PRELIMINARY
Flood Control Work Plan
TEHUACANA CREEK WATERSHED
A Subwatershed of the Trinity River
TX-SCD-23-40-31 Tr. No. 42
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DESCRIPTION OF THE WATERSHED

Tehuacana Creek rises at the town of Tehuacana, in Limestone County, and flows in an easterly direction for 40 miles, entering the Trinity River about 12 miles east of Fairfield, Freestone County, Texas. The subwatershed varies from 4 to 18 miles in width, averaging 12 miles. Big Brown, Pin Oak, Cottonwood, Caney, Cedar, and Little Tehuacana Creeks are the major tributaries.

The incorporated towns of Tehuacana, Mexia, Wortham, Streetman, Kirvin, Teague, Fairfield and several small villages are located in the watershed. There are 728 miles of roads, of which 93 miles are hard-surfaced. Of the 112 bridges 10 are major bridges spanning the larger streams.

The watershed has an area of 286,000 acres, of which 279,111 acres are in farms. The remaining 6,889 acres, about 2.4 percent, are in urban areas, roads, and miscellaneous uses. Bottomland areas include 14,847 acres of flood plain and 390 acres of stream channels. All of the flood plain was covered by the September, 1932 flood.

Soils

The soils of the Blackland Prairies, lying largely north of the main stem of Tehuacana Creek, comprise 18 percent of the watershed. The remaining 82 percent is composed of soils of the Forested Coastal Plain.

Topography and Land Use

The bottomlands are not intensively utilized, approximately 14 percent being in cultivation. About 22 percent of the upland area is cultivated.

Upland slopes generally range from 1 to 8 percent, with some slopes as steep as 15 percent. Most of the abandoned cropland is under some type of vegetative cover, mainly brush and weeds. The cultivated lands of the area have lost much of their fertility and organic matter through long and intensive cultivation, but they respond well to land treatment practices and fertilization. The cultivated lands are used chiefly for cotton, corn, and truck crops.

Climate

The climate of the area is characterized by long summers and short winters. The winters are usually mild but occasional northers cause sudden drops in temperature. As a rule, these cold spells last only a few days. Few winters pass without a light fall of snow which generally melts as it falls.

Mean temperatures range from 77.1 degrees Fahrenheit in summer to 54.7 degrees in winter. The average temperature for the area is 65.9 degrees. The extreme recorded temperatures are 2 degrees below zero and 112 degrees above zero. The average date of the last killing frost is March 14, and that of the first killing frost is November 20, or a normal frost-free period of 251 days.

The mean annual precipitation of 37.61 inches is fairly evenly distributed, with the greatest amounts of rainfall occurring in April and May. Individual rains of excessive amounts which fall at irregular intervals during the year cause serious erosion and flood damage.

Water Resources

The principal use of water in the area is for stock water and domestic purposes on farms and in the urban areas. Water for domestic uses on the farms is taken largely from wells, while livestock needs are supplied by live streams and small reservoirs. Most of the small towns obtain water from reservoirs. Many of the reservoirs have been greatly reduced in capacity by sedimentation and are becoming inadequate to meet the needs.

ECONOMY OF THE WATERSHED

Agricultural Economy

There are some small dairies in the Tehuacana Creek watershed which sell most of their milk to urban areas. Of the cattle in the watershed, 95 percent are used for beef production. There has been a trend toward improved pastures and better breeding stock for beef production in the past few years.

Most of the area used for pasture is in woods and brush. Because of this condition a considerable number of goats and hogs are raised. The ready market for broiler chickens has caused some trend toward poultry farming in the watershed. Due to the predominance of livestock enterprises 60 percent of the cropland is used for feed production including corn, hay, and grain sorghums. The principal cash crops are cotton, tomatoes, watermelons, peanuts, and peppers.

Because of the frequency of flooding 28 percent of the flood plain formerly used for high-income crops such as cotton, corn or truck crops is now meadow, pasture or idle land.

The Tehuacana Creek watershed is served by two Soil Conservation Service work units which are assisting the Limestone-Falls, Navarro-Hill, and Freestone-Leon Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 349 conservation plans on 65,509 acres within the watershed boundaries. Where land treatment measures have been applied and maintained for as long as two or three years, crop yields have increased 30 to 35 percent.

Urban and Other Influences

Industries in the watershed include chair, furniture, and ax handle factories at Fairfield; railroad shops at Teague; and oil production in the northwest portion of the watershed. These industries provide approximately 75 percent of the income to the residents in the watershed.

The 728 miles of roads do not provide adequate access to all parts of the watershed. As bridges have washed out, many roads have been permanently closed causing extra travel to and from markets.

Two railroads traverse the watershed and provide ample loading facilities for carload lot shipments.

FLOOD PROBLEMS AND DAMAGES

Tehuacana Creek has flooded frequently and caused moderate annual damage. Devastating floods have occurred at intervals of 10 to 12 years. The September, 1932 flood covered the entire flood plain. During the 20-year period, 1923 to 1942 inclusive, there were 16 floods which covered more than one-half of the flood plain and 104 smaller floods. One-third of the larger floods occurred during the spring months, causing great damage to growing crops. Occasional large floods occurred in the fall months and completely destroyed some mature crops.

More frequent flooding occurs on Caney, Cottonwood, Pin Oak and Big Brown Creeks and the main stem of Tehuacana Creek below the confluence of Caney Creek. With the exception of Grindstone Creek, a tributary of Caney, the stream channels in these areas are small and the flood plains are covered generally by dense growths of woods and brush. Because of this condition little flood damage occurs in these areas and channel improvement would be needed to materially reduce the extent of flooding. There is no evidence that intensified use of flood plain lands would result from flood protection to tributaries in this area. Bottomlands which seldom or never become inundated are still in woods which have little commercial use. No benefits to flood plain lands in this area from land treatment and flood control measures have been included in the plan.

FLOOD CONTROL ACTIVITIES

Only minor efforts have been made in the watershed to control floods. Small levees have been built without proper planning or construction and have not proved effective.

LAND TREATMENT ACTIVITIES

During the past four years 46 small neighborhood groups, lying wholly or partially within the Tehuacana Creek watershed, have been cooperating with the soil conservation districts in the planning and application of land treatment measures on their lands.

HYDRAULIC AND HYDROLOGIC INVESTIGATIONS

From a graph showing cumulative departures from normal precipitation, the rainfall series for the period 1923 to 1942 inclusive was selected as most representative for the Tehuacana Creek watershed. The flood which occurred in September, 1932 was caused by a rainfall of 9.30 inches as estimated from information given by the residents of the area. Because of the location of rain gages this amount of rainfall was not shown in the weighted rainfall series. This rain was considered only for the purpose of determining the total flood plain area, since its expected frequency of occurrence was greater than 20 years.

The design storm would produce 4.71 inches of runoff from the watershed under present conditions. Runoff of this magnitude is not expected to occur more frequently than once in 25 years, and this value was used in determining detention storage requirements. From a study of the rainfall-runoff relationships for this watershed it was found that a rain of 0.75 inch, occurring within a three-day period, was the minimum which would cause flooding at the smallest channel section. Therefore, no rains of less than this amount were considered for flood routing purposes.

The largest rain considered in the rainfall series was one of 7.85 inches, which produced 3.61 inches of runoff. Under present conditions 5,340 acres of the flood plain above main stem valley Section 10 and on Grindstone Creek would be flooded by the runoff from this storm. If such a storm were to occur after land treatment practices and measures have been applied it is estimated that the area inundated would be reduced to 4,515 acres. With land treatment measures applied and the proposed detention structures in operation only 1,594 acres would be flooded as a result of such a storm. Approximately 48 acres of flood plain would lie within the permanent pools of the proposed detention structures, and 29 acres within the detention pools.

The channel capacity of Tehuacana Creek at Section 10 is 3,320 cubic feet per second. This section is located approximately one mile east of Highway 75 and immediately above the confluence of Sloans and Caney Creeks with Tehuacana Creek. The peak discharge at this point for a 7.85 inch rain under present conditions is 21,000 cubic feet per second. The discharge would be reduced to 5,800 cubic feet per second by the proposed system of detention structures.

SEDIMENTATION CONDITIONS

Gully erosion has developed at an accelerated rate in some of the smaller tributary watersheds in both the Forested Coastal Plain and Blackland Prairies areas. Sheet erosion is occurring at various intensities throughout the watershed, but is more active in the Blackland Prairies. Flood plain scour is causing severe damage to the valley lands and is contributing a sizable amount of sediment to downstream areas.

The principal sedimentation damages in Tehuacana Creek and tributary valleys include (1) overbank deposition on valley lands, and (2) channel filling.

Overbank Deposition

Modern overbank deposits occur chiefly along tributaries originating in the Wilcox sand formation of the Forested Coastal Plain. Some modern deposition is also occurring along the small tributary streams which rise in the Blackland Prairies, but these deposits are difficult to identify. In general, the sandy deposition is causing more damage than the fine textured sediment derived from the Blackland Prairies.

Damaging deposition was identified on approximately 1,043 acres of the flood plain system of which approximately 998 acres were damaged 10 to 15 percent and 45 acres were damaged 40 percent. Excluding flood plain areas for which no control was planned the estimated average annual sediment damages in terms of reduced productivity were: one acre of pasture land damaged 40 percent, 2 acres damaged 15 percent, and 10 acres damaged 10 percent, in addition to 6 acres of cropland damaged 10 percent.

Channel Filling

Channel filling is occurring at an accelerated rate over most of the length of all the stream channels in the watershed. Loss of channel capacity has caused more frequent flooding, particularly in the lower part of the main valley and in valleys originating in the Wilcox formations. In the wooded valleys channel filling has been so severe that the channels do not have enough capacity to carry the release rate from the proposed detention structures. Channel filling is not severe in the valleys for which controls are planned. The channel of Little Tehuacana Creek has lost approximately 10 percent of its capacity and the remaining channels are normal to slightly enlarging.

Swamping of Valley Lands

Swamping occurs on a very small portion of the flood plain in the area for which controls are planned. The major cause of swamping is poor surface drainage.

Sediment Output Rates

Under present conditions it is estimated that the average rate of sediment output in the watershed ranges from 1.3 to 2.5 acre-feet per square mile of drainage area annually. The lower rates occur on large watersheds with a low percentage of cultivated land, while the higher rates occur on the smaller watersheds with a high percentage of cultivated land. It is estimated that the present rates of sediment output will be reduced 40 to 50 percent by the application of land treatment measures on the drainage area. The Forested Coastal Plain area has a very low sediment output rate, ranging from 0.3 to 0.8 acre-foot per square mile of drainage area, but no detention structures are planned in this area.

FLOOD PLAIN SCOUR

Flood plain scour was observed on a total of 415 acres in the area for which flood control treatment is planned. Approximately 70 percent of the scour channels occur in pasture and woodland and 30 percent in cropland. Most of these channels are wide and flat and can be crossed by farm implements. Of the total area damaged, 244 acres have been damaged 15 to 25 percent and 171 acres have been damaged 50 to 90 percent.

FLOOD DAMAGES

Flood damage information for approximately 90 percent of the flood plain area of Tehuacana Creek and its major tributaries was obtained from landowners or operators. Most of the specific information as to amounts and extent of damage related to the September, 1932 flood. Other information obtained included flood plain land use, yields of major crops, property damages which would result from a major flood, and general flood problems. The monetary value of the percentage of damage to flood plain lands by sediment deposition and scour was determined on the basis of present prices and costs.

Information concerning flood damage to roads and bridges was requested from highway officials. There was considerable damage caused by the September, 1932 flood, but at the time additional relief bridges were built, and only minor damage has occurred since that time. No flood damage to railroad property was reported.

Damage rates as determined for the September, 1932 flood were used to indicate damage rates to be expected from floods of various sizes and seasons. These rates were multiplied by acreages covered by each flood, by size and season, in the evaluation series and adjustments made for recurrence of flooding. Flood plain areas lying within the pool limits of proposed detention structures were excluded from all damage calculations.

The total direct floodwater and sedimentation damages are estimated to average $81,939 annually under present conditions, of which $56,680 (69 percent) is crop and pasture damage. These figures are based on the entire flood plain area in the controlled portion of the watershed. After excluding the areas of flood plain inundated by the proposed detention structures the average annual direct damage would be $81,139, of which $55,999 is crop and pasture damage. In addition, there are indirect damages such as losses sustained by dealers and industries dependent upon agricultural products from or sales to residents of the flooded areas, depreciation in property values in the flooded areas, and similar items. Ten percent of the total annual value of the direct damages, or $8,114, was taken as a conservative evaluation of the annual indirect flood damages. The average annual monetary flood damages are summarized in Table 1.

THE REMEDIAL PROGRAM AND ITS EVALUATION

Land Treatment Measures Needed

The major land treatment measure needed is the seeding of 100,000 acres of the following three types of areas: (1) Idle land, (2) rangeland which has been so overgrazed that reseeding is necessary to establish adequate cover, and (3) areas now in cultivation on which a permanent grass cover needs to be established.

Approximately 1,044 miles of terraces need to be constructed to assist in the control of erosion on 21,000 acres of cultivated land. About 406 acres of vegetated waterways will be needed to carry the runoff from these systems of terraces.

Other land treatment measures needed include 72 miles of diversion terraces; 191 farm ponds; 48 miles of fencing to inclose newly retired and reseeded areas; improved crop rotations on 31,250 acres of cropland; and 114,000 acres of improved range and pasture management.

The estimated total cost of installing these and other measures needed to expedite the application of land treatment is $2,453,561 and the annual cost, including installation and maintenance, is $87,687.

Flood Control Structures and Measures

The flood control structures and measures needed to provide flood protection for the flood plain lands considered are listed in Table 2, items 1 to 5 inclusive.

A system of 10 detention structures is needed to protect the flood plain lands along Grindstone Creek and the portion of Tehuacana Creek above valley Section 10. The proposed detention structures and their drainage areas are shown on the Work Plan Map. Descriptive information concerning the structures is summarized in Table 5.

The system of detention structures will detain the runoff from 49 percent of the Tehuacana Creek watershed above hydrologic Section 10, and 48 percent of the Grindstone Creek watershed above its confluence with Caney Creek. Sufficient detention storage can be developed at all proposed detention structure sites to permit the use of vegetated emergency spillways.

The other flood control structures and measures listed in Table 2 are needed to control major gully erosion and thereby to protect the detention structures from rapid sedimentation. As indicated, it will be necessary to raise or relocate portions of several county roads which cross the pool areas of proposed detention structures.

The total cost of installing these measures is estimated to be $703,558. The estimated annual cost, including installation and maintenance, is $21,542.

Effect of These Measures on Damages and Benefits

The combined program of land treatment and flood control measures described above would prevent damage from all but 21 of the 104 minor and 16 major floods which occurred during the 20-year period of study. The remaining floods would be reduced to minor floods covering an average of 474 acres annually and causing an estimated average annual damage of only $3,499.

Most of the expected reduction in annual flood damage would be effected by the land treatment program. The annual value of the reduction in flood damages attributable to the detention structures is estimated to be $38,203 out of the total of $85,754 from all measures as shown in Table 1.

Owners and operators of flood plain lands say that if flood protection is provided they will intensify their use of these lands by growing high-value crops such as vetch, corn, and cotton on areas now used for pasture or woodland because of the frequency of flooding. It is estimated that this more intensive use would increase the net income from the land, after all expenses are deducted, by $33,331 annually.

The total flood control benefits, including both the reductions in flood damages and the benefits from more intensive use of flood plain lands, are estimated to be $119,085 annually. In addition, it is estimated that the benefits to landowners and operators from the application of land treatment measures on upland would be $836,983 annually. The total expected benefit from the combined program would amount to $956,068 annually.

The expected land treatment benefits were determined by estimating the increased net income to the land which would result from application of the needed land treatment practices and measures. It was assumed that the proportion of the cropland used for each crop would not change, although the total area used for cropland would be decreased by the retirement of idle cropland and steep and severely eroded cultivated areas to pasture or meadow. Likewise, it was assumed that there would be no change in the percentage of cattle used for dairying and beef production, although the total number of cattle would increase materially because of the increased acreages of pasture and meadow and the greater per-acre hay production and pasture carrying capacity to be expected from the application of land treatment measures.

The estimated increase in annual net income is $491,274 from crops and $345,709 from pasture, or a total of $836,983 annually.

Comparison of Cost and Benefit

The ratio of the average annual benefit from detention structures, $71,534, to their average annual cost including the appurtenant structures for their protection, $21,542, is 3.32:1.

The ratio of the average annual benefit, $884,534, from the land treatment measures and practices to their average annual cost, $87,687, is 10.09:1.

The ratio of total average annual benefits, $956,068, to total average annual cost, $109,229, is 8.75:1. See Table 4.

ANNUAL MAINTENANCE

Estimated annual maintenance costs after the land treatment measures and flood control structures have been installed are shown in Table 3.

It is expected that the flood control structures will be maintained by the benefited farmers under an agreement with the Soil Conservation District which carries the responsibility for maintenance. Group organizations of farmers will be developed for this purpose. The land treatment measures will be maintained by the landowners or operators of the farms on which the measures are installed.

Table 1
Summary of Average Annual Monetary Floodwater and Sediment Damage
and Flood Control Benefit from the Recommended Program 1/
TEHUACANA CREEK WATERSHED

Damages	Average Annual Damage			Average Annual Benefit		
	Under Present Conditions (dollars)	With Land Treatment Only (dollars)	With Land Treatment and Detention Storage (dollars)	From Land Treatment Only (dollars)	From Detention Storage Only (dollars)	Total Flood Control Benefits (dollars)
Floodwater Damage						
Crop and Pasture	55,999	27,047 48.3	2,510 4.5	28,952	24,537	53,489
Flood Plain Scour	420	201 47.9	30 7.1	219	171	390
Flood Plain Swamping 2/	41	19 46.3	3 7.3	22	16	38
Other Agricultural	24,238	10,446 43.1	622 2.6	13,792	9,824	23,616
Road and Bridge	342	144 42.1	8 2.3	198	136	334
Sub-Total	81,040	37,857	3,173	43,183	34,684	77,867
Sediment Damage						
Channel Enlargement	45	27 60.0	4 8.9	18	23	41
Overbank Deposition	54	27 50.0	4 7.4	27	23	50
Sub-Total	99	54	8	45	46	91
Indirect Damage	8,114	3,791	318	4,323	3,473	7,796
Total Damage	89,253	41,702	3,499	xxx	xxx	xxx
Benefit from Reduction of Damage	xxx	xxx	xxx	47,551	38,203	85,754
Benefit from More Intensive Use of Flood Plain	xxx	xxx	xxx	xxx	33,331	33,331
Total Flood Control Benefit	xxx	xxx	xxx	47,551	71,534	119,085

1/ Areas to be inundated by proposed detention structures excluded.

2/ Swamping represents temporary ponding and is not a permanent damage to land.

Table 2
Cost Estimate Table
TEHUACANA CREEK WATERSHED

tructure or Measure	Unit	No.	Cost			
			To Farmer	To Federal Funds	To State, County or Other	Total
			(dollars)	(dollars)	(dollars)	(dollars)
otention Structures	Each	10		622,194		622,194
ite Acquisition	Total			65,175		65,175
rop Inlets	Each	2		5,839		5,839
rop Structures	Each	1		1,600		1,600
elocating Roads	Mile	3.5			8,750	8,750
arm Waterways	Acre	406	30,450	10,150		40,600
eeding Retired Areas	Acre	100,000	1,020,000	680,000		1,700,000
roup Collective Outlets	Acre	99		9,900		9,900
arth Gully Plugs	C.Y.	2,400		690		690
erracing	Mile	1,044	130,500			130,500
arm Diversions	Mile	72	10,800			10,800
arm Ponds	Each	191	85,950			85,950
arm Fencing	Mile	48	19,200			19,200
Drop Inlets	Each	2		6,720		6,720
Drop Structures	Each	12		20,201		20,201
arm and Ranch Planning and Application	Acre	286,000		429,000		429,000
Total			1,296,900	1,851,469	8,750	3,157,119
stimated Amount to be xpended During 1951 iscal Year			124,000	135,000	5,500	264,900

Table 3
Annual Costs
TEHUACANA CREEK WATERSHED

Structure or Measure	Unit	No.	Annual Cost		
			Installation	Maintenance	Total
Detention Structures	Each	10	$18,448	$ 1,000	$19,448
Site Acquisition	Total		1,629		1,629
Drop Inlets	Each	2	146	50	196
Drop Structures	Each	1	40	10	50
Relocating Roads	Mile	3.5	219		219
Farm Waterways	Acre	406	1,472	1,624	3,096
Seeding Retired Areas	Acre	100,000	57,800		57,800
Group Collective Outlets	Acre	99	248	396	644
Earth Gully Plugs	C.Y.	2,400	17	15	32
Terracing	Mile	1,044	5,220	10,440	15,660
Farm Diversions	Mile	72	432	576	1,008
Farm Ponds	Each	191	3,438	3,438	6,876
Farm Fencing	Mile	48	768	960	1,728
Drop Inlets	Each	2	168	50	218
Drop Structures	Each	12	505	120	625
Total			$90,550	$18,679	$109,229

Flood Control Structures and Measures		$ 21,542
Land Treatment Measures		87,687
Annual Maintenance to Farmer	$18,679	

Table 4
Comparison of Average Annual Benefit and Cost of the Recommended Program
TEHUACANA CREEK WATERSHED

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	21,542	71,534	3.32
Land Treatment			
Flood Control	xxx	47,551	xxx
Land Treatment	xxx	836,983	xxx
Total	87,687	884,534	10.09
All Sources	109,229	956,068	8.75

APPENDIX
Increase in Income Through More Intensive Use of Flood Plain Lands
TEHUACANA CREEK WATERSHED - 5340 Acres

Land Use	Acres	Yield	Production	Gross Income	Cost	Net Income
Present Conditions						
Cotton	1,382	310 lbs.	428,420	$147,805	$ 69,252	$ 78,553
Corn	771	40 bu.	30,840	45,027	12,922	32,105
Meadow	215	1.3 tons	279	4,882	4,368	514
Pasture	2,691	1.6 AUM	4,306	13,564		13,564
Idle	281					
Total	5,340			$211,278	$ 86,542	$124,736
After Land Treatment and Detention Storage						
Cotton	1,437	315 lbs.	452,655	$156,166	$ 72,798	$ 83,368
Corn	943	45 bu.	42,435	61,955	15,804	46,151
Meadow	138	2.0 tons	276	4,830	2,842	1,988
Vetch	557	200 lbs.	111,400	22,280	8,912	13,368
Pasture	2,265	2 AUM	4,530	14,270		14,270
Total	5,340			$259,501	$100,356	$159,145

Gross Increase	$48,223	Net Increase	$ 34,409
		Less Cost of Brushing	160
		Less Added Damage	410
		Net Benefit	$ 33,839

Yields of crops were increased after treatment because of use of vetch in rotation.

5,340 ac.
-76 ac. under pools
5,264 ac.

$\frac{5,264}{5,340}$ = 98.5% correction factor to be used on Table 1.

APPENDIX

Table 1

Summary of Average Annual Monetary Floodwater and Sediment Damage and Flood Control Benefit from the Recommended Program 1/

TEHUACANA CREEK - MAIN STEM

Damages	Average Annual Damage			Average Annual Benefit		
	Under Present Conditions (dollars)	With Land Treatment Only (dollars)	With Land Treatment and Detention Storage (dollars)	From Land Treatment Only (dollars)	From Detention Storage Only (dollars)	Total Flood Control Benefits (dollars)
Floodwater Damage						
Crop and Pasture	48,141	21,996	1,954	26,145	20,042	46,187
Flood Plain Scour	412	196	29	216	167	383
Flood Plain Swamping 2/	41	19	3	22	16	38
Other Agricultural	22,648	9,493	529	13,155	8,964	22,119
Road and Bridge	342	144	8	198	136	334
Sub-Total	71,584	31,848	2,523	39,736	29,325	69,061
Sediment Damage						
Overbank Deposition	42	20	3	22	17	39
Sub-Total	42	20	3	22	17	39
Indirect Damage	7,163	3,187	253	3,976	2,934	6,910
Total Damage	78,789	35,055	2,779	xxx	xxx	xxx
Benefit from Reduction of Damage	xxx	xxx	xxx	43,734	32,276	76,010
Benefit from More Intensive Use of Flood Plain 3/	xxx	xxx	xxx	xxx	24,866	24,866
Total Flood Control Benefit	xxx	xxx	xxx	43,734	57,142	100,876

1/ Areas to be inundated by proposed detention structures excluded.

2/ Swamping as used represents temporary ponding and is not a permanent damage to land.

3/ For details of calculations, see Table 2.

APPENDIX
Table 2
Increase in Income Through More Intensive Use of Flood Plain Lands
TEHUACANA CREEK MAIN STEM - 4800 Acres

Land Use	Acres	Yield	Production	Gross Income	Cost	Net Income
Present Conditions						
Cotton	1,323	310 lbs.	410,130	$141,495	$66,296	$ 75,199
Corn	739	40 bu.	29,560	43,158	12,386	30,772
Meadow	114	1.3 tons	148	2,590	2,316	274
Pasture	2,343	1.6 AUM	3,749	11,809		11,809
Idle	281					
Total	4,800			$199,052	$80,998	$118,054
After Land Treatment and Detention Storage						
Cotton	1,323	315 lbs.	416,745	$143,777	$67,023	$ 76,754
Corn	840	45 bu.	37,800	55,188	14,078	41,110
Meadow	114	2.0 tons	228	3,990	2,348	1,642
Vetch	450	200 lbs.	90,000	18,000	7,200	10,800
Pasture	2,073	2.0 AUM	4,146	13,060		13,060
Total	4,800			$234,015	$90,649	$143,366
			Gross Increase	$ 34,963	Net Increase	$ 25,312
					Less Cost of Brushing	80
					Less Added Damage	366
					Net Benefit	$ 24,866

Yields of crops were increased after treatment because of use of vetch in rotation.

APPENDIX
Table 3
Cost Estimate Table
TEHUACANA CREEK WATERSHED - MAIN STEM

Structure or Measure	Unit	No.	Cost			
			To Farmer (dollars)	To Federal Funds (dollars)	To State, County or Other (dollars)	Total (dollars)
Detention Structures	Each	9		522,917		522,917
Site Acquisition	Total			59,463		59,463
Drop Inlets	Each	1		3,954		3,954
Drop Structures	Each	1		1,600		1,600
Relocating Roads	Mile	3.5			8,750	8,750
Farm Waterways	Acre	377	28,275	9,425		37,700
Seeding Retired Areas	Acre	98,320	1,002,864	668,576		1,671,440
Group Collective Outlets	Acre	96		9,600		9,600
Earth Gully Plugs	C.Y.	2,400		690		690
Terracing	Mile	979	122,375			122,375
Farm Diversions	Mile	60	9,000			9,000
Farm Ponds	Each	185	83,250			83,250
Farm Fencing	Mile	48	19,200			19,200
Drop Inlets	Each	2		6,720		6,720
Drop Structures	Each	12		20,201		20,201
Farm and Ranch Planning and Application	Acre	276,400		414,600		414,600
Total			1,264,964	1,717,746	8,750	2,991,460
Estimated Amount to be Expended During 1951 Fiscal Year			118,000	128,000	5,500	251,500

APPENDIX
Table 4
Annual Costs
TEHUACANA CREEK WATERSHED - MAIN STEM

Structure or Measure	Unit	No.	Annual Cost		
			Installation	Maintenance	Total
Detention Structures	Each	9	$15,504	$ 900	$ 16,404
Site Acquisition	Total		1,487		1,487
Drop Inlets	Each	1	99	25	124
Drop Structures	Each	1	40	10	50
Relocating Roads	Mile	3.5	219		219
Farm Waterways	Acre	377	1,367	1,508	2,875
Seeding Retired Areas	Acre	98,320	56,829		56,829
Group Collective Outlets	Acre	96	240	384	624
Earth Gully Plugs	C.Y.	2,400	17	15	32
Terracing	Mile	979	4,895	9,790	14,685
Farm Diversions	Mile	60	360	480	840
Farm Ponds	Each	185	3,330	3,330	6,660
Farm Fencing	Mile	48	768	960	1,728
Drop Inlets	Each	2	168	50	218
Drop Structures	Each	12	505	120	625
Total			$85,828	$17,572	$103,400

Flood Control Structures and Measures		$ 18,284
Land Treatment Measures		85,116
Annual Maintenance to Farmer	$17,572	

APPENDIX
Table 5
Comparison of Average Annual Benefit and Cost of the Recommended Program
TEHUACANA CREEK WATERSHED - MAIN STEM

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	18,284	57,142	3.12
Land Treatment			
Flood Control	xxx	43,734	xxx
Land Treatment	xxx	808,944	xxx
Total	85,116	852,678	10.02
All Sources	103,400	909,820	8.80

APPENDIX
Table 1A
Summary of Average Annual Monetary Floodwater and Sediment Damage and Flood Control Benefit from the Recommended Program 1/.
GRINDSTONE CREEK WATERSHED

Damages	Average Annual Damage			Average Annual Benefit		
	Under Present Conditions	With Land Treatment Only	With Land Treatment and Detention Storage	From Land Treatment Only	From Detention Storage Only	Total Flood Control Benefits
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage						
Crop and Pasture	7,858	5,051	556	2,807	4,495	7,302
Flood Plain Scour	8	5	1	3	4	7
Other Agricultural	1,590	953	93	637	860	1,497
Sub-Total	9,456	6,009	650	3,447	5,359	8,806
Sediment Damage						
Channel Enlargement	45	27	4	18	23	41
Overbank Deposition	12	7	1	5	6	11
Sub-Total	57	34	5	23	29	52
Indirect Damage	951	604	66	347	538	885
Total Damage	10,464	6,647	721	xxx	xxx	xxx
Benefit from Reduction of Damage	xxx	xxx	xxx	3,817	5,926	9,743
Benefit from More Intensive Use of Flood Plain 2/	xxx	xxx	xxx	xxx	8,973	8,973
Total Flood Control Benefits	xxx	xxx	xxx	3,817	14,899	18,716

1/ Areas to be inundated by proposed detention structures excluded.
2/ For details of calculations, see Table 2A

APPENDIX
Table 2A
Increase in Income Through More Intensive Use of Flood Plain Lands
GRINDSTONE CREEK WATERSHED - 540 Acres

Land Use	Acres	Yield	Production	Gross Income	Cost	Net Income
Present Conditions						
Cotton	59	310 lbs.	18,290	$ 6,310	$2,956	$ 3,354
Corn	32	40 bu.	1,280	1,869	536	1,333
Meadow	101	1.3 tons	131	2,292	2,052	240
Pasture	348	1.6 AUM	557	1,755		1,755
Total	540			$12,226	$5,544	$ 6,682
After Land Treatment and Detention Storage						
Cotton	114	315 lbs.	35,910	$12,389	$5,775	$ 6,614
Corn	103	45 bu.	4,635	6,767	1,726	5,041
Meadow	24	2.0 tons	48	840	494	346
Vetch	107	200 lbs.	21,400	4,280	1,712	2,568
Pasture	192	2.0 AUM	384	1,210		1,210
Total	540			$25,486	$9,707	$15,779

Gross Increase	$13,260	Net Increase	$ 9,097
		Less Cost of Brushing	80
		Less Added Damage	44
		Net Benefit	$ 8,973

Yields of crops were increased after treatment because of use of vetch in rotation.

APPENDIX
Table 3A
Cost Estimate Table
GRINDSTONE CREEK WATERSHED

Structure or Measure	Unit	No.	Cost			
			To Farmer	To Federal Funds	To State, County or Other	Total
Detention Structures	Each	1	$	$ 99,277		$ 99,277
Site Acquisition	Total			5,712		5,712
Drop Inlets	Each	1		1,885		1,885
Farm Waterways	Acre	29	2,175	725		2,900
Seeding Retired Areas	Acre	1,680	17,136	11,424		28,560
Group Collective Outlets	Acre	3		300		300
Terracing	Mile	65	8,125			8,125
Farm Diversions	Mile	12	1,800			1,800
Farm Ponds	Each	6	2,700			2,700
Farm and Ranch Planning and Application	Acre	9,600		14,400		14,400
Total			$31,936	$133,723		$165,659
Estimated Amount to be Expended During 1951 Fiscal Year			$ 6,000	$ 7,000		$ 13,000

APPENDIX
Table 4A
Annual Costs
GRINDSTONE CREEK WATERSHED

Structure or Measure	Unit	No.	Annual Cost		
			Installation	Maintenance	Total
Detention Structures	Each	1	$2,944	$ 100	$3,044
Site Acquisition	Total		142		142
Drop Inlets	Each	1	47	25	72
Farm Waterways	Acre	29	105	116	221
Seeding Retired Areas	Acre	1,680	971		971
Group Collective Outlets	Acre	3	8	12	20
Terracing	Mile	65	325	650	975
Farm Diversions	Mile	12	72	96	168
Farm Ponds	Each	6	108	108	216
Total			$4,722	$1,107	$5,829

Flood Control Structures and Measures		$3,258
Land Treatment Measures		2,571
Annual Maintenance to Farmer	$1,107	

APPENDIX
Table 5A
Comparison of Average Annual Benefit and Cost of the Recommended Program
GRINDSTONE CREEK WATERSHED

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	3,258	14,899	4.57
Land Treatment			
Flood Control	xxx	3,817	xxx
Land Treatment	xxx	28,039	xxx
Total	2,571	31,856	12.39
All Sources	5,829	46,755	8.02