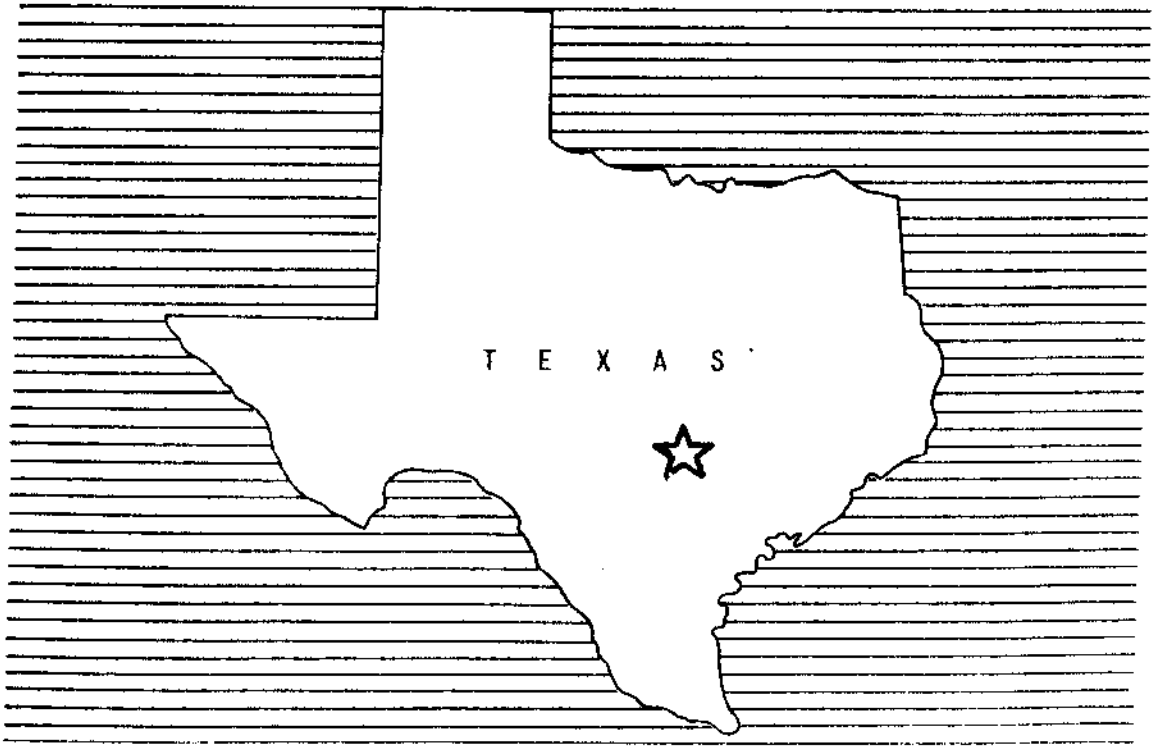
WORK PLAN

FOR WATERSHED PROTECTION, FLODD PREVENTION
AND FISH AND WILDLIFE OEVELOPMENT

LOWER PLUM CREEK WATERSHED

HAYS AND CALDWELL COUNTIES, TEXAS



August 1960

WATERSHED WORK PLAN AGREEMENT

between the

Hays-Caldwell-Travis Soil Conservation District
Local Organization

Plum Creek Conservation District
Local Organization

City of Lockhart, Texas
Local Organization

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 **Lower Plum 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 **Lower Plum 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 $ 421,198 .)

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)
1	**Multiple-Purpose Structure**	**2.64**	**97.36**	**$ 154,869**
14	**Floodwater Retarding Structures**	**0**	**100**	**$ 1,160,280**
24.7	**Miles Channel Improvement**	**0**	**100**	**$ 1,313,565**

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 $ 27,816 .)

The Service will bear 83.22 percent of the cost of installation services applicable to works of improvement for fish and wildlife development and the Sponsoring Local Organization will bear 16.78 percent of the cost of such services. (Estimated cost $ 7,099 .)

The Sponsoring Local Organization will bear the cost of all installation services applicable to works of improvement for nonagricultural water management. (Estimated cost $ None .)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 8,500 .)

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.

Hays-Caldwell-Travis Soil Conservation District
Local Organization

By J. D. Stirling

Title Chairman S.C.D.

Date Jan 5. 1961

The signing of this agreement was authorized by a resolution of the governing body of the **Hays-Caldwell-Travis Soil Conservation District**
Local Organization

adopted at a meeting held on Jan 5 1961

Max Ohlendorf
(Secretary, Local Organization)

Date Jan 5 1961

Plum Creek Conservation District
Local Organization

By Albert Blackwell

Title Vice-President

Date Jan 5, 1961

The signing of this agreement was authorized by a resolution of the governing body of the **Plum Creek Conservation District**
Local Organization

adopted at a meeting held on Jan 5, 1961

W. V. Schroeder
(Secretary, Local Organization)

Date Jan 5, 1961

City of Lockhart, Texas
Local Organization

By [signature]

Title Mayor

Date 1-5-61

The signing of this agreement was authorized by a resolution of the governing body of the **City of Lockhart, Texas**
Local Organization

adopted at a meeting held on 1-5-61

Pat Kelly
(Secretary, Local Organization)

Date 1-5-61

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION,

AND FISH AND WILDLIFE DEVELOPMENT

LOWER PLUM CREEK WATERSHED
Hays and Caldwell Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

Prepared By: Hays-Caldwell-Travis Soil Conservation District
(Cosponsor)

Plum Creek Conservation District
(Cosponsor)

City of Lockhart, Texas
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
U. S. Department of Interior
Fish and Wildlife Service
Texas Game and Fish Commission

August 1960

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

SECTION 2 - Continued

List of Tables and Figures

SECTION 1

WATERSHED WORK PLAN

LOWER PLUM CREEK WATERSHED
Hays and Caldwell Counties, Texas
August 1960

GENERAL SUMMARY

The work plan for watershed protection, flood prevention, and fish and wildlife development for the Lower Plum Creek watershed, Texas was prepared by the Hays-Caldwell-Travis Soil Conservation District, Plum Creek Conservation District and the city of Lockhart, Texas as the local cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture, the United States Department of Interior and the Texas Game and Fish Commission.

During the 29-year evaluation period (1930 through 1958) there were 20 major floods which inundated more than half of the flood plain. The largest and most damaging flood was in 1936. It was estimated that the damages from this one flood were well in excess of $1,000,000. A total of 110 floods occurred in the 29 years, an average of 3.8 floods per year.

This project on Lower Plum Creek watershed together with the approved project on Plum Creek watershed will reduce flood damages in Lower Plum Creek watershed by 87.5 percent. With both projects installed, damages from 45 of the 110 evaluation period floods would have been eliminated. Approximately 89 percent of the flood plain area will flood less often than once in three years on the average and most of the major floods will be reduced to minor floods.

Benefits from reduction in sediment yield by the planned atructural measures to the Gonzales Reservoir, a Corps of Engineers' authorized project, were estimated to be $1,905 annually.

The economy of the watershed is largely agricultural. Installation of this project will tend to promote agricultural progress in the area as well as the prosperity of towns, such aa Lockhart and Luling, which are mainly dependent on agriculture. In addition, the scenic and recreational resources will be enhanced by the provision for fish and wildlife storage in Site 36 near Lockhart. The watershed protection provided by this project will provide the basis by which the natural resources of this watershed can be developed to the fullest extent.

The Plum Creek Conservation District and the city of Lockhart are legal subdivisions of the State of Texas with the powers of taxation and eminent domain. The Plum Creek Conservation District will contract for the construction of all the structural measures and be responsible for the operation and

maintenance of the 14 floodwater retarding structures and 24.7 miles of channel improvement. The city of Lockhart will be responsible for the operation and maintenance of multiple-purpose Site 36. The Plum Creek Conservation District will raise its share of the project costs by a district-wide ad valorem tax and the city of Lockhart will raise its share of the costs of multiple-purpose Site 36 by a proposed city-wide bond issue. The project will be installed during a 5-year period.

The Federal share of installation of structural measures will be $3,258,349. Local cost of easements, rights-of-way, administration, and cost-sharing on Site 36 will be $434,978, of which about $224,000 is anticipated out-of-pocket cost to the local organization. The sponsors do not plan to apply for an FHA loan.

A statistical summary can be found at the beginning of Section 2.

DESCRIPTION OF WATERSHED

Physical Data

Plum Creek heads approximately 3 miles north of Kyle, Hays County, and flows east and south to its confluence with the San Marcos River about 4 miles southeast of Luling, Caldwell County, Texas. This drainage area has been divided into two watersheds to facilitate the planning application, operation, and maintenance of works of improvement. The cosponsoring organizations have requested that the two watersheds be planned simultaneously since they are component parts of the larger watershed.

This work plan, for watershed protection, flood prevention, and fish and wildlife development, comprises that portion of the Plum Creek drainage area below State Highway 20 (figure 1).

Tenneys Creek, Clear Fork, and West Fork are the major tributaries of Lower Plum Creek. The area of the watershed is 238.9 square miles (152,900 acres).

The topography ranges from nearly level along the alluvial valley to gently rolling in the upland areas. Elevations range from 700 feet to 320 feet above mean sea level. The flood plain of Lower Plum Creek is well defined and consists of 16,239 acres not including 998 acres of stream channels. The flood plain, as considered in the plan, is the bottomland area inundated by the runoff from the 25-year frequency storm based on gage records.

The northern 10 percent of the watershed is in the Blackland Prairie Land Resource Area and is underlain by limestone, shales, marls and clays of the Upper Cretaceous system. The remaining portion of the watershed lies within the East Texas Timberlands Land Resource Area and is underlain by sandstones, sand, sandy shales, and clays of the Eocene system. An area of Leona gravel, a terrace remnant of Pleistocene age, occurs within the bottomland area. Trinity, Crockett, Wilson, Tabor, Edge and Sawyer are the major soil series found in the watershed.

The overall land use (Table 4) for the watershed is as follows:

Land Use	Acres	Percent
Cropland	58,102	38.0
Pastureland	23,394	15.3
Rangeland	38,465	25.2
Woodland	29,663	19.4
Miscellaneous 1/	3,276	2.1
Total	152,900	100.0

1/ Includes road, highway, railroad rights-of-way, urban areas, etc.

LEGEND

Plum Creek Watershed

Lower Plum Creek Watershed

Gonzales Reservoir - To be constructed

———— Flood Pool (Elev. 343.0 Feet)

- - - - - - Flood Pool-10 Year Frequency (Elev. 327.0 Feet)

Figure 1

LOCATION MAP

LOWER PLUM CREEK WATERSHED

Hayes & Caldwell Counties, Texas

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

0 1 2 MILES

Approximate Area 152,900 Acres

Apr. 12-60

4-R-1476

Rev. 11-60 Base 4-R-1277

Land use in the flood plain is as follows: 36 percent in cultivation; 53 percent in pasture; 9 percent in woods; and 2 percent in miscellaneous uses.

The Mixed Blackland is the only range site found in the watershed. Soils of the Wilson and Crockett series are associated with this range site. Slopes range from 2 to 5 percent. The climax vegetation consisted of little bluestem, Indian grass, and switch grass. The present cover condition is fair to good.

The mean annual rainfall is 33.00 inches as weighted from three gages in or near the watershed. The monthly averages range from 1.92 inches in August to 3.89 inches in May. Average temperatures range from 84.7 degrees Fahrenheit in the summer to 51.4 degrees in the winter. The normal frost-free period of 268 days extends from March 3 to November 26.

Water for livestock and rural domestic use is obtained from surface ponds and wells.

Economic Data

The region was settled by English-speaking colonists in the 1840's. Battles with the Comanche Indians were frequent in the area and the Lockhart State Park memorializes the battle of Plum Creek that on August 12, 1840 signaled the end of the last big Comanche raid.

The Lower Plum Creek watershed is primarily a farming and livestock raising area located in South Central Texas. Oil production has been important since 1922 as a source of additional income in the watershed. Cotton, corn, watermelons, and grain sorghum are the main crops grown. Beef cattle production, dairying, and poultry raising are important in the watershed. According to the 1954 Census of Agriculture, the average size farm in Caldwell County is approximately 252 acres with an average value for land and buildings of $20,315.

The towns located wholly or partially within the watershed and their estimated population are: Lockhart, 7,000; Luling, 5,300; Dale, 275; Maxwell, 250; and McMahan, 150. Lockhart, the county seat of Caldwell County, and Luling, located near the mouth of Plum Creek, are the principal marketing centers serving the watershed. Austin, San Marcos, and San Antonio are within easy driving distance of the watershed. These cities provide the needed marketing, educational, cultural, recreational, and medical facilities for the inhabitants of the area.

The watershed is adequately served by 295 miles of roads, 113 of which are paved (U. S. Highways 183 and 90; State Highways 142, 20, and 21; Farm to Market Roads 86, 713, 1854, 964, and 672). Adequate rail facilities are provided by the Missouri, Kansas, and Texas; and Texas and New Orleans Railroads.

WATERSHED PROBLEMS

Floodwater Damage

The bottom land of Lower Plum Creek and its tributaries have long suffered from periodic flooding causing loss of life on several occasions and extensive damage to property as well as disruption of normal community activities.

The largest and most damaging flood was in 1936 and another serious flood occurred in 1913. Each of these floods caused damages amounting to more than $1,000,000 in terms of dollar value at time of occurrence. In addition to causing untold misery and hardship, these floods have prevented farmers from fully utilizing the highly productive bottomland in the Plum Creek watershed. Instead of corn, cotton, and grain sorghum, many farmers have been forced to put flood plain land into less valuable alternate uses such as pasture and meadow.

During the 29-year period (1930 - 1958) 20 major floods inundated more than half of the flood plain in Lower Plum Creek watershed (figure 4). An additional 90 minor floods inundated less than half of the flood plain. Nine of the major floods and 52 of the minor floods occurred during the growing season, causing heavy damage to growing crops. Less damaging floods occur during the winter months. The adverse economic and physical effect of these floods has been felt throughout the entire watershed community and has prompted local participation in the alleviation of the flood problem. For the floods experienced during the period studied, the total direct agricultural and nonagricultural floodwater damages under present conditions were estimated to average $210,298 annually at long-term price levels (table 7), of which $167,299 is crop and pasture damage, $26,367 is other agricultural damage, and $16,632 is nonagricultural damage such as damage to roads, bridges, railroads, urban, and oil wells. Indirect damages such as interruption of travel, re-routing of school bus and mail routes, losses sustained by businessmen in the area, and similar losses are estimated to average $14,068 annually.

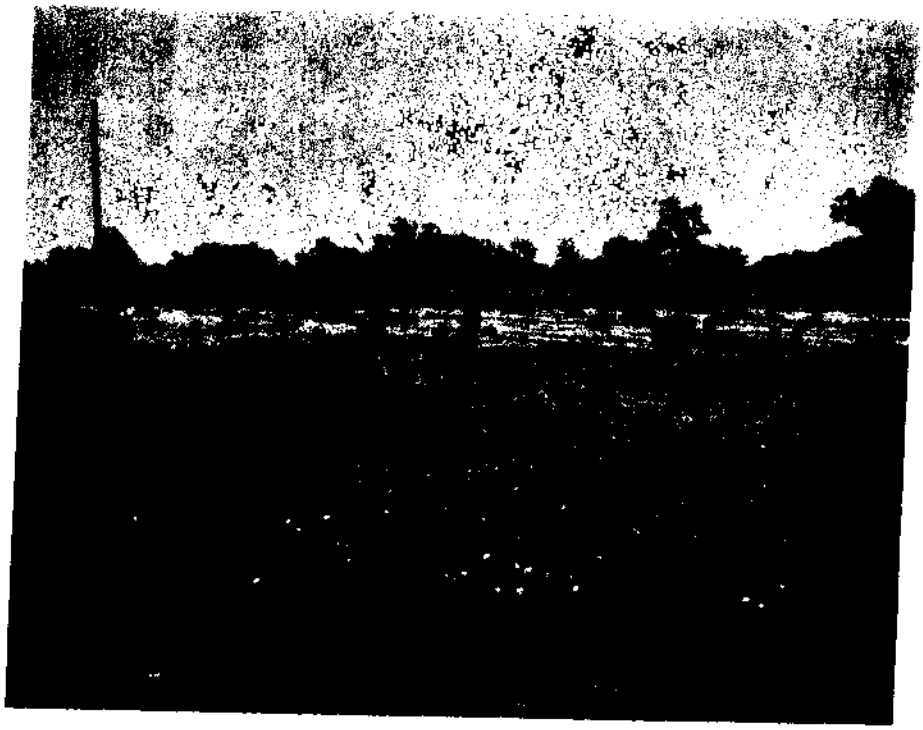
Sediment Damage

Damage by overbank deposition is moderate to severe in the watershed. Erosion in the upland areas has resulted in deposition of fine textured silty clays and clays, and fine and coarse textured sands, sandy silts, silty sands and sandy clays on flood plain land. This damaging sediment is low in organic matter, crusts and puddles readily, and is generally low in productivity. The productive capacity has been reduced from 10 to 50 percent on an estimated 8,983 acres of flood plain by this process. The areas affected by overbank deposition are as follows:

Flood damage to fences in Lower Plum Creek Watershed

Flood damage to growing crops in the watershed - April 1960 storm.

Flooding along Lower Plum Creek during floods that occurred in 1957



Floods of 1959 - Sediment deposition represents a sizeable damage.

Evaluation Reach (Figure 4)	Acres Damaged: Percent 10	20	30	40	50	Total
A	74	261	212	185	0	732
B	807	1,332	853	161	0	3,153
C	182	1,012	619	0	0	1,813
F	0	280	317	235	208	1,040
G	242	175	30	0	0	447
H	0	310	532	111	0	953
Peach Creek	0	139	236	46	0	421
Luling Branch	0	93	104	80	69	346
Upper Clear Fork	78	0	0	0	0	78
Total	1,383	3,602	2,903	818	277	8,983

The estimated average annual monetary damage by overbank deposition is $32,627 (table 7) at long-term price levels.

Erosion Damage

Erosion rates in the upland areas are low to moderately severe. Sheet erosion is the major process in the upland areas, accounting for 93 percent of the annual gross erosion. Gully and streambank erosion account for 7 percent. The average annual rate of upland gross erosion is 2.58 acre-feet per square mile. Flood plain erosion is moderate in the watershed. It is estimated that 1,298 acres are being damaged annually by this process. The productive capacity of this area has been reduced from 10 to 90 percent by scour. Flood plain erosion damage by evaluation reach is as follows:

Evaluation Reach (Figure 4)	Acres Damaged: Percent 10	20	30	40	50	60	90	Total
A	0	49	64	0	0	0	0	113
B	0	0	0	109	0	21	27	157
C	0	120	60	126	0	0	0	306
F	68	51	48	0	0	0	0	167
G	10	9	24	66	82	0	0	191
H	139	43	0	0	0	0	0	182
Peach Creek	18	57	0	0	0	0	0	75
Luling Branch	25	19	29	0	0	0	0	73
Upper Clear Fork	34	0	0	0	0	0	0	34
Total	294	348	225	301	82	21	27	1,298

The estimated average annual monetary damage by flood plain scour is $5,207 (table 7) at long-term prices.

Problems Relating to Water Management

There is little or no activity relative to drainage, irrigation, or other agricultural water management in the watershed. Studies relative to ground water recharge in the Leona formation indicated that recharge is not economically feasible at this time.

Even though adequate additional storage capacity is available at several floodwater retarding structure sites for municipal water storage, an engineering survey made by the city of Lockhart showed it to be more economical to secure additional water from new wells drilled near the existing city wells.

The following is a summary of a study made by the Fish and Wildlife Service, USDI, and concurred in by the Texas Game and Fish Commission, which points up the need for fish and wildlife resources in the watershed.

> "Stream fisheries are lacking in the project area. There are several hundred small privately-owned farm ponds in the watershed; however, fishery resources are inadequate to meet present and future needs since there is no public access for fishing on these areas. People unable to obtain permission to use the private ponds must travel outside the watershed to fish. Sportsmans expenditures associated with fishing are insignificant".

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The Lower Plum Creek watershed is served by the Soil Conservation Service work units at Lockhart and San Marcos, which assist the Hays-Caldwell-Travis Soil Conservation District. These work units have assisted farmers in preparing 382 basic and progressive soil and water conservation plans on 73,637 acres, representing 48.2 percent of the agricultural land within the watershed, and have given technical guidance in establishing and maintaining planned measures.

The overall plan for development for the Guadalupe-Blanco River Basins, as developed by the Guadalupe-Blanco River Authority, proposes a conservation storage reservoir on Plum Creek, a Corps of Engineers Reservoir on the San Marcos River near Gonzales, and a Bureau of Reclamation reservoir on the Guadalupe River near Hochheim.

The Corps of Engineers is authorized by the Flood Control Act of 1954 to construct the Gonzales Reservoir on the San Marcos River approximately 12 miles below its confluence with Plum Creek. The conservation and flood pools of this reservoir will inundate the lower portion of the Plum Creek flood plain (figure 1). This work plan was developed considering the Gonzales Reservoir to be in place. This project will have no known detrimental effect

on these downstream projects. It will complement the projects by providing needed protection to flood plain lands on Plum Creek which would not be provided by the Gonzales or Hochheim Reservoirs, and reduce delivery of sediment from this watershed to the downstream reservoirs.

A work plan for watershed protection and flood prevention on Plum Creek watershed (figure 1) was approved by Congress in August 1960. The works of improvement proposed in that work plan will have a measurable beneficial effect on the flood problems of Lower Plum Creek watershed. The works of improvement in Lower Plum Creek watershed were planned considering the proposed structural measures in Plum Creek watershed in place.

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 Hays-Caldwell-Travis Soil Conservation District, is necessary for a sound watershed protection and flood prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on accelerating the establishment of land treatment practices which have a measurable effect on the reduction of floodwater, sediment, and erosion damages.

Approximately 59,635 acres of the total watershed area of 152,900 acres lie above the planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. Land treatment constitutes the only planned measures on the remaining upland area. Land treatment measures on the 15,396 acres of flood plain lands not within the pools of proposed structures are also important in reducing floodwater and erosion damages.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in Table 1. The estimated total cost of planning and installing these measures is $778,940, including $45,550 of Public Law 566 funds for the acceleration of technical assistance during the 3-year installation period to help owners and operators to plan and speed up the application of conservation practices.

Land treatment measures will decrease erosion damage and sediment production from fields and pastures by providing improved soil-cover conditions. These measures include conservation cropping systems, cover cropping, use of rotation hay and pasture, crop residue use for cropland, and pasture planting to establish good cover on grassland and formerly cultivated lands. They also include brush control to allow grass to improve and replace the poor brush cover; construction of farm ponds to provide adequate watering places to prevent cover-destroying seasonal concentrations of livestock and obtain

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/
Lower Plum Creek Watershed, Texas
Price Base: 1959

Installation Cost Item	Unit	Number to be Applied	Estimated Cost: Public Law 566 Funds (dollars)	Estimated Cost: Other Funds (dollars)	Total (dollars)
ND TREATMENT FOR					
atershed Protection					
Soil Conservation Service					
Cropland					
Contour Farming	Acre	5,580	-	13,950	13,950
Conservation Cropping System	Acre	11,250	-	0	0
Cover Cropping	Acre	9,278	-	51,029	51,029
Crop Residue Use	Acre	23,331	-	52,495	52,495
Rotation Hay and Pasture	Acre	4,435	-	26,610	26,610
Diversion Construction	Mile	12	-	3,360	3,360
Terracing	Mile	465	-	88,350	88,350
Grassed Waterways	Acre	444	-	17,760	17,760
Pastureland					
Brush Control	Acre	7,910	-	94,920	94,920
Pasture Planting	Acre	3,720	-	46,500	46,500
Pasture Improvement	Acre	13,283	-	0	0
Rotation Grazing	Acre	19,460	-	0	0
Pond Construction	Each	320	-	160,000	160,000
Rangeland					
Brush Control	Acre	10,048	-	120,576	120,576
Deferred Grazing	Acre	4,680	-	4,680	4,680
Proper Range Use	Acre	30,221	-	0	0
Range Seeding	Acre	3,802	-	19,010	19,010
Technical Assistance			45,550	34,150	79,700
Subtotal			45,550	733,390	778,940
AL LAND TREATMENT			45,550	733,390	778,940
UCTURAL MEASURES					
oil Conservation Service					
Multiple-Purpose					
Floodwater Retarding Structures	No.	1	150,780	4,089	154,869
Channel Improvement	No.	14	1,160,280	-	1,160,280
Subtotal	Mile	24.7	1,313,565	-	1,313,565
Subtotal - Construction			2,624,625	4,089	2,628,714
allation Services			2,624,625	4,089	2,628,714
oil Conservation Service					
Engineering Service			393,570	1,191	394,761
Other			240,154	-	240,154
Subtotal			633,724	1,191	634,915
ubtotal - Installation Services			633,724	1,191	634,915
r Costs					
and, Easements & R/W			-	421,198	421,198
dministration of Contracts			-	8,500	8,500
ubtotal - Other			-	429,698	429,698
L STRUCTURAL MEASURES			3,258,349	434,978	3,693,327
L PROJECT			3,303,899	1,168,368	4,472,267
ARY					
ubtotal SCS			3,303,899	1,168,368	4,472,267
L PROJECT					

proper use and rotation grazing of pasture and rangeland to provide improvement, protection, and maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

In addition to the soil improvement and cover measures, land treatment includes contour farming, terracing, and diversion construction and the grassed waterways necessary to serve these measures, all of which have a measurable effect in reducing peak discharge by slowing the runoff of water from watershed lands. These measures also contribute to the reduction of erosion damage and sediment production.

Structural Measures

A system of 14 floodwater retarding structures, 1 multiple-purpose structure and 24.7 miles of channel improvement will be installed to provide needed protection for flood plain land that cannot be attained by the land treatment measures described above. Additional storage of 1,627 acre-feet will be included in multiple-purpose Site 36 for fish and wildlife development.

This system of structures will temporarily detain runoff from 39.0 percent of the entire watershed. The 14 floodwater retarding structures and 1 multiple-purpose structure will have floodwater detention capacity to detain an average of 5.50 inches of runoff from the watershed area above them. This is the equivalent of 2.14 inches of runoff from the entire 152,900-acre watershed.

Figure 2 shows a section of a typical floodwater retarding structure. The location of the structural measures is shown on the Project Map, Figure 3.

The total estimated cost of installing the structural works of improvement is $3,693,327. The estimated annual equivalent cost of installation, $128,374, with an estimated annual operation and maintenance cost of $12,699 makes a total annual cost of $141,073. This does not include $1,846, the annual equivalent of the incremental cost of fish and wildlife development.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar type of spillway. All applicable State water laws will be complied with in the design and construction of the planned structural measures.

BENEFITS FROM WORKS OF IMPROVEMENT

The following tables are a summary of the damage reductions expected with the proposed works of improvement:

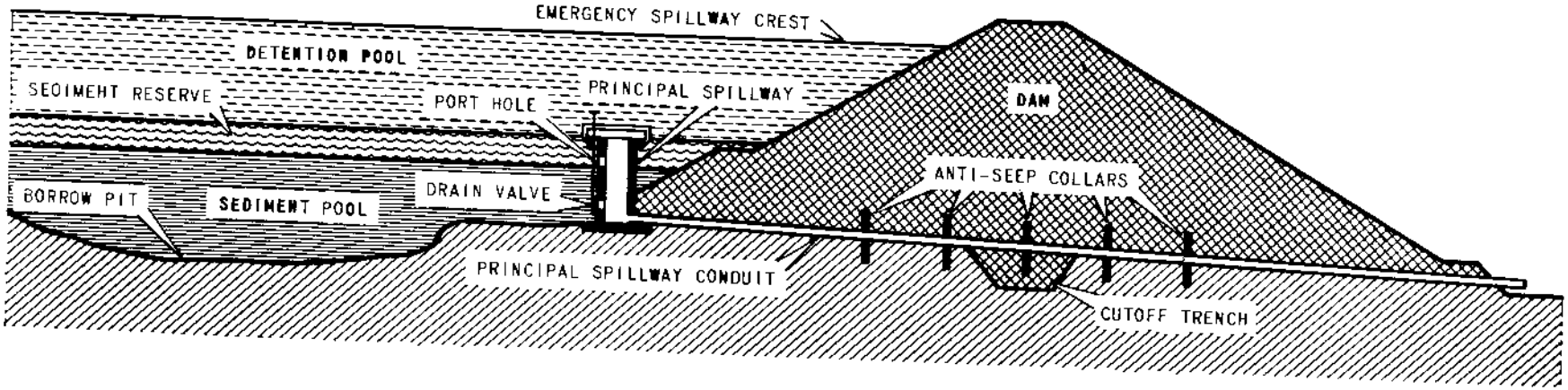


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-31-60 4-L-10, DT1

	Without Project	With Project
Area flooded by 3-year frequency storm (acres)	12,027	3,804
Reduction (percent)	-	68.4
Area flooded by 25-year frequency storm (acres)	16,239	12,606
Reduction (percent)	-	22.4
Average annual damage (dollars)	262,200	32,728
Reduction (percent)	-	87.5
Flood events in evaluation series (number)	110	65
Major flood events in evaluation series (number)	20	2

AVERAGE ANNUAL AREA FLOODED

valuation Reach Figure 4)	Present (acres)	With Land Treatment and Floodwater Retarding Structures (acres)	With Land Treatment, Floodwater Retarding Structures and Channel Improvement (acres)
A	1,015	644	69
B	4,750	3,692	278
C	5,142	2,504	1,823
F	1,262	491	491
G	965	574	574
H	1,869	908	120
ubtotal	15,003	8,813	3,355
eduction (percent)		41.3	77.6
uling Branch 1/	482	456	456
each Creek 1/	700	675	675
pper Clear Fork 1/	289	274	274
TOTAL	16,474	10,218	4,760
otal Reduction (percent) -		38.0	71.1

/ No planned structural measures, land treatment only.

FLOOD DAMAGE REDUCTION 1/

Evaluation Reach (Figure 4)	By Land Treatment and Floodwater Retarding Structures	By Land Treatment, Floodwater Retarding Structures and Channel Improvement
	(percent)	(percent)
A	47.4	87.4
B	45.9	90.4
C	67.7	80.2
F	65.1	65.1
G	60.8	60.8
H	64.4	91.6
Subtotal	58.0	83.7
Luling Branch 2/	7.1	7.1
Peach Creek 2/	7.4	7.4
Upper Clear Fork 2/	6.9	6.9
TOTAL	54.8	78.9

1/ Does not include value of restoration of productivity.
2/ No planned structural measures, land treatment only.

After protection from flooding and adapted soil improving crop rotations have been put into effect, 8,229 acres of the 8,983 acres damaged by overbank deposition and 754 acres of the 1,298 acres damaged by flood plain scour can be fully productive again, while the remaining acres damaged are not fully recoverable. A monetary reduction of 67.4 percent in sediment damage will occur after the installation of the complete project, with 13.2 percent resulting from land treatment measures and the remaining 54.2 percent from structural measures. A monetary reduction of 57.1 percent in scour damage will occur after the installation of the project, with 5.2 percent due to land treatment and the remaining 51.9 percent attributed to structural measures (table 5). The installation of the planned land treatment program can be expected to reduce the total annual upland gross erosion in the watershed from 572 acre-feet to 469 acre-feet, a reduction of 18 percent.

The estimated average annual floodwater, sediment, erosion, and indirect damages (table 7) within the watershed, including an allowance for restoration of former productivity, will be reduced from $262,200 to $32,728, a reduction of 87.5 percent. Approximately 94.5 percent, $215,907, of the expected reduction in the average annual damage will result from the system of floodwater retarding structures and channel improvement in this watershed and the structural measures in Plum Creek watershed. Of this expected reduction in damages $48,503 were allocated to structural measures to be constructed in Plum Creek watershed (table 7). In addition, the installation of the complete project will reduce the amount of sediment delivered to the authorized Gonzales Reservoir from this watershed by an average of

39 acre-feet annually. The average annual monetary benefit from this reduction is $1,905 at long-term prices.

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore some land now in pasture or meadow to production of cotton, corn, and grain sorghum. All of this land was in cultivation at one time, but is now chiefly used for hay or pasture because of the frequency of flooding. None of the benefits claimed come from an increase in the acreage of allotment crops in the watershed; however, it is expected that about 933 acres of cotton will be shifted from the upland to the more productive flood plain soils as a result of protection. The upland cotton will be replaced by better adapted upland crops. It is estimated that net income from such restoration of land to former productivity will amount to $107,450 (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.

A smaller acreage, now largely in woods, will be cleared and used for improved pasture and crops. The average annual benefit from this change in land use, after deduction of associated costs and discounting for time needed for development, is estimated to be $10,114.

The total flood prevention benefits as a result of structural measures within Lower Plum Creek watershed are estimated to average $180,423 annually.

COMPARISON OF BENEFITS AND COSTS

The ratio of average annual benefits from planned structural measures for flood prevention ($180,423) to the average annual equivalent cost ($141,073) is 1.3 to 1 (table 8). It was assumed that the benefit from fish and wildlife purposes would equal the average annual equivalent cost of the purpose ($1,846).

The project will increase the level of economic activity in the watershed and in neighboring communities by providing greater purchasing power, improved economic stability and an increased flow of agricultural products for processing, transportation and consumption. This community benefit is not included in the economic justification of the project. In addition, there are other unevaluated benefits, such as a greater sense of security, diminished hazards to life, improved fish and wildlife habitat, and improved recreational opportunities that will follow installation of the proposed measures.

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.

Land Treatment Measures

The land treatment measures, itemized in table 1, will be established by farmers and ranchers during the 5-year installation period in cooperation with the Hays-Caldwell-Travis Soil Conservation District which is giving assistance in the planning and application of the conservation measures in the watershed.

The governing body of the Hays-Caldwell-Travis Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program under way, with the Plum Creek Conservation District assisting 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 and ranches. District-owned equipment will be made available to the landowners and operators in accordance with existing arrangements for equipment usage in the district. The Guadalupe-Blanco River Authority will continue to make its equipment available for the installation of land treatment measures.

The soil conservation district governing body will make, or cause to be made, periodic inspections of the completed conservation measures within the watershed. The Soil Conservation Service will assign additional technicians and aids to the Hays-Caldwell-Travis Soil Conservation District to assist landowners and operators cooperating with the district in accelerating the preparation and application of soil, 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 committees will cooperate with the governing bodies of the soil conservation districts 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 in the educational phase of the program by conducting general information and local farm meetings, preparing press, radio, and television releases, and using other methods of getting information to landowners and operators in the Lower Plum Creek watershed. This activity will help to get both the land treatment practices and the structural measures for flood prevention carried out.

Structural Measures for Flood Prevention and Fish and Wildlife Development

The Plum Creek Conservation District has the right of eminent domain, under applicable State law and will obtain the necessary land, easements, and rights-of-way including utility, road and improvement changes; will provide necessary legal, administrative, and clerical personnel, facilities, supplies,

and equipment to advertise, award, and administer contracts; and will determine the legal adequacy of easements, permits, etc., for the construction of 14 floodwater retarding structures and 24.7 miles of channel improvement included in the plan. Funds for the local share of the above project costs including land, easements, rights-of-way, and administration of contracts is being raised through a district-wide ad valorem tax.

Funds for the local share of the project costs in multiple-purpose Site 36 including land, easements, rights-of-way, and the local share of costs allocated to fish and wildlife development, will be raised through a proposed city-wide bond issue by the city of Lockhart. The Plum Creek Conservation District will advertise, award, and administer the contract.

The city of Lockhart proposed investing approximately $75,000 for the local share of fish and wildlife development in this site. They will provide an additional $25,000 for the development of roads to assure public access, recreational areas, sanitation facilities, and other items not a part of this project which are considered necessary for full enjoyment of the facility by the general public.

All of the proposed structural works of improvement are considered to be one construction unit.

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	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Sites 26,28,29,31, and Land Treatment	446,386	200,839	647,225
2nd	Sites 23, 24, 25, 34, & Land Treatment	363,989	222,004	585,993
3rd	Sites 27, 32, 33, 37, & Land Treatment	386,576	204,918	591,494
4th	Site 30, Mainstem Plum Creek Channel Improvement and Land Treatment	1,496,560	258,723	1,755,283
5th	Sites 35, 36, Tenneys Creek Channel Improvement and Land Treatment	610,388	281,884	892,272
TOTAL		3,303,899	1,168,368	4,472,267

This schedule will be adjusted from year to year on the basis of any significant changes found to be mutually desired, and in the light of appropriations and accomplishments actually made. Channel improvement on the mainstem of Lower Plum Creek must be installed prior to or concurrently with Sites 9, 14, and 19 in Plum Creek watershed.

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 installed or is in the process of being installed.

2. All land, easements, and rights-of-way have been secured or a written statement is furnished by the Plum Creek Conservation District or the city of Lockhart that its right of eminent domain will be used, if needed, to secure any remaining easements within the project installation period and that sufficient funds are available for paying for those easements, permits, and rights-of-way.

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

4. The contracting agency is prepared to discharge its responsibilities.

5. Water rights for fish and wildlife storage in multiple-purpose Site 36 have been obtained.

6. Local requirements for fish and wildlife development facilities have been met.

7. Project and operation and maintenance agreements have been executed.

8. Public Law 566 funds are available.

'echnical assistance will be provided by the Soil Conservation Service to ssist in the design, preparation of plans and specifications, supervision f construction, preparation of contract payment estimates, final inspecion, execution of certificate of completion and related tasks necessary o establish the planned structural measures for flood prevention and fish nd wildlife development.

he various features of cooperation between the cooperating parties have een covered in appropriate memoranda of understanding and working agreeents.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

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

Structural Measures for Flood Prevention and Fish and Wildlife Development

The estimated annual operation and maintenance cost is $12,699 (table 6) based on long-term price levels. The Plum Creek Conservation District will be responsible for operation and maintenance of 14 floodwater retarding structures and 24.7 miles of channel improvement. The city of Lockhart will be responsible for operation and maintenance of multiple-purpose Site 36. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. The Plum Creek Conservation District and the city of Lockhart will establish a permanent reserve fund for this purpose in the following manner and amounts: As floodwater retarding structures and channel improvement are completed, $200 per year per structure and $200 per mile of channel improvement will be placed in a reserve fund for operation and maintenance until the sum of $25,000, for both Plum Creek and Lower Plum Creek watersheds, is established. The permanent reserve fund will be maintained at this level by replacing used funds at the rate of $200 per structure and $200 per mile of channel per year.

The floodwater retarding structures and the channel improvement will be inspected by the Plum Creek Conservation District and Site 36 by the city of Lockhart after each heavy streamflow or at least annually. A Soil Conservation Service representative will participate in these inspections at least annually. For the floodwater retarding and multiple-purpose structures items of inspections will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as a part of the structure. For the improved channel items of inspection will include, but will not be limited to, the need for removal or control of woody vegetation, removal of sediment bars, control of meander, and corrective measures to prevent gully erosion or head cutting in side drains.

The Soil Conservation Service, through the Hays-Caldwell-Travis Soil Conservation District, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

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

Follow-up technical assistance for the operation and maintenance of the fish and wildlife facilities included in Site 36 will be provided by the Texas State Game and Fish Commission.

The soil conservation district, the Plum Creek Conaervation District, and the city of Lockhart fully understand their obligations for operation and maintenance and will execute specific operation and maintenance agreements prior to the issuance of invitation to bid on construction of the structural measures.

COST-SHARING

Public Law 566 funds are expected to provide technical assistance in the amount of $45,550 during the 5-year inatallation period to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. These Public Law 566 funds will be in addition to $34,150 of Public Law 46 funds under going program criteria. Local interests will install these measures at an estimated cost of $699,240 which includes ACPS payments based on present program criteria (table 1).

The installation cost of the 14 floodwater retarding structures and 24.7 miles of channel improvement, $3,424,823 will be shared $3,063,616 (conatruction, $2,473,845, and installation services, $589,771) by Public Law 566 funds and $361,207 (easements, $234,537, changes in utilities, roads, and improvements, $108,670, legal fees, $10,000, and administration of contracts, $8,000) by other than Public Law 566 funds.

The installation cost of the multiple-purpose structure, $268,504, will be shared $194,733 (construction, $150,780 and installation aervices, $43,953) by Public Law 566 funds and $73,771 (construction, $4,089, installation services, $1,191, water rights and legal fees, $1,300, easements, $62,851, changes in utilities, roads and improvements, $3,840 and administration of contracts, $500) by other than Public Law 566 funds.

The estimated out-of-pocket cost to the local sponsors for installation of structural measures is $224,000.

Access roads, parking areas, and boating facilities for the harvesting or enjoyment of fish and wildlife resources will be provided by the city of Lockhart and will be in addition to the project cost described herein.

The total cost of structural measures, $3,693,327 will be shared 88.2 percent, $3,258,349 by Public Law 566 funds and 11.8 percent, $434,978, by other than Public Law 566 funds.

The total project cost of $4,472,267 will be shared 73.9 percent, $3,303,899 Public Law 566 funds and 26.1 percent, $1,168,368 by other than Public

Law 566 funds. In addition, the cost of operation and maintenance ($12,699 annually) will be borne by local interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the watershed protection, flood prevention and fish and wildlife development project on the Lower Plum Creek watershed will make a definite contribution to the objectives of the overall Guadalupe-Blanco River Authority development program.

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

SECTION 2

STATISTICAL SUMMARY, INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

STATISTICAL SUMMARY

The Watershed

Drainage Area	238.9 square miles or 152,900 acres
Total Flood Plain	16,239 acres
Area Benefited	13,520 acres
Owners of land benefited from structural measures: (number)	350
Range in benefited acreage owned	5 to 400 acres
Estimated current market price of land in benefited area: (per acre)	$75 to $150
Estimated current market price of agricultural upland in watershed: (per acre)	$50 to $125

Land Use Changes

Land Use	Flood Plain (Acres)		Upland (Acres)	
	Without Project	With Project	Without Project	With Project
Cropland	5,897	10,695	52,205	50,750
Pastureland	8,508	3,792	14,886	16,720
Rangeland	0	0	38,465	38,465
Woodland - Grazed	1,499	748	28,164	27,378
Miscellaneous (Urban, roads, railroads, sediment pools, etc.)	335	1,004	2,941	3,348

Structural Measures

Floodwater Retarding Structures		14
Floodwater detention capacity	23,222 acre-feet	
Sediment storage capacity	3,914 acre-feet	
Multiple Purpose Structures		1
Floodwater detention capacity	4,107 acre-feet	
Sediment storage capacity	853 acre-feet	
Fish and wildlife storage capacity	1,627 acre-feet	
Channel Improvement (miles)		24.7
Watershed control by structures (percent)		39.0

Cost of Project

Measures	Public Law 566 Funds	Other Funds	Total
	(dollars)	(dollars)	(dollars)
Land Treatment	45,550	733,390	778,940
Structural	3,258,349	434,978	3,693,327
Total	3,303,899	1,168,368	4,472,267

Damages and Benefits

Present average annual flood damages $262,200
- Crop and pasture $167,299
- Other agricultural . . . . . $ 26,367
- Nonagricultural . . . . . $ 16,632
- Sediment and Erosion . . . . . $ 37,834
- Indirect . . . . . $ 14,068

Reduction in average annual damage by project (percent) . . . 87.5

Total average annual benefits expected from structural measures in Lower Plum Creek Watershed $180,423

Total average annual cost of structural measures $141,073
- Annual equivalent cost of project installation . $128,374
- Annual cost of operation and maintenance . . . $ 12,699

Benefit-cost ratio: 1.3:1

INVESTIGATIONS AND ANALYSES

Project Formulation

Project Objectives

Watershed problems were discussed with the cosponsoring local organizations and the following project objectives reached:

1. Determine the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to watershed protection, flood prevention and sediment control.

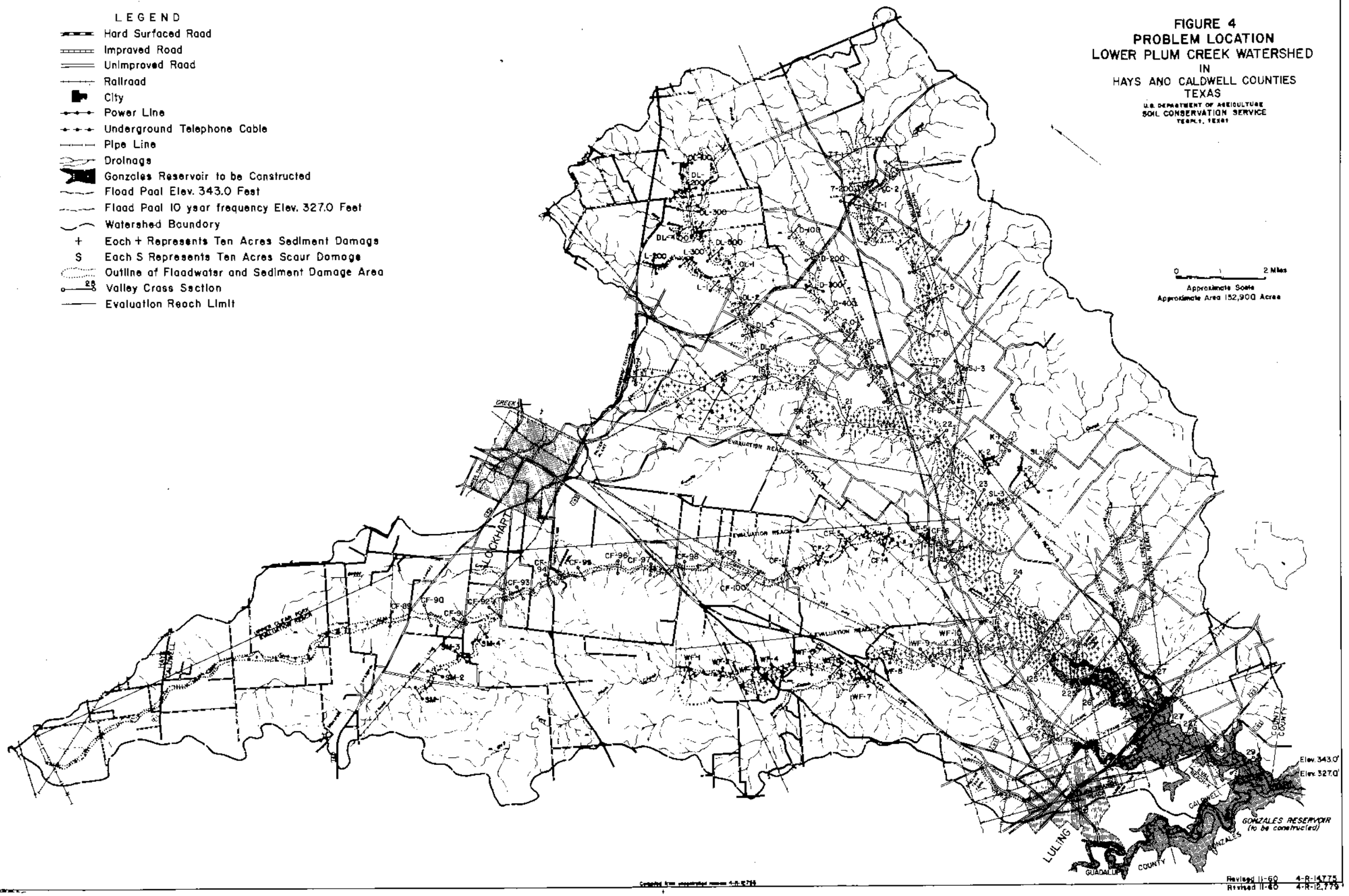
2. Obtain a uniformly distributed reduction of 70 to 80 percent in average annual flood damage, exclusive of benefits from restoration of productivity, to the

LEGEND

- Hard Surfaced Road
- Improved Road
- Unimproved Road
- Railroad
- City
- Power Line
- Underground Telephone Cable
- Pipe Line
- Drainage
- Gonzales Reservoir to be Constructed
- Flood Pool Elev. 343.0 Feet
- Flood Pool 10 year frequency Elev. 327.0 Feet
- Watershed Boundary
- \+ Each + Represents Ten Acres Sediment Damage
- S Each S Represents Ten Acres Scour Damage
- Outline of Floodwater and Sediment Damage Area
- 28 Valley Cross Section
- Evaluation Reach Limit

FIGURE 4
PROBLEM LOCATION
LOWER PLUM CREEK WATERSHED
IN
HAYS AND CALDWELL COUNTIES
TEXAS

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



Compiled from cooperative reports 4-R-12,778

Revised 11-60 4-R-14,775
Revised 11-60 4-R-12,779

flood plain lands, considering the works of improvement planned on Plum Creek watershed to be in place. If waterflow control measures are required, as much of the control as possible will be obtained by use of floodwater retarding structures. Channel improvement will be planned only if necessary to attain the desired level of protection.

3. Provide additional storage for fish and wildlife development in at least one structure.

4. Investigate the possibilities for ground water recharge in the Leona gravel formation.

5. Inform the city of Lockhart of structure sites in which additional storage can be provided for supplemental municipal water supply.

6. Inform the Plum Creek Conservation District of structure sites in which additional storage can be provided for irrigation.

Land Treatment Measures

The status of land treatment measures for the watershed was developed by supervisors of the Hays-Caldwell-Travis Soil Conservation District with assistance from personnel of the Soil Conservation Service Work Units at Lockhart and San Marcos. The measures needed and those already applied were tabulated for each farm or group of farms on which conservation plans were available. This information was expanded to represent the watershed. Amounts of land treatment practices already applied, soil conditions, trends in farming operations, grassland cover conditions, and other pertinent data were used in estimating future land treatment needs. Estimates were made of practices that will be applied during the 5-year installation period for the entire watershed. The cost of applying the land treatment measures was based on current costs and going program criteria (table 1).

Structural Measures

The procedures used to determine the most feasible plan of structural measures to meet the objectives of the sponsoring local organizations that could not be accomplished by land treatment measures were as follows:

1. A base map of the watershed was prepared showing watershed boundary, drainage pattern, systems of roads and railroads, utility lines, and other pertinent information.

2. Using a copy of the base map, a current ownership map of all farms in the watershed was prepared by the Plum Creek Conservation District.

3. Photographic study supplemented by field examination indicated the limits of flood plain subject to flood damage.

4. Map and photo studies and field investigations indicated the watershed should be one evaluation unit since all structural measures will be related.

5. By means of a stereoscopic photo study and field examination, all possible floodwater retarding structure sites were located. Sites which did not have sufficient storage capacities were dropped from further consideration.

6. Twenty-three sites which appeared to have sufficient storage capacity were recommended to the local sponsoring organizations for further consideration and detail survey. A list of landowners whose farms probably would be effected by the floodwater retarding structures was prepared for each site and submitted to the local sponsoring organizations to facilitate their study of these structures.

7. After agreement was reached with the local sponsoring organizations on location of floodwater retarding structure sites for further consideration and detail survey, topographic maps with 4-foot contour intervals and a scale of 8 inches equal 1 mile were prepared for each site. Topographic maps with 2-foot contour interval and a scale of 1 inch equals 100 feet were prepared for each emergency spillway. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, an estimate of all installation costs, and the most economical design of each structure. Criteria outlined in Soil Conservation Service, Washington Engineering Memorandum 27, and Texas State Manual Supplement 2441 were used to determine the sediment and floodwater detention storage requirements, structure classification, principal and emergency spillway design. Sites which did not have sufficient storage capacities, or which would cause relocation or alteration of expensive improvements were dropped from further consideration. Sites 35 and 36 were considered key locations which would be needed to meet the objectives for reduction of floodwater damages. Sites 34 and 35 were placed in series because they represented the most economical systems which could be installed.

8. Data obtained in land treatment needs studies for the watershed, as well as hydraulic, hydrologic, geologic, sedimentation, and economic investigations provided the necessary means for evaluating various combinations and locations of floodwater retarding structures. As a result of this analysis it was determined that 15 floodwater retarding structures would be the most economical system to install and would provide the level of protection desired by the cosponsoring organizations except in Reaches A, B, C, F, G, and H. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 5 and 5A.

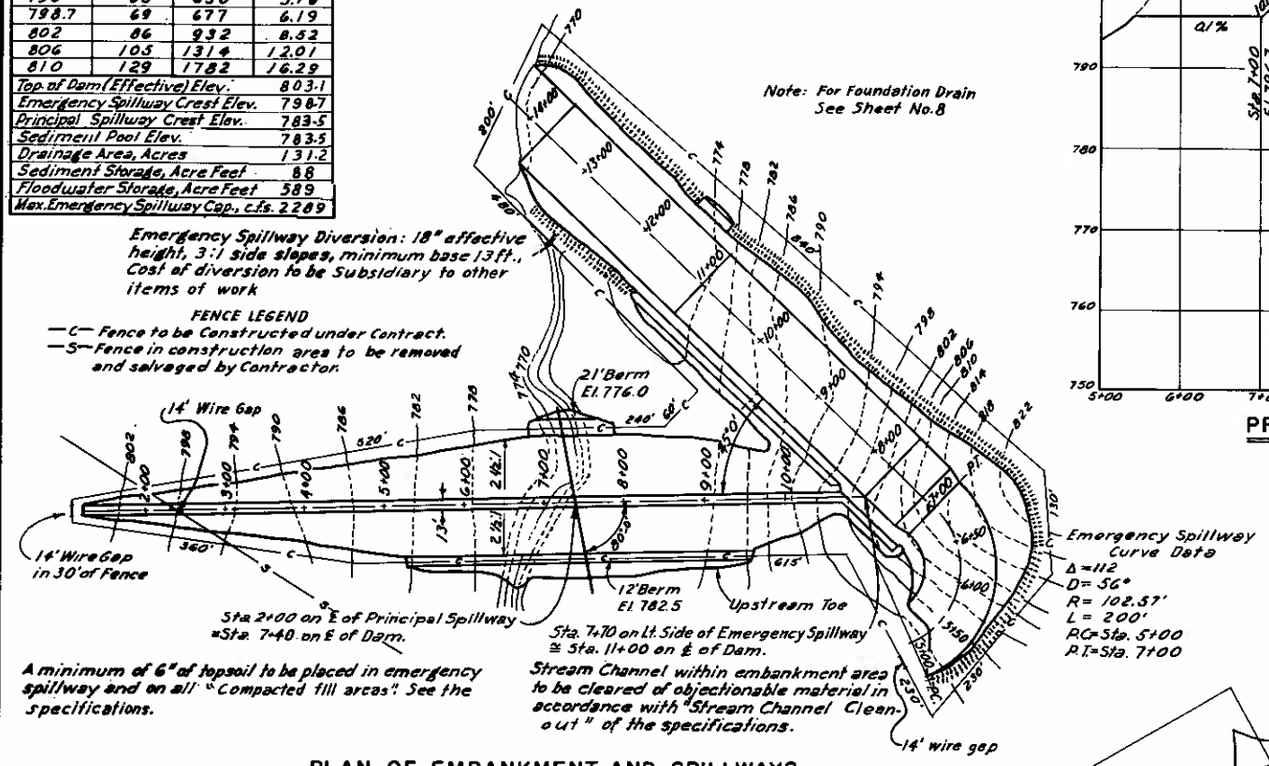
Elevation	Surface Acres	Storage	
		Acre Feet	Inches
774	1	2	.02
778	7	18	.16
782	12	56	.51
783.5	15	76	.69
786	21	122	1.12
790	34	232	2.12
794	50	400	3.66
798	65	630	5.76
798.7	69	677	6.19
802	86	932	8.52
806	105	1314	12.01
810	129	1782	16.29

Top of Dam (Effective) Elev.	803.1
Emergency Spillway Crest Elev.	798.7
Principal Spillway Crest Elev.	783.5
Sediment Pool Elev.	783.5
Drainage Area, Acres	131.2
Sediment Storage, Acre Feet	88
Floodwater Storage, Acre Feet	589
Max. Emergency Spillway Cap., c.f.s.	2289

Note: For Foundation Drain See Sheet No.8

Emergency Spillway Diversion: 18" effective height, 3:1 side slopes, minimum base 13 ft., Cost of diversion to be Subsidiary to other items of work

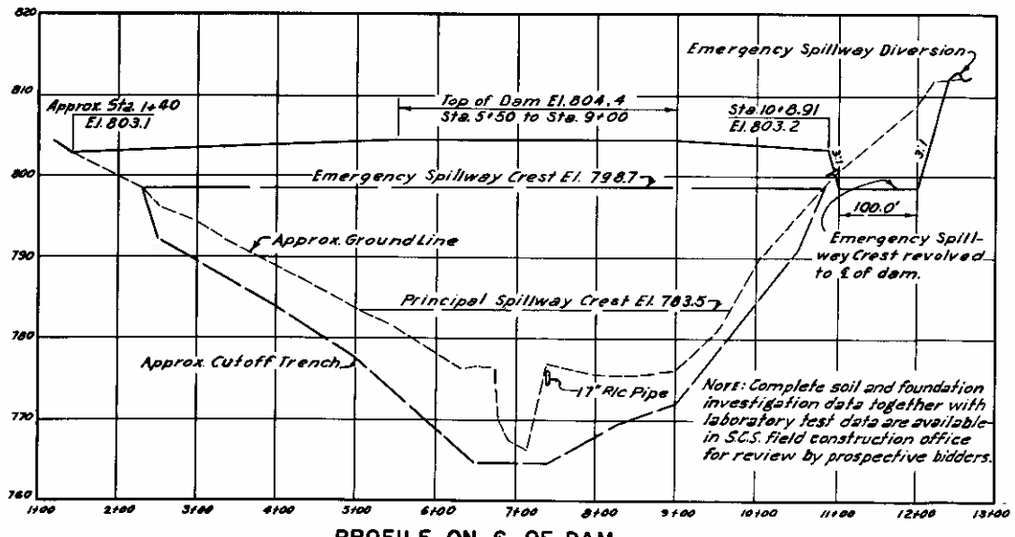
FENCE LEGEND
—C— Fence to be Constructed under Contract.
—S— Fence in construction area to be removed and salvaged by Contractor.



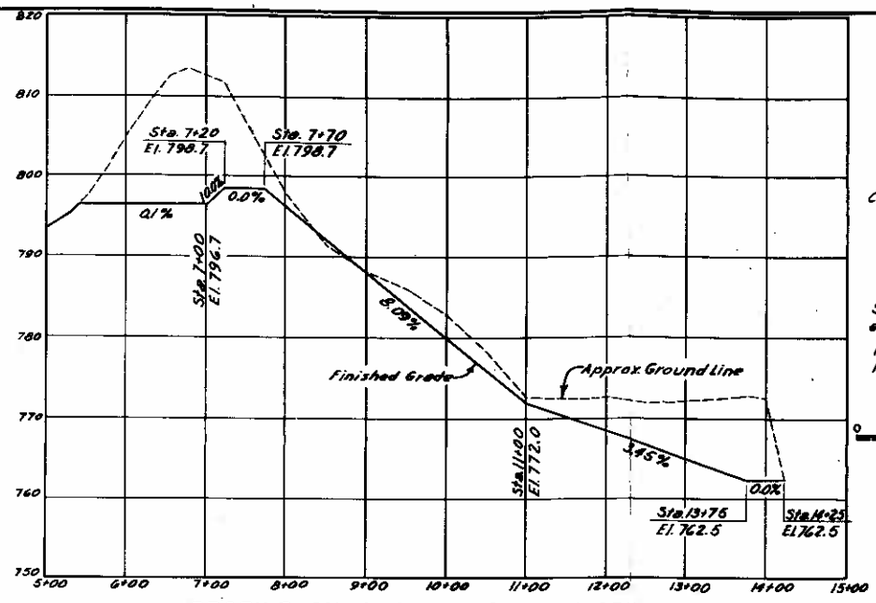
A minimum of 6" of topsoil to be placed in emergency spillway and on all "Compacted fill areas". See the specifications.

PLAN OF EMBANKMENT AND SPILLWAYS

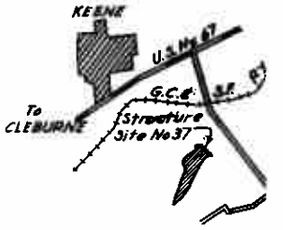
0 100 200 300 400 500
SCALE IN FEET



PROFILE ON ℄ OF DAM



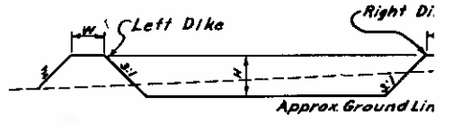
PROFILE ON ℄ OF EMERGENCY SPILLWAY



Structure located 1.5 miles east of Keene, Johnson County, Texas. For Ownership see General Plan Reservoir.

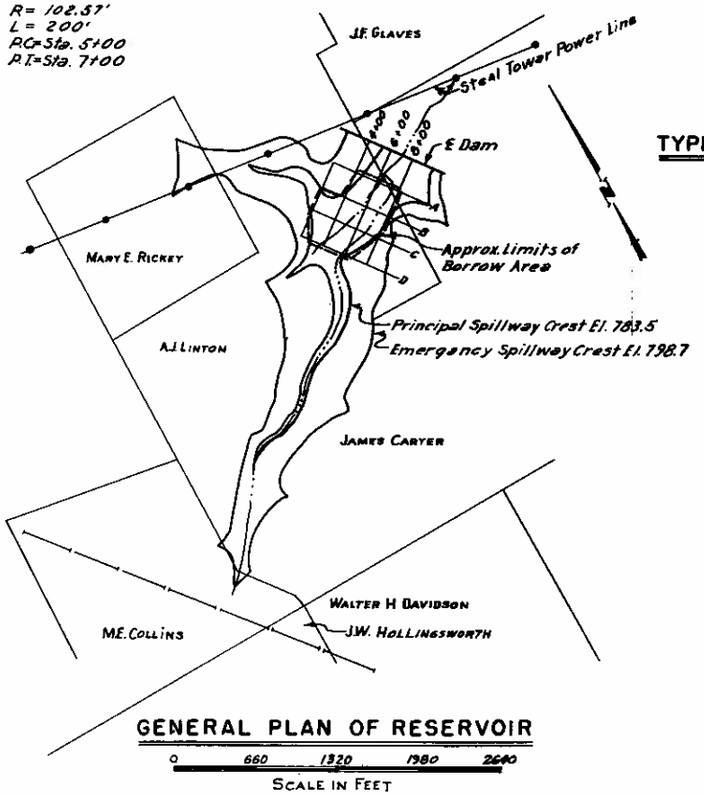
VICINITY MAP

0 1 2 3
SCALE IN MILES



Right Dike: Sta. 11+25 to Sta. 11+75, H = 3.0'
Left Dike; Sta. 7+08 to Embankment Top El. 803.2, W=3; Z=2.5:1. From Embankment to Sta. 11+50, W=10.0' Z=3:1 and H=3.0' above grade.

TYPICAL SECTION - EMERGENCY SPILLW



GENERAL PLAN OF RESERVOIR

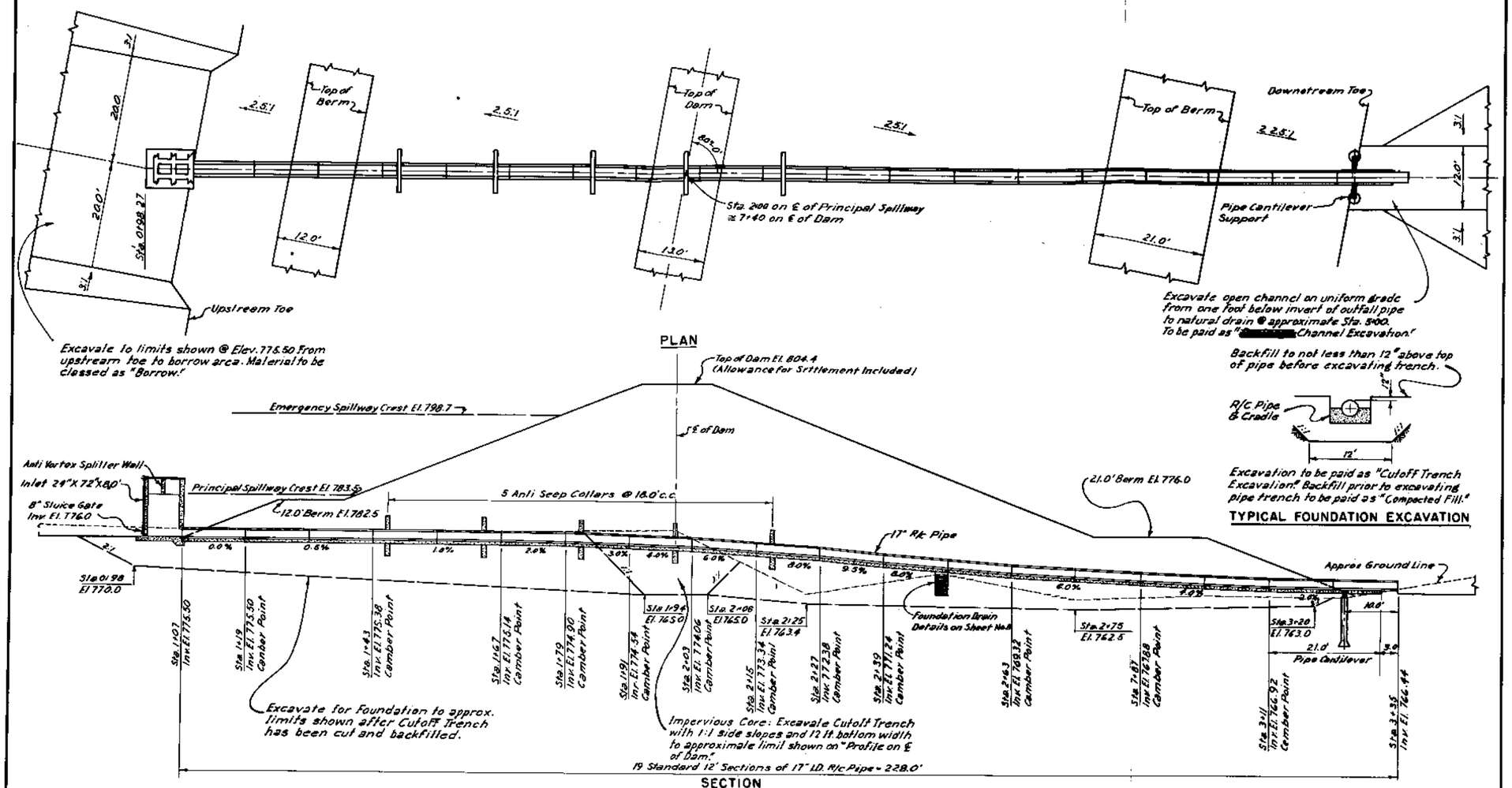
0 660 1320 1980 2640
SCALE IN FEET

Figure 5
TYPICAL
FLOODWATER RETARDING STRUCTU
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTU
SOIL CONSERVATION SERVICE

		Date
Designed	W.E.C.	3-60
Drawn	W.E.C. & F.C.S.	4-60
Traced	F.C.S.	4-60
Checked	W.E.C. & G.W.T.	4-60

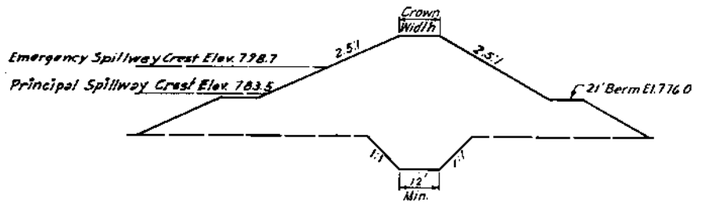
Approved by ... STATE CONSERVATIONIST
TEMPLE, TEXAS
Drawing No. 4-R-1448
Sheet No. 2 of 8 Sheets



PLAN

SECTION

PRINCIPAL SPILLWAY



TYPICAL SECTION

EMBANKMENT DATA

EMBANKMENT SECTION		REQUIRED COMPACTION DATA									
		SOURCE OF FILL MATERIAL		LAB. TEST		COMPACTION REQUIREMENTS				Lab. Curve
Sec. No.	Description	Location	Avg. Depth Fact		Modified		Min. Dry Density	Moisture Range		
			From	To	Max. Dry Den.	Opt'm Moist	Lbs. Per Cu. Ft.	Percent		No.
								From	To	
	Cutoff Trench or Center Section	Borrow Zone B	1	6	119.0	14.0	107.0	13	up	3
		Emergency Spillway	1	5	117.0	14.5	105.0	13	up	4
		Emergency Spillway	5	Grade	119.5	13.0	107.0	12	up	5
	Outside Section	Cutoff Excavation	1	6	126.0	10.5	113.0	9	up	1
		Borrow Zone A	2	11	126.0	10.5	113.0	9	up	2
Note: Material represented by Curve 2 is to be used in conjuction with Foundation Drain see sheet No. 8		See Geologic Investigations, Sheet No.1 for Borrow Zones.								

If the material being placed in the fill contains ¾ inch or larger material in amounts differing from the percentages found in the laboratory sample, the minimum dry density and moisture requirement shown above will be corrected for this variation.

TYPICAL FOUNDATION EXCAVATION

Excavation to be paid as "Cutoff Trench Excavation." Backfill prior to excavating pipe trench to be paid as "Compacted Fill."

Figure 5A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	W.E.C.	3-60
Drawn	W.E.C. & R.C.S.	4-60
Traced	R.C.S.	4-60
Checked	W.E.C. & G.W.T.	4-60

Approved by: [illegible] Area Engineer, Soil Conservation Service, Fort Worth, Texas

State Texas
Sheet No. 3 of 8
Drawing No. 4-R-14489

9. To attain the desired degree of protection, channel improvement was investigated in Reaches A, B, C, F, G, and H. It was found that the existing highway and railroad bridges had sufficient capacity to pass 1.3 inches of runoff from the uncontrolled area plus principal spillway releases from the proposed floodwater retarding structures in both this and Plum Creek watersheds. This is the runoff that will be produced by a storm of approximately 3-year frequency. Further analysis revealed that the additional benefits that would accrue from providing larger channel capacities would not justify the cost of enlarging highway and railroad bridges. It was also found that the flood damage reduction that would result from the proposed floodwater retarding structures and channel improvement sufficient to carry 1.3 inches of runoff plus principal spillway releases would afford the level of protection desired by the local people in Reaches A, B, C and H, but channel improvement could not be economically justified in Reaches F and G. The failure to meet project objectives in these two reaches was acceptable to the local people. After consideration of such measures as levees, floodwater diversions and channel enlargement it was determined that an enlarged channel would be the most economical to install. This improvement would extend from the confluence of Plum Creek and the San Marcos River a distance of 16.5 miles to a point 2200 feet upstream from valley section R-19, and from the confluence of Tenneys and Plum Creek a distance of 5.3 miles to a point 1480 feet upstream from valley section T-3 on Tenneys Creek. Hydraulic investigations also revealed that the capacity of the existing channel on the mainstem of Plum Creek from a point 2,200 feet above valley section R-19 to State Highway 20, a distance of 2.9 miles could be increased sufficiently by removing all trees, brush, and stumps. Additional cross section and profile data were obtained to supplement the available valley section data to make the channel improvement cost estimates.

10. Evaluation of these proposed works of improvement on an incremental basis indicated that the additional benefits which could be obtained would be more than enough to justify the inclusion of this 24.7 miles of channel improvement.

11. Tentative capacity-cost curves for Sites 35 and 36 were developed to determine the cost of providing additional storage for fish and wildlife development. These curves plus additional factors such as location, accessibility, and topography were considered in determining that Site 36 would be the most desirable for the inclusion of storage for fish and wildlife development. The local sponsors selected this structure for conversion from a floodwater retarding to a multiple-purpose structure.

12. A study of available USGS data, supplemented by field investigations, indicated that it would not be feasible to attempt ground water recharge of the Leona Gravel formation for the following reasons:

    (1) The elevated position of the aquifer would make recharge difficult.

    (2) The maintenance of the recharge areas would be very expensive.

    (3) The storage capacity is limited.

13. The city of Lockhart employed a private engineering firm to determine the feasibility of obtaining additional storage in Sites 23, 27, and 35 to supplement the existing municipal water supply. The results of this study indicated that it would be more economical to drill wells to obtain additional water.

14. Although a limited amount of additional storage for irrigation can be obtained in most of the floodwater retarding structure sites, there was insufficient interest to develop these sites for this purpose at this time.

15. Cost distribution (table 2) and structure data tables (table 3 and 3A) were prepared to show for each structure, the estimated cost, drainage area, capacity needed for detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, release rate of the principal spillway, acres inundated by the sediment and detention poola, volume of fill in the dam, and other pertinent data.

16. The sponsoring local organizations requested that the entire watershed be considered as one construction unit. However, if the cosponsors had desired, the following 4 construction units could have been set up with each unit having sufficient benefits accruing within its boundary to fully justify the costs: (1) Tenneys Creek, Site 28, 29, and 30; (2) West Fork, Sites 36 and 37; (3) the remaining floodwater retarding structures and channel improvement on the mainstem of Plum Creek; and (4) channel improvement on Tenneys Creek. Either Unit 1 or 2 could be installed first but both units must be in place as well as the proposed sites in the Plum Creek work plan except Sites 9, 14 and 19 before Unit 3 can be installed. Units 1, 2, and 3 must be in place before Unit 4 is installed.

Hydraulic and Hydrologic Investigations

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

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

2. Engineering surveys were made of channel and valley cross sections selected to adequately represent the stream hydraulics and flood plain area. Preliminary locations for cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground, giving due consideration to the needs of the economist and the geologist. The evaluation reaches were delineated in conference with the economist and geologist. Ten of the 34 mainstem valley cross sections were from the Corps of Engineers' survey and were modified by a new survey of the channel segment. The Corps of Engineers' data after comparing four additional typical sections with new surveys were considered to reflect present conditions adequately.

3. The present hydrologic conditions of the watershed for evaluation computations were determined by comparing the weighted rainfall with the gaged runoff from United States Geological Survey stream gage on Plum Creek near Luling. The Temple and Cameron rainfall records were used. The present hydrologic condition and runoff curve numbers for sites were determined by investigating the soil-cover condition of representative site drainage areas. These data were expanded to the entire watershed and the resulting cover complex curve number compared favorably to that obtained from the gaged runoff. The future hydrologic condition of the watershed was determined by obtaining from the work unit conservationists the changes in land use and treatment that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were 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 evaluation storm series.

4. Cross section rating curves were computed from field survey data listed in item 2, above, by solving water surface profiles for various discharges, using Doubt's Method as described on pages 3.14-7 to 3.14-13 of the NEH, Section 4, Supplement A.

5. The relationship of peak discharge and drainage area was determined to be 10,700 cubic feet per second per inch of runoff at 356 square miles of drainage area. The exponent of the concordant flow equation is 0.50.

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

7. From a tabulation of cumulative departure from normal precipitation, the period 1930 through 1958 was determined to be representative of normal precipitation on the watershed, and is the period from which the historical evaluation series was developed. The evaluation series was limited to storms which did not exceed 25-year frequency.

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

   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 and stream channel improvement.

   e. Alternative systems of structures.

9. The evaluation series contained 110 storms that would produce flooding at the smallest cross section, or an average of 3.8 floods per year. Peak discharges were converted to depth of runoff in inches by means of the runoff-peak discharge relationship. Maximum annual values of discharge and runoff were used to develop annual flood frequency lines and, from these, partial duration lines were developed as needed.

10. The largest flood in the 29-year period occurred on July 1, 1936. The gage records indicate 5.68 inches of runoff and a peak discharge of 78,500 cubic feet per second. The annual flood frequency line, developed by means of peak discharges from 29 years of gage records, indicates a frequency of once in 83 years for this storm. The following table indicates the flows at which flood damages begin in the various evaluation reachea. The reference section is valley cross section 29, which is near the mouth of Plum Creek:

Evaluation Reach (Figure 4)	Capacity of Smallest Section in Reach (c.f.s.)	Discharge at Reference Section (29) when Capacity of Minimum Section is Reached (c.f.s.)
A	1,330	1,364
B	44	319
C	25	242
F	265	836
G	100	737
H	132	506

11. The minimum floodwater detention volume in the structures as determined in accordance with Washington Engineering Memorandum 27 using Yarnell's 6-hour 25 and 50-year frequency rainfall amounts, revised to conform to Technical Paper No. 25, is 3.78 and 4.51 inches respectively. In accordance with Texas State Manual Supplement 2441 the recommended detention storage volume for this watershed varies from 5.15 inches for Class A structures to 7.10 inches for Class B structures depending on size of drainage area. The recommended detention storage volume for Class A and Class B structures less the volume which will be released through the principal spillway during a 2-day period was used as the minimum detention storage volume for all floodwater retarding structures. Detention volumes in excess of those recommended in accordance with Texas State Manual Supplement 2441 were used in a number of sites to obtain a more economical or desirable emergency spillway or structure design. Percent chance of use of emergency spillways based on regional analysis of gaged runoff from similar watersheds, was determined by adding to the actual detention storage the volume which would be released by the principal spillways during a 2-day period.

12. Average principal spillway release rates range from 5 to 8 c.s.m. with 6.4 c.s.m. being the average for the watershed. The higher rates were used in some structures to decrease the period of time valuable cultivated land would be inundated or to provide less frequent use of emergency spillways.

13. The appropriate emergency spillway and freeboard design storms were selected from Figures 3.21-1 and 3.21-4 of NEH Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum 27, and Texas State Manual, Supplement 2441.

14. Spillway hydrographs were developed for each site in the watershed. The principal spillway hydrographs represented a flood

event that will not be exceeded, on the average, more often than once in 25 years for Class A structures or 50 years for Class B structures. For Class A structures the emergency spillway and freeboard hydrographs were computed using moisture condition II with 0.5 and 1.23 respectively, of the adjusted point rainfall for the 6-hour storm. Emergency spillway hydrographs and freeboard hydrographs for Class B structures were developed in the same manner except that .75 and 1.73 of the adjusted point rainfall, respectively, were used. Since routing of the emergency spillway hydrographs resulted in either no flow or very shallow flow through emergency spillways, the dimensions of the emergency spillways were determined from the freeboard hydrographs. Hydrographs were developed for each of the floodwater retarding structures by the distribution graph method. The combination of emergency spillway width and depth, and the elevation of top of dam for the most economical structure was estimated by an empirical equation. The final design was made by the flood routing method described on page 5.8-12 of the NEH, Section 5.

15. The improved channels were designed to carry approximately 1.3 inches of runoff from the uncontrolled area plus principal spillway releases from the floodwater retarding structures. The design slope was obtained through the average of the cross section elevations at which floodwater damage starts. This grade line was then used as the hydraulic gradient of the designed channel. A roughness coefficient of .040 was used in all segments of the improved channels.

Sedimentation Investigations

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

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 15 planned structures according to the following procedures:

1. Detailed investigations were made in the drainage areas of 6 of the planned structures. Estimates of sediment rates were made for the remaining 9 sites based on similarity of these drainage areas to areas which had been surveyed in detail.

2. Field surveys included: mapping soil units by slope in percent; slope length in feet; present land use; present land treatment on cultivated land; present cover condition

classes on pasture and woodland; land capability classes; lengths, widths, and depths, of all gullies; lengths, widths, and depths of all stream channels affected by erosion; and the estimated annual lateral erosion of gullies and stream channels in feet.

3. Office computations included summarizing erosion by sources (sheet, gully, and streambank erosion) in order to fit these data into formulas for computation of annual gross erosion in acre-feet.

   The following formula was used for computing sheet erosion:

   E = A x F x SF x CF x RF, where
   E = Sheet erosion in acre-feet per year
   A = Area in Acres
   F = Basic erosion rate of soil unit in feet per year
   SF = Slope factor, based on percent and length of slope
   CF = Cover factor, based on present cover and land treatment
   RF = Rainfall factor based on maximum two-year 30-minute rainfall intensity

   The following formula was used for computing gully and streambank erosion:

   E = N x L x P x H x W ÷ 43,560, where
   E = Erosion in acre-feet per year
   N = Number of banks affected
   L = Length of gully or streambank in feet
   P = Percent of gully or streambank affected by erosion
   H = Average height of bank in feet
   W = Estimated annual lateral erosion in feet.

4. Field surveys to determine the estimated sediment rates for the remaining 9 structures under present conditions consisted of mapping the land use and arranging the sites to be estimated into homogeneous groups.

5. Office computations to determine the estimated sediment rates for the 9 structures not investigated in detail under present conditions consisted of preparation of aediment source summary sheets based on the homogeneous grouping of the sites and the detailed investigations.

6. The sediment rates were then adjusted to reflect the effect of expected land treatment on the drainage areas of the planned structures. The computed sediment storage requirement for each site is based on a gradual improvement of watershed conditions as a result of the installation of needed land treatment measures expected to be installed during the first

10 years and maintaining these measures at 75 percent effectiveness during the next 40 years.

7. The ratio of sediment storage volume in the pools to soil in place was estimated to be 1.4 for all structures in the Blackland Prairies Land Resource Area, and 1.3 for all structures in the East Texas Timberlands Land Resource Area.

8. The allocation of sediment to the structure pools was based on 15 percent deposition in the detention pool and 85 percent in the sediment pool in the Blackland Prairies Land Resource Area, and 20 percent deposition in the detention pool and 80 percent in the sediment pool in the East Texas Timberlands Land Resource Area. Sediment in multiple-purpose structure Site 36 was allocated 80 percent in the sediment and fish and wildlife development pool and 20 percent in the detention pool.

A summation of the annual sediment yields above the 15 planned structures was found to be 97.48 acre-feet. The average annual rate of sediment delivered to the structures is 1.01 acre-feet per square mile of watershed area. The detailed sediment source studies in the upland areas were used as a basis for determining the annual gross erosion that would result from sheet erosion and from gully and streambank erosion. A realistic estimate of the needed land treatment measures that will be applied during the installation period was used in determining the reduction of sediment production from the upland areas.

The benefits obtained by reduction of the 39 acre-feet of sediment deposited annually in the authorized Gonzales Reservoir were determined in the following manner:

Annual gross erosion from all sources was computed for present conditions. A delivery rate was estimated and used to determine the volume of sediment delivered to the Gonzales site under present conditions.

Reduction of the volume of sediment delivered under future conditions was based on (1) the effect of land treatment measures in reducing annual gross erosion rates and (2) the extent of areal control provided by the floodwater retarding structures in the watershed.

Due consideration was given to the entire watershed area above the authorized Gonzales Reservoir and to this watershed individually in order to arrive at the total annual sediment contribution to the site for both present and future conditions.

Channel Stability Investigations:

Random soil borings were made along the route of the proposed improved channel in the watershed to determine the nature of the soil and bed load material. The bed load material consists primarily of fine and medium sand

and has an average depth of one to two feet. Underlying this non-cohesive material are cohesive silty and sandy clays. Based on permissible velocities, as shown in "Design of Stable Channels, By Emory Lane ASCE Proceedings, 1955", it is expected that the design velocities will result in removal of the non-cohesive bed load material. The underlying cohesive material is expected to withstand the design velocities.

Flood Plain Sedimentation and Scour

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

1. Borings with a power soil sampler and hand auger were made along each of the valley cross sections (figure 4) making note of the depth and texture of the deposit, soil condition, scour channels, sheet scour areas, stream channel degradation or aggradation, and other pertinent factors contributing to flood plain damage.

2. The elevation of the original flood plain before modern deposition began was estimated for each valley section.

3. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators.

4. A damage table was developed to show percent damage by texture and depth increment for deposition and percent damage by depth and width for scour.

5. The depth and width of the modern alluvial deposits and scour areas were measured and tabulated.

6. The damage areas were grouped by segments, which consisted of the area between two to five valley sections.

7. Within each of the segments the area for each depth increment of deposition and scour was computed.

8. The damage to the productive capacity of the flood plain was assessed, by percent, for each category of damage.

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

10. Using the average annual erosion rates as a basis, the average

annual sediment yields at selected valley sections along the flood plain were estimated for present conditions and with land treatment and structures installed. The results were compared to show the average reduction of overbank deposition in the watershed. The estimated reduction of scour damage due to installation of the complete project is based on reduction of depth and area inundated.

Geologic Investigations

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

Description of Problems

Pleistocene terraces and formations of the Midway and Wilcox groups of the Eocene series crop out at dam sites in the watershed. No sites are located on the Cretaceous formations.

The Midway group consists of all the strata between the Upper Cretaceous and the sands of the Wilcox group. Two formations make up the Midway, the Kincaid and the Wills Point. These formations in the Plum Creek area consist mainly of Wills Point sediments with only small, indistinct layers of the Kincaid. For the purpose of this plan only the Wills Point will be described as being significant.

The Wills Point formation consists of stratified clay layers that are diatinctly laminated. The laminations are especially wavy and uneven. Paper thin partings of silt are contained throughout the clay. Calcareous concretions are abundant throughout the formation. The soils of the Wills Point are yellowish brown sandy and silty clays, generally classified CL, ML, CH, and SC. Site 34 is located within the Midway group. No rock excavation is anticipated at this site. Because of the sandy nature of the foundation and gravel occurrences some foundation drainage may be necessary. The Wilcox group is represented in the watershed by a heterogeneous series, several hundred feet thick, of sandy, lignitiferous noncalcareous clays, stratified deltaic silts and cross-bedded river sands. Iron-bearing concretions are in evidence throughout the group. The soils of the Wilcox are generally classified as SC, CL, ML, and CH. Sites 24 through 33, 36, and 37 are located within the Wilcox outcrop. Some rock excavation in the form of soft sandstone may be encountered at some of the sites. Due to the very sandy nature of the area, foundation drainage may be necessary at most of the sites.

A broad flat alluvial plain beginning just south of Kyle extends to Lockhart and then to near the confluence of Clear Fork of Plum Creek and Plum Creek. This flat plain is thought to be the ancient high terrace of the Blanco River which subsequently changed to its present course. This broad plain is some

25 miles long, averages three miles wide, and consists of approximately 3 feet of black clay over several feet of gravel, called the Leona formation of Pleistocene age. The plain forms a 90-foot high escarpment on its north and east side while its drainage is into Clear Fork of Plum Creek. Sites 23 and 35 are located near the edge of this plain.

Site 23 is located on the east side of the plain on one of the many deeply incised gullys draining directly into Plum Creek. The foundation of this site probably will be in gravel, which may necessitate foundation drainage. The abutments are also in gravel. The soils are black clays and gravelly clays generally classified GC, and CL.

Site 35 is located on the western edge of the plain, near its center, on Clear Fork of Plum Creek. The right abutment is in the Midway group (previously described) while the left abutment is in the gravel formation. Foundation drainage may be necessary at this site. The soils are black clays, silty clays and gravely clays, generally classified GC and CL. No rock excavation is anticipated at this site.

All of the formations in the watershed when stripped of vegetative cover are very susceptible to erosion. Embankments and emergency spillways will be vegetated as soon as possible after construction. Maximum permissible velocities in the exit channel of the emergency spillway of the sites will be 8 feet per second, as recommended in Soil Conservation Service Technical Paper 61.

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

Economic Investigations

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based on schedules obtained in the field covering approximately 35 percent of the flood plain of Lower Plum Creek and its tributaries. These schedules covered land use, crop distribution under present conditions, crop yields, changes made in land use because of flooding, probable restoration of production, land use changes that would be made if flooding were reduced, and historical data on flooding and flood damage. Analysis of this information formed the basis for determining damage rates for various depths and seasons of flooding. In calculating crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of the damage. The applicable rates of damages were applied, flood by flood, to the floods covering the period 1930 through 1958 and an adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year.

The flood plain land use was mapped in the field. Estimates of normal yields

were based on data obtained from the schedules supplemented by information obtained from agricultural workers in the area.

It was found that significant differences in land use, crop yield, frequency of flooding, and future land use changes existed. The flood plain was therefore divided into 7 evaluation reaches, each with its own damageable value. The evaluation reaches (figure 4) are:

Reach X - From the confluence of Plum Creek with the San Marcos River upstream to valley section 28 (below the 10-year frequency flood line of the Gonzales Reservoir).

Reach A - From valley section 28 upstream to valley section 26 (Between 10-year frequency flood line and top of the Gonzales Reservoir flood pool).

Reach B - From valley section 26 upstream to a point 2/3 of the way between valley sections 23 and 22, including Hines Branch and Copperas Creek.

Reach C - From a point 1/3 of the way between valley sections 23 and 22 upstream to State Highway 20, including Daniels and Dry-Linscome Creeks.

Reach F - West Fork of Plum Creek to its confluence with the mainstem of Plum Creek.

Reach G - Lower end of Clear Fork of Plum Creek to its confluence with the mainstem of Plum Creek.

Reach H - Tenneys Creek to its confluence with the mainstem of Plum Creek.

An investigation was also made of the Upper End of Clear Fork, Peach Creek and Luling Branch reaches to determine if damages were significant. This investigation indicated that structural works of improvement would not be feasible and that these reaches did not warrant a detailed evaluation. Damages in these reaches were estimated and included in total damages.

Floodwater, scour, and sediment damages were calculated under present conditions and under conditions that will prevail after completion of each class of measure to be installed. The difference between average annual damages at the time of initiation of each class of measure and those expected after its installation constitutes the benefits 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 effect of reduction in area inundated and reduced depth of inundation. Benefits from reduction of sediment damage, derived from each class of measure were determined on the basis of estimated reduction in rate of sediment production and in area flooded after installation of each class of measure.

Estimates of damages to other agricultural property such as fences, livestock, farm equipment and levees were obtained from analysis of flood damage schedules and correlated with size of floods. Estimates of damages to roads and bridges in the flood plain were obtained from the county judges and commissioners in Caldwell and Hays County and from the State Highway Department maintenance foreman. These estimates were supplemented by information obtained from local farmers.

Indirect damages in this watershed primarily involve additional travel time for farmers, school busses, and mail deliveries; costs for extra feed for livestock during and following floods, and the like. Upon analysis, it appeared that those damages are about 10 percent of the direct damage not including the value of restoration of productivity.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. This information, together with landowner's and operator's estimates of changes in land use and crop distribution as a result of reduction in flood extent and frequency, capability of the land and size of fields and their accessibility, was the basis for estimating benefits from restoration of productivity. Benefits from restoration of productivity are included as crop and pasture benefits. Consideration was given to increased damage after restoration of productivity and net benefits remaining after production, harvesting, and all other allied costs were deducted. All benefits from restoration of productivity were discounted to provide for a 5-year lag in accomplishment and totaled $107,450 annually at long-term price levels, ARS projection of September 1957.

Analysis of the schedules, the degree of protection and the physical capabilities of the flood plain indicated that about 672 additional acres of flood plain now in wooded pasture would be cleared and put into more productive use as open pasture or cropland after installation of the project. The average annual benefit from this source after deduction of additional damage, associated cost and added overhead, and discounting for the lag in accrual is estimated at $10,114. Neither the restoration in productivity nor this change in flood plain land use will involve an increase in the acreage of cotton in the watershed, since increases in cotton acreage in the flood plain will be compensated by decreases in the upland. Table A shows the crop distribution and yields with and without the project, and net return and net benefits from restoration of productivity and changed land use.

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 project. 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 15 structures and 24.7 miles of channel improvement were determined by individual appraisal in cooperation with representatives of the Plum Creek Conservation District. The average annual net loss in production within the sites

TABLE A - CROP DISTRIBUTION AND NET RETURNS FOR AREAS ON WHICH RESTORATION OF PRODUCTIVITY AND FLOOD PLAIN CHANGED LAND USE BENEFITS WERE CALCULATED 1/

Crop Distribution	Without Project			With Project			Difference in Net Return
	Acres	Yield	Net Return (dollars)	Acres	Yield	Net Return (dollars)	(dollars)
Cotton	407	300 lbs. lint	10,606	1,340	300 lbs. lint	34,920	24,314
Corn	407	40 bu.	9,048	1,340	40 bu.	29,788	20,740
Grain Sorghum	1,905	26 cwt.	50,997	6,258	26 cwt.	167,526	116,529
Johnson Grass Meadow	711	3.0 tons	10,971	157	3.0 tons	2,423	- 8,548
Sudan	711	4.0 aum	3,555	157	4.0 aum	785	- 2,770
Pasture	5,691	2.5 aum	24,187	1,252	2.5 aum	5,321	-18,866
Wooded Pasture	857	0.8 aum	643	185	0.8 aum	139	- 504
Miscellaneous	219	-	-	219	-	-	-
Total	2/ 10,908	-	110,007	2/ 10,908	-	240,902	130,895

Difference in Net Returns	130,895
Less Associated Costs 3/	1,338
Less Discount for Lag in Conversion	11,993
Net Benefits from Restoration of Productivity and Changed Land Use 4/	117,564

1/ Long-term prices, ARS projection of September 1957.
2/ Does not include 2,612 acres of flood plain below structures on which the flooding would not be reduced sufficiently to cause restoration or a change in land use.
3/ Includes damage to increased values from remaining flooding, increased taxes and overhead and cost of clearing or other land development.
4/ Restoration of productivity benefits discounted for a 5-year lag in accrual, changed land use benefits discounted 10 years.

was calculated and this value was compared with the amortized cost of the land required for the structures and channel improvement. The larger amount was used in the economic appraisal of the project to insure a conservative appraiaal.

In the economic analysis of this project, the authorized Gonzales Reservoir was considered in place. No benefits other than those which might accrue from reduced deposition of sediment were claimed in Reach X since it is below the 10-year frequency flood line of the reservoir. No restoration of production or changed land use benefits were claimed in Reach A because it is between the 10-year frequency flood line and the top of the Gonzales Reservoir flood pool.

Cost-Sharing Summary

Site 36 is planned as a multiple-purpose structure for flood prevention and fish and wildlife development. The cost allocation was made on an incremental basis with fish and wildlife development costs being the last increment, of which 50 percent will be paid from Public Law 566 funds.

Cost Allocation

1.	Multiple-purpose structure cost	$268,504
2.	Less alternate flood prevention cost	-216,157
3.	Cost allocated to fish and wildlife development . . .	$ 52,347

Cost Sharing

1.	Public Law 566 share of fish and wildlife development (50 percent)	$ 26,173
2.	Other than Public Law 566 ahare (50 percent)	26,174
3.	Incremental other cost 1/	-20,894
4.	Local share of construction and installation service cost	5,280

Item	P.L. 566 Funds	Other Funds	Total
1. Construction	$150,780	$4,089	$154,869
2. Installation Services	43,953	1,191	45,144
3. Other Costs 1/	-	68,491	68,491
Total	$194,733	$73,771	$268,504
Percent	72.5	27.5	100.0

1/ 167 acres additional land required for fish and wildlife purpose @ $125 per acre $20,875
67 acres decrease in flood pool @ $63 per acre -4,221
Relocation of improvements 1,000
Water rights 400
Land surveys 1,500
Fencing (Three miles) 1,340
Total $20,894

Determination of Annual Benefits Outside Watershed Resulting from Project

Data from the Corps of Engineers Report on the survey of the Guadalupe and San Antonio Rivers and Tributaries were analyzed. The authorized Gonzales Reservoir was considered in place. Benefits from reduction in sediment yield from the Lower Plum Creek watershed to the Gonzales Reservoir by the planned structures were calculated and apportioned to them according to their sediment storage capacity.

Details of Methodology

Details of the procedure used in the investigations are described in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, December 1958.

Fish and Wildlife Investigations

The Fish and Wildlife Service, USDI, made a detailed study of the fish and wildlife aspects of Site 36 in Lower Plum Creek watershed. The following is a summary of a Fish and Wildlife Service report dated June 30, 1960 and concurred in by the Texas Game and Fish Commission:

> "Modification of Site 36 to include conservation storage for fish and wildlife will create a high quality fishery, easily manageable to maintain optimum fish populations. The reservoir will contain shallow spawning and forage areas and will have clear water, highly productive for such game fish species as largemouth bass, bluegill, white croppie, and channel catfish.
>
> "Site 36 will be located within a 50-mile radius of about one million people. Reservoir fishing within 75 miles of Site 36 will be provided by Canyon, Buchanan, Granite Shoals, Marble Falls, Inks, Travis, and Austin Reservoirs. By 2010 the population in the area is expected to exceed 2 million people. Because of the excellent fishing conditions anticipated in Site 36 Reservoir, heavy fishing pressure will be exerted by local people, as well as by people living within a 50-mile radius of the reservoir. Fisherman expenditures associated with the reservoir are expected to be approximately $30,000 annually.
>
> "Despite the opportunities present for development of waterfowl and wildlife habitat, it is felt that, due to the small area involved with the project, safety regulations will make it necessary to prohibit hunting on the area.
>
> "Since the project area will not be open for upland game or waterfowl hunting, the reservoir will be intensively managed in order to maintain a high quality fishery. The tentative fishery management plan agreed upon between the sponsoring organizations and the Texas Game and Fish Commission included the following proposals:

1. Site 36 reservoir will be initially stocked with hatchery reared largemouth bass, channel catfish, and an appropriate species of sunfish.

2. Subsequent to the initial fish planting, restocking will be done only after investigations made by the Texas Game and Fish Commission have determined that such action is necessary.

3. Upon request of the city of Lockhart, the Texas Game and Fish Commission will determine fish populations, and take whatever action is necessary to maintain a balanced sport fish population.

4. A cooperative aquatic-plant control program between the city of Lockhart and Texas Game and Fish Commission will be conducted throughout the life of the project.

5. Fish populations in the stream, and in those ponds draining into the reservoir should be determined, and if undesirable species are present, the ponds and stream will be chemically treated prior to impoundment to eradicate the undesirable fish populations from all farm ponds within the contributing drainage area of the reservoir to minimize reintroduction of unwanted species. This would, of necessity, have to be done with the permission of the landowners. The Texas Game and Fish Commission will assist in the removal of fish and restock the private ponds.

6. The city of Lockhart will be receptive to future advances in fishery management and apply them, if needed, only upon the advice of the Texas Game and Fish Commission.

7. Public access will be assured by at least two roads or rights-of-way, one on each side of the lake, from public roads to lands acquired through purchase or perpetual easement by the city of Lockhart for the project. Adequate parking facilities will be provided.

8. Additional developments, not a part of the project, will be made by local organizations as funds and resources become available. Such developments may include land acquisition, additional roads, camping, picnicking, boat-launching, sanitary, water, power, trailer parking, and other public use facilities.

"The high degree of interest in fish and wildlife conservation measures evidenced by the sponsors for the development of Site 36 should facilitate the application of measures beneficial to fish and game throughout the watershed. Fish and wildlife management practices adopted on the project site may in many cases be applicable to other floodwater retarding structures and farm ponds in the watershed.

"Increased fishing and hunting on private lands should be encouraged by educating sportsmen and landowners that greater harvests of fish and game are desirable. Improved relationships between the two groups should be sought by all participants in the watershed project.

"In future determinations of the "highest use" of lands or waters in the watershed, local sponsoring organizations should consider inclusion of fish and wildlife resources in their analysis. Floodwater retarding structures, new farm ponds, and some of the land treatment measures will tend to minimize the adverse effects of recurring droughts on fish and wildlife resources.

"Site 36 of the Lower Plum Creek Watershed project can serve as a workshop for watershed-wide fish and wildlife conservation programs for local civic groups, youth groups, landowners, sportsmen's clubs, and other interested organizations and individuals. Fish and wildlife resources can be expected to benefit by the community approach to problems which cannot be otherwise resolved.

"It is recommended:

1. That land to elevation 461.4, or 458.4 plus 300 feet horizontally, be purchased in fee title or perpetual easement to be taken on the non-fee-title land.

2. That the tentative agreement entered into between the sponsoring organizations and the Texas Game and Fish Commission to manage the reservoir to achieve maximum fish and wildlife benefits be adopted.

3. That public access roads be provided to each side of the reservoir by the city of Lockhart.

4. That all fee-title or perpetual-easement lands be open to public use for fishing except for sections reserved for safety, efficient operation, or protection of public property.

5. That wildlife food and cover plants be established around floodwater-detention reservoirs in the watershed to replace, in part, wildlife habitat lost as a result of the project.

6. That clearing specifications for reservoir sites, waterway developments, and channel straightening provide for the retention of all possible woody vegetation.

7. That floodwater-detention reservoirs be fenced to exclude livestock.

8. That, if water is required for livestock, structures be designed to provide a tank outside the enclosure to which water may be piped.

9. That in all determinations of the "highest use" of lands or water, fish and wildlife resources be given consideration."

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Lower Plum Creek Watershed, Texas
Price Base: 1959

Structure Site Number or Name	Installation Cost - Public Law 566 Funds					Installation Cost - Other Funds						Total Installation Cost
	Construction		Installation Services		Total Public Law 566	Construction		Installation Services	Adm. of Contracts	Easements and R/W	Total Other	
	Engineer's Estimate	Contingencies	Engineering	Other		Engineer's Estimate	Contingencies					
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures												
23	74,900	7,490	16,478	7,539	106,407	-	-	-	500	5,070	5,570	111,977
24	34,800	3,480	7,656	3,503	49,439	-	-	-	500	13,652	14,152	63,591
25	76,300	7,630	16,786	7,680	108,396	-	-	-	500	19,779	20,279	128,675
26	35,500	3,550	7,810	3,573	50,433	-	-	-	500	10,997	11,497	61,930
27	88,400	8,840	19,448	8,897	125,585	-	-	-	500	15,497	15,997	141,582
28	135,500	13,550	29,810	13,638	192,498	-	-	-	500	23,251	23,751	216,249
29	77,800	7,780	17,116	7,831	110,527	-	-	-	500	9,028	9,528	120,055
30	73,200	7,320	16,104	7,368	103,992	-	-	-	500	21,095	21,595	125,587
31	59,000	5,900	12,980	5,938	83,818	-	-	-	500	8,885	9,385	93,203
32	61,900	6,190	13,618	6,230	87,938	-	-	-	500	13,364	13,864	101,802
33	63,400	6,340	13,948	6,381	90,069	-	-	-	500	10,079	10,579	100,648
34	63,800	6,380	14,036	6,421	90,637	-	-	-	500	34,825	35,325	125,962
35	158,300	15,830	34,826	15,933	224,889	-	-	-	500	52,705	53,205	278,094
36	137,073	13,707	30,156	13,797	194,733	3,717	372	1,191	500	67,991	73,771	268,504
37	52,000	5,200	11,440	5,234	73,874	-	-	-	500	17,300	17,800	91,674
Subtotal	1,191,873	119,187	262,212	119,963	1,693,235	3,717	372	1,191	7,500	323,518	336,298	2,029,533
Channel Improvement Mainstem Channel	1,055,550	105,555	116,112	106,241	1,383,458	-	-	-	500	89,950	90,450	1,473,908
Tenneys Creek	138,600	13,860	15,246	13,950	181,656	-	-	-	500	7,730	8,230	189,886
Subtotal	1,194,150	119,415	131,358	120,191	1,565,114	xxx	xxx	xxx	1,000	97,680	98,680	1,663,794
GRAND TOTAL	2,386,023	238,602	393,570	240,154	3,258,349	3,717	372	1,191	8,500	421,198	434,978	3,693,327

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Lower Plum Creek Watershed, Texas

See letter 1-11-74

Item	Unit	STRUCTURE NUMBER 23	24	25	26	27	28	29	30	31
Drainage Area	Sq.Mi.	3.38	1.87	5.12	3.91	5.66	7.33	4.88	3.35	3.51
Storage Capacity										
Sediment pool (200 acres or less)	Ac.Ft.	144	110	199	167	199	199	156	54	75
Sediment reserve below riser	Ac.Ft.	-	-	47	-	42	113	-	-	-
Sediment in detention pool	Ac.Ft.	18	20	54	21	30	79	26	18	19
Floodwater	Ac.Ft.	973	564	1,406	1,178	1,600	2,892	1,405	964	1,048
Fish and Wildlife	Ac.Ft.	-	-	-	-	-	-	-	-	-
Total	Ac.Ft.	1,135	694	1,706	1,366	1,871	3,283	1,587	1,036	1,142
Surface Area										
Sediment Pool 2/	Acre	21	30	68	48	62	88	36	18	27
Floodwater Pool	Acre	79	94	229	178	244	365	160	112	158
Fish and Wildlife	Acre	-	-	-	-	-	-	-	-	-
Volume of Fill	Cu. Yd.	165,800	66,200	152,300	69,000	192,800	282,800	170,600	168,200	106,600
Elevation Top of Dam	Foot	458.4	491.8	457.9	444.9	430.7	479.4	498.0	459.0	413.9
Maximum Height of Dam	Foot	42	28	25	23	27	34	33	35	21
Emergency Spillway										
Crest elevation	Foot	453.5	488.0	453.0	440.0	426.0	474.5	493.5	454.0	410.0
Bottom width	Foot	240	140	230	140	200	500	200	120	150
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent chance of use 3/		3.39	3.17	3.64	3.08	3.45	1.52	3.33	3.39	3.14
Average Curve No. Condition II		84	81	81	81	81	77	66	66	66
Emergency Spillway Hydregraph										
Storm rainfall (6-hour) 4/	Inch	7.19	7.36	7.05	7.14	7.02	10.34	7.07	7.19	7.18
Storm runoff	Inch	5.32	5.14	4.85	4.94	4.82	7.46	3.25	3.35	3.35
Velocity of flow (Vc) 5/	Ft.Sec.	2.0	1.2	1.6	1.5	1.0	2.1	0	0	0
Discharge rate 6/	c.f.s.	692	154	443	205	165	1,554	0	0	0
Maximum water surface elevation 6/	Foot	454.9	488.9	454.2	441.1	426.8	476.0	-	-	-
Freeboard Hydrograph										
Storm rainfall (6-hour) 7/	Inch	17.62	18.02	17.26	17.49	17.19	23.79	17.32	17.62	17.59
Storm runoff	Inch	15.53	15.48	14.72	14.95	14.65	20.50	12.38	12.66	12.63
Velocfty of flow (Vc) 8/	Ft./Sec.	9.5	8.2	9.3	9.3	9.2	9.2	9.0	9.4	8.4
Discharge rate 6/	c.f.s.	6,479	2,478	5,808	3,555	4,865	12,304	4,680	3,179	2,738
Maximum water surface elevation 6/	Foot	458.4	491.8	457.9	444.9	430.7	479.4	498.0	459.0	413.9
Principal Spillway Capacity (Maximum)	c.f.s.	~~21~~ 75	~~12~~ 29	~~32~~ 63	~~25~~ 61	~~45~~ 65	~~46~~ 71	~~30~~ 71	~~21~~ 72	~~22~~ 64
Capacity Equivalents										
Sediment volume (200 acres or less)	Inch	0.80	1.10	0.73	0.80	0.66	0.51	0.60	0.30	0.40
Sediment reserve volume below riser	Inch	-	-	0.17	-	0.14	0.29	-	-	-
Sediment in detention pool	Inch	0.10	0.20	0.20	0.10	0.10	0.20	0.10	0.10	0.10
Detention volume	Inch	5.40	5.66	5.15	5.65	5.30	7.40	5.40	5.40	5.60
Fish and Wildlife volume	Inch	-	-	-	-	-	-	-	-	-
Spillway storage	Inch	2.35	4.14	4.85	5.10	4.70	5.25	3.20	3.60	4.00
Class of Structure	-	A	A	A	A	A	B	A	A	A

(Footnotes on next page)

Release Rates changed as per memo dated 4-13-67 W.M.J.

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Lower Plum Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 32	33	34	35	36	37	Total
Drainage Area	Sq.Mi.	4.55	5.15	7.65	1/ 18.20	14.53	4.09	93.18
Storage Capacity								
Sediment pool (200 acres or less)	Ac.Ft.	146	110	200	194	194	131	2,278
Sediment reserve below riser	Ac.Ft.	-	-	412	679	504	-	1,797
Sediment in detention pool	Ac.Ft.	24	27	82	97	155	22	692
Floodwater	Ac.Ft.	1,298	1,538	2,183	4,951	4,107	1,222	27,329
Fish and Wildlife	Ac.Ft.	-	-	-	-	1,627	-	1,627
Total	Ac.Ft.	1,468	1,675	2,877	5,921	6,587	1,375	33,723
Surface Area								
Sediment pool 2/	Acre	40	30	125	142	134	43	912
Floodwater pool	Acre	178	188	300	480	560	173	3,498
Fish and Wildlife	Acre	-	-	-	-	298	-	298
Volume of Fill	Cu. Yd.	136,500	138,800	137,700	344,700	266,500	107,400	2,505,900
Elevation Top of Dam	Foot	417.9	428.2	573.5	546.3	474.1	450.8	xxx
Maximum Height of Dam	Foot	31	40	36	51	40	26	xxx
Emergency Spillway								
Creat elevation	Foot	413.0	423.5	568.5	539.6	468.5	446.0	xxx
Bottom width	Foot	120	100	360	600	300	140	xxx
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent chance of use 3/	-	3.69	3.08	3.33	3.26	3.12	3.11	xxx
Average Curve No. Condition II		66	58	84	88	79	75	xxx
Emergency Spillway Hydrograph								
Storm rainfall (6-hour) 4/	Inch	7.10	7.05	6.88	6.44	6.56	7.13	xxx
Storm runoff	Inch	3.28	2.45	5.03	5.05	4.19	4.26	
Velocity of flow (Vc) 5/	Ft./Sec.	0	0	1.6	1.4	0	0.4	xxx
Discharge rate 6/	c.f.s.	0	0	717	1,040	0	34	xxx
Maximum water surface elevation 6/	Foot	-	-	569.7	540.8	-	446.6	xxx
Prseboard Hydrograph								
Storm rainfall (6-hour) 7/	Inch	17.38	17.26	16.84	15.78	16.06	17.46	xxx
Storm runoff	Inch	12.43	10.85	14.76	14.24	13.26	14.01	xxx
Velocity of flow (Vc) 8/	Ft./Sec.	9.4	9.2	9.4	10.8	10.0	9.3	xxx
Discharge rate 6/	c.f.s.	3,171	2,448	9,392	24,370	9,772	3,554	xxx
Maximum water surface elevation 6/	Foot	417.9	428.2	573.5	546.3	474.1	450.8	xxx
Principal Spillway Capacity (Maximum)	c.f.s.	~~29~~ 68	~~32~~ 76	~~48~~ 120	~~230~~ 310	~~128~~ 200	~~26~~ 65	xxx
Capacity Equivalents								
Sediment volume (200 acres or less)	Inch	0.60	0.40	0.49	0.20	0.25	0.60	xxx
Sediment reserve volume below riser	Inch	-	-	1.01	0.70	0.65	-	xxx
Sediment in detention pool	Inch	0.10	0.10	0.20	0.10	0.20	0.10	xxx
Detention volume	Inch	5.35	5.60	5.35	5.10	5.30	5.60	xxx
Fish and Wildlife volume	Inch	-	-	-	-	2.10	-	xxx
Spillway storage	Inch	4.30	3.75	4.30	4.05	4.75	4.60	xxx
Class of Structure	-	A	A	A	A	A	A	xxx

1/ Excludiog the area from which runoff is controlled by other structures.

2/ Surface area to the top of the riser.

3/ Is the percent chance that the emergenty spillway will function in any given year.

4/ For Class A structures 0.5 x P of the 6-hour rainfall shown by figure 3.21-1, NEH-4, Supplement A, and 0.75 x P for Class B structures.

5/ Where velocity is shown it waa obtained from the formula $V = \frac{Q}{A}$ and was determined from the routed Hp and Q. Critical velocity was not attained by any outflow of the emergency spillway hydrographs.

6/ Values obtained from routing.

7/ For Class A atructures 1.23 x P, Clasa B structures 1.73 x P, for 6-hour raiofall shown on figure 3.21-1, NEH, Sec. 4, Suppl. A.

8/ Obtained from curves drawn from figure 4-R-11472 revised 3.59 and ES 98 dated 4-27-55, bosed on flows obtained from graphical routing of the Freeboard Hydrograph.

Release Rate Changed as per Memo dtd 4-13-62 W.M.S.

August 1960

TABLE 3A - STRUCTURE DATA

CHANNELS

Lower Plum Creek Watershed, Texas

Channel Designation	Station Numbering for Reach: Station (100 feet)	to Station (100 feet)	Watershed Area 1/ (Sq.Mi.)	Planned Channel Capacity (c.f.s.)	Bottom Width (feet)	Side Slope	Depth (feet)	Fall (ft./ft.)	Velocity at Design Depth (ft./sec.)	Volume of Excavation (1000 cu.yds.)
Plum Creek										
	1501+80	1656+40	Clearing and snagging only							
	1656+40	1697+90	38.68	3,110	40	2:1	11.0	.0010	4.6	40
	1697+90	1749+00	50.60	3,674	43	2:1	12.0	.0009	4.6	126
	1749+00	1845+65	56.67	3,970	43	2:1	12.5	.0009	4.7	218
	1845+65	1945+85	75.59	4,768	45	2:1	13.5	.0009	4.9	266
Enter Tenneys Creek	1945+85	2050+35	79.59	4,867	50	2:1	13.5	.0008	4.7	564
	2050+35	2142+65	116.76	6,000	65	2:1	13.0	.0009	5.0	241
	2142+65	2296+55	143.69	6,840	90	2:1	12.0	.0009	5.0	765
	2296+55	2339+75	158.44	7,635	110	2:1	11.5	.0009	5.0	178
	2339+75	2375+45	161.23	7,450	110	2:1	11.5	.0008	4.9	251
	2375+45	2408+30	172.89	7,734	110	2:1	12.0	.0008	4.8	241
	2408+30	2453+75	173.38	7,984	105	2:1	12.5	.0008	4.9	112
Mouth	2453+75	2528+70	177.36	7,985	80	2:1	15.5	.0006	4.6	127
									Total	3,129
Tenneys Creek										
	1626+70	1661+25	3.87	790	18	2:1	6.0	.0022	4.4	14
	1661+25	1700+10	5.58	1,053	26	2:1	6.0	.0022	4.6	34
	1700+10	1738+50	6.48	1,167	30	2:1	6.0	.0022	4.6	41
	1738+50	1779+55	9.67	1,515	35	2:1	6.4	.0022	5.0	42
	1779+55	1822+50	10.56	1,609	40	2:1	6.2	.0022	5.0	68
Mouth	1822+50	1906+60	11.74	1,677	35	2:1	8.0	.0012	4.1	144
									Total	343
									GRAND TOTAL	3,472

1/ Uncontrolled area below floodwater retarding structures.

August 1960

TABLE 4 - SUMMARY OF PHYSICAL DATA

Lower Plum Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	238.9	xxx
Watershed Area	Acre	152,900	xxx
Area of Cropland	Acre	58,102	61,445
Area of Pastureland	Acre	23,394	20,512
Area of Rangeland	Acre	38,465	38,465
Area of Woodland	Acre	29,663	28,126
Miscellaneous Area	Acre	3,276	1/ 4,352
Overflow Area Subject to Damage	Acre	2/ 16,239	2/12,606
Area Damaged By:			
Overbank Deposition	Acre	8,983	4/ 1,168
Flood Plain Scour	Acre	3/ 1,298	4/ 402
Annual Rate of Erosion			
Sheet	Ac.Ft.	535.15	240.76
Gully	Ac.Ft.	24.35	8.85
Streambank	Ac.Ft.	12.82	12.82
Scour	Ac.Ft.	89.59	28.67
Sediment Delivered to Authorized Reservoir (Gonzales)	Ac.Ft./Yr.	64.82	25.55
Average Annual Rainfall	Inch	33.00	xxx

1/ Includes area inundated by sediment and fish and wildlife pools of the planned structures.

2/ Area inundated by the 25-year frequency storm, based on gaged runoff.

3/ Acreage on which some production loss occurs each year.

4/ The acreage on which production loss will occur each year after all recovery has taken place. Applies to all flooding up to the area inundated by the largest storm studied in the 29-year series.

August 1960

TABLE 5 - SUMMARY OF PLAN DATA
Lower Plum Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	3,303,899
Other Funds	Dollar	1,168,368
Annual O and M Cost		
Public Law 566 Funds	Dollar	-
Other Funds	Dollar	12,699
Average Annual Monetary Benefits 1/	Dollar	180,423
Agricultural	Percent	91.4
Nonagricultural	Percent	8.6
Structural Measures		
Floodwater Retarding Structures	Each	14
Multiple-Purpose Structures	Each	1
Channel Improvement	Mile	24.7
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	579
Fish and Wildlife Pool	Acre	90
Detention Pool	Acre	174
Upland		
Sediment Pool	Acre	333
Fish and Wildlife Pool	Acre	74
Detention Pool	Acre	2,248
Watershed Area Above Structures	Acre	59,635
Reduction of Floodwater Damage	Dollar	193,421
By Land Treatment Measures		
Watershed Protection	Percent	3.3
By Structural Measures	Percent	88.7
Reduction of Sediment Damage	Dollar	28,202
By Land Treatment Measures		
Watershed Protection	Percent	13.2
By Structural Measures	Percent	54.2
Reduction of Erosion Damage	Dollar	2,976
By Land Treatment Measures		
Watershed Protection	Percent	5.2
By Structural Measures	Percent	51.9
Flood Prevention Benefit from Changed Land Use	Dollar	10,114
Benefits Outside of Watershed	Dollar	1,905

1/ From structural measures.

August 1960

TABLE 6 - ANNUAL COST 1/

Lower Plum Creek Watershed, Texas

Measures	Amortization of Installation Costs 2/	Operation and Maintenance Costs 3/			Total
		Public Law 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures 23 through 35, 37, Multiple-Purpose Structure 36 in combination with channel improvement on Plum and Tenneys Creeks 4/	128,374	-	12,699	12,699	141,073
Total	128,374	-	12,699	12,699	141,073

Does not include $1,846, the annual equivalent of the incremental cost for fish and wildlife development.

Price Base: 1959 prices amortized for 50 years at 2.5 percent.

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

Interrelated measures.

August 1960

TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

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

Item	Estimated Average Annual Damage: Without Project (dollars)	Estimated Average Annual Damage: After Land Treatment for W/S Protection (dollars)	Estimated Average Annual Damage: With Project (dollars)	Average Annual Monetary Benefits (dollars)
ɔodwater Damage				
Crop and Pasture	167,299	163,722	12,386	151,336
Other Agricultural	26,367	24,277	2,693	21,584
Nonagricultural (Road, Bridge Railroad, Urban, and Oil Wells)	16,632	15,437	1,798	13,639
Subtotal	210,298	203,436	16,877	186,559
liment Damage				
Overbank Deposition	32,627	28,336	10,645	17,691
Subtotal	32,627	28,336	10,645	17,691
sion Damage				
Flood Plain Scour	5,207	4,936	2,231	2,705
Subtotal	5,207	4,936	2,231	2,705
irect Damage	14,068	12,927	2,975	9,952
al, All Damages	262,200	249,635	32,728	216,907
nged Land Use to Crop roduction	xxx	xxx	xxx	10,114
efits Outside Project Area 2/	xxx	xxx	xxx	1,905
al Flood Prevention Benefits	xxx	xxx	xxx	228,926
efits Allocated to Structural easures to be constructed in lum Creek Watershed	xxx	xxx	xxx	48,503
AL NET FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	180,423
AL NET PRIMARY BENEFITS	xxx	xxx	xxx	180,423
AL MONETARY BENEFITS	xxx	xxx	xxx	180,423

As projected by ARS, September 1957.

Reduction of sediment yield from Lower Plum Creek Watershed to the Authorized Gonzales Reservoir.

August 1960

TABLE 8 - BENEFIT COST ANALYSIS

Lower Plum Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/						Average Annual Cost 3/	Benefit-Cost Ratio
	Flood Prevention							
	Flood-water	Sediment	Erosion	Indirect	Other 2/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 23 through 35 and 37 in combination with channel improvement on mainstem Plum Creek and Tenneys Creek and Multiple-Purpose Structure 36 4/ 5/	146,864	13,787	2,108	7,755	9,909	180,423	141,073	1.3:1
GRAND TOTAL	146,864	13,787	2,108	7,755	9,909	180,423	141,073	1.3:1

1/ Price Base: Long-term prices as projected by ARS, September 1957.
2/ Changed land use benefits and benefits outside Lower Plum Creek Watershed.
3/ Derived from installation costs based on 1959 price level and operation and maintenance cost based on long-term price levels, as projected by ARS, September 1957. Does not include $1,846, the annual equivalent of the incremental cost of fish and wildlife development.
4/ Interrelated measures.
5/ Benefits shown in this line differ from those in Table 7 by the amount of each type of benefit accruing to structures in Plum Creek Watershed.

August 1960

ADDENDUM

TABLE 8 - BENEFIT COST ANALYSIS 1/

Lower Plum Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 2/ Flood Prevention						Average Annual Cost 4/	Benefit-Cost Ratio
	Floodwater	Sediment	Erosion	Indirect	Other 3/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 23 through 35 and 37 in combination with channel improvement on mainstem Plum Creek and Tenneys Creek and Multiple-Purpose Structure 36 5/ 6/	146,864	13,787	2,108	7,755	9,909	180,423	144,284	1.3:1
GRAND TOTAL	146,864	13,787	2,108	7,755	9,909	180,423	144,284	1.3:1

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

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

3/ Changed land use benefits and benefits outside Lower Plum Creek Watershed.

4/ Derived from installation costs based on 1959 price level and operation and maintenance cost based on long-term price levels, as projected by ARS, September 1957. Does not include the annual equivalent of the incremental cost of fish and wildlife development.

5/ Interrelated measures.

6/ Benefits shown in this line differ from those in Table 7 by the amount of each type of benefit accruing to structures in Plum Creek Watershed.

August 1960

TABLE 9 - ALLOCATION OF INSTALLATION COSTS OF STRUCTURAL MEASURES

Lower Plum Creek Watershed, Texas
Price Base: 1959

Item	Purpose		Total
	Flood Prevention	Fish and Wildlife	
	(dollars)	(dollars)	(dollars)
tep A			
ingle Purpose			
Sites 23 through 35 and 37	1,761,029	-	1,761,029
Channel Improvement (Mainstem of Plum Creek)	1,473,908	-	1,473,908
Channel Improvement (Tenneys Creek)	189,886	-	189,886
ultiple Purpose			
Site 36	216,157	52,347	268,504
Total	3,640,980	52,347	3,693,327
tep B			
Public Law 566	3,232,176	26,173	3,258,349
Other	408,804	26,174	434,978
Total	3,640,980	52,347	3,693,327

August 1960

LEGEND

- Hard Surfaced Road
- Improved Road
- Unimproved Road
- Railroad
- City
- Power Line
- Underground Telephone Cable
- Pipe Line
- Drainage
- Gonzales Reservoir to be Constructed
- Flood Pool Elev. 343.0 Feet
- Flood Pool 10 year frequency Elev. 327.0 Feet
- Watershed Boundary
- (25) Structure Site Number
- Drainage Area Controled by Structure
- Floodwater Retording Structure
- Area Benefited
- Channel Improvement for Flood Prevention

LEGEND

Site No.	Acres - Drainage Area
23	2,163
24	1,197
25	3277
26	2,502
27	3,622
28	4,691
29	3,123
30	2,144
31	2,246
32	2,912
33	3,296
34	4,896
35	11,648
36	9,299
37	2,617
38	1,373

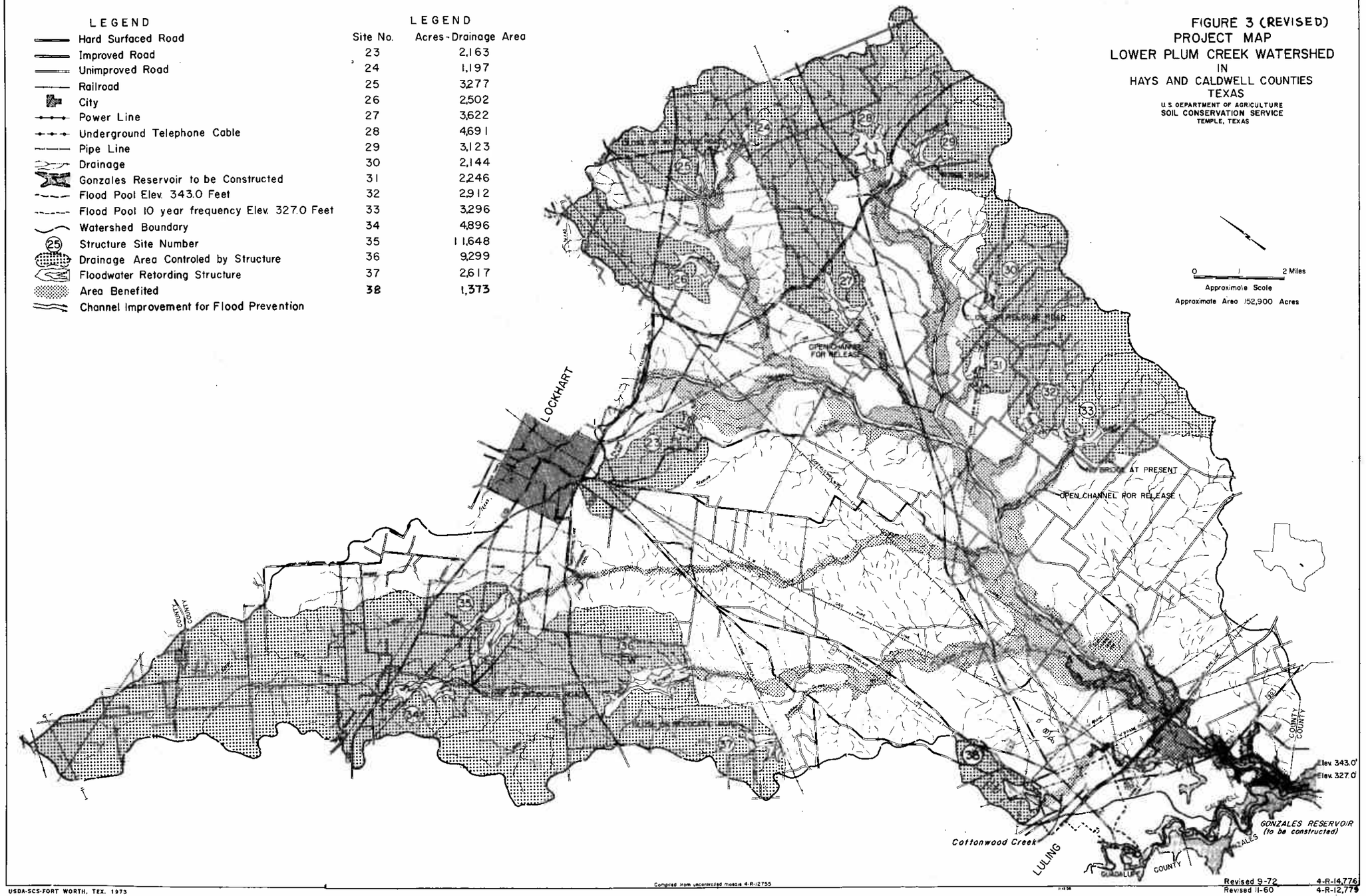


FIGURE 3 (REVISED)
PROJECT MAP
LOWER PLUM CREEK WATERSHED
IN
HAYS AND CALDWELL COUNTIES
TEXAS

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

Compiled from uncontrolled mosaic 4-R-12755

USDA-SCS-FORT WORTH, TEX. 1973

Revised 9-72 4-R-14,776
Revised 11-60 4-R-12,775