outlined previously under "Hydraulic and Hydrologic Investigations" and "Economic Investigations" were followed in calculating damages and benefits in each of the watersheds outside the project area. Benefits from reduction of these damages were apportioned back to the works of improvement in Chiltipin-San Fernando Creeks watershed in proportion to the reduction in flooding resulting from them. In a similar manner benefits in this watershed produced by works of improvement in the San Diego-Rosita Creeks watershed were determined and credited to the appropriate works of improvement.

Details of Methodology

Details of the procedure used in the investigations are described in the Soil Conservation Service, Interim Economics Guide for Watershed Protection and Flood Prevention, Revised April 1, 1956.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Chiltipin-San Fernando Creeks Watershed, Texas
Price Base: 1957

Structure Number	Public Law 566 Installation Cost					Other Installation Cost			Estimated Total Cost
	Construction		Instal. Services		Total Public Law 566	Adm. of Contracts	Easements and R/W	Total Other	
	Engineering Estimate	Contingencies	Engineering	Other					
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	82,036	8,204	16,407	11,731	118,378	500	9,657	10,157	128,535
2	138,812	13,881	27,762	19,850	200,305	500	16,200	16,700	217,005
3	89,528	8,953	17,906	12,803	129,190	500	21,260	21,760	150,950
4	110,839	11,084	22,168	15,850	159,941	500	13,600	14,100	174,041
5	116,753	11,675	23,351	16,696	168,475	500	16,780	17,280	185,755
6	114,870	11,487	22,974	16,426	165,757	500	21,530	22,030	187,787
7	76,895	7,690	15,379	10,996	110,960	500	12,500	13,000	123,960
8	39,331	3,933	7,866	5,624	56,754	500	5,200	5,700	62,454
9	27,920	2,792	5,584	3,993	40,289	500	5,760	6,260	46,549
Subtotal	796,984	79,699	159,397	113,969	1,150,049	4,500	122,487	126,987	1,277,036
Channel Improvement	158,133	15,813	31,627	22,613	228,186	1,000	36,950	37,950	266,136
Levee	13,664	1,366	2,732	1,954	19,716	500	6,930	7,430	27,146
Subtotal	171,797	17,179	34,359	24,567	247,902	1,500	43,880	45,380	293,282
Urban Protection Levee and Channel Improvement	76,638	7,664	15,326	10,957	110,585	500	53,446	53,946	164,531
Subtotal	76,638	7,664	15,326	10,957	110,585	500	53,446	53,946	164,531
GRAND TOTAL	1,045,419	104,542	209,082	149,493	1,508,536	6,500	219,813	226,313	1,734,849

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TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURE

Chiltipin-San Fernando Creeks Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	Total
Drainage Area	sq.mi.	14.50	23.22	17.60	20.00	20.40	19.55	8.10	4.90	3.15	131.42
Storage Capacity											
Sediment pool	ac.ft.	200	200	200	200	200	200	186	78	64	1,528
Sediment reserve below riser	ac.ft.	24	122	110	152	192	50	-	-	-	650
Sediment in detention pool	ac.ft.	54	87	75	85	98	63	-	-	-	462
Floodwater detention	ac.ft.	2,854	4,693	3,933	3,840	3,362	3,649	1,486	943	529	25,289
Total	ac.ft.	3,132	5,102	4,318	4,277	3,852	3,962	1,672	1,021	593	27,929
Surface Area											
Sediment pool (top of riser)	acre	77	80	88	88	122	82	68	30	22	657
Floodwater detention pool	acre	392	530	590	538	605	453	297	164	131	3,700
Maximum Height of Dam	foot	29	30	26	27	24	28	24	19	17	xxx
Volume of Fill	cu.yd.	181,290	291,550	193,830	209,100	211,100	265,000	175,200	86,860	76,000	1,689,930
Emergency Spillway											
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Frequency of Use	year	28	32	37	29	25	25	25	25	25	xxx
Design storm rainfall											
Duration	hour	6	6	6	6	6	6	6	6	6	xxx
Total	inch	10.8	10.4	10.6	10.5	10.5	10.5	11.3	11.5	11.9	xxx
Bottom width	foot	400	350	300	400	450	500	350	400	200	xxx
Design depth	foot	3.7	3.8	4.1	3.8	4.0	3.5	3.9	2.9	3.1	xxx
Design capacity	c.f.s.	7,900	7,200	7,000	8,200	12,300	8,850	7,500	5,180	2,900	xxx
Freeboard	foot	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	xxx
Total capacity	c.f.s.	11,500	10,500	9,800	12,000	17,000	13,570	10,750	8,520	4,620	xxx
Principal Spillway											
Capacity	c.f.s.	73	116	204	304	479	196	277	25	16	xxx
Capacity Equivalents											
Sediment volume	inch	0.36	0.33	0.41	0.41	0.45	0.30	0.43	0.30	0.38	xxx
Detention volume	inch	3.69	3.79	4.19	3.60	3.09	3.50	3.44	3.61	3.15	xxx
Spillway storage	inch	2.77	2.48	3.70	2.97	3.91	2.22	4.43	3.04	3.98	xxx
Class of Structure	-	A	A	A	A	A	A	A	A	A	xxx

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Chiltipin-San Fernando Creeks Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	337.09	xxx
Watershed Area	Acre	215,740	xxx
Area of Cropland	Acre	83,477	83,477
Area of Grassland	Acre	125,965	125,965
Area of Miscellaneous Uses	Acre	6,298	6,298
Overflow Area Subject to Damage 1/	Acre	13,569	4,862
Overflow Area Damaged Annually by:			
Sediment	Acre	2/ 178	3/ 14
Flood Plain Scour	Acre	2/ 4,734	3/ 949
Streambank Erosion	Acre	1.21	1.21
Annual Rate of Erosion			
Sheet	Ac.Ft.	355.02	253.22
Gully	Ac.Ft.	2.58	2.13
Streambank	Ac.Ft.	9.85	9.85
Scour	Ac.Ft.	83.39	16.18
Dirt Roads	Ac.Ft.	2.52	2.52
Average Annual Rainfall	Inch	26	xxx

1/ Area inundated by the runoff from a 25-year frequency storm.
2/ Acres on which some loss of production is occurring each year.
3/ The 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 size storm listed under 1/.

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TABLE 5 - SUMMARY OF PLAN DATA

Chiltipin-San Fernando Creeks Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	1,533,536
Other	Dollar	1,338,104
Annual O & M Cost		
Federal	Dollar	0
Other	Dollar	8,539
Average Annual Monetary Benefits 1/	Dollar	75,893
Agricultural	Percent	76.4
Nonagricultural	Percent	23.6
Structural Measures		
Floodwater Retarding Structures	Each	9
Channel Improvement	Mile	20.35
Levee	Mile	5.7
Urban Protection		
Levee and Channel Improvement	Mile	3.5
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	125
Detention Pool	Acre	211
Upland		
Sediment Pool	Acre	532
Detention Pool	Acre	2,832
Watershed Area above Structures	Acre	84,109
Reduction of Floodwater Damage	Dollar	55,831
By Land Treatment Measures -		
Watershed Protection	Percent	5.8
By Structural Measures	Percent	78.1
Reduction of Sediment Damage	Dollar	1,595
By Land Treatment Measures -		
Watershed Protection	Percent	39.7
By Structural Measures	Percent	51.6
Reduction of Erosion Damage	Dollar	25,334
By Land Treatment Measures -		
Watershed Protection	Percent	5.6
By Structural Measures	Percent	66.2

1/ Includes benefits from the Agua Dulce watershed and Agua Dulce Laterals watershed accruing to works of improvement in this watershed.

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TABLE 6 - ANNUAL COST

Chiltipin-San Fernando Creeks Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Total
		Public Law 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures 1 through 9 in combination with Channel Improvement and Levee	55,364	0	7,695	7,695	63,059
Subtotal	55,364	0	7,695	7,695	63,059
Urban Protection: Levee and Channel Improvement	5,801	0	844	844	6,645
Subtotal	5,801	0	844	844	6,645
TOTAL	61,165	0	8,539	8,539	69,704

1/ Price Base: 1957 prices amortized for 50 years at 2.5 percent.

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

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Chiltipin-San Fernando Creeks Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project (dollars)	After Land Treatment for W/S Protection (dollars)	With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	39,586	37,865	8,594	29,271
Other Agricultural	7,792	7,270	1,127	6,143
Nonagricultural				
Transportation	9,600	8,693	929	7,764
Urban (Town of Bishop)	5,388	5,287	20	5,267
Other	4,216	3,635	81	3,554
Subtotal	66,582	62,750	10,751	51,999
Sediment Damage				
Overbank Deposition	1,747	1,053	152	901
Subtotal	1,747	1,053	152	901
Erosion Damage				
Flood plain scour	35,282	33,300	9,948	23,352
Subtotal	35,282	33,300	9,948	23,352
Indirect Damages	13,269	12,424	2,198	10,226
Total, All Damages	116,880	109,527	23,049	86,478
Benefits Outside Project Area 2/	xxx	xxx	xxx	23,395
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	109,873
Benefits Allocated to Structural Measures to be Constructed in San Diego-Rosita Creek Watershed	xxx	xxx	xxx	33,980
TOTAL NET FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	75,893
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	75,893
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	75,893

1/ As projected by ARS, September 1957.

2/ Includes $12,195 damage reduction on Agua Dulce Creek watershed flood plain and $11,200 damage reduction on the Agua Dulce Laterals watershed flood plain.

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TABLE 8 - BENEFIT COST ANALYSIS

Chiltipin-San Fernando Creeks Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention						Average Annual Cost 2/	Benefit Cost Ratio
	Flood-water	Sediment	Erosion	Indirect	Other 3/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
STRUCTURAL MEASURES FOR FLOOD PREVENTION								
Floodwater Retarding Structures 1 through 9 in combination with channel improvement and levee 4/ 5/	27,034	462	13,087	4,653	23,395	68,631	63,059	1.1:1
Urban Protection Levee and Channel Improvement	5,267		-	1,995	-	7,262	6,645	1.1:1
GRAND TOTAL	32,301	462	13,087	6,648	23,395	75,893	69,704	1.1:1

1/ Price Base: Long-Term prices as projected by ARS, September 1957.
2/ Derived from installation costs based on 1957 price level and operation and maintenance cost based on long-term price levels, as projected by ARS, September 1957.
3/ Includes benefits from reduction in damages to the Agua Dulce Creek watershed flood plain below Pintas Creek and reduction in damages to the Agua Dulce Laterals flood plain.
4/ All floodwater retarding structures, channel improvement and levee are interdependent.
5/ Benefits shown in this line differ from those in table 7 by the amount of each type of benefit accruing to structures in San Diego-Rosita Creeks watershed.

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TABLE 9 - COST SHARING SUMMARY

Chiltipin-San Fernando Creeks Watershed, Texas
Price Base: 1957 1/

Type of Cost	P.L. 566 Funds		Other		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment						
Non-Federal Land For Watershed Protection	25,000	2.2	1,111,791	97.8	1,136,791	36.5
Subtotal	25,000	2.2	1,111,791	97.8	1,136,791	36.5
Structural Measures Installation						
Flood Prevention	1,508,536	87.0	226,313	13.0	1,734,849	55.7
Subtotal	1,508,536	87.0	226,313	13.0	1,734,849	55.7
Total Installation Cost	1,533,536	53.4	1,338,104	46.6	2,871,640	92.2
Operation and Maintenance 2/	-	0	242,186	100.0	242,186	7.8
Total Structural Cost	1,508,536	76.3	468,499	23.7	1,977,035	63.5
TOTAL PROJECT COST	1,533,536	49.2	1,580,290	50.8	3,113,826	100.0

1/ Except operations and maintenance which is based on long-term prices, as projected by ARS, September 1957.

2/ Capitalized for 50 years at 2.5 percent.

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