

PRELIMINARY WORK PLAN
For Runoff and Waterflow Retardation
and Soil Erosion Prevention
GRAYS CREEK WATERSHED
A Subwatershed of the Trinity River
TX-SCD-19 & 23 Tr. No. 34
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DESCRIPTION OF THE WATERSHED

Grays Creek rises near the town of Alma in Ellis County, Texas, and flows in an easterly direction for 14 miles, entering the Trinity River about 4 miles east of Montfort. The watershed is comprised of Grays Creek and several small Trinity River tributaries including Hackberry, Willow, and Westbrook Creeks. Grays, Hackberry, and Willow Creeks form a common bottomland area where they enter the Trinity River flood plain.

There are no incorporated towns, and only two small community centers, located in the watershed.

The watershed has an area of 53,584 acres, (84 square miles), of which 53,043 acres are in farms. The remaining 541 acres, about 1.0 percent, are in roads and miscellaneous uses. Bottomland areas include 4,293 acres of flood plain on Grays, Hackberry, and Willow Creeks and 66 acres of flood plain on Westbrook Creek. Other bottomland areas include 1,600 acres of Trinity River bottomland protected by levees, and 6,000 acres that are unprotected. Approximately 162 acres are in stream channels.

There are 70 miles of roads, of which 10 miles are hard surfaced. Of the 35 bridges, 7 are major bridges spanning the larger streams.

Soils and Land Use

The Grays Creek watershed lies almost entirely in the Blackland Prairies Problem Area in Soil Conservation, with the exception of a few small areas of Forested Coastal Plain soils in the southeast portion of the watershed. The prairies soils consist of dark fine textured soils developed from limy marls and shales, and medium textured light colored soils developed from sandy layers in the underlying marl formations. The forested soils in the southeastern part of the watershed consist of medium and coarse textured soils developed from sandy parent materials.

Of the area in the watershed, 43 percent is cultivated, 15 percent is idle, 41 percent is in pasture and woods pasture, and 1 percent is in urban areas and miscellaneous uses. The cultivated acreage includes 1600 acres of leveed Trinity River bottomland. The more gently rolling areas in the western and southwestern portions of the watershed have been affected by slight to moderate erosion while the steeper portions of the watershed have been affected by moderate to very severe erosion.

Geology and Topography

The watershed is underlain by two major geologic formations, the Navarro and Taylor marls, and to a minor extent by the Wilcox sand. The Taylor and Navarro formations give rise primarily to fine textured soils, with some areas of medium textured soils being formed from interbedded sands in the marl formations. The Wilcox formation weathers to produce medium and coarse textured soils.

Physiographically, the watershed is a plain bounded on the East by the Trinity River valley and dissected by numerous small streams flowing into the major valley. The upper portions of these small drainage areas are gently rolling to rolling, but the slopes into the lower portion of the lateral drainages and the immediate slopes into the Trinity valley are steep. Slopes in the watershed range from less than 2 percent in the upper portions of the drainage areas to more than 20 percent in some areas adjoining the Trinity valley. Local relief ranges from 30 to 150 feet.

Climate

The climate of the area is characterized by long summers and short winters. These 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 84.1 degrees in summer to 45.2 degrees Fahrenheit in winter. The average temperature for the area is 65.5 degrees. Extreme temperatures of 3 degrees below zero and 105 degrees above zero have been recorded. The average date of the last killing frost is March 16 and that of the first killing frost is November 17, or a normal frost-free period of 246 days.

The mean annual precipitation of 35.2 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. The minimum recorded annual rainfall of 18.82 inches occurred in 1917, while the maximum annual rainfall of 53.10 inches fell in 1929.

Water Resources

The principal use of water in the area is for stockwater and domestic purposes. Most of the water for domestic use is taken from shallow wells. Livestock water is generally supplied by farm ponds. There are approximately 165 existing farm ponds in the watershed. The increased acreage of pasture and the application of improved range management practices will cause a need for approximately 213 additional farm ponds.

ECONOMY OF THE WATERSHED

Agricultural Economy

There are estimated to be 265 farms in the Grays Creek watershed with an average size of 200 acres. The better uplands scattered throughout the area are devoted largely to the production of crops. The more broken lands are used to produce livestock and dairy products. Of the cattle in the watershed 80 percent are used for beef production, and 20 percent are dairy cattle.

The principal crops grown in the watershed are cotton, corn, grain sorghum, and small grains, with 76 percent of the cropland being devoted to the production of these crops. The approximate yields per acre are: lint cotton, 180 pounds; corn, 18 bushels; grain sorghum, 1,200 pounds; and oats, 23 bushels. Other crops grown are forage sorghum, madrid clover, hubam clover, and vetch. Production is still good on the level areas and gentle slopes, but the need for improved rotations on all cropland to increase the organic matter and productivity of the soil is apparent. Large areas of steeper slopes are badly eroded and should be planted to permanent grasses.

Because of the frequency of flooding 41 percent of the flood plain that was formerly used for production of high-income crops is now Johnsongrass meadow, pasture or idle land.

The Grays Creek watershed is served by three Soil Conservation Service Work Units, which are assisting the Ellis-Prairie and Navarro-Hill Soil Conservation Districts. These work units have assisted farmers in preparing 42 conservation plans on 12,871 acres within the watershed boundaries.

It is expected that when land treatment practices have been applied and maintained for as long as two or three years yields in the watershed will be increased approximately 20 percent.

Urban and Other Influences

The residents of the two small community centers operate small businesses or have farms located nearby on which they depend for livelihood. Since there are few nearby industries to provide employment, most of the income is from agricultural sources.

The 70 miles of roads are adequate to provide access to all parts of the watershed except during rainy seasons when the unimproved roads are not passable. Occasional floods wash out road bridges, thus delaying travel and resulting in expense for replacement.

The T. & N.O. Railroad, at the upper end of the watershed, and bus and truck lines furnish adequate transportation and shipping facilities.

FLOOD PROBLEMS AND DAMAGES

The streams in the Grays Creek watershed have flooded frequently and caused moderate annual damage. Since the proposed flood control plan would have little effect on the Trinity River bottomlands, no flood damages to them were included in this plan.

During the 20-year period, 1923 to 1942 inclusive, there were 15 floods which flooded more than one-half the flood plain, and 87 smaller floods. Half of the larger floods occurred during the spring months, causing damage to growing crops. Occasional large floods occurred in the fall months and completely destroyed some mature crops.

The types of flood damage encountered in the watershed were (1) damage to crops and pasture, (2) deposition of sediment in existing floodways, (3) flood plain scour, and (4) damage to roads, bridges, and fences. Other damages include late planting of crops and the planting of lower income crops of shorter growing season, due to spring floods.

LAND TREATMENT ACTIVITIES

During the past four years landowners in 5 small neighbor groups, with membership wholly or partially within the Grays Creek watershed, have been cooperating with the Soil Conservation Districts in the planning and application of land treatment measures on their lands.

FLOOD CONTROL ACTIVITIES

Efforts to control floodwater from the Grays Creek watershed have been minor; however, 1,600 acres of Trinity River bottomland has been protected from Trinity River floodwater by a levee system.

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 Grays Creek watershed.

The design storm used for determining detention storage capacity would produce 5.28 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 minimum floodwater detention storage requirements. From a study of the rainfall-runoff relationships for this watershed, it was found that a rain of 1.00 inch, occurring in a one-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, which occurred during the 20-year period, was one of 7.64 inches which produced 4.68 inches of runoff. Under present conditions 4,073 acres of flood plain would be flooded by the runoff from this storm. If such a rain were to occur after land treatment practices and measures have been applied, it is estimated that the area inundated would be reduced to 3,810 acres. These figures are based on the entire flood plain area. With land treatment measures applied and the proposed detention structures, floodway, and floodwater diversion in operation 1,031 acres would be flooded as a result of such a storm. In addition to the above acreage, approximately 151 acres of flood plain would lie within the permanent pools of the proposed structures and 75 acres within the detention pools.

The channel capacity of Grays Creek at Section 2, located approximately two miles below the Chatfield Road, is 995 cubic feet per second, and the peak discharge at this point for a 7.64 inch rain under present conditions was 8,400 cubic feet per second. The discharge would be reduced to 1,837 cubic feet per second by the proposed system of detention structures.

The channel capacity of Westbrook Creek at section 1 is 420 cubic feet per second. The peak discharge at this point for a 7.64 inch rain under present conditions was 2,830 cubic feet per second. The discharge would be reduced to 260 cubic feet per second by the proposed structures.

SEDIMENTATION AND OTHER RELATED FLOOD PLAIN DAMAGES

Soil erosion in the Grays Creek watershed ranges from very severe on the steeply sloping lands to slight on the more gently sloping areas. Sheet erosion is the dominant process on the gently sloping lands, and both sheet and gully erosion are active on the steeper slopes.

The principal sedimentation damages in the watershed are: (1) channel filling, and (2) accessory damages. Other related damages encountered in the flood plain are: (1) flood plain scour, and (2) channel enlargement in the upper reaches of the drainage systems.

SEDIMENTATION DAMAGES

Channel Filling

Channel filling is a serious sedimentation problem in the watershed. The deposition of fine textured sediment in the stream beds and on stream banks has been severe in the middle reaches of Grays Creek and in the lower reaches of Hackberry Creek. Channel filling ranges up to 30 percent in these areas. The reduction in channel capacity is causing more frequent flooding and increased flood heights.

Three floodways in the watershed are receiving very severe damage from sediment accumulation. Based on information from residents of the area, the annual cost of sediment removal from floodways on Hackberry Creek, Willow Creek and the area south of Willow Creek has amounted to an average annual cost of 50 cents per linear foot of floodway.

Overbank Deposition

Overbank deposition, ranging in thickness from 1 to 6 feet, has occurred on most of the flood plain in the drainage system in the form of valley-wide accumulations and natural levees. Modern sediment is of about the same texture and fertility as the old alluvial soils and, therefore, is causing negligible damage to the land. The primary damage from this deposition is in the impairment of surface drainage.

A small area in the Westbrook Creek valley has suffered slight damage from deposition of 4 to 6 inches of sandy material over the flood plain. There has been 10 percent damage to slightly less than 5 acres of cropland in this area.

Accessory Damage

Damages caused by the deposition of fine sediment (silt and clay) on field crops and pasture grasses have been of considerable magnitude in the flood plains of the drainage system. These damages were measured in terms of field crop and pasture damage and were included with floodwater damages.

Reservoir Damages

No large impounding reservoirs now exist in the Grays Creek watershed. There has been considerable damage to small farm ponds in the watershed by the loss of storage capacity due to sediment accumulation.

Sediment Output Rates

The present sediment output rates above the proposed detention structures range from 2.7 to 6.0 acre-feet annually per square mile of drainage area. These estimated rates are based on the sedimentation surveys of Lake Halbert and the Hubbard City Lakes made by the Soil Conservation Service in 1949 and surveys of other existing lakes with similar drainage area and climatic conditions.

In estimating the present sedimentation rates at the proposed floodwater detention structures, adjustments were made for: (1) size and shape of the watershed; (2) present land use, erosion rates and vegetative cover of the watershed lands; and (3) the location of high sediment output areas with reference to the detention structure sites.

OTHER RELATED FLOOD PLAIN DAMAGES

Flood Plain Scour

Scour damage has been moderate on the flood plain of the watershed. The majority of the scour channels are wide with flat bottoms and can be crossed with farm implements; however, some steep-sided channels carry a large amount of floodwater which prevents the growth of crops or grasses in the channel. A total of 110 acres of cropland and 129 acres of pasture land have been damaged 10 to 90 percent.

Channel Enlargement

Bank erosion on the stream channels within the flood plain of the watershed is slight. Some local bank erosion is occurring in the upper reaches of the Grays Creek channel and in the lower reaches of some of the smaller tributary channels.

FLOOD DAMAGES

Flood damage information for approximately 80 percent of the flood plain area of Grays Creek watershed was obtained from landowners or operators. Most of the specific information as to amounts and extent of damages related to the May, 1948 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 flood damage to flood plain lands by scour was determined on the basis of present prices and costs. Sediment damage to existing floodways was based on the cost of removing silt from the floodways.

Information concerning flood damage to roads and bridges was obtained from county road commissioners.

Damage rates as determined for the May, 1948 flood were used to indicate damage rates to be expected from floods of a various size 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 \$59,114 annually under present conditions, of which \$45,223 is crop and pasture damage. These figures are based on the entire flood plain area. After excluding the areas of flood plain which would be inundated by the proposed detention structures, the average direct damage would be \$55,834 annually, of which \$42,714 is crop and pasture damage. In addition there are indirect damages such as the interruption of travel, 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, \$5,583, 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 measures needed are the seeding of 10,912 acres (approximately 20 percent of the watershed) of retired land; the sodding of 558 acres of farm waterways; and the construction of 1,229 miles of terraces.

Other land treatment measures include 25 miles of farm diversions; 213 farm ponds; 107 miles of fencing to enclose newly reseeded and retired areas; installation of 5 drop inlets and 9 drop structures to accelerate the application of land treatment measures; conservation rotations on 24,580 acres of cultivated land; and good management practices on 19,000 acres of pasture.

The estimated cost of installing these measures is \$630,099, and the annual cost including installation and maintenance, is \$43,401.

Flood Control Structures and Measures

The flood control structures and measures needed to provide flood protection for flood plain lands are listed in table 2, items 1 to 6 inclusive.

A system of 10 detention structures is needed to protect the flood plain lands along the larger streams in the Grays Creek watershed. In addition to the detention structures, Hackberry and Willow Creeks will need 2.0 miles of floodway and 1.4 miles of floodwater diversion to further reduce flooding and sediment deposition on the fertile bottomlands at the lower end of these streams. The common flood plain area south of Willow Creek will need 2.5 miles of floodwater diversion. The proposed detention structures and their drainage areas, and the location of the floodway and floodwater diversions are shown on the Work Plan Map. Descriptive information concerning the detention structures is summarized in table 5.

The system of detention structures and floodwater diversions will detain the runoff from 60 percent of Grays, Hackberry and Willow Creeks, and 95 percent of Westbrook Creek. Sufficient detention storage capacity can be developed at all proposed sites to permit the use of vegetated emergency spillways.

It will be necessary to raise or relocate portions of several county roads which cross the pool areas of proposed detention structures.

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 and floodwater diversions from rapid sedimentation.

The estimated cost of installing these measures is \$449,125, and the annual cost, including installation and maintenance, is \$16,003.

Effect of these Measures on Damages and Benefits

The combined program of land treatment and flood control measures described above would prevent damage from 47 of the 102 floods which occurred in the 20-year period 1923 to 1942, inclusive. The remaining floods would be reduced to minor floods covering an average of 505 acres annually and causing an estimated average annual damage of only \$7,815.

Most of the expected reduction in annual flood damage would be effected by the system of detention structures. The annual value of the reduction in flood damages attributable to the detention structures is estimated to be \$30,551, out of the total of \$53,602, from all measures 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 cotton on areas now idle or used for pasture or meadow 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 \$15,888 annually.

The total flood control benefits, including both reductions in flood damages and the benefits from more intensive use of flood plain lands, are estimated to be \$69,490 annually. In addition, it is estimated that benefits to land owners and operators in upland areas of the watershed from application of land treatment measures would be \$254,145 annually. The total expected benefit from the combined program would amount to \$323,635 annually.

The expected land treatment benefits were determined by estimating the increased net income to the land which would result from the application of the needed land treatment practices and measures. It was assumed that the proportion of the cropland used for each crop would not be changed, although the total area used for cropland would be decreased by the retirement of idle cropland and steep and severely eroded areas to pasture and 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 be increased 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 \$231,273 from crops and \$22,872 from pasture; or a total of \$254,145 annually.

Comparison of Costs and Benefits

The ratio of the average annual benefit from detention structures, \$39,914, to their average annual cost, including the appurtenant structures for their protection, \$12,591, is 3.17:1.

The ratio of the average annual benefit, \$10,679, from the floodway and floodwater diversion on Hackberry and Willow Creeks to their average annual cost, \$1,553, is 6.88:1.

The ratio of the average annual benefit, \$5,312, from the floodwater diversion south of Willow Creek to its average annual cost, including the appurtenant structures for its protection, \$1,859, is 2.86:1.

The ratio of the average annual benefit, \$267,730, from land treatment measures and practices to their average annual cost, \$43,401, is 6.17:1.

The ratio of total average annual benefits, \$323,635, to total average annual cost, \$59,404, is 5.45:1.

ANNUAL MAINTENANCE

Estimated annual maintenance costs after the conservation measures and flood control structures have been installed are shown on 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 conservation 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/}
 GRAYS CREEK WATERSHED

Damages	Average Annual Damage					Average Annual Benefit			
	Under Present Conditions	With Land Treatment Only	With Land and Detention Storage	With Land Detention and Floodwater Diversion	With Land Treatment, Detention Storage, Floodwater and Floodway	From Land Treatment Only	From Storage Only	From Floodwater Diversion Only	From Floodwater Diversion Only
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
<u>Floodwater Damage</u>									
Crop and Pasture	42,714	32,498	6,217	5,574	4,077	10,216	26,281	643	1,444
Flood Plain Scour	965	731	143	133	95	234	588	10	
Other Agricultural	655	498	95	88	63	157	403	7	
Roads and Bridges	200	152	30	28	20	48	122	2	
Sub-Total	44,534	33,879	6,485	5,823	4,255	10,655	27,394	662	1,546
<u>Sediment Damage</u>									
To Existing Floodways	11,300	9,605	9,225	6,080	2,850	1,695	380	3,145	3,225
Sub-Total	11,300	9,605	9,225	6,080	2,850	1,695	380	3,145	3,225
<u>Indirect Damage</u>	5,583	4,348	1,571	1,190	710	1,235	2,777	381	446
Total Damage	61,417	47,832	17,281	13,093	7,815	xxx	xxx	xxx	xx
Benefit from Reduction of Damage	xxx	xxx	xxx	xxx	xxx	13,585	30,551	4,188	5,214
Benefit from More Intensive Use of Flood Plain	xxx	xxx	xxx	xxx	xxx	xxx	9,363	1,124	5,446
Total Flood Control Benefit	xxx	xxx	xxx	xxx	xxx	13,585	39,914	5,312	10,660

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

Table 2
 Cost Estimate Table
 GRAYS CREEK WATERSHED

Structure or Measure	Unit	No.	Cost			Total
			To Farmer	To Federal Funds	To State, County Or Other	
Detention Structures	Each	10		\$265,376		\$265,376
Site Acquisition	Total			66,288		66,288
Relocating Roads	Mile	1.8			\$4,400	4,400
Drop Inlets	Each	5		57,586		57,586
Floodwater Diversion	Mile	3.9		40,046		40,046
Floodway	Mile	2.0		15,429		15,429
Sub-Total				\$444,725	\$4,400	\$449,125
Farm Waterways	Acre	558	\$ 47,125	\$ 8,675		\$ 55,800
Seeding Retired Areas	Acre	10,912	139,217	46,287		185,504
Terracing	Mile	1,229	153,625			153,625
Farm Diversions	Mile	25	3,750			3,750
Farm Ponds	Each	213	95,850			95,850
Farm Fencing	Mile	107	42,800			42,800
Drop Inlet	Each	5		6,000		6,000
Drop Structure	Each	9		7,200		7,200
Farm & Ranch Planning & Application	Acre	53,047		79,570		79,570
Sub-Total			\$482,367	\$147,732		\$630,099
TOTAL			\$482,367	\$592,457	\$4,400	\$1,079,224
Estimated Amount to Be Expended During 1952 Fiscal Year			\$207,996	\$111,998		\$319,994

Table 3
Annual Costs
GRAYS CREEK WATERSHED

Structure or Measure	Unit	No.	Cost		Total
			Installation	Maintenance	
Detention Structures	Each	10	\$ 9,357	\$ 1,000	\$10,357
Site Acquisition	Total		1,657		1,657
Relocating Roads	Mile	1.8	110		110
Drop Inlets	Each	5	1,440	125	1,565
Floodwater Diversion	Mile	3.9	1,001	156	1,157
Floodway	Mile	2	386	771	1,157
Sub-Total			\$13,951	\$ 2,052	\$16,003
Farm Waterways	Acre	558	\$ 2,023	\$ 2,232	\$ 4,255
Seeding Retired Areas	Acre	10,912	6,306		6,306
Terracing	Mile	1,229	6,146	12,290	18,436
Farm Diversions	Mile	25	150	200	350
Farm Ponds	Each	213	3,834	3,834	7,668
Farm Fencing	Mile	107	1,712	2,140	3,852
Drop Inlets	Each	5	150	125	275
Drop Structure	Each	9	180	90	270
Farm & Ranch Planning & Application	Acre	53,047	1,989		1,989
Sub-Total			\$22,490	\$20,911	\$43,401
TOTAL			\$36,441	\$22,963	\$59,404

Flood Control Structures and Measures	16,003
Land Treatment Measures	43,401
Annual Maintenance - Farmer	22,963

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

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar Of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	12,591	39,914	3.17
Floodway	1,553	10,679	6.88
Floodwater Diversion	1,859	5,312	2.86
Total	16,003	55,905	3.49
Land Treatment			
Flood Control	xxx	13,585	xxx
Land Treatment	xxx	254,145	xxx
Total	43,401	267,730	6.17
All Sources	59,404	323,635	5.45

Table 5
 Detention Structure Data
 GRAYS CREEK WATERSHED

Site No.	Sq. Ni.	Drainage Area	Perms. : Det. : Pool	Storage Capacity : Acre Feet	Inches of Runoff : Perms. : Det. : Pool	Total : Pool	Surface Area : Flood Plain : Acres	Inundated : Top of : Pool	Perms. : Det. : Pool	Max. : Ht. : of : Dam	Volume : of fill : Rate	Draw : Type : of : Spill-	Est. : Total : Cost		
1	5.78	555	1,712	2,267	1.8	5.4	287	112	40	20	60	74, 147	30	Veg.	\$33,366
2	1.55	137	443	580	1.7	5.3	84	44	15	7	22	32,963	8	"	14,833
3	1.31	136	350	486	1.9	5.1	65	36	6	3	9	32,174	7	"	14,478
4	3.05	279	878	1,157	1.7	5.4	135	64	16	8	24	72,783	16	"	32,752
5	3.53	308	983	1,291	1.6	5.3	140	53	15	7	22	110,822	18	"	49,870
6	1.58	125	444	569	1.5	5.2	56	20	8	4	12	50,191	8	"	22,586
7	6.72	609	1,932	2,541	1.7	5.4	280	108	32	17	49	87,797	34	"	39,509
8	0.95	140	263	403	1.8	5.2	70	41	6	3	9	43,357	5	"	19,511
9	2.34	226	673	899	2.8	5.4	119	52	5	3	8	41,740	12	"	18,783
10	3.62	324	923	1,247	1.7	4.7	145	65	8	3	11	43,750	18	"	19,688
Total	30.43	2,839	8,601	11,440			595	1,381	151	75	226	589,724			\$265,376 1/

1/ Construction Cost \$230,877
 Technical Services 34,499

APPENDIX

Table 1 A & B

Summary of Average Annual Monetary Floodwater and Sediment Damage and Flood Control Benefit from the Recommended GRAYS CREEK WATERSHED (Grays, Hackberry, and Willow Creeks)

Damages	Average Annual Damage						Average Annual			
	Under Present Conditions	With Land Treatment Only	and Willow Creek	and Grays Creek	and Floodwater Diversion	and Floodwater Diversion	From Land Treatment Only	From Storage on Hackberry and Willow Creek Only	From Storage on Grays Creek Only	From Floodwater Diversion Only
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
<u>Floodwater Damage</u>										
Crop and Pasture	40,681	31,005	24,427	6,217	5,574	4,077	9,676	6,578	18,210	643
Flood Plain Scour	950	722	570	143	133	95	228	152	427	10
Other Agricultural	630	479	378	95	88	63	151	101	283	7
Roads and Bridges	200	152	120	30	28	20	48	32	90	2
Sub-Total	42,461	32,358	25,495	6,485	5,823	4,255	10,103	6,863	19,010	662
<u>Sediment Damage</u>										
To Existing Floodways	11,300	9,605	9,225	9,225	6,080	2,850	1,695	380	0	3,145
<u>Indirect Damage</u>	5,376	4,196	3,472	1,571	1,190	710	1,180	724	1,901	381
Total Damage	59,137	46,159	38,192	17,281	13,093	7,815	xxx	xxx	xxx	xxx
Benefit from Reduction of Damage	xxx	xxx	xxx	xxx	xxx	xxx	12,978	7,967	20,911	4,188
Benefit from More Intensive Use of Flood Plain	xxx	xxx	xxx	xxx	xxx	xxx	xxx	3,186	5,917	1,124
Total Flood Control Benefit	xxx	xxx	xxx	xxx	xxx	xxx	12,978	11,153	26,828	5,312

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

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

Damages	Average Annual Damage			Average Annual Benefit		
	Under Present Conditions (dollars)	With Land Treatment Only (dollars)	With Land and Detention Storage (dollars)	From Land Treatment Only (dollars)	From Detention Storage Only (dollars)	Total Flood Control Benefits (dollars)
<u>Floodwater Damage</u>						
Crop and Pasture	2,033	1,493	0	540	1,493	2,033
Flood Plain Scour	15	9	0	6	9	15
Other Agricultural	25	19	0	6	19	25
Sub-Total	2,073	1,521	0	522	1,521	2,073
<u>Indirect Damage</u>	207	152	0	55	152	207
Total Damage	2,280	1,673	0	xxx	xxx	xxx
Benefit from Reduction of Damage	xxx	xxx	xxx	607	1,673	2,280
Benefit from More Intensive Use of Flood Plain	xxx	xxx	xxx	xxx	260	260
Total Flood Control Benefit	xxx	xxx	xxx	607	1,933	2,540

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

APPENDIX
Table 2A
Cost Estimate Table
GRAYS CREEK WATERSHED
Grays Creek

3

Structure or Measure	Unit	No.	Cost			
			To Farmer	To Federal Funds	To State, County Or Other	Total
Detention Structure	Each	5		\$145,299		\$145,299
Site Acquisition	Total			34,128		34,128
Relocating Roads	Mile	1.5			\$3,800	3,800
Drop Inlets	Each	2		16,682		16,682
Sub-Total				\$196,109	\$3,800	\$199,909
Farm Waterways	Acre	175	\$ 13,125	\$ 4,375		\$ 17,500
Seeding Retired Areas	Acre	3,399	34,670	23,113		57,783
Terracing	Mile	385	48,125			48,125
Farm Diversions	Mile	8	1,200			1,200
Farm Ponds	Each	67	30,150			30,150
Farm Fencing	Mile	33	13,200			13,200
Drop Inlet	Each	3		3,600		3,600
Drop Structure	Each	5		4,000		4,000
Farm & Ranch Planning & Application	Acre	16,584		24,876		24,876
Sub-Total			\$140,470	\$ 59,964		\$200,434
TOTAL			\$140,470	\$256,073	\$3,800	\$400,343
Estimated Amount to be Expended During 1952 Fiscal Year			\$ 78,065	\$ 42,035		\$120,100

APPENDIX
 Table 2 B
 Cost Estimate Table
 GRAYS CREEK WATERSHED
 Hackberry and Willow Creeks

Structure or Measure	Unit	No.	Cost			Total
			To Farmer	To Federal Funds	To State, County Or Other	
Detention Structure	Each	4		\$100,389		\$100,389
Site Acquisition	Total			25,200		25,200
Relocating Roads	Mile	0.2			\$600	600
Floodwater Diversion	Mile	1.4		13,600		13,600
Floodway	Mile	2.0		15,429		15,429
Sub-Total				\$154,618	\$600	\$155,218
Farm Waterways	Acre	130	\$ 9,750	\$ 3,250		\$ 13,000
Seeding Retired Areas	Acre	2,620	26,724	17,816		44,540
Terracing	Mile	286	35,750			35,750
Farm Diversions	Mile	6	900			900
Farm Ponds	Each	50	22,500			22,500
Farm Fencing	Mile	25	10,000			10,000
Drop Inlet	Each	2		2,400		2,400
Drop Structure	Each	4		3,200		3,200
Farm & Ranch Planning & Application	Acre	12,373		\$ 18,560		18,560
Sub-Total			\$105,624	\$ 45,226		\$150,850
TOTAL			\$105,624	\$199,844	\$600	\$306,068
Estimated Amount to be Expended During 1952 Fiscal Year			\$ 59,683	\$ 32,137		\$ 91,820

APPENDIX
 Table 2 C
 Cost Estimate Table
 GRAYS CREEK WATERSHED
 Floodwater Diversion Area

Structure or Measure	Unit	No.	Cost		
			To Farmer	To Federal Funds	To State, County Or Other
Drop Inlets	Each	3		\$40,904	\$40,904
Floodwater Diversion	Mile	2.5		26,446	26,446
Sub-Total				\$67,350	\$67,350
Farm Waterways	Acres	17	\$ 1,275	\$ 425	\$ 1,700
Seeding Retired Areas	Acres	338	3,448	2,298	5,746
Terracing	Mile	38	4,750		4,750
Farm Diversions	Mile	1	150		150
Farm Ponds	Each	7	3,150		3,150
Farm Fencing	Miles	4	1,600		1,600
Farm & Ranch Planning & Application	Acres	1,651		2,476	2,476
Sub-Total			\$14,373	\$ 5,199	\$19,572
TOTAL			\$14,373	\$72,549	\$86,922
Estimated Amount to be expended During 1952 Fiscal Year			\$16,950	\$ 9,127	\$26,077

APPENDIX
 Table 2 D
 Cost Estimate Table
 GRAYS CREEK WATERSHED
 Westbrook Creek

Structure or Measure	Unit	No.	Cost		
			To Farmer	To Federal Funds	To State, County Or Other Total
Detention Structure	Each	1		\$19,688	\$19,688
Site Acquisition	Total			6,960	6,960
Sub-Total				\$26,648	\$26,648
Farm Waterways	Acre	25	\$ 1,875	\$ 625	\$ 2,500
Seeding Retired Areas	Acre	450	4,590	3,060	7,650
Terracing	Mile	56	7,000		7,000
Farm Diversions	Mile	1	150		150
Farm Ponds	Each	9	4,050		4,050
Farm Fencing	Mile	5	2,000		2,000
Farm & Ranch Planning & Application	Acre	2,416		3,624	3,624
Sub-Total			\$19,665	\$ 7,309	\$26,974
TOTAL			\$19,665	\$33,957	\$53,622
Estimated Amount to be Expended During 1952 Fiscal Year			\$ 8,006	\$ 4,311	\$12,317

APPENDIX
 Table 2 E
 Cost Estimate Table
 GRAYS CREEK WATERSHED
 Direct Drains

Structure or Measure	Unit	No.	Cost			Total
			To Farmer	To Federal Funds	To State, County Or Other	
Farm Waterways	Acre	211	\$21,100			\$ 21,100
Seeding Retired Areas	Acre	4,105	69,785			69,785
Terracing	Mile	464	58,000			58,000
Farm Diversions	Mile	9	1,350			1,350
Farm Ponds	Each	80	36,000			36,000
Farm Fencing	Mile	40	16,000			16,000
Farm & Ranch Planning & Application	Acre	20,023		\$30,034		30,034
TOTAL			\$202,235	\$30,034		\$232,269
Estimated Amount to be Expended During 1952 Fiscal Year			\$ 45,292	\$24,388		\$ 69,680

APPENDIX
 Table 3 A
 Annual Costs
 GRAYS CREEK WATERSHED
 Grays Creek

Structure or Measure	Unit	No.	Cost		
			Installation	Maintenance	Total
Detention Structures	Each	5	\$ 5,123	\$ 500	\$ 5,623
Site Acquisition	Total		853		853
Relocating Roads	Mile	1.5	95		95
Drop Inlets	Each	2	417	50	467
Sub-Total			\$ 6,488	\$ 550	\$ 7,038
Farm Waterways	Acre	175	\$ 634	\$ 700	\$ 1,334
Seeding Retired Areas	Acre	3,399	1,965		1,965
Terracing	Mile	385	1,926	3,850	5,776
Farm Diversions	Mile	8	48	64	112
Farm Ponds	Each	67	1,206	1,206	2,412
Farm Fencing	Mile	33	528	660	1,188
Drop Inlets	Each	3	90	75	165
Drop Structures	Each	5	100	50	150
Farm & Ranch Planning & Application	Acre	16,584	622		622
Sub-Total			\$ 7,119	\$6,605	\$13,724
TOTAL			\$13,607	\$7,155	\$20,762
Flood Control Structures and Measures					\$ 7,038
Land Treatment Measures					13,724
Annual Maintenance - Farmer				\$7,155	

APPENDIX
 Table 3 B
 Annual Costs
 GRAYS CREEK WATERSHED
 Hackberry and Willow Creeks

9

Structure or Measure	Unit	No.	Cost		
			Installation	Maintenance	Total
Detention Structures	Each	4	\$ 3,540	\$ 400	\$ 3,940
Site Acquisition	Total		630		630
Relocating Roads	Mile	0.2	15		15
Floodwater Diversion <u>1/</u>	Mile	1.4	340	56	396
Floodway	Mile	2.0	386	771	1,157
Sub-Total			\$ 4,911	\$1,227	\$ 6,138
Farm Waterways	Acre	130	471	520	991
Seeding Retired Areas	Acre	2,620	1,514		1,514
Terracing	Mile	286	1,430	2,860	4,290
Farm Diversions	Mile	6	36	48	84
Farm Ponds	Each	50	900	900	1,800
Farm Fencing	Mile	25	400	500	900
Drop Inlet	Each	2	60	50	110
Drop Structure	Each	4	80	40	120
Farm & Ranch Planning & Application	Acre	12,373	464		464
Sub-Total			\$ 5,355	\$4,918	\$10,273
TOTAL			\$10,266	\$6,145	\$16,411
Flood Control Structures and Measures					\$ 6,138
Land Treatment Measures					10,273
Annual Maintenance - Farmer				\$6,145	

1/ This floodwater diversion is an appurtenant structure to the floodway.

APPENDIX
 Table 3 C
 Annual Costs
 GRAYS CREEK WATERSHED
 Floodwater Diversion Area

Structure or Measure	Unit	No.	Cost		Total
			Installation	Maintenance	
Drop Inlets	Each	3	\$1,023	\$ 75	\$1,098
Floodwater Diversion	Mile	2.5	661	100	761
Sub-Total			\$1,684	\$175	\$1,859
Farm Waterways	Acre	17	\$ 62	\$ 68	\$ 130
Seeding Retired Areas	Acre	338	195		195
Terracing	Mile	38	190	380	570
Farm Diversions	Mile	1	6	8	14
Farm Ponds	Each	7	126	126	252
Farm Fencing	Mile	4	64	80	144
Farm & Ranch Planning & Application	Acre	1,651	62		62
Sub-Total			\$ 705	\$662	\$1,367
TOTAL			\$2,389	\$837	\$3,226
Flood Control Structures and Measures					\$1,859
Land Treatment Measures					1,367
Annual Maintenance - Farmer				\$837	

APPENDIX
 Table 3 D
 Annual Costs
 GRAYS CREEK WATERSHED
 Westbrook Creek

Structure or Measure	Unit	No.	Cost		
			Installation	Maintenance	Total
Detention Structure	Each	1	\$ 694	\$ 100	\$ 794
Site Acquisition	Total		174		174
Sub-Total			\$ 868	\$ 100	\$ 968
Farm Waterways	Acre	25	\$ 91	\$ 100	\$ 191
Seeding Retired Areas	Acre	450	260		260
Terracing	Mile	56	280	560	840
Farm Diversions	Mile	1	6	8	14
Farm Ponds	Each	9	162	162	324
Farm Fencing	Mile	5	80	100	180
Farm & Ranch Planning & Application	Acre	2,416	91		91
Sub-Total			\$ 970	\$ 930	\$1,900
TOTAL			\$1,838	\$1,030	\$2,868

Flood Control Structures and Measures	\$ 968
Land Treatment Measures	1,900
Annual Maintenance - Farmer	\$1,030

APPENDIX
 Table 3 E
 Annual Costs
 GRAYS CREEK WATERSHED
 Direct Drains

Structure or Measure	Unit	No.	Cost		
			Installation	Maintenance	Total
Farm Waterways	Acre	211	\$ 765	\$ 844	\$ 1,609
Seeding Retired Areas	Acre	4,105	2,372		2,372
Terracing	Mile	464	2,320	4,640	6,960
Farm Diversions	Mile	9	54	72	126
Farm Ponds	Each	80	1,440	1,440	2,880
Farm Fencing	Mile	40	640	800	1,440
Farm & Ranch Planning & Application	Acre	20,023	751		751
TOTAL			\$8,342	\$7,796	\$16,138
Land Treatment Measures					\$16,138
Annual Maintenance - Farmer				\$7,796	

APPENDIX
Table 4A

Comparison of Average Annual Benefit and Cost
of the Recommended Program
GRAYS CREEK WATERSHED
Grays Creek

Source of Benefit	Annual Cost (dollars)	Annual Benefit (dollars)	Benefit per Dollar Of Cost (dollars)
Detention Storage	7,038	26,828	3.81
Land Treatment			
Flood Control	xxx	7,138	xxx
Land Treatment	xxx	89,989	xxx
Total	13,724	97,127	7.08
All Sources	20,762	123,955	5.97

APPENDIX

14

Table 4 B

Comparison of Average Annual Benefit and Cost
of the Recommended Program
GRAYS CREEK WATERSHED
Hackberry and Willow Creeks

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar Of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	4,585	11,153	2.43
Floodways	1,553	10,679	6.88
Total	6,138	21,832	3.56
Land Treatment			
Flood Control	xxx	5,191	xxx
Land Treatment	xxx	65,446	xxx
Total	10,273	70,637	6.88
All Sources	16,411	92,469	5.63

APPENDIX
Table 4 C

Comparison of Average Annual Benefit and Cost
to the Recommended Program
GRAYS CREEK WATERSHED
Floodwater Diversion Area

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar Of Cost
	(dollars)	(dollars)	(dollars)
Floodwater Diversion	1,859	5,312	2.86
Land Treatment			
Flood Control	xxx	649	xxx
Land Treatment	xxx	8,181	xxx
Total	1,367	8,830	6.46
All Sources	3,226	14,142	4.38

APPENDIX
Table 4 D

16

Comparison of Average Annual Benefit and Cost
of the Recommended Program
GRAYS CREEK WATERSHED
Westbrook Creek

Source of Benefit	Annual Cost	Annual Benefit	Benefit per Dollar Of Cost
	(dollars)	(dollars)	(dollars)
Detention Storage	968	1,933	2.00
Land Treatment			
Flood Control	xxx	607	xxx
Land Treatment	xxx	14,394	xxx
Total	1,900	15,001	7.90
All Sources	2,868	16,934	5.90

APPENDIX
Table 4 E

17

Comparison of Average Annual Benefit and Cost
of the Recommended Program
GRAYS CREEK WATERSHED
Direct Trinity Drainage

Source of Benefit	Annual Cost (dollars)	Annual Benefit (dollars)	Benefit per Dollar Of Cost (dollars)
Land Treatment			
Flood Control	xxx	xxx	xxx
Land Treatment	xxx	76,135	xxx
Total	16,138	76,135	4.72

APPENDIX

18

Table 5 A

Increase in Income Through More Intensive Use
of Flood Plain Lands
GRAYS CREEK WATERSHED

Land Use	Acres	Yield	Production	Gross Income (dollars)	Cost (dollars)	Net Income (dollars)
<u>Present Conditions</u>						
Cotton	676	354 Lbs.	239,304	92,371	52,024	40,347
Corn	214	38 Bu.	8,132	10,084	3,317	6,767
Grain Sorghum	143	18 Cwt.	2,574	4,659	2,184	2,475
Madrid Clover	71	3 Cwt.	213	6,390	1,420	4,970
Meadow	178	2 Tons	356	5,774	1,250	4,524
Temporary Pasture	107	5 AUM	535	1,338	749	589
Pasture	1,066	2.5 AUM	2,665	6,663	533	6,130
Woods pasture	676	0.5 AUM	338	845		845
Idle	391					
Miscellaneous	36					
Total	3,558			128,124	61,477	66,647
Flooded too often for intensive use	236					
	3,794					
<u>After Land Treatment and Detention Storage</u>						
Alfalfa	50	3 Tons	150	3,903	1,629	2,274
Hubam Clover	150	3 Cwt	450	4,500	2,400	2,100
Cotton	776	354 Lbs.	274,704	106,036	59,720	46,316
Corn	214	38 Bu.	8,132	10,084	3,317	6,767
Grain Sorghum	174	18 Cwt.	3,132	5,669	2,657	3,012
Madrid Clover	95	3 Cwt.	285	8,550	1,900	6,650
Meadow	88	2 tons	176	2,855	618	2,237
Temporary Pasture	107	5 AUM	535	1,338	749	589
Pasture	1,066	2.5 AUM	2,665	6,663	533	6,130
Woods Pasture	676	0.5 AUM	338	845		845
Idle	126					
Miscellaneous	36					
Total	3,558			150,443	73,523	76,920
				Net Increase		10,273
				Less Added Damage		123
				Less Increase in Overhead Expense		<u>1,047</u>
				Net Benefit		9,103

(Continued)

APPENDIX

19

Table 5 A
 Increase in Income Through More Intensive Use
 of Flood Plain Lands
 GRAYS CREEK WATERSHED

Land Use	Acres	Yield	Production	Gross Income (dollars)	Cost (dollars)	Net Income (dollars)
<u>After Land Treatment, Detention Storage and Floodwater Diversions</u>						
Alfalfa	50	3 Tons	150	3,903	1,629	2,274
Hubam Clover	150	3 Cwt	450	4,500	2,400	2,100
Cotton	796	354 Lb.	281,784	108,769	61,260	47,509
Corn	214	38 Bu.	8,132	10,084	3,317	6,767
Grain Sorghum	174	18 Cwt	3,132	5,669	2,657	3,012
Madrid Clover	95	3 Cwt	285	8,550	1,900	6,650
Meadow	88	2 ton	176	2,855	618	2,237
Temporary Pasture	107	5 AUM	535	1,338	749	589
Pasture	1,066	2.5 AUM	2,665	6,663	533	6,130
Woods Pasture	676	0.5 AUM	338	845		845
Idle	106					
Miscellaneous	36					
Total	3,558			153,176	75,063	78,113
						1,193
						11
						58
						1,124

(Continued)

APPENDIX
Table 5 A

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Increase in Income Through More Intensive Use
of Flood Plain Lands
GRAYS CREEK WATERSHED

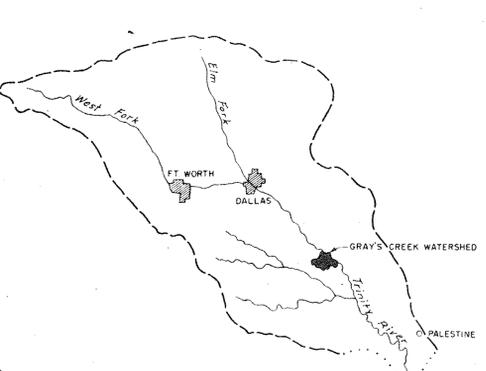
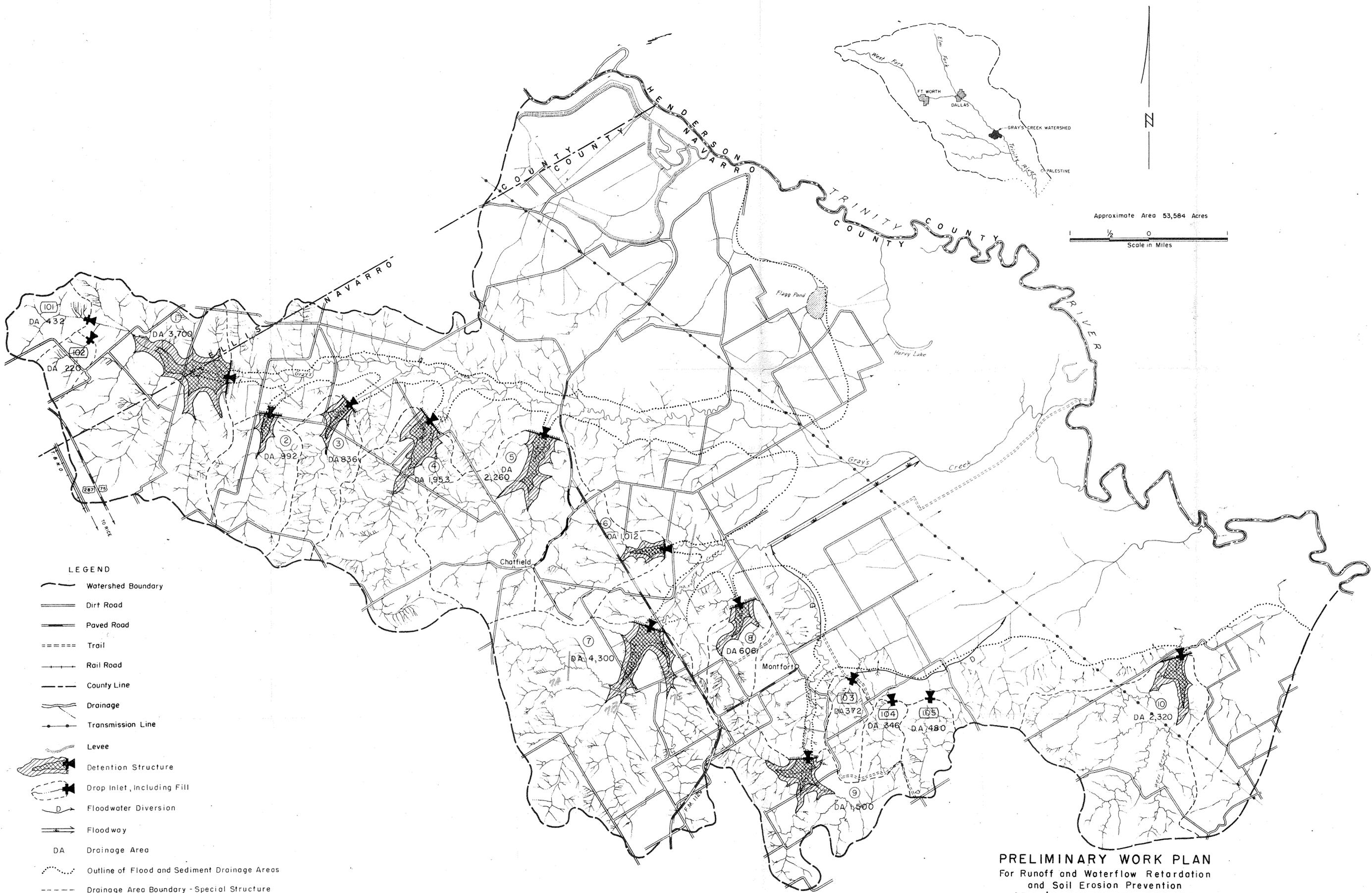
Land Use	Acres	Yield	Production	Gross Income (dollars)	Cost (dollars)	Net Income (dollars)
<u>After Land Treatment, Detention Storage, Floodwater Diversions, and Floodways</u>						
Alfalfa	124	3 Tons	372	9,679	4,039	5,640
Hubam Clover	150	3 Cwt	450	4,500	2,400	2,100
Cotton	845	354 Lbs	299,130	115,464	65,032	50,432
Corn	197	38 Bu.	7,486	9,283	3,054	6,229
Grain Sorghum	174	18 Cwt.	3,132	5,669	2,657	3,012
Madrid Clover	95	3 Cwt.	285	8,550	1,900	6,650
Meadow	88	2 Tons	176	2,855	618	2,237
Temporary Pasture	107	5 AUM	535	1,338	749	589
Pasture	1,066	2.5 AUM	2,665	6,663	533	6,130
Woods Pasture	676	0.5 AUM	338	845		845
Miscellaneous	36					
Total	3,558			164,846	80,982	83,864
						Net Increase 5,751
						Less Added Damage 37
						Less Increase in Overhead Expense 313
						Net Benefit 5,401

APPENDIX

21

Table 5 B
 Increase in Income Through More Intensive Use
 of Flood Plain Lands
 GRAYS CREEK WATERSHED
 Westbrook Creek

Land Use	Acres	Yield	Production	Gross Income (dollars)	Cost (dollars)	Net Income (dollars)
<u>Present Conditions</u>						
Cotton	30	375 Lbs.	11,250	4,343	2,384	1,959
Corn	5	39 Bu.	195	242	78	164
Truck	5	\$300	1,500	1,500	500	1,000
Idle	10					
Miscellaneous	3					
Total	53			6,085	2,962	3,123
<u>After Land Treatment and Detention Storage</u>						
Cotton	30	375 Lbs.	11,250	4,343	2,384	1,959
Corn	5	39 Bu.	195	242	78	164
Truck	5	\$300	1,500	1,500	500	1,000
Vetch	10	3 Ort	30	450	160	290
Miscellaneous	3					
Total	53			6,535	3,122	3,413
						Net Increase 290
						Less Added Cost 0
						Less Increase in Overhead Expense 30
						Net Benefit 260



Approximate Area 53,584 Acres
 Scale in Miles
 1/2 0 1

LEGEND

- Watershed Boundary
- Dirt Road
- Paved Road
- Trail
- Rail Road
- County Line
- Drainage
- Transmission Line
- Levee
- Detention Structure
- Drop Inlet, Including Fill
- Floodwater Diversion
- Floodway
- Drainage Area
- Outline of Flood and Sediment Drainage Areas
- Drainage Area Boundary - Special Structure

PRELIMINARY WORK PLAN
 For Runoff and Waterflow Retardation
 and Soil Erosion Prevention
GRAY'S CREEK WATERSHED
 Sub-watershed No. 34 of the Trinity River
 TEXAS
 U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
 H. H. BENNETT - CHIEF
 REGION 4 DIRECTOR - LOUIS P. MERRILL

REFERENCE
 CARTOGRAPHIC APPROVAL _____ TECHNICAL APPROVAL _____
 COMPILED _____ TRACED _____ CHECKED _____ DATE _____
 J.B.L. G.B. 8-3-51
 Revised 7-20-51 E.A.T. 3-30-51
 Revised 8-2-51