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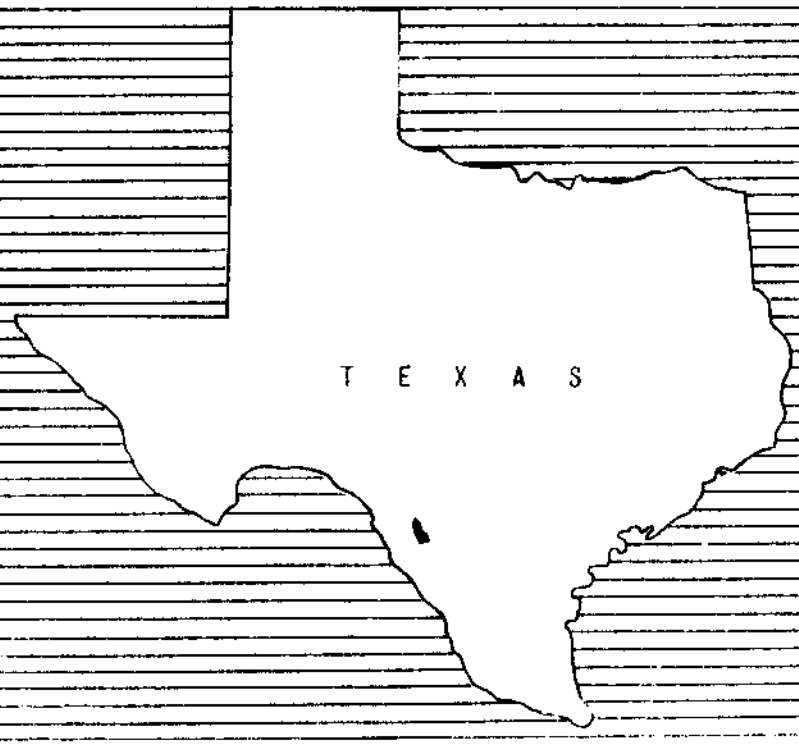
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

LEONA RIVER WATERSHED

UVALDE COUNTY, TEXAS



January, 1973

4-29744 REVISED 10-74
USDA-SCS-FORT WORTH, TEX. 1974

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ADDENDUM

LEONA RIVER WATERSHED, TEXAS

The purpose of this addendum is to include in the work plan certain requirements of the Principles and Standards which are: Part I - Benefit to cost comparisons; Part II - Abbreviated four account displays; and Part III - Abreviated Environmental Quality Plan.

PART I

This addendum shows the project cost, benefits, and benefit-cost ratio hased on a 5 7/8 percent interest rate, current normalized prices and the 1973 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1.	Project costs are	$129,340
2.	Project benefits are	$252,000
3.	The project benefit-cost ratio is	1.9 to 1.0

PART II

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Leona River Watershed, Texas

Components	Measures of effects 1/
Beneficial effects:	
A. The value to users of increased outputs of goods and services	
1. Flood prevention	$173,190
2. Incidental groundwater recharge	$ 33,000
Total beneficial effects	$206,190

Components	Measures of effects 1/
Adverse effects:	
A. The value of resources required for a plan	
1. Four floodwater retarding structures and channel work	
a. Project installation	$ 97,120
b. Project administration	11,430
c. Operation and maintenance	4,270
Total adverse effects	$112,820
Net beneficial effects	$ 93,370

1/ Average annual

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Selected Plan

REGIONAL DEVELOPMENT ACCOUNT

Leona River Watershed, Texas

Components	Measures of effects 1/ Region 2/	Measures of effects 1/ Rest of Nation
A. Income:		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region.		
a. Flood prevention	$173,190	----
b. Incidental ground water	33,000	----
c. Secondary	19,980	----
Total beneficial effects	$226,170	----

Components	Measures of effects 1/ Region 2/	Measures of effects 1/ Rest of Nation
A. Income:		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Four floodwater retarding structurea and channel work.		
Project installation (structural measures)	$ 15,870	$ 81,260
Project administration	278	11,150
Operation and maintenance	4,270	---
Total adverse effects	$ 24,410	$ 92,410
Net beneficial effects	$205,760	$-92,410

1/ Average annual

2/ The region consists of Uvalde County, Texas

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Selected Plan
REGIONAL DEVELOPMENT ACCOUNT (continued-2)

Leona River Watershed, Texas

Components	Measures of effects: Region 1/	Measures of effects: Rest of Nation
B. Employment		
Beneficial effects:		
1. Increase in the number and types of jobs.		
a. Agricultural employment.	6 permanent semi-skilled jobs.	---
b. Employment for project construction.	67 man-years of semi-skilled employment during the installation period (5 years).	---
Total beneficial effects	6 permanent semi-skilled jobs.	---
	67 man-years of semi-skilled employment over the installation period (5 years).	---

Components	Measures of effects: Region 1/	Measures of effects: Rest of Nation
B. Employment:		
Adverse effects:		
1. Decrease in number and types of jobs.	0	0
Total adverse effects	0	0
Net beneficial effects	6 permanent semi-skilled jobs.	
	67 man-years of semi-skilled employment over the installation period (5 years).	

1/ The region consists of Uvalde County, Texas

September, 1974

Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT

Leona River Watershed, Texas

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. Project output will make available regional funds and resources that can be used to enhance the physical appearance of 75 farms and ranches on 7,352 acres of agricultural flood plain and 30 business and 380 residential properties on 745 acres of urban flood plain land.
	2. Provide a diversity of landscape by application of land treatments measures such as brush management.
	3. Create an open-space within the City of Uvalde along the Cooks Slough channel.
	4. Temporarily inundate 50 acres of cropland and 1,218 acres of rangeland needed for sediment pools below the lowest ungated outlets.
B. Quality considerations of water and land resources.	1. Reduce floodplain erosion on 183 acres of agricultural land.
	2. Reduce sediment deposition on 231 acres of agricultural cropland.
	3. Sediment leaving the watershed will be reduced by an average of 12 acre-feet annually. Suspended sediment concentration carried by runoff water leaving the watershed will be reduced from 1,300 to 900 mgl.
	4. Initially reduce the average annual volume of streamflow at the bottom of the watershed 1.9 percent.
C. Biological resources and selected ecosystems.	1. Enhance habitat and food supply for most wildlife species throughout the watershed.

Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT - Continued

Leona River Watershed, Texas

Components	Measures of effects
D. Irreversible or irretrievable commitments.	1. Conversion of 662 acres of cropland, rangeland, pastureland, and stream channels to dams, emergency spillways, sediment pools, excavated channel, berms, and maintenance rights-of-way.
	2. Materials, labor, equipment, fuel, and capital used in construction, operation, and maintenance will be irreversibly committed.

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT (Continued-3)

Leona River Watershed, Texas

Components	Measures of effects	
	Region 1/	Rest of Nation
C. Population Distribution		
Beneficial effects	Create 6 permanent semi-skilled jobs in a rural area and 67 man-years of semi-skilled employment over the installation period (5 years)	---
Adverse effects	---	---
D. Regional Economic Base and Stability		
Beneficial effects	Create 6 permanent semi-skilled jobs and 67 man-years of semi-skilled employment over the installation period (5 years). Reduce flood hazard on about 8,097 acres of flood plain. Reduce flood hazard to owners and occupants of about 380 homes and 30 businesses in Uvalde.	
Adverae effects	---	---

1/ The region consists of Uvalde County, Texas

September, 1974

Selected Plan

SOCIAL WELL-BEING ACCOUNT

Leona River Watershed, Texas

Components	Measures of Effects
Beneficial and adverse effects:	
A. Real Income distribution	1. Create 6 permanent semi-skilled jobs and 67 man-years of semi-skilled employment over the installation period (5 years).
	2. Create regional income benefit distribution of $252,000 benefits by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	11	16
3,000 - 10,000	27	44
More than 10,000	62	40

	3. The average annual local cost of $20,410 will be borne by the City of Uvalde and Uvalde County and financed by tax revenue. The percentages of contribution to local costs by income classes is not readily available.
B. Life, health, and safety	1. Provide protection from the 100-year event to 380 houses and 30 businesses in Uvalde with population of 10,764 in 1970. Future threats of loss of life and displacements during floods will be eliminated.

September 1974

PART III

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

LEONA RIVER WATERSHED, TEXAS

Environmental quality largely determines the degree to which man is able to exist in harmony with his environment. This plan was developed for the Leona River Watershed in an effort to identify conditions which affect the quality of the watershed environment and to provide a plan of action to meet environmental quality objectives. Environmental quality objectives of the plan are the preservation or enhancement of areas of natural beauty, conservation and improvement of the soil, water, air and related resources, and the preservation and enhancement of biological resources and ecosystems of the watershed.

A study of existing conditions within the watershed indicates that damage caused by flooding and inadequate treatment of agricultural lands constitute the most significant environmental quality problems. Flooding causes monetary and property losses, disruption of normal human activity, and concern for life and property. Lack of adequate conservation land treatment has resulted in the deterioration of soil, plant, water, and related resources including ecosystems with wildlife habitat value.

Inadequate land treatment results in a loss of the soils resource through erosion, sediment damage to urban and agricultural areas, increased pollution of surface water and less recharge of the Leona Aquifer. Flooding and inadequate land treatment detracts from the appearance of the watershed.

Standing water in Cooks Slough, the Leona River and urban areas create a vector problem for area residents. Additional recreational facilities and open space are needed. Air pollution from unpaved streets and confined livestock operations detract from the environmental quality of the watershed.

The watershed is located in the Edwards Plateau and South Texas Plains vegetational areas of Texas.[1/] The Edwards Plateau portion of the watershed is predominately rangeland with shallow soils underlain by limestone or caliche. The South Texas Plains portion of the watershed is primarily rangeland with cropland confined to the deeper soils, valley bottoms, and areas near towns. The topography is level to rolling and is dissected by stream courses.

Component needs for solving problems related to specific environmental conditions are listed below.

1. Areas of Natural Beauty

    a. Reduce upland erosion, tributary gully erosion, and the resultant deposition of sediment and debris.

1/ Gould, F. W.-Texas Plants--A checklist and Ecological Summary, Texas Agricultural experiment Station, 1962.

b. Provide a diversity of landscapes.

c. Landscape existing open pits.

d. Provide for disposal of solid wastes.

e. Create additional open space and preserve Fort Inge as a historic site.

2. Quality of Water, Land, and Air Resources

a. Improve the quality of streamflow by reducing the amount of sediment delivered to streams and lakes from gully and sheet erosion.

b. Protect the soils resource from deterioration by reducing erosion and sediment deposition.

c. Maintain or improve the productivity of cropland and grassland.

d. Improve air quality by reducing dust from unpaved streets and odors from confined feedlot operations.

e. Prevent flood damage to homes, businesses, transportation systems, and utilities.

f. Prevent flood damage to agricultural land.

g. Increase the amount of recharge to the Edwards and Leona underground aquifers.

h. Reduce the amount of solid wastes and debris entering streams.

i. Reduce the potential for damage to future floodplain development.

j. Prevent contamination of surface and underground water reaources.

k. Improve urban drainage.

3. Biological Resources and Ecosystems.

a. Eliminate the vector problem in Cooks Slough and the Leona River.

b. Preserve and improve habitat conditions for fish and wildlife by:

1. Creating additional fishery habitat.

2. Providing improved food supplies for wildlife.

3. Conducting research and providing information to land users concerning natural ecosystem use.

4. Providing technical assistance to land users in the application of brush management.

5. Reducing sediment and water pollutants, which enter streams and lakes.

6. Reducing the incidence of flooding for protection of ground nesting species.

The plan elements for environmental quality consist of land treatment measures, structural measures, shaping and vegetation measures, research, information activities, land acquisition, and land use controls.

Land treatment measures would consist of conservation cropping systems, crop residue use, irrigation systems, terraces, diversions and waterways on cropland. Conservation treatment measures on rangeland would consist of proper grazing use, planned grazing systems, brush management, deferred grazing, range seeding, and livestock water installations. Wildlife upland habitat management practices would be applied on cropland and rangeland which has a secondary use as wildlifeland. Land users would be assisted in the application and maintenance of these measures by the Nueces-Frio-Sabinal Soil and Water Conservation District with technical assistance provided by the Soil Conservation Service. Financial assistance on a cost-share basis is available through the Rural Environmental Conservation program administered by the Agricultural Stabilization and Conservation Service. Loans for the application of needed soil and water conservation measures are available through the Farmers Home Administration.

Installation of four floodwater retarding structures and channel work on Cooks Slough would reduce rural and urban flooding, sediment deposition, and sediment pollution to streams and lakes in the watershed. These elements would be implemented by local units of government with assistance from the Soil Conservation Service. Financial assistance would be provided through the PL-566 Small Watershed Program.

Shaping and revegetation on 200 acres, and the installation of three grade stabilization structures in the lower portion of the watershed would control gully erosion and resultant sedimentation. These elements would be implemented jointly by land users and local units of government with technical assistance by the Soil Conservation Service.

Fort Inge would be restored and a 50 acre recreational area with rest rooms and recreational facilities would be provided. One hundred and seventy five acres along Cooks Slough would be landscaped, fenced and devoted to open space and recreation. Outdoor study areas and nature trails would be provided for public use and enjoyment. These elements would be implemented by local units of government. Grant assistance would be available from the Bureau of Outdoor Recreation.

A 5,000 acre research area for range, wildlife, and other ecosystems study would be provided for use by the Agricultural Extension Service, Texas Agricultural Experiment Station, Southwest Texas Junior College and other agencies. This element would be implemented by Texas A & M University.

A 350 acre area would be obtained and developed for a sanitary land fill for use by the city of Uvalde and Uvalde County. This element would be implemented by the city of Uvalde and the Uvalde County Commissioners Court.

About 10 miles of city streets would be paved, curbed and guttered. About 6.6 miles of buried interceptor systems and needed surface drainage facilities would be installed. This element would be implemented by the city of Uvalde.

Flood plain restrictions on development of flood prone areas of Cooks Slough and the Leona River below the corporate city limits of Uvalde would be enacted. The city of Uvalde and the County Commissioners Court would implement this segment of the plan.

The estimated installation costs of elements of the environmental quality plan are as follows:

1.	Four floodwater retarding structures and channel work on Cooks Slough	$1,964,400
2.	50 acres and rehabilitation of Fort Inge and development of recreational facilities	$ 450,000
3.	5,000 acre area for range, wildlife, and ecosystems study	$1,000,000
4.	350 acre area for sanitary land fill	$ 262,500
5.	Technical and financial assistance to complete land treatment measures	$ 540,000
6.	Pave, curb, and gutter 10 miles of city streets	$1,320,000
7.	Floodplain restrictions on the Leona River and Taylor Slough below the corporate limits of Uvalde	$ 20,000
8.	Landscape, fence, and develop 175 acres along Cooks Slough and the Leona River	$ 118,000
9.	200 acres of grading, shaping, and vegetating and 3 grade stabilization structures	$ 250,000
10.	6.6 miles of buried interceptor systems and surface drainage	$ 350,000
	The total installation cost of the environmental quality plan is estimated to be	$6,274,900

The environmental effects which would result from the installation of the environmental quality plan are as follows.

1. Areas of Natural Beauty

   a. Provide 175 acres along Leona River and Cooks Slough for public use as green belt, open space, and recreation areas.

   b. Increase diversity of flora by establishing desired vegetation in open areas of floodplain on 175 acres.

   c. Rehabilitate 50 acres of gravel pits and disturbed areas.

   d. Eliminate unsightly open dumps and reduce the occurrence of litter.

   e. Improve esthetics of Leona River, Fort Inge Site, and county lake area by creation of a park-like atmosphere.

   f. Provide a diversity of landscape through planned land use.

   g. Eliminate unsightly areas of active erosion on side tributaries in lower portion of watershed.

   h. Provide nature trails and outdoor study areas along Leona River, Cooks Slough and county lake area for public use and enjoyment.

   i. Reduce above ground transmission lines and eliminate structural disruption to the natural environment in developing areas and the city.

2. Quality of Water, Land and Air Resources

   a. Improve the quality of water in Leona River and its tributaries by:

      1. Reducing sediment being delivered to streams and county lake from streambank erosion, flood plain scour, and sheet erosion.

      2. Installation of needed sanitary facilities.

      3. Reduce turbidity of water in Leona River and County Lake.

      4. Sustain underground irrigation water by improving all surface irrigation systems on 9,000 acres of irrigated cropland.

b. Maintain and enhance the productivity of the land resource base.

c. Protect the land resource base from further deterioration by reducing sheet erosion, flood plain scour, streambank erosion, and sediment deposition by maintaining application of a land treatment program.

d. Improve the quality of air by:

1. Eliminating traffic-induced dust within the city by paving 10 miles of streets.

2. Elimination of livestock odors through construction of adequate pollution abatement systems of stock yards and confined feedlot operations.

3. Prevent destruction of houses, business, transportation and utility systems and sources of livelihood of human inhabitants by flooding.

3. Biological Resources and Ecosystems

a. Improve the fisheries resource of county lake and permanent water reach in Leona River.

b. Improve the quality of habitat for wildlife through proper management of agricultural lands.

c. Provide an area of biological uniqueness within the 175 acre tract dedicated along the stream courses of Leona River and Cooks Slough.

d. Alter upland Wildlife habitat on about 462 acres of agricultural land.

e. Acquire an area of 5,000 acres for use as a research station to study land use as it affects natural ecosystems.

4. Archeological and Historic Resources

a. Survey, identify, collect, and record significant archeological resources directly affected by project installation. Place such findings and history in local museum for educational purposes.

b. Provide public access to and knowledge about Fort Inge with full restoration for watershed residents and public.

5. Irreversible or Irretrievable Commitments

   a. Commit about 1,930 acres of land now being used for agricultural, urban, existing channel, and miscellaneous use for Flood Prevention Project purposes.

   b. Commit an additional 200 acres of urban, agricultural and stream channel for public enjoyment of open space, preserve riparian vegetation and beauty.

   c. Commitment of labor, energy, and materials for total project construction.

   d. Commit about 350 acres of land now being used for agricultural use for sanitary land fill site.

WATERSHED WORK PLAN AGREEMENT

between the

Nueces-Frio-Sabinal Soil and Water Conservation District
Local Organization

Uvalde County Commissioners Court
Local Organization

City of Uvalde
Local Organization

Edwards Underground Water District
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Texas

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 Leona River Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended; 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 Leona River 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 can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. Except as hereinafter provided, the Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated Cost $276,090). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Land Rights Cost (dollars)
4 Floodwater Retarding Structures	100	0	145,190
Channel Improvement	100	0	130,900

2. The Sponsoring Local Organization will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the sponsoring local organization will comply with the real property acquisition policies contained in said Act and Regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

   The Service will bear 100 percent of the first $25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of $25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the sponsoring local organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	30.04	69.96	36,730

3. 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.

4. The percentages of construction costs of structural measures 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)
4 Floodwater Retarding Structures	0	100	942,790
Channel Improvement	0	100	431,950

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
4 Floodwater Retarding Structures	0	100	48,470
Channel Improvement	0	100	21,600

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $4,980 and $201,790 respectively.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and 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 is not a fund obligating document. 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.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. 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.

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.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Nueces-Frio-Sabinal Soil and Water Conservation District
Local Organization

By Mike Q. Smith

Title Chr. Board

Address Sabinal 75881
Zip Code

Date 5-23-72

The signing of this agreement was authorized by a resolution of the governing body of the Nueces-Frio-Sabinal Soil and Water Conservation District
Local Organization

adopted at a meeting held on March 14, 1972

Royal C. Stoner
(Secretary, Local Organization)

Address Uvalde 78801
Zip Code

Date 5-23-72

Uvalde County Commissioners Court
Local Organization

By [illegible]

Title [illegible]

Address [illegible]
Zip Code

Date [illegible]

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

adopted at a meeting held on May 25, 1972

Mrs Elaine M. Smith
(Secretary, Local Organization)

Address Box 284 Uvalde Tex 7880
Zip Code

Date 5-25-72

City of Uvalde
Local Organization

By [illegible]

Title Mayor

Address Box 799 Uvalde 78801
Zip Code

Date May 23, 1972

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

adopted at a meeting held on April 27, 1972

[illegible]
(Secretary, Local Organization)

Address Box 799 Uvalde 78801
Zip Code

Date May 23, 1972

Edwards Underground Water District
Local Organization

By Rodney Earl Krueger

Title Uvalde County Area Chairman

Address RH Knippa Texas 78870
Zip Code

Date May 23, 1972

The signing of this agreement was authorized by a resolution of the governing body of the Edwards Underground Water District
Local Organization

M.A. Kimble
(Secretary, Local Organization)

Address Box 142, Uvalde Texas 78801
Zip Code

Date 5-23-72

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

By Edward E. Thomas
State Conservationist

Date Oct. 25, 1974

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

LEONA RIVER WATERSHED

Uvalde County, 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:

Nueces-Frio-Sabinal Soil and Water Conservation District
(Sponsor)

Uvalde County Commissioners Court
(Sponsor)

City of Uvalde
(Sponsor)

Edwards Underground Water District
(Sponsor)

With Assistance By:

U.S. Department of Agriculture
Soil Conservation Service
January 1973

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USDA-SCS-FOSF WOSSH, 73P, 1033

WATERSHED WORK PLAN

LEONA RIVER WATERSHED

January 1973

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for Leona River watershed has been prepared by the Nueces-Frio-Sabinal Soil and Water Conservation District, Uvalde County Commissioners Court, City of Uvalde, and the Edwards Underground Water District as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources of the watershed.

Financial assistance in developing the work plan was provided by the Texas State Soil and Water Conservation Board and the Edwards Underground Water District.

Leona River watershed comprises an area of 172 square miles in Uvalde County. It is estimated that 74.3 percent of the watershed is rangeland, 16.1 percent is cropland, 2.7 percent is pasture and hayland, and 6.9 percent is in miscellaneous uses such as the City of Uvalde, a National Fish Hatchery, public roads, railroads, farm and ranch headquarters, and stream channels.

The principal problem within the watershed is one of frequent and extensive flooding on portions of the 8,097 acres of flood plain which results in damages to crops, grasses, soils, agricultural properties, residential and commercial properties, roads, bridges, and railroad properties. The total floodwater, sediment, flood plain erosion, and indirect damages are estimated to average $191,870 annually.

The work plan proposes installing, in a five-year period, needed land treatment measures, four floodwater retarding structures, and approximately 18,300 feet of channel improvement. Land treatment measures included are those which contribute directly to watershed protection and reduction of floodwater damages.

The total project installation cost is estimated to be $2,390,200 including $425,800 for installation of planned land treatment and $1,964,400 for structural measures. The share of total project installation cost from sources other than Public Law 566 funds is estimated to be $717,900, and the Public Law 566 share is estimated to be $1,672,300. The Public Law 566 cost share for structural measures is estimated to be $1,672,300, and the local share is estimated to be $292,100.

Average annual damages will be reduced from $191,870 to $19,820 by the proposed project. Average annual benefits accruing to structural measures in the watershed will be $226,170, which includes $169,190 damage reduction

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benefits, $33,000 incidental ground water recharge benefits, $4,000 damage reduction benefits on the main stem of Leona River outside the watershed, and $19,980 secondary benefits. The ratio of total average annual benefits accruing to structural measures ($226,170) to the average annual cost of these measures ($112,820) is 2.0:1.0.

Land treatment measures will be operated and maintained by owners and operators of the land upon which the measures will be applied under agreement with the Nueces-Frio-Sabinal Soil and Water Conservation District. The Uvalde County Commissioners Court will be responsible for operation and maintenance of the floodwater retarding structures. The City of Uvalde will be responsible for operation and maintenance of the channel improvement. The cost of operation and maintenance for all structural measures is estimated to be $4,270 annually.

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DESCRIPTION OF WATERSHED

Physical Data

The Leona River watershed project area lies in southwestern Texas about 85 miles west of San Antonio. The lower limit of the watershed project area, as included in the work plan, is the Uvalde-Zavala County boundary. The entire project area is within Uvalde County and excludes tributaries which join the Leona River downstream from the southern boundary of Uvalde County (figure 7). The project area comprises 172 square miles (110,080 acres).

Rising in central Uvalde County about 14 miles north of the City of Uvalde, the Leona River flows southward through Uvalde, thence southeastward into Zavala County. Continuing its southeasterly course, the Leona River enters the Frio River in southern Frio County. The Frio River joins the Nueces River near the town of Three Rivers in Live Oak County. The Nueces River flows through Lake Corpus Christi and into Nueces Bay on the Gulf of Mexico.

Cooks and Taylor Sloughs are major tributaries of the Leona River within the project area. Cooks Slough flows across the western portion of Uvalde while Taylor Slough skirts the eastern edge of the City. Boon Slough is another tributary which joins Cooks Slough immediately upstream from Uvalde.

Stream courses in the watershed are well defined and generally unaltered from their natural state. However, some landowners have attempted on an individual basis to enlarge,straighten, and levee portions of stream channels. The City of Uvalde has altered a segment of channel within the city to alleviate flooding from Leona River. Stream flow in the watershed is ephemeral with exception of a portion of mainstem Leona River downstream from vicinity of Farm and Ranch Road 140, which is intermittent (see figure 7, Project Map).

The Balcones fault zone, a system of northeastward trending normal faults with upthrown sides generally on the northwest, crosses the watershed and separates two major land resources areas. Uvalde lies within the fault zone, the width of which extends about seven miles north and three miles south of Uvalde (figure 6). The Edwards Plateau Land Resource Area, underlain by Lower Cretaceous limestone and shale, is characterized by shallow soils and rough broken slopes. It lies mainly to the northwest of major displacement in the fault zone and occupies about 30 percent of the watershed.

The Rio Grande Plain Land Resource Area lies mostly within and to the southeast of the fault zone and comprises about 70 percent of the watershed. Its topography is mostly gently rolling to nearly level, but occasional hills with moderate to strong relief are common. Most of the bedrock is covered by thick alluvium deposited by ancient streams which flowed southward from the Edwards Plateau. The older deposits (Uvalde Gravel) have been dissected by erosion which was triggered by uplift of the area. As a result, the Uvalde Gravel presently occupies topographically high areas. Alluvium of the younger Leona Formation lies at lower elevations and has been only slightly altered by erosion. Thus, ancient valleys of late Pleistocene streams remain strongly evident (figure 6). The most significant one is a broad plain extending westward from Uvalde across the poorly defined water-

shed divide and into the Nueces River Valley. Another one is a more narrow valley presently occupied by Taylor Slough. It extends about 10 miles north-northeastward from Uvalde, crosses the watershed divide, and joins the valley of the Dry Frio River. A third but smaller valley, presently occupied by Cooks Slough, extends northwestward from Uvalde into the valley of Indian Creek. The present Leona River has cut a relatively narrow, deep channel into the alluvium of the Leona Formation downstream from Uvalde.

Watershed elevations range from about 1,600 feet above mean sea level along the northwestern divide in the Edwards Plateau to about 770 feet where the Leona River leaves Uvalde County.

Geologic strata exposed in the watershed range in age from Recent to Lower Cretaceous (figure 6). The units which crop out within the watershed and the approximate area of each outcrop are shown on tabulation A (page 5).

The harder, more pure limestone beds have undergone considerable solution, especially within the Georgetown and Edwards Formations. In the Balcones fault zone, where the limestone beds are highly fractured, a large system of interconnected cavities and caverns exists. The pattern of the system tends to be most pronounced along and parallel to the faults and fractures. Similar conditions occur along the entire Balcones fault zone, which extends more than 200 miles from west of Uvalde eastward to San Antonio and thence northeastward to the vicinity of Georgetown in Williamson County. A vast ground water reservoir lies beneath the surface in the fault zone. This reservoir is most pronounced in parts of Kinney, Uvalde, Medina, Bexar, Comal, and Hays Counties where it is known as the Edwards Underground Reservoir. In Uvalde County this limestone reservoir is composed primarily of the Georgetown, Kiamichi, Edwards, and Comanche Peak Formations which behave as a single hydrologic unit. The Geological Survey, U.S. Department of the Interior, refers to these formations as the Edwards and associated limestones. Streams which cross the fault zone, losing most of their flow, are the primary source of recharge to the aquifer.

Natural outlets for ground water which occur within the watershed are along the Leona River downstream from Uvalde where springs issue from gravel beds of the Leona Formation. The source for these springs is ground water discharging from the Edwards and associated limestones into the Leona Formation. The Geological Survey reports that these two aquifers are hydrologically connected in some places. There is no spring flow on the Leona River upstream from Uvalde.

Rains of low to moderate intensity, falling on the Leona River watershed above Uvalde, mostly disappear into the porous rocks in the fault zone and contribute only meager volumes of direct runoff to the Rio Grande Plain. High intensity rains, however, produce flood flows which greatly exceed the infiltration capacity of the fault zone resulting in heavy flooding downstream.

The municipal water supply for Uvalde is obtained from wells in the Edwards Underground Reservoir. Water for livestock and rural domestic use is supplied by wells and surface ponds. In the Leona River Valley, southeast of Uvalde, large supplies of water for irrigation are pumped from gravel beds of the Leona Formation and from the Edwards and associated limestones.

Tabulation A

EXPOSED GEOLOGIC STRATA

System	Series	Group	Formation	Lithology of Outcrop	Approximate Thickness in Watershed Vicinity (Feet)	Approximate Area of Outcrop Within Watershed (Acre)
Quaternary	Recent		Alluvium	Clay, silt, sand, and gravel	20	57,240
	Pleistocene		Leona	Clay, silt, sand, gravel, and cobbles	70	
Tertiary	Pliocene		Uvalde Gravel	Gravel, cobbles, silt, clay, sand, and caliche	15	13,070
	Eocene	Wilcox	Indio	Poorly cemented, thin bedded, clayey sandstone, and sandy shale	150	1,890
Tertiary or Late Cretaceous			(Intrusive Igneous)	Mostly basalt plugs, dikes, and sills		2,260
Cretaceous	Gulf (Upper Cretaceous)	Navarro	Escondido	Fine-grained sandstone interbedded with shale and clay	285 ±	130
		Taylor	Anacacho Limestone	Limestone and bentonitic clay	500 ±	220
		Austin	Austin Chalk	Thin bedded to massive, chalky limestone and calcareous shale	400 ±	1,480
		Eagle Ford	Eagle Ford	Interbedded flaggy limestone snd calcareous shale	150	1,340
	Comanche (Lower Cretaceous)	Washita	Buda Limestone	Hard, massive limestone	80	12,290
			Grayson	Calcareous, shaley clay containing thin fossiliferous limestone beds and interspetsed gypsum	90	
			Georgetown Limestone	Hard, massive, vugular limestone	350	20,160
		Fredericks-burg	Kiamichi	Flaggy limestone and shale	175	
			Edwards Limestone	Hard, massive, vugular limestone	75	

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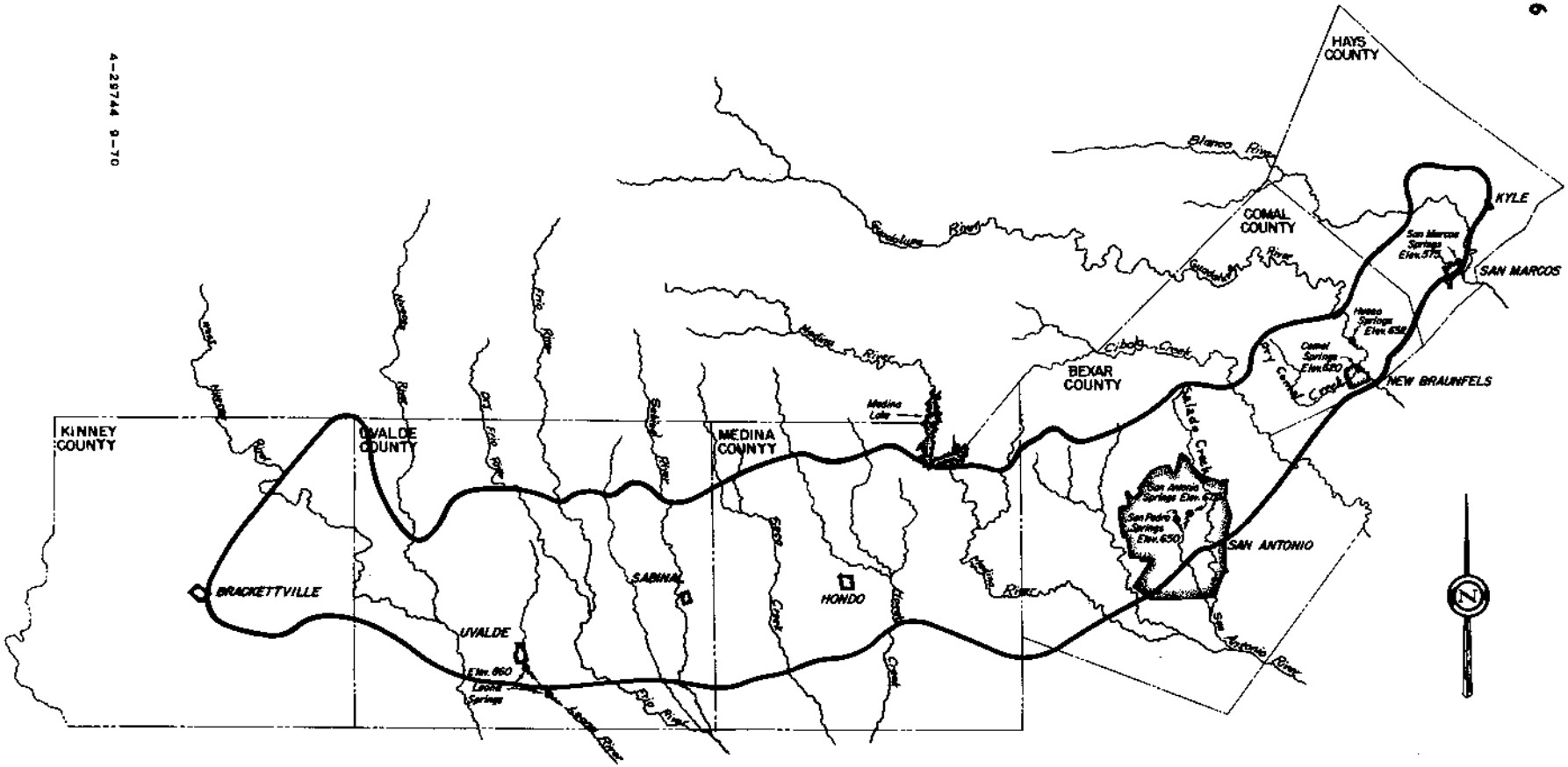


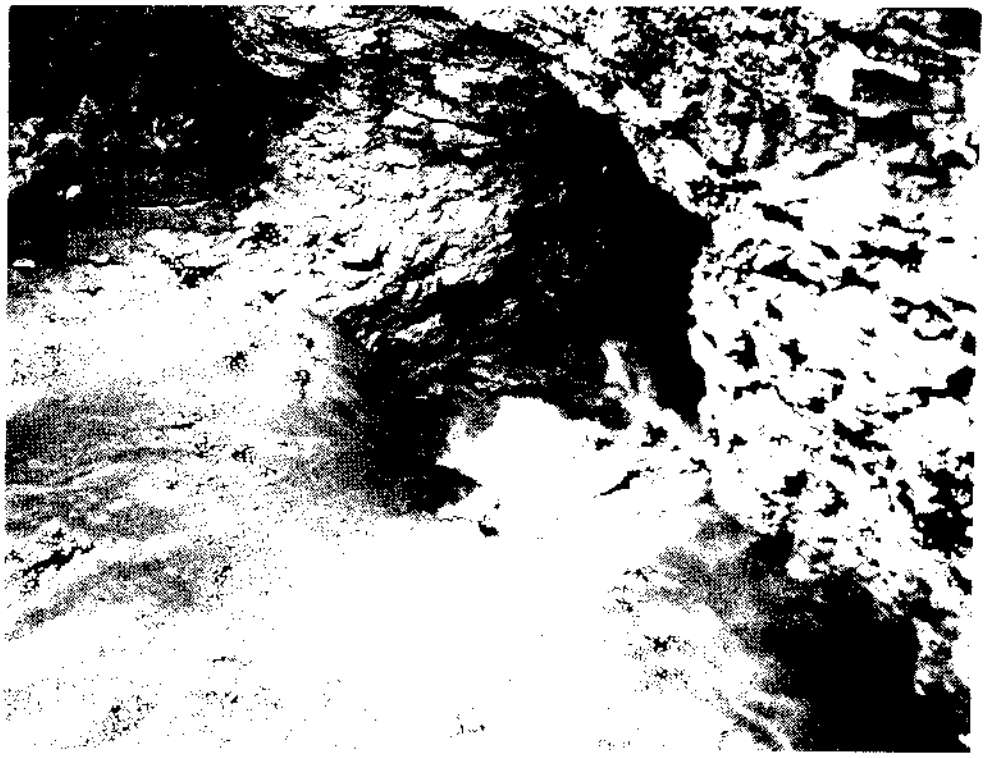
EDWARDS UNDERGROUND WATER RESERVOIR

Map Courtesy of Edwards Underground Water District

LEGEND

BOUNDARY OF EDWARDS RESERVOIR

SPRING



Surface water entering ground water reservoir three miles west of Uvalde.

Typical outcrop of vugular Edwards Limestone.

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The soils of the watershed, in general, are calcareous. Permeabilities range from very slow to moderately rapid, the major portion having moderate permeability. Edwards Plateau soils are mostely shallow to very shallow, fine textured, and stony. Most of the Rio Grande Plain soils are deep with fine textured surfaces. The occurrence of gravel in both the surface and subsurface horizons is common. The predominant soils are clays of the Knippa, Montell, Tobosa, Kavett, and Val series; silty clay loams of the Uvalde and Frio series; Tarpley gravelly clay; Olmos gravelly loam; Webb fine sandy loam; Hindes-Quemado very gravelly loam; and stony clay loams of the Ector and Ingram series.

The climate is semi-arid. Summers are hot, and winters are generally mild but subject to rapid temperature changes with the passage of cold fronts. The average annual rainfall at Uvalde is about 23 inches. Two out of three years receive less than average rainfall. Droughts of two to three years duration occur about every 10 years, and severe extended droughts can be expected every 20 to 30 years. About 50 percent of the average annual rainfall occurs in May, June, September, and October. Winters are quite dry. Temperatures range from a mean maximum of 96 degrees Fahrenheit in July to a mean minimum of 40 degrees in January. The normal growing season, extending from March 10 through November 21, is 255 days.

Land use within the watershed is shown in the following tabulation.

Land Use	Acres	Percent
Cropland	17,677	16.1
Pasture and Hayland	3,027	2.7
Rangeland	81,746	74.3
Miscellaneous 1/	7,630	6.9
Total	110,080	100.0

1/ Includes roads, highways, railroad rights-of-way, urban areas, farmsteads, stream channels, etc.

Hydrologic cover conditions on grassland range from poor to good. An estimated 70 percent is in fair to good hydrologic condition. The remaining 30 percent is in poor condition. Predominate range sites within the watershed include clay flat, clay loam, loamy bottomland, stoney ridge and shallow ridge. When these sites are in excellent condition, the dominant grasses include cane bluestem, plains bristlegrass, plains lovegrass, sideoats grama, lovegrass tridens, Arizona cottontop, vine-mesquite, trichloris, pink pappusgrass, curlymesquite, fall witchgrass, Texas bristlegrass, buffalograss, and slim tridens. Woody plants make up a small percentage of climax vegetation on several range sites. Some examples are guajillo on the Gravelly Ridge site; large elm, oak, and pecan on the Loamy Bottomland site; kidneywood and guajillo on the Shallow Ridge site; live oak on the Low Stony Hills site; and oaks and ash juniper on the Steep Rocky site.

Overgrazing has caused invasion of such plants as red grama, hairy tridens, Halls panic, threeawns, mesquite, whitebrush, cacti, catclaw, coyotillo, blackbrush, ash juniper, mescalbean, and oak.

There are no historic areas, buildings, or properties in the watershed listed in, or in the process of nomination to, the National Register of Historic Places. The Texas State Historical Survey Committee recognizes some buildings in the City of Uvalde as having historical significance. Among these buildings is the home of John Nance Garner who served as Vice-President of the United States.

The Texas Archeology Survey, The University of Texas at Austin conducted field surveys to locate and appraise archeological resources in the watershed. Eleven archeological sites were observed, recorded, and described in Research Report No. 37 "Leona River Watershed, Uvalde County, Texas, an Archeological and Historical Survey of Areas Proposed for Modification" by staff archeologist, Grand D. Hall.

The recorded number and description of the eleven archeological sites surveyed and an appraisal of the Cooks Slough area to be effected by channel work 1/ are as follows:

Two archeological sites, 41 UV 43 and 41 UV 53, were found in the area required for the construction and functioning of floodwater retarding structure No. 1 on Cooks Slough.1/

41 UV 43 2/

The site is characterized by an area of flint cobbles eroding out of the slough bank. Artifacts found included numerous flint cores, flakes showing bulbs of percussion, and partially worked bifaces. An absence of small flint flakes indicating marginal retouch or finishing of artifacts advances the possibility that the site represents a flint supply source where flint "blanks" were roughed out and then carried off to some other location for manufacture into finished artifacts.

The heavy concentration of chert cobbles in this area apparently represents a residual accumulation created as a very stony soil deposit was deflated by running water. The material evidencing

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1/ See figure 7, Project Map, for locations of Floodwater retarding structures and channel work.

2/ Standard archeological site designated system utilized by the Texas Archeological Research Laboratory, The University of Texas at Austin. 41 indicates the State of Texas, UV is the abbreviation for Uvalde County, and 43 the numerical designation of the archeological site within the county.

the site is most noticeable in a band running parallel to the slough where water erosion has been in the greatest.

It is obvious from surface indications that the flint cobble source was utilized in obtaining materials for artifact production. Whether the exploitation of this resource was a one-time event or took place over a number of years cannot be determined. It may, however, be conclusively stated that this supply was, in one form or another, expressed surficially during periods of aboriginal activity in the area. Possibilities for further archeological investigation at this site are considered to be limited due to its lack of depth and probable post-depositional disturbance.

41 UV 53

This site consists of an area of scattered burned rock with several locally heavier concentrations. It appears to have some depth to its deposit and has not been drastically modified by land clearing or root plowing operations.

Three sites, 41 UV 44, 41 UV 45, and 41 UV 46 were located in the vicinity of planned floodwater retarding structure No. 2 on Boone Slough. All three sites are above the emergency spillway creast elevation of 981.6 feet above mean sea level.

41 UV 44

The site is roughly 50 yards square and consists of an area of scattered burned rock, flint degitage, and gravel. Artifacts collected included bifacial scrapers and retouched flint flakes. As the site lies on the flank of a rocky hill it is believed to have little or no depth to its deposit.

41 UV 45

The site seemed undisturbed except where bisected by a transmission line. There is a heavy cover of vegetation and the soil deposit is thicker than in the surrounding vicinity.

The surface collection included flint flakes, a bifacial scraper, wire, glass fragments, a square nail, and a porcelain potsherd. The latter artifacts may indicate either an historic Indian encampment or, more probably, a non-aboriginal site superimposed over the remains of aboriginal occupation.

41 UV 46

The site is moderately to heavily eroded and is characterized

by scattered burned rock and flint degitage. Utilized flint flakes and biface fragments were recovered.

Four sites were described in the vicinity of the area needed for floodwater retarding structure No. 3.

41 UV 47

Extensive portions of 41 UV 47 lie in an area that has been cleared of brush and root plowed to a depth of approximately 1 foot below the present ground surface. Surface indications consisted of scattered burned rock with locally heavier concentrations. Numerous artifacts, including projectile points, bifacial scrapers, utilized flakes, and flint cores were recovered.

Two test pits were excavated to provide information concerning the depth of cultural material and the extent to which the deposit has been disturbed by brush clearing activities. Both pits were 5 feet square, oriented on a north/south axis, and excavated in arbitrary 1/2 foot vertical levels.

In Test Pit 1 at the western end of the site, most of the cultural material was concentrated within the first 0.5 feet with lesser indications observed to a depth of 2 feet. Burned rocks were sparsely scattered through the fill. No obvious changes in soil composition or color were noted during excavation. There was, however, a notable increase in river pebbles from Level 4 to Level 6 (1.5 to 3.0 feet) coincident with a decrease in the occurrence of artifacts.

In Test Pit 2 at the eastern end, a very dense layer of burned rock with a matrix of black loam was encountered between ground level and a depth of 1.3 feet. Below this cultural layer was a light tan sand interspersed with numerous pebbles. Material recovered included four projectile points, many flint flakes, one specimen of bone, and mussel shell fragments.

Diagnostic artifacts recovered in Test Pits 1 and 2 included an Ensor dart point and two Scallorn arrow points (Suhm and Jelks 1962). 1/ On the basis of conclusions reached following investigations at the Kyle Site (Jelks 1962), 2/ at Arenosa

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1/ Suhm, Dee Ann and Edward B. Jelks 1962, Handbook of Texas Archeology: Type Descriptions. The Texas Archeological Society, Special Publication No. 1 and the Texas Memorial Museum, Bulletin No. 4. Austin.

2/ Jelks, Edward B. 1962, The Kyle Site: A Stratified Central Texas Aspect Site in Hill County, Texas. Archeology Series, No. 5. Department of Anthropology, The University of Texas. Austin.

Shelter (Dibble 1967), [1/] and at the La Jita Site (Hester 1971), it may be very tentatively advanced that the occupation at 41 UV 47 represents a time period stretching from Late Archaic (circa A.D. 500) to Late Prehistoric (circa A.D. 1200). It is emphasized that these are gross estimations of periods of occupation and by no means provide a conclusive statement on the temporal situation at the site.

In comparing the two test pits, it is important to note that the culturally productive zone in Test Pit 1 is visually indistinct while in Test Pit 2 it is very well defined. The first pit is located in an area which has undergone brush clearing operations and the second in an undisturbed area of the site. This is one possible explanation for the differences in the concentration of material from one pit to the other. Other possibilities are that the perceived differences are a result of the variations in the type of occupation or localized activities and the time interval involved.

From this, it is emphasized that the more distinct of the cultural deposits tested in the two areas lie in the eastern extent of the site where disturbance has not apparently affected archeological resources. It is believed that the undisturbed portion of the site is worthy of further investigation aimed at collecting at least a sample of the information contained within the site.

41 UV 48

41 UV 48 lies along the right (west) bank of the Leona River starting at its confluence with a major northwest trending tributary. As with 41 UV 47, this site is characterized by burned rock scattered along the river terrace. Relatively greater concentrations occur at the southwest end of the site. Flint blades, a chopper, flakes, and bifacial fragments were surface collected. Few intact deposits remain as significant portions of the site locality have been cleared of brush and root plowed.

41 UV 49

This site consists of an oblong mound approximately 70 yards long and 30 yards wide. A sizeable amount of burned rock is visible on the surface. The site is overgrown with brush and large oak trees. It has not suffered any readily apparent post-depositional disturbance.

41 UV 50

41 UV 50 is located in the bottom of a gently sloping draw. The site consists of two or more definable rock hearths and

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1/ Dibble, David S. 1967, Excavations at Arenosa Shelter, 1965-66. Mimeographed Report Submitted to the National Park Service by the Texas Archeological Salvage Project.

other scattered burned rock. The area containing these features has been severely eroded. Material collected includes a projectile point, flint blades, and flakes.

Two archeological sites were described in the area required for planned floodwater retarding structure No. 4 on Taylor Slough.

41 UV 51

Surface expressions indicating the location of this site consisted of burned rock and dark midden soil. Test Pit 3 was excavated within site 41 UV 51 in a 5-foot square using 1/2 foot vertical levels and was oriented north/south. The pit was placed on the southeast flank of an apparent midden because surface indications were more pronounced in this area than at higher elevations on the midden. A very dense deposit of burned rock containing numerous flint artifacts were found between the ground surface and a depth of approximately 2 feet. Here, the cultural layer ended abruptly and was underlain by grayish-tan gravelly sand.

Only one diagnostic artifact, an Ensor point, was recovered from Test Pit 3. Although an age estimage made on the basis of one point is highly inconclusive, it is tentatively advanced that the occupation at 41 UV 51 dates back to Late Archaic times with the oldest and most recent dates of occupation being unknown factors.

The information recovered from this testing operation combined with surficial observations indicate that the site is fairly large and contains a cultural deposit at least 2 feet in depth and probably deeper at higher elevations on the site. The general area in which the site is located has apparently undergone little modification, although brush clearance has taken place in the vicinity.

In view of the precarious location of the site in relation to the proposed floodwater retarding structure, the apparent horizontal and vertical dimensions of the site, and its relatively undisturbed nature, it is believed that further investigation of the site would be of significant importance to the understanding of the archeology in the Uvalde area.

41 UV 52

This site lies immediately west of 41 UV 51 and is bisected by both a dirt road and a fence. 41 UV 52 consists of an area of burned rock approximately 15 feet in diameter. No artifacts were collected on the site, and it is badly disturbed by the dirt road cutting through it.

Along approximately 18,300 feet of Cooks Slough running from Farm-to-Market 1052 to U. S. Highway 83, only scattered cultural material was observed. There were no areas deemed to be archeologically significant judging from materials observed on the ground surface. The channel segment extending from F.M. 1052 and the Central Power and Light Company's power station is, however, considered to be an archeologically sensitive zone on the basis of its deep alluvial deposits and apparently undisturbed nature.

The natural setting in the area points to the possible existence of cultural remains even though no evidence is visible on the ground surface in the vicinity.

Economic Data

The agricultural economy of the watershed is dependent on the production and sale of cash crops and livestock. The most important crops produced for direct sale are vegetables, grain sorghum, and small grains. Vegetables grown include onions, carrots, cabbage, tomatoes, and snap beans. Some farmers grow two crops a year on the same land. Agricultural land not devoted to crop production is used primarily for the grazing of cattle, sheep, goats, and wildlife. About 60 percent of the total agricultural income in the watershed is derived from the sale of cash crops and 40 percent from the sale of livestock and livestock products.

Important mineral resources in the watershed include limestone, clay, gravel, and igneous rock used for road materials. Rock asphalt is quarried from the Anacacho Limestone about 10 miles west of the watershed.

There are approximately 160 farms and ranches, wholly or partially within the watershed, averaging 640 acres in size. About 50 percent are smaller than 300 acres. About 37 percent of the farms and ranches in Uvalde County, which is representative of the watershed gross, less than $2,500 annually, from agricultural sales. Approximately 40 percent of the farm and ranch operators worked off-the-farm for 100 days or more in 1969.

It is estimated that less than 15 percent of the agricultural land in the benefited area is devoted to farms and ranches using 1-1/2 man-years or more of hired labor.

The average value of land and buildings per farm is currently estimated at about $100,000. The estimated current market price of land ranges from $135 to $500 per acre. The range in land prices depends primarily on location, accessibility, and productive capability. Agriculture land is largely owner-operated with about 16 percent being leased or rented.

The "Work Force Estimates for Nonmetropolitan Counties in Texas for April 1972", the latest statistics which are available, shows a labor force of 6,035 or 18.6 percent, from a total population of 17,348 for Uvalde County. Approximately 6.9 percent, or 415 workers, are unemployed. This exceeds the state and national rate of unemployment. Approximately 18.6 percent, 1,125 workers, are employed in the agricultural sector. The nonagricultural sector employs 4,495 workers: 450 workers in the manufacturing sector, and 4,045 workers in the nonmanufacturing sector. A problem of underemployment also

exists. Much of the labor force is employed in seasonal occupations which results in significant underemployment of the total labor resources of the area.

The major source of income in the watershed and Uvalde County is from direct sale of agricultural commodities and retail and wholesale agricultural oriented businesses.

The City of Uvalde, located in the center of the watershed, is the county seat of Uvalde County. Uvalde is the commercial center for the surrounding farm and ranch area, providing important marketing and supply services.

It is anticipated that the population of Uvalde will increase from the 1970 census count of 10,764 to about 12,800 by 1985.

Several landmarks of historic interest are in Uvalde. Among them is the home of John Nance Garner, who served as Vice-President of the United States.

Land Treatment Data

Farmers and ranchers operating 83 percent of the agricultural land in the Leona River Watershed, are practicing soil and water conservation in cooperation with the Nueces-Frio-Sabinal Soil and Water Conservation District. The Soil Conservation Service work unit at Uvalde is assisting the district in preparing and applying soil and water conservation plans.

There are no critical sediment source areas and no improper use of watershed land.

There are 138 operating units, wholly or partially within the watershed, which are under district agreement. There are 119 conservation plans covering 83 percent of the agricultural land. Soil surveys have been completed on the entire watershed. It is estimated that 40 percent of the needed land treatment practices have been installed and that more than 80 percent of the watershed is adequately protected from erosion. Needed land treatment measures have been applied to date at an estimated expenditure of $615,500 by landowners and operators (table 1A). The level of accomplishment for needed land treatment practices is expected to reach at least 75 percent in five years as a result of the planned land treatment program.

Fish and Wildlife Resource Data

The fish and wildlife aspects of the watershed, as described by the Bureau of Sport Fisheries and Wildlife, are as follows:

> "There is not enough permanent water in the project area to provide significant sport or commercial fishing.
>
> Wildlife species in the project area are white-tailed deer, javelina, wild turkey, mourning dove, white-winged dove, bobwhite, scaled quail, fox squirrel, cottontail, jackrabbit, raccoon, ringtailed cat, and armadillo. The population levels of the important game species in the project area are as follows: deer are found in moderate to high numbers,

except along the Leona River south of Uvalde where they appear in moderate numbers; bobwhite and scaled quail are found in low numbers in the northern part of the project area, but the southern portion of the area supports low to moderate numbers of those birds; squirrels are found in moderate numbers south of the City of Uvalde; few javelina are present in the project area; but doves are abundant."

WATERSHED PROBLEMS

Floodwater Damage

An estimated 8,097 acres of the watershed, excluding stream channels, is flood plain. This is the area that would be inundated by a 100-year frequency flood.

Present flood plain land use is as follows: rangeland, 49 percent; cropland, 27 percent; pasture and hayland, 11 percent; and miscellaneous uses including urban areas,public roads, and railroads, 13 percent. Current trends are toward improvement of native rangeland.

Some landowners, on an individual basis, have attempted to enlarge, straighten, and levee some streams. This has resulted in very little reduction of flood damage. The City of Uvalde has attempted to eliminate damages resulting from flooding from the Leona River by improving a segment of the channel within the City. This has materially reduced the damages caused by small floods of frequent occurrence, but has had little effect on larger floods. The adverse economic and physical effect of flooding has been felt throughout the entire watershed and will prompt local participation in the alleviation of the flood problem.

Flooding occurs frequently in portions of the watershed causing damages to agricultural and nonagricultural properties. Major floods, inundating more than half the flood plain, occur on the average of once every seven to eight years. Minor floods, inundating less than half the flood plain, occur on the average of about once a year.

Cumulative totals of recurrent flooding show an average of 1,709 acres flooded annually during the evaluation period. Damage to flood plain lands from deposition of sediment and flood plain erosion has resulted in reductions in crop yields.

The most disastrous flood in recent years occurred on August 31, 1953. The total storm rainfall occurred over a 6.5 hour period and varied from approximately 3 inches in the upper portion of the watershed to the official 4.51 inches recorded at Uvalde. The recurrence interval of the resulting flood peak was estimated to be about 17 years. The resulting flood inundated approximately 5,700 acres of flood plain in the watershed, of which 500 acres are located inside the urban area of Uvalde along the Leona River and Cooks Slough.

Currents of rushing water caused evacuation of between 30 and 40 families as water crept into their homes. Numerous low water crossings were closed. Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be $360,000, of which

Average annual flooding exceeds 1,700 acres.

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Crop loss and scour damage to flood plain land.

Overbank deposition of sediment causes loss of productivity on flood plain soils and necessitates cleanup of roads and other properties.

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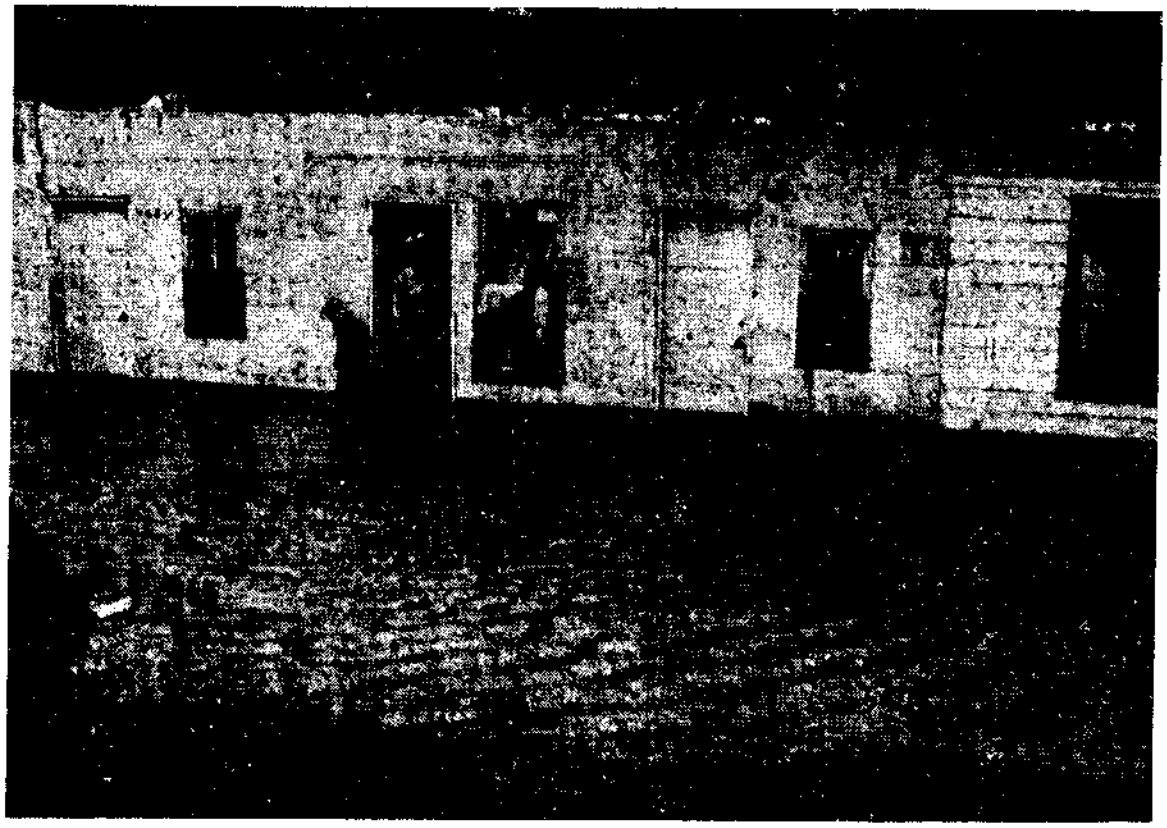

House flooded by water from Cooks Slough. Average annual damage to urban properties within the flood plain exceeds $125,000.

(Photograph courtesy of the Uvalde Leader-News)

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Southern Pacific railroad embankment and culvert washed out by floodwaters of Cooks Slough.

Automobile swept off highway by rushing water of Cooks Slough.

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$228,400 would be to urban properties. About $143,900 of urban property damage would be along the Leona River and about $84,500 along Cooks Slough.

Other recent large floods that caused severe floodwater damages occurred in 1965, 1963, 1959, 1958.

The estimated direct floodwater damages to existing urban properties that would result from a 100-year frequency flood event are estimated at $753,830. Of this amount, $503,670 would be to properties along the Leona River and $250,160 to properties along Cooks Slough.

For the floods evaluated, which includes floods up to and including a 100-year frequency, the total direct floodwater damage is estimated to average $159,910 annually at adjusted normalized prices (table 5). Of this amount, $29,810 is crop and pasture damage, $12,400 is other agricultural damage, $990 is road and bridge damage, and $116,710 is damage to urban and other nonagricultural development.

Indirect damages such as interruption of travel, losses sustained by businesses, evacuation of premises when floods threaten, and similar losses are estimated to average $28,060 annually.

Sediment Damage

The estimated average annual sediment production rate is 0.56 tons per acre. This amounts to an average annual sediment yield of 34 acre-feet at the lower limit of the watershed. The estimated suspended sediment concentration at the lower end of the watershed averages about 1,300 milligrams per liter.

Sediment derived from the watershed is a source of pollution in the Leona, Frio, and Nueces Rivers lowering the quality of water for all present and probable future uses. No estimate of the monetary value of this type of sediment damage has been made.

Low inherent erosion rates of most of the watershed soils, the fine texture of sediment, fair to good hydrologic cover on most of the grassland, and the large Leona River channel are primarily responsible for a low rate of sediment damage on the flood plain. An estimated 231 acres of flood plain land within the project area are damaged by thin overband deposits of silt and clay. This damage is estimated to average five percent in terms of reduced productive capacity. The average annual monetary value of the damage is estimated to be $2,290 at adjusted normalized price levels (table 5).

Erosion Damage

The estimated average annual rate of gross erosion is 2.33 tons per acre. Of this, sheet erosion accounts for 94 percent, streambank erosion three percent, and flood plain scour three percent. The only evident gully erosion occurs in the extreme lower end of the watershed where small tributaries have steep gradients as they enter the Leona River. Upland erosion rates are low, primarily because the soils on steeper slopes are either stony or gravelly and are used as rangeland.

An estimated 183 acres are damaged by flood plain scour. The damaged areas range from 0.5 to 2.0 feet in depth and from 100 to 300 feet in width. It is estimated that scour causes a 10 percent loss of productive capacity on 13 acres and 5 percent on 170 acres. The average annual value of this damage is estimated to be $1,610 at adjusted normalized price levels (table 5).

Problems Relating to Water Management

There is no local interest in providing additional storage in any planned floodwater retarding structure for agricultural or nonagricultural water management purposes.

There is no activity relative to drainage in the watershed.

At present, about 9,000 acres within the watershed are irrigated. Irrigation water is obtained from shallow wells in the Leona Formation and the Edwards and associated limestones. Although hard, it is generally of good quality for irrigation and public supply. However, water in the Edwards in the southern part of the watershed is too saline for irrigation and most other uses. Also, according to the Geological Survey, there is a tendency for water to be more highly mineralized with increasing depth of ground water occurrence. The Leona Formation has become dry during periods of lengthy drought.

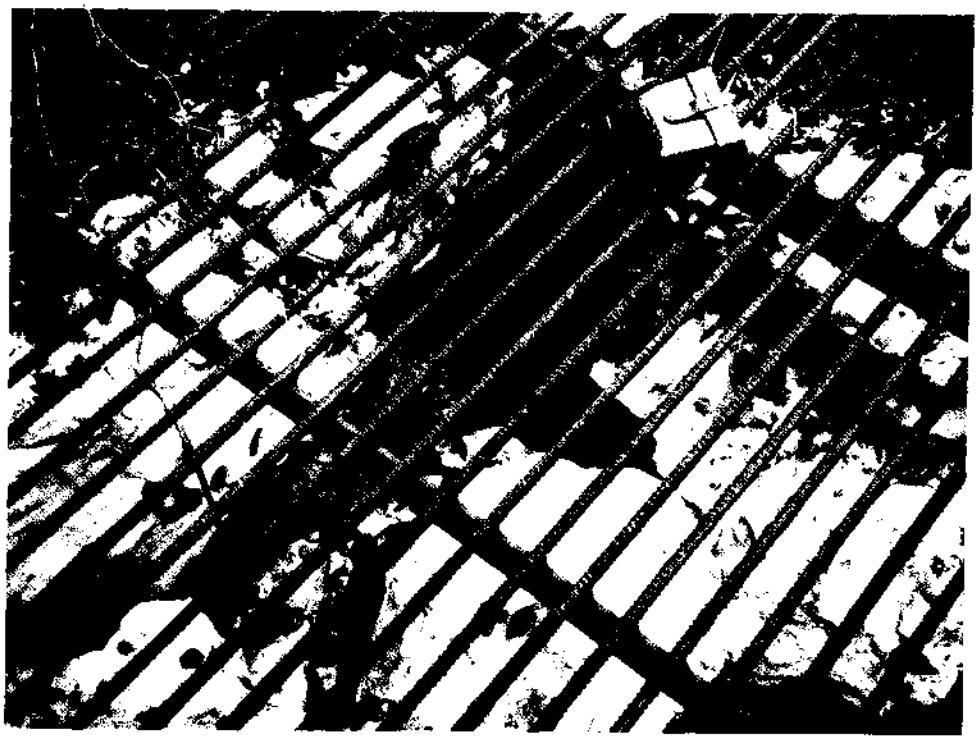
Problems in management exist on about 50 percent of the irrigated land. The major problems encountered involve steep slopes, length of irrigation runs, frequency of water application, maintenance of irrigation ditches, and the need for lined or underground delivery systems. However, farmers are currently improving their irrigation systems to provide for more efficient utilization of irrigation water.

Irrigated crops consist mainly of vegetables which are well adapted to the soils on which they are grown.

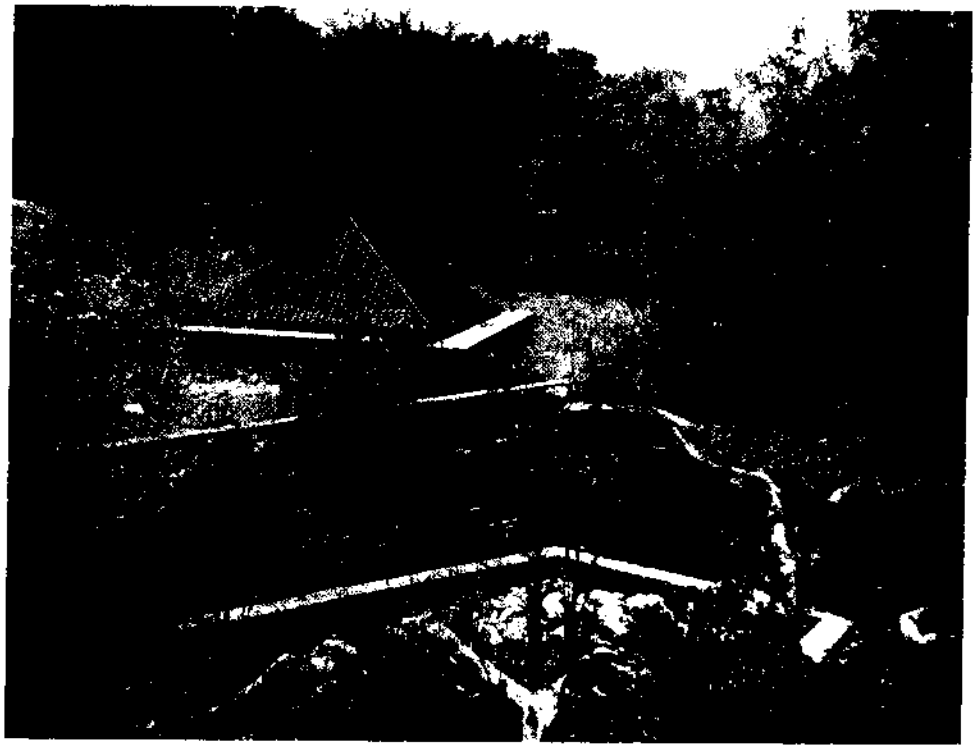
A sufficient supply of municipal and industrial water for Uvalde is obtained from wells in the Edwards Underground Reservoir. This aquifer has a notable capacity of being recharged rapidly. Increased rates of withdrawal in the Uvalde area would result in decreased movement of ground water toward the east and the reduction of cessation of spring flow along the Leona River.

There is no immediate threat to the quality or quantity of water supply for Uvalde. A limestone reservoir such as the Edwards is highly susceptable to contamination. Future urban and industrial expansion will result in increased potential sources of pollution. Extreme caution and careful watershed management will be necessary in the recharge zone in order to maintain good quality of ground water in the Edwards Underground Reservoir.

The Amistad Reservoir on the Rio Grande is located approximately 80 miles to the west of Uvalde. This reservoir offers an abundance of opportunities for year-round water based recreation.



Natural cavern opening protected by grating.



Low concrete detention dam, recharge well with trash guard, and netural caverns covered with grating.

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There is a low water concrete dam on the Leona River about five miles south of Uvalde just below the confluence of the Leona River and Cooks Slough. The Commissioners Court of Uvalde County presently operates and maintains this dam. The small lake offers limited opportunities for fishing and other water based recreation. During normal rainfall periods, this lake receives plentiful inflow from springs along the Leona River but becomes depleted during extended droughts.

Rural domestic and livestock water is furnished adequately from shallow wells and/or farm ponds.

The Commissioners Court of Uvalde County has installed measures for artificial recharge of the Edwards Underground Reservoir. Recharge wells were drilled and natural openings were cleaned out. The openings were protected with heavy grating, and small diversion dams were built to direct runoff water into the ground water reservoir. Although the resulting increased recharge has been small in comparison to total recharge, the methods used have proven to be sound.

PROJECTS OF OTHER AGENCIES

There are no existing or proposed water resource development projects of any other agencies within the watershed.

The works of improvement included in this plan will have no known detrimental effects on any existing or proposed downstream works of improvement of other agencies.

PROJECT FORMULATION

There is a history of extensive flood damage to business, residential, and railroad properties; city streets; and utilities in Uvalde and to agricultural properties along the Leona River and its major tributaries. In addition, the Leona River watershed lies within the vast area depending on the Edwards Underground Reservoir for water supply. The increased use of ground water due to expanding industry, irrigation farming, military installations, and cities coupled with periods of drought has intensified water problems of the watershed and the surrounding area. Realizing the social and economic impact of these problems, foresighted sponsoring local organizations sought assistance. Representatives of the Commissioners Court of Uvalde County, the City of Uvalde, the Edwards Underground Water District, the Nueces-Frio-Sabinal Soil and Water Conservation District, and the Soil Conservation Service initially made studies to identify existing problems. Meetings were held to reach agreement on water and land resource development needs. Desires of sponsoring local organizations were discussed, and project objectives were formulated. Watershed protection and flood prevention were the primary objectives expressed by the sponsors.

The following specific objectives were agreed to:

1. Reduce erosion and increase rainfall infiltration by establishing land treatment measures which would contribute directly to watershed protection and flood prevention. The goal is to increase the establishment of needed land treatment measures from the present 40

percent to 75 percent during the five-year installation period. At least 75 percent of the land above floodwater retarding structures would be adequately protected from erosion before construction would begin on any structural measure.

2. Attain a 60 to 65 percent reduction in total average annual agricultural damages.

3. Attain a 90 to 95 percent reduction in average annual flood damages in Uvalde with consideration given to the 100-year frequency storm.

In addition, the Edwards Underground Water District is vitally interested in increased ground water recharge to the Edwards Ground Water Reservoir which would occur incidental to the installation of floodwater retarding structures.

Recommendations by the Bureau of Sport Fisheries and Wildlife for the preservation and enhancement of the fish and wildlife resources were considered in formulating the land treatment and structural measures of the work plan.

Possible sites for eight floodwater retarding structures and approximately nine miles of channel improvement were investigated in order to select the least costly system needed to provide the agreed upon level of protection. In selecting sites for structural measures, consideration was given to locations which would provide maximum protection to areas most subject to damage. Topographic, geologic, hydrologic, and other physical features had considerable influence upon the size, number, design, and cost of structures included in the plan.

Three possible floodwater retarding structure sites and approximately 5.5 miles of related downstream channel improvement in the lower part of the watershed were investigated but not included in the final project plan. These possible sites and channel are located on Weyerts and Kincaid Sloughs (figure 1). Runoff from the rolling areas results in flooding of nearly level irrigated cropland downstream. Structural measures at these sites were not included in the final plan in view of the very low reduction of damages which they would provide.

A floodwater retarding structure site on an unnamed tributary to Cooks Slough was investigated but not included in the final work plan. Studies showed that a structure at this location would provide no significant reduction in the peak flows on Cooks Slough and the Leona River, nor would it reduce significantly the design capacity of channel improvement on Cooks Slough necessary to meet project objectives.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Farmers and ranchers, operating 83 percent of the agricultural land in the watershed, are applying and maintaining soil and water conservation plans on their land with assistance from the Nueces-Frio-Sabinal Soil and Water Conservation District. These plans, which are essential to a sound program

for watershed protection and flood prevention, are based on the use of each acre within its capabilities and its treatment in accordance with its needs. Needed land treatment measures have been applied to date at an estimated expenditure of $615,500 by landowners and operators (table 1A).

Increased application and maintenance of land treatment measures is particularly important for protection of the 59.08 square miles which comprise the drainage areas of planned floodwater retarding structures. This treatment will reduce the capacities required for sediment accumulation and will retard runoff into the structures.

There are 112.92 square miles downstream from floodwater retarding structures that will continue to contribute sediment and runoff to flood plain areas. Land treatment on these lands will further reduce floodwater and sediment damages.

The acreage in each major land use, on which land treatment measures will be established during the five-year project installation period, is included in table 1. These measures will be established and maintained by landowners and operators in cooperation with the Nueces-Frio-Sabinal Soil and Water Conservation District.

Cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from erosion. Conservation cropping systems in this watershed include soil conserving crops and crop residue management. Terraces will be installed to control erosion and retard runoff from the more rolling areas.

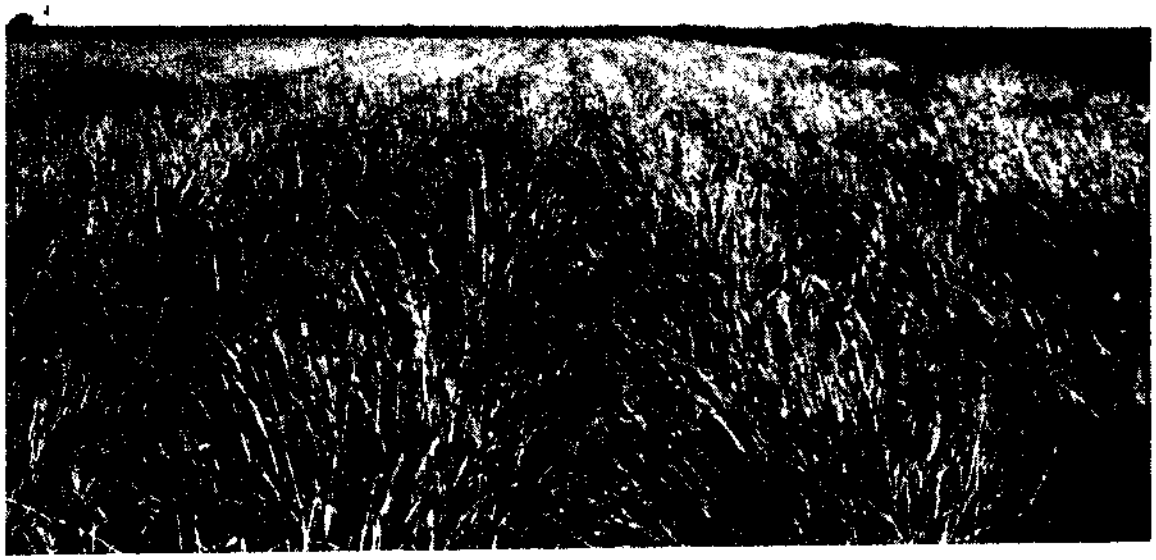
A good base cover of desirable forage plants will be attained by pasture and/or hayland planting and pasture and/or hayland management.

Proper grazing use, range seeding, and deferred grazing will be practiced to improve the quality of range vegetation and maintain adequate cover for soil protection. Rangeland with infestations of woody plants will be either bulldozed, root plowed, chained, or sprayed with approved materials to control brush. Ranch operators planning brush control will be encouraged to accomplish this in a manner which will be compatible with the needs of wildlife for both cover and concealment in dirurnal movement. In addition to range seeding on areas having brush controlled, the seeding of barren areas of sediment pools and adjacent soils will be encouraged to retard erosion and siltation and increase fertility in the impoundments. Destruction of cover caused by over-use around present watering places will be reduced by establishing ponds and wells.

Damage to land caused by rapid runoff from steeper areas will be reduced by construction of diversions.

In addition, irrigated cropland will receive irrigation land leveling, irrigation ditch and canal lining, irrigation pipeline, and irrigation water management. The combined effects of these measures will be reduced erosion, more efficient use of water, and increased net income to farm operators.

Local people will continue to install and maintain measures needed in the watershed following the project installation period.



Pretorie 90 bluestem established and properly managed on improved pasture in Rio Grande Plain.

Irrigated cropland in Rio Grande Plain protected from erosion by crop residue management.

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Range grasses provide protective cover and dependable forage in Edwards Plateau as result of proper grazing use.

Wildlife management receives serious consideration in conservation plans for ranches in the watershed.

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The application of land treatment planned for the installation period will reduce average annual erosion by about 15 percent and increase infiltration of rainfall as a result of improved ground cover in cultivated areas and increased grass vigor on pasture and rangeland.

Structural Measures

A system of four floodwater retarding structures and approximately 18,300 feet of channel improvement will be constructed in the Leona River watershed. Figure 2 shows a section of a typical floodwater retarding structure. Figure 3 and 3A include a general plan of dam, spillway, and reservoir; embankment plan and profile; and cross section of a zoned embankment typical of the type of floodwater retarding structure included in this work plan. Figure 4 shows a typical cross section of channel improvement.

The locations of structural measures to be installed are shown on the Project Map (figure 7).

Major factors which will affect construction of floodwater retarding structures will be rock excavation in the emergency spillways at all structure sites; zoning of available borrow material within embankments at all structure sites; permeable gravel deposits within foundations at all sites; and porous limestone within foundations at all structure sites.

Emergency spillways at all floodwater retarding structure sites will have erosion resistant rock crests and forebays. Exit channels will be mostly underlain by rock at shallow depths.

Structural details will be treated in the final design phase. Preliminary and present indications are that the principal spillways will be on compressible foundations and will have monolithic rectangular reinforced concrete inlets. Floodwater retarding structure sites Nos. 3 and 4 lend themselves to monolithic rectangular reinforced concrete barrels, and structure sites Nos. 1 and 2 to prestressed concrete-lined, steel cylinder pipe outlet barrels. Rock-lined plunge pools for structure sites Nos. 1 and 2 and reinforced concrete de-energizing basins for sites Nos. 3 and 4 are included in the preliminary details.

Principal spillway capacities and floodwater detention storage in all planned floodwater retarding structures will provide a one percent chance of emergency spillway use.

Sufficient volumes of clay, silty clay, and gravelly clay for construction of very slowly premeable central embankment sections are available within short haul distances. The remainder of the embankments will be comprised primarily of clayey gravel and limestone. It is anticipated that limestone blankets will cover the embankments of all floodwater retarding structures. The upper limit of limestone blankets shall be determined by the yield of durable rock from emergency spillway excavation and the durable gravel and cobble content in common excavation.

Foundations are characterized by the presence of flood plain and stream terrace deposits of clay, silt, and gravel containing rapidly permeable horizons. These materials have good bearing and shear strength. The alluvium is underlain at relatively shallow depth by limestone bedrock at sites Nos. 2, 3 and 4. Foundation drains will be needed at all floodwater

retarding structures because of expected high rates of seepage from pools.

All structures are designed with sufficient sediment capacities to provide 100-year project life. Principal spillway crests will be set at the elevation of the 100-year sediment pool. Principal spillways for all floodwater retarding structures will be ported, as required by Texas Water Rights Statutes, at elevations which will limit potential water impoundments to 200 acre-feet or less. The 200 acre-foot limitation includes anticipated borrow areas below port (lowest ungated outlet) elevations. The floodwater retarding structures are not expected to hold water for significant periods of time due to the high seepage rates.

The four planned floodwater retarding structures will detain an average of 3.13 inches of runoff from 59.08 square miles of drainage area. These structures will control runoff from approximately 34 percent of the total watershed, approximately 71 percent of the drainage area of Leona River above Uvalde, and approximately 39 percent of the drainage area of Cooks Slough above Uvalde.

Tables 1, 2, and 3 show details on quantities, cost, and design for each floodwater retarding structure.

Installation of floodwater retarding structures will require changes in location or modification of known existing improvements as follows: Utility lines at Sites Nos. 2, 3, and 4; private roads and fences at Sites Nos. 1, 2, 3, and 4; and barns, corrals, utility buildings, water well, livestock storage reservoir, livestock underground pipelines, livestock watering devices, and a livestock dipping vat at Site No. 4. There are numberous private and public road crossings below the planned floodwater retarding structures which will be made impassable by release flows. The public crossings will be improved to make them passable during prolonged release flows or alternate routes will be provided for use during periods of inundation. All costs for necessary changes in location or modification as listed above are land rights costs and will be borne by the sponsoring local organizations. Private road crossings can be handled the same as public crossings or a permit to inundate the crossing will be required.

All applicable State laws will be complied with in the design and construction of all structural measures as well as those pertaining to the storage, maintenance of quality, and use of water.

Channel improvement to be installed on Cooks Slough (figure 4) will consist of enlargement, by excavation, of the existing channel; spreading of soil; vegetating side slopes, berms, and bottom; and concrete riprap across the channel beneath the bridge on U. S. Highway 90. In the existing state, Cooks Slough has a well defined natural channel that has not previously been modified. Channel flow occurs only during periods of surface runoff. The planned channel improvement will begin at U. S. Highway 83 and extend approximately 18,300 feet upstream to approximately 1,000 feet south of Farm Road 1052. The improved channel will have a 180-foot bottom width from approximately station 10+00 to 135+00 (figure 7). The depth of excavation beneath the present channel bottom will average about six feet. A transition section will exist between station 135+00 and U. S. Highway 83 where the capacity of the improved channel will be reduced to the capacity of the existing channel at U. S. Highway 83. The present bridge

capacity at U. S. Highway 83 is sufficient to pass the design discharge of the improved channel. The depth of excavation will decrease from about six feet at station 135+00 to zero at U. S. Highway 83. The entire section of channel improvement will have 4:1 side slopes.

The material through which the channel will be excavated consists of alluvial deposits ranging from Pleistocene to Recent in age. The upper portion of channel banks will be highly plastic silty clay (Recent Alluvium). The lower portion of banks and the bottom will consist generally of calcareous, silty, sandy clay of moderate plasticity (Leona Formation). However, in some localized portions of the improved channel the entire channel cross section will be composed of highly plastic clay.

Cooks Slough flows across massive to thick bedded, durable Buda Limestone immediately upstream from the upper limit of channel improvement. The limestone is exposed along about one-fourth mile of the channel bottom and serves as a natural grade stabilizing feature.

The planned design 100-year frequency discharge was selected from flood routings made for without and with project conditions.

The 100-year frequency flood for with project conditions will be contained within the section of channel improvement from station 10+00 to station 135+00 (figure 7). The 100-year frequency flood protection will end at at station 135+00. Flood protection will decrease porportionally as the improved channel decreases in size in a downstream direction to U.S. Highway 83 where channel improvement will end. The transition section is located and designed so that back water effects will be minimal.

Vegetation is planned throughout the reach of channel improvement for protection of channel blanks, berms, and the flow area outside the berms from infrequent high velocity flows expected to develop during periods of excessive runoff.

No inline grade control structures are planned as appurtenances to channel improvement.

Durable side channel inlet structures are planned as appurtenances to channel improvement.

There are five homes along the area of planned channel improvement on Cooks Slough which, without alteration or removal, could be affected adversely by temporary impoundment of local drainage water behind channel berms. These houses will be removed in accordance with decisions reached by sponsoring local organizations and concurred in by the Soil Conservation Service. Relocation of persons or families will be in decent, safe, and sanitary dwellings equal to or exceeding existing conditions.

Installation of channel improvement will require change in location or modification of known existing improvements as follows: fencing; underground telephone cables; television cable poles; telephone poles; power poles; sewer line; water line; gas line; underground street light cable; barns; portions of Elizabeth, Benson, and Castro Streets; private low water crossings; public low water crossing on Ft. Clark Street; and five houses. All costs for necessary change in location or modification as listed above are land rights costs and will be borne by the sponsoring local organizations.

Concrete riprap, as agreed upon between the Soil Conservation Service and the Texas Highway Department, will be placed across the channel beneath the U.S. Highway 90 bridge. The Highway Department states that a residual piling penetration of 10 feet is necessary to support the structure loading. The purpose of the riprap is to prevent further exposure of bridge pilings by scour. This cost will be borne by Public Law 566 funds.

Under present conditions, the acquisition of land rights needed for the installation of the floodwater retarding structure No.4 will result in the relocation of contents of one barn which is an integral part of a farm operation. The acquisition of land rights needed for the installation of the channel improvement will result in the displacement of persons from four owner-occupied dwellings and one tenant-occupied dwelling. No other displacement or relocation is apparent at this time. However, if other relocation becomes necessary, relocation payments will be cost shared in accordance with percentages shown in the work plan agreement.

Grant D. Hall, Texas Archeology Survey, The University of Texas at Austin submitted in Research Report No. 37 the following recommendations for further investigation and study of surveyed archeological sites prior to construction of floodwater retarding structure Nos. 1, 3, and 4 and before performing the channel work on Cooks Slough.

"(1) At 41 UV 43 on Cooks Slough, a controlled surface collection of all artifacts and associated lithic residue located within the area defined as a flint source. Analysis of this material could provide valuable data concerning specific activities that took place at the site.

(2) For 41 UV 53 on Cooks Slough, that potentially marginal damage to the site resulting from the placement of a flowage channel be kept to a minimum.

(3) At 41 UV 47 on the Leona River, a limited testing program in the interact eastern portion of the site to retain a hopefully representative sample of the information contained within the entire site.

(4) At UV 51 at Damsite 4 on Taylor Slough, considered to be the most significant archeological resource dealt with in relation to the Leona River Watershed Project because it is relatively deep,of sizable horizontal extent, and appears to be undisturbed, it is suggested either that (a) project plans be changed to avoid damaging the site or, (b) if such changes are not feasible, that an intensive program of excavation be conducted to record as much of the information contained within the site as is possible.

(5) Along the Cooks Slough channel through Uvalde, specifically that segment between F.M. 1052 and the Central Power and Light Company station, provision for periodic monitoring of modifications by a qualified archeologist to determine whether or not sub-surface archeological resources do exist and to record, insofar as would then be possible, pertinent information concerning any archeological resources discovered during the course of construction."

In compliance with Public Law 86-523, the Secretary of the Interior, through the appropriate National Park Archeological Center, will be kept informed of the construction schedule so that the Secretary can initiate whatever salvage or preservation of archeological resources deemed appropriate. The Texas Archeological Survey estimated the cost to effectively reduce the loss of the most significant endangered locations through archeological excavations would be about $15,000.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures listed in table 1 will be applied by local interests at an estimated cost of $425,800. This includes an estimated $21,900 of Public Law 46 funds to be provided by the Soil Conservation Service under the going program for technical assistance during the five-year installation period and cost-sharing in the establishment of approved conservation measures under the Rural Environmental Assistance Program as administered by the Agricultural Stabilization and Conservation Service. The costs of application of the various measures are based on present prices being paid by landowners and operators in the area.

The total installation cost of structural measures is estimated to be $1,964,400 of which $1,672,300 will be borne by Public Law 566 funds and $292,100 by local interests.

The Public Law 566 costs for installation of structural measures include $1,374,740 for construction, $70,070 for engineering services, $25,700 for relocation payments, and $201,790 for project administration.

The local costs for installation of structural measures include $195,980 for the value of land; $53,260 for change in location or modification of power lines, telephone lines, underground utility pipelines, private roads, city streets, buildings, stock pens, water well and reservoir, livestock watering devices, and low water crossings; $20,500 for houses; $6,350 for legal fees; $11,030 for relocation payments; and $4,980 for project administration.

The total costs for apparent eligible relocation payments resulting from dislocations are estimated to be $36,730. The share of these costs to be borne by Public Law 566 funds is 69.96 percent and the share to be borne by other funds is 30.04 percent, and are based upon the ratio of Public Law 566 funds and other funds to the total project costs less relocation payments.

Construction costs include the engineer's estimates and constingencies. The engineer's estimates were based on unit costs of structural measures in similar areas modified by special conditions inherent to each individual site location. Included are such items as permeable foundations, special placement of embankment materials, and rock excavation in emergency spillways. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs.

Engineering services and project administration costs were based on an analysis of previous work in similar areas. Engineering services costs consist of, but are not limited to, detailed surveys, geologic investigations, laboratory analyses, reports, designs, and cartographic services.

Public Law 566 project administration costs consist of construction inspection, contract administration, assistance to the sponsors in providing relocation advisory assistance, and maintenance of Soil Conservation Service records and accounts.

The local costs for project administration includes sponsors' costs relative to contract administration, overhead and organizational costs, whatever construction inspection they desire to make at their own expense and all relocation advisory assistance service costs. Estimated costs of $2,180 for providing relocation advisory assistance services are expected to amount to $2,000 for the City of Uvalde and $180 for Uvalde County.

The cost of land rights was determined by appraisal in cooperation with representatives of the sponsoring local organizations.

The following is the estimated schedule of obligations for the five-year installation period.

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	-	63,870	63,870
Second	Land Treatment	-	63,870	63,870
	Structure No. 3	376,150	55,500	431,650
Third	Land Treatment	-	85,160	85,160
	Structures Nos. 1 and 2	385,570	50,100	435,670
Fourth	Land Treatment	-	106,450	106,450
	Channel Improvement	541,460	144,520	685,980
Fifth	Land Treatment	-	106,450	106,450
	Structure No. 4	369,120	41,980	411,100
	Total	1,672,300	717,900	2,390,200

This schedule may be changed from year to year to conform with appropriations, accomplishments, and any mutually desirable changes.

EFFECTS OF WORKS OF IMPROVEMENT

This project will benefit directly the owners or operators of approximately 75 farms and ranches in the flood plain, the owners and occupants of about 380 residential units, and the owners or operators of about 30 business units in Uvalde through reduction of floodwater damage. In addition, the owners and operators of the farms and ranches along the Leona River immediately below the watershed will receive some benefit from the project.

After installation of the combined program of land treatment and structural measures described above, average annual flooding will be reduced from 1,709 acres to 584 acres, a reduction of 66 percent.

Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas to be benefited as a result of reduced flooding, caused by the combined program of land treatment and structural measures are presented in the following tabulations:

Average Annual Area Inundated

Evaluation Reach (figure 1)	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
1	Leona River below City of Uvalde	958	363	62
2	Leona River-Urban Area-City of Uvalde	30	0	100
3	Leona River above City of Uvalde	161	18	89
4A	Cooks and Boon Sloughs above Uvalde	174	78	55
4B	Cooks Slough below Uvalde	113	81	28
5	Cooks Slough-Urban-Area City of Uvalde	110	0	100
6	Taylor Slough	163	44	73
	Total	1,709	584	66

Area Inundated

Evaluation Reach (figure 1)	Average Recurrence Interval: 2-Year Without Project (acres)	2-Year With Project (acres)	5-Year Without Project (acres)	5-Year With Project (acres)	25-Year Without Project (acres)	25-Year With Project (acres)	100-Year Without Project (acres)	100-Year With Project (acres)
1	480	0	1,990	513	3,546	2,392	4,451	3,412
2	0	0	5	0	248	0	338	0
3	80	15	124	30	946	51	1,177	70
4A	105	43	244	132	517	317	708	437
4B	60	30	189	129	435	397	485	448
5	99	0	169	0	305	0	407	0
6	127	28	235	71	374	155	531	241
Total	951	116	2,956	875	6,371	3,312	8,097	4,608

Figure 5 shows the urban area of Uvalde inundated by the flood of August 31-September 1, 1953, and the area that would be inundated by a 100-year frequency flood without and with project conditions. The proposed project will provide flood-free protection from the 100-year event to all existing urban and residential properties. With the project, urban damages from such a flood will be eliminated. The actions of people during times of floods, whether major or minor, cannot be predicted. However, with any reasonable precautions, the hazard to life from floodwaters will be eliminated.

Application of the planned land treatment is expected to reduce annual gross erosion from about 255,000 tons to 217,000 tons, a reduction of 15 percent. The average annual sediment yield from the watershed will be reduced from an estimated 34 acre-feet to 22 acre-feet as a result of the combined program of land treatment and floodwater retarding structures.

Sediment transported in suspension is the major pollutant in the Nation's streams. It is estimated that the concentration of suspended sediment leaving the watershed will be reduced from 1,300 to 900 milligrams per liter in 7.62 centimeters (3.0 inches) of watershed runoff as a result of the combined program of land treatment and floodwater retarding structures. Due consideration was given to groundwater recharge and discharge from Leona Springs.

After the complete program is installed, a 76 percent reduction in overbank sediment deposition damages on 231 acres will be effected.

Annual flood plain scour damage on 183 acres is expected to be reduced about 65 percent.

Average annual ground water recharge will be increased from an estimated 5,100 acre-feet to about 7,300 acre-feet, an incidental benefit resulting from the installation of floodwater retarding structures. The project will increase the total supply of water available for withdrawal from the Edwards Underground water supply by an average of about 2,200 acre-feet annually.

The quality of watershed runoff entering the Edwards and associated limestones and Leona Formation is not expected to change appreciably with project installation. However, preservation of runoff quality and ground water recharge will be enhanced by land treatment from reduction of sediment concentrations and by proper application of approved chemical materials for brush control.

None of the floodwater retarding structure pools are expected to hold water for any significant period of time following inflow because of high rates of seepage. Therefore, no incidental recreation use is anticipated at any of the floodwater retarding structures. If water is impounded during or following periods of above normal rainfall, the sponsors will discourage use of pool areas for recreation unless sanitary facilities, meeting State and local health requirements, are provided.

The effects of the works of improvement on fish and wildlife habitat are described by the Bureau of Sport Fisheries and Wildlife as follows:

"Without the project, future wildlife populations would be expected to remain at their present levels. Hunting probably would increase as a result of better management of the wildlife resources and increasing human populations.

In general, the project would not influence game populations significantly. Land treatment measures such as conservation cropping systems, proper grazing use, and deferred grazing would be beneficial to big game and upland game. Increasing the density to grass cover in the project area would not be advantageous to doves, bobwhites, and scaled quail."

Analysis of information collected indicated that no significant changes would be made in the use of agricultural land within the flood plain, either in the form of restoration of former productivity or in more intensive use. Allotted crops are minor and no significant changes are expected.

Benefits will accrue to the floodwater retarding structures in the watershed from reduction of floodwater damages on the main stem flood plain of the Leona River below the Leona River watershed.

A total of 548 acres of land in sediment pools, dams, and emergency spillways will be retired from agricultural production. About 5 acres of this amount is cropland and 543 acres is rangeland. Installation of planned channel improvement will require the dedication of about 300 acres to project purposes for excavated channel, berms, and maintenance rights-of-way. Of the required area, about 66 acres are cropland, 25 acres are pasture, 138 acres are rangeland, 44 acres are classified as residential and industrial land, 23 acres are existing channel, and 4 acres are in miscellaneous uses such as street and road rights-of-way, etc. With the existing flood hazard, the resource value of this area is low for both agricultural and urban uses.

The effects of the works of improvement on mineral resources within the watershed have been considered. The sponsors recognize the importance of the production of limestone, clay, gravel, and igneous rock used for road construction in the watershed. The installation of the project will not adversely affect or be affected by the extraction of mineral resources.

The effects of the project on archeological resources are discussed by Grand D. Hall in Research Report 37, Texas Archeological Survey, The University of Texas at Austin.

"Sites 41 UV 43 (Damsite 1), 41 UV 47 (Damsite 3), and 41 UV 51 (Damsite 4) are all located in planned sediment pools and borrow areas. They are in a zone of maximum potential disturbance. 41 UV 53 (Damsite 1) will be only marginally and insignificantly damaged if borrow activities are restricted to areas upstream from the damsite.

From the standpoint of their scientific importance, 41 UV 47 and 41 UV 51 are seen to be significant because they have undergone little or no disturbance and contain definable

subsurface cultural deposits. 41 UV 43 is considered to be of lesser importance as it is apparently a surface site offering limited opportunities for further, and more intensive, study. Other than establishing its precise location and making a limited surface collection, no test work or further evaluation was done at 41 UV 53 because of its peripheral situation to proposed project modifications.

Beyond their obvious physical attributes, sites 41 UV 47 and 41 UV 51 offer a valuable opportunity for elaboration and clarification of the archeological record in the Uvalde area. This vicinity represents a transitional zone between the relatively well studied Trans-Pecos and Central Texas regions. As was indicated in the introduction (of Report No.37), little archeological investigation has taken place in Uvalde and surrounding counties.

Because so few sites have been located and evaluated in the area, it is virtually impossible to pass valid judgements of a specific nature concerning the cultural and environmental import of those sites believed to be directly endangered by project proposals. Sufficient quantities of sound comparative data necessary for arriving at such conclusions do not exist. Consequently, the relationships of the sites dealt with during this survey to the surrounding cultural province cannot be determined.

The minimization of damage to archeological resources endangered by the proposed Leona River Watershed project would insure the availability of resources for future study. Should such protective measures be impractical, intense investigation of archeological resources prior to destruction would undoubtedly result in the generation of original date highly pertinent to the archeology of the Upper Nueces River Region."

Indirect damage reduction benefits will accrue to the project. These benefits include the reduction or elimination of expenses associated with interruption or delay of travel, rerouting of school buses and mail routes, disruption of farm operations, business losses in the area, and similar losses.

Secondary benefits, including improved economic conditions in the area, will result from the installation of the complete project for flood prevention. The increased economic activity in the area will create the equivalent of five permanent jobs for local residents. During construction of the proposed project, additional requirements for building materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 67 man-years of employment which will further strengthen the economy during the construction phase. The operation and maintenance of the project measures will provide some employment opportunities for local residents.

Significant intangible public health benefits will accrue in the City of Uvalde including reduced hazards of loss of life and injury, elimination of health hazards associated with damage to water supply and waste disposal systems, improved vector control, and the prevention of other factors accompanying floods which tend to disrupt the maintenance of public health. Additional intangible benefits will accrue to the project allowing an opportunity for the shifting of public funds from the repair of damage to sewer and water lines and streets to investment in schools, libraries, and other public facilities that improve the quality of living. Likewise, private funds now going to repair of flood damage could be shifted to raising the standard of living of the residents in the affected area.

With the installation of the channel improvement, five homes will be destroyed. These dwellings are all substandard as defined by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646). Persons and families will be relocated under the provisions of Public Law 91-646 and provided with decent, safe, and sanitary housing, with opportunity to maintain these conditions. In each case at least standard dwellings, as determined by the act, will replace substandard housing.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, flood plain erosion, and indirect damages (table 5) within the watershed will be reduced from $191,870 to $19,820 by the proposed project. This is a reduction of 90 percent.

Benefits to landowners and operators from the planned land treatment measures were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

Reduction in monetary flood damages vary with respect to locations within the watershed. The following tabulations show the general locations of damage reduction benefits attributed to the combined program of land treatment and structural measures.

Average Annual Damage

Evaluation Reach (figure 1)	Location	Without Project (dollars)	With Project (dollars)	Reduction (Percent)
1	Leona River below City of Uvalde	45,110	17,300	62
2	Leona River-Urban Area-City of Uvalde	91,720	0	100
3	Leona River above City of Uvalde	1,390	150	89
4A	Cooks and Boon Sloughs above Uvalde	2,530	1,140	55
4B	Cooks Slough below Uvalde	1,020	700	31
5	Cooks Slough-Urban Area-City of Uvalde	48,340	0	100
6	Taylor Slough	1,760	530	70
	Total	191,870	19,820	90

Direct Monetary Floodwater Damage at Present Level of Development

Evaluation Reach (figure 1)	Average Recurrence Interval: 2-Year		5-Year		25-Year		100-Year	
	Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)
1	13,110	0	69,480	14,040	163,640	97,310	231,580	156,680
2	0	0	7,150	0	244,000	0	503,670	0
3	670	60	1,050	120	5,940	400	9,860	610
4A	1,280	420	2,710	1,130	9,310	5,620	19,840	10,430
4B	400	150	930	500	4,960	4,040	8,060	6,930
5	5,400	0	20,300	0	115,800	0	250,160	0
6	1,040	320	4,150	730	5,770	1,850	8,680	3,500
Total	21,900	950	105,770	16,520	549,420	109,220	1,031,850	178,150

The monetary value of the incidental ground water recharge is estimated to average $33,000 annually.

Benefits averaging $4,000 annually will accrue to the floodwater retarding structures from reduction of floodwater, sediment, and scour damages on the main stem of the Leona River outside the watershed. These damage reduction benefits are distributed as follows:

Crop and Pasture	$1,750
Other Agricultural	940
Sediment	600
Scour	710

It is estimated that the project will produce local secondary benefits, which exclude indirect benefits in any form, averaging $19,980 annually.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Uvalde County has not been designated as an area eligible for assistance under the Economic Development Act. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation and project administration cost, plus operation and maintenance) is $112,820. These measures are expected to produce average annual benefits, excluding secondary benefits, of $206,190 resulting in a benefit-cost ratio of 1.8:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($226,170) to the average annual cost of structural measures ($112,820) is 2.0:1.0 (table 6).

PROJECT INSTALLATION

Landowners and operators will establish planned land treatment (table 1) in cooperation with the Nueces-Frio-Sabinal Soil and Water Conservation District during a five-year period. Technical assistance in planning and application of land treatment is provided under the going program of the district. Soil surveys have been completed on the entire watershed.

An estimated 40 percent of needed soil and water conservation practices has been applied. The goal is to increase the level of land treatment application to at least 75 percent of total needs during the installation period.

In reaching this goal, it is expected that accomplishments of additional treatment will progress as shown in the following tabulation:

Land Use	Fiscal Year 1st (acres)	2nd (acres)	3rd (acres)	4th (acres)	5th (acres)	Total (acres)
Cropland	470	470	630	780	780	3,130
Pasture	170	180	230	290	290	1,160
Rangeland	5,230	5,240	6,980	8,720	8,720	34,890
Total	5,870	5,890	7,840	9,790	9,790	39,180

The governing body of the Nueces-Frio-Sabinal Soil and Water Conservation District will assume aggressive leadership in getting the land treatment program underway. Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. In addition, landowners and operators where floodwater retarding structures will be located will be encouraged to apply and maintain measures for the enhancement of wildlife. The Soil Conservation Service will provide technical assistance in the planning and application of soil, plant, and water conservation measures.

Special emphasis will first be placed on getting a higher degree of land treatment in the drainage areas of floodwater retarding structures. Then the emphasis will be on land outside drainage areas of structures.

The Extension Service will assist with the educational phase of the program by providing information to landowners and operators in the watershed.

The Uvalde County Commissioners Court and the City of Uvalde have rights of eminent domain under applicable State law and have the financial resources to fulfill their responsibilities.

The Soil Conservation Service, in compliance with a request from the sponsors, will provide the necessary administrative and clerical personnel; facilities, supplies, and equipment to advertise, award, and administer contracts; and will be the contracting agency to let and service contracts. The Uvalde County Commissioners Court will represent sponsoring local organizations in coordination with the Soil Conservation Service on matters concerning construction.

The Uvalde County Commissioners Court will have the following responsibilities pertaining to the four planned floodwater retarding structures.

1. Obtain the necessary land rights;

2. Provide for the change in location or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of floodwater retarding structures;

3. Provide for the necessary improvements to low water crossings on public and private roads to make them passable during prolonged release flows from floodwater retarding structures or provide equal alternate routes for use during periods of inundation;

4. Determine and certify legal adequacy of easements and permits for construction of the floodwater retarding structures; and

5. Provide for relocation advisory assistance services and relocation costs necessary for installation of floodwater retarding structures.

The City of Uvalde will have the following responsibilities pertaining to channel improvement on Cooks Slough:

1. Obtain the necessary land rights;

2. Provide for the change in location or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of channel improvement;

3. Determine legal adequacy of easements and permits for construction of channel improvement; and

4. Provide for relocation advisory assistance services and relocation costs necessary for installation of channel improvement.

Each sponsor will through its own facilities, for those structures for which it has assumed responsibility, (1) provide personally, or by first class mail, written notice of displacement and appropriate application forms to each displaced person, or farm operation; (2) give each displaced person notice to vacate at least 90 days prior to the date they must move; (3) assist in filing applications; (4) review and approve applications for relocation assistance; (5) review and process grievances in connection with displacements; and (6) make relocation payments.

Each sponsor, having responsibility for furnishing relocation advisory assistance services will provide such measures, facilities, or services as may be necessary or appropriate in order to: (1) determine the need, if any, of displaced persons for relocation assistance; (2) provide current and continuing information on the availability, prices, and rentals of comparable decent, safe, and sanitary sale and rental housing, and of comparable commercial properties and locations for displaced businesses and farm operations; (3) assure,that within a reasonable period of time prior to displacement, replacement dwellings will be available; (4) assist a displaced person displaced from his business or farm operation in obtaining and becoming established in a suitable replacement location; (5) supply information concerning housing programs, disaster loan programs, and other Federal or State programs offering assistance to displaced persons; (6) provide other advisory services to displaced persons in order to minimize hardships to such persons in adjusting to relocation; (7) advise displaced persons that they should notify the displacing agency

before they move; and (8) prior to initiation of acquisition, provide persons from whom it is planned to acquire land a brochure or pamphlet outlining the benefits to which they may be entitled.

Construction of any structural measures causing a displacement will not be initiated until decent, safe, and sanitary replacement housing is available for all displaced families.

The sponsoring local organizations recognize the importance of limestone, gravel, clay, igneous rock, and rock asphalt and the possible future importance of other rocks and minerals in the watershed vicinity. There is no intention by the sponsors to prevent the extraction of such resources as long as the operations can be performed without detrimental effects upon the structural measures included in this project.

Technical assistance will be provided by the Soil Conservation Service in preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install planned structural measures.

The structural measures will be constructed during four years of a five-year project installation period in the general sequence as follows:

Second Year - Floodwater Retarding Structure No. 3
Third Year - Floodwater Retarding Structure Nos. 1 and 2
Fourth Year - Channel Work
Fifth Year - Floodwater Retarding Structure No. 4

In order for construction to proceed according to schedule, land rights for each floodwater retarding structure and channel improvement are scheduled by the Uvalde County Commissioners Court and the City of Uvalde to be secured not later than the six-month increment shown in the following tabulation. The schedule will begin when the work plan is approved for operations.

First six months - Floodwater Retarding Structures Nos. 3 and 1
Second six months - Floodwater Retarding Structure No. 2
Sixth six months - Channel Improvement
Seventh six months - Floodwater Retarding Structure No. 4

FINANCING PROJECT INSTALLATION

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

The cost of applying land treatment measures will be borne by landowners and operators.

Funds for the local share of all project installation cost relative to floodwater retarding structures will be provided by Uvalde County. The City of Uvalde will provide funds for the local share of all project installation cost relative to channel improvement. The Commissioners

Court of Uvalde County and the City of Uvalde will set aside revenue funds to finance the local share of installation costs.

The sponsors will carry out all phases of project installation, operation, and maintenance and have the financial ability to make adequate arrangements for carrying out their responsibilities.

It is anticipated that approximately 70 percent of the easement value for structural measures will be donated. Out-of-pocketcost for land rights, legal expenses, and project administration are estimated to be $155,000.

Structural measures will be constructed during the five-year project installation period pursuant to the following conditions:

1. Requirements for land treatment in drainage areas of floodwater retarding structures have been satisfied.

2. All land rights have been obtained for all structural measures, or a written statement is furnished by the Uvalde County Commissioners Court and the City of Uvalde that their rights of eminent domain will be used, if needed, to secure any remaining land rights within the project installation period and that sufficient funds are available for purchasing them.

3. Provisions have been made, at no cost to the Federal Government, for improving low water crossings on bridges and/or culverts on public roads making them passable during periods of prolonged release flow from structures or provisions have been made for equal alternate routes for use during periods of inundation.

4. Utilities, such as power lines, telephone lines, and pipelines, have been relocated or permission has been obtained to inundate the properties involved.

5. Project agreements have been executed.

6. Operation and maintenance agreements have been executed.

7. Public Law 566 funds are available.

Various features of cooperation between the cooperating parties have been covered in appropriate memorandums of understanding and working agreements.

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

The County Agricultural Stabilization and Conservation committee will cooperate with the governing body of the soil and water conservation district by continuing to provide financial assistance for selected conservation practices.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Planned land treatment measures will be maintained by landowners and operators of farms and ranches on which measures are applied under agreement with the Nueces-Frio-Sabinal Soil and Water Conservation District. Representatives of the district will make periodic inspections of land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance.

Structural Measures

Upon acceptance of the completed works of improvements from the contractors the Uvalde County Commissioners Court will be totally responsible for maintenance of the four floodwater retarding structures, and the City of Uvalde will be totally responsible for maintenance of the approximately 18,300 feet of channel improvement. Maintenance will be performed promptly as the need arises.

The estimated total annual operation and maintenance coat for structural measures is $4,270, of which $1,190 is for floodwater retarding structures and $3,080 is for channel improvement. Monies for operation and maintenance of the floodwater retarding structures will be supplied from the General Fund of Uvalde County. Operation and maintenance costs for channel improvement will be defrayed by monies from the General Fund of the City of Uvalde. These funds are supported by revenue from existing taxes. Each year the Uvalde County Commissioners Court and the City of Uvalde will budget sufficient funds for operation and maintenance.

A specific operation and maintenance agreement will be executed prior to the issuance of invitation to bid on construction of any of the floodwater retarding structures or channel improvement.

Floodwater retarding structures and channel improvement will be inspected at least annually and after each heavy rain by representatives of the Uvalde County Commissioners Court, the City of Uvalde, and the Nueces-Frio-Sabinal Soil and Water Conservation District. The Soil Conservation Service will participate in these inspections for a period of at least three years following construction and will participate in inspections as often as it elects to do so after the third year. Items of inspection will include, but will not be limited to, conditions of principal spillways and their appurtenances; emergency spillways and earth fills for floodwater retarding structures; degradation, aggradation and bank erosion; condition of vegetation; obstruction of flow caused by debris and/or sediment; growth of brush and trees; and the condition of side inlets and drains for channel improvement.

The Soil Conservation Service will assist in operation and maintenance only to the extent of furnishing technical guidance.

Provisions will be made for unrestricted access by representatives of sponsoring local organizations and the Soil Conservation Service to inspect all structural measures and their appurtenances at any time and for sponsoring local organizations to operate and maintain them.

The Uvalde County Commissioners Court and the City of Uvalde will maintain a record of all maintenance inspections made and maintenance performed and have it available for inspection by Soil Conservation Service personnel.

The necessary maintenance work will be accomplished either by contract, force account,or equipment owned by sponsoring local organizations.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Leona River Watershed, Texas

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ Public Law: 566 Funds Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT					
Soil Conservation Service					
Rangeland	Acre	34,890	-	161,200	161,200
Pasture	Acre	1,160	-	21,600	21,600
Cropland	Acre	3,130	-	221,100	221,100
Technical Assistance				21,900	21,900
TOTAL LAND TREATMENT				425,800	425,800
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Floodwater Retarding Structures	No.	4	942,790	-	942,790
Channel Improvement	Feet	18,300	431,950	-	431,950
Type (N) 2/	Miles	3.47	-	-	-
Subtotal - Construction			1,374,740	-	1,374,740
Engineering Services					
Soil Conservation Service			70,070	-	70,070
Subtotal - Engineering Services			70,070	-	70,070
Relocation Payments					
Soil Conservation Service			25,700	11,030	36,730
Subtotal - Relocation Payments			25,700	11,030	36,730
Project Administration					
Soil Conservation Service					
Relocation Advisory Assistance Services			-	2,180	2,180
Construction Inspection			84,490	500	84,990
Other			117,300	2,300	119,600
Subtotal - Project Administration			201,790	4,980	206,770
Other Costs					
Land Rights			-	276,090	276,090
Subtotal - Other Costs			-	276,090	276,090
TOTAL STRUCTURAL MEASURES			1,672,300	292,100	1,964,400
TOTAL PROJECT			1,672,300	717,900	2,390,200

1/ Price Base: 1972

2/ Unmodified well Defined Natural Channel or Stream

January 1973

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

Leona River Watershed, Texas

Measures	Unit	Number Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	12,635	12,600
Crop Residue Management	Acre	12,649	25,300
Terraces	Foot	84,906	8,500
Diversion	Foot	11,589	1,200
Pasture and Hayland Management	Acre	1,314	5,300
Pasture and Hayland Planting	Acre	1,002	20,000
Proper Grazing Use	Acre	31,361	15,700
Range Seeding	Acre	1,862	9,300
Brush Control	Acre	9,886	138,400
Pond	No.	28	28,000
Irrigation Pipeline and Ditch and Canal Lining	Foot	120,585	241,200
Irrigation Land Leveling	Acre	986	78,900
Irrigation Water Management	Acre	3,820	11,500
Pipeline	Foot	15,750	6,300
Deferred Grazing	Acre	26,506	13,300
TOTAL			615,500

1/ Price Base: 1972

January 1973

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Leona River Watershed, Texas
(Dollars) 1/

Item	Installation Cost Public Law 566 Funds				Installation Cost Other Funds			Total Installation Cost
	Construction	Engineering	Relocation Payments 2/	Total Public Law 566	Relocation Payments 2/	Land Rights 3/	Total Other	
Floodwater Retarding Structures								
1	252,870	12,640	-	265,510	-	35,470	35,470	300,980
2	66,740	4,670	-	71,410	-	13,830	13,830	85,240
3	314,740	15,740	-	330,480	-	54,890	54,890	385,370
4	308,440	15,420	490	324,350	210	41,000	41,210	365,560
Subtotal	942,790	48,470	490	991,750	210	145,190	145,400	1,137,150
Channel Improvement Type (N) 4/	431,950	21,600	25,210	478,760	10,820	130,900	141,720	620,480
Subtotal	431,950	21,600	25,210	478,760	10,820	130,900	141,720	620,480
Subtotal Watershed	1,374,740	70,070	25,700	1,470,510	11,030	276,090	287,120	1,757,630
Project Administration				201,790			4,980	206,770
GRAND TOTAL	1,374,740	70,070	25,700	1,672,300	11,030	276,090	292,100	1,964,400

1/ Price Base: 1972
2/ Relocation payments for displacements will be shared as provided in Public Law 91-646 and in paragraph numbered 2 of the Watershed Work Plan Agreement.
3/ Includes $6,350 for legal fees and $73,750 for change in location or modification of other fixed improvements and utilities.
4/ Type of Channel Before Project: (N) - an unmodified, well defined natural channel or stream.

January 1973

59.08
-10.34
48.64

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Leona River Watershed, Texas

Item	Unit	Structure Number 1	2	3	4	Total
Class of Structure		C	C	C	C	xxx
Drainage Area	Sq.Mi.	7.91	3.81	37.02	10.34	59.08
Curve No. (1-day)(AMC II)		75	78	75	78	xxx
T_c	Hrs.	3.03	1.29	2.48	1.45	xxx
Elevation Top of Dam	Ft.	988.5	989.5	1023.6	1005.8	xxx
Elevation Crest Emergency Spillway	Ft.	979.4	981.6	1010.0	996.4	xxx
Elevation Crest Principal Spillway	Ft.	970.4	973.1	998.7	985.5	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	968.8	971.8	990.3	982.9	xxx
Maximum Height of Dam	Ft.	27	29	45	35	xxx
Volume of Fill	Cu.Yd.	262,900	89,800	267,200	216,000	835,900
Total Capacity	Ac.Ft.	1,924	1,197	6,417	2,427	11,965
Sediment Pool(Lowest Ungated Outlet) 1/	Ac.Ft.	181	173	185	198	737
Sediment Submerged 2/	Ac.Ft.	219	238	1,066	364	1,887
Sediment in Detention Pool-Aerated	Ac.Ft.	26	24	119	33	202
Retarding Pool	Ac.Ft.	1,679	935	5,232	2,030	9,876
Surface Area						
Sediment Pool(Lowest Ungated Outlet)	Acres	45	45	42	50	182
Sediment Pool-Principal Spillway Crest	Acres	77	58	210	80	425
Retarding Pool	Acres	329	173	690	315	1,507
Principal Spillway						
Rainfall Volume (areal)(1-day)	In.	9.20	9.20	8.79	9.19	xxx
Rainfall Volume (areal)(10-day)	In.	14.60	14.60	14.28	14.59	xxx
Runoff Volume (10-day)	In.	6.19	7.52	4.75	6.41	xxx
Capacity (Maximum)	cfs	137	92	780	352	xxx
Frequency Operation-Emergency Spillway	% chance	1.0	1.0	1.0	1.0	xxx
Size of Conduit	In.	36	30	66x66	48x48	xxx
Emergency Spillway						
Rainfall Volume (ESH)(areal)	In.	12.80	12.80	11.26	12.72	xxx
Runoff Volume (ESH)	In.	9.51	9.95	8.06	9.88	xxx
Type		Rock	Rock	Rock	Rock	xxx
Bottom Width	Ft.	200	200	600	440	xxx
Velocity of Flow (V_e)	Ft./Sec.	8.7	7.7	12.4	9.1	xxx
Slope of Exit Channel	Ft./Ft.	0.034	0.020	0.029	0.040	xxx
Maximum Water Surface Elevation	Ft.	982.9	984.5	1016.0	1000.4	xxx
Freeboard						
Rainfall Volume (FH)(areal)	In.	30.70	30.70	27.02	30.52	xxx
Runoff Uolume (FH)	In.	27.03	27.56	23.39	27.38	xxx
Maximum Water Surface Elevation	Ft.	988.5	989.5	1023.6	1005.8	xxx
Capacity Equivalents						
Sediment Volume	In.	0.58	1.29	0.60	0.72	xxx
Retarding Volume	In.	3.98	4.60	2.65	3.68	xxx

1/ Volume for lowest ungated outlet includes anticipated borrow to be excavated below this elevation. This borrow volume is included in the submerged Sediment.

2/ Excludes anticipated allowance for borrow

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TABLE 3A - STRUCTURE DATA

CHANNELS

Leona River Watershed, Texas

Channel	Station	Drainage Area Sq.Mi.	Capacity cfs Required	Capacity cfs Design	Water Surface Elev. 1/	Hydraulic Gradient (ft./ft.) 2/	Channel Dimensions Bottom (ft.)	Channel Dimensions Depth (ft.) 1/	Channel Dimensions Side Slopes	"n" Value 3/ Aged	"n" Value 3/ As Built	Velocities (ft./sec.) 4/ Aged	Velocities (ft./sec.) 4/ As Built	Excavation (1000 Cu.Yds.)	Type of Improvement	
Cooks Slough 7/	10+20	18.24	13,300	13,920	906.5	0.00080	180	11.4	4:1	.035	.025	4.3	5.4	-	II	5/
	45+30	20.51	13,400	13,920	903.4	0.00078	180	11.5	4:1	.035	.025	4.2	5.2	269.7	II	5/
	87+10	20.53	13,750	13,920	900.0	0.00070	180	12.0	4:1	.035	.025	3.9	4.9	241.4	II	5/
	119+60	21.92	13,900	13,920	897.8	0.00055	180	12.8	4:1	.035	.025	3.3	4.0	157.3	II	5/
	134+70	22.26	13,920	13,920	896.9	0.00048	180	13.3	4:1	.035	.025	3.0	3.5	31.6	II	5/
	192+60	23.19	6/	6/	891.0	0.0016	Existing Channel			.035	.035	4.7	4.7	101.2	II	5/

1/ Based on aged "n" values
2/ Computed from water surface profile data
3/ Value as determined from NEH-5, Supplement E
4/ 10-year frequency velocities (other frequency velocities are shown on page 50)
5/ II-Enlargement of existing channel or stream
6/ 100-year design not computed for this reach
7/ Without project conditions, all channel reaches are unmodified and have well defined natural channel sections. All channel reaches are ephemeral.

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TABLE 4 - ANNUAL COST

Leona River Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures Numbers 1 through 4 and Channel Improvement	97,120	4,270	101,390
Project Administration	11,430		11,430
GRAND TOTAL	108,550	4,270	112,820

1/ Price Base: Installation - 1972, O&M - Adjusted normalized prices, April 1966

2/ 100-years at 5.500 percent interest

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Leona River Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	29,810	12,090	17,720
Other Agricultural	12,400	4,460	7,940
Nonagricultural			
Road and Bridge	990	360	630
Urban 2/			
Residential Property	106,380	0	106,380
Business Property	8,460	0	8,460
Streets and Utilities	1,870	0	1,870
Subtotal	159,910	16,910	143,000
Sediment			
Overbank Deposition	2,290	560	1,730
Erosion			
Flood Plain Scour	1,610	560	1,050
Indirect	28,060	1,790	26,270
TOTAL	191,870	19,820	172,050

1/ Price Base: Nonagricultural damages - Current prices (1972); All other damages adjusted normalized prices, April 1966.

2/ Evaluation of damages resulting from floods up to and including a 100-year frequency event. Floods larger than the 100-year frequency event still will cause some damage after project installation.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Leona River Watershed, Texas
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 3/	Benefit Cost Ratio
	Damage Reduction	Incidental Ground Water Recharge	Other 2/	Secondary	Total		
Floodwater Retarding Structures Numbers 1 through 4 and Channel Improvement	169,190	33,000	4,000	19,980	226,170	101,390	2.2:1.0
Project Administration						11,430	
GRAND TOTAL	169,190 4/	33,000	4,000	19,980	226,170	112,820	2.0:1.0

1/ Price Base: Nonagricultural benefits - Current prices (1972); All other benefits adjusted normalized prices, April 1966.
2/ Benefits from reduction of damages on the main stem of the Leona River outside the watershed.
3/ From Table 4
4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $2,860 annually.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment for the watershed was developed by the Nueces-Frio-Sabinal Soil and Water Conservation District assisted by personnel from the Soil Conservation Service work unit at Uvalde, Texas. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent conservation needs of the entire watershed. The quantity of each land treatment practice, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. The estimated number of acres, by land use, to be treated during the project installation period are shown on table 1. Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of flood damage reduction desired by local people.

Hydrologic soil and cover conditions were determined by detailed mapping of a 39 percent sample of the watershed.

Present hydrologic cover conditions were determined on the basis of the percentage of vegetative ground cover and litter. Future hydrologic cover conditions were estimated on the basis of the expected percentage of needed land treatment to be applied during the installation period and the probable effectiveness of the application.

Hydraulics and Hydrology

Rating curves were developed, by Mannings formula, from surveyed valley cross sections located with joint consultation with the economist and geologist.

Project formulation, hydrology, was developed for present and with project conditions using procedures as outlined in Technical Release No. 20.

Water surface profile computations were made on Cooks Slough for present and with project conditions.

Water surface profiles and project formulation, hydrology, were developed by automatic data processing using the computer at the South Regional Technical Service Center.

The frequency method for evaluation was used to develop area and depth inundation tables and curves.

Engineering

Studies were made on both the agricultural flood plain and the urban flood plain in Uvalde to locate those areas subject to flood damage. High

water marks of previous floods were obtained from local people who were eye-witnesses to past floods. The areas subject to flood damage were separated into evaluation reaches in order to formulate the most feasible system of structural measures necessary to meet project objectives (figure 1).

No floodwater retarding structure sites were given consideration as possible multiple-purpose structures. The soils and geologic strata of abutments and beneath the sediment and detention pools of Sites Nos. 1, 2, 3, and 4 do not exhibit favorable water holding characteristics.

Comprehensive surveys and investigations were made at eight possible floodwater retarding structure sites and on approximately nine miles of stream channel.

Four floodwater retarding structures and approximately 18,300 feet of channel improvement were selected for inclusion in the final work plan. Structure locations are shown on figures 5, 5A, and 7.

Special emphasis was placed on controlling as much drainage area as possible with floodwater retarding structures on Cooks Slough. Considerable time was expended in searching for adequate floodwater retarding structure sites on tributaries to Cooks Slough. Structures Nos. 1 and 2 were located as far downstream as topographic and other site conditions would permit. Locations of possible floodwater retarding structure sites were examined on tributaries between State Highway 55 and Farm Road 2369 and between U.S. Highway 90 and Farm Road 481. Broad shallow valleys at the possible sites result in unsuitable characteristics for storage of sediment and floodwater. Unfavorable topographic conditions and the involvement of numerous improvements at any possible site made floodwater retarding structure control on these two tributaries infeasible.

Sediment and floodwater storage, structure classification, and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27.

Multiple routings of both principal and emergency spillways were made to determine principal spillway sizings, height of embankment, detention storage requirements, and to analyze the effects of release flows on downstream improvements such as highway and railroad bridges and low water crossings. Least cost studies of alternate designs were made for each planned floodwater retarding structure site because of extensive rock excavation in the emergency spillways on Sites Nos. 2, 3, and 4 and large embankment quantities required on Sites Nos. 1, 3, and 4.

Capacity required for channel improvement design was determined by flood routing runoff from a 100-year frequency storm for the uncontrolled drainage area of Cooks Slough above the urban area.

Design velocities of the improved channel were determined from water surface profiles developed by use of the Project Formulation Hydraulics Program. Separate computations were made for an "aged" "n" value of .035 and an "as

built" "n" value of .025. These velocities for various frequencies are summarized below at representative channel stations.

Velocities For "Aged" "n" Value of .035

Station	10-Year Frequency	25-Year Frequency	100-Year Frequency
	(feet per second)		
10+20	4.3	4.8	5.4
45+30	4.2	4.8	5.3
87+10	3.9	4.4	5.1
119+60	3.3	3.9	4.7
134+70	3.0	3.6	4.5

Velocities For "As Built" "n" Value of .025

Station	10-Year Frequency	25-Year Frequency	100-Year Frequency
	(feet per second)		
10+20	5.4	6.1	6.8
45+30	5.2	5.9	6.6
87+10	4.9	5.5	6.2
119+60	4.0	4.7	5.4
134+70	3.5	4.2	5.0

The planned channel improvement includes excavation beneath the U.S. Highway 90 bridge. The Texas Highway Department states that the load carrying capacity of the bridge pilings is developed through friction and that a residual piling penetration of 10 feet is necessary to support the structure loading. The design elevation of the bottom of the improved channel will provide the 10-foot minimum. However, any significant degradation would result in a penetration less than the minimum required. Therefore, concrete riprap, as agreed upon by the Texas Highway Department and the Service, will be placed across the channel under the bridge to assure safety.

Geology

Soils and Foundations

Preliminary geologic investigations were made at each of the four floodwater retarding structure sites (figures 6 and 7) to obtain information on the nature and extent of embankment and foundation materials, types of materials in emergency spillway excavation, emergency spillway stability, and other problems that might be encountered during construction. These investigations were made in accordance with Techncial Release No. 17, "Geologic Investigations for Watershed Planning", March 1966 and NEH, Section 8, Chapter 6. These investigations included hand auger borings and surface observations of valley slopes, alluvium, channel banks, and exposed geologic strata. Geologic maps and reports concerning the watershed and vicinity were studied.

Findings of these investigations were used in making cost estimates of structures and to assure that sites selected are feasible for construction.

All four planned floodwater retarding structures will be located within the Balcones fault zone. In general the faults are the normal type, trend toward the east-northeast, and are upthrown on the north-northwest. The regional dip is toward the south-southeast, but local dips in almost any direction can be found. The dip angles are generally less than two degrees.

Site No. 1 is located on very gentle topography. It is underlain primarily by Pliestocene alluvial deposits of the Leona Formation which consist mainly of clay and gravel. The upper five to ten feet, including some Recent alluvium, is mainly silty clay of moderate to high plasticity. The underlying materials are characterized by the presence of gravel which becomes more significant with increasing depth. These materials consist primarily of interbedded calcareous gravelly clay, clayey gravel, and silty gravel. The thickness of the Leona Formation is estimated to be greater than 30 feet beneath the major portion of the dam and pool areas. The Buda Limestone of the Cretaceous System is exposed on the left abutment and in the emergency spillway area.

Site No. 2 lies on the Cretaceous outcrops of the Georgetown Limestone, Grayson Formation, and Buda Limestone. The topographic relief is moderate. The left abutment is composed of hard, massive to thick bedded, somewhat vugular Georgetown Limestone. The upper portion of the right abutment consists mostly of calcareous clay and shale of the Grayson Formation which overlies the Georgetown Limestone. The Buda Limestone, which overlies the Grayson Formation, is involved only on the uppermost portion of the right abutment. A gentle westward dip and possible minor faulting account for the geologic difference in the two abutments. Recent Alluvium, consisting of clay, silty clay, gravelly clay, and clayey gravel, occupy the valley floor and range up to 10 feet in thickness. Indurated caliche is common at the base of the alluvium and rests upon limestone bedrock.

Site No. 3 is underlain by hard, medium to thick bedded Buda Limestone which dips gently downstream (southeast). Silty clay, gravelly clay, and clayey gravel of the Leona Formation and Recent Alluvium overlie the Buda Limestone in the flood plain and a large portion of the gently sloping left abutment. A relatively steep slope and very shallow to shallow soils covering the Buda Limestone characterize the right abutment. Clay and shale of the Grayson Formation, which underlies the Buda Limestone, crop out a short distance upstream from the centerline of dam. This is caused by the structural dip exceeding the slope of the land surface.

Thick deposits of alluvial clay, silt, and gravel belonging to the Leona Formation have accumulated along Taylor Slough, including the Site No. 4 vicinity. The magnitude of the deposition is explained by geologic evidence indicating that the ancient Dry Frio River flowed through the present valley of Taylor Slough during Pleistocene time. The alluvium, characterized by very gentle topography, covers most of the site. However, the left abutment will consist of hard, massive to thick bedded Georgetown Limestone, exhibiting relatively steep topography.

Foundation materials at the four sites exhibit evidence of sufficient bearing and shear strength. However, the need for foundation drainage measures is

is anticipated at all floodwater retarding structure sites because of the common occurrence of rapidly permeable zones in both the alluvium and bedrock.

Sufficient volumes of alluvial clay, silty clay, gravelly clay, and clayey gravel are available for embankment construction within short haul distances. Durable limestone from emergency spillway excavation will be available at all sites for use as rock blankets on the embankments.

Preliminary estimates of rock excavation in emergency spillways are 24,800 cubic yards at Site No. 1; 11,030 cubic yards at Site No. 2; 73,360 cubic yards at Site No. 3; and 95,500 cubic yards at Site No. 4.

Detailed investigations, including exploration with core drilling equipment, will be made at all sites prior to final design. Laboratory tests will be made to determine suitability and methods of handling foundation and embankment materials.

Ground Water

An investigation was made in accordance with NEH, Section 18, and Technical Release No. 17, "Geologic Investigation for Watershed Planning", March 1966, to determine the effect the project would have on ground water resources of the area.

Pertinent information was gathered from recent publications of the Geological Survey, United States Department of the Interior, concerning ground water in the vicinity of the watershed. Field studies included inspecting and mapping exposed geologic strata, borings with power drilling equipment, and observations of water losses during bore hole advancement.

The Leona River watershed is underlain by two important aquifers, the Edwards and associated limestones of Cretaceous age and the Leona Formation of Pleistocene age. Other less important aquifers will not be discussed in the work plan.

The principal aquifer is the Edwards and associated limestones, consisting of the Georgetown Limestone, the Kiamichi Formation, Edwards Limestone, and the Comanche Peak Limestone. These formations behave as a single hydrologic unit beneath an extensive portion of south-central Texas and comprise a vast ground water reservoir. The reservoir lies within the Balcones fault zone, where numerous joints, fractures, sinkholes, and solutional channels in the limestones permit rapid infiltration and movement of water. The size of openings ranges from caverns, through which water moves freely, to minute solutional cavities and cracks where large head losses occur.

The aquifer is recharged primarily by streams which originate upstream from the Balcones fault zone, flow across the fault zone, and lose large volumes of water to the limestones. The greater volume of ground water in the reservoir moves from Kinney County eastward through Uvalde and Medina Counties and into Bexar County to the San Antonio vicinity. The direction of flow then turns toward the northeast, crosses Comal County, and extends to San Marcos in Hays County.

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Much of the natural discharge from the aquifer occurs at the eastern end of the reservoir in Bexar, Comal, and Hays Counties. Artificial discharge is increasing rapidly. This is due primarily to increasing irrigation and expanding cities and military bases. Irrigation is by far the greatest user of ground water in Uvalde County.

Pronounced and rapid water level fluctuations occur in response to droughts, pumping, and rainfall. Since about 1934, the estimated average annual recharge has been less than average annual discharge. Further increases in withdrawals from the western part of the aquifer would result in decreased water flowing eastward.

The Leona Formation, composed of alluvial clay, silt, sand, gravel, and cobbles, is also an important aquifer occupying the valleys of Leona River and its major tributaries. It is recharged primarily by ground water discharging from the Edwards and associated limestones in the subsurface where the two aquifers are hydrologically connected. Springs southeast of Uvalde on the Leona River flow intermittently from gravel beds of the Leona Formation. These springs flow in direct response to water level fluctuations in the Edwards and associated limestones. Recharge to the Leona Formation by direct stream flow seepage from the Leona River is insignificant according to the Geological Survey. The primary cause for this is a persistent bed of nearly impervious clay which lines the Leona River channel upstream from the springs.

In the Leona River watershed, the Edwards and associated limestones are recharged primarily by runoff from streams which cross the Balcones fault zone to the west. The Leona River heads on the outcrop of the Edwards Limestone within the Balcones fault zone. Thus, much of the rain that falls on the upper part of the watershed enters the Edwards and associated limestones.

A study was made to estimate the significance of ground water recharge within the Leona River watershed under existing conditions. The estimate was based on the amount of water resources (average annual runoff if there were no recharge losses) and the length of channel flow across the recharge zone. The estimate of average annual water resources was based on stream gage data for the Dry Frio River at Reagan Wells. The drainage area above the Reagan Wells gage is in a nonrecharge zone.

The "Survey Report on Edwards Underground Reservoir", Vol. 1, Corps of Engineers and Edwards underground Water District, 1965, furnished estimates of average annual recharge for most streams crossing the recharge zone. Dry Comal and Salado Creeks were selected as representative of the Leona River because of the similarities in geology, hydrology, and watershed size for all three watersheds. The average annual rates of recharge, expressed in acre-feet per acre-foot of water resources per mile of channel flow across the recharge zone, are 0.32 for Dry Comal Creek and 0.35 for Salado Creek. Using the average of the two, the estimate of average annual recharge for the Leona River watershed is 5,100 acre-feet.

All four floodwater retarding structures will be located such that they will retard runoff from nonrecharge areas as well as from recharge areas. The pools of all four structures will lie, at least partially, within recharge areas. The estimated increase in average annual ground water benefits, resulting incidentally from installation of floodwater retarding structures, is 2,200 acre-feet. In addition, there are excellent opportunities for local interests to install other works such as recharge wells and improved openings for maximum injection of release flows from floodwater retarding structures.

Channel Stability

Channel stability investigations were made for the approximately 18,300 feet of planned stream channel improvement on Cooks Slough (figure 7) in accordance with Technical Release No. 25, "Planning and Design of Open Channels", December 1964. Surface observations were made along the entire length of planned channel improvement. Hand and power auger borings were made at selected locations to study the nature of materials involved and to obtain representative samples for laboratory analyses.

The planned channel improvement is located on the northern edge of the Rio Grande Plain Land Resource Area where widespread alluvial outwash from the Edwards Plateau was deposited during Pleistocene time (figure 6). There is much evidence suggesting drastic rearrangement of stream drainage either during or following Pleistocene time. For instance, Cooks Slough is presently flowing within the valley of a much larger ancient stream. The decreased drainage area size, water losses to the Edwards Underground Reservoir, and a gentle stream gradient have resulted in insufficient volumes and velocities of flow on Cooks Slough to incise a well defined channel into the Pleistocene alluvium. Instead, there has been a gradual filling of the channel with clay, silt, and some gravel during Recent time. The filling results primarily from a gentle stream gradient and relatively dense vegetative growth rather than from a high rate of sediment production.

The upper portion of channel banks will be composed of Recent Alluvium consisting of highly plastic silty clay. The plasticity index for this soil is about 30. Pleistocene deposits of moderately plastic, calcareous, silty, sandy clay belonging to the Leona Formation underlie Recent Alluvium and will constitute the major portion of the channel bottom and the lower portion of the banks. The plasticity index for this material ranges between 10 and 20. In some places, the entire surface of improved channel cross section will be composed of the younger, more plastic clay.

The allowable velocity approach, as outlined in Technical Release No. 25, was used as a basis for arriving at a stable channel design. Velocities of the 100-year frequency flow at all surveyed cross sections are within the limiting criteria (TR-25) for vegetated channels. The 10-year frequency velocities are either within or exceed slightly the limiting criteria.

Channel improvement was installed on about one mile of the Leona River within the City of Uvalde in 1936. The materials through which this channel was excavated are very similar to those on Cooks Slough. The improved

channel has remained remarkably stable, although velocities and peak flows experienced on this channel exceed those expected to occur on the planned Cooks Slough channel.

Immediately upstream from the upper limit of planned channel improvement, Cooks Slough flows across the massive to thick-bedded, erosion resistant Buda Limestone for a distance of at least one-fourth mile. The limestone will serve as a natural grade stabilization feature.

Sedimentation

Sedimentation investigations were made in accordance with procedures as outlined in NEH, Section 3, Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1966, and Technical Release No. 12, "Procedure-Sediment Storage Requirements for Reservoirs", January 1968.

Sediment Storage

Determinations for 100-year sediment storage requirements for the four planned floodwater retarding structures (figure 7) were made according to the following procedure:

> Detailed studies of soils, slopes, and cover were made within sample areas covering 39 percent of the watershed. The sample areas were selected to be representative of the watershed in respect to sediment producing characteristics. Average annual sheet erosion rates, for both present and future conditions, were computed. The soil loss equation by Musgrave was used. Estimates of average annual sheet erosion within drainage areas of structure sites were based on the computed erosion rates.
>
> Computations of gully and streambank erosion were based on estimated lateral bank erosion rates, bank heights, and channel lengths affected by erosion.
>
> Sediment delivery ratios and trap efficiency adjustments were applied to computed average annual erosion to arrive at estimates of sediment volumes to be deposited in reservoirs.
>
> Allowances were made for differences in density between soil in place and sediment. These densities were based on estimated volume weights of 60 pounds per cubic foot for submerged sediment and 82 pounds per cubic foot for soil in place.
>
> Allocation of sediment to the pools of floodwater retarding structures was based on sediment texture and reservoir topography. The allocation was approximately 90 percent in sediment and sediment reserve pools and 10 percent in detention pools.

A sedimentation survey was made at Davenport Lake just prior to work plan development. This lake is located within the drainage area of Site No. 2

(figure 7). After computing the actual rate of sediment deposition in the 106 acre reservoir, the procedure described above was followed in order to determine its applicability in estimating sediment storage requirements for planned floodwater retarding structures in the Leona River watershed. The accuracy of the procedure was approximately 90 percent.

Flood Plain Sediment and Scour Damages

The following investigations and computations were made to determine the nature and extent of physical damage to flood plain lands and the effect of the project on these damages:

Borings were made along valley cross sections (figure 1). Factors such as depth and texture of sediment deposits, soil condition, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded. The elevation of the original flood plain before modern deposition began was estimated for each valley section. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators.

A damage table was developed to show percent loss of productive capacity by texture and depth increment for sediment and by depth and width for scour. Due consideration was given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages. Adjustments for recoverability of productive capacity were made on the basis of field studies and interviews with farmers.

Each valley cross section represents a segment of flood plain within an evaluation reach. The area of each damage category was computed by segments and summarized by evaluation reaches.

Estimated reductions of damaging sediment yield were based on detailed sediment source studies. Sediment yields to evaluation reaches were computed for without project conditions, with land treatment measures applied, and with the combined program of land treatment and structural measures installed. The reductions in sediment yields were adjusted to reflect the relative importance of each sediment source as a contributor of damage. The estimated reduction of monetary damage from overbank deposition was based on reduction of area inundated by floodwater and reduction in damaging sediment yield.

The estimated reduction of scour damage due to installation of the project was based on reduction of depth and area inundated by floodwater.

Economics

Basic methods used in the economic investigations and analyses are outlined in the "Economics Guide for Watershed Protection and Flood Prevention", U.S. Department of Agriculture, Soil Conservation Service, March 1964.

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Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into six evaluation reaches (figure 1). Of these, two were in the urban area of Uvalde.

Determination of Nonagricultural Damages

Because the major floodwater damages in this watershed are to nonagricultural property, the frequency method of analysis was used. Information was collected in the field on damages experienced from the flood of August 1953 and from several other smaller floods. At the same time an evaluation was made of the damages that would occur from a flood which could be expected on an average of once in 100 years. Under without project conditions, a flood of this magnitude would result in highwater elevations in Uvalde of approximately 2.0 feet higher than the high water elevations recorded in 1953 along Cooks Slough and from 2.0 to 2.4 feet higher than experienced in 1953 along Leona River. High water marks from the experienced floods were used to determine peak stages which in turn were related to stages calculated for the evaluation series. Stage damage curves were developed to cover the range of damage producing floods. Average annual damages under the present state of development were calculated for each evaluation reach.

An analysis was made of existing data pertaining to the economic development of the Uvalde area. In addition, data developed by the Office of Business Economics (OBE), U.S. Department of Commerce, for Area 09135, which includes the City of Uvalde, was analyzed to determine the factors which have contributed to the overall economic growth of the area. Bank deposits were also considered. A comparison of pertinent historic data relative to economic activities in Uvalde and in the total OBE area indicates that population, per capita income, and the resulting total personal income for Uvalde will incease at about the same rate as projected for the OBE area.

The urban flood plain of Leona River is subject to infrequent flooding. Properties in the flood plain reflect a high percentage of business development. Future increased development in this area will be tied largely to increases in total personal income as business development is related to increases in the total population of an urban area and increases in per capita income. For this reason, it is believed that projections of total personal income best reflect the number and values of properties that would be subject to flood damage even in the absence of a project. Therefore, damage to the existing development was increased by 171.9 percent to reflect the gradual accrual of these values discounted to present worth.

The urban flood plain of Cooks Slough is subject to more frequent flooding than Leona River. As a result, most of the property in the flood plain is composed of moderate to low value residential units. Very few business properties exist or are expected to be developed in the area. For the past 10 to 20 years population increases in this area have been considerably less than in the rest of Uvalde. Property subject to flooding will continue to increase in value because of progressively higher per capita incomes. For these reasons, it is believed that projections of per capita income best reflect the value of properties that would be subject to flood damage even in the absence of a project. Therefore, damage to the existing development was increased by 104.5 percent to reflect the gradual accrual of these values discounted to present worth.

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In order to assure a conservative present worth estimate of future development, projected increases were considered for only the first 50 years of the evaluation period. During the second 50 years, the level of development was assumed to remain constant.

Because a high percent of the damage by the larger floods is to businesses, indirect damages associated with urban flooding will bear a higher than normal relationship to the direct damage. Expenses associated with dislocation of residents and rehabilitation of businesses will be high. For this reason, it is estimated that indirect damages to urban property would approximate 20 percent of the direct damage.

Estimates of damages to railroads, roads, highways, and bridges in the flood plain were obtained from railroad officials, county officials, state highway officials, and supplemented by information from local residents.

Determination of Agricultural Damages

Agricultural damage calculations were based on information obtained in interviews with owners and operators of approximately 50 percent of the acreage of the flood plain. Schedules covered flooding and flood damage; past, present, and intended future use; and yield data. Verification of information gained by interviews in the field was obtained from local agricultural technicians.

The frequency method of analysis of damages was used, and the occurrence of more than one flood in a growing season was considered in determining crop and pasture damage. The computed damages were discounted for the recurrence with allowance for partial recovery between floods.

Other agricultural damages to irrigation facilities, fences, farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected in the field and correlated with area and depth of flooding.

Monetary damages to the flood plain from scour and overbank deposition were based on the value of production losses. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows. Reduction in monetary damages from sediment deposition was based on the effectiveness of land treatment measures, trap efficiency of planned floodwater retarding structures, and the average annual area flooded under each progressive phase of the project.

Incidental Benefits from Ground Water Recharge

Ground water recharge will occur incidental to the installation of the floodwater retarding structures. Flood prevention was the only purpose considered in the location and design of these structures. No additional costs are involved in obtaining recharge as it takes place naturally as seepage. When the structures are installed, it is estimated that an additional 2,200 acre-feet will be recharged annually.

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Investigations were made in an attempt to determine the areas of recovery and probable use of the additional water made available by recharge. These investigations indicated that because of the vastness of the Edwards aquifer and its hydraulic gradient, generally to the east, areas of recovery and purposes of use could not be predicted with any degree of certainty. Undoubtedly some of the recharge will be recovered in the immediate area, but most of it will probably be recovered from that portion of the Edwards Underground Reservoir between Uvalde County and the springs at San Marcos.

Water recovered from this area is used largely for agriculture, recreation at Comal and San Marcos springs, municipal and industrial use, and abatement of stream flow pollution. Based on studies made by the U.S. Army Corps of Engineers and the Edwards Underground Water District, the value of an acre-foot of water to increase the pumping potential of the underground aquifer varies from about $15 to $38. In view of uncertainties regarding the efficiency of recovery, the value of ground water recharge was appraised at the lowest estimated value or $15 per acre-foot.

Other Benefits

Other benefits, from reduction of damages on the main stem of the Leona River outside the project area, were evaluated in the same manner as those in the watershed.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over the period of project life. No production in sediment pools was considered and the land covered by detention pools was assumed to be rangeland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification.

Secondary Benefits

Secondary benefits were estimated by adaption of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in "An Input-Output Model of the South Central Region of Texas" which was developed as part of the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, March 1972.

Increased employment resulting from the proposed project was estimated by the use of multipliers as calculated in "An Input-Output Analysis of the Texas Economy Emphasizing Agriculture" by Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance study of Leona River watershed. This report was valuable in work plan development pertaining to fish and wildlife. In addition to data presented in other parts of the work plan, the following is reproduced from the Bureau of Sport Fisheries and Wildlife reconnaissance survey report:

"If any of the floodwater retarding structures could hold water, they would provide sport fishing opportunities in an area where few now exist. The reservoirs would provide habitat for such fish as largemouth bass, bluegill, and channel catfish. There would be no commercial fishing with the project.

If herbs are planted in the sediment pool of the floodwater retarding structures expected to hold water, the water fertility would be increased and the turbidity would be decreased. Vegetation planted on the barren areas draining into the reservoir also would improve fertility and reduce turbidity.

The control of livestock entrance into the area in and around reservoir sediment pools would reduce fouling of the water and aid the growth of wildlife food and cover plants. When practicable, the sediment pools should be fenced and livestock water requirements supplied by providing water lanes to the pools.

It would be of benefit to landowners and the project sponsors if they consulted the Texas Parks and Wildlife Department regarding the fish stocking requirements of the waters. Such consultation would discourage and possibly prevent the introduction of undesirable fish species into the watershed and would insure the best fish stocking rate.

As much brush and timber as possible should be retained in the watershed for wildlife. Areas of particular value to wildlife can be preserved and in some cases enhanced if brush control is applied selectively in the area of treatment. In addition, losses of brush and timber resulting from the installation of project measures could be partly offset by planting trees and shrubs at appropriate locations such as idle lands, eroded areas, streambanks, gulliea, along fencerows and hedgerows, and around the floodwater retarding reservoirs.

In view of the above it is recommended that:

1. Herbs be planted on barren areas in and adjacent to the sediment pool of the floodwater retarding structures which are expected to hold water.

2. The sediment pool of floodwater retarding structures which hold water be fenced and livestock water requirements be supplied by providing water lanes to the pools.

3. Floodwater retarding reservoirs and farm ponds be stocked with fish species and at rates recommended by the Texas Parks and Wildlife Department.

4. Clearing of timber and brush in the watershed be kept to a minimum.

5. Brush control be applied with wildlife habitat preservation and enhancement in mind.

6. Losses of timber and brush due to the building of structural measures be compensated for by planting trees and shrubs suitable for wildlife at appropriate locations such as idle lands, eroded areas, streambanks, along fencerows, and around reservoirs.

The above recommendations are in conformance with the U.S.D.A. Soil Conservation Service Biology Memorandum-7 (Rev. 1), National Standards for Biology Practices. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and, additionally, fish and wildlife benefits would accrue to the project.

A detailed study of the watershed by the Bureau of Sport Fisheries and Wildlife is not considered necessary at this time. Should the sponsors desire, our Bureau, in cooperation with the Texas Parks and Wildlife Department, would be happy to be of further assistance."

Archeology

Archeological field surveys of the four floodwater retarding structure sites and the area required for the channel work were conducted by the Texas Archeology Survey, The University of Texas at Austin. The surveys and resulting report, "Leona River Watershed, Uvalde County, Texas, an Archeological and Historical Survey of Areas Proposed for Modification, Research Report No. 37" were carried out and written respectively under the guidance of staff archeologist, Grand D. Hall. Eleven archeological sites were observed, all in the localities of the four floodwater retarding structures included in the project. No archeological sites were observed along Cooks Slough in the area required for channel work. However, a portion of this area is considered to be an archeologically sensitive zone due to the presence of deep alluvial soil deposits that are apparently undisturbed.

The procedures used, as described in Research Report No. 37, in carrying out the field surveys are as follows:

"Prior to the initiation of field investigations, maps and files housed at the Texas Archeological Research Laboratory were reviewed for information pertaining to past archeological research in Uvalde County and vicinity. It was found that no sites had been recorded for any of the areas involved in the current survey. Files containing data on the other sites in Uvalde County were examined to give the field archeologist a working knowledge of the type of resources expected to be found in the study area.

Maps used during the field survey included a U.S.G.S. 7.5' quadrangle map and U.S.D.A. Soil Conservation Service land rights maps for each dam site. These maps provided large scale coverage of the project areas and demonstrated landmark features and topography very accurately. As the field survey progressed, the locations of sites found in the study area were recorded on these maps. The San Marcos office of the Soil Conservation Service provided aerial photographs of the segment of Cooks Slough running through the City of Uvalde.

The survey consisted for the most part of an intensive superficial inspection of proposed dam sites, predicted sediment pools, the land to be inundated during times of flood, and segments of channel. The strictest attention was, however, paid to those areas to undergo the most radical modifications. These were the proposed dam sites and the borrow areas from which the fill material for the dams will be obtained.

All field data were recorded on standard forms established by the Texas Archeological Research Laboratory. Notes, photographs, and the artifacts generated by the survey are housed at the Texas Archeological Research Laboratory, Balcones Research Center, The University of Texas at Austin."

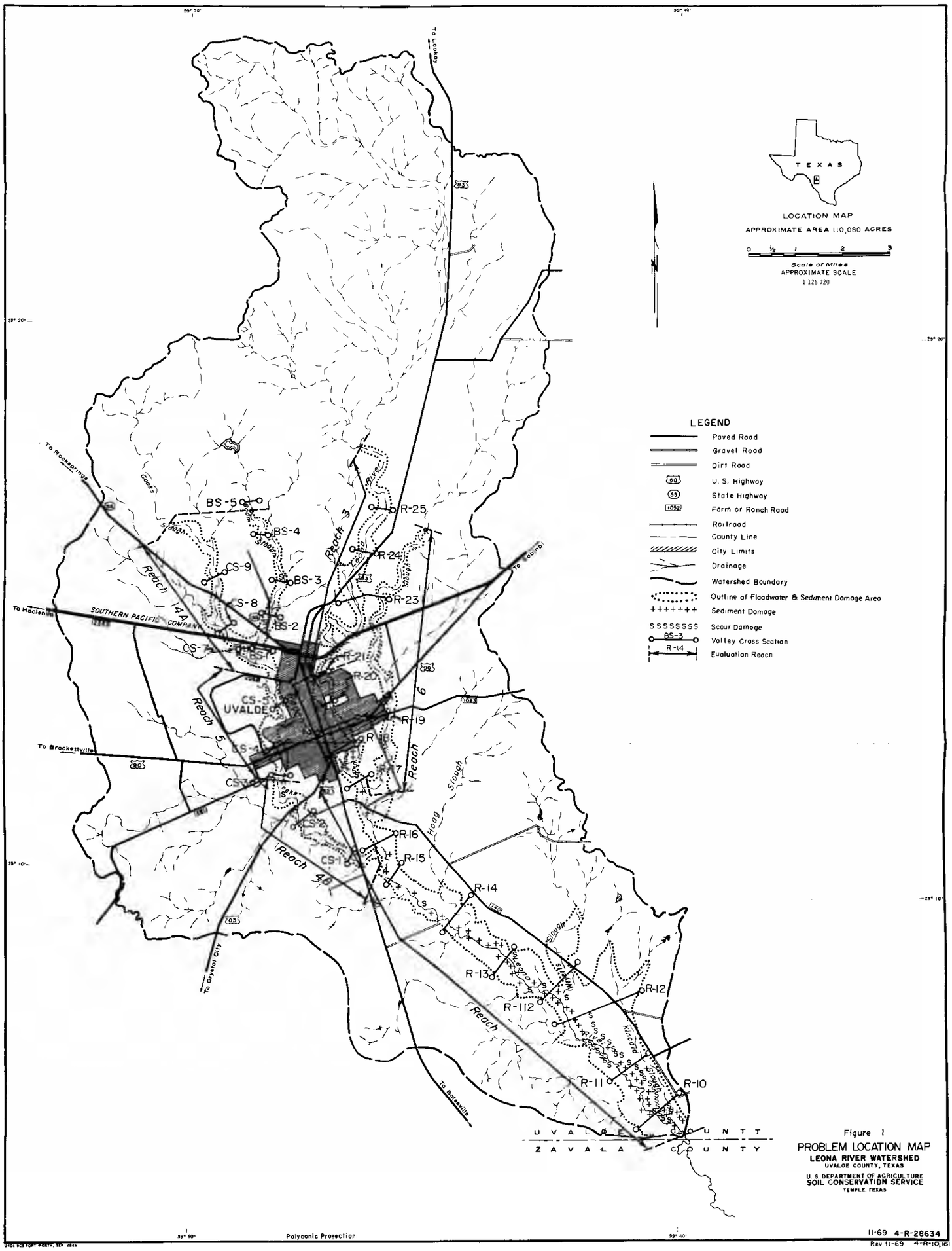


Figure 1

PROBLEM LOCATION MAP

LEONA RIVER WATERSHED

UVALDE COUNTY, TEXAS

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

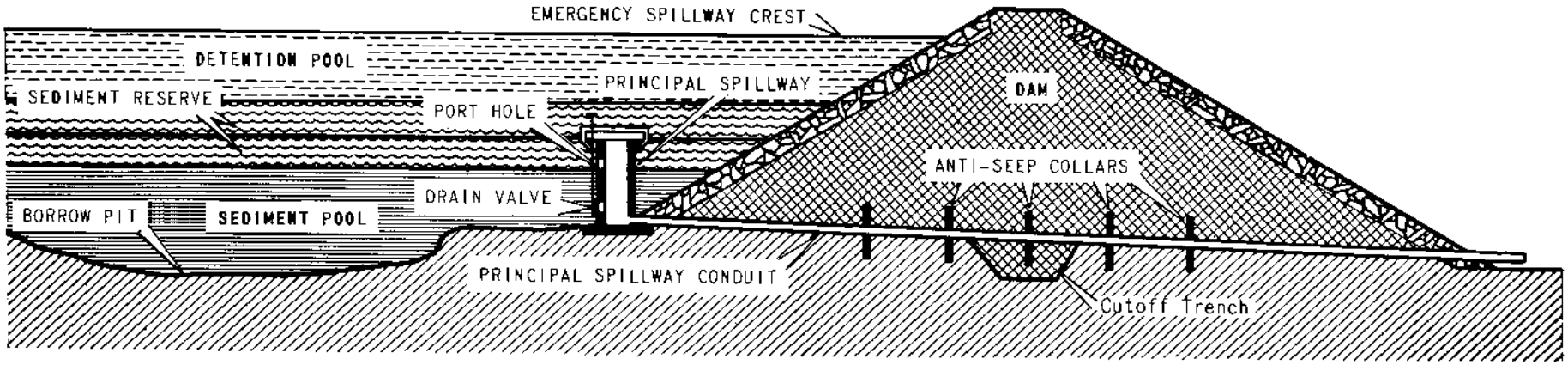
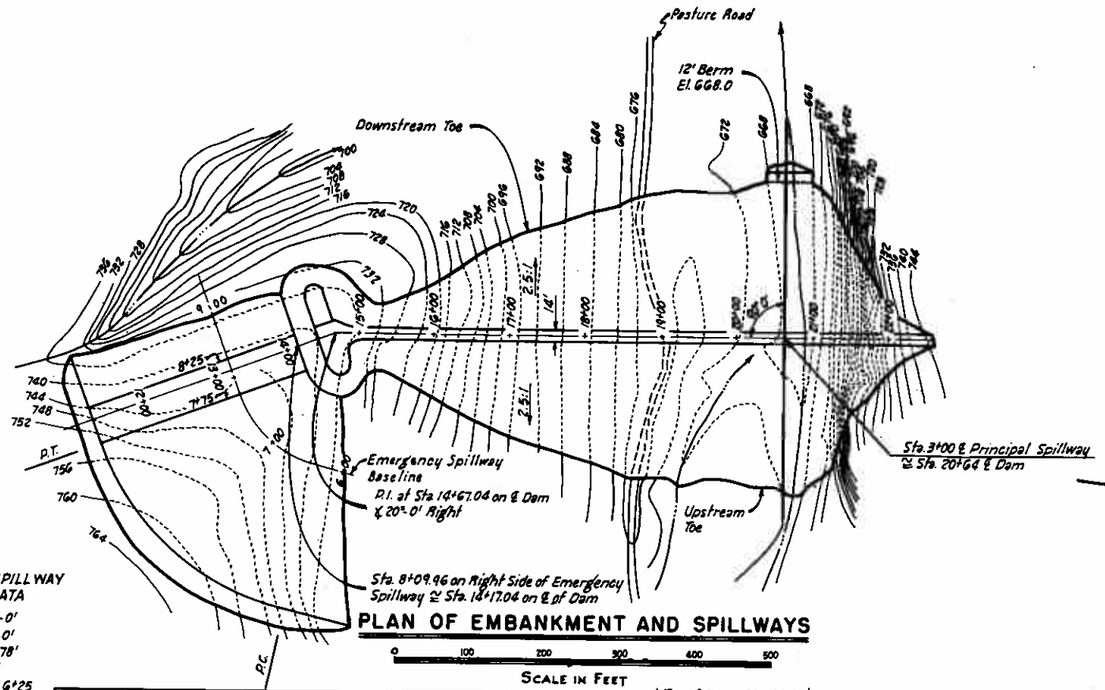


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE
USDA-SCS-F087 WOSTM, TXX. 1970

8-70 4-L-29670

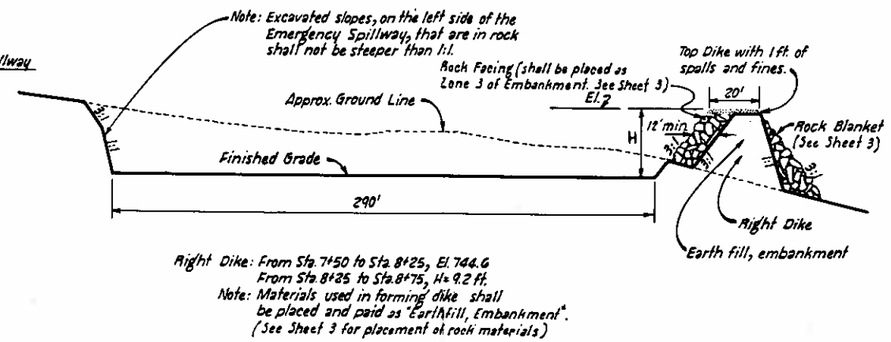


EMERGENCY SPILLWAY
CURVE DATA

Δ = 57°-0'
D = 38°-0'
R = 150.78'
L = 150'
P.C. = Sta. 6+25
P.T. = Sta. 7+75

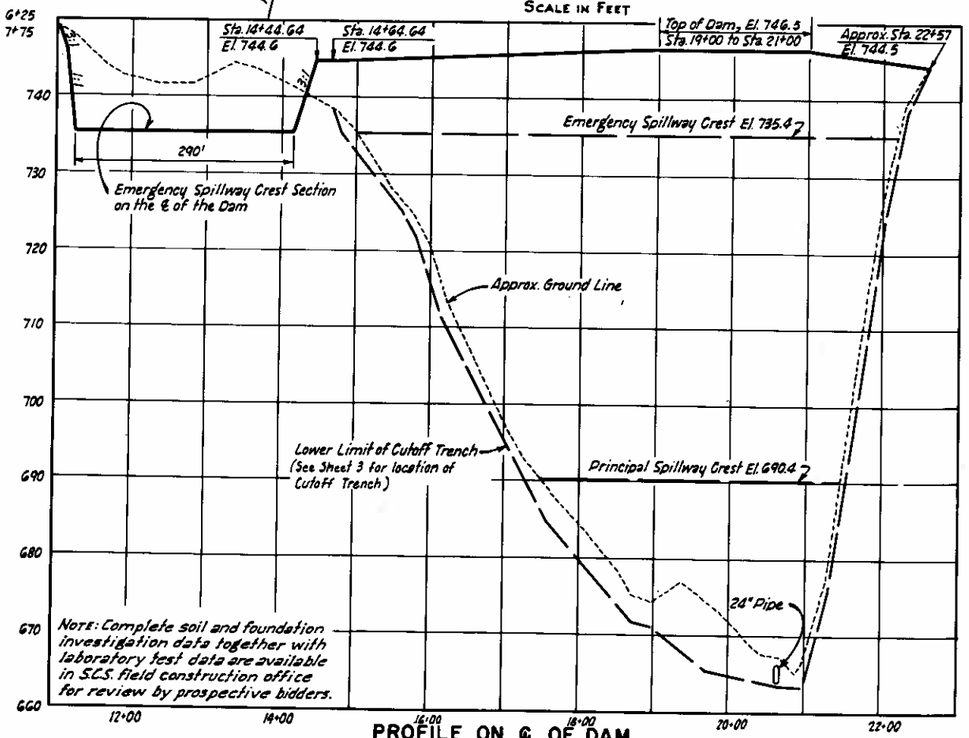
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

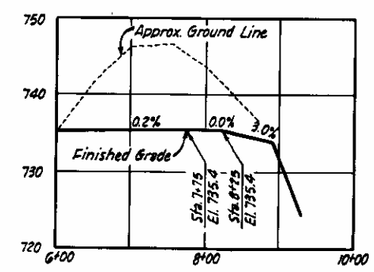


Right Dike: From Sta. 7+50 to Sta. 8+25, El. 744.6
From Sta. 8+25 to Sta. 8+75, H = 9.2 ft.
Note: Materials used in forming dike shall
be placed and paid as "Earthfill, Embankment".
(See Sheet 3 for placement of rock materials)

TYPICAL SECTION - EMERGENCY SPILLWAY



PROFILE ON ℄ OF DAM



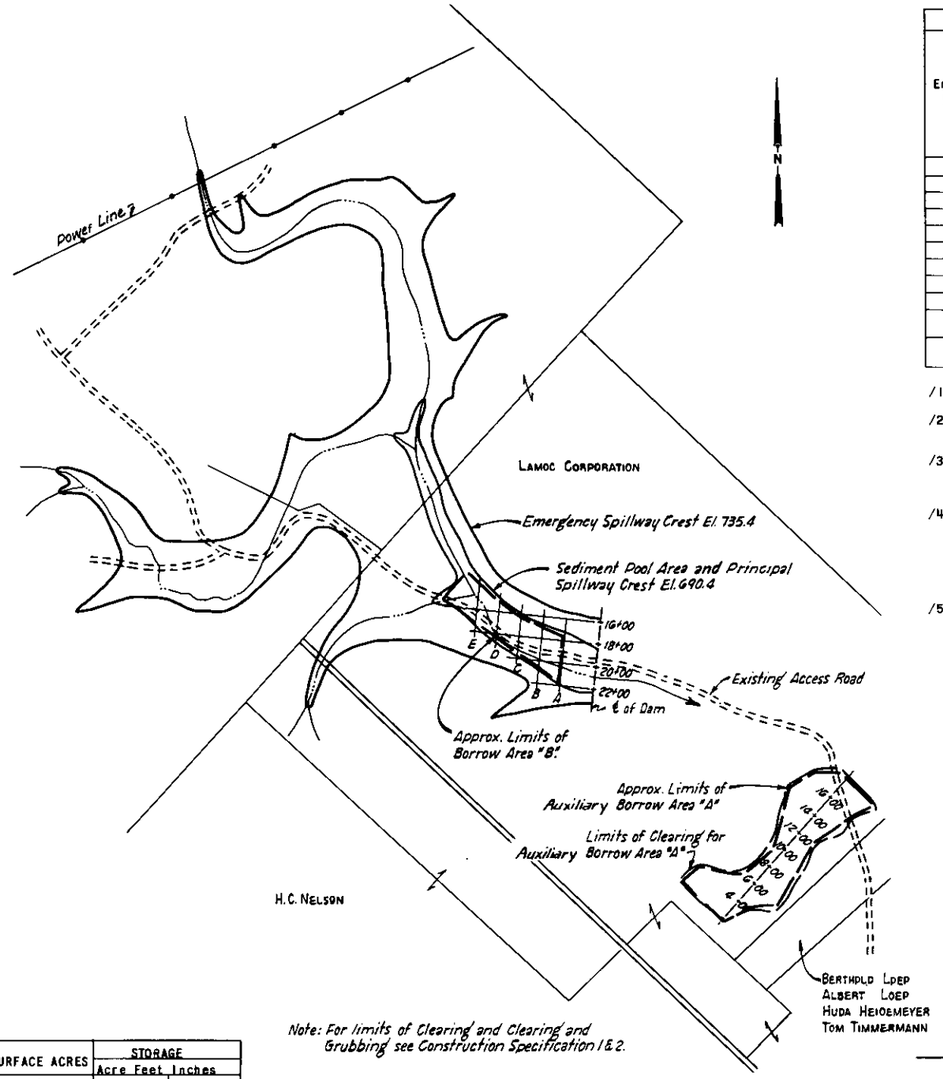
PROFILE ON BASELINE OF EMERGENCY SPILLWAY

Figure 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT AND EMERGENCY SPILLWAY
PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	M.D.K.	2-66	Approved by: HEAD TECHNICIAN & SUPERVISING ENGINEER FORT WORTH, TEXAS
Drawn	M.D.K.	2-66	STATE CONSERVATION ENGINEER S C S
Traced	R.C.G.	2-66	TEMPLE, TEXAS
Checked	M.D.K. & G.W.T.	3-66	Sheet No. 2 of 12 — Drawing No. 4-E-21,155

REV. 10-69



Note: For limits of Clearing and Clearing and Grubbing see Construction Specification 1 & 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET

ELEVATION	SURFACE ACRES	STORAGE Acre Feet	STORAGE Inches
688	16	94	0.14
690.4	18.5	135	0.20
692	20	166	0.24
696	26	258	0.37
700	32	374	0.54
704	39	516	0.75
708	49	692	1.00
712	59	908	1.32
716	70	1166	1.69
720	82	1470	2.13
724	95	1824	2.64
728	110	2234	3.24
732	128	2710	3.93
735.4	147.5	3178	4.61
736	151	3268	4.74
740	171	3912	5.67
Top of Dam (effective) Elev.			744.5
Emergency Spillway Crest Elev.			735.4
Principal Spillway Crest Elev.			690.4
Sediment Pool Elev.			690.4
Drainage Area, Acres			8,272
Sediment Storage, Ac. Ft.			138
Floodwater Storage, Ac. Ft.			3,040
Max. Emergency Spillway Cap., cfs			20,115

MATERIAL PLACEMENT DATA

Embankment Zone No. /1	Source of Fill Materials: Material Location /2	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow A-1	0	2	MH	D-1557	A	6"	9"	A	90	Opt.	+4%	D-1557	A	1	101.0	20.5
1	Borrow A-1	2	4	CH	D-1557	D	6"	9"	A	90	-1%	+5%	D-1567	C	1-X	114.0	14.0
1	Borrow A-1	5	10	CH	D-1557	A	6"	9"	A	90	Opt.	+5%	D-1557	A	4	109.0	17.0
1	Borrow A-1	10	14	CL	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	2-X	119.0	14.0
1	Borrow A-3	0	9	CH	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	4-X	110.0	18.0
1	Borrow A-3	9	18	CL	D-1557	A	6"	9"	A	90	-1%	+4%	D-1557	A	8	116.5	14.5
2	Borrow A-1	3	6	GC	D-1557	A	6"	9"	A	90	-2%	+3%	D-1557	A	3	113.5	14.5
2	Borrow A-1	11	16	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	3-X	127.0	10.5
2	Borrow A-3	0	11	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	5-X	126.0	10.0
3	/3			Limestone Rock	-	-	24"	24"	/4								
4	/3			Limestone Rock	-	-	24"	24"	/5								

/1 The zone boundaries shown in the typical section are approximate. Adjustments will be made by the Engineer to permit the use, witin the neat lines of the embankment, of all suitable materials from the required excavations.

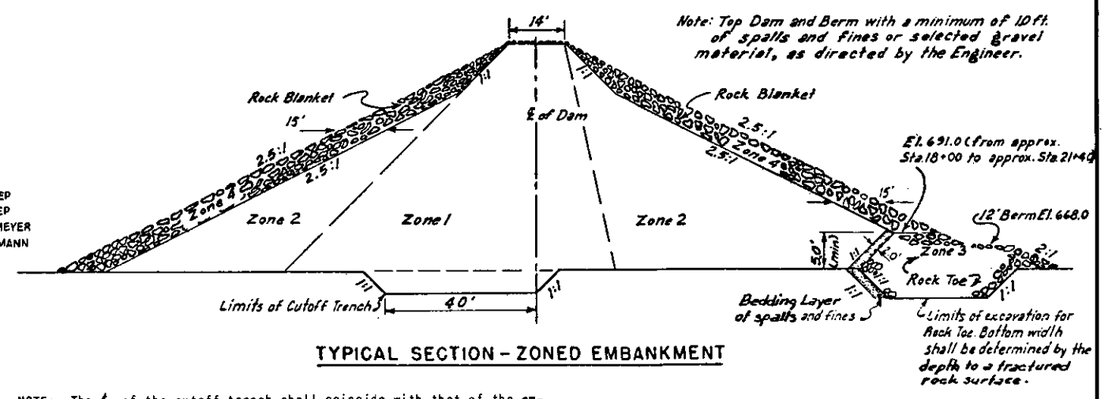
/2 Materials from the repuired excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials covered under Materials Placement Data.

/3 Rock materials for construction of Zones 3 and 4, rock facing for the emergency spillway dike, and tha rock lining of the plunge basin shown on Sheet 5 shall be obtained from the required rock excavation in the emergency spillway and foundation excavation and from the over-sized rock material from the borrow and other required excavations. The Contractor shall be required to excavate approximately 26,000 cu. yds. from Borrow Area "B" to fulfill the requirements for rock materials shown in the typical section.

/4 No specified compaction or moisture control will be required. The rock placed in Zone 3 and in the rock lining for the plunge basin shall be dumped and spread into place in approximately horizontal layers not more than 2 ft. in thickness and shall be placed in such a manner as to produce a reasonably homogeneous, stable fill that contains no segregated pockets of large or small fragments or large unfilled spaces caused by bridging of the larger fragments.

Where a bedding layer beneath the rock is specified, the bedding materials shall be spread uniformly on the prepared suborade surfaces to the depths indicated. Compaction of the bedding layers will not be required, but the surfaces of such layers shall be finished free from mounds, dips, or windrows.

/5 No specified compaction or moisture control will be required. The rock placed in Zone 4 shall be dumped and spread into place in approximately horizontal layers not more than 2 feet in thickness. The rock shall be placed and manipulated so that the completed fill shall be graded with the smaller rock fragments placed toward the inner portion of the fill and the larger rock fragments placed on the outer slopes and shall be placed in such a manner as to produce a stable fill that contains no large unfilled spaces caused by bridging of the larger fraction. Inclusion of spalls, gravel, and other fine materials in an amount not in excess of that required to fill the voids in the coarser material will be permissible. Placement and manipulation of the rock material may be accomplished by initially depositing the rock material in a sequence of workable piles or layers near the outer edge of the concurrent lifts of Zone 2, in order to provide suitable room for a raking or combing operation to move the rock material into Zone 4 and accomplish the specified placement.



TYPICAL SECTION - ZONED EMBANKMENT

NOTE: The ℄ of the cutoff trench shall coincide with that of the embankment from Sta. 14+64 to Sta. 16+00 and from Sta. 22+00 to Sta. 22+57. From Sta. 16+50 to Sta. 21+50, the ℄ of the cutoff trench shall be located 20 ft. upstream from the ℄ of the embankment. Transition sections between Sta. 16+00 and Sta. 16+50 and between Sta. 21+50 and Sta. 22+00 shall be as staked by the Engineer.

ZONED EMBANKMENT DATA

REV. 10-69

Figure 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN OF RESERVOIR & SECTION-ZONED EMBANKMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date		
Designed	M.D.K.	2-66	Approved by	J.W.A.
Drawn	M.D.K.	2-66		
Traced	R.C.G.	2-66	Sheet No. 3 of 12	Drawing No. 4-E-21,155
Checked	M.D.K. & G.M.T.	3-66		

USDA-SCS-FORT WORTH, TEX. 1955

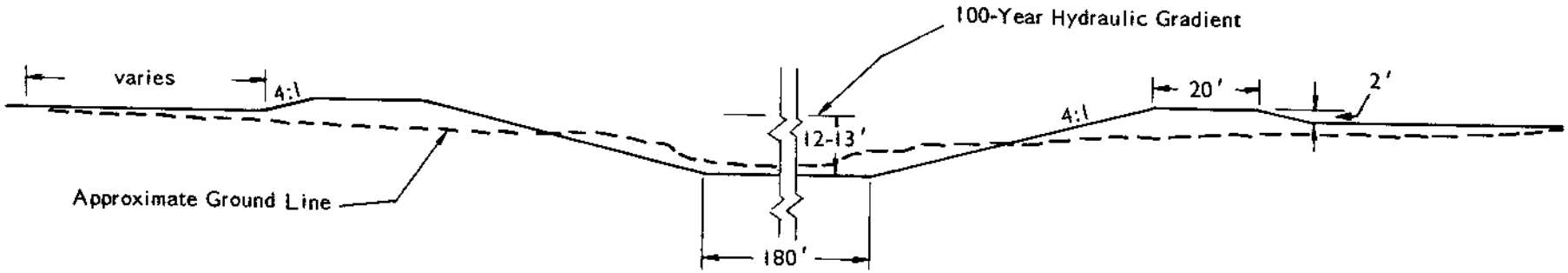
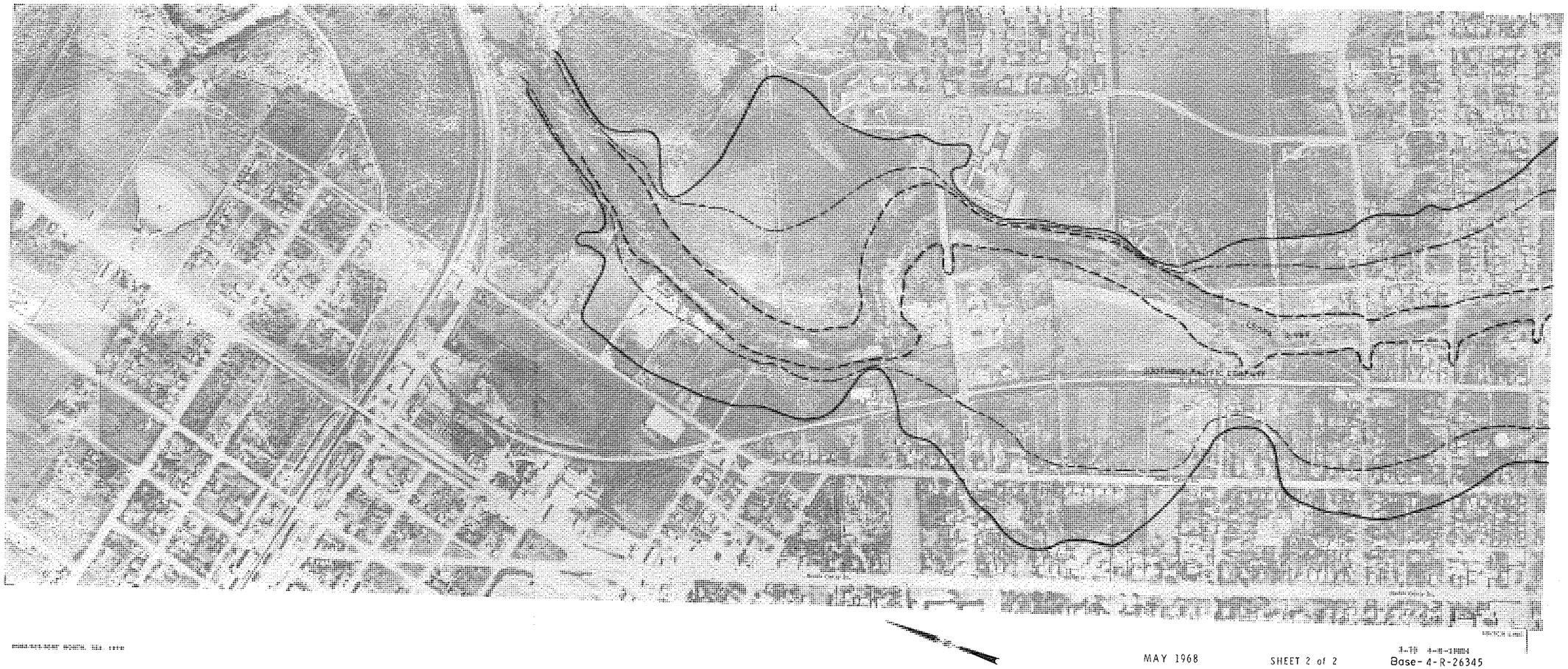


Figure 4

TYPICAL CROSS SECTION
IMPROVED CHANNEL

USDA-SCS-FORT WORTH, TXX. 1970

8-70 4-L-29,662



MAY 1968 SHEET 2 of 2 Base- 4-R-26345

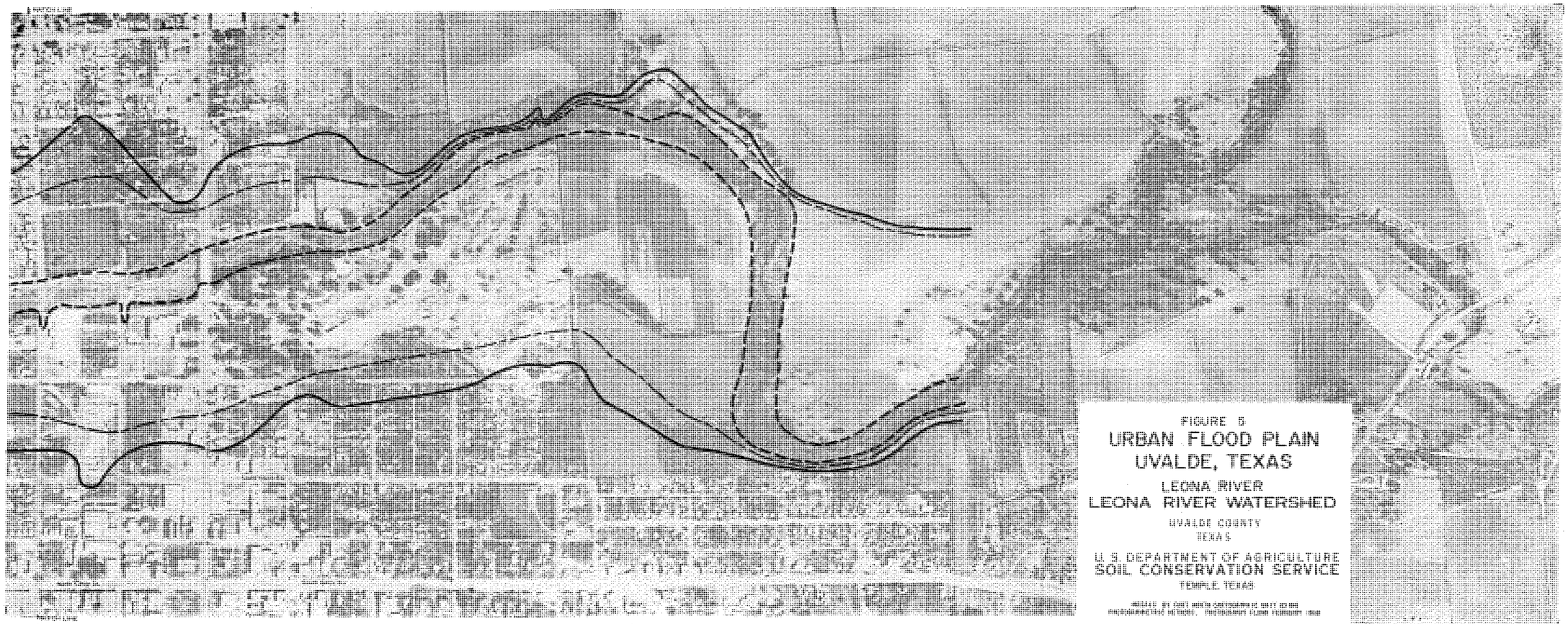


FIGURE 5
URBAN FLOOD PLAIN
UVALDE, TEXAS
LEONA RIVER
LEONA RIVER WATERSHED
UVALDE COUNTY
TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

LEGEND
100 – YEAR FLOOD WITHOUT PROJECT
100 – YEAR FLOOD WITH PROJECT
1953 FLOOD

400 0 400 800 1200
SCALE IN FEET

MAY 1968 SHEET 1 of 2

3-70 4-R-29054
Base-4-R-26345

MAY 1968
SHEET 2 of 2

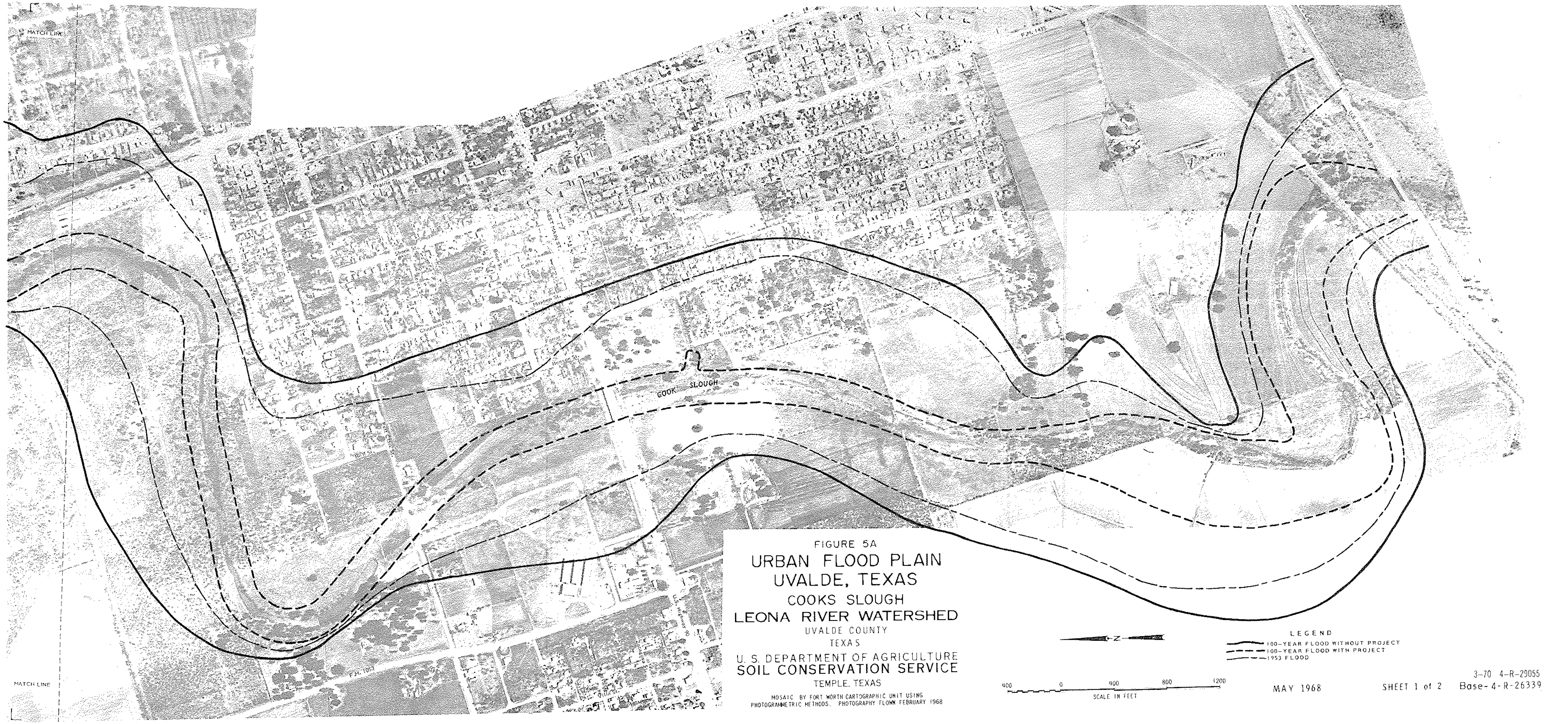


FIGURE 5A

URBAN FLOOD PLAIN UVALDE, TEXAS

COOKS SLOUGH

LEONA RIVER WATERSHED

UVALDE COUNTY

TEXAS

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

MOSAIC BY FORT WORTH CARTOGRAPHIC UNIT USING PHOTOGRAMMETRIC METHODS. PHOTOGRAPHY FLOWN FEBRUARY 1968

MAY 1968

SHEET 1 of 2

3-70 4-R-29055

Base-4-R-26339

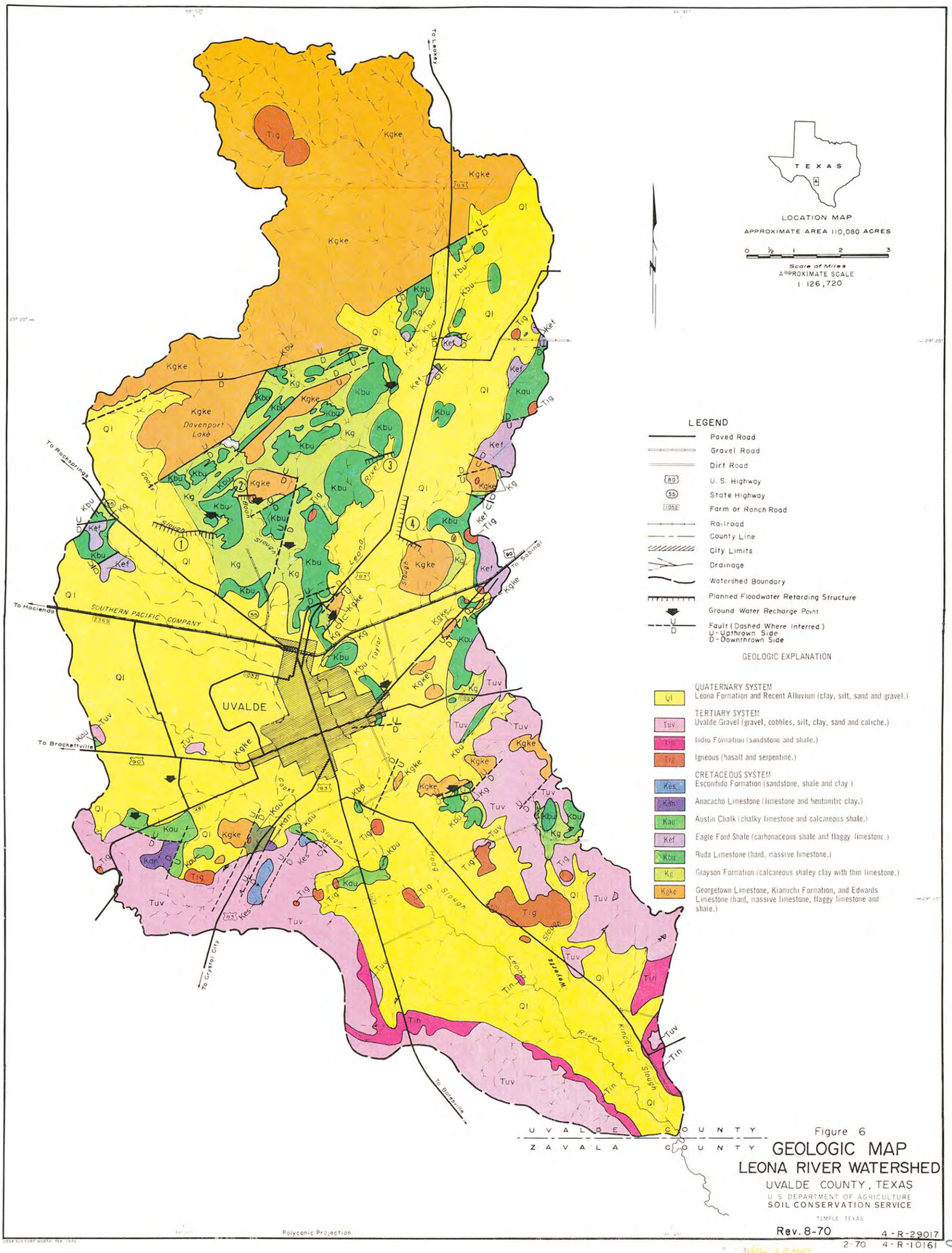


Figure 6

GEOLOGIC MAP
LEONA RIVER WATERSHED

UVALDE COUNTY, TEXAS

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

Rev. 8-70 4-R-29017
2-70 4-R-10161

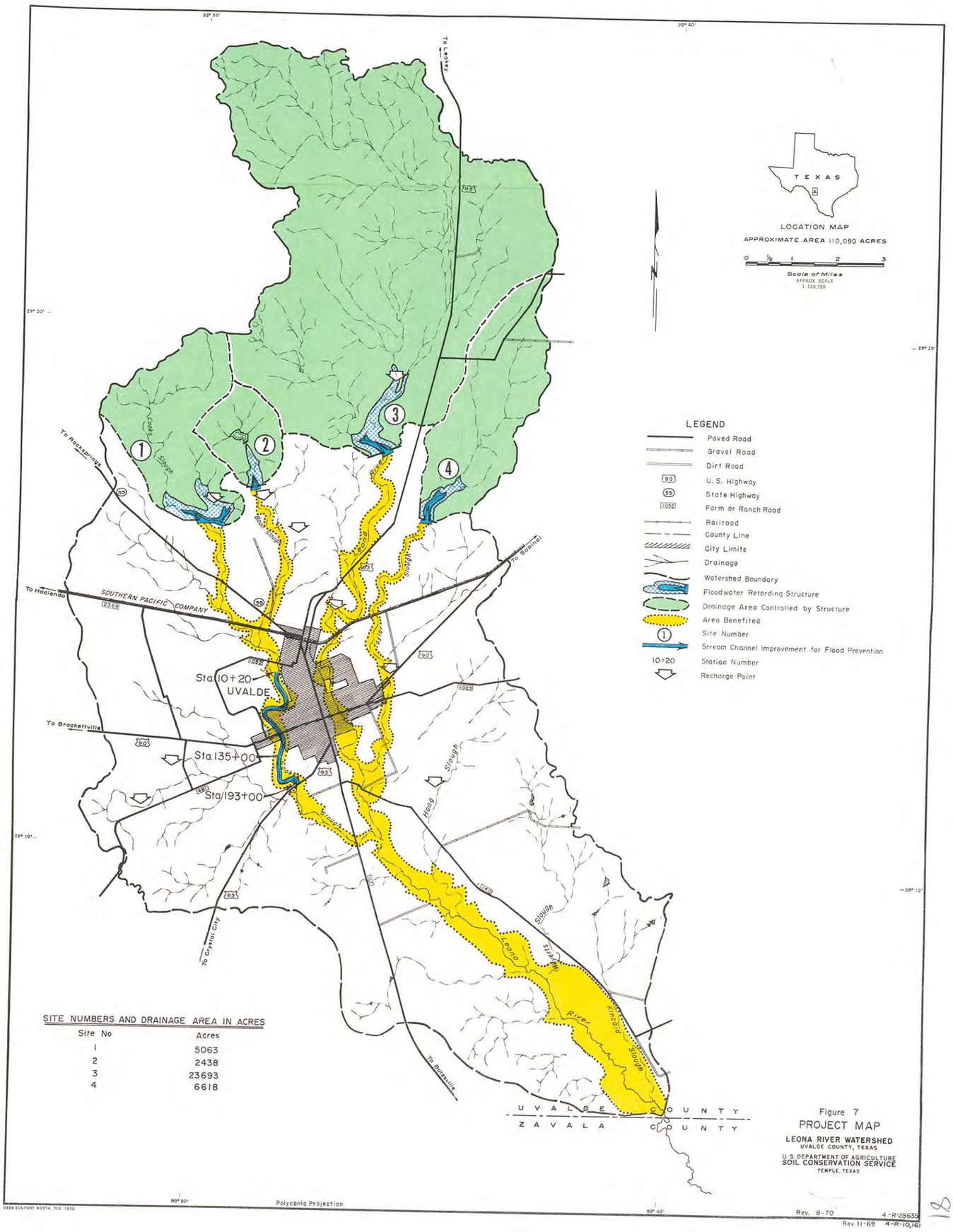


Figure 7
PROJECT MAP
LEONA RIVER WATERSHED
UVALDE COUNTY, TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

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