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14

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

DIABLO ARROYO WATERSHED

Hudspeth County, Texas

January, 1957

USDA-SCS-FORT WORTH, TEX. 1957

WATERSHED WORK PLAN AGREEMENT

between the

El Paso Hudspeth Soil Conservation District
Local Organization

Hudspeth County Conservation & Reclamation District No. 1
Local Organization

Hudspeth County Commissioners Court
Local Organization

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 **Diablo Arroyo** 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 **Diablo Arroyo** Watershed, State of **Texas** hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

USDA-SCS-FORT WORTH, TEX. 1957

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 2 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 $ 15,920 .)

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 the works of improvement to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Percent Sponsoring Local Organization Will Pay	Percent Service Will Pay	Estimated Construction Cost
Site # 1	0	100%	$102,377
Site # 2	0	100%	$225,630

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 engineering services applicable to works of improvement for flood prevention, and irrigation, drainage, and other agricultural water management. (Estimated cost $ 59,637 .)

   The Sponsoring Local Organization will bear the cost of all engineering services applicable to works of improvement for all purposes other than flood prevention, and irrigation, drainage, and other agricultural water management. (Estimated cost $ None .)

5. The Sponsoring Local Organization will employ or provide the following engineering and other services in connection with the installation of the works of improvement:

   The contracting officer will be Mr. Lennox W. Moore, a member of the Hudspeth County Conservation and Reclamation District #1 board of directors, McNary, Texas. The contracting officer's representative will be the manager of the Hudspeth County Conservation and Reclamation District #1, Fort Hancock, Texas.

   Necessary legal assistance will be provided by Ted Andress of the law firm of Andress, Lipscomb, Peticolas and Fisk.

   Clerical assistance will be provided by the Hudspeth County Conservation and Reclamation District #1, Fort Hancock, Texas.

   The Sponsoring Local Organization will bear all costs of administering contracts except the cost of engineering services applicable to works of improvement for flood prevention, and irrigation, drainage, and other agricultural water management.

6. The Service will provide the following engineering and other services in connection with the installation of the works of improvement: Necessary engineering services for surveys, site investigations, layout, design, preperation of specifications, supervision of construction and related forms of assistance.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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 in 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, the Sponsoring Local Organization and the Contracting 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.

13. 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.

Revised 10/1/56

14. 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.

El Paso-Hudspeth Soil Conservation District
Local Organization

By B Tom Holmsley

Title Chairman

Date April 23 - 1957

The signing of this agreement was authorized by a resolution of the governing body of the El Paso-Hudspeth Soil Conservation District
Local Organization
adopted at a meeting held on April 23, 1957.

[signature]
(Secretary, Local Organization)

Date 4/23.57

Hudspeth County Conservation & Reclamation District No. 1
Local Organization

By Ronald Miller

Title President

Date 4/23/57

The signing of this agreement was authorized by a resolution of the governing body of the Hudspeth County Conservation & Reclamation District No. 1
Local Organization
adopted at a meeting held on April 23, 1957.

J B Williams
(Secretary, Local Organization)

Date April 23 1957

Revised 10/1/56

Hudspeth County Commissioners Court
Local Organization

By Tom H. Neely

Title County Judge

Date 4-23-1957

The signing of this agreement was authorized by a resolution of the governing body of the Hudspeth County Commissioners Court
Local Organization
adopted at a meeting held on April 23, 1957.

Bernice M. Elder
Clerk of the Comm. Court
(Secretary, Local Organization)

Date April 23, 1957

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

Revised 10/1/56

WATERSHED WORK PLAN

Diablo Arroyo Watershed
Hudspeth County, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666 as Amended by Public Law 1018, 84th Congress; 7 Stat. 1088).

Prepared by: El Paso-Hudspeth Soil Conservation District
(Cosponsor)

Hudspeth County Conservation and Reclamation District No. 1
(Cosponsor)

Hudspeth County Commissioners Court
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
January, 1957

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SECTION 1

WATERSHED WORK PLAN

Diablo Arroyo Watershed
Hudspeth County, Texas
January, 1957

SUMMARY OF PLAN

General Summary

The watershed work plan for watershed protection and flood prevention for the Diablo Arroyo watershed, Texas, was prepared by the El Paso-Hudspeth Soil Conservation District, the Hudspeth County Conservation and Reclamation District No. 1, and the Hudspeth County Commissioners Court as the cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture.

The watershed work plan covers an area of approximately 64.05 square miles, or 40,992 acres, in Hudspeth County, Texas. Approximately 10 percent of the watershed is cropland, 89 percent is rangeland, and 1 percent miscellaneous, such as stream channels, towns, roads, etc.

The only Federal lands within the watershed are those few acres of stream channel located within the International Boundary and Water Commission's levees at the mouth of the watershed.

No water management developments are involved.

The work plan proposes installing in a 2-year period a project for the protection and development of the watershed at a total estimated installation cost of $442,928. This is entirely a structural measures cost for a plan consisting of two floodwater retarding structures having an aggregate capacity of 9,243 acre-feet. The local or non-Federal share of this cost will be $16,920. In addition, local interests will bear the entire cost of operation and maintenance which has a capitalized value of $17,471. Of the total project cost of $460,199, the non-Federal share will be $34,391, and the Federal share $425,808. The non-Federal share of the total cost of structural measures includes land, easements, and rights-of-way, 46 percent; operation and maintenance, 51 percent; and administering contracts, 3 percent.

No costs have been included to cover continuation of efforts to establish land treatment measures.

Damages and Benefits

The estimated average annual damage without the project is $25,796. The estimated average annual damage with the project is $2,712. The average

annual primary benefits accruing to structural measures are $23,423, which are distributed as follows:

Floodwater damage reduction	$ 4,225
Sediment damage reduction	18,014
Indirect damage reduction	845
Benefits from below project area	339

The ratio of the average annual benefits ($23,423) to the average annual cost of structural measures ($16,226) is 1.44 to 1.

Provisions for Financing Construction

The Hudspeth County Conservation and Reclamation District No. 1, which has taxing power, will contract for the construction of the two floodwater retarding structures listed in the plan. Funds for the local share of the project will be raised through a bond issue financed by local taxes.

Operation and Maintenance

The two floodwater retarding structures will be operated and maintained by the El Paso-Hudspeth Soil Conservation District with joint responsibility carried by the Hudspeth County Conservation and Reclamation District No. 1, which has legal authority to raise funds.

DESCRIPTION OF WATERSHED

Physical Data

Diablo Arroyo rises in the Finlay Mountains in the west-central part of Hudspeth County, approximately 17 miles northeast of McNary, Texas. It flows through Hudspeth County in a southwesterly direction for approximately 20 miles. It enters the rectified channel of the Rio Grande about two miles southwest of McNary, Texas. Camp Grande Arroyo is the main tributary. The watershed has an area of 40,992 acres, nearly all of which is in farms and ranches.

Elevations range from 3,500 feet above mean sea level along the flood plain of the Rio Grande to 5,000 feet along the watershed divide. Topographically, the watershed is divided into four broad categories: (1) the Finlay Mountains; (2) clay flats below the mountains; (3) a rough broken area in the central reaches and part of the lower reaches of the watershed; and (4) the nearly level Rio Grande flood plain.

The watershed lies entirely within the Trans-Pecos Land Resource Area. The soils range from fine-textured poorly aggregated clays to coarse sand and gravel. Most of the soils in the hills and escarpment area are stony and very shallow. Beginning at the foot of the escarpment and extending half of the distance to the railroad, the soils are shallow and contain some

gravel and caliche. Deep soils are found on the flatter areas where deposition has taken place. The soils on the Diablo-Rio Grande common flood plain are deep, fine to medium textured, permeable, and suitable for irrigation farming. Control of the high salt content of these soils, caused by the evaporation of saline irrigation water, is a problem. The semidesert nature of this locality and overuse of rangeland have resulted in little good forage-producing vegetation on upland areas.

The overall land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cultivation	4,046	10
Range	36,641	89
Miscellaneous 1/	305	1
Total	40,992	100

1/ Includes irrigation ditches, roads, towns and railroads.

A rainfall frequency analysis was made, by the Hazen method, of records from rain gages in the vicinity of the watershed. The 100-year frequency storm was the largest storm considered in developing the project. This storm would produce 1.20 inches of runoff and flood 29 percent of the 4,046 acres of flood plain. Under present conditions, the entire flood plain would be inundated by the design storm, which would produce 1.44 inches of runoff. All of the flood plain has been in cultivation, but due to the present shortage of good irrigation water, only about 40 percent is now being farmed.

Average temperatures range from 81 degrees Fahrenheit in the summer to 43 degrees in the winter. The normal frost-free season of 242 days extends from March 19 to November 16.

The mean annual rainfall is 8.31 inches, as recorded at El Paso, Texas. It is well distributed, with the wettest months being July, August and September. High intensity rains in excessive amounts occur occasionally throughout the watershed but cover only small areas. Although the storms may occur during any season, the majority have occurred in the summer and fall months. The minimum recorded annual rainfall was 2.73 inches; the maximum was 17.80 inches.

Water is inadequate for irrigation, for proper range use and for drinking and household uses. Water for household use is hauled by rail for some 100 miles. Irrigation water normally is obtained from the Rio Grande and supplemented by wells. River water has been inadequate in quantity during recent years and well water is of relatively poor quality. Livestock on the range is watered from wells and ponds; however, suitable watering places are limited and generally cannot be located so as to assist in getting uniform grazing of rangeland.

Economic Data

The economy of the watershed is almost entirely agricultural. The 4,046 acres of cropland are all irrigated when sufficient water is available and are located along the Rio Grande. The principal crops grown are cotton and alfalfa. The cotton produced in the watershed is of unusually unform grade and high quality and commands a premium price. The cotton is ginned locally and is usually marketed in Fabens or El Paso through local cooperatives. Dairies around El Paso furnish a good market for alfalfa, though much of this crop is sold to truckers coming from all over the state.

The average size unit in the irrigated section is 368 acres. This acreage is more than sufficient for an economical unit when plenty of irrigation water is available. Since 1951, however, irrigation water has been extremely short or nonexistent, so only about 40 percent of the 4,046 acres is in cultivation at the present time. Many landowners in the irrigated area have drilled wells, but many of these wells have had to be abandoned due either to the low quantity or the poor quality of water. The remaining wells are pumping an average of 650 gallons per minute, with an average salt content of 6.17 tons per acre-foot, which is too high to permit prolonged use for irrigation. Landowners who have had to cease or greatly curtail irrigation farming have found it necessary to seek other means of livelihood. Many have moved their farming interests to other areas. Some have taken jobs nearby, allowing them to keep up land payments and taxes. In all cases, however, landowners are very optimistic and feel that their moves are of a temporary nature only. Land values are high but very little of the irrigated land is for sale. Tenancy is not a problem as most of the land is owner-operated.

The rangeland located above the irrigated section is largely owned by the State of Texas and the Texas and Pacific Land Trust. Other small holdings are to be found throughout the watershed, but all the rangeland in the watershed is under lease to five operators.

A post office and other facilities are maintained at McNary, population 300. It is only 29 miles to Fabens, population 3,000; 29 miles to Siarra Blanca, population 860; and 57 miles to El Paso, population 186,000.

The watershed is served by a Soil Conservation Service work unit at Fabens, Texas, assisting the El Paso-Hudspeth Soil Conservation District. This work unit has assisted farmers and ranchers in preparing 15 conservation plans on all the 4,046 acres of irrigated land and 36,641 acres of rangeland within the watershed. Where land treatment measures have been applied and maintained for as long as three to five years, irrigated crop yields have increased 25 to 40 percent.

The Texas and Pacific and the Southern Pacific Railroads, both of which have loading facilities at McNary, adequately serve the agriculture of the watershed.

There are 7.5 miles of paved road (U. S. Highway 80 and F. M. 92). Private and county roads are adequate to provide access to the entire watershed.

WATERSHED PROBLEMS

Floodwater Damage

Damage to the Diablo Arroyo flood plain from floodwater has been infrequent. In 1941 the railroad bridge across the Arroyo was washed out and the highway bridge suffered considerable damage. In addition, there was high damage to a few acres of cropland.

It is evident that, with the continued decrease in channel capacity through the alluvial fan at the mouth of the arroyo, the frequency of flooding will be increased with the return of normal rainfall. Analysis of this effect on flood frequency indicated that during the project life the total direct floodwater damages would average $4,225 annually without the project, of which $2,654 is crop damage, $688 is other agricultural damage and $883 is nonagricultural, such as damage to roads, bridges and railroads.

Indirect damages, such as interruption of travel and the production and related losses sustained when irrigation services in the area, are interrupted, will be proportionately high. The total annual value of these indirect damages is estimated to be $845.

Sediment Damage

The principal sediment damage in this watershed is that resulting from deposition of sand at the confluence of the Rio Grande and Diablo Arroyo. This is of particular importance since the International Boundary and Water Commission expends considerable sums of money annually to remove from the Rio Grande sediment that has been deposited at this point by flows from Diablo Arroyo. The sediment is removed in compliance with a treaty that requires maintenance of the river channel to a specified capacity. Using the International Boundary and Water Commission estimates of yardage of sediment hauled from the damaged area of Alamo Arroyo as a reference, it was estimated that an average of 143,035 cubic yards will have to be removed annually if present conditions continue to exist. The estimated value of this sedimentation damage is $20,726 annually.

Damage by overbank deposition of sediment in the watershed is minor and has not been separated from floodwater damages to crops.

There are no large reservoirs in the watershed. Pond sedimentation is of minor importance, since the ponds are located in the area where sediment yields are low.

Erosion Damage

There are 35,709 acres subject to sheet erosion in this watershed. The

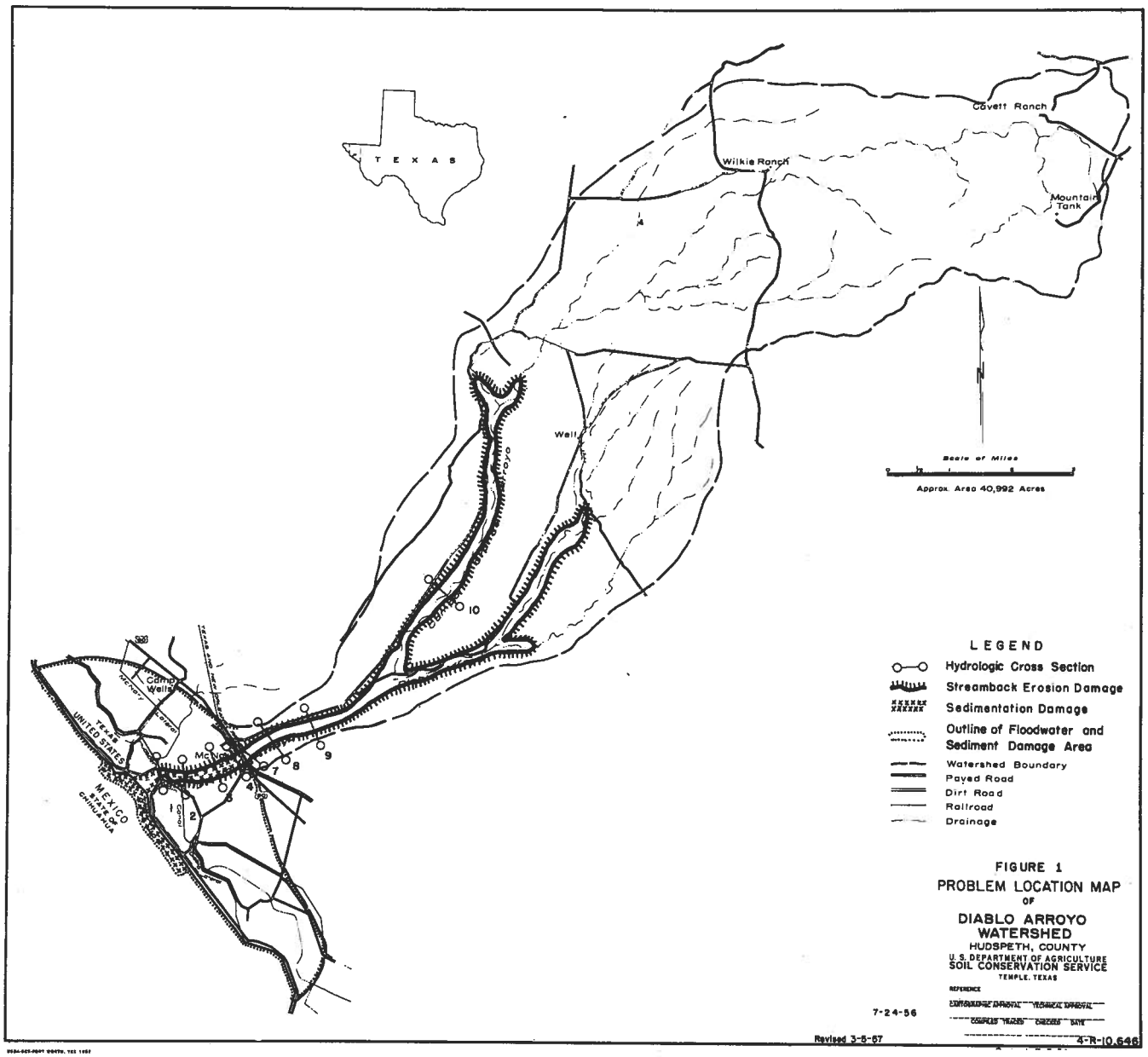


FIGURE 1
PROBLEM LOCATION MAP
OF
DIABLO ARROYO WATERSHED
HUDSPETH, COUNTY
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

sheet erosion rates on the greater portion of Diablo Arroyo watershed are moderate because:

1. The arid climate reduces the amount of water available for erosive action.

2. The gravelly nature of the soils has produced a desert pavement or armor which protects part of the critical "badlands" area.

3. The broad clay flats area has a low degree of slope.

Seventy-one percent of the sediment produced in the watershed originates in the "badlands". This is caused by both sheet and gully erosion occurring in areas unprotected by the desert pavement. Bank erosion is severe but is found mostly along the main channel below the confluence of the major tributary channels. This is a primary source of sediment causing downstream damage. Eleven percent of the sediment produced above structures results from channel erosion. Flood plain scour is insignificant.

Problems Relating to Methods Now Used in the Conservation, Development, Utilization and Disposal of Water

There is considerable activity relative to drainage and irrigation in this watershed. The Hudspeth County Conservation and Reclamation District No. 1 indicated an interest in providing additional storage capacity in floodwater retarding structures for irrigation purposes; however, District representatives decided that the average annual rainfall would not provide sufficient water to materially help the district's irrigation program. None of the towns in the watershed indicated an interest in providing additional storage capacity in any of the floodwater retarding structures.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Efforts to prevent or to control floodwater and sediment in the Diablo Arroyo watershed have been minor. However, during the past ten years the Hudspeth County Conservation and Reclamation District No. 1, recognizing the Hazard to its facilities and productive cropland, has made some effort to control floods. The International Boundary and Water Commission has raised and extended levees in an attempt to reduce the flood peril.

Land Treatment Measures For Watershed Protection

Except for the 4,046 acres of irrigated land located along the Rio Grande, the rest of the watershed, 36,641 acres, is rangeland. Practically all the rangeland is owned by the State of Texas and the Texas and Pacific Land Trust, leased to five operators. The present management program for these lands will result in improved vegetative cover within climatic limitations on these range sites. Because of extremely limited productivity, slow rate of recovery, and unfavorable topography of watershed lands, extensive additional land treatment measures are not feasible. At present, grazing use of watershed lands is on a seasonal basis. Grazing management to allow for maximum

vegetative recovery under environmental conditions existing in this locality is a fundamental part of the plan, and will allow vegetation to make its maximum contribution in reducing erosion and sediment movement.

The absence of extensive rangeland treatment measures, except management, will not, however, adversely affect operation and maintenance of the structural measures to be installed. The structural measures are designed to be fully effective for 50 years under present watershed conditions; any cover improvement which may be experienced resulting from management during years with more favorable climatic conditions will merely serve to lengthen structural usefulness. No costs have been included in the plan for accomplishing this management, since it is nominal in amount and represents merely a continuation of present efforts.

Both the El Paso - Hudspeth Soil Conservation District and the Hudspeth County Conservation and Reclamation District No. 1 have been urging all water users to adopt practices for conservation of water. These practices include land leveling, construction of earth and lined laterals, irrigation water management and rotation hay and pasture to keep irrigated soils in good condition. Efforts along these lines will be continued for irrigated lands protected from flood damage, but they do not contribute measurably to watershed protection. They are not included, therefore, in the plan.

Structural Measures for Flood Prevention

A system of two floodwater retarding structures will be installed in the watershed to afford the needed protection to flood plain lands and channel improvements on the Rio Grande. The structures will detain the runoff from 95 percent of the watershed from a storm that can be expected to occur no more often than once in 180 years. Figure 2 shows a section of a typical floodwater retarding structure.

The possibility of using a single floodwater retarding structure at the lower site, as an alternate to the system of two structures, was investigated. It was found that it was considerably less costly to the Federal government to build the two structures in series because of very favorable economic storage potentialities available at the upper site.

Sites for the floodwater retarding structures will be provided by local interests at no cost to the Federal government. The value of these sites is estimated to be $3,975, based on market values furnished by real estate dealers and other local people. No flood plain is involved within the structure sites.

The locations of the floodwater retarding structures are shown on the Planned Structural Measures Map, figure 3. The total estimated cost of establishing these works of improvement is $442,728, of which $16,920 will be borne by non-Federal interests, and $425,808 by the Federal Government.

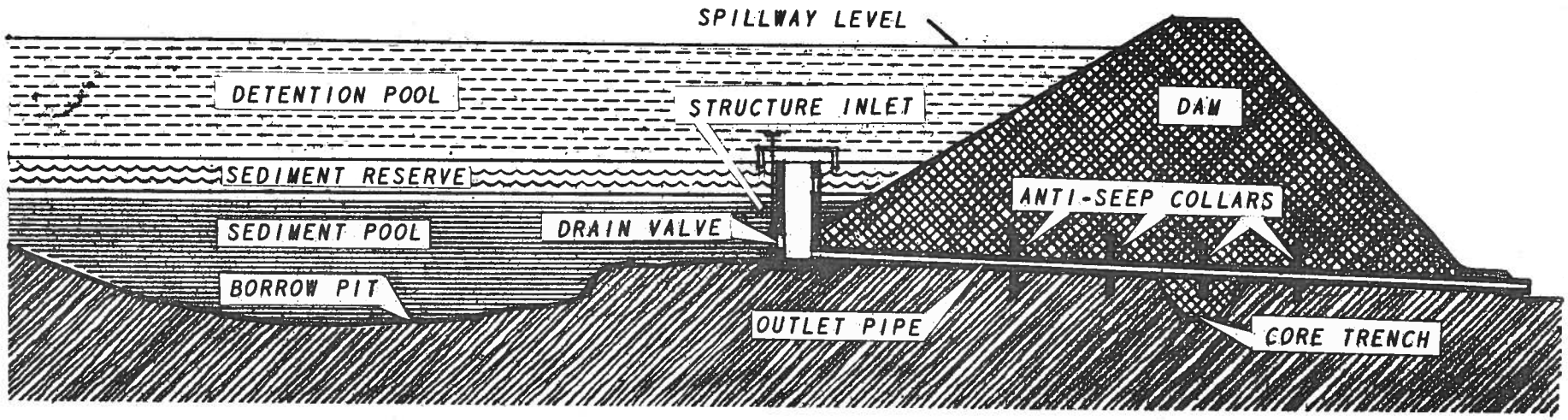


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U.S.D.A. SOIL CONSERVATION SERVICE

9-20-55 4-L-10071

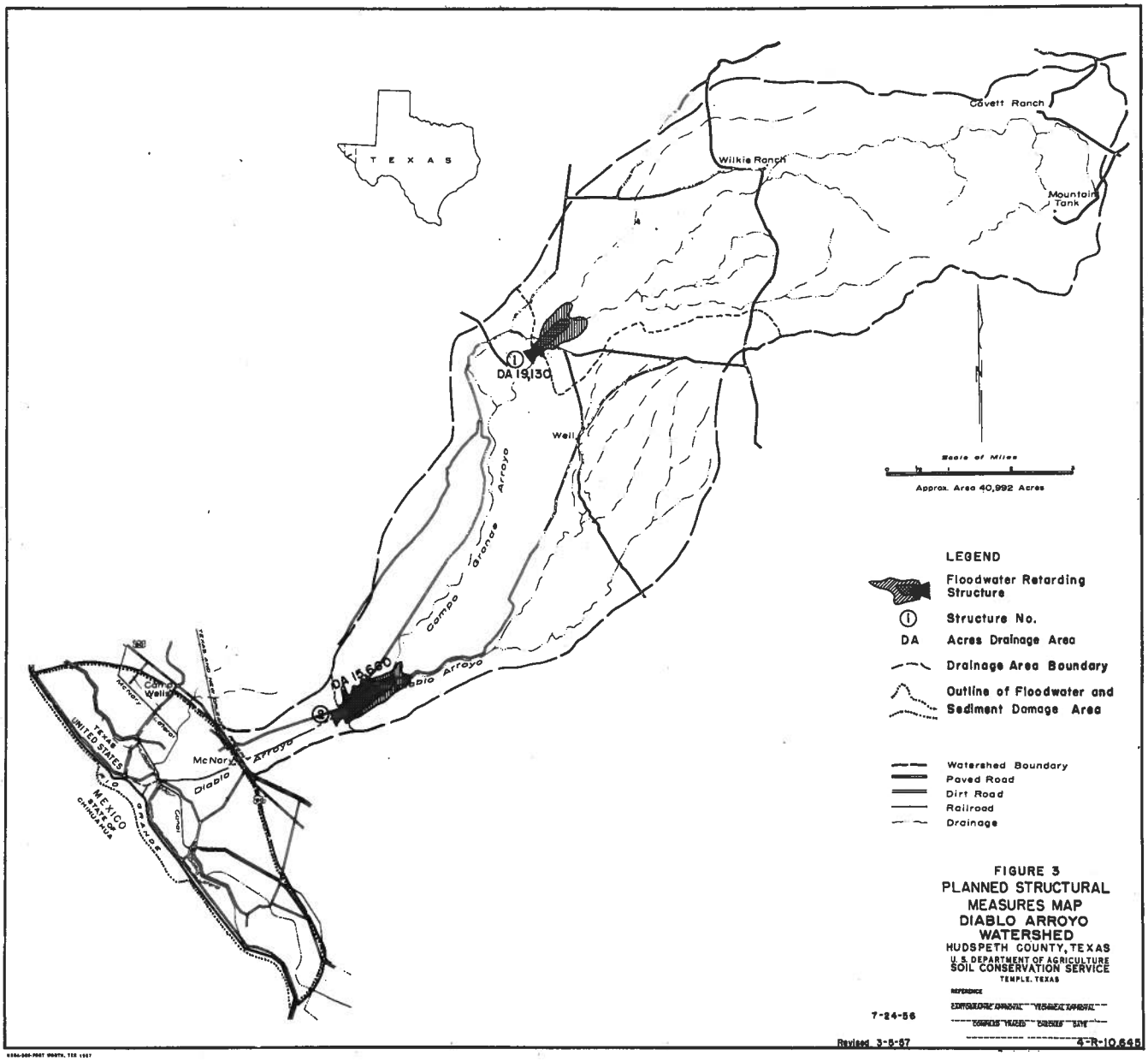


FIGURE 3
PLANNED STRUCTURAL MEASURES MAP
DIABLO ARROYO WATERSHED
HUDSPETH COUNTY, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

TABLE 1 - ESTIMATED INSTALLATION COST 1/
(Based on 1955 Price Levels)

Diablo Arroyo Watershed, Texas

For: Total Project

Item	Unit	No. to be Applied	Estimated Cost: Federal (dollars)	Estimated Cost: Non-Federal (dollars)	Total (dollars)
LAND TREATMENT PRIMARILY FOR WATERSHED PROTECTION					
Soil Conservation Service					
Proper Use of Range	Acre	36,441	-	-	-
TOTAL LAND TREATMENT		36,441	-	-	-
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	2	328,007	-	328,007
TOTAL CONSTRUCTION COST			328,007	-	328,007
INSTALLATION SERVICE					
Soil Conservation Service					
Engineering Service			59,637	-	59,637
Other			38,164	-	38,164
TOTAL INSTALLATION SERVICE			97,801	-	97,801
OTHER COSTS					
Land, Easements & R/W			-	15,920	15,920
Administering Contracts			-	1,000	1,000
TOTAL OTHER COSTS			-	16,920	16,920
TOTAL INSTALLATION STRUCTURES			425,808	16,920	442,728
TOTAL INSTALLATION			425,808	16,920	442,728
SUMMARY					
TOTAL SCS			425,808	16,920	442,728
TOTAL			425,808	16,920	442,728

1/ No Federal lands are involved.

Date: January, 1957

BENEFITS FROM WORKS OF IMPROVEMENT

With the project installed, the area subject to damage from Diablo Arroyo will be essentially flood-free for all storms up to the size that can be expected to occur no more frequently than once in 100 years.

The estimated average annual floodwater and sediment damage within the watershed would be reduced from $25,796 to $2,712, or a reduction of 89 percent. All of the expected reduction in the average annual damage would result from the system of floodwater retarding structures.

Floodwater retarding structures will effect a further benefit, below the project area, of an estimated $339 annually, making a total estimated flood prevention benefit of $23,423 annually.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures (converted from total installation cost plus operation and maintenance) is estimated to be $16,226. When the project is completely installed, it is expected to produce average annual benefits of $23,423. Therefore, the project will produce benefits of $1.44 for each dollar of cost. There are other substantial values which will accrue from the project, such as increased opportunity for recreation, improved wildlife conditions, better living conditions and a sense of security, which have not been used for project justification.

ACCOMPLISHING THE PLAN

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

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

Land Treatment Measures

Land treatment measures will be established by farmers and ranchers in cooperation with the El Paso-Hudspeth Soil Conservation District. The cost of applying them will be borne by owners and operators of the land. The soil conservation district is giving assistance in the planning and application of these measures under its going program.

The governing body of the El Paso-Hudspeth Soil Conservation District,

with the assistance of the Hudspeth County Conservation and Reclamation District No. 1, will arrange for meetings according to a definite schedule. By this means and by individual contacts they will encourage the landowners and operators within the watershed to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with the existing arrangements for equipment usage in the district. The district governing body will make periodic inspections of the completed conservation measures within the district and follow through to see that needed maintenance is performed.

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

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

Structural Measures for Flood Prevention and Sediment Reduction

The landowners of the watershed and the El Paso-Hudspeth Soil Conservation District, the Hudspeth County Commissioners Court, and the Hudspeth County Conservation and Reclamation District No. 1, which has powers of taxation under the State laws of Texas, plan to cooperate in installing this project.

The Hudspeth County Conservation and Reclamation District No. 1 will contract for the construction of all floodwater retarding structures listed in the plan. Funds for the local share of the project costs, including land, easements, rights-of-way, and administration of contracts, will be raised through a bond issue financed by local taxes. The bond issue will be voted on as soon as the project is approved. Land or easements for the sites of the floodwater retarding structures and the pools created by them will be obtained insofar as possible by private donations. In those instances where such donations would create excessive hardships, easements will be purchased. Construction of the structural measures will be started as soon as the local organization is equipped to handle its responsibilities and local and Federal funds are available. The floodwater retarding structures will be scheduled for construction so as to complete the project within a 2-year period. All land, easements, and rights-of-way for the entire project must be obtained before Federal financial assistance will be provided for installation.

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

The cooperating parties have agreed on a two-year schedule calling for installation of structure No. 1 first, and structure No. 2 last. This schedule will be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desired, and in light of appropriations and accomplishments actually made.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners or operators of the farms and ranches on which the measures are installed, under agreements with the El Paso-Hudspeth 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 maintenance. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention and Sediment Reduction

The two floodwater retarding structures will be operated and maintained by the El Paso-Hudspeth Soil Conservation District with joint responsibility shared by the Hudspeth County Conservation and Reclamation District No. 1, which has legal authority to raise funds.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or streamflow. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, and fences and gates installed as a part of the floodwater retarding structures. The cosponsoring local organizations will maintain records of all maintenance inspections.

The estimated annual operation and maintenance cost is $616, based on long-term price levels. 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. Funds for accomplishing the maintenance work will be obtained from revenue derived through assessments on the benefitted lands in the Hudspeth County Conservation and Reclamation District No. 1.

Provisions will be made for free access of cosponsoring organization and Federal representatives to inspect the two floodwater retarding structures and their appurtenances at any time.

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

COST SHARING

No costs have been included for establishing land treatment measures.

The required non-Federal costs for structural measures, consisting of the value of land, easements, and rights-of-way, the capitalized value of operation and maintenance of works of improvement, and the cost of administering contracts are estimated at $34,391.

The entire cost of constructing the structural measures, amounting to $328,007 will be borne by the Federal Government. In addition, the installation services estimated cost of $97,801 will be a Federal expense. This is a total Federal project cost of $425,808.

The total project cost, including operation and maintenance, of $460,199 will be shared 93 percent ($425,808) by the Federal government and 7 percent ($34,391) by non-Federal interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the proposed watershed protection and flood prevention project on the Diablo Arroyo watershed and the expansion of this program to other arroyos in this area would give added protection to flood plain lands along the Rio Grande and significantly reduce the sediment loads contributed to the Rio Grande from these arroyos. This project plan conforms to all Federal laws and regulations and will have no known detrimental effect on any downstream projects that might be constructed in the future.

SECTION 2

INVESTIGATIONS, ANALYSES AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

The soils in the Diablo Arroyo watershed are in relatively poor condition. The rangeland has been overused, leaving very little litter on the soil. The organic matter content of the soil is very low. Salt spots, formed by the evaporation of saline irrigation water, are present in the flood plain area. These spots are toxic to most forms of vegetation.

Cover Conditions and Range Sites

The rangeland in the watershed is 9.2 percent in fair condition and 90.8 percent in poor range condition. There are seven range sites in this watershed; Draw (overflow) site, Sand site, Sandy Loam site, Stony Hills site, Gravelly Hills site, Rough Stony Mountains site, and the Badlands site.

The Draw (overflow) site is made up of deep, fine-textured bottom land soils. It occupies nearly level flats which are subject to frequent overflow from surrounding higher elevations. The soils of this site are composed of materials derived or washed from surrounding areas. Invaders, such as tarbush, creosotebush and mesquite, which replace the better range plants when the original vegetation has been reduced in stand and vigor are the major plants growing on this site. Some grasses,such as alkali sacaton and tobosa, are present.

The Sand site varies from nearly level areas and gently rolling small hills to steep dunes. Soils range from sand to loamy fine sand, and from light reddish brown to reddish brown. The open nature of this soil enables this site to absorb a large portion of water that falls. The Sand site is characterized by a predominance of mesquite, creosotebush and soaptree yucca, all of which are invaders. Scattering plants of spike dropseed and mesa dropseed, climax species which decrease with pressure of use and other unfavorable factors, are present.

The Sandy Loam site is made up of soils ranging from fine sandy loam to very fine sandy loams, occupying level to gently rolling areas. These soils have the type of structure which permits a fast intake of water and good plant-soil-moisture relationship. This site is dominated by mesquite brush. Other invading species are creosotebush, yucca and fluffgrass. Only occasional plants of good climax grasses, such as black grama, sideoats grama, plains bristlegrass, bush muhly and spike dropseed, all decreasers, can be found in the area. Perennial threeawn, an increaser, may also be found on this site.

The Stony Hills site occurs in areas of steep rocky hills. The soils range from 6 to 18 inches in depth and are predominantly fine-textured, with the occasional occurrence of medium-textured soils. On this site traces of the better grasses are found including chino grama, sideoats grama, green sprangletop, cane bluestem and plains bristlegrass. Hairy grama and blue grama, lower value grasses, also are common to this site. As in all this range country, the invaders dominate. Sotol, creosotebush and mesquite are the more prominent ones.

The Gravelly Hills site consists of hills and ridges with steep to gentle slopes characterized by shallow to very shallow gravelly soils. Decreasers, such as black grama and sideoats grama are common to this site. The principal form of vegetation, however, consists of such invaders as lechuguilla, mescat acacia, and cacti.

The Rough Stony Mountain site is made up of very steep, rough, stony land. Steep escarpments and large areas of barren rock are common. Much of this site is almost inaccessible to livestock. The principal grass found on this site is chino grama, an increaser. Lechuguilla, cactus and sotol, invaders, are the common forms of vegetation.

The Badlands site is composed of steep, bare, clay hills, often multicolored. There is very little true soil on this site. A few mesquite and some annual weeds are present. Where sand or silt has washed or blown in on the Badlands, it grows the vegetation adapted to the new site. There are no excellent, good or fair range conditions available for examination.

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

Range Site and Condition Class

Condition Class	Acres	Percent for Site
	Draw (overflow) Site	
Fair	0	0
Poor	257	100
Total	257	100
	Sand Site	
Fair	0	0
Poor	8,391	100
Total	8,391	100
	Sandy Loam Site	
Fair	660	11.3
Poor	5,203	88.7
Total	5,863	100.0

Range Site and Condition Class - Continued

Condition Class	Acres	Percent for Site
	Stony Hills Site	
Fair	1,099	13.9
Poor	6,815	86.1
Total	7,914	100.0
	Gravelly Hills Site	
Fair	0	0
Poor	10,662	100
Total	10,662	100
	Rough Stony Mountains Site	
Fair	1,612	84.6
Poor	293	15.4
Total	1,905	100.0
	Badlands Site	
Fair	0	0
Poor	1,649	100
Total	1,649	100
	All Sites	
Fair	3,371	9.2
Poor	33,269	90.8
Total All Range Lands	36,641	100.0

Land Use and Treatment Needs

The land use in the upland was obtained by interpretation of aerial photographs. The land use of the floodplain was determined from the El Paso-Hudspeth Soil Conservation District records.

The current conservation needs of the El Paso-Hudspeth Soil Conservation District were used as the basis for arriving at the land treatment needs for the watershed.

Program Determination

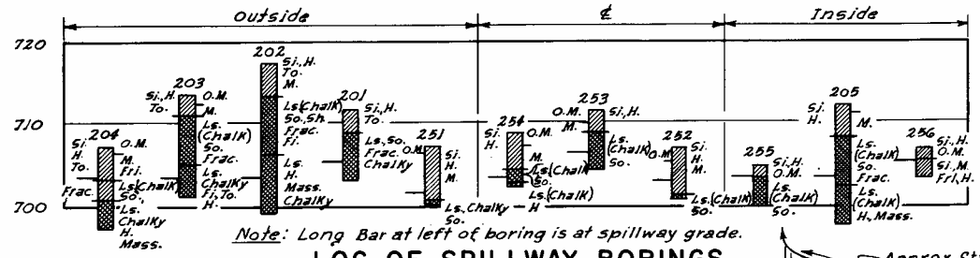
Determination was made, first, of the needed land treatment measures remaining to be done in the watershed, based on range condition classes and land capability classes developed from soil surveys. The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effect of these measures as related to sediment and flood damages. These investigations showed that, due to the climatic, geologic and economic conditions that prevail in the watershed, the establishment of needed land treatment measures on the rangeland would be too slow to effect a significant benefit within a reasonable length of time. It was apparent that other sediment and flood prevention measures would be required to attain the degree of watershed protection and sediment and flood reduction desired.

Determination was then made of structural measures for sediment control and flood prevention which would be feasible to install. The study made and the practices used in that determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. Studying United States Department of Interior, Geological Survey, 20-foot contour quadrangle sheets, and stereoscopic study of 4-inch consecutive aerial photographs located all probable floodwater retarding structure sites, the limits and the area of the flood plain, and points where valley cross sections should be taken for the determination of hydraulic characteristics and for flood-routing purposes. This information was placed on the watershed base map for use in field surveys. Cross sections of the flood plain were surveyed at the selected locations. Data developed from these cross sections permitted the computation of peak discharge-damage relationships for various flows. A map was prepared of the flood plain on which land use, cross section locations, and other pertinent information were recorded.

2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not show good storage possibilities were dropped from further consideration. From the remaining sites a system of floodwater retarding structures was selected for further consideration and detailed survey. Plans of a floodwater retarding structure, typical of those planned for this watershed, are illustrated by figures 4 and 4A.

3. A topographic map was made of the pool area of each of the proposed sites in order to determine the storage capacity of the site, the estimated cost of the dam and the areas of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the storage volume needed to temporarily



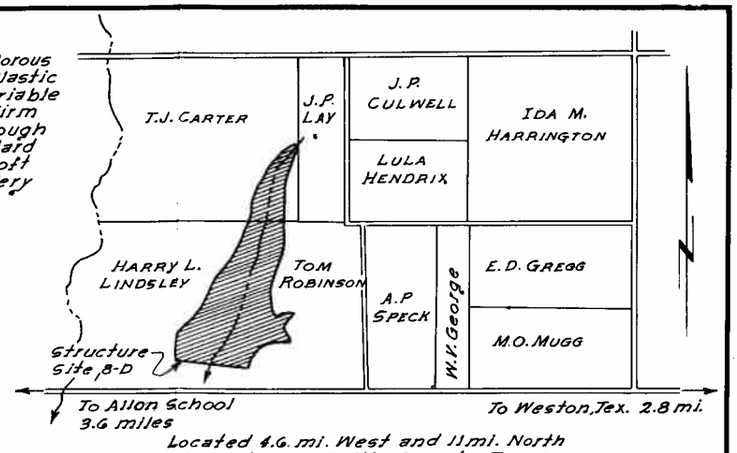
LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

Clay
Stone

Ch.	Chalk	Chalky	Por	Porous
Si.	Silt	Silty	Pl.	Plastic
Gr.	Gravel	Gravelly	Fri.	Friable
M.	Marl	Marly	Fi.	Firm
O.M.	Organic Matter		To.	Tough
C.C.	Calcium Carbonate		H.	Hard
Com	Compact		So.	Soft
Ls.	Limestone		V	Very
Mass.	Massive			
Con	Concretions			

LEGEND OF BORINGS



Located 4.6 mi. West and 11 mi. North of Mc Kinney, Collin County, Texas

VICINITY MAP

0 1/4 1/2 1
SCALE IN MILES

SPILLWAY CURVE DATA
Δ = 73°-30'
R = 50'
L = 64.1'
P.C. = Sta. 2+35.9
P.T. = Sta. 3+00

Approx Sta. 6+65 Creek Channel County Road Bridge

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

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

Farm pond to be filled in and the area levelled by Knocking old dam out.

Note: Creek is property line.

Downstream Toe 420'

Upstream Toe 390'

10' Berm

Wire Gap

12' Gate

Spillway Diversion

Sta. 2+35.9 on right side of Spillway ≡ Sta. -0+20 on ℄ of Dam

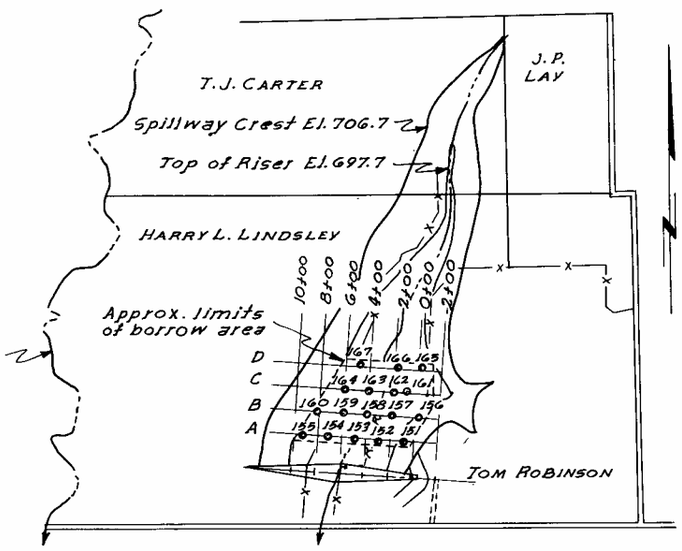
Sta. 2+00 on ℄ of Structure ≡ Sta. 7+00 on ℄ of Dam

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

Fence Legend
—C— Fence to be constructed
—X— Existing fence
—R— Fence to be removed
—L— Fence to be relocated

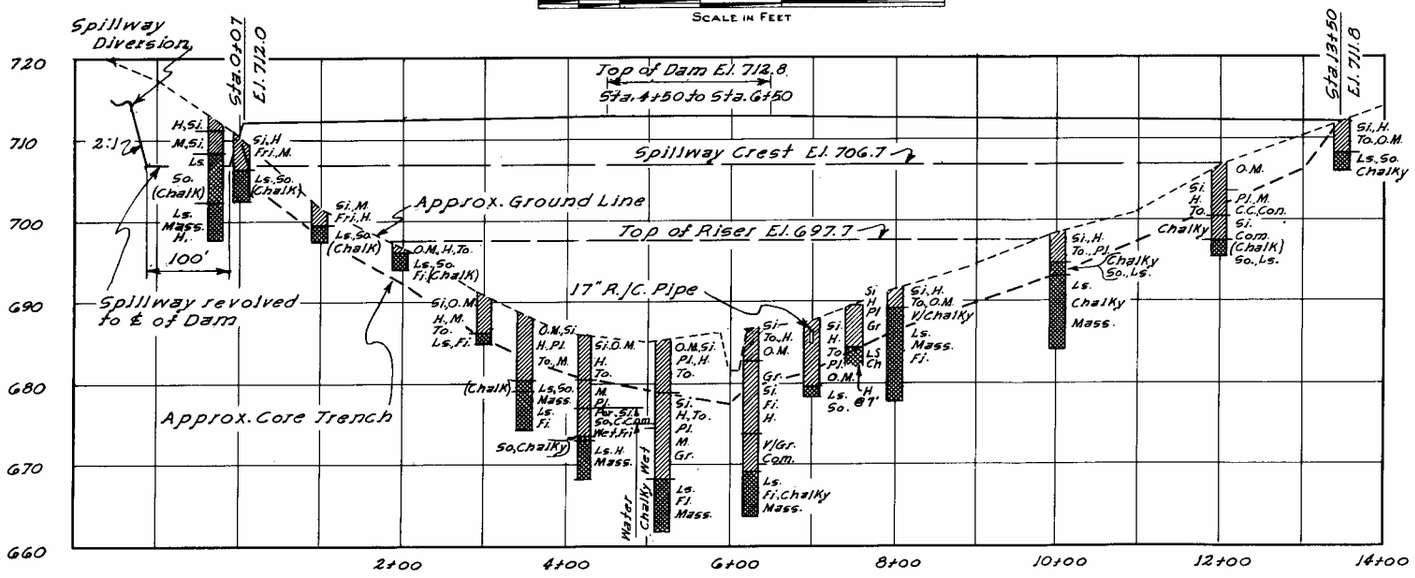
PLAN OF EMBANKMENT AND SPILLWAY

100 0 100 200 400
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

660 0 660 1980
SCALE IN FEET



PROFILE ON ℄ OF DAM

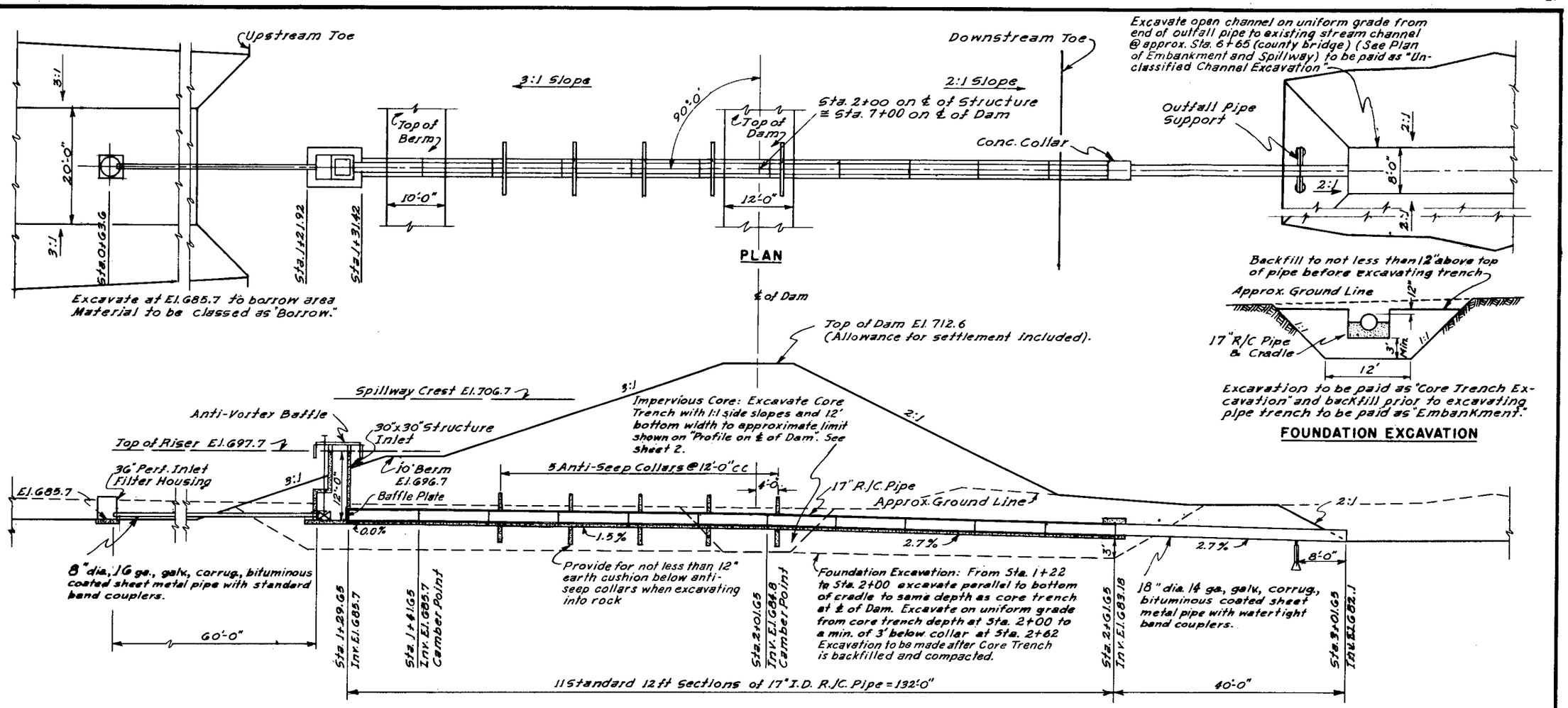
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
694.0	18.0	64.0	.82
697.7	30	154.0	1.98
698.0	31.0	162	2.08
698.3	35.6	172	2.20
702.	45	314	4.03
706	63	530	6.79
706.7	67	576	7.38
710	85	826	10.59

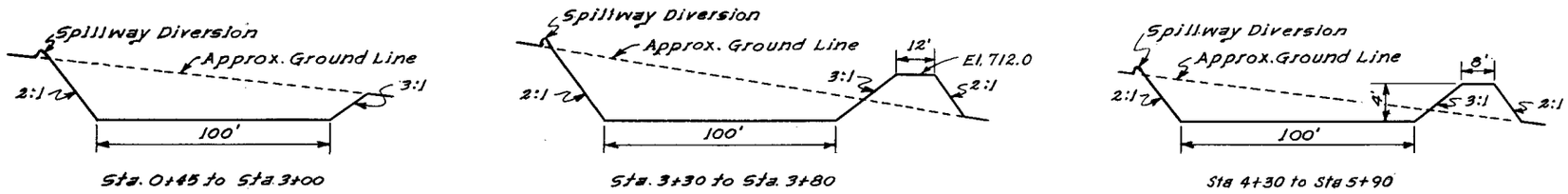
Top of Dam (Effective) Elev.	711.8
Spillway Crest Elev.	706.7
Top of Riser Elev.	697.7
Sediment Pool Elev.	698.3
Drainage Area, Acres	936.0
Sediment Storage, Ac. Ft.	172.0
Floodwater Storage, Ac. Ft.	422.0

Figure 4
TYPICAL FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

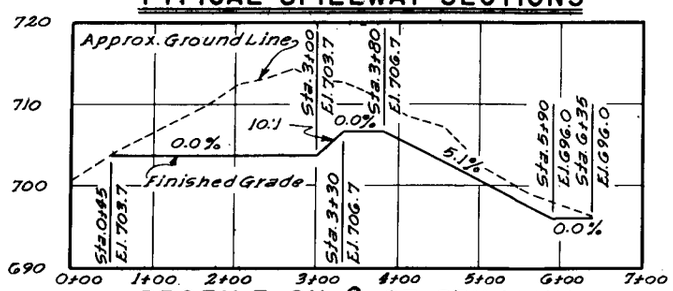
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	L.A.W.	6-56	Approved by HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	L.A.W. & G.R.	6-56	STATE CONSERVATION ENGINEER, S.C.S. TEMPLE, TEXAS
Traced	G.R.	6-56	Sheet No. 2 of 7
Checked	L.A.W. & G.W.T.	7-56	Drawing No. 4-E-10,581





TYPICAL SPILLWAY SECTIONS



PROFILE ON ℄ OF SPILLWAY

Figure 4A
TYPICAL FLOODWATER RETARDING STRUCTURE
STRUCTURE—PLAN AND SECTION

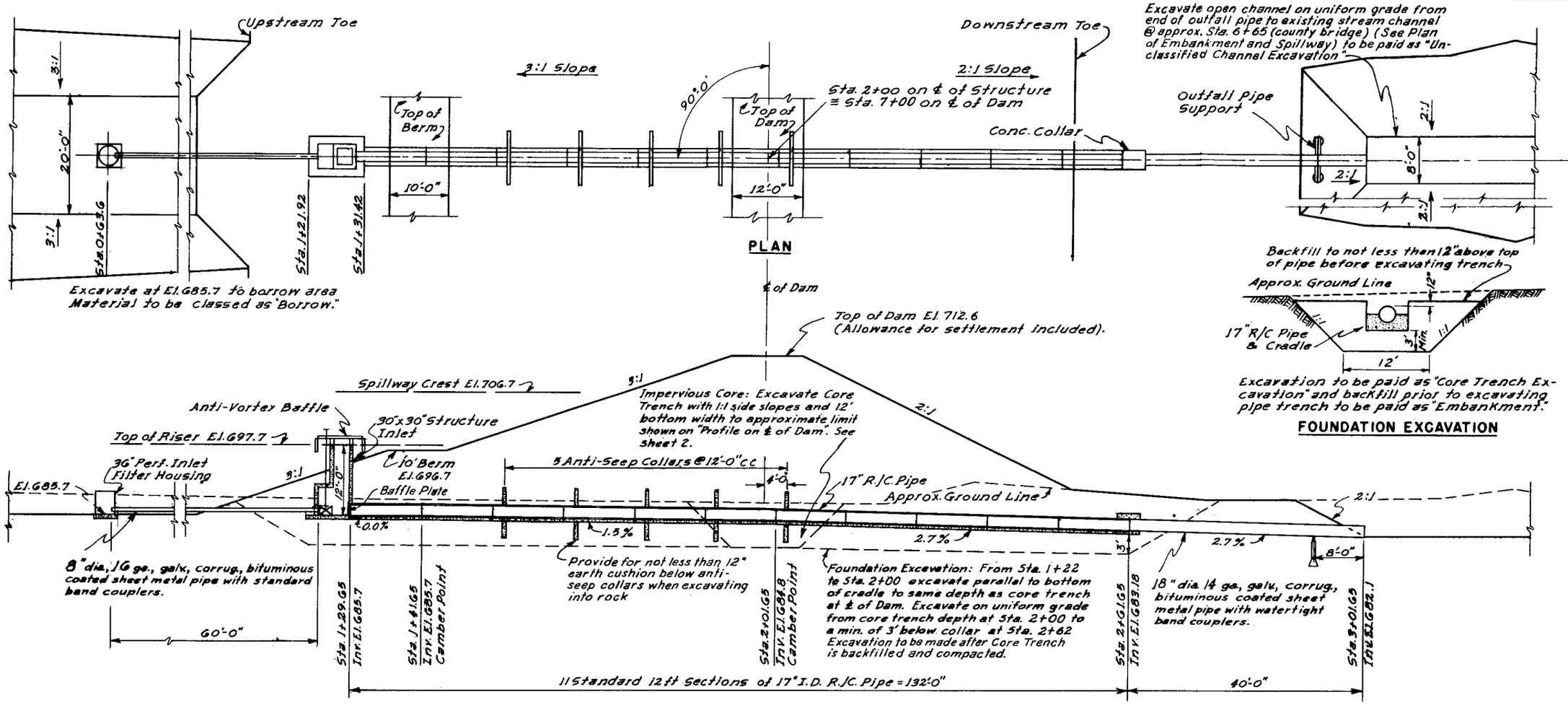
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

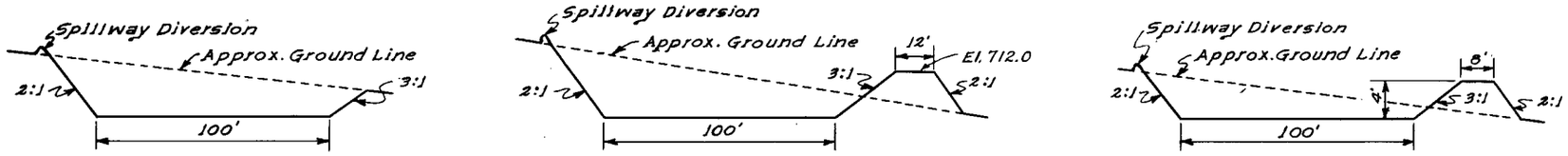
		Date
Designed	L.A.W.	6-56
Drawn	L.A.W. & G.R.	6-56
Traced	G.R.	6-56
Checked	L.A.W. & G.W.T.	7-56

Approved by: H. M. HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
STATE CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS

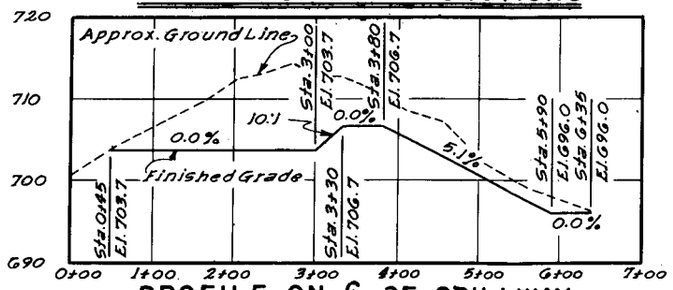
Sheet No. 3 of 7

Drawing No. 4-E-10,581





TYPICAL SPILLWAY SECTIONS



PROFILE ON ℄ OF SPILLWAY

Figure 4A
TYPICAL FLOODWATER RETARDING STRUCTURE
STRUCTURE—PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	L. A. W.	6-56	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	L. A. W. & G. R.	6-56	STATE CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS
Traced	G. R.	6-56	Sheet No. 3 of 7
Checked	L. A. W. & G. W. T.	7-56	Drawing No. 4-E-10,581

detain a minimum of 1.44 inches of runoff and to provide the additional storage needed for sediment. The limits of the flood pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, the storage capacity needed for floodwater detention and sediment storage in acre-feet and in inches of runoff from the drainage areas, the release rate of the principal spillway, the acres inundated by the sediment and the detention pools, the volume of fill in the dams, and the estimated cost of the structures (tables 2 and 3).

4. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and surveys of sample areas. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of peak discharge and volume of runoff as determined by flood routings. These flood routings were made using conditions without the project and future conditions assuming that the proposed works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of the effect of each on reduction of damages. In this manner it was determined that floodwater retarding structures could be economically justified. By further analysis those individual structures which had favorable benefit-cost ratios were determined. These were included in the plan.

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

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated and analyzed.

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities and other hydraulic characteristics, and on proposed structure sites to collect data used in design.

3. Determination was made of the hydrologic conditions of the watershed, taking into consideration such factors as soils, land use, topography, vegetative cover, and climate.

4. Determination was made of the rainfall-runoff relationship. This was then compared to nearby actual gaged runoff. The frequency of meteorologic events was determined from a curve developed by computing the plotting positions of historical series taken from climatological papers and water supply bulletins and plotting runoff and peak discharges on Hazen probability paper. The relationships of runoff, peak discharges and damages were determined for various frequencies.

5. Determination was made of peak discharges under present conditions, as related to damages caused by various peak discharge frequencies.

6. Determination was made of peak discharges and damages caused by various peak discharge frequencies which would exist due to floodwater retarding structures.

Due to scarcity of available meteorologic data and the high intensity thunderstorm patterns of this area, and after a study of the hydraulic and hydrologic characteristics, available data, topography and geology of this watershed and the types of damage occurring, it was determined that the annual flood frequency method should be used for analysis in this watershed. Due to the meteorologic and climatic conditions that prevail in this watershed, the possibility of establishing land treatment measures on the rangeland will be greatly limited. In view of these conditions, it was determined that land treatment measures would not materially affect the peak discharge.

The largest rain studied was the 100-year-frequency storm of 3.70 inches which would produce 1.20 inches of runoff. It was determined that this storm would produce a peak discharge of 28,000 cubic feet per second at cross section number 1, which is the reference section. This section is located approximately 0.5 mile north of the confluence of Diablo Arroyo and the Rio Grande. With structural measures for flood prevention in operation, a peak discharge of 2,220 cubic feet per second for the 100-year-frequency storm would be obtained. A runoff of 1.44 inches was used as the detention storage requirement in the floodwater retarding structures. Extremely poor spillway conditions and the difficulty of properly protecting them with vegetative cover make it imparative to so design the structure that emergency spillway flows are unlikely to occur. Consequently a runoff appreciably greater than the 100-year-frequency runoff of 1.20 inches was used.

Inflow hydrographs for structure design and minimum structure cost determinations were developed by the method described in Section V-15 of the Hydrology Guide, using the runoff as given by the Moisture Condition No. III curve. This amount of runoff would be produced by a 7-inch point rain in a period of six hours.

It was determined that crop and pasture damage began at a discharge of 12,400 cubic feet per second at cross section number 1, the control section; therefore, no storms producing less than this peak discharge were used in flood routing.

The channel capacity at the reference section is 26,600 cubic feet per second. The peak discharge at this point for the 100-year-frequency storm was 28,000 cubic feet per second. After installation and full functioning of the planned measures, the discharge at the same point would be reduced to 2,220 cubic feet per second.

Sedimentation Investigations

The field surveys of the sedimentation problems in the watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans", Water Conservation-6, SCS, Region 4, Revised February, 1954. Field studies to locate areas of damaging overbank deposits and to determine the extent of streambank erosion were made at many points along the length of the channel. A flood plain on Diablo Arroyo above the irrigated area is practically nonexistent. The nature of the damages on this watershed required a prediction of the annual sediment yield at the mouth of the watershed under both present and future conditions. This information was of particular importance, since the International Boundary and Water Commission expects to expend considerable sums of money annually in compliance with a treaty that requires removal of restrictive sediment from the Rio Grande, to which Diablo Arroyo is a heavy contributor. In preparation of the work plan, tabular summaries of all the above findings, with explanatory text, were prepared. These were used by the economist as a basis for calculating monetary damages.

Estimates of sediment storage requirements in the proposed floodwater retarding structures were based on detailed sedimentation surveys of floodwater retarding structures in the San Felipe watershed located nearby in the same land resource area. These rates were then adjusted for such factors as drainage area, size, topography, channel density, location of sediment-source areas, and other watershed characteristics. The use of aerial photographs and interviews with local people also furnished important information to the survey. Estimates of rates of sediment production were made for the areas above and below structures to estimate the present and future sediment yield at the mouth of the watershed.

Based on these studies, the total annual sediment yields above the proposed floodwater retarding structures were estimated as follows: 89 acre-feet from sheet and gully erosion and 8 acre-feet from channel enlargement. The estimated average annual production of sediment above structures is 1.8 acre-feet per square mile. The principal source of sediment is sheet erosion on rangeland; however, wind-blown sediment and sediment derived from channel and bank erosion are important contributors to the volume of damaging sediment in this watershed.

Effect of Watershed Treatment on Sediment Yields

The principal damage in this watershed is caused by sediment which restricts the flow of water into and in the Rio Grande and which must be removed in the future by the International Boundary and Water Commission.

No reduction in the annual volume of sediment produced at the mouth of the watershed through land treatment measures was indicated. Previous range management practices and dry weather conditions have reduced range cover to such an extent that any effective recovery in condition cannot be safely anticipated within the life of the project.

Geologic Investigations

Geologic reconnaissance investigations were made at the two floodwater retarding structure sites in the watershed. The lower structure site is located on cross-bedded alluvium which, when fully investigated, may call for changes from the normal design of floodwater retarding structures.

The soils in the borrow areas, although not laboratory tested, appear to be usable, for the most part. Some dangerously salty soils that may be contained in the borrow may be unusable, but soils of all textures will be usable at some place in the fill. From the geologic standpoint, the structures may be constructed of a clay core wall, sandwiched between upstream and downstream sections of gravel and sand. The cost of the two structures is expected to be above the average for those built of soft soils.

Economic Investigations

Determination of Annual Benefits from Reduction in Damage

Damage schedules covering all of the area previously damaged by floodwater from Diablo Arroyo were obtained from landowners or operators. These schedules covered land use and crop distribution, yields, and historical data on flooding and flood damages. From this information the damage area was outlined on a map. The damage area is alluvial and the floodwater will spread out in one or both directions until the flow is eventually dissipated. With this information it was decided to use the Overland Flow method of analysis as outlined in Chapter 2 in the Interim Economics Guide. Based on information obtained from the local people it was calculated that for each acre-foot of damaging floodwater, there would be .55 of an acre flooded.

The damage area does not include any range or pasture. In the calculation of crop damage, all expenses saved, such as cost of harvesting, were deducted from the gross value of the damage. The calculated rates of damages were applied to the acres flooded. The damages and benefits were discounted to allow for the following factors:

1. Sixty percent of tillable land will require five years to become productive after irrigation water becomes available.

2. Only 90 percent of the tillable land will be farmed, on the average, over the project life (due to droughts, high water tables, etc.).

3. A recurrence factor of .95 was applied to discount for the possibility of more than one damage-producing storm occurring in any one year.

Damage estimates to other agricultural property, such as irrigation canals, drains, and laterals, were obtained from an analysis of the damage schedules and correlated with size of floods. The major items of nonagricultural damage were those sustained by the highway and the railroad. Estimates of these damages were obtained from highway and railroad officials.

Since this irrigated area is highly productive, indirect damages are higher than normal. Information regarding damages of this type was obtained from farmers, cotton ginners, and other operators of business establishments. Upon analysis, it appeared that indirect damages amounted to at least 20 percent of the floodwater damage.

The chief item of damage is the sediment deposited in the Rio Grande channel. The International Boundary and Water Commission is obligated by treaty to maintain the channel of the Rio Grande to a certain size; thus, the cost of removing sediment and hauling it away in trucks is considered a damage. Records of the International Boundary and Water Commission were adequate for a reliable estimate of this cost. In the near future, acquisition of areas on which to spread the spoil will increase the cost. The cost, converted to long-term price levels, was applied to the volume of sediment deposited annually in the Rio Grande by Diablo Arroyo.

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 the production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pools. The land covered by the detention pool is already in range, so no change was projected in the land use of these areas.

Determination of Annual Benefits Outside Watershed Resulting from the Project

Damage to crops in other parts of the Irrigation District, when irrigation services are disrupted by floods originating in the project area, was considered. The district continues down the river from the project area for an additional 6.8 miles. It was estimated that storms of from 50- to 100-year-frequency would disrupt irrigation facilities to such an extent that one-third of the irrigated lands would have a 5-percent reduced yield.

Details of Methodology

In general, details of the procedures used in the investigation are described in the Interim Economics Guide for Watershed Protection and Flood Prevention, revised April 1, 1956.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Diablo Arroyo Watershed, Texas
Price Base: 1955

Structure Site Number	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST			Estimated Total Cost
	Contract	Contin-gencies	Installa-tion Services	Adm. and Misc.	Total Federal	Adm. of Contract	Easement and R/W	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	93,070	9,307	18,614	11,799	132,790	500	8,530	9,030	141,820
2	205,118	20,512	41,023	26,365	293,018	500	7,390	7,890	300,908
GRAND TOTAL	298,188	29,819	59,637	38,164	425,808	1,000	15,920	16,920	442,728

Date: January, 1957

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES

Diablo Arroyo Watershed, Texas

Item	Unit	Structure Number 1	Structure Number 2	Total
Drainage Area	Sq.Mi.	29.89	1/24.47	54.36
Storage Capacity				
Sediment Pool	Ac.Ft.	1,185	2,992	4,177
Floodwater Detention	Ac.Ft.	3,190	1,876	5,066
Total	Ac.Ft.	4,375	4,868	9,243
Surface Area				
Sediment Pool	Acres	84	169	253
Floodwater Detention Pool	Acres	267	275	542
Maximum Height of Dam	Feet	63.3	54.0	-
Volume of Fill	Cu.Yds	201,652	444,423	646,075
Emergency Spillway				
Type		Veg.	Veg.	xxx
Frequency of Use	Years	500	200	xxx
Design Storm Rainfall				
Duration	Hours	6	6	xxx
Total	Inches	5.46	5.56	xxx
Bottom Width	Feet	300	300	xxx
Design Depth	Feet	4.5	4.1	xxx
Design Capacity	C.F.S.	8,300	7,350	xxx
Total Freeboard 2/	Feet	6.5	6.1	xxx
Total Capacity	C.F.S.	14,950	13,550	xxx
Principal Spillway				
Capacity	C.F.S.	299	544	xxx
Capacity Equivalents				
Sediment Volume	Inches	.74	2.29	xxx
Detention Volume	Inches	2.00	1.44	xxx
Spillway Storage	Inches	1.08	1.30	xxx
Class of Structure		B	B	xxx

1/ Excluding the area from which runoff is controlled by structure No. 1.
2/ Difference between spillway crest elevation and elevation of the top of the dam.

Date: January, 1957

TABLE 4 - SUMMARY OF PHYSICAL DATA

Diablo Arroyo Watershed, Texas

Item	Unit	Quantity Without Program	Quantity With Program
Watershed Area	Sq.Mi.	64.05	xxx
Watershed Area	Acres	40,992	xxx
Area of Cropland	Acres	4,046	4,046
Area of Grassland	Acres	36,441	36,441
Area Damaged Annually by:			
Streambank Erosion	Acres	3.690	2.744
Sheet Erosion	Acres	35,709	35,709
Sediment Yield, Total 1/	Cu. Yds.	188,836	39,252
Sediment Yield, Damaging 2/	Cu. Yds.	143,035	18,714
Average Annual Rainfall	Inches	8.31	xxx

1/ Total sediment yield to damage area, including nondamaging sediment passed out of project area.

2/ Quantity of damaging sediment to be removed from confluence of Diablo Arroyo and Rio Grande.

Date: January, 1957

TABLE 5 - SUMMARY OF PLAN DATA

Diablo Arroyo Watershed, Texas

Item	Unit	Quantity
Years to Complete Program	Year	2
Total Installation Cost		
Federal	Dollar	425,808
Non-Federal	Dollar	16,920
Annual O & M Cost		
Federal	Dollar	0
Non-Federal	Dollar	616
Average Annual Monetary Benefits	Dollar	23,423
Agricultural	Percent	19
Nonagricultural	Percent	81
Structural Measures		
Floodwater Retarding Structures	Each	2
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acre	0
Sediment Pool	Acre	0
Upland		
Detention Pool	Acre	289
Sediment Pool	Acre	253
Watershed Area Above Structures	Acre	34,790
Reduction of Floodwater Damage	Dollar	4,225
By Land Treatment Measures	Percent	0
By Structural Measures	Percent	100
Reduction of Sediment Damage	Dollar	18,014
By Land Treatment Measures	Percent	0
By Structural Measures	Percent	87

Date: January, 1957

TABLE 6 - ANNUAL COSTS

Diablo Arroyo Watershed, Texas

Structure Site Number	Amortization of Installation Costs 1/			Operation and Maintenance Costs 2/			Total
	Federal	Non-Federal	Total	Federal	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
1 and 2	15,013	597	15,610	-	616	616	16,226
TOTAL	15,013	597	15,610	-	616	616	16,226

1/ 1955 prices amortized for 50 years at 2.5 percent.

2/ Long-term prices, as projected by BAE, 1951.

Date: January, 1957

TABLE 7 - SUMMARY OF MONETARY BENEFITS

Diablo Arroyo Watershed, Texas

Price Base Long-Term 1/

Item	Estimated Average Annual Damages: Without Project (dollars)	After Land Treatment For W/S Protection (dollars)	With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	2,654	2,654	0	2,654
Other Agricultural	688	688	0	688
Nonagricultural				
Roads and Bridges	883	883	0	883
Subtotal	4,225	4,225	0	4,225
Sediment Damage				
Channel	20,726	20,726	2,712	18,014
Subtotal	20,726	20,726	2,712	18,014
Erosion Damage	0	0	0	0
Indirect Damage	845	845	0	845
Total, All Damage	25,796	25,796	2,712	23,084
Benefit Outside Project Area	xxx	xxx	xxx	339
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	23,423
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	23,423

1/ As projected by BAE, 1951

Date: January 1957

TABLE 8 - BENEFIT COST ANALYSIS

Diablo Arroyo Watershed, Texas

Structure Site Number	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention					Average Annual Cost 2/	Benefit-Cost Ratio
	Flood-water	Sediment	Indirect	Other	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
1 and 2	4,225	18,014	845	339	23,423	16,226	1.44:1
GRAND TOTAL	4,225	18,014	845	339	23,423	16,226	1.44:1

1/ Long-term price levels as projected by BAE, 1951.

2/ Derived from installation costs based on 1955 price level and operation and maintenance cost based on long-term price level, as projected by BAE, 1951.

Date: January, 1957

TABLE 9 - COST-SHARING SUMMARY

Diablo Arroyo Watershed, Texas

Price Base 1955 1/

Type of Cost	Federal Cost		Non-Federal Cost		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Structural Measures						
Installation Flood Prevention	425,808	96	16,920	4	442,728	96
Operation & Maintenance 2/	-	-	17,471	100	17,471	4
Total-Structural Cost	425,808	93	34,391	7	460,199	100
TOTAL PROJECT COST	425,808	93	34,391	7	460,199	100

1/ Except operation and maintenance, which is based on long-term prices, as projected by BAE, 1951.

2/ Capitalized for 50 years at 2.5 percent.

Date: January, 1957