

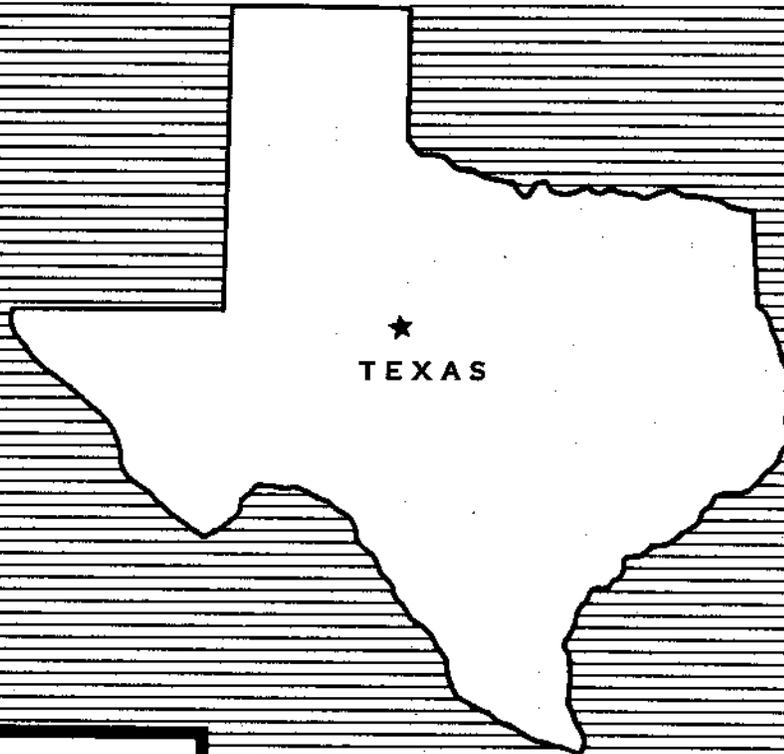
*auth. for operations 6/8/76*

**WORK PLAN**

**FOR WATERSHED PROTECTION AND FLOOD PREVENTION**

**WILLOW CREEK  
WATERSHED**

**RUNNELS AND TOM GREEN COUNTIES, TEXAS**



**MAY 1976**

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## ADDENDUM

### WILLOW CREEK WATERSHED, TEXAS

#### INTRODUCTION

This addendum is based on the Water Resource Council's "Principles and Standards for Planning Water and Related Land Resources," which became effective October 30, 1973. It is prepared to be consistent with the requirements of the Water Resource Council's Procedure No. 1 for the phase-in of the Principles and Standards. The information presented is:

#### Part I - Benefits to Cost Comparison

An evaluation of the selected plan with reformulation, using current normalized prices, current construction costs, and the current interest rate.

#### Part II - Four Account Displays

Evaluated effects of the selected plan are displayed under separate accounts for (1) National Economic Development, (2) Environmental Quality, (3) Regional Development, and (4) Social Well-Being. The displays are consistent with the intent of the Principles and Standards.

#### Part III - Abbreviated Environmental Quality Plan

An environmental quality plan, consistent with the intent of the Principles and Standards, but which is abridged in detail, has been developed by an interdisciplinary team. This plan was formulated from information and data obtained during the investigative and analysis phases of project planning. Formulation began with the inventory and

recognition of the watershed problems and needs. Desired environmental effects, as translated from the problems and needs, provided a basis for examining appropriate water and land resource use and management opportunities. Opportunities that emphasized contributions to the component needs were selected and are shown as plan elements of the abbreviated environmental quality plan. The cost of \$269,560 for its installation is a preliminary estimate.

Implementation of features of this environmental quality plan would require acceptance by the local people. Adequate legal authorities do exist for installation; however, funding for all plan elements is presently not available through existing legislative authorities.

PART I

This addendum shows the project cost, benefits, and benefit-cost based on a 6-1/8 percent interest rate, current normalized prices, and the 1975 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1. Project benefits are	<u>\$44,840</u>
2. Project costs are	<u>24,110</u>
3. The project benefit-cost ratio is	<u>1.9 to 1.0</u>
4. The project benefit-cost ratio excluding secondary benefits is	<u>1.4 to 1.0</u>

May 1976

PART II

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Willow Creek Watershed, Texas

<u>Components</u>	<u>Measures of effects</u> <sup>1/</sup>	<u>Components</u>	<u>Measures of effects</u> <sup>1/</sup>
Beneficial effects:			
A. The value to users of increased outputs of goods and services		Adverse effects:	
1. Flood prevention	\$34,640	A. The value of resources required for a plan	
1. Flood prevention	\$34,640	1. Two floodwater retarding structures	
Total beneficial effects		a. Project installation	\$20,740
		b. Project administration	2,550
		c. Operation and maintenance	820
		Total adverse effects	\$24,110
		Net beneficial effects	\$10,530

<sup>1/</sup> Average annual

May 1976

ENVIRONMENTAL QUALITY ACCOUNT

Willow Creek Watershed, Texas

<u>Components</u>	<u>Measures of effects</u>	<u>Components</u>	<u>Measures of effects</u>
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 78 farms and ranches in the watershed.		3. Suspended sediment concentration carried by runoff water leaving the watershed will be reduced from 4,590 milligrams per liter to 3,410 milligrams per liter.
	2. Inundate 68 acres of range-land and one acre of cropland needed for sediment pools below the lowest ungated outlets.		4. A maximum initial reduction in average annual runoff of 103 acre-feet is expected from the effects of evaporation from sediment pools of the floodwater retarding structures. This will result in an initial reduction from 3,350 to 3,247 acre-feet, 3.08 percent, in average annual volume of watershed runoff.
B. Quality considerations of water and land resources.	1. Reduce erosion on 158 acres of agricultural flood plain land.		
	2. Reduce sediment deposition on 107 acres of agricultural flood plain land.		
		C. Biological resources and selected ecosystems.	1. Enhance habitat and food supply for most wildlife species throughout the watershed.

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Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT - Continued

Willow Creek Watershed, Texas

<u>Components</u>	<u>Measures of effects</u>
D. Irreversible or irretrievable commitments	<ol style="list-style-type: none"><li>1. Conversion of 110 acres of cropland, 297 acres of rangeland, and two acres of pastureland to dams, emergency spillways, sediment pools, and detention pools.</li><li>2. Materials, labor, equipment, fuel, and capital used in construction, operation, and maintenance will be irreversibly committed.</li></ol>

May 1976

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT

Willow Creek Watershed, Texas

<u>Components</u>	<u>Measures of effects 1/ Region 2/</u>	<u>Rest of Nation</u>	<u>Components</u>	<u>Measures of effects 1/ Region 2/ Rest of Nation</u>
-------------------	---	---------------------------	-------------------	--

A. Income:

A. Income:

Beneficial effects:

Adverse effects:

1. The value of increased output of goods and services to users residing in the region.

1. The value of resources contributing from within the region to achieve the outputs.

a. Flood prevention	\$34,640	
b. Secondary	10,200	

a. Two floodwater retaining structures	
--	--

Total beneficial effects      \$44,840

Project installation (structural measures)	\$4,630	
Project administration	60	\$16,110
Operation and maintenance	820	2,490
		-

Total adverse effects      \$ 5,510

\$18,600

Net beneficial effects

-\$18,600

1/ Average annual

2/ South Central Region of Texas, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

REGIONAL DEVELOPMENT ACCOUNT - Continued-2

Sabanna River Watershed, Texas

Measures of effects  
Region 1/ Rest of  
Nation

Components

Measures of effects  
Region 1/ Rest of  
Nation

B. Employment:

B. Employment:

Beneficial effects:

Adverse effects:

1. Increase in the number and types of jobs

1. Decrease in number and types of jobs

a. Agricultural Employment

Total adverse effects

b. Employment for project construction

Net beneficial effects

4 permanent semi-skilled jobs

4 permanent semi-skilled jobs

12 man-years of semi-skilled employment over the installation period (3 years)

12 man-years of semi-skilled employment over the installation period (3 years)

Total beneficial effects

4 permanent semi-skilled jobs

12 man-years of semi-skilled employment over the installation period (3 years)

1/ South Central Region, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

May 1976

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT - Continued-3

Willow Creek Watershed, Texas

<u>Components</u>	<u>Measures of effects</u>	
	<u>Region I/</u>	<u>Rest of Nation</u>
C. Population Distribution		
Beneficial effects	Create 4 permanent semi-skilled jobs in a rural area and 12 man-years of semi-skilled employment over the installation period (3 years).	-
Adverse effects	-	-
D. Regional Economic Base and Stability		
Beneficial effects	Create 4 permanent semi-skilled jobs and 12 man-years of semi-skilled employment over the installation period (3 years). Reduce flood hazard on 1,780 acres of flood plain.	-
Adverse effects	-	-

I/ South Central Region of Texas, as designated in the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination.

May 1976

Selected Plan

SOCIAL WELL-BEING ACCOUNT

Willow Creek Watershed, Texas

Components

Measures of effects

Beneficial and adverse effects:

A. Real income distribution

1. Create 4 permanent semi-skilled jobs and 12 man-years of semi-skilled employment over the installation period (3 years).
2. Create an average annual regional income benefit distribution of \$44,840 by income class as follows:

<u>Income Class</u> (dollars)	<u>Percentage of Adjusted Gross Income in Class</u>	<u>Percentage Benefits in Class</u>
Less than 3,000	6	-
3,000 - 10,000	42	10
More than 10,000	52	90

3. Local average annual cost to be borne by region total \$5,510. The percentage of contributions to local costs, by income classes, is not readily available.

B. Life, health, and safety

1. Reduce flooding on 1,780 acres from an average annual flooding of 810 acres to 205 acres or 74.7 percent.

May 1976

### PART III

#### ABBREVIATED ENVIRONMENTAL QUALITY PLAN

##### Willow Creek Watershed, Texas

Environmental quality is a major concern that must be considered in planning soil and water conservation projects which involve changes in land use and alterations of existing ecosystems. This plan was developed for the Willow Creek 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.

Willow Creek Watershed is located in the east-central portion of west Texas in Runnels and Tom Green Counties. Willow Creek rises in northeastern Tom Green County about 15 miles northeast of the city of San Angelo. Following a southeastward course, Willow Creek crosses the extreme southwestern corner of Runnels County, passes closely by the city of Miles, and flows back into Tom Green County where it conflues with the Concho River. The Concho River is a tributary of the Colorado River which is in the Texas Gulf Water Resource Region. The watershed drainage area is 45.91 square miles (29,382 acres), has an average width of 3.7 miles, and is about 12.5 miles long.

The watershed lies within the Central Rolling Red Plains Land Resource Area. Watershed elevations within the watershed range from about 2,100 feet above mean sea level along the northwestern divide to 1,700 feet at the confluence of Willow Creek and the Concho River. The extreme northwestern edge of the watershed is a hilly, rolling area that changes abruptly to gently sloping, nearly level topography. About nine percent (2,650 acres) of the watershed has slopes ranging from three to twenty percent. The topography of greatest slopes is found in the hilly area previously mentioned and as valley slopes along the major stream courses. The remaining 91 percent (26,732 acres) of the watershed is gently sloping to nearly level (less than three percent slope).

Climatic conditions in the watershed are semi-arid. The average annual precipitation is about 20 inches. Thirty years of records indicate that about 32 percent of the precipitation falls during the months of May and September. Winter and early spring are usually dry. Net annual evaporation rate for the area is about 62 inches. Temperatures range from a mean maximum in July of 97 degrees Fahrenheit to a mean minimum of 34 degrees Fahrenheit in January. Normal growing season is from about March 30 to November 15, or 230 days.

Land uses in the watershed are cropland (15,805 acres); pastureland and hayland (118 acres); rangeland (10,694 acres); and miscellaneous (2,765 acres) which includes roads, highways, urban areas, farmsteads, cemetery, and the local year facility.

A study of existing conditions within the watershed indicates that damage caused by flooding and inadequate treatment of agricultural lands constitute significant environmental quality problems. Flooding causes monetary and property losses, disruption of normal human activity, depletion of the basic soils resource, and concern for life and property.

Inadequate application of planned conservation land treatment has limited the most efficient use 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 agricultural areas, and increased pollution of surface water. Flooding and inadequate land treatment also detract from the appearance of the watershed.

Ground water obtained from wells is used for domestic purposes and for livestock throughout the watershed. Municipal water for Miles is also obtained from wells. A small acreage of cropland south and north of U.S. Highway 67 is irrigated with ground water. During years of near normal rainfall the quantity available for these uses is adequate. However, during extended periods of drought, ground water is not a dependable source for these uses.

Surface water resources for livestock and domestic uses in the area are from small farm ponds and limited ground water seeps. The quality of these sources is considered to be within tolerable limits of health and safety for the locale. However, during prolonged periods of drought, these are not reliable sources of water.

Fisheries habitat within the watershed is limited to farm ponds and semi-permanent pools in stream channels.

A limited population of white-tailed deer inhabit the western edge of the watershed. The population is estimated to be about one deer for 200 to 250 acres in the western portion of the watershed. Winter food for deer is sometimes scarce, suppressing population. Due to economic considerations from recreational opportunities provided by deer hunting, it is desirable to at least maintain, if not increase, the deer population in the watershed and surrounding area.

Rio Grande turkey utilize a large portion of the watershed along stream courses primarily during the spring and summer. Waterfowl populations are limited due to lack of suitable habitat; however, numerous species of waterfowl and sandhill cranes utilize farm ponds and cropland as resting areas during migration periods.

Bobwhite quail, scaled quail, and mourning dove are the primary game species in the watershed. A survey conducted by the Texas Parks and Wildlife Department in 1969 and a field investigation by Fish and Wildlife Service in June 1974 indicated 0.33 quail per acre in the Runnels County portion of the watershed. Bobwhite quail is the dominant species. Quail population on the Tom Green County portion of the watershed is 0.125 quail per acre. Scaled quail is the dominant species. Mourning dove are very plentiful in the watershed. Large acreages of grain sorghum and small grain maintain a dove population year-round.

There are four archeological sites in the watershed. They occur just above the confluence of the north and west branch of Willow Creek.

Three sites are along the north branch and one site is along the west branch. The sites have a combined area of about 48,950 square meters. Preservation and resulting study of these sites would add to man's understanding and knowledge of the surrounding area.

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.
  - b. Maintain and enhance a diversity of landscapes.
  - c. Properly dispose of any unsightly refuse that is presently lying along county roads.
2. Quality and Quantity of Water, Land, and Air Resources
  - a. Improve the quality of streamflow by reducing the amount of sediment delivered to streams and lakes from sheet and gully erosion.
  - b. Protect the soils resource from deterioration by reducing erosion and sediment deposition.
  - c. Maintain or improve productivity of cropland and grassland.
  - d. Prevent flood damage to transportation systems and to utilities.
  - e. Prevent flood damage to agricultural land.

- f. Reduce the amount of solid wastes and debris entering streams.
  - g. Reduce the potential for damage to future flood plain development.
  - h. Prevent contamination of surface water resources.
  - i. Provide a suitable means of collecting and disposing of solid wastes from Miles and the watershed area.
3. Biological Resources and Ecosystems
- a. Create additional fishery habitat.
  - b. Provide improved food supplies for wildlife.
  - c. Reduce damage to habitat from flooding, sedimentation, and scour.
  - d. Provide information to land users concerning natural ecosystem use.
  - e. Provide technical assistance to land users in the application of land treatment beneficial to wildlife.
  - f. Develop an informational program to gain the cooperation and assistance of watershed land users and residents in establishing significant wildlife habitat in the watershed.
4. Geological, Archeological, and Historical Resources
- a. Preserve four archeological sites for future study and appreciation.
  - b. Nominate Site X41TG2 to the National Register of Historic Places.

The plan elements for environmental quality consist of land treatment measures, land acquisition, public information activities, and land use conversion. Public and private funds will be used for implementation of those planned elements.

Cropland treatment measures would include cropping systems (use of diversified crops in rotation and the management of their residue), terrace systems, grassed waterways, and diversions. Pastureland treatment would consist of planting or seeding adapted species of perennial or biennial forage plants and managing these for long-term production and use. Conservation land treatment on rangeland would consist of brush management, range seeding, deferred grazing, proper grazing use, and planned grazing systems. Wildlife upland habitat management would also be an increment of the land treatment to be implemented as either a primary or secondary land use. Fish pond management could be used to develop fisheries in the watershed. Land users would be encouraged and assisted in the application and maintenance of these measures by the three local soil and water conservation districts with technical assistance from 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 and the Great Plains Conservation Program administered by the Soil Conservation Service. Loans for the application of needed soil and water conservation measures are available through the Farmers Home Administration and through local commercial lending institutions.

A suitable landfill site for proper disposal of solid wastes would be acquired and operated with a cooperative effort of the City of Miles and the county commissioner's courts of the two counties in which the watershed is located.

The adequate preservation of four archeological sites will require a total of approximately 48,950 square meters of land to be preserved in situ. It is anticipated that funds could be available from the Tom Green County Historical Society to acquire the needed land.

In order to substantially reduce the need for flood protection, it would be necessary to convert about 640 acres of cropland in the flood plain to a land use less susceptible to floodwater damage. With this measure it is anticipated that about 80 percent of the cropland would be converted to improved pastureland and about 20 percent would revert to native vegetation. This alternative would significantly reduce the flood plain damage caused by floodwater, sediment, and erosion.

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

1. Completion of planning and implementation of needed land treatment \$189,560
2. Acquisition of five acres suitable as a landfill site and machinery to properly operate the facility \$ 46,000
3. Acquisition of approximately 48,950 square meters of land to be preserved in situ for four archeological sites \$ 21,000

- |    |   |                  |
|----|---|------------------|
| 4. | Changing the present land use on about 604 acres in the flood plain to a use that is less susceptible to damage by flooding | <u>\$ 13,000</u> |
|    | TOTAL:  | \$269,560        |

The environmental effects which would result from the implementation of the environmental quality plan are as follows:

1. Areas of Natural Beauty
  - a. Enhance the appearance of the 78 farms and ranches in the watershed through the application and maintenance of land treatment.
  - b. Eliminate unsightly litter and solid wastes from along watershed roads, unauthorized dumps, and within Miles by providing a sanitary landfill to the residents of the watershed area as a suitable means of disposal.
2. Quality and Quantity of Water, Land, and Air Resources
  - a. Reduce the sediment load carried in watershed runoff through reduction of sheet erosion, gully erosion, and flood plain scour by installation of needed land treatment and changing the land use on approximately 640 acres.
  - b. Prevent the deterioration of the land resource base by providing protection from erosion by installing or applying needed vegetative and structural treatment measures.
  - c. Maintain and enhance the productivity of the land resource base by applying agronomic and vegetative management practices.

- d. Reduce flooding on approximately 1,780 acres of agricultural land in the flood plain by installation of needed land treatment.
  - e. Reduce the interruption of use from floodwater of the transportation system in the flood prone areas.
3. Biological Resources and Selected Ecological Systems
- a. Create additional fisheries in the watershed with the completion of 13 farm ponds as a part of the planned land treatment.
  - b. Improve the quality of habitat for wildlife through reduction of flooding, sedimentation, and flood plain erosion.
  - c. Improve the quality and quantity of habitat for wildlife through wildlife upland habitat management as either a primary or secondary land use.
4. Geological, Archeological, and Historical Resources
- a. Protect four archeological sites from further deterioration.
  - b. Nominate one of the four archeological sites to the National Register of Historic Places.
  - c. Increase man's knowledge and appreciation of the surrounding area.
5. Irreversible or Irretrievable Commitments
- a. Commit the use of approximately 48,950 square meters of agricultural land for an indefinite period of time for the preservation of four archeological sites.
  - b. Commit labor, energy, and materials for total project construction.

WATERSHED WORK PLAN AGREEMENT

between the

Willow Creek Water Control District  
Local Organization

Runnels Soil and Water Conservation District  
Local Organization

North Concho River Soil and Water Conservation District  
Local Organization

Concho Soil and Water Conservation 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 Willow Creek Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83d 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 Willow Creek Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about three 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. The Sponsoring Local Organization will acquire, with other than PL-566 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost \$75,390)
2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in 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. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Relocation Payment Costs</u> (dollars)
Relocation Payments	35.2	64.8	0 <u>1</u> /

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.

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
Two (2) Floodwater Retarding Structures	0	100	248,410

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

<u>Works of Improvement</u>	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Engineering Costs</u> (dollars)
Two (2) Floodwater Retarding Structures	0	100	13,970

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$1,000 and \$40,510 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 availability of appropriations 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 except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties.
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, as amended, 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 otherwise 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.

Willow Creek Water Control District  
Local Organization

By Richard Book  
Richard Book  
Title Chairman

Route 2, Box 157  
Miles, Texas                      76861  
Address                                      Zip Code

Date April 6, 1976

The signing of this agreement was authorized by a resolution of the governing  
body of the Willow Creek Water Control District  
Local Organization

adopted at a meeting held on April 6, 1976

James Urban  
Secretary, Local Organization  
James Urban  
Date April 6, 1976

Route 2, Box 157  
Miles, Texas                      76861  
Address                                      Zip Code

Runnels Soil and Water  
Conservation District  
Local Organization

By Cone Robinson, Sr.  
Cone Robinson, Sr.  
Title Chairman

Box 446, Ballinger, Texas      76821  
Address                                      Zip Code

Date April 6, 1976

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

adopted at a meeting held on March 12, 1976

Otto Gottschalk Acting  
Secretary, Local Organization  
Otto Gottschalk  
Date April 6, 1976

Box 446, Ballinger, Texas      76821  
Address                                      Zip Code

North Concho River Soil  
and Water Conservation District  
Local Organization

By S.K. Horwood  
S. K. Horwood  
Title Chairman

P. O. Box 724  
Sterling City, Texas 76951  
Address Zip Code

Date April 6, 1976

The signing of this agreement was authorized by a resolution of the governing  
body of the North Concho River Soil and Water Conservation District  
Local Organization  
adopted at a meeting held on March 9, 1976

August Frysak  
Secretary Local Organization  
August Frysak  
Date April 6, 1976

P. O. Box 724  
Sterling City, Texas 76951  
Address Zip Code

Concho Soil and Water  
Conservation District  
Local Organization

By Ben O. Sims  
Ben O. Sims  
Title Chairman

P. O. Box 392  
Eden, Texas 76837  
Address Zip Code

Date April 6, 1976

The signing of this agreement was authorized by a resolution of the governing  
body of the Concho Soil and Water Conservation District  
Local Organization  
adopted at a meeting held on March 4, 1976

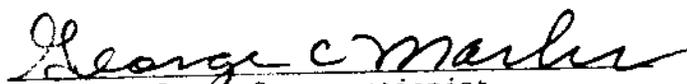
Larry Book  
Secretary Local Organization  
Larry Book  
Date April 6, 1976

P. O. Box 392  
Eden, Texas 76837  
Address Zip Code

Appropriate and careful consideration has been given to the environmental aspects of this project.

Soil Conservation Service  
United States Department of Agriculture

Approved By:

  
State Conservationist

197 11 1976

Date

WATERSHED WORK PLAN  
FOR  
WATERSHED PROTECTION AND FLOOD PREVENTION

WILLOW CREEK WATERSHED  
Runnels and Tom Green Counties, Texas

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

Prepared by:

Willow Creek Water Control District  
(Sponsor)

Runnels Soil and Water Conservation District  
(Sponsor)

North Concho River Soil and Water Conservation District  
(Sponsor)

Concho Soil and Water Conservation District  
(Sponsor)

With Assistance by:

U.S. Department of Agriculture  
Soil Conservation Service

May 1976

WATERSHED WORK PLAN

WILLOW CREEK WATERSHED

May 1976

SUMMARY OF PLAN 1/

This work plan for watershed protection and flood prevention for Willow Creek Watershed has been prepared by the Willow Creek Water Control District and the Concho, North Concho River, and Runnels Soil and Water Conservation Districts as the Sponsoring Local Organization. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The U.S. Fish and Wildlife Service, United States Department of the Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of fish and wildlife resources of the watershed. The watershed work plan has been coordinated with the Texas Historical Commission and the National Park Service, USDI. Archeological surveys of the floodwater retarding structure sites were conducted by the Archaeology Research Program, Department of Anthropology, Southern Methodist University.

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

Willow Creek Watershed comprises a total area of 45.91 square miles in portions of Runnels and Tom Green Counties. It is estimated that 53.8 percent of the watershed is cropland; 0.4 percent is pastureland and hayland; 36.4 percent is rangeland; and 9.4 percent is in miscellaneous uses such as the city of Miles, public roads, farmsteads, stream channels, a cemetery, and the Goodyear facility.

The principal problem within the watershed is one of extensive and frequent flooding on portions of the 1,780 acres of flood plain which results in damage to crops, grasses, soils, agricultural properties, public roads, and bridges. Total floodwater, sediment, erosion, and indirect damages are estimated to average \$46,880 annually.

Project objectives are the proper use, treatment, and management of soil and water resources in the watershed; protection of flood plain lands and property; and stimulation of economic development of the area as a result of project installation. The project as formulated meets these objectives.

1/ All information and data in this work plan, except as otherwise noted by reference to source, were collected during watershed planning investigations by the Soil Conservation Service, U.S. Department of Agriculture.

Landowners and operators will establish and maintain needed land treatment measures on 2,300 acres of cropland, 120 acres of pastureland, and 2,980 acres of rangeland during a three-year installation period. Secondary treatment for wildlife upland habitat management will also be applied. The installation cost of these land treatment measures is estimated to be \$91,050, which will be from funds other than Public Law 566.

The structural measures in this plan are two floodwater retarding structures to be installed within a three-year installation period. The total estimated cost of those measures is \$379,280, of which the local share is \$76,390, and Public Law 566 share is \$302,890. Local share of the cost consists of land rights and project administration.

Installation of the project will contribute to the conservation; orderly development; and productive use of the watershed's soil, water, and related resources.

Watershed lands will be protected from erosion, and sediment yielded to flood plain areas and downstream sediment accumulation will be reduced. The project will provide protection to 1,780 acres of flood plain lands within the watershed and will benefit directly 20 owners and operators of agricultural land in the flood plain. Water temporarily impounded in the sediment pools can be used for waterfowl nesting and resting areas, fisheries habitat, and livestock and wildlife watering areas.

Additional opportunities for employment will be created effecting a greater potential for increased income to households and demand for services.

Installation and functioning of the two floodwater retarding structures will require 409 acres of agricultural land. A total of 104 acres of this area will be needed for dams, emergency spillways, and sediment pools up to the lowest ungated outlet. The existing vegetation on this 104 acres will be destroyed during construction. Approximately 305 acres of wildlife habitat in the sediment reserve and retarding pools will be altered. Water impounded in the sediment pools will create 69 acres of fish habitat. Dove nesting habitat will be reduced; and upland habitat for deer, turkeys, fur animals, bobwhites, and songbirds will be minimally displaced with the installation of the floodwater retarding structures. Waterfowl habitat will be created on approximately 69 acres. Flowage easements will be obtained on 24 acres below the spillway of Floodwater Retarding Structure No. 1.

Average annual floodwater, sediment, erosion, and indirect damages will be reduced from \$46,880 to \$9,870 by the proposed project. Average annual benefits accruing to floodwater retarding structures in the

watershed will be \$44,840 which includes \$34,640 damage reduction benefits and \$10,200 secondary benefits. The ratio of total average annual benefits accruing to floodwater retarding structures (\$44,840) to the average annual cost of those measures (\$24,110) is 1.9:1.0.

Land treatment measures will be implemented and maintained by owners and operators of land upon which the measures will be applied under agreements with the Concho, North Concho River, and Runnels Soil and Water Conservation Districts.

The Willow Creek Water Control District will be responsible for operation and maintenance of the floodwater retarding structures. Cost of operation and maintenance of the floodwater retarding structures is estimated to be \$820 annually.

## WATERSHED RESOURCES - ENVIRONMENTAL SETTING

### Physical Resources

#### Location and Size

Willow Creek Watershed is located in the east-central portion of west Texas in Runnels and Tom Green Counties. Willow Creek rises in northeastern Tom Green County about 15 miles northeast of the city of San Angelo. Following a southeastward course, Willow Creek crosses the extreme southwestern corner of Runnels County, passes closely by the city of Miles, and flows back into Tom Green County where it confluences with the Concho River. The Concho River is a tributary of the Colorado River which is in the Texas Gulf Water Resource Region. The watershed drainage area is 45.91 square miles (29,382 acres), has an average width of 3.7 miles, and is about 12.5 miles long.

Major tributaries to Willow Creek are Bottle Creek which flows through Miles, Texas; and three unnamed creeks (figure 5).

Stream channels and banks in the watershed are in their natural state except where they have been modified by the construction of bridges or low water crossings. Streamflow is ephemeral, occurring only in response to surface runoff.

#### Climatic Features

Climatic conditions in the watershed are semi-arid. The average annual precipitation is about 20 inches. Thirty years of records indicate that about 32 percent of the precipitation falls during the months of May and September. Winter and early spring are usually dry. Net annual evaporation rate for the area is about 62 inches. Temperatures range from a mean maximum in July of 97 degrees Fahrenheit to a mean minimum of 34 degrees Fahrenheit in January. Normal growing season is from about March 30 to November 15, or 230 days (Texas Almanac 1973).

## Geology

Geologic strata, listed in ascending order, that crop out in the watershed are the Vale and Choza formations of the Clear Fork Group and the San Angelo Formation of the Double Mountain Group. These formations are all sedimentary rock in the Permian System. Pleistocene and Recent alluvial deposits are present on and adjacent to the flood prone areas.

Permian strata in the watershed strike generally northeast-southwest and dip gently to the northwest. There is no faulting or folding of strata in the watershed and surrounding area.

The oldest rock unit exposed in the watershed is the Vale Formation. This formation crops out in the eastern and southern portions of the watershed and is comprised of two parts totaling about 115 feet in thickness. The lower 50 feet is red and green shale or sandy shale; and the upper 65 feet is the Bullwagon Member composed of red and green gypsiferous shale with two ten-foot thick beds of dolomite or dolomitic limestone separated by about three feet of shale. There are surface exposures of the Bullwagon Member along the Concho River near the mouth of Willow Creek.

The Choza Formation lies conformably over the Vale Formation and crops out in the central portion of the watershed. The Choza Formation consists of red and green shale with dolomite and dolomitic limestone. Merkel Dolomite which occurs in the Choza Formation is the most obvious and persistent dolomite member in the watershed vicinity. Total thickness of the formation, according to Henderson (1928), is 625 feet.

The San Angelo Formation overlies unconformably the Choza Formation and crops out in the extreme northwestern portion of the watershed. This formation, as exposed in the watershed, is composed of a basal quartz and chert conglomerate overlain by brick-red, fine-grained argillaceous and clayey sandstone.

Remnants of Pleistocene alluvial deposits (Leona Formation) are present on valley slopes along stream courses and as topographically high terrace materials in the form of silt, sand, and gravel on gently sloping areas and on level areas. Poorly consolidated caliche is overlain by one to two feet of indurated caliche on nearly level areas. Recent deposits in the flood plain areas are comprised of clay, silt, sand, and reworked gravel from the Leona Formation.

## Elevation, Topography, and Slope

Elevations within the watershed range from about 2,100 feet above mean sea level along the northwestern divide to 1,700 feet at the confluence

of Willow Creek and the Concho River. The extreme northwestern edge of the watershed is a hilly, rolling area that changes abruptly to gently sloping, nearly level topography. About nine percent (2,650 acres) of the watershed has slopes ranging from three to twenty percent. The topography of greatest slopes is found in the hilly area previously mentioned and as valley slopes along the major stream courses. The remaining 91 percent (26,732 acres) of the watershed is gently sloping to nearly level (less than three percent slope).

### Soils

The entire watershed lies within the Central Rolling Red Plains Land Resource Area. Fertility of most soils is naturally high. Some have been cultivated since 1910 and crop yields are still high. Erosion attributable to man has not had an adverse effect on the productive capability of upland soils in the watershed. On many areas, it is not readily apparent that erosion has occurred.

Soils in the watershed are divided into four associations (figure 3). A soil association is a landscape that consists of a characteristic pattern or arrangement of soil series. A soil series is a distinctive kind of soil that is determined by examining the profile from surface to parent material and describing the physical, chemical, and mineralogical properties. A soil association usually consists of one or more dominant soil series in areal extent and at least one minor soil series. The association is named for the dominant soils.

Mereta-Kimbrough Association. This association is upland soils that comprise about 45 percent of the watershed. Both the Mereta series and the Kimbrough series are very shallow or shallow soils and comprise about 80 percent of the association. They were developed in ancient alluvial materials (Leona Formation). The remaining percentages are composed of deeper soils. The deeper soils (greater than 40 inches of total depth) are on nearly level slopes (zero to one percent) while the very shallow soils (zero to 12 inches) and shallow soils (12 to 20 inches) are on nearly level to steep slopes (zero to 45 percent).

Soils of the Mereta series comprise 50 percent of the association. These soils are dark grayish-brown calcareous clay loams 12 to 20 inches deep over indurated caliche. They are well drained, have a moderate shrink-swell potential, and are moderately slowly permeable. Mereta soils are used as cropland and rangeland.

The Kimbrough series is 30 percent of the association. Soils in this series are dark grayish brown gravelly loams three to 12 inches deep over indurated caliche. They are well drained, have a low shrink-swell potential, and are moderately permeable. These soils, because of very shallow soil depth, are not suitable for cultivation and are used as rangeland.

The minor soil series comprise the remaining 20 percent of the association and are the Portales, Estacado, Rowena, Angelo, and Olton. The Portales, Estacado, and Rowena series are deep clay loams with moderate to moderately slow permeability, low to moderate shrink-swell potential, and used as cropland and rangeland. Angelo and Olton soil series are described under the following discussion of the Angelo-Olton association.

Angelo-Olton Association. About 45 percent of the watershed soils are comprised of this association. These are deep, nearly level upland soils developed in ancient alluvial sediments, well suited for and generally used as cropland.

The Angelo series are 70 percent of the association. Soils in this series are calcareous dark grayish brown to reddish brown clay loams. They are well drained, have a high shrink-swell potential, and are moderately slowly permeable.

Olton soils are 20 percent of the association. These soils are clay loams that are noncalcareous in the upper horizons of the profile and calcareous in the lower horizons. They are dark brown, well drained, have a moderate shrink-swell potential, and have a moderately slow permeability rate.

The Tobosa, Rowena, Portales, Lipan, and Mereta series are the minor soils that comprise the remaining 10 percent of the association. Soils in the Tobosa series are deep calcareous clays that are well drained, very slowly permeable, and have a very high shrink-swell potential. Rowena, Portales, and Mereta series have been previously discussed.

Vernon-Cobb Association. This association is located in the extreme northwestern portion of the watershed and comprises about three percent of the total drainage area. Soils in the association are gently sloping to steep slopes (one percent to 45 percent respectively) that have developed from clay-shale and sandstone. They are used mainly as rangeland; however, some very small acreages are cultivated.

Soils of the Vernon series are calcareous reddish brown clay from 20 to 36 inches thick over marine clay-shale. They are well drained, have a high shrink-swell potential, and are very slowly permeable.

Cobb soils have reddish brown fine sandy loam in the upper horizons and sandy clay loam in the lower horizons, ranging from 20 to 40 inches in depth. They are noncalcareous, well drained, have a low shrink-swell potential, and moderately permeable. These soils developed over sandstone.

The minor soil series in the association are Cosh, Berda, and Kimbrough. The Cosh series is very similar to Cobb soils, but the depth is 12 to 20 inches to sandstone. Berda soils are deep, moderately permeable loams with slopes exceeding four percent. Kimbrough soils have been discussed previously.

Spur-Rioconcho Association. This association comprises about seven percent of the watershed. Soils of the bottomland areas have been developed from recent, nearly level, alluvium.

The Spur series is 60 percent of the association. These soils are calcareous clay loams, well drained, moderately permeable, and have a low shrink-swell potential. Clay content is less than 35 percent.

Rioconcho soils are 40 percent of the association. These soils are deep clay loams with a clay content of more than 35 percent. They are moderately well drained, slowly permeable, and have a high shrink-swell potential.

#### Mineral and Ground Water Resources

Mineral resources in the watershed consist of caliche, sand, gravel, and petroleum. Oil is produced from eight wells. Production from these wells is apparently low. Presently there are four caliche and gravel pits in the watershed that furnish road building and repair materials for local use. These materials are excavated from small open pits. There are numerous locations throughout the watershed and surrounding area that will yield caliche and gravel. Generally, these materials are found in the Leona Formation. There is a sand and gravel pit outside the watershed to the west of Farm Road 1692 and near the confluence of Willow Creek and Concho River. This pit has yielded large amounts of gravel and is apparently capable of producing much more; however, excavation operations have been on an intermittent basis during recent years.

One gravel and caliche pit and one oil well are in the drainage area of each of the two planned floodwater retarding structures. However, there are no known mineral resources in the areas to be occupied by the two floodwater retarding structures.

Ground water, obtained from wells, is used for domestic purposes and for livestock throughout the watershed. Municipal water for Miles is also obtained from wells. A small acreage of cropland south and north of U.S. Highway 67 is irrigated with ground water. During years of near normal rainfall, the quantity available for these uses is adequate. However, during extended periods of drought, ground water is not a dependable source for these uses. Ground water quality is discussed under Water Quality Problems.

## Land Use

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

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cropland	15,805	53.8
Pastureland and Hayland	118	0.4
Rangeland	10,694	36.4
Miscellaneous *	<u>2,765</u>	<u>9.4</u>
Total	29,382	100.0

\*Includes roads and highways, railroad, city of Miles, farmsteads, cemetery, Goodyear Tire and Rubber Company Proving Grounds, etc.

There is a slight trend in land use of less cropland and rangeland and more improved pastureland and hayland.

The flood plain consists of 1,780 acres excluding stream channels. This is the area that would be inundated by a flood having a recurrence interval of once in every 100 years (figure 1). There are 20 farm and ranch units that have land within this area.

## Surface Water Resources

Surface water resources for livestock and domestic uses in the area are from small farm ponds and limited ground water seeps. The quality of water from those sources is considered to be within tolerable limits of health and safety for the locale. However, during prolonged periods of drought, they are not reliable sources of water.

## Wetlands

Wetlands in the watershed are two areas of Lipan clay soils totaling approximately 100 acres. Both areas are classified Type 1 wetlands--seasonally flooded basins or flats (Shaw and Fredine 1971). The larger of the two areas is within the corporate limits of Miles, and the smaller area is just to the north of the community. Both areas are either in cultivation as cropland or other uses such as roads and a few homesites. Lipan clay soils will characteristically pond intermittently, and offer some limited waterfowl habitat. The present land use, however, precludes and limits its value as wetland.

## Economic Resources

### Principal Crops

The economy of the watershed is dependent largely on agriculture, which is comprised mostly of the production and sale of livestock, cotton, and grain sorghum.

During recent years, the trend in the watershed has been toward increased livestock production. This has resulted in the shifting of cropland from cash crop to forage and hay crops and improved pastureland. Some unimproved and brushy pastureland has been established to improved pastures and hay crops.

#### Agricultural Enterprises

There are approximately 109 farm and ranch units wholly or partially within the watershed. These units average about 260 acres in size and range from less than 30 to more than 1,770 acres. There has been a gradual increase in size and a decrease in the number of farms and ranches. About 85 percent of the agricultural land is owner-operated. There is no public-owned land in the watershed other than highways, schools, etc.

#### Current Land Values

The estimated current market price ranges from about \$200 to \$425 per acre. The range in land prices depends on locations, accessibility, soil capability, and land use.

#### Current Economic Conditions

Based on 1969 Agricultural Census data for Runnels and Tom Green Counties, about 24 percent of the farms and ranches gross less than \$2,500 annually from agricultural sales. Approximately 36 percent of the farm and ranch operators had off-farm income 100 days or more in 1969.

It is estimated that less than five percent of the agricultural land in the flood plain area is in operating units using one and one-half man-years or more of hired labor.

The "Labor Force Estimates for Texas Counties - April 1974," the latest statistics available from the Texas Employment Commission, shows a labor force of 35,650 for the two counties within which the watershed is located. Slightly over 2.5 percent of 905 workers were unemployed. There were 9,620 workers employed in the agricultural sector. The nonagricultural sector employs 25,095 workers; 5,350 in the manufacturing sector and 19,745 in the nonmanufacturing sector.

#### Population Centers and Accessibility

The city of Miles is an incorporated, general law municipality with a 1970 population of 631. It is located in the east-central portion of the watershed at the intersection of U.S. Highway 67 and Farm Road 1692. Census data limited to the watershed area is not available. However, it is estimated that about 100 people reside in the rural area. Little change has occurred during the last 10-15 years, and no significant change is anticipated within the near future.

The incorporated area of Miles contains approximately 930 acres and lies within the area served by the West Central Texas Council of Governments.

Land use in Miles is typical of that found in other small, rural communities of the region; i.e., scattered residential developments and a concentrated commercial and public services area. The major economic resource base is from agriculture with some contribution from local industry.

Nearby cities and their approximate distances from Miles are: San Angelo, 19 miles southwest, and Ballinger, 17 miles northeast. These cities provide the needed services and marketing facilities for the area.

Approximately 61 miles of federal, state, and county roads, of which 16 are paved, serve the watershed residents. Mainline tracks of the Atchison, Topeka, and Santa Fe Railway Company traverse the watershed parallel to U.S. Highway 67. Loading and unloading facilities are maintained at Miles.

#### Plant and Animal Resources

##### Floral Setting

Gould (1962) has divided Texas into ten primary vegetational areas, characterized by a distinctive climax vegetation in each area. Runnels and Tom Green Counties are somewhat unique in that they occur within portions of two vegetational areas: the Edwards Plateau and the Rolling Plains (Regions 7 and 8). The convergence of the two areas is significant in that the mixing of two or more regions may increase the botanical diversity of the counties.

Willow Creek Watershed occurs wholly within the area designated by Gould as the Rolling Plains (Region 8). The Rolling Plains in Texas comprise about 24,000,000 acres of gently rolling to moderately rough topography. In a broader sense, this area is the southern most extension of the Great Plains region of the central United States. The Rolling Plains are further characterized as being dissected by narrow, intermittent stream valleys that flow mostly east and southeast. Elevation of the Rolling Plains ranges from 800 to 3,000 feet, and annual precipitation varies from almost 30 inches in eastern portions to about 22 inches in the western portions.

It can be inferred from Gould that the frequency and amounts of precipitation have influenced the vegetational climax of the Rolling Plains. Typically, the original climax vegetation is considered to be a prairie of tall and midgrasses. The original vegetative composition in relative percentages was probably grasses greater than 90 percent, woody plants less than 5 percent, and forbs 5 percent.

### Present Plant Communities

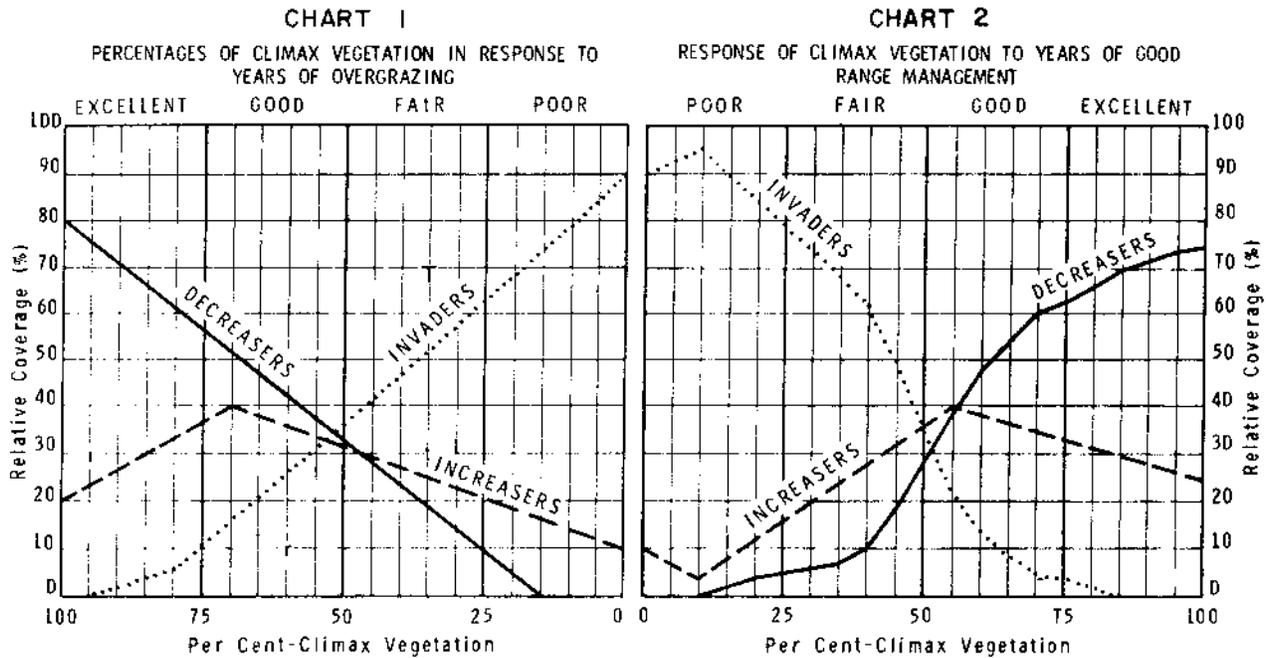
The major plant community which is comprised of a mid and short grass prairie with scattered stands of mixed brush is used as rangeland. As a result of past management, the majority of rangeland within the watershed presently bears little resemblance to its true climax status and is generally in fair condition, having only 26 to 50 percent of climax species present. In years of adequate precipitation, there is an abundance of vegetation; however, many of the grasses are considered to be increasers or invaders. Presence of those species indicates that overgrazing in the past has allowed the brush and shrubs to increase while the more desirous grasses and forbs have decreased. The effect of overgrazing and proper grazing management on vegetation is illustrated by charts 1 and 2.

The description of rangeland is usually accomplished by classifying native vegetation on a particular range site. A range site is an area having similar combinations of edaphic, climatic, topographic, and natural biotic factors, resulting in a distinct climax vegetation or plant community, and a potential forage production. They are usually significantly different from adjacent areas. Range site descriptions developed by plant ecologists and range conservationists of the Service coincide closely with the basic vegetational setting as established by Gould and other authorities. The seven major range sites identified in the watershed are the clay loam, shallow, very shallow, loamy bottomland, heavy clay, sandstone hills, and sandy loam (figure 4). A more detailed listing of climax plants on each range site is provided from the Range Site Descriptions maintained in the respective local Service field offices. Those lists enumerate the relative percentage composition of plant species in climax condition. In addition, they relate the relative forage quality of plant species for various classes of livestock and wildlife species. Chart 3 illustrates the grazing capacity of watershed range sites.

Hydrologic cover conditions on the watershed differ from ecological conditions in that they are concerned primarily with the quantity of existing vegetation and litter rather than species composition. An estimated two percent of the rangeland is in good hydrologic condition, 78 percent is in fair hydrologic condition, and 20 percent is in poor hydrologic condition. Approximately 75 percent of the cropland is in good hydrologic condition and the remaining percentage is in poor condition. All of the pastureland is in good hydrologic condition.

Of the seven range sites, the clay loam, shallow, very shallow, and loamy bottomland occur on areas to be occupied by floodwater retarding structure sites.

# RANGE CONDITION



**DECREASERS** - Plants present in the potential plant community which decrease with overgrazing.

**INCREASESERS** - Plants present in the potential plant community which initially increase with overgrazing but eventually decrease if overgrazing is prolonged.

**INVADERS** - Plants not present in the potential plant community but which encroach and occupy the area vacated by the decreaseers and increasers under prolonged over-use.

## CHART NO. 1

This chart illustrates the reaction of rangeland vegetation to prolonged periods of overgrazing. The more desirable plants decrease. Others present increase for a short time and then decrease as the grazing load shifts to them. Undesirable plants present only in trace amounts invade and occupy the area vacated by the original plants.

## CHART NO. 2

### POOR CONDITION

The invader plants increase in percent ground cover during the first few years when grazing pressure is lightened or wholly removed. This increase continues as long as there is bare ground for this type of plant to occupy. The increaser plants are low in vigor and are slow to start spreading. Both increaser plants and the trace of decreaseer plants begin to occupy more area as the cover and litter accumulates and plant vigor increases. At this stage, the less competitive invaders, such as annuals, begin to diminish and give way to plants of higher order.

### FAIR CONDITION

The increaser plants continue to spread and compete more heavily for the water, nutrients, and light. Decreaser plants gain vigor, produce seed, and begin to spread more rapidly by establishing new plants by vegetative means. The invader species start to decline rapidly as competition becomes more and more severe.

### GOOD CONDITION

Decreaser plants increase more rapidly. Invader species continue to be eliminated as competition with plants of higher ecological status becomes more severe. Increasers spread for a short time until competition with plants of higher rank force them to diminish gradually.

### EXCELLENT CONDITION

Invader plants are soon reduced to only a trace of the composition. Adjustment between the climax plants continues to take place as the decreaseers slow down their spread but continue a gradual climb in percent coverage. The increaser species are gradually reduced to their proper percentage in the highly competitive community. Decreasers may not attain as high a percentage of the composition as they occupied before deterioration, due to some species having been eliminated completely.

Chart 3

Grazing Capacity 1/ of Rangelands by  
Range Site and Condition Class 2/

Range Site	Condition Class			
	Excellent	Good	Fair	Poor
Clay loam	10-14	12-17	17-20	20-30+
Shallow	12-15	14-17	16-24	24+
Very shallow	25-35	30-40	38-55	50+
Loamy bottomland	10-16	14-24	22-38	34+
Heavy clay	11-14	13-18	18-22	22-35
Sandstone hills	16-20	20-25	25-32	32-40
Sandy loam	14-18	18-22	20-32	32+

1/ Expressed in acres required to furnish forage for one animal unit on a year-long basis.

2/ Expressed in qualitative and quantitative terms as the allowable percent composition of climax plants present on a particular site. The four condition classes recognized by the Soil Conservation Service are as follows:

- Excellent - 76 to 100 percent climax plants present
- Good - 51 to 75 percent climax plants present
- Fair - 26 to 50 percent climax plants present
- Poor - 0 to 25 percent climax plants present

Clay loam. The clay loam range site occurs on nearly level to gently sloping plains, lying generally below the hills approaching drainage ways and on the divides. Slopes range primarily from one to three percent, and elevations vary from 1,800 to 2,100 feet. Major soils which characterize the site include Rowena clay loam and Angelo clay loam. The climax vegetation was a grassland with some forbs <sup>1/</sup>, and an occasional oak or sugar hackberry. It was a typical mixed prairie of mid and short grasses.

The present composition contains approximately 33 percent of the climax species present. In climax condition, brush (woody plants) comprised only a trace; however, the present composition contains more than 25 percent brush. As retrogression occurs the short grasses increase and dominate, mesquite invades, and in low condition, red grama becomes the major grass. Some agarito and southwest condalia invades.

Shallow. The shallow range site occurs on footslopes and divides. Elevation ranges from 1,800 to 2,100 feet. A soil that characterizes this site is Mereta clay loam. Climax vegetation consisted of mid and short grasses with scattered woody plants. Live oak and vasey shin oak would generally occur on the very shallow outcrop spots.

Present species composition is composed of approximately 40 percent climax plants. Brush has now invaded on approximately 32 percent of this site, but in climax condition brush comprised only 2 percent of species composition. As retrogression occurs, honey mesquite, lotebush, agarito, littleleaf sumac, pricklypear, and pencil cholla are the principal woody increasers and invaders. Other increasers may be perennial threeawn, lovegrasses, windmillgrasses, annual brome grasses, red grama, hairy tridens, bladderpod, dozedaisy, gaillardia, caltrop, western ragweed, pepperweed, texas croton, and broom snakeweed. Red-berry juniper invades to a degree.

Very shallow. The very shallow range site occurs on both gently sloping and steep upland areas. It may be found occasionally as a knoll within other sites. Slopes range from one to thirty percent. Major soils which characterize this site are found in the Mereta-Kimbrough association. The climax plant community was composed of a mixture of tall, mid, and short grasses. There was also a good variety of forbs and brush, giving the site a good balance of forage produced. Production was limited due to shallow soil depth and the inability to store moisture.

The average species composition on this site is comprised of approximately 37 percent climax plants. More than 30 percent of the site has been

<sup>1/</sup> All plant names are referenced to Soil Conservation Service (1971 and 1974). A complete list of common and scientific plant names used in this Work Plan is presented as Appendix A.

invaded by several species of noxious brush. As retrogression occurs, there is marked increase in perennial threeawns, hairy tridens, slim and rough tridens, and broom snakeweed. Upon further deterioration, perennial threeawns, hairy tridens, and broom snakeweed become dominant.

Loamy bottomland. The loamy bottomland range site characteristically occurs on nearly level flood plains. Slopes range from 0.4 to one percent. It may receive overflow as well as having a relatively high water table. Soils which characterize this site are the Rioconcho and Spur soils, and Rioconcho clay loam. The climax plant community was composed mainly of tall and mid grasses with an excellent variety of browse, forbs, and woody plants. It is, and was, common that following severe floods, vegetative composition may change abruptly as influenced by the damaging deposits of overwash.

Climax species on this range site now comprise approximately 30 percent of the vegetative composition. Brush and woody plants have increased and now comprise at least 35 percent of the present composition. As retrogression occurs, there is a loss of the taller grasses and forbs and an increase in buffalograss, tobosa, sand dropseed, and annuals. Upon further deterioration, grasses such as red grama, needlegrass, hairy tridens may become dominant. There is also a rapid increase in mesquite, lotebush, and pricklypear.

#### Faunal Setting

The Willow Creek Watershed is located in the Kansan Biotic Province of Texas as described by Blair (1950), specifically situated in the southern portion of the Permian Red Plains Region of the Province. The fauna is a mixture of species typical of east Texas forests and species common to west Texas grasslands, with the latter predominating.

Bobwhite quail, scaled quail, and mourning dove are the primary game species in the watershed. A survey conducted by the Texas Parks and Wildlife Department in 1969 (Litton 1970) and a field investigation by Fish and Wildlife Service in June 1974, indicated 0.33 quail per acre in Runnels County portion of the watershed. Bobwhite quail is the dominant species. Quail population on the Tom Green County portion of the watershed is 0.125 quail per acre. Scaled quail is the dominant species. Mourning dove are very plentiful in the watershed. Large acreages of grain sorghum and small grain maintain a dove population year round.

A limited population of white-tailed deer inhabit the western edge of the watershed. The population is estimated to be about one deer for 200 to 250 acres in the western portion of the watershed. Rio Grande turkey utilize a large portion of the watershed along stream courses primarily during the spring and summer. Furbearers common to the watershed are raccoon, ringtail, opossum, skunks, red fox, gray fox, badger, and coyote. Other animal species that inhabit the watershed are cottontail and jackrabbits, nongame birds, raptors, rodents, reptiles, and amphibians.

Hunting is limited to family and by invitation on most watershed farms and ranches. Service field office records indicate only one landowner leases for hunting. Hunting is confined almost entirely to doves and quail.

Waterfowl populations are limited due to lack of suitable habitat, although numerous species of waterfowl and sandhill cranes utilize farm ponds and cropland as resting areas during migration periods.

Fishery resources in the watershed are limited. Willow Creek is an ephemeral stream and has insufficient water to support a fisheries resource. Thirty-seven farm ponds have been constructed in the watershed. Most of the ponds are 10 to 12 feet in depth and less than one-half acre in size. Most of the ponds have been stocked with largemouth bass, channel catfish, and sunfish. Service field office records indicate only four of these ponds are managed for fish production. Fishing is limited to landowners and by invitation.

#### Present Wildlife Habitats

Two important wildlife upland habitat types occur in the watershed. The primary upland type is native rangeland with scattered stands of woody vegetation consisting primarily of mesquite, condalia, agarito, catclaw acacia, pricklypear, and pencil cholla. Littleleaf sumac, sugar hackberry, bumelia, and live oak occur in limited amounts. Similarly, sugar hackberry, cedar elm, western soapberry, mesquite, and a few scattered pecan are found along watercourses.

Upland habitat occurring on rangeland may be further divided into three subtypes which correspond to existing range sites. These subtypes are loamy bottomland, clay loam, and very shallow. The loamy bottomland subtype occurs on nearly level flood plains and typically has a moderate to heavy infestation of woody species. This subtype furnishes needed habitat for quail, deer, turkey, and furbearers. The clay loam subtype occurs on nearly level to gently sloping plains below hills and approaching drainage ways and on divides. It is commonly invaded by honey mesquite, agarito, and southwest condalia, and provides habitat for quail, dove, deer, turkey, and other upland species. Characteristically, this habitat has fewer woody species and produces less food for most wildlife than does the loamy bottomland subtype. The very shallow subtype occurs on sloping to steep upland areas and is limited in its ability to provide wildlife food and cover due to shallow soils and its inability to store moisture.

The second major wildlife habitat type includes areas that are used primarily as cropland with small inclusions of native vegetation. A limited number of flat areas which impound water for short periods of time following heavy rainfall occur in this type. This upland habitat is cultivated intensively and furnishes food for wildlife primarily from waste grain. A limited amount of wildlife cover is provided by fence

rows, grassed waterways, field borders, and inclusions of rangeland. Cropland areas comprised of Lipan clay soils, which pond water following periods of rainfall, provide limited food for migrating waterfowl species primarily during the fall and early winter.

The wildlife habitat value of existing native vegetation at the structure sites has been seriously reduced by livestock grazing practices in the past. Woody plants and forbs having forage value for wildlife have been largely eliminated. Annual weeds such as Texas croton provide a food supply for dove and quail. No turkey roosts were observed during surveys in the areas of the planned floodwater retarding structures.

#### Endangered and Threatened Species

The Endangered Species Act of 1973 (Public Law 93-205) now encompasses all species of the plant kingdom and all species of the animal kingdom. "Species" now includes any species, subspecies, and any smaller taxonomic unit; or any viable population segment thereof. "Endangered Species" as defined in the act refers to species whose existence are directly threatened with extinction throughout all or in a significant portion of their range. Similarly, "Threatened Species" are those species which are likely to become endangered within the foreseeable future throughout all or in a significant portion of their range. There is no designation for "native" or "foreign" species (U.S. Department of the Interior, 1974).

Endangered or threatened flora. An official Federal inventory as to the existence or occurrence of endangered or threatened flora has been established. In a preliminary document, the Smithsonian Institution (1974) has prepared a list that attempts to deal with this most complex subject. The list gives a definitive approach to the status of each species. Generalized distribution ranges are included.

To date, the State of Texas has not officially recognized the status of any plant species. The Texas Organization for Endangered Species (1975a) has inventoried, classified, and published a revised list of endangered plants. TOES is not associated with any governmental entity, although, much input of the information and data collection has been on the part of personnel from the Service, the Fish and Wildlife Service, and the Texas Parks and Wildlife Department; as well as biologists, naturalists, and others from educational institutions and the private sector.

A widely circulated list of endangered flora for Texas has been developed and revised by the Rare Plant Study Center (1974) at the University of Texas at Austin. The new list, as revised, represents an assessment of the species most directly threatened with extinction in Texas. The species in question are either endemic (localized), indigenous, or widely distributed over Texas. However, in some cases the species may have a wider and more common distribution outside of Texas.

The only species whose known distribution includes the project area is Texas bluegrass. The occurrence of this species within the watershed area has not been documented. A careful reconnaissance of the floodwater retarding structure sites by Service biologists in Fall 1973 has not recorded the presence of this species. Thus, it must be inferred that this species is not threatened on those sites.

Endangered or threatened fauna. The U.S. Fish and Wildlife Service (1974) recognizes two species of endangered animals whose natural ranges extend over and throughout the project area of the watershed. These two species are birds--the southern bald eagle and the American peregrine falcon.

The bald eagle has been sighted twice in Tom Green County, and the last confirmed sighting was 10 years ago at North Concho Lake. The American peregrine falcon has been seen three times around the San Angelo Lakes, and the latest sighting of this bird was in 1973. These sightings have occurred no closer than approximately 15 miles to the watershed. Neither of the species in question have ever been observed in the area of the watershed or the sites for the planned floodwater retarding structures. Presently, habitat at each of the structure sites is not preferable for inducing or sustaining a population of these birds, and is only transitory, offering neither preferred nesting sites nor a sustained food source.

Additional protection in Texas has been afforded the above species under the Texas Parks and Wildlife Code (Chapter 68, Acts of the 64th Legislature, Regular Session, 1975), which relates to nongame and endangered species. A list which includes the southern bald eagle and the American peregrine falcon has been filed with the Texas Secretary of State. The list cites those animals threatened with extinction in Texas. The above birds are also cited by TOES (1975b) as endangered.

No other endangered or threatened vertebrates or invertebrates were found to have range distributions within the watershed, and no additional sightings or evidence of any other species has been recorded.

#### Recreational Resources

Willow Creek has no dependable water source for water-based recreational use; however, there are eight large reservoirs or lakes with existing developments for water-based recreation within a 50-mile radius of Willow Creek Watershed. These are Twin Buttes Reservoir, Lake Nasworthy, San Angelo Lake, Lake Coleman, Lake Abilene, Hords Creek Lake, E.V. Spence Reservoir, and Oak Creek Reservoir. Some water-based recreation is also available about 14 miles north of the watershed (Miles) along the Colorado River and approximately four miles to the south of Miles along the Concho River.

There was no known local interest in developing additional resources for recreation.

#### Archeological and Historical Resources

Runnels and Tom Green Counties have a long history of settlement and exploration. Runnels County, named for legislator-planter H.G. Runnels, was created in 1858 from Bexar and Travis Counties and organized in 1880. Ballinger, the county seat, was established in 1886 and originally called Hutchins City. Similarly, Tom Green County was created from the Bexar District in 1874 and named for General Tom Green of the Texas Revolution. The county was organized in 1875, and the original county area was so large, 12 additional counties were eventually created. San Angelo, the county seat, grew up around the frontier site of Fort Concho. This fort was established in 1867 at the junction of the middle and north branches of the Concho River. San Angelo grew as a center of early ranching enterprises for both cattle and sheep (Texas Almanac 1973 and Texas Highway Department 1968)!. According to the Census of 1880, San Angelo had a population 4,000 (Cram 1887).

Prior to 1890, the first people to permanently settle the area from Miles to San Angelo were ranchers who grazed large numbers of both cattle and sheep on thousands of acres. Ranges were unfenced and the livestock was herded rather than being confined; thus, overgrazing was uncommon. In this near-natural state, there were several large colonies of prairie dogs and scattered stands of honey mesquite. The turf grass (probably buffalograss) was six to eight inches tall on the deeper soils and the hills and ridges were covered with taller growing species. Between 1890 and 1900, the area around Willow Creek was settled by farmers. Those farmers were, for the most part, operators who had a few cattle and sheep. Small fields were cultivated to grow feed. Overgrazing occurred in the period from 1900 to 1910, when the rangeland was fenced and the livestock confined in relatively smaller areas (personal communication, Herman Heinze, area farmer, Miles, Texas).

The nearest historic site, as recognized by the U.S. Department of the Interior, National Park Service (1973 and subsequent dates), in Tom Green County (San Angelo) is Fort Concho, a National Historic Landmark; and in Runnels County (Ballinger) is the Ballinger Carnegie Library. The Texas Historical Foundation (n.d.) lists only one historical marker in Miles. A historical building medallion marks the site of the Old Thiele Building which is presently the Citizens State Bank. According to the Tom Green County Historical Society, there are no other known monuments or historical sites within the bounds of the watershed project (Dean Chenoweth, personal communication, former president of the Tom Green County Historical Society, San Angelo). However, several archeological resources of scientific interest have been located in the watershed.

Dr. S. Alan Skinner and Mr. C. Britt Bousman, archeologists with the Archaeology Research Program, Department of Anthropology, Southern Methodist University, conducted an archeological survey in January 1974 on portions of the watershed that would be affected by project structural measures. 1/

A total of three artifact sites were located within areas of construction or inundation by Floodwater Retarding Structure No. 1, and one site was recorded in the area of Floodwater Retarding Structure No. 2. The "West Branch Dam" refers to Floodwater Retarding Structure No. 2, and the "North Branch" refers to Floodwater Retarding Structure No. 1. The following is quoted from their unpublished findings:

"...the West Branch Dam...site, X41TG1, which covers 30,000 square meters. This site includes large numbers of flint cores, flakes, bifaces, scrapers, retouched flakes, and naturally occurring unmodified flint cobbles. Three major artifact concentrations were noted. A dart point was found which may be used to tentatively date the occupation of the site to Archaic times (5,000 B.C. to A.D. 500).

"The North Branch also demonstrated aboriginal occupation. The entire area was littered with a light scattering of cores and flakes. Three major artifact concentrations were recorded and each classified as a separate site (X41TG2, X41TG3, X41TG4). X41TG2...consists of flint cobbles, flakes, and cores. X41TG3 was in the Willow Creek floodplain...The site contained flakes, cores, and unmodified flint cobbles. The site may possibly be buried, but depth is unknown. X41TG4...is characterized by flakes, cores, and unmodified flint cobbles. X41TG3 covers 500 square meters and X41TG4 covers 225 square meters. No temporal placement can be made for the occupation of any of the North Branch sites.

"Based on the surface occurrence of artifacts, it appears that the inhabitants were utilizing the naturally occurring flint for the manufacture of various tools. These sites appear to be the areas where flint was being quarried and initially shaped by chipping. Very little is known about quarries as sites."

In July 1975, an additional archeological survey was conducted by Banks and Bagot (1975) under the direction of Dr. Skinner. 1/ The four sites previously mentioned were resurveyed to determine their significance and if Site X41TG2 is of such value that it should be preserved and action taken to nominate it to the National Register of Historic Places.

1/ Those findings are available for review at the State Office, Soil Conservation Service, First National Bank Building, Temple, Texas 76501.

Based on data collected during the course of the recent survey the following action was recommended:

"Although X41TG2 is a surface site, its size and concentration of quarrying [sic] biproducts [sic] makes it a valuable site. Therefore, we are recommending that the site be placed on the National Register of Historic Places. This measure is considered necessary so that the importance of this site be recognized."

No further work was recommended for sites X41TG1, X41TG3, or X41TG4.

#### Soil, Water, and Plant Management Status

The Concho, North Concho River, and Runnels Soil and Water Conservation Districts were organized as a subdivision of the Texas State Government with responsibility in the field of soil and water conservation in Runnels and Tom Green Counties. The Districts are dedicated to the conservation of soil, water, plant, wildlife, and related resources and are governed by locally elected boards of directors. Technical assistance to the Districts is provided by the Service through an existing memorandum of understanding with the United States Department of Agriculture. The Districts establish policies and set priorities for conservation of resources. Soil and water conservation districts constitute a significant level of citizen control in decision making (Irland and Vincent 1974).

The Districts do not have regulatory authority and operate a cooperative voluntary program of assistance to land users within their established geographical boundaries.

Land users who elect to cooperate with the Districts in the application of a conservation program are provided technical assistance in the planning and application of conservation measures.

Conservation plans developed by land users in consultation with resource personnel assisting the District are the basis for most land treatment measures. Conservation plans contain soil, water, and other needed inventories; data on critical conservation problems; and a record of decisions which have been agreed upon in order to reach conservation objectives. Technical assistance is provided to land users by the District to apply and maintain conservation practices towards completion of the conservation plan. The length of time required to fully implement a plan is contingent upon many factors including available labor, capital, and materials.

Conservation plans are developed which accomplish the objectives of the land user and result in conservation of natural resources. A careful evaluation of alternatives often reveals conflicts in the selection of planned land treatment measures. As an example, the conversion of rangeland to cropland may increase economic returns and reduce wildlife values. The ultimate decision of land use and treatment rests with the landowner.

The Sponsoring Local Organization has limited control of land acquired by formal easements that will be directly affected by installation of the planned floodwater retarding structures. This land constitutes a small part of the total watershed (approximately two percent).

About 82 land users in the watershed are cooperating with the Districts. Conservation plans have been developed for 78 farm and ranch units covering about 23,250 acres or about 86 percent of the agricultural land in the watershed.

The Service administers the Great Plains Conservation Program (GPCP) in the watershed area. This program is designed to assist owners and operators of farms and ranches within designated counties of the Great Plains region in making land use adjustments through cost-sharing and technical assistance under long-term contracts; and to install measures needed to conserve, protect, develop, and utilize their soil and water resources. There are five GPCP contracts presently active in the watershed which cover about 1,160 acres. An additional eight GPCP contracts covering about 1,640 acres have expired following completion of planned conservation practices.

Soil surveys, which are essential to sound planning and application of land treatment measures, have been completed for the watershed. A soil survey is the classification, mapping, correlation, and interpretation of various types of soils in an area. Soils are classified considering their physical, chemical, and mineralogical characteristics. The classified soils are located and outlined on a map or aerial photograph of the area being surveyed, and correlated to determine the relationship of the various soils in the area to one another and to similar or identical soils identified in other areas. Soil survey interpretations indicate the limitations and suitability of a soil for selected uses.

There are presently no significant changes in land use occurring in the watershed, and no significant changes are expected in the foreseeable future.

There is a trend toward the application of specific management practices which benefit wildlife. About 60 percent of the conservation plans developed contain specific practices designed to enhance wildlife resources on farms and ranches. This trend is expected to continue as the demand for hunting increases.

The adoption of deferred grazing is increasing and an estimated 5,100 acres are now being operated under deferred grazing programs. This trend is expected to continue.

## WATER AND RELATED LAND RESOURCE PROBLEMS

### Land and Water Management

Land users in the watershed have made significant progress in the application of conservation measures on cropland, pastureland, and rangeland (table 1a). However, problems still remain that need to be corrected.

The major problem on cropland is inadequate moisture conservation. Precipitation effectiveness has been reduced on some areas due to inadequately treated land. Approximately 3,700 acres, or 23 percent, of the cropland in the watershed needs additional treatment to conserve moisture and minimize soil erosion.

Inadequate forage production resulting from overgrazing is the primary problem on rangeland. About 2,190 acres of rangeland are so heavily infested with woody plants that forage production is reduced and returns from livestock grazing are significantly lowered.

The major objective in range restoration is to improve the stand and productivity of forage plants when brush has been controlled. Some grasslands have enough of the desirable forage plants left to make needed improvement if existing vegetation is properly managed. Most grass on brush-infested rangeland is low in vigor as a result of overgrazing and competition with the brush for sunlight, moisture, and soil nutrients. Other rangeland may have so little grass remaining that reseeding of adapted grasses is necessary. Seedbed preparation and price of seed add to the cost of rangeland restoration. Reseeded areas must be rested for one growing season or longer to permit new seedlings to become established. Deferred grazing following treatment is often the key to successful rangeland improvement. Treatment is nullified when forage plants are not properly grazed following brush management.

Control of reinfestation is the second step in range conservation if lasting benefits are to be realized. Resprouts and seed either on the ground or brought in by birds or animals are major sources of reinfestation. There is no treatment presently known that eradicates all woody plants. Complete eradication is generally impossible and impractical and is usually not desirable because the woody plants with certain densities and patterns of growth have considerable value as wildlife food and cover. Complete removal of woody vegetation may also detract from future land values if resale is contemplated.

Many areas which have had control measures applied in the past and have not received follow-up treatment and management now support denser stands of woody species than were present prior to the application of initial control.

Additional watering facilities for livestock are needed on some ranches. Large pastures need additional cross-fencing in many instances to allow



Brush management is needed on approximately 2,190 acres of rangeland in the watershed. Brush management applied with wildlife consideration would not only increase the forage productivity, but also enhance upland habitat.



Some of the farms and ranches in the watershed need additional watering facilities for livestock.

the implementation of planned grazing systems and deferred grazing for better grassland management. Approximately 5,390 acres, or 50 percent of the rangeland in the watershed need additional treatment for optimum production and protection from soil and water erosion.

#### Floodwater Damage

The flood plain within the scope of the planned project consists of 1,780 acres excluding stream channels. This is the area that will be inundated by a flood having a recurrence interval of once in every 100 years (figure 1). There are 20 farm and ranch units that have land within this area.

Present flood plain land uses are as follows: cropland, 36 percent; pastureland and rangeland, 62 percent; and miscellaneous use including roads, highways, and railroad, 2.0 percent. Cropland is devoted to the production of cotton, grain sorghum, and forage sorghum.

Flooding occurs frequently and causes moderate to severe damages to crops, pastures, fences, farm improvements, livestock, public roads, and bridges. Major floods, inundating more than half of the flood plain, occur on the average of once every four to five years. Minor floods, inundating less than half of the flood plain, occur on the average of once or twice a year. Cumulative totals of recurrent flooding show an average of 810 acres flooded annually during the evaluation period. Damage to flood plain lands from deposition of sediment and flood plain scour has resulted in reduction of crop yields and caused some shift of cultivated land to pastureland and hayland. The deposition of debris is also a problem.

Flood plain lands are utilized below their potential. Because of frequent flooding, farm and ranch operators are not able to establish improved management practices to any significant extent on much of the flood plain. Flooding may occur at any time and results in severe damage, greatly reducing the effectiveness of management practices, and associated monetary inputs.

The largest flood in recent years occurred August 10-11, 1971. The recurrence interval of this flood was estimated to be about 10 years, and floodwaters inundated approximately 1,160 acres of flood plain. Damages to crops, pasture-grasses, fences, livestock, other agricultural properties, and roads and bridges were severe. Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be \$65,270.

Other recent large floods that caused extensive floodwater damages occurred in 1966, 1964, and 1961.



Extensive flooding on Willow Creek following a ten-year frequency rain on April 10-11, 1971.



Accumulations of debris in Willow Creek left by floodwaters in April 1971.

(Photographs courtesy of Werner Harach)



The flood in April 1971 caused the temporary closing of several roads in the watershed and the disruption of local transportation.



Extensive road damage was sustained on April 11, 1971, where Willow Creek crosses Farm Road 1692.

(Photographs courtesy of Werner Harsch)

A flood having a predicted recurrence interval of once in every 100 years would cause direct floodwater damages in excess of \$118,700. For the floods evaluated, which includes floods up to and including a predicted recurrence interval of once in every 100 years, total direct floodwater damage is estimated to average \$39,770 at current normalized prices (table 5). Of this amount, \$23,770 is crop and pasture damage, \$14,500 is other agricultural damage, and \$1,500 is road and bridge damage.

#### Erosion Damage

The weighted average annual erosion rate for the entire watershed is 2.69 tons per acre. Sheet erosion accounts for 95 percent of this rate, and streambank and gully erosion the remaining five percent. Streambank erosion is significant only on sharp bends and meanders of Willow Creek and its tributaries, and on small areas where protective bank vegetation is sparse.

Estimated annual soil erosion on cropland used for small grain and hay crops ranges from a minimum of 1.20 tons to a maximum of 14.91 tons of erosion per year for a weighted average of 2.05 tons per acre. On cropland producing row crops such as cotton and grain sorghum, the estimated soil loss ranges from a minimum of 1.37 tons per acre to a maximum rate of 17.45 tons per acre per year for a weighted average of 5.82 tons per acre per year.

Soil losses on grassland (rangeland and pastureland) are estimated to range from 0.07 tons to 3.08 tons annually with a weighted average of 0.66 tons per acre per year for all grassland in the watershed.

Upland soils in the watershed can tolerate average soil losses (average annual erosion rates) of one to five tons per acre. This soil loss tolerance or permissible soil loss, hereafter referred to as the T factor, is the maximum rate of soil erosion that will permit a high level of crop productivity to be sustained indefinitely. A T factor value is assigned to each soil series using the numbers one through five, which represent the permissible tons of soil erosion per acre per year where food, feed, and fiber plants are to be grown. These values are not applicable to construction sites or to other non-farm areas. T factors for soils in the Mereta-Kimbrough association vary from one to five. The Mereta series (about 23 percent of the watershed) has a T factor of two. Some Mereta soils used for growing crops indicate erosion on these soils is approaching, if not exceeding, the tolerable limits. The T factor for the Kimbrough series, approximately 14 percent of the watershed, is one. These soils are used as grassland; however, as previously indicated, there are some grassland areas in the watershed where the annual erosion rate exceeds one ton per acre, and in these areas there are Kimbrough soils. T factors for the minor series in this association vary from two to five.

Soil loss tolerances for the Angelo-Olton association range from two to five tons per acre per year. The T factors for the Angelo and Olton series are four and five respectively. These two series comprise about 41 percent of the watershed and are used as cropland. On areas where small grains and hay crops are produced, erosion rates are within the permissible soil loss limits in most parts of the watershed. The exception is in the upper portion of the watershed where erosion rates exceed the T factors due to greater slopes.

Erosion rates on areas where row crops are grown are generally in slight excess (weighted average annual rate of 5.82 tons per acre) of the greatest T factor of five.

The Vernon-Cobb association T factors range from one to five. Soils in this association are located in the extreme northwestern portion of the watershed and are used as rangeland. Excessive erosion is on small isolated areas that can be effectively controlled with vegetative management practices. Gully erosion in the watershed is very minor. However, there are a few small isolated areas adjacent to the flood plain that are actively eroding. With intensified application of land treatment, erosion on these areas will be effectively reduced.

Annual erosion damages occur on 71 acres of cropland and 87 acres of grassland in the flood plain area. The damaging erosion ranges from about 0.5 to 3 feet deep and 5 to 200 feet wide.

The areas and estimated annual losses in productive capability on cropland are: 36 acres, 5 percent; 21 acres, 10 percent; and 14 acres, 20 percent. Annual productive capability losses on grassland are: 79 acres, 5 percent; and 8 acres, 10 percent. The average annual value of the damages are estimated to be \$1,700 at current normalized prices (table 5).

#### Sediment Damage

About 107 acres in the flood plain are damaged annually by sediment deposition. The average depth of the damaging sediment is about 0.5 foot and consists of clay, silt, sand, and gravel. The deposits effecting the most damage are those that contain a high percentage of sand or gravel. The productive capability on 55 acres of cropland has been reduced as follows: 35 acres, 5 percent; 10 acres, 10 percent; and 10 acres, 20 percent. Grassland damages are: 35 acres, 5 percent; 12 acres, 10 percent; and 5 acres, 20 percent. The average annual monetary value of this damage is \$1,220 at current normalized prices (table 5).

Sediment yielded annually to the confluence of Willow Creek and the Cancho River is about 12 acre-feet. This amounts to a sediment concentration on an average annual basis of 4,590 milligrams per liter in 3.18 centimeters (1.25 inches) of annual watershed runoff. Monetary damage for this concentration has not been evaluated.

### Indirect Damages

Indirect damages such as interruption or delay of travel, rerouting of school buses and mail routes, disruption of farm operations, business losses in the area, and similar losses are estimated to average \$4,260 annually.

### Irrigation Problems

Irrigated cropland in the watershed is limited to approximately 460 acres north and south of U.S. Highway 67 in Tom Green County. This land constitutes less than three percent of the total cropland in the watershed. The major crop is cotton with occasional rotation of forage and grain sorghums.

The major problem associated with the several irrigation wells in the watershed is that of relatively high concentrations of nitrates in the water. Studies by Jones (1973) have documented the problem of high nitrate solutes in Runnels County. However, since the concentrations in the ground water appear to be attributed to mostly natural nitrate in the soil, rather than from introduced sources, the problem is complex and long-term and not within the scope of this project. No adverse effects have been documented for their use for agriculture. Current rates of application have not been to a level that has been detrimental to the production of agronomic crops.

### Municipal and Industrial Water Problems

The source of water for Miles is from four ground water wells which are the Coleman Well, Salling Well, Lightfoot Well, and Old City Well. Two wells are used constantly and two are used on a stand-by basis. These wells, which are drilled into the Vale Formation, presently yield an adequate quantity of water during years of normal or near normal rainfall. However, interviews with local officials indicate that during times of drought, the ground water is not dependable, thus inadequate. Miles has no water treatment plant.

The population of Miles (631) may decline, thereby, decreasing water demand. According to current State Board of Insurance Standards, the present ground storage is inadequate and the elevated storage is adequate.

The U.S. Army Corps of Engineers (1974) have investigated the municipal water supply and waste treatment facility of Miles. The following is quoted from their report:

"The existing sewage treatment plant is seven years old and is located in the southeast corner of the City....The plant utilizes a rectangular Imhoff tank for primary treatment followed by a 2.2-acre oxidation pond for secondary

treatment. Specifically, sewage first passes through a manually-cleaned bar screen and grit channel and flows into the Imhoff tank. Effluent from the Imhoff tank flows by gravity into the oxidation pond and thence is discharged into Bottle Creek. No chlorination of effluent prior to discharge is currently practiced. Sludge from the Imhoff tank is periodically wasted into sludge drying beds, and the dried sludge is disposed in a landfill.

\* \* \* \* \*

"Generally, the plant is fairly well operated and maintained. The existing site covers 9.5 acres, of which about 5 acres are available for expansion. All of the treated wastewater is discharged into Bottle Creek with no irrigation of effluent currently practiced.

"Since the City of Miles obtains its water supply from wells, there are no water treatment plant wastes produced in the area. There are no significant industrial or agricultural wastes produced within the corporate limits of Miles nor are any anticipated in the future."

Based on the data provided in the Corps' report, sewage effluent reaching Willow Creek at its confluence with Bottle Creek is not a significant problem. The relatively low discharge (50,000 gallons per day) combined with evaporation and seepage losses preclude sewage effluent from reaching Willow Creek except during periods of heavy precipitation and resulting runoff.

#### Plant and Animal Problems

The primary problem which limits the management of quality fish habitat in farm ponds in the watershed is a lack of sufficient water during drought periods. Most farm ponds have been constructed primarily for livestock water and do not retain adequate permanent water to support a fish population.

Conversion of rangeland to cropland in large tracts during the early part of this century removed needed cover for many species of wildlife. Presently, large areas of cropland provide food for wildlife but do not provide needed cover for species such as deer, turkey, and quail.

Brush management practices applied in past years without regard to wildlife needs have reduced the quality of wildlife habitat in some areas.

Overgrazing by livestock has removed valuable forage plants and increased the intensity of competition for remaining plants between livestock and wildlife. Wildlife species are generally less adaptable to stress conditions and changes in diet than are domestic livestock. Reduced wildlife populations have occurred as a result of overgrazing, particularly during drought periods.

#### Water Quality Problems

The established parameters for water quality become an integral part of the total "environmental health" of any particular area. Unusually high or low values may be suspect for some form of disturbance while normal values set trends and allow for comparison with other data. In evaluating water quality of the Willow Creek Watershed it is necessary to include pertinent discussions covering the nature and extent of pollution in watershed streams (chemical, biological, thermal, etc.) and trends or conditions in land use affecting the transport of fertilizers and sediment.

The major stream course in the watershed is Willow Creek, a natural stream with ephemeral flow. At the present time, because of ephemeral flow, no supportive data exists for surface water quality in the watershed. There are no known point sources of suspect water pollution or degradation within the drainage areas above the planned floodwater retarding structures.

Soil erosion has contributed to a decline in the water quality and overall productivity of the streams. Annually, hundreds of tons of suspended sediments from fertile and productive lands are entrained in the primary stream courses and ultimately in perennial streams.

Water quality data for ground water in the watershed is limited. The City of Miles maintains four wells for municipal use. While standards for ground water are not fixed firmly, some limited inference may be drawn from established quality standards for surface waters (Texas Water Quality Board 1973; U.S. Environmental Protection Agency 1973; and U.S. Department of Health, Education, and Welfare 1962). Physical parameters such as color, odor, temperature, and turbidity are generally good. Chemical parameters such as chlorides, sulfates, and dissolved solids are important as they affect taste and have laxative properties. Available data indicate that with the exception of nitrates, concentration values of water quality parameters tested were consistently higher for the Lightfoot Well when compared to the other wells. The Lightfoot Well exceeded the criteria for sulfates, 250 mg/l, and total dissolved solids, 500 mg/l, (Texas Water Quality Board 1973). Sulfate values exceeded 600 mg/l at all wells except the Coleman Well (131 mg/l). The Coleman Well did have a nitrate concentration exceeding the established standard of 45 mg/l. However, no health irregularities have been reported as a result of using these wells by the City Water Works at Miles.

### Economic and Social Problems

Additional employment opportunities are needed for the 905 unemployed workers in the two counties where this watershed is located.

It is estimated that less than five percent of the agricultural land in the flood plain is in operating units using one and one-half man-years or more of hired labor.

### PROJECTS OF OTHER AGENCIES

The U.S. Army Corps of Engineers has prepared for the Governor's Planning Committee a comprehensive wastewater management plan for the Colorado River Basin. This plan includes the recommended steps that will be necessary if the wastewater treatment facility operated by the City of Miles is to be within compliance of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) by 1977. 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, and will constitute a harmonious element in the full development of the Colorado River Basin.

### PROJECT FORMULATION

Prior to the initiation of planning and during the planning phase, informational meetings were held. These meetings were attended by representatives of the Commissioners Courts of Runnels and Tom Green Counties; the Concho, North Concho River, and Runnels Soil and Water Conservation Districts; the City of Miles; the Willow Creek Water Control District; and other interested individuals. It was recognized at these meetings that favorable public opinion toward a watershed project was needed before submitting an application for planning assistance to the Texas State Soil and Water Conservation Board. It was also emphasized at these meetings that under the auspices of Public Law 566, a watershed project would be a local endeavor with federal assistance. With the ensuing endorsement by those present to take positive action, the City Council of Miles agreed to serve as a steering committee to draft an application for planning assistance and to coordinate and carry out local responsibilities during planning.

Subsequent public meetings were held by the Sponsoring Local Organization to inform the general public and involved landowners and to gain opinions and information from interested individuals. A field reconnaissance of the watershed and hearing was conducted to observe the status of land treatment, damages from past floods, and potential benefited areas from a flood reduction program. Landowners and operators were shown how their properties were involved in the potential floodwater retarding structures with the use of maps and on-site observations.

Newspapers serving the watershed area published articles announcing public meetings and reported information and conclusions resulting from the meetings. In addition, the individuals whose land was directly involved with potential floodwater retarding structures were notified and invited on an individual basis to attend meetings.

Representatives of the Fish and Wildlife Service, U.S. Department of the Interior, and the Texas Parks and Wildlife Department made joint studies with biologists from the Service. They described the fish and wildlife resources in the project, effects of the project, and recommendations for maintaining and enhancing fish and wildlife resources of the watershed.

Investigations concerning archeological and historical resources were conducted in consultation with the State Historic Preservation Officer. In addition, the National Register of Historic Places was also consulted. The Archaeology Research Program, Department of Anthropology, Southern Methodist University, conducted field investigations in the area needed for the construction and functioning of the floodwater retarding structures to determine if any archeological resources would be affected by the structures.

Meetings with the Sponsoring Local Organization and the steering committee were held during the planning process to coordinate, evaluate, exchange information, and reach agreements on a system of measures that would serve the needs of the people and the watershed resources. Newspapers serving the watershed area have published articles announcing public meetings and have reported information and follow-up articles which have generated public awareness.

### Objectives

An initial study was made by representatives of the Soil Conservation Service and Sponsoring Local Organization to determine watershed problems and possible solutions. After determining the location and extent of problems and discussing potential solutions, project objectives were formulated. Watershed protection and flood prevention were the primary objectives expressed by the sponsors.

In addition to expressing the desire for establishment of a complete program for soil and water conservation on the watershed, the following specific objectives were agreed to:

1. Establish land treatment measures which contribute directly to watershed protection and flood prevention. Included is the application by the end of the three-year project installation period of measures that will adequately protect soil, water, and plant resources on at least 85 percent of the agricultural land in the watershed. These resources are considered to be adequately protected when their deterioration, either naturally or caused by man, is effectively curtailed.

2. Attain a reduction of 70 to 75 percent in average annual flood damage to agricultural flood plain lands with consideration of the effects upon the environment, wildlife, existing improvements such as highways, county roads, and topographic conditions.
3. Develop municipal and industrial water storage in a multiple-purpose structure for immediate use as the principal source of water supply for Miles.

It was agreed that these objectives were reasonable and consistent with watershed resource conservation and development.

#### Environmental Considerations

The sponsors considered the impacts, both favorable and adverse, in developing the plan for meeting the project objectives. The objectives selected were those that would contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources.

The sponsors selected measures which would help to achieve these objectives and included all practical measures to minimize adverse impacts.

Land treatment measures planned for the watershed are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the structural measures, reduce flooding, and preserve and improve the fish and wildlife resources of the watershed.

The Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, made a detailed study of the watershed and submitted ten recommendations for the preservation, enhancement, and use of fish and wildlife resources in the watershed. Each recommendation and the rationale for response is included in the following:

Recommendation No. 1: "To improve fish habitat, floodwater retarding reservoirs and farm ponds built during the installation period be constructed with an abrupt drop in water depths. Depths should range from about 6 inches near the shoreline to at least 3 feet at a distance of 10 feet horizontally."

Response: The floodwater retarding structures are not designed to hold water per se. Rather they are designed to retard floodwater and impound sediment. While the term "sediment pool" has been used to describe the components of the structures, the primary purpose of floodwater retardation supercedes all other uses of any impounded surface water. Construction funds allocated under Public Law 566 are not spent on wildlife habitat improvement, but rather for mitigation measures. The increased depths

recommended are not possible as further excavation not only increases construction costs but also is not a permanent improvement as the artificial deepening will ultimately be negated by sediment deposition. The additional disturbance of natural ground would greatly increase the danger of erosion. By increasing the steepness of side slopes around the periphery of the sediment pool, there is a real danger of storm runoff accelerating erosion in the small tributaries. It is highly plausible that such events could and would cause severe erosion of the shoreline and stream channels of tributaries entering the sediment pools. The deepening of farm ponds specifically for fish habitat improvement and recreation is possible when the landowner desires it at his own expense.

Recommendation No. 2: "To facilitate management, floodwater reservoirs and farm ponds be equipped with drains that will allow the structures to be completely drained or drawn down to a level where chemical reclamation of the fish populations will be practical and effective, if it becomes necessary."

Response: Floodwater retarding structures are routinely designed with such appurtenances. Farm pond designs are not customarily so equipped. The cost of constructing such appurtenances on farm ponds would be borne directly by the landowner and in light of current economic conditions, would seem highly unlikely.

Recommendation No. 3: "To assist in management, landowners and sponsors seek the help and advice of biologists of the Texas Parks and Wildlife Department regarding the stocking and management of the floodwater retarding reservoirs and farm ponds."

Response: Noted. It will also be advised that biologists from the Service perform similar duties.

Recommendation No. 4: "To provide better fishing, landowners be encouraged to grant access to fishermen for the purpose of fishing in floodwater retarding reservoirs and farm ponds."

Response: Noted. However, as the structures are to be located on private property, no binding agreement can be secured to permit fishing by the public. The sponsors do not plan to assure public access to any of the structures; therefore, public recreational use will be prohibited at both sites.

Recommendation No. 5: "To minimize wildlife habitat losses, brush cleared from the sediment pools, dams, and spillways be placed around the detention pools and along the downstream side of the dams. At Site No. 1 brush should be piled along the northwestern and western sides of the reservoir and along the downstream side of the dam. At Site No. 2 brush should be piled in the vicinity of the windmill along the northern portion of the reservoir."

Response: It is acknowledged that brush piles placed around the periphery of floodwater impoundments would provide additional cover for wildlife. However, brush placed around the sediment pools could constitute a hazard to the function of the primary spillway if it should become dislodged during a period of storm runoff.

Brush piles placed adjacent to the detention pools would provide limited cover for bobwhites, cottontails, and ground-nesting songbirds for a limited period of time. As discussed by Jackson (n.d.) completely cut brush deteriorates rapidly and soon loses its usefulness as quail habitat.

The areas on which brush piles would be placed are outside of the areas which the Sponsoring Local Organization will obtain easements. If adjacent landowners did not object to the construction of brush piles for esthetic or other reasons and desired to provide brush piles for wildlife, it is felt this practice could be implemented at the time of construction. Brush piles would provide cover for skunks, rodents, snakes, and other predatory species after they have deteriorated. Assistance to land users in the application of wildlife upland habitat management practices such as food and cover plantings is felt to offer the greatest potential for improving wildlife resources in the watershed.

The Service and Sponsoring Local Organization will encourage landowners to establish more suitable wildlife habitat indigenous to the watershed. These measures, provided at the expense of the landowners, will establish permanent cover, resting, and feeding areas, as opposed to the transient brush piles.

Recommendation No. 6: "To reduce loss of vegetation, the edges of the emergency spillway, the upstream side of the dam above the area subject to wave action, the downstream portion of the dam, the area between the dam and emergency spillway, and areas on the dam and spillway not subjected to severe erosion, he planted with a mixture of switchgrass, kleingrass, plains bristlegrass, and sand lovegrass. If seed is available, include bushsunflower, and englemann daisy in the mixture."

Response: Whenever and wherever feasible, vegetation on critical areas will be replaced as an integral part of erosion control and wildlife habitat replacement. The judicious use of multi-purpose plants for wildlife use will be routinely considered at the time of project planning.

Recommendation No. 7: "To preserve important wildlife habitat, brush management be done in such a way that allows brush to remain within 100 feet of streams, in rough or steeply sloping areas, and in the area of present or potential turkey roost trees."

Response: Noted. This is already a part of Service policy.

Recommendation No. 8: "To retain wildlife habitat, the 1,410 [sic] acres of brush management be undertaken in a strip or small block pattern as described in the Discussion Section of this report."

Response: Noted. The practice of strip clearing of brush with wildlife consideration has been adopted by the Service for some time. Landowners and operators will be encouraged by the Service and Sponsoring Local Organization; however, the decisions of implementation rests solely with the producer.

Recommendation No. 9: "To protect wildlife, upland-habitat management should include measures to retain proper kinds and amounts of weedy and brush vegetation on rangeland, select plants used for range seeding that are of value to wildlife, plant field borders and fence rows, and preserve odd areas such as abandoned roads, ditch banks, and field corners for wildlife. Plants used for range seeding, field border planting, fence row planting include sunflowers, switchgrass, kleingrass, panic grass, bristleglass, englemann daisy, bushsunflower, ragweed, and crotons."

Response: Noted. Those practices constitute a significant portion of Service policies involving rangeland restoration and wildlife upland habitat management. It should be noted, however, that the ultimate decision rests with the individual producer.

Recommendation No. 10: "Landowners and sponsors seek the help and advice of biologists of the Texas Parks and Wildlife Department regarding the management of their lands for wildlife."

Response: Noted. Landowners, producers, and sponsors will also be encouraged to seek the recommendations, suggestions, and assistance from field biologists of the Soil Conservation Service.

The Sponsoring Local Organization and the Service considered and included recommendations Nos. 2, 3, 6, 7, 8, 9, and 10 in formulating the land treatment and structural measures in the work plan. After careful study, recommendations Nos. 1, 4, and 5, were determined not to be desirable or feasible and were not used to develop the work plan. It was concluded by the Sponsoring Local Organization that recommendation Nos. 1, 4, and 5 were not compatible with the objectives of the project and the purposes of Public Law 566.

Archeological surveys of the floodwater retarding structure sites were conducted by the Archaeology Research Program, Department of Anthropology, Southern Methodist University, under the direction of Dr. S. Alan Skinner as principal investigator.

The initial survey report stated that specific evidence of prehistoric occupation was noted in the survey areas. Specifically, a total of three artifact sites were located within areas of construction or

inundation by Floodwater Retarding Structure No. 1, and one site was recorded in the area of Floodwater Retarding Structure No. 2. It was the opinion of the investigators that some archeological resources will be affected by the proposed floodwater retarding structures. To quote from the survey report:

"The technology of quarrying and initial stone chipping procedures is very poorly understood in west central Texas. Thus, in order to mitigate the loss of information which dam construction and flooding will produce, an archaeological program...for depth of occupation is necessary."

Additional testing of all archeological sites was completed in July, 1975. A reevaluation of the data suggested that Site X41TG2 be nominated to the National Register of Historic Places. Site X41TG2 is inside the easement boundary, and adjacent to areas that will be dedicated to the dam of Floodwater Retarding Structure No. 1. Subsequent documents called for all precaution measures to be taken (necessary) to protect the site from damage during construction. Appropriate measures will be taken for protection of this site. The State Historic Preservation Officer has concurred with this course of action and has recommended Site X41TG2 for inclusion in the National Register of Historic Places. Formal nomination of that site will be initiated by the Archaeology Research Program, Department of Anthropology, Southern Methodist University.

Sites X41TG1, X41TG3, and X41TG4 do not warrant nomination to the National Register of Historic Places and will not be protected during construction processes. During construction, if additional cultural resources are encountered, work will cease in those areas and a qualified archeologist will make an assessment before work can resume.

Based on experience on similar structures in nearby watersheds, it is not anticipated that any health or water quality problems will arise at any of the sediment pools of the floodwater retarding structures used for livestock water, lake fisheries, and/or public recreation. However, land users will be prohibited from using any bodies of water created by the project for public recreation until sanitary facilities meeting local and state health requirements are installed.

During work plan development, studies were made by the Sponsoring Local Organization and the Service to avoid or at least minimize the displacement or relocation of individuals, farms, and businesses. There are no apparent relocations or displacements that will be caused by installation of the project.

#### Alternatives

The considered alternatives to the proposed project action were: (1) an accelerated program of applying land treatment measures for watershed protection, (2) changing the present use of flood plain land to uses

that are less susceptible to damage by flooding, and (3) foregoing the implementation of a project.

#### Alternative No. 1

This alternative consisted of applying the land treatment measures as proposed in the project action. Most of the impacts of the application of land treatment measures are discussed under the EFFECTS OF WORKS OF IMPROVEMENT section of this work plan which describes the proposed action. Average annual damages from floodwater would be reduced by 5.8 percent in downstream areas. The weighted average annual erosion rate for the entire watershed would be reduced from 2.69 tons per acre to 2.62 tons per acre, a three percent reduction. This alternative would have little effect in reducing flood plain scour on cultivated land and in reducing the volume of sediment produced by this process. The volume of sediment being delivered to the mouth of the watershed would be reduced from 12 acre-feet annually to 11 acre-feet, a reduction of eight percent. The adverse impacts caused by installation of the floodwater retarding structures would be eliminated. The estimated cost of this alternative is \$102,760.

#### Alternative No. 2

This alternative consisted of changing the present use of the land to one that is less susceptible to damage by flooding.

The potential land uses, listed in order from highest to lowest susceptibility to flood damage, are cropland, pastureland, and rangeland. Land used for other purposes, such as transportation systems (roads), are damaged to varying degrees by flooding, depending upon the type of development and depth and duration of flooding.

In order to substantially reduce the need for flood protection, it would be necessary to convert about 640 acres of cropland to a land use less susceptible to floodwater damage. With this alternative it is anticipated that about 80 percent of the cropland would be converted to improved pastureland, and about 20 percent would revert to native vegetation. This alternative would significantly reduce the actual monetary damage caused by floodwater, sediment, and erosion. Damages to the transportation system would continue at about the same rate, because it is impractical to move the system out of the flood hazard area. The gross economic returns to landowners and operators of agricultural land in the flood hazard area would be reduced by about \$128,440 annually if the land use was changed to improved pastureland and native grassland. The initial cost of land use conversion is estimated to be \$19,800.

#### Alternative No. 3

Alternative No. 3 consisted of foregoing the implementation of a project.

This would delay the application of land treatment measures, which would delay the impact these measures have on reducing sediment yield from the watershed and would also delay the impact these measures have in reducing flood damage. It is reasonable to expect, however, that landowners and operators would eventually install the land treatment measures to maintain the productivity of their lands. Flooding would continue, resulting in damage to agricultural land and the transportation system. The deterioration of the cultivated flood plain soils by scour would continue until the cumulative effect of this damage forced land use conversion to less productive uses. Areas subject to scour and stream-bank erosion would continue to produce sediment.

The need to use 409 acres of land for the installation of the structural measures and resultant adverse impacts would be eliminated.

The opportunity to realize about \$44,840 in average annual benefits would be foregone.

#### Other Investigations

Several systems of floodwater retarding structures were evaluated in developing the work plan. In selecting potential sites for floodwater retarding structures, consideration was given to locations which would provide the agreed upon level of protection to areas subject to damage. The site, number, design, and cost of the structures were influenced to a high degree by the physical, topographic, and geologic conditions in the watershed.

Investigations were made for the feasibility of a multiple-purpose structure for Miles. A site located about 3,700 feet upstream above the Santa Fe railroad was investigated for this purpose.

It was determined that municipal water could be supplied by a multiple-purpose structure at this location. The basic site information for multiple-purpose storage was reviewed with the Sponsoring Local Organization at several meetings. After considerable evaluation the City of Miles determined not to include municipal water storage as a project purpose because it could not meet the financial responsibilities necessary for the development of a surface water supply and required appurtenances.

Upon completion of studies to ascertain the location and extent of flood problems, three structure site locations were selected for general evaluation of their effects on watershed problems. Preliminary surveys and investigations were made at potential floodwater retarding structure site locations on Bottle Creek, on Willow Creek above Site No. 2, and on an unnamed tributary entering Willow Creek immediately above Valley Cross Section WC-5. Studies indicated that floodwater damages to agricultural and non-agricultural properties on the flood plain above Site No. 2 are minor. Control of runoff from Bottle Creek, from Willow Creek above Site No. 2, and from the unnamed tributary is not necessary to

achieve the desired level of protection along the main stem of Willow Creek. Therefore, no detailed investigations were made at these locations.

Detailed surveys and investigations were made at two floodwater retarding structure sites located at the confluence of the two streams presently planned for control. Structures constructed at both of these investigated sites would adequately control runoff above the two planned sites. Studies indicated that the two planned sites constituted the most feasible system of structural measures to install in order to meet project objectives for flood prevention to flood plain lands at the least cost.

### PLANNED PROJECT

#### Land Treatment Measures

Conservation of soil, water, plant, and wildlife resources is an important element of a watershed protection and flood prevention project. Treatment and use of land within the watershed influences the degree to which conservation objectives are attained. Proper land treatment is the element which distinguishes the Public Law 566 Small Watershed Program from any other Federal or Federally assisted program for the development of water and related land resources.

Conservation land treatment consists of individual measures and practices or a combination of measures and practices that are planned, installed, and maintained on privately owned land by individuals or groups of land users or by local organizations. Land treatment measures planned for the watershed are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, reduce flooding, and preserve or improve the fish and wildlife habitat resources of the watershed.

Adequate conservation land treatment will be applied on about 5,400 additional acres during a three-year installation period. Of these additional acres 2,980 acres are rangeland, 2,300 acres are cropland, and 120 acres are pastureland and hayland (table 1). These measures will be applied in addition to those already applied on approximately 17,970 acres to achieve effective treatment on about 87 percent of the agricultural land in the watershed.

Conservation measures to be applied on cropland include conservation cropping systems, crop residue management, diversions, terraces, and grassed waterways.

Conservation cropping systems involve growing crops in combination with needed cultural and management measures that reduce erosion and protect the soil. Crop residue management utilizes plant residue left on or near the soil surface to protect cultivated lands during critical erosion periods.

A diversion is a channel with a supporting ridge on the lower side constructed across the slope of a field and is designed and located to protect land from erosion-producing storm runoff from adjacent areas. A terrace is also a land treatment measure consisting of an earth embankment or ridge and channel constructed across the slope of the land to retard and increase infiltration of runoff and reduce erosion on the land on which it is constructed. A grassed waterway or outlet is a natural or constructed waterway or outlet shaped or graded and established in suitable vegetation as needed for the safe disposal of runoff from a field, diversion, or terrace.

Conservation measures which will be applied on pastureland and hayland include the planting or seeding of adapted species of perennial forage plants and their management for sustained production and use.

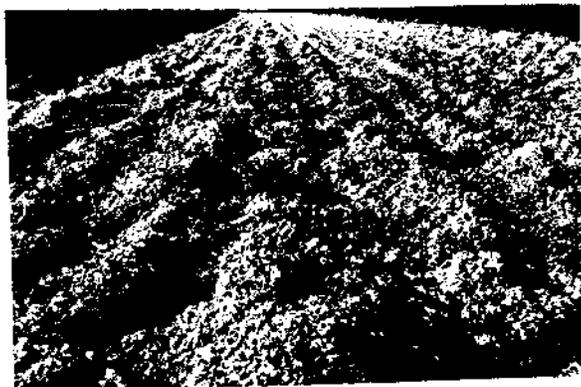
Rangeland will be managed to maintain or improve existing vegetation. Conservation measures to be applied on rangeland include proper grazing use, range seeding, planned grazing systems, brush management, and deferred grazing. Wells, troughs, and pipelines for additional livestock and wildlife water will be installed. Proper grazing use, planned grazing systems, and deferred grazing are range management practices which involve the grazing of forage plants at periods of time and at intensities which are compatible with the physiological needs of plants. Application of these practices contribute to continued growth and survival of desired plant species. Range seeding is the establishment of adapted plants on rangeland. Range seeding usually follows brush management on lands that do not have an adequate seed source to obtain a cover of plants through natural succession within a reasonable period time.

Brush management involves the control or manipulation of stands of brush to allow the establishment or growth of desired plant species. About 800 acres of brush management is expected to be accomplished during the project installation period. Root plowing and aerial spraying are the most common methods of brush management practices. Most brush management practiced is confined to the clay loam and loamy bottomland range sites.

Brush management cannot be economically applied on sites such as the very shallow site which has a relatively low potential for forage production. Brush management by range sites results in patterns of brush interspersed with open areas.

Wildlife upland habitat management on rangeland will consist primarily of brush management applied with wildlife considerations and proper grazing use of plants having wildlife value.

District cooperators will be provided technical assistance in the application of brush management practices which preserve existing wildlife habitat. On land which is utilized by livestock and wildlife, a compromise is often necessary to meet the needs of all animals. Ideally,



Mulches such as cotton burs applied to cropland reduces erosion, loss of moisture, and helps maintain soil fertility.



Parallel terraces on cropland help conserve valuable soil moisture by diverting and slowly releasing excess runoff into grassed waterways.



Conservation cropping systems such as those shown help maintain the productivity of the soil by systematically alternating soil-depleting crops with soil-building crops on a rotational basis.



Grassed waterways and outlets provide for the safe disposal of excess water and furnish additional areas for grazing and wildlife habitat.

enough brush should be removed to significantly increase livestock forage production and still retain enough browse and cover for wildlife. Land users who seek optimum wildlife production usually control brush on about 50 to 60 percent of their land. Landowners who seek to optimize livestock production and still retain significant wildlife values should leave at least 30 percent of their land in brush. A brush management program must be carefully planned to fit the existing conditions on a particular land unit. Strips and blocks which alternate with uncontrolled areas is recommended. Steep slopes and stream courses are prime wildlife habitat areas which will be designated for protection in planned programs of brush management.

Grazing use by domestic livestock at a level which results in proper use of plants having wildlife value will be planned on rangeland. Conservation plans will contain data on key wildlife plant species as well as species of value for domestic livestock. Recommended degrees of use for these key species will be provided to land users. Reductions in livestock numbers and reductions in wildlife numbers, particularly deer, may be necessary when excessive use occurs on key forage plants.

### Structural Measures

#### Floodwater Retarding Structures

A system of two floodwater retarding structures will be constructed in Willow Creek Watershed. Locations of the floodwater retarding structures to be installed are shown on the Project Map (figure 5).

The two planned floodwater retarding structures will detain an average of 2.77 inches of runoff from 16.51 square miles of drainage area. These structures will control runoff from approximately 36 percent of the total watershed. Total storage capacity of the floodwater retarding structures is 3,346 acre-feet, of which 909 acre-feet are for sediment storage and 2,437 acre-feet for floodwater detention (table 3).

All structures are designed with sufficient sediment storage capacities to provide 100-year project life. All planned structures will store both submerged and aerated sediment. Principal spillway crests of all structures will be set at the elevation of the 100-year sediment pools (figure 2). Principal spillways will require a port below their respective crest elevation because the 200 acre-foot impoundment limitation, with borrow volume included, will be exceeded. There will be 400 acre-feet of sediment storage capacity provided below the lowest ungated principal spillway openings of the floodwater retarding structures.

All of the structures will have provisions to release impounded water in order to perform maintenance, and if it becomes necessary, to avoid encroachment upon prior downstream water rights.

Unusual problems which will materially affect construction of floodwater retarding structures are not anticipated.



Proper grazing use will provide a balance between carrying capacity of the range and adequate utilization of the forage plants.



Range seeding following brush management will establish native and adapted plants on once low-productive rangeland.

Both the emergency spillways will be excavated in materials having a high potential for erosion in both the control and exit channel sections. Additional floodwater detention capacity has been added to Floodwater Retarding Structure Site No. 1 to reduce both the size and frequency of operation of the emergency spillway. The percent chance of use of the emergency spillways is 1.2 for Site No. 1 and 4.0 for Site No. 2.

Vegetation effective in controlling erosion will be established on the emergency spillways, exit channel areas, and embankment slopes. A combination of multiple use plants, adapted to prevailing conditions, will be planted on all other disturbed areas for erosion control and wildlife food and cover.

Specifically, the structures will be surrounded by low bluffs and gently rolling hills. Vegetation adjacent to the structures consists of limited stands of honey mesquite and sugar hackberry, open prairie, seeded areas, and field crops. The gullies, washes, and similar erosion problems will, for the most part, be alleviated. Conscientious and judicious use of herbaceous and semi-woody plants that have both domestic and wildlife forage value, as well as stabilizing soil erosion, will be used. Eroded gullies and washes will subsequently have perennial cover, or as structure design dictates, be covered with impounded water or dam and fill material.

The type of vegetation to be used will be perennial vegetation of native and introduced grasses and forbs. Plant species will be selected, sited, and planted in accordance with SCS Technical Specifications for Establishment of Wildlife Habitat on or Adjacent to Watershed Works of Improvement. These plantings will be sited and planned in detail during the final design stage in consideration of specific site conditions. The selection of exact species to be used will be from the adapted species of seed and plant stock available at the time of construction. Seed mixtures will be selected from the following species: sideoats grama, King Ranch bluestem, caucasian bluestem, buffalograss, kleingrass-selection 75, lehmann lovegrass, and green sprangletop. In selected areas, forbs having wildlife value such as englemann daisy, maximillian sunflower, and bush sunflower will be used. Fences will be constructed around the embankment and emergency spillway of each structure to protect the vegetation from damage by grazing.

Preliminary and present indications are that principal spillways will be on a compressible foundation. The principal spillways will have monolithic, rectangular, reinforced concrete inlets and prestressed, concrete-lined, steel cylinder pipe outlet barrels. Rock or concrete-lined plunge pools for all floodwater retarding structures are included in the preliminary details. Structural details will be treated in the final design phase. The embankments will be earth fill with vegetative cover.

Ample and suitable earth materials for the two embankments are available within short haul distances. These materials consist of sandy clay,

silty clay, and gravelly clay (SC, CL, and GC as classified in accordance with the Unified Soils Classification System). It is estimated that required emergency spillways excavation will provide about 30 percent of the needed embankment material for the two floodwater retarding structures. Preliminary investigations indicate that the remainder of needed material can be obtained from the sediment pool below the elevation of the lowest ungated outlet.

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

During construction, contractors will be required to adhere to strict standards set forth in a construction contract to protect the environment by minimizing soil erosion and water and air pollution. These standards will be in compliance with U.S. Department of Agriculture, Soil Conservation Service Engineering Memorandum 66, "Guidelines for Minimizing Soil Erosion and Water and Air Pollution During Construction." Excavation and construction operations will be scheduled and controlled to prevent exposure of extraneous amounts of unprotected soil to erosion and the resulting translocation of sediments. Measures to control erosion will be specified at the work site and will include, as applicable, use of temporary vegetation, mulches, diversions, mechanical retardation of runoff, and traps. Harmful dust and other pollutants inherent to the construction process will be held to minimum practical limits. Haul roads and excavation areas, and other work sites will be sprinkled with water as needed to keep dust within tolerable limits. Contract specifications will require that fuel, lubricants, and chemicals be adequately labeled and stored safely in protected areas, and disposal at work sites will be by approved methods and procedures. Clearing and disposal of brush and vegetation will be carried out in accordance with applicable laws, ordinances, and regulations in respect to burning. Each contract will set forth specific stipulations to prevent uncontrolled grass or brush fires. Disposal of brush and vegetation will be by burying, hauling to approved off-site locations, or controlled burning, as applicable.

Stringent requirements for safety and health in conformance with the Construction Safety Act will be included in the construction contract.

In conformance with federal, state, and local water pollution control regulations, necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such facilities being a pollution hazard to wells or other water sources. Special provisions in the construction contract will incorporate by reference and thereby make the contract provisions conform to "Safety and Health Regulations for Construction, Part I and Part II," U.S. Department of the Interior, Bureau of Reclamation.

Service guidelines that provide for incorporating of the Bureau of Reclamation regulations into construction contracts are in the Service's

"Administrative Services Handbook," Part 6, Section 2000. Conformance to all environmental control requirements will be monitored constantly by a construction inspector who will be on-site during all periods of construction operation.

Impoundment in the sediment pool will not be suitable for water-based recreation due to an average depth of less than six feet and a historically low annual water yield. Without intensive fish pond management, proliferation of aquatic vegetation and nongame fish will severely limit the use of the impoundment as a sport fishery. Consequently, the sponsors at the present time have no plans for using the sites for any recreational purposes and do not intend to provide public access to the impoundments; therefore, public recreation use will be prohibited at all sites. If at some future time, public access is provided at any of the sites, the sponsors have given assurance that adequate sanitary facilities meeting local and state health standards will be installed prior to making the impoundments in the sediment pools available for public use.

If any previously unidentified evidence or cultural values are discovered during detailed investigations or construction, the National Park Service will be notified, and the procedures as outlined in Public Law 93-291 will be followed. Inasmuch as this is a federally assisted local project, there will be no change in the existing responsibilities of the Service under Executive Order 11593 which respect to archeological and historical resources. Archeological Site X41TG2, adjacent to the proposed dam of Floodwater Retarding Structure No. 1, will be kept intact by protecting it during construction.

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect floodwater retarding structures; to provide for flowage of water in, upon, or through the structures; and provide for the storage and temporary detention, either or both, of any sediment or water.

Installation of the floodwater retarding structures will require change in location or modification of known existing improvements as follows:

- Site No. 1 - Private road
- Site No. 2 - Private road, stock pond, barn, well, windmill,  
and concrete tank

All costs for necessary changes in location or modifications as listed above are land rights costs and will be borne by the Sponsoring Local Organization.

Under present conditions there will be no apparent displacements or relocations of persons, businesses, or farm operations as a result of installation of the floodwater retarding structures. If relocations or displacements become necessary, they will be carried out under the provisions of Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

## Land Requirements

Installation (excluding flowage easement) of the two floodwater retarding structures will require 409 acres of land which include 110 acres of cropland, 297 acres of rangeland, and two acres of pastureland. The construction of dams and emergency spillways will require about 35 acres of which 34 acres are rangeland and one acre is cropland. The sediment pools at the lowest ungated outlet will inundate 69 acres of which one acre is cropland and 68 acres are rangeland. Installation of the two floodwater retarding structures will destroy, alter, or inundate approximately 1.8 miles of natural stream channel. All needed borrow for the embankments can be obtained from the emergency spillway areas and from within the sediment pool areas. A flowage easement will be obtained on 24 acres of rangeland immediately below the spillway of Floodwater Retarding Structure No. 1.

About 104 acres, of which 102 acres are rangeland and two acres are cropland, are needed for construction of the dams, emergency spillways, and the sediment pool areas up to the lowest ungated outlet. This land will be cleared of existing woody vegetation. Natural vegetation affected by installation of the two floodwater retarding structures is as follows:

Floodwater Retarding Structure No. 1 - About 55 acres will be cleared which consist of rangeland vegetation characteristic of the loamy bottomland, clay loam, and very shallow range sites. The predominate woody species found in the area is mesquite. A sparse woody understory exists which is composed of southwest condalia, agarito, catclaw acacia, pencil cholla, and pricklypear. Major herbaceous species include western ragweed, broom snakeweed, texas croton, upright prairie-coneflower, annual bushsunflower, indian-mallow, texas wintergrass, perennial threeawns, sideoats grama, hairy grama, texas grama, and silver bluestem. The site area was aerial sprayed in 1973, which resulted in a reduction of mesquite and other woody species. The aerial spraying resulted in a top-kill on most mesquite trees. The effective root-kill was not evaluated, but often ranges from 15 to 35 percent in the area.

Floodwater Retarding Structure No. 2 - About 47 acres will be cleared which consist of rangeland vegetation characteristic of the loamy bottomland and very shallow clay loam range sites. The area was cleared of woody vegetation in the past and only one small mott of honey mesquite about one acre in size presently exists. Small woody plants include regrowth honey mesquite, southwest condalia, catclaw acacia, agarito, pencil cholla, and pricklypear. Major herbaceous species include annual bushsunflower, texas croton, broom snakeweed, western ragweed, upright prairie-coneflower, indianmallow, texas wintergrass, texas grama, red grama, sideoats grama, silver bluestem, and hairy grama.

### EXPLANATION OF INSTALLATION COSTS

Public Law 566 funds, in the amount of about \$9,710 for technical assistance during the three-year installation period, will be provided to accelerate the application of the planned land treatment for watershed protection. These funds will be in addition to about \$9,310 of Public Law 46 funds provided under the going program. It is expected that 26 new conservation plans and about 10 conservation plan revisions will be developed during the installation period. During that same period, it is estimated 22 new cooperators will sign agreements with the Districts involved. Watershed landownership and ownership patterns are experiencing numerous changes, and it is imperative that new conservation plans and revisions be made and applied to accomplish the projected goals. Local interests will apply the planned land treatment at an estimated cost of \$83,740, which includes expected reimbursements from the Great Plains Conservation Program of the Service and the Agricultural Conservation Program (ACP) of the Agricultural Stabilization and Conservation Service (ASCS). The costs of application of the various measures are based on current average prices being paid by landowners and operators in the area.

Total installation cost of the structural measures is estimated to be \$379,280 of which \$302,890 will be borne by Public Law 566 funds and \$76,390 will be borne by other interests.

Public Law 566 costs for installing the structural measures total \$302,890 and includes \$248,410 for construction, \$13,970 for engineering services, and \$40,510 for project administration.

Other costs for project installation which total \$76,390 include \$70,390 for the value of the land; \$3,000 for fences, water well, and windmill; \$2,000 for legal fees; and \$1,000 for project administration.

Construction costs include the engineer's estimate and contingencies. The engineer's estimate was based on unit cost of structural measures in similar areas modified by special conditions inherent to the site locations. The costs of mitigating measures are included as part of the structural measures. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs. No unusual construction problems are anticipated.

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, and laboratory analysis, reports, designs, and cartographic services.

Public Law 566 project administration costs consist of construction inspection, contract administration, and maintenance of the Service State Office records and accounts.

Other costs for project administration include the sponsors' costs related to contract administration, overhead and organizational administrative costs, and whatever construction inspection they desire to make at their own expense.

The value of land rights was determined by appraisal in cooperation with representatives of the Sponsoring Local Organization.

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

Schedule of Obligations				
Fiscal Year	Measures	Public Law 566 Funds	Other Funds	Total
First	Land Treatment	3,400	32,950	36,350
Second	Land Treatment Structures Nos. 1 and 2	3,300	31,410	34,710
		302,890	76,390	379,280
Third	Land Treatment	3,010	28,690	31,700
TOTAL		312,600	169,440	482,040

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

#### EFFECTS OF WORKS OF IMPROVEMENT

##### Flood Prevention, Erosion, and Sediment

Installation of conservation land treatment measures on 5,400 acres of land in addition to effectively maintaining those already applied on 16,900 acres will protect soil, water, and related resources by preventing soil erosion, reducing water pollution by sediment, conserving irrigation water, and reducing flood flows.

Application of cropland treatment measures such as terraces, grassed waterways, and diversions will decrease the rate of floodwater runoff and reduce the rate of erosion on untreated fields. Conservation cropping systems and crop residue management will provide soil protecting cover to reduce erosion and help maintain soil productivity.

Application of pastureland treatment measures including pasture planting and proper management will protect the soil and decrease the rate of runoff by providing a good ground cover on this intensively used land.

Application of rangeland treatment measures, including range seeding, planned grazing systems, proper grazing use, deferred grazing, brush control, and livestock watering facilities will increase the productivity and the density of desirable grasses and forbs normally found in the natural plant community. Increasing the quality and quantity of vegetation will reduce erosion by improving the cover and litter on the soil. Ponds, wells, and pipelines installed for watering livestock will reduce livestock travel and distribute grazing to prevent overuse of vegetation near sources of water and under-utilization of vegetation at greater distances from water. After the project is complete, the level of accomplishment for adequate land treatment on agricultural land is expected to reach at least 87 percent.

The combination of watershed conservation land treatment and structural works of improvement will reduce average annual direct floodwater damages 78.6 percent, flood plain scour damages 81.8 percent, and sediment damages from overbank deposition 86.1 percent. Sediment delivered annually to the mouth of the watershed will be decreased from 12 acre-feet to 9 acre-feet, a 25 percent curtailment. Suspended sediment leaving the watershed will be reduced from 4,590 to 3,410 milligrams per liter, a 26 percent reduction. Adsorbed chemicals such as fertilizer and insecticides will accordingly be reduced.

During construction of the structural works of improvement, air and water pollution will increase slightly from dust and sediment inherent to the construction process. This increase will be kept within tolerable limits. At the end of construction and with the establishment of vegetation for erosion control, the dust and sediment increase intrinsic to construction operations will have completely subsided.

Owners, residents, and operators of 20 farms and ranches in the flood plain will be directly affected from reduction of floodwater and associated damages. In addition, the owners and operators of farms and ranches along the Concho River, immediately below the watershed, will receive favorable impacts from the proposed project.

The installation of all project measures, both conservation land treatment and floodwater retarding structures, will provide damage reduction on 1,780 acres of flood plain land. Average annual flooding will be reduced from 810 acres to 205 acres, a reduction of 74.7 percent. Reduction in area inundated varies with respect to location within the watershed. The number of acres inundated without and with the project by various frequency floods is presented in the following tabulation:

Area Inundated by Selected Recurrence Intervals

Evaluation: Reach (figure 1)	2-Year		5-Year		25-Year		100-Year	
	Without: Project	With: Project	Without: Project	With: Project	Without: Project	With: Project	Without: Project	With: Project
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
1	550	117	893	217	1,538	583	1,780	772

If the project had been installed at the time of the August 10-11, 1971 flood, acres flooded would have been reduced from about 1,159 acres to 385 acres, a reduction of approximately 66.8 percent.

The following tabulation shows effects of the project on flood damages. All figures indicate average annual reductions.

Damage Reduction in Percent

Evaluation: Reach (figure 1)	Crop		Other		Non- Agri- cultural		Flood Overbank: Sediment: Erosion	
	and Pasture	: Agri- cultural	: Agri- cultural	: Agri- cultural	: Overbank: Sediment: Erosion	: Overbank: Sediment: Erosion	: Overbank: Sediment: Erosion	: Overbank: Sediment: Erosion
1	77.9	77.3	82.7	86.1	81.8			

With project completed, the estimated average annual direct floodwater damage will be reduced 78.6 percent; crop and pasture damage, 77.9 percent; other agricultural, 79.3 percent; and road and bridge, 82.7 percent. The average annual scour damage to the 158 acres in the flood plain is expected to reduce 81.8 percent. The sediment deposition will be reduced on the 107 acres by 86.1 percent.

A maximum initial reduction in average annual runoff of 103 acre-feet is expected because of evaporation from the sediment pools of the two floodwater retarding structures. Average annual volume of watershed runoff will be reduced from 3,350 acre-feet to 3,247 acre-feet, or 3.08 percent. This initial water loss will be reduced as sediment accumulates in the sediment pools over the life of the project.

Due to reduced flooding, owners and operators will be able to improve their management of flood plain lands to reach optimum use.

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

### Fish and Wildlife

Installation of the planned project will increase the waterfowl and fish resources of the watershed on approximately 69 acres. Seven additional farm ponds will be constructed with technical assistance from the respective Soil and Water Conservation Districts.

Installation of the two floodwater retarding structures will remove vegetation on about 102 acres of rangeland and two acres of cropland. Browse species on the acreage will be removed. These browse plants and browse on adjoining areas show no evidence of overuse by wildlife. Overuse of plants on adjoining lands will not occur as a result of the removal of browse plants in the vicinity of the floodwater retarding structures. Additional edge habitat will be created as a result of site clearing. This clearing will alter the normal stages of succession by increasing the diversity of the habitat, therefore, resulting in a greater variety of plant and animal species. A temporary increase in annual weeds with food value for rabbits, quail, dove, and songbirds will occur due to disturbance of soil during the construction process. Periodic flooding for periods of two or three days will temporarily displace wildlife which utilize the flood pools. Temporary flooding will result in increased growth of annual weeds in the flood pools.

Application of land treatment measures will generally benefit wildlife in the watershed. Brush management applied with wildlife considerations will have beneficial effects for wildlife by providing more edge type habitat and by providing more forbs and succulent grasses in open areas. Brush management applied without wildlife considerations will be detrimental to most wildlife species.

Other range management practices such as deferred grazing, proper grazing use, and planned grazing systems increase the variety, quality, and quantity of vegetation. Overuse of desirable browse, forb, and grass species is reduced. These practices are generally beneficial to most wildlife species.

Conservation cropping systems, crop residue use, and plantings of winter cover crops such as oats will provide an increased variety of food and more cover for most species of wildlife.

In order to accurately determine the effects of installation of the planned project, it is necessary to make a subjective comparison of existing habitats and compare the changes that may take place with project. To that end, a system of quantitative and qualitative measurement was employed in order to determine approximate gain or loss for selected wildlife species.

The existing habitat was evaluated using definitive terms for habitat quality (chart 4). Each acre was evaluated on the basis of its habitat value in respect to the various wildlife species present. For the

Chart 4. EXISTING WILDLIFE-HABITAT VALUE IN PROPOSED STRUCTURE LOCATIONS

Willow Creek Watershed  
(409 Acres)

Species	Habitat Type												TOTAL VALUE RATING
	Cropland (110 ac.)	Pastureland (2 ac.)	Loamy Bottomland (142 ac.)	Clay Loam (120 ac.)	Very Shallow (35 ac.)	Rating 1/	Value	Rating	Value	Rating	Value	Rating	
Dove	3	1	2	2	2	284	2	240	2	70	926		
Quail	2	1	2	2	2	284	2	240	2	70	816		
Turkey	1	1	2	2	1	284	1	120	1	35	551		
Deer	1	1	2	2	1	284	1	120	1	35	551		
Waterfowl	1	1	2	0	0	0	0	0	0	0	112		
Furbearers	1	1	2	2	1	284	1	120	1	35	551		
Fish	0	0	0	0	0	0	0	0	0	0	0		
TOTALS	990	12	1,420	840	245	3,507							

1/ Rating factors are defined as follows:

- 0 - Habitat is nonexistent or of no significant value for a particular species.
- 1 - Low value habitat is habitat which lacks adequate food, cover, or other essential elements to support a significant population of a particular species.
- 2 - Moderate value habitat is habitat which has the needed elements to support a particular species but at population levels below the optimum.
- 3 - High value habitat is habitat which has all necessary habitat elements to support an optimum population of a particular species.

2/ Value ratings are derived by multiplying the habitat rating factor by the acreage of habitat type.

purpose of clarification, habitat types were determined by land use; i.e., cropland, rangeland, etc. Cropland consisted of close-spaced, high residue grain sorghum; and rangeland was subdivided into respective range sites.

Projected wildlife habitat was evaluated by hypothetically changing the land use to that as would exist under project conditions. Projected wildlife habitat as determined by land use is shown on Chart 5. The same procedure was followed in evaluating the projected wildlife habitat after installation of the planned project. A subjective comparison was made to compare the change in wildlife habitats with and without project.

Habitat values for upland game species will be decreased in the floodwater retarding structure site areas by about 22 percent. Habitat values for furbearers will be decreased by about 15 percent. Fish and waterfowl habitat values will be increased by about 255 percent. Installation of the structural measures is projected to decrease the total wildlife habitat value in the area of the sites by about 13 percent.

It is planned that approximately 1,050 acres of wildlife upland habitat management will be installed in the watershed during the project installation period. Based on comparable areas of land use, vegetative cover, and habitat quality, it is considered that the average existing habitat on these 1,050 acres equals the value rating of the habitat that presently exists at the proposed structure locations. The average habitat rating on these 1,050 acres will need to be increased through management by approximately five percent to compensate for the habitat loss incurred with project installation. This is a realistic increase for those acres for the three-year installation period. Studies have shown rapid increases in productivity after established methods of wildlife upland habitat management have been employed.

The planned system of floodwater retarding structures will have no adverse effect on any known populations of endangered or threatened species.

#### Archeological and Historical

Presently there are no known locations of historic significance in the watershed that would be affected by installation of the project.

A field survey and evaluation of archeological resources to be affected by the floodwater retarding structures was carried out by the Archaeology Research Program at Southern Methodist University. As a result of the survey, it was determined that three archeological sites may be either inundated or disturbed by installation of the structural measures. These investigations and subsequent testing indicated that those sites were not eligible for nomination to the National Register of Historic Places. Archeological Site X41TG2 adjacent to the dam of Floodwater Retarding Structure No. 1, and partially inside the easement boundary,

Chart 5. PROJECTED WILDLIFE HABITAT VALUE WITH STRUCTURES

Willow Creek Watershed  
(409 Acres)

Species	Habitat Type										Seeded and Protected Area : (35 ac.)	TOTAL VALUE : RATING :	
	Rating 1/ : Value : Rating 2/ : Rating :	Loamy : Bottomland : (58 ac.) : Value : Rating :	Clay : Loam : (84 ac.) : Value : Rating :	Very Shallow : (53 ac.) : Value : Rating :	Water Area : (69 ac.) : Value : Rating :	Rating :			Rating :				
Dove	1	110	2	116	2	168	2	106	1	69	2	70	639
Quail	1	110	2	116	2	168	2	106	1	69	2	70	639
Turkey	1	110	2	116	1	84	1	53	1	69	1	35	467
Deer	1	110	2	116	1	84	1	53	1	69	1	35	467
Waterfowl	1	110	0	0	0	0	0	0	2	138	0	0	248
Furbearers	1	110	2	116	1	84	1	53	1	69	1	35	467
Fish	0	0	0	0	0	0	0	0	2	138	0	0	138
TOTALS		660		580		588		371		621		245	3,065

1/ Rating factors are defined as follows:

0 - Habit is nonexistent or of no significant value for a particular species.

1 - Low value habitat is habitat which lacks adequate food, cover, or other essential elements to support a significant population of a particular species.

2 - Moderate value habitat is habitat which has the needed elements to support a particular species but at population levels below the optimum.

3 - High value habitat is habitat which has all necessary habitat elements to support an optimum population of a particular species.

2/ Value ratings are derived by multiplying the habitat rating factor by the acreage of habitat type.

will be kept intact by protecting it during construction. The State Historic Preservation Officer has concurred with this course of action and has recommended that site for inclusion in the National Register of Historic Places in accordance with all appropriate laws and regulations pertaining to the protection of archeological, cultural, and historical resources.

The recognition and protection, as appropriate, will not only minimize loss of archeological resources affected by installation of structural measures but also will make a significant contribution to the understanding of primitive man's occupation and use of the Willow Creek Watershed area. Specifically, three archeological sites will be affected as follows:

- a. Site X41TG1 will be disturbed by topsoil removal and core trench excavation of Floodwater Retarding Structure No. 2.
- b. Sites X41TG3 and X41TG4 will be inundated in the sediment pool of Floodwater Retarding Structure No. 1.

#### Economic and Social

Under current level of development, there will be no minority persons affected by installation of the planned project in Willow Creek Watershed.

Increased agricultural efficiency will be realized by the operators of land that will become more productive after damaging floods and sediment deposition have been alleviated or reduced. The reduction of damages will provide for a higher quality of living and social upgrading by watershed residents. Increased needs of the entire economy will create the equivalent of four permanent jobs for local residents.

During the construction stage of the proposed project, additional requirements for building materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 12 man-years of employment, which will further strengthen the economy during the construction phase. The operation and maintenance of project measures will also provide employment for local residents.

Additional intangible benefits will accrue to the project allowing an opportunity for the shifting of public funds from the repair of damages to county roads and bridges to investment in schools and improving existing roads. 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.

### Water Resources and Water Quality

Installation of the structures will cause a change in the flow regime. During periods of runoff, the depth, velocity, and duration of out-of-channel flows will be reduced downstream from these structures. The duration of the low flows (within channel) will be increased. This change in flow regime will reduce downstream flooding and associated flood damages.

Installation of the structures should have a slight effect on water quality. The sediment concentration in the floodwaters will be reduced by the structures. The structures are designed to store a total of 817 acre-feet of sediment during a 100-year period. The quantity and timing of water passing the structures will be changed slightly. Flood flow into the structures will be detained and released over a longer period of time. Initially, it will require a total of about 817 acre-feet of water to fill the sediment pools.

The installation of land treatment measures on about 5,400 acres of agricultural lands will aid in the prevention of silt-laden runoff, agricultural chemicals, and other solutes from entering the watershed's drainage ways.

Water quality in each of the sediment pools is not expected to be significantly different from other impoundments in the watershed. There are no mine or excessive animal wastes which will drain directly into either of the structures. It is not anticipated that any health or water quality problems will arise in either of the sediment pools used for livestock water or sport fisheries. Installation of the structural measures should have no effect on the water resources or the water quality of the other tributaries.

### Air Quality

Installation and maintenance of conservation land treatment on 5,400 acres of agricultural land in the watershed will provide more and better soil protection which will ultimately reduce dust and associated particulates.

The only impact that installation of these structures will have on air quality is during construction and any operation and maintenance activities. There will be an increase in pollutants such as dust and chemicals from equipment exhausts during these phases. Also, there will be an increase in noise levels as a result of these activities. The construction sites are in a rural area. Construction noise or air pollution during construction or maintenance activities will not be of such a level to be anything more than temporary nuisance.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, scour, and indirect damage within the flood plain will be reduced from \$46,880 to \$9,870. This is a reduction of 78.9 percent of which 5.1 percent is attributed to land treatment. The damage reduction benefits are \$2,370 from land treatment and \$34,640 from structural measures for total primary benefits of \$37,010 (table 5).

It is estimated that the project will produce local secondary benefits averaging \$10,200 annually. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Benefits from the planned land treatment measures, other than floodwater, sediment, and scour damage reduction on the flood plain, were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

If the project had been installed at the time of the August 10-11, 1971 storm, the direct floodwater damage would have been reduced from \$65,270 to \$16,690, a reduction of 74.4 percent.

Damages without and with project by various frequency floods is presented in the following tabulation:

Direct Monetary Floodwater Damages								
		Recurrence Interval						
Evaluation:	2-Year		5-Year		25-Year		100-Year	
Reach	:Without	:With	:Without	:With	:Without	:With	:Without	:With
(figure 1):	Project	Project	Project	Project	Project	Project	Project	Project
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	28,470	4,150	48,850	9,940	89,860	23,530	118,700	38,680

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of the structural measures (amortized total installation and project administration costs, plus operation and maintenance) is \$24,110 (table 4). These measures are expected to produce total average annual benefits of \$44,840 resulting in a benefit cost ratio of 1.9:1.0 (table 6).

The ratio of total average annual benefits, excluding secondary benefits, accruing to structural measures (\$34,640) to the average annual cost of structural measures (\$24,110) is 1.4:1.0.

### PROJECT INSTALLATION

Landowners and operators will establish planned land treatment (table 1) in cooperation with the Concho, North Concho River, and Runnels Soil and Water Conservation Districts during a three-year period. Technical assistance in planning and application of land treatment will be provided under the going program of the districts in addition to accelerated assistance under Public Law 566. Soil surveys have been made on the entire watershed (29,382 acres).

An estimated 67 percent of needed soil and water conservation practices have been applied. The goal is to increase the level of land treatment application to at least 87 percent of total needs during the installation period. In reaching this goal, it is expected that accomplishments of the additional treatment will progress as shown in the following tabulation:

Land Use	Fiscal Year			Total (acres)
	1st (acres)	2nd (acres)	3rd (acres)	
Cropland	800	750	750	2,300
Pastureland	40	40	40	120
Rangeland	1,000	990	990	2,980
<b>TOTAL</b>	<b>1,840</b>	<b>1,780</b>	<b>1,780</b>	<b>5,400</b>

The governing bodies of the Concho, North Concho River, and Runnels Soil and Water Conservation Districts 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 Service will provide technical assistance in the planning and application of soil, plant, and water conservation measures.

Special emphasis will be placed first on getting a higher degree of land treatment in the drainage areas of floodwater retarding structures. Then the emphasis will be on drainage areas not controlled by structures.

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

The Sponsoring Local Organization has requested the Service to administer contracts.

The Willow Creek Water Control District will represent the Sponsoring Local Organization in coordination with the Service on matters concerning construction.

The Willow Creek Water Control District will have the following responsibilities pertaining to the planned Floodwater Retarding Structures Nos. 1 and 2:

1. Obtain the necessary land rights;
2. Provide for the change in location or modification of a water well, windmill, fences, and other privately owned improvements necessary for installation of the floodwater retarding structures;
3. Provide for the necessary improvements to low water crossings on private roads within the boundaries of Willow Creek Watershed to make them passable during prolonged release flows from the floodwater retarding structures or provide equal alternate routes for use during periods of inundation; and
4. Determine and certify legal adequacy of easements and permits for construction of structural measures.

The Willow Creek Water Control District have rights of eminent domain under applicable state law and have the financial resources to fulfill their responsibilities.

Technical assistance will be provided by the 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 the planned structural measures.

The two floodwater retarding structures will be constructed during the second year of a three-year project installation period.

In order for construction to proceed according to schedule, all land rights for the floodwater retarding structures are to be secured by the end of the first six months of the installation period. The schedule will begin when the work plan is approved for operations.

#### 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, 83d Congress; 68 Stat. 666), as amended.

The cost of applying land treatment measures will be borne by landowners and operators. Funds provided under the on-going program (Public Law 46) and Public Law 566 funds will be used for technical assistance in planning and applying soil and water conservation measures. The Public Law 566 funds will be used for the acceleration of planning and application of these measures.

Funds for the local share of the cost of this project relative to structural measures will be provided by the Willow Creek Water Control District. The District has the ability to make financial arrangements to carry out their responsibilities. They will set aside funds to finance their respective local share of the installation costs of the two floodwater retarding structures. Funds will come from a \$50,000 bond issue passed by the voters in 1968. Taxes will be collected by the Willow Creek Water Control District for repayment of the bond.

The structural measures will be constructed during the second year of a three-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.
3. Project agreements have been executed.
4. Operation and maintenance agreements have been executed.

Financial and other assistance to be furnished by the Service is contingent upon the appropriation of funds for this purpose.

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

Financial assistance is available from several sources to assist land users in the application of conservation measures on farms and ranches. Cost-share assistance is available through: (1) the Agricultural Conservation Program administered by the Agricultural Stabilization and Conservation Service and (2) the Great Plains Conservation Program administered by the Service.

Loans to land users for conservation measures are also available through the Soil and Water Conservation Program administered by the Farmers Home Administration (FmHA) and through local commercial lending institutions.

## PROVISIONS FOR OPERATION AND MAINTENANCE

### Land Treatment Measures

The operation and maintenance of applied conservation measures will be essentially the responsibility of land users. Land users who elect to become District Cooperators agree to maintain all applied conservation measures which are installed with technical assistance from the District. Technical assistance will be provided to land users to maintain applied conservation measures in an effective condition. Board members of the Soil and Water Conservation Districts will make periodic field reconnaissance of the watershed and maintain personal communications with watershed land users to determine the status of applied land treatment practices.

### Structural Measures-Floodwater Retarding Structures

The Willow Creek Water Control District will be responsible for operation and maintenance of the floodwater retarding structures. A \$50,000 bond was approved by the voters in 1968. Those bonds can be sold to defray the local costs of land rights and project administration. Taxes will continue to be collected by the Willow Creek Water Control District for repayment of the bonds and for operation and maintenance of the structures.

A specific operation and maintenance agreement will be prepared for each structural measure and will be executed prior to signing a project agreement and the issuance of invitations to bid on construction of structural measures. The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with Public Law 566 financial assistance. The agreement will set forth specific details on procedures in line with recognized assignments of responsibility and will be in accordance with the Texas Watersheds Operation and Maintenance Handbook.

The floodwater retarding structures will be inspected at least annually and after each heavy rain by representatives of the Willow Creek Water Control District, North Concho River, Soil and Water Conservation District, and the designated Service representative. A written report will be made within ten days of the date on which the inspection was made and a copy provided to the designated Service representative.

Upon completion of each floodwater retarding structure by the contractor, subject to the establishment of vegetation, the Willow Creek Water Control District will assume responsibility for maintenance of the structure. They will perform promptly, or have performed promptly, all maintenance of the structure as determined to be needed by either the sponsors or the Service, including that required to prevent soil erosion and water pollution. Specifically, the dams will be earth embankments and the emergency spillways will be excavated. A vegetative cover of

grass to protect those structural components from erosion will be established by seeding. Fertilization and weed control will be carried out to establish as well as maintain a good vegetative cover. The dam and emergency spillway will be fenced. Fences will be maintained.

The estimated average annual cost of operation and maintenance for the two floodwater retarding structures is \$820.

Sponsors will also control the handling, use, and application of any herbicides and pesticides that may be needed for operation and maintenance of structural measures. If the use of chemicals should be required, only approved and authorized reagents and compounds will be used. Their application will be compatible with current laws regulating their use. In addition to prudent judgement, ordinances and standards concerned with the disposal of storage of unused chemicals, empty containers, contaminated equipment, etc., will be observed and applied.

The Service will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for unrestricted access by representatives of the Sponsoring Local Organization and the Service to inspect all structural measures and their appurtenances at any time and for the Sponsoring Local Organization to perform operation and maintenance. Easements insuring this unrestricted ingress and egress will be furnished by the Sponsoring Local Organization.

The Willow Creek Water Control District will maintain a record of all maintenance inspections made, maintenance performed, and cost of such maintenance and have it available for inspection by Service personnel.

The necessary maintenance work will be accomplished by contracts, force accounts, or equipment owned by the Sponsoring Local Organization.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Willow Creek Watershed, Texas

Installation Cost Item	:Unit	: Land	Estimated Cost (Dollars) 1/			: Total
			: Public Law:	: 566 Funds	: Other	
			: Non-Federal	: Non-Federal	: Non-Federal	
<b>LAND TREATMENT</b>						
Land Areas 2/						
Cropland	Acre	2,300	-	35,860		35,860
Pastureland	Acre	120	-	6,460		6,460
Rangeland	Acre	2,980	-	41,420		41,420
Technical Assistance			9,710	9,310		19,020
<b>TOTAL LAND TREATMENT</b>			9,710	93,050		102,760
<b>STRUCTURAL MEASURES</b>						
<u>Construction</u>						
Floodwater Retarding Structures	No.	2	248,410	-		248,410
Subtotal-Construction			248,410	-		248,410
<u>Engineering Services</u>			13,970	-		13,970
<u>Project Administration</u>						
Construction Inspection			18,940	500		19,440
Other			21,570	500		22,070
Subtotal-Administration			40,510	1,000		41,510
<u>Other Costs</u>						
Land Rights			-	75,390		75,390
<b>TOTAL STRUCTURAL MEASURES</b>			302,890	76,390		379,280
<b>TOTAL PROJECT</b>			312,600	169,440		482,040

1/ Price Base: 1975

2/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be applied throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

May 1976

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

Willow Creek Watershed, Texas

Measure	: Unit	: Number : Applied : To Date	: Total : Cost : (Dollars) 1/
<u>LAND TREATMENT</u>			
Brush Management	Acre	3,210	70,640
Conservation Cropping System	Acre	12,200	12,200
Contour Farming	Acre	9,950	14,930
Crop Residue Management	Acre	11,600	29,000
Deferred Grazing	Acre	5,100	5,100
Diversion	Feet	34,960	8,740
Pond	Number	37	44,400
Grassed Waterway or Outlet	Acre	30	3,240
Pasture and Hayland Management	Acre	200	1,980
Pasture and Hayland Planting	Acre	210	4,920
Proper Grazing Use	Acre	5,900	2,950
Range Seeding	Acre	1,290	28,360
Terrace, Level	Feet	2,101,880	273,240
Terrace, Parallel	Feet	136,110	17,690
Wildlife Upland Habitat Management	Acre	9,450	18,900
<u>TOTAL:</u>			536,290

1/ Price Base: 1975

May 1976

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION  
 Willow Creek Watershed, Texas  
 (Dollars) 1/

Item	Installation Costs		Installation Costs		Total : Installation : Cost
	Con- : struction:	Engi- : neering :	Land : Rights :	Other : Funds :	
Floodwater Retarding Structures					
1	170,800	8,540	34,180	34,180	213,520
2	77,610	5,430	41,210	41,210	124,250
Subtotal	248,410	13,970	75,390	75,390	337,770
Project Administration		40,510		1,000	41,510
GRAND TOTAL	248,410	13,970	75,390	76,390	379,280

1/ Price Base: 1975

2/ Includes \$1,000 for relocation of windmill and water well, \$2,000 for change in location or modification of fences, and \$2,000 for legal fees.

May 1976

TABLE 3 - STRUCTURAL DATA  
STRUCTURES WITH PLANNED STORAGE CAPACITY

Willow Creek Watershed, Texas

Item	Unit	Structure Nos.		Total
		1	2	
Class of Structure		A	A	xxx
Drainage Area	Sq.Mi.	8.14	8.37	16.51
Curve No. (1-day)(AMC II)		70	79	xxx
Tc	Hr.	2.06	2.43	xxx
Elevation Top of Dam	Ft.	1,864.2	1,862.2	xxx
Elevation Crest Emergency Spillway	Ft.	1,858.7	1,856.5	xxx
Elevation Crest Principal Spillway	Ft.	1,847.7	1,846.5	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	1,841.4	1,843.0	xxx
Maximum Height of Dam	Ft.	35.0	34.0	xxx
Volume of Fill	Cu.Yd.	233,633	100,470	334,103
Total Capacity	Ac.Ft.	1,784	1,562	3,346
Sediment Pool (Lowest Ungated Outlet) 1/	Ac.Ft.	200 2/	200 2/	400
Sediment Pool (Submerged)	Ac.Ft.	469	348	817
Sediment in Detention Pool-Aerated	Ac.Ft.	52	40	92
Retarding Pool	Ac.Ft.	1,263	1,174	2,437
Surface Area				
Sediment Pool (Lowest Ungated Outlet)	Acre	35	34	69
Sediment Pool-Principal Spillway Crest	Acre	73	57	130
Retarding Pool	Acre	170	204	374
Principal Spillway				
Rainfall Volume (areal)(1-day)	In.	8.05	6.50	xxx
Rainfall Volume (areal)(10-day)	In.	12.90	10.40	xxx
Runoff Volume (10-day)	In.	4.27	4.09	xxx
Capacity (Maximum)	cfs.	104	102	xxx
Frequency Operation-Emergency Spillway	% chance	1.2	4.0	xxx
Size of Conduit	In.	30	30	xxx
Emergency Spillway				
Rainfall Volume (ESH)(areal)	In.	7.50	6.02	xxx
Runoff Volume (ESH)	In.	4.04	3.70	xxx
Type	Veg.			xxx
Bottom Width	Ft.	150	150	xxx
Velocity of Flow (Ve)	Ft./Sec.	5.7	5.7	xxx
Slope of Exit Channel	Ft./Ft.	0.034	0.0475	xxx
Maximum Water Surface Elevation	Ft.	1,860.3	1,857.9	xxx
Freeboard				
Rainfall Volume (FH)(areal)	In.	12.30	12.30	xxx
Runoff Volume (FH)	In.	8.33	9.60	xxx
Maximum Water Surface Elevation	Ft.	1,864.2	1,862.2	xxx
Capacity Equivalents				
Sediment Volume	In.	1.20	0.87	xxx
Retarding Volume	In.	2.91	2.63	xxx

1/ Volume included in submerged sediment.

2/ Includes volume created by anticipated excavation of earth materials for dam.

May 1976

TABLE 4 - ANNUAL COST

Willow Creek Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures Nos. 1 and 2	20,740	820	21,560
Project Administration	2,550		2,550
<b>GRAND TOTAL</b>	<b>23,290</b>	<b>820</b>	<b>24,110</b>

1/ Price base: 1975

2/ 100 years at 6.125 percent interest

May 1976

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Willow Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage:		Damage Reduction Benefits
	Without Project	With Project	
<b>Floodwater</b>			
Crop and Pasture	23,700	5,230	18,470
Other Agricultural	14,500	3,000	11,500
Nonagricultural			
Road and Bridge	1,500	260	1,240
Subtotal	39,700	8,490	31,210
<b>Sediment</b>			
Overbank Deposition	1,220	170	1,050
<b>Erosion</b>			
Flood Plain Scour	1,700	310	1,390
<b>Indirect</b>			
	4,260	900	3,360
<b>TOTAL</b>	<b>46,880</b>	<b>9,870</b>	<b>37,010</b>

1/ Price Base: Agricultural-October, 1974 current normalized prices;  
all other-1975

May 1976

TABLE 6 - COMPARISON OF BENEFITS AND COSTS

Willow Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/			Average Annual		Benefit Cost Ratio
	Damage Reduction	Secondary	Total	Cost	2/	
Floodwater Retarding Structures Nos. 1 and 2	34,640	10,200	44,840	21,560		2.1:1.0
Project Administration				2,550		
GRAND TOTAL	34,640 <sup>3/</sup>	10,200	44,840	24,110		1.9:1.0

1/ Price Base: Agricultural-October 1974 current normalized prices; all other-1975

2/ Installation-1975 prices amortized for 100 years at 6.125 percent interest.  
Operation and Maintenance-1975 prices

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$2,370 annually.

May 1976

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APPENDIX A

Selected List of Common and Scientific Plant Names

Grasses

Family: GRAMINEAE

Andropogon gerardi - big bluestem

Andropogon caucasicus - caucasian bluestem

Andropogon hallii - sand bluestem

Andropogon ischaemum - King Ranch bluestem

Andropogon scoparius - little bluestem

Aristida spp. - perennial threeawn

Bouteloua curtipendula - sideoats grama

Bouteloua gracilis - blue grama

Bouteloua hirsuta - hairy grama

Bouteloua rigidiseta - texas grama

Bouteloua trifida - red grama

Bromus spp. - annual brome

Buchloe dactyloides - buffalograss

Chloris sp. - windmillgrass

Cynodon dactylon - bermudagrass

Eragrostis lehmanniana - lehmann lovegrass

Eragrostis sp. - lovegrass

Hilaria mutica - tobosa

Leptochloa dubia - green sprangletop

Panicum coloratum - Kleingrass, selection 75

Panicum virgatum - switchgrass

Sorghastrum nutans - yellow indiagrass

Sporobolus cryptandrus - sand dropseed

Stipa spp. - needlegrass

Stipa leucotricha - texas wintergrass

Trichachne californica - arizona cottontop

Tridens elongatus - rough tridens

Tridens muticus - slim tridens

Forbs and Suffrutescent Vegetation

Family: CRUCIFERAE

Lepidium sp. - pepperweed

Lesquerella sp. - bladderpod

Family: COMPOSITAE

Ambrosia psilostachya - western ragweed

Aphanostephus sp. - dozedaisy

Aster ericoides - heath aster

Engelmannia pinnatifida - englemanndaisy

Gaillardia sp. - gaillardia

Gutierrezia sarothrae - broom snakeweed

Helianthus maximiliani - maximilian sunflower

Liatris punctata - dotted gayfeather

Ratibida columnifera - upright prairie-coneflower

Simsia exaristata - annual bushsunflower

Family: EUPHORBIACEAE

Croton texensis - texas croton

Family: KRAMERIACEAE

Krameria lanceolata - trailing krameria

Family: MALVACEAE

Abutilon incanum - indianmallow

Family: ONAGRACEAE

Gaura spp. - gaura

Oenothera spp. - eveningprimrose

Family: VERBENACEAE

Verbena spp. - verbena

Family: ZYGOPHYLLACEAE

Kallstroemia sp. - caltrop

#### Trees and Shrubs

Family: ANACARDIACEAE

Rhus microphylla - littleleaf sumac

Family: BERBERACEAE

Berberis trifoliolata - agarito

Family: CACTACEAE

Opuntia spp. - pricklypear

Opuntia leptocaulis - pencil cholla

Family: CURRESSACEAE

Juniperus pinchotif - redberry juniper

Family: EPHEDERACEAE

Ephedra sp. - ephedra

Family: FAGACEAE

Quercus pungens vaseyana - vasey shin oak

Quercus virginiana - live oak

Family: JUGLANDACEAE

Carya illinoensis - pecan

Family: LEGUMINOSAE

Acacia greggii - catclaw acacia

Prosopis juliflora glandulosa - honey mesquite

Family: LILIACEAE

Yucca sp. - yucca

Family: RHAMNACEAE

Condalia lycioides - southwest condalia

Condalia obtusifolia - lotebush

Family: SAPINDACEAE

Sapindus drummondii - western soapberry

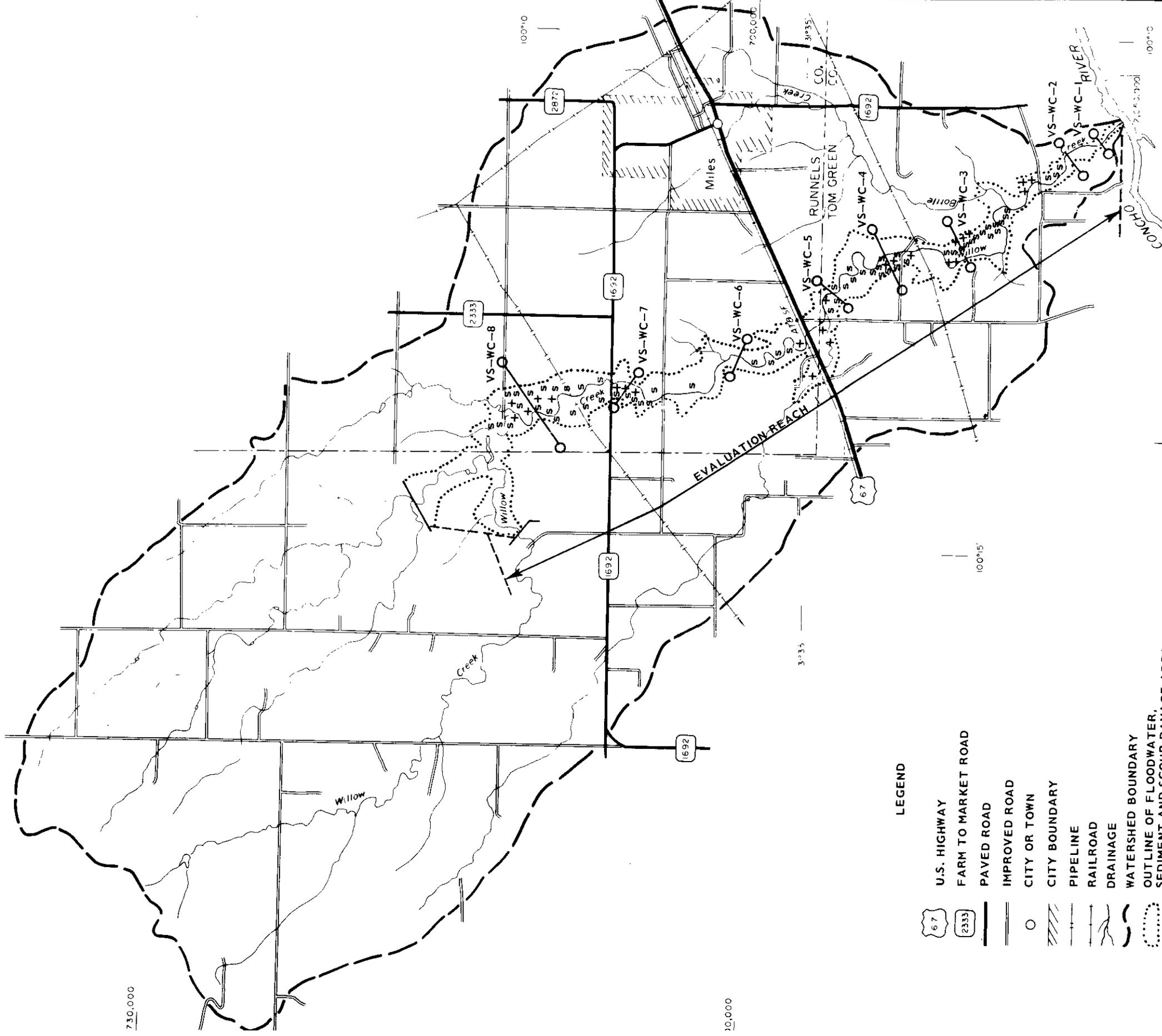
Family: SAPOTACEAE

Bumelia sp. - bumelia

Family: ULMACEAE

Celtis laevigata - sugar hackberry

Ulmus crassifolia - cedar elm



LEGEND

-  U.S. HIGHWAY
-  FARM TO MARKET ROAD
-  PAVED ROAD
-  IMPROVED ROAD
-  CITY OR TOWN
-  CITY BOUNDARY
-  PIPELINE
-  RAILROAD
-  DRAINAGE
-  WATERSHED BOUNDARY
-  OUTLINE OF FLOODWATER, SEDIMENT AND SCOUR DAMAGE AREA

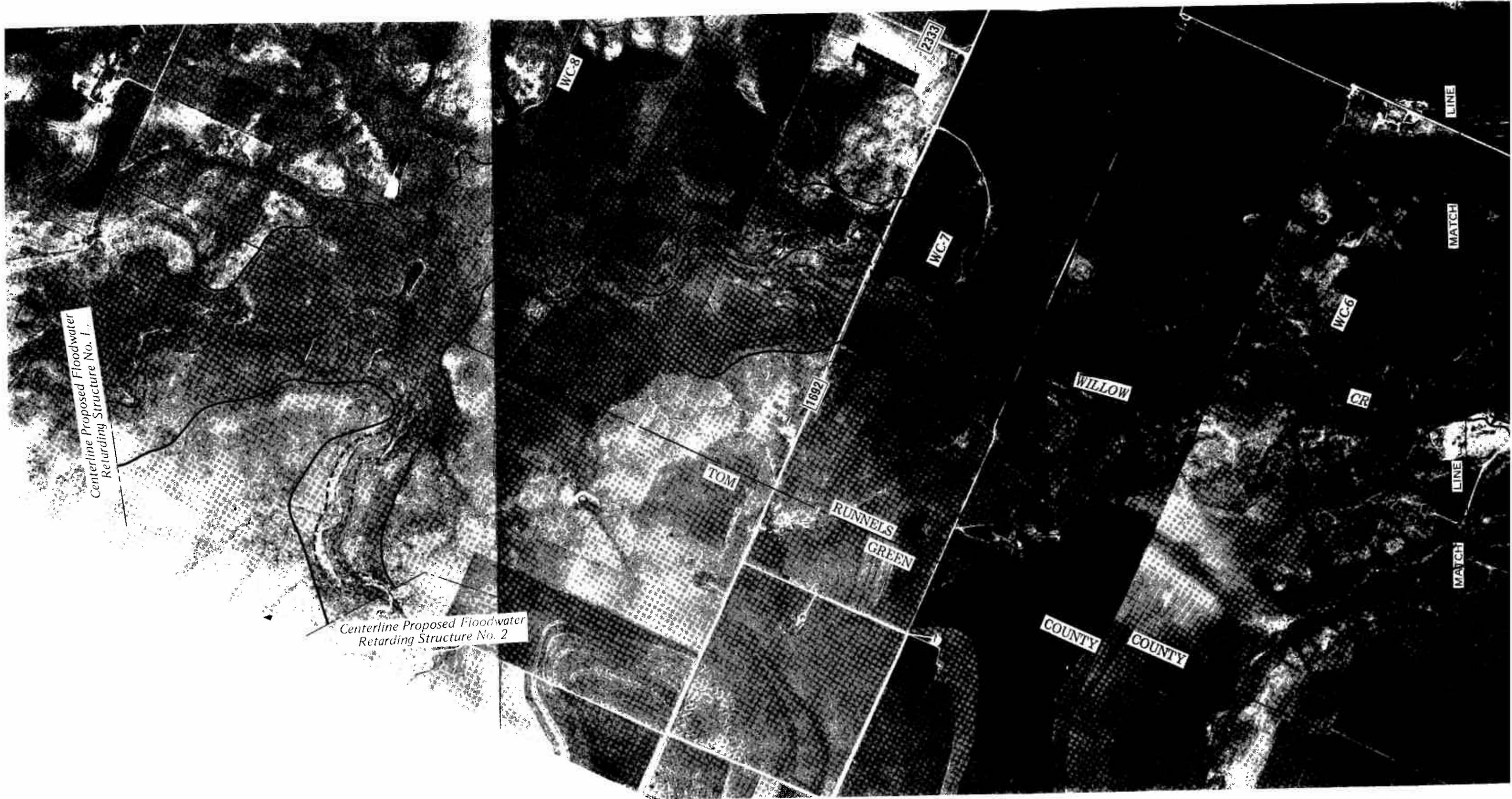
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10,000

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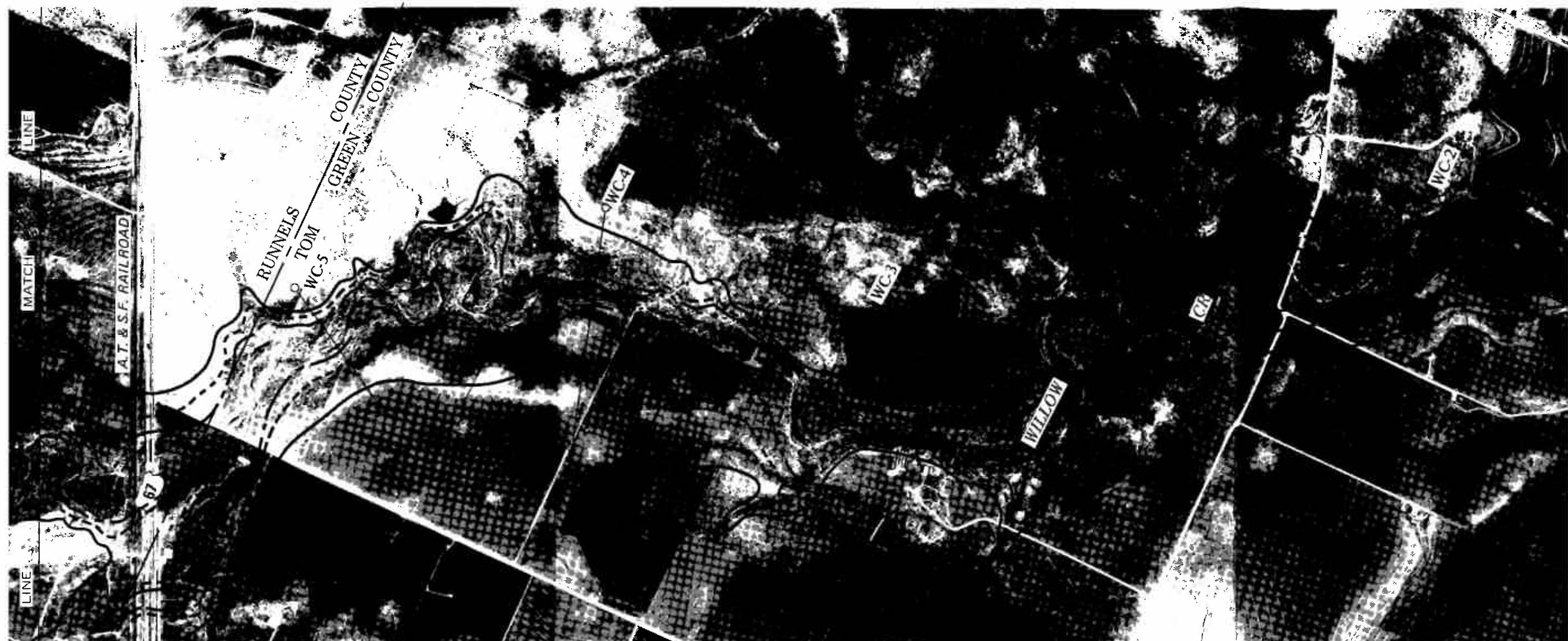
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100°±0



Centerline Proposed Floodwater Retarding Structure No. 1

Centerline Proposed Floodwater Retarding Structure No. 2



WATER SURFACE ELEVATIONS AT VALLEY SECTIONS FOR 100-YEAR AND 5-YEAR FREQUENCIES

Valley Section	100-Year Frequency		5-Year Frequency
	Without Project	With Project	With Project
WC-1	1702.8	1701.9	1696.6
WC-2	1708.3	1707.5	1703.3
WC-3	1730.5	1729.7	1726.9
WC-4	1740.8	1740.0	1737.4
WC-5	1751.6	1750.7	1748.5
WC-6	1771.5	1769.0	1766.9
WC-7	1793.0	1788.5	1786.3
WC-8	1806.9	1802.6	1800.6

NOTE: The area within the 100-year frequency lines is considered hazardous for residential dwellings and industrial and business developments. The area within the 5-year frequency lines is considered hazardous for production of cultivated crops.



LEGEND

-  100-YEAR FLOOD WITHOUT PROJECT
-  100-YEAR FLOOD WITH PROJECT
-  5-YEAR FLOOD WITH PROJECT
-  U.S. HIGHWAY
-  FARM TO MARKET ROAD

Figure  
FLOOD PLANS  
WILLOW CREEK  
RUNNELS AND  
GREEN COUNTY  
U. S. DEPARTMENT OF  
SOIL CONSERVATION  
TEMPLE, TEXAS

0 1320  
Approximate  
1 inch equals 1320 feet

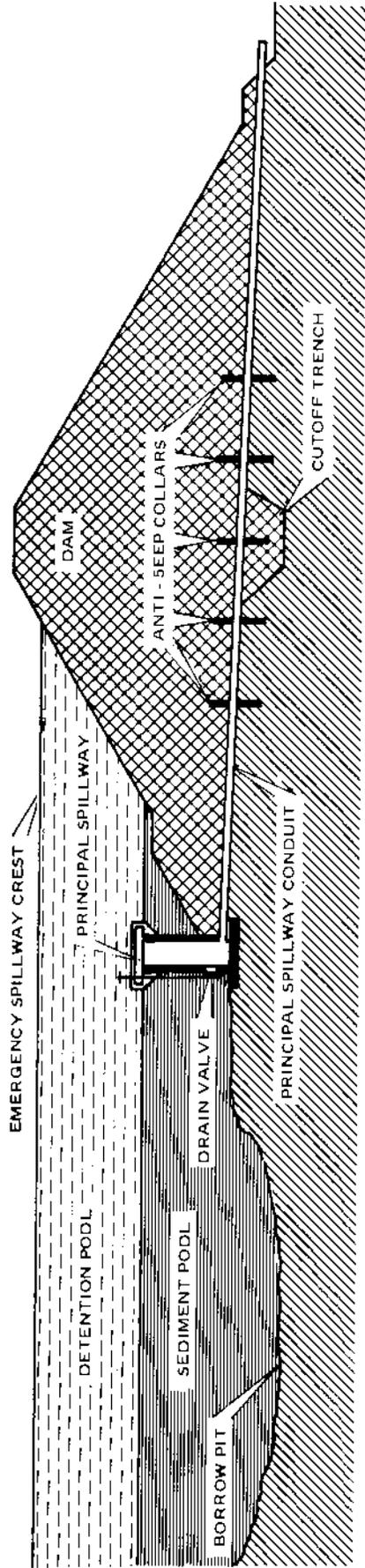
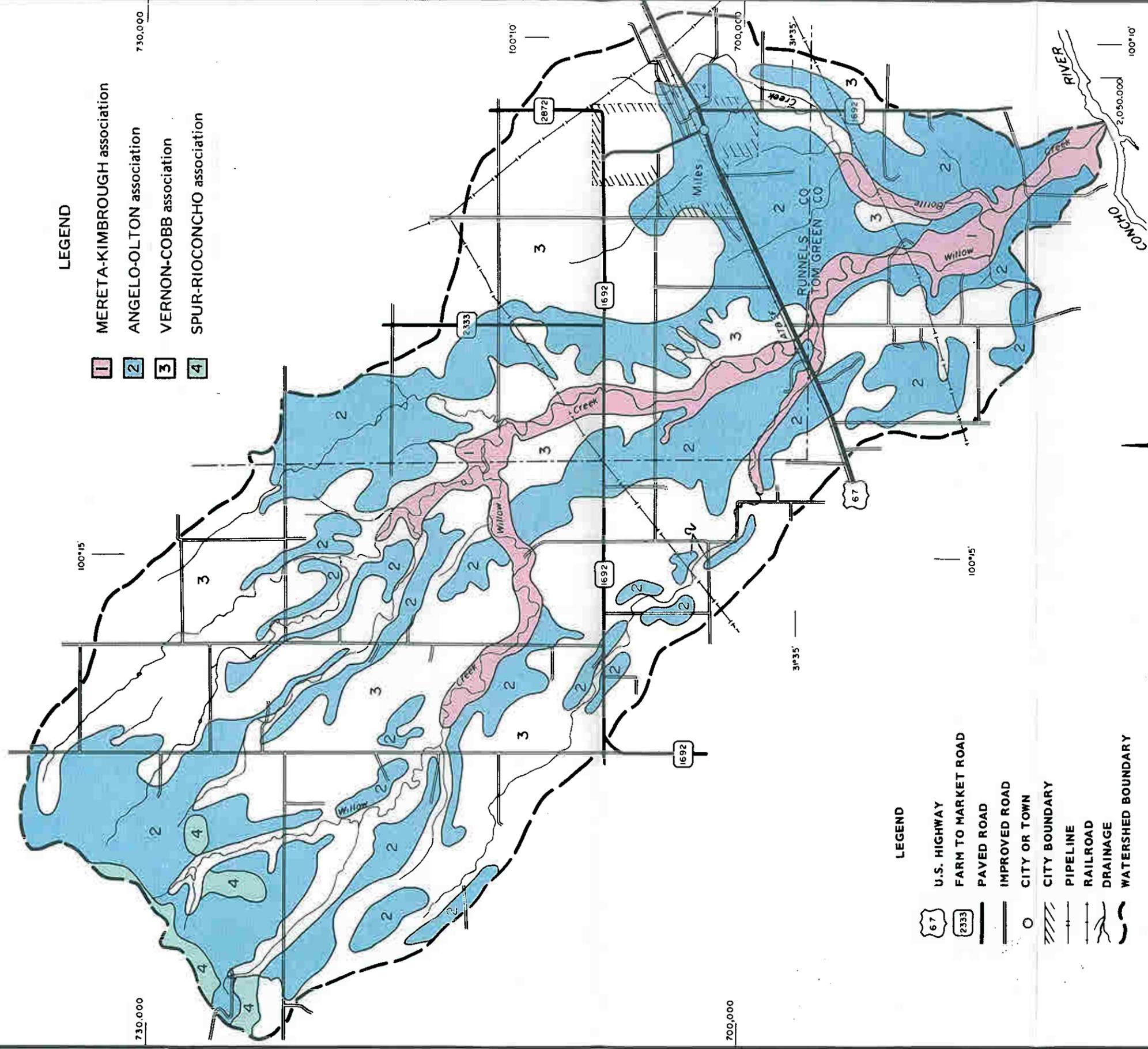


Figure 2  
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



LEGEND

- 1 MERETA-KIMBROUGH association
- 2 ANGELO-OLTON association
- 3 VERNON-COBB association
- 4 SPUR-RIOCONCHO association

730,000

100°15'

3

3

3

2333

3

1692

1692

700,000

100°15'

LEGEND

- 67 U.S. HIGHWAY
- 2333 FARM TO MARKET ROAD
- PAVED ROAD
- IMPROVED ROAD
- O CITY OR TOWN
- CITY BOUNDARY
- PIPELINE
- RAILROAD
- DRAINAGE
- WATERSHED BOUNDARY

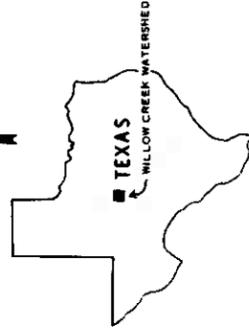
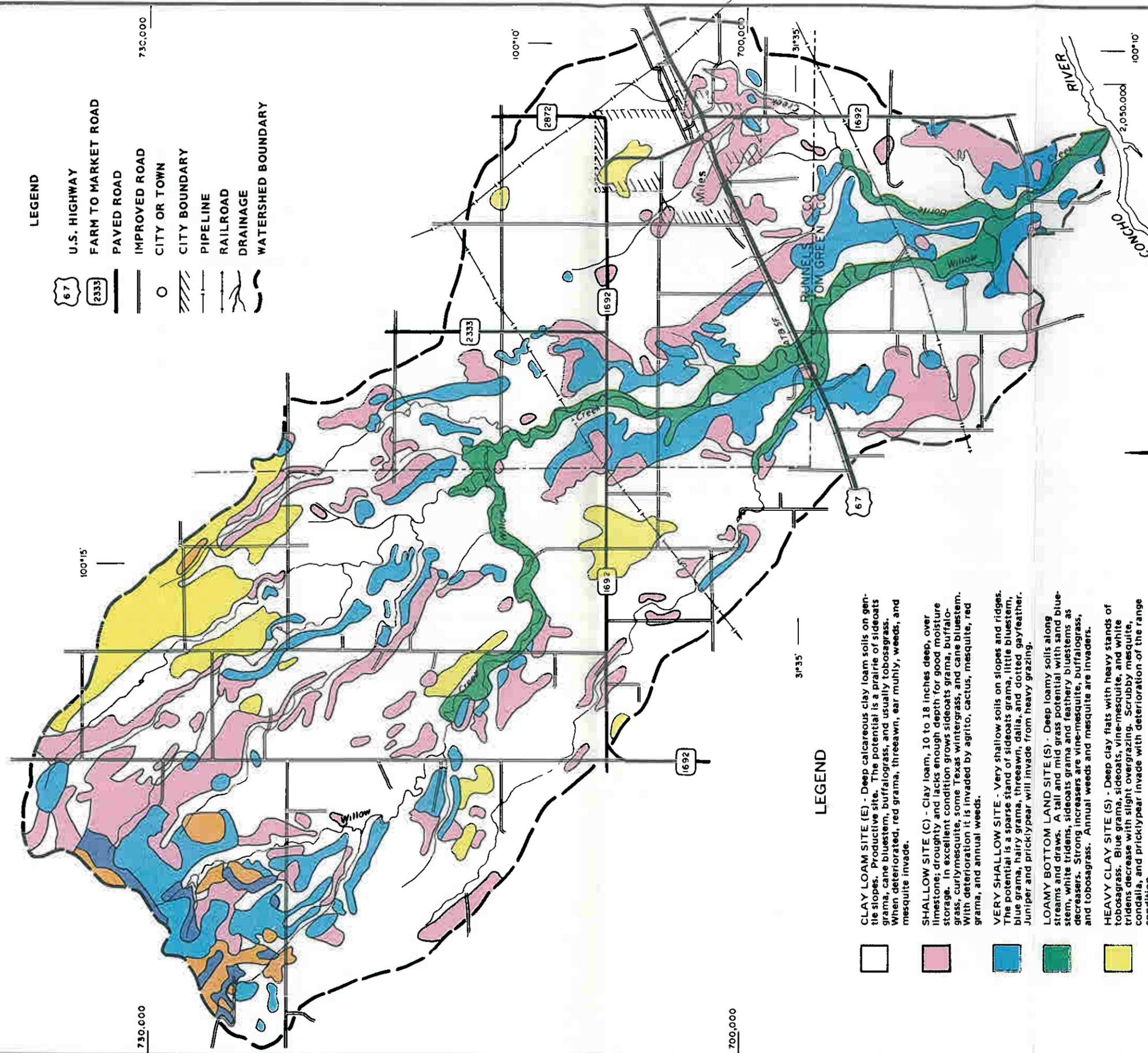


Figure 3  
**GENERAL SOIL MAP**  
**WILLOW CREEK WATERSHED**  
**RUNNELS AND TOM GREEN**  
**COUNTIES, TEXAS**

Approximate Scale - Miles  
 1:43340 or 1" = 1 Mile  
 0 1 2

Base Map compiled from USGS Quadrangles and General Highway Map. All Planimetric features as well as Lat. and Long. and State Plane Coordinates taken from these sources.



**LEGEND**

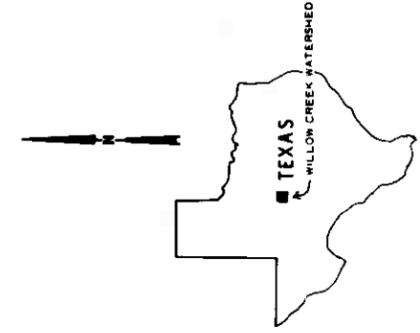
- U.S. HIGHWAY
- FARM TO MARKET ROAD
- PAVED ROAD
- IMPROVED ROAD
- CITY OR TOWN
- CITY BOUNDARY
- PIPELINE
- RAILROAD
- DRAINAGE
- WATERSHED BOUNDARY

**LEGEND**

- CLAY LOAM SITE (E) - Deep calcareous clay loam soils on gentle slopes. Productive site. The potential is a prairie of sideoats grama, cane bluestem, buffalograss, and usually tobosagrass. When deteriorated, red grama, threawn, ear mully, weeds, and mesquite invade.
- SHALLOW SITE (C) - Clay loam, 10 to 18 inches deep, over limestone; droughty and lacks enough depth for good moisture storage. In excellent condition grows sideoats grama, buffalograss, curlymesquite, some Texas wintergrass, and cane bluestem. With deterioration it is invaded by agrito, cactus, mesquite, red grama, and annual weeds.
- VERY SHALLOW SITE - Very shallow soils on slopes and ridges. The potential is a sparse stand of sideoats grama, little bluestem, blue grama, hairy grama, threawn, dalia, and dotted gayfeather. Juniper and pricklypear will invade from heavy grazing.
- LOAMY BOTTOM LAND SITE (S) - Deep loamy soils along streams and draws. A tall and mid grass potential with sand blue stem, white tridens, sideoats grama and feathery bluestems as decreasers. Strong increasers are vine-mesquite, buffalograss, and tobosagrass. Annual weeds and mesquite are invaders.
- HEAVY CLAY SITE (S) - Deep clay flats with heavy stands of tobosagrass. Blue grama, sideoats, vine-mesquite, and white tridens decrease with slight overgrazing. Scrubby mesquite, condalia, and pricklypear invade with deterioration of the range condition.
- SANDSTONE HILLS SITE - Very shallow stony sandy loam on ridges. Rock and boulders abundant. Lack of soil reduces production. Can grow little bluestem, sideoats grama, fall witchgrass, with scrub oak. Invaders are catclaw, persimmon, threawn, and weeds.
- SANDY LOAM SITE - Deep sandy loams on gentle to steep slopes. Potential decreasers are sideoats grama, cottontop, and little bluestem with some tall and short grasses. Deteriorates to a mixture of brush and weeds including sand sagebrush, shin oak, skunkbush, mesquite, and yucca.

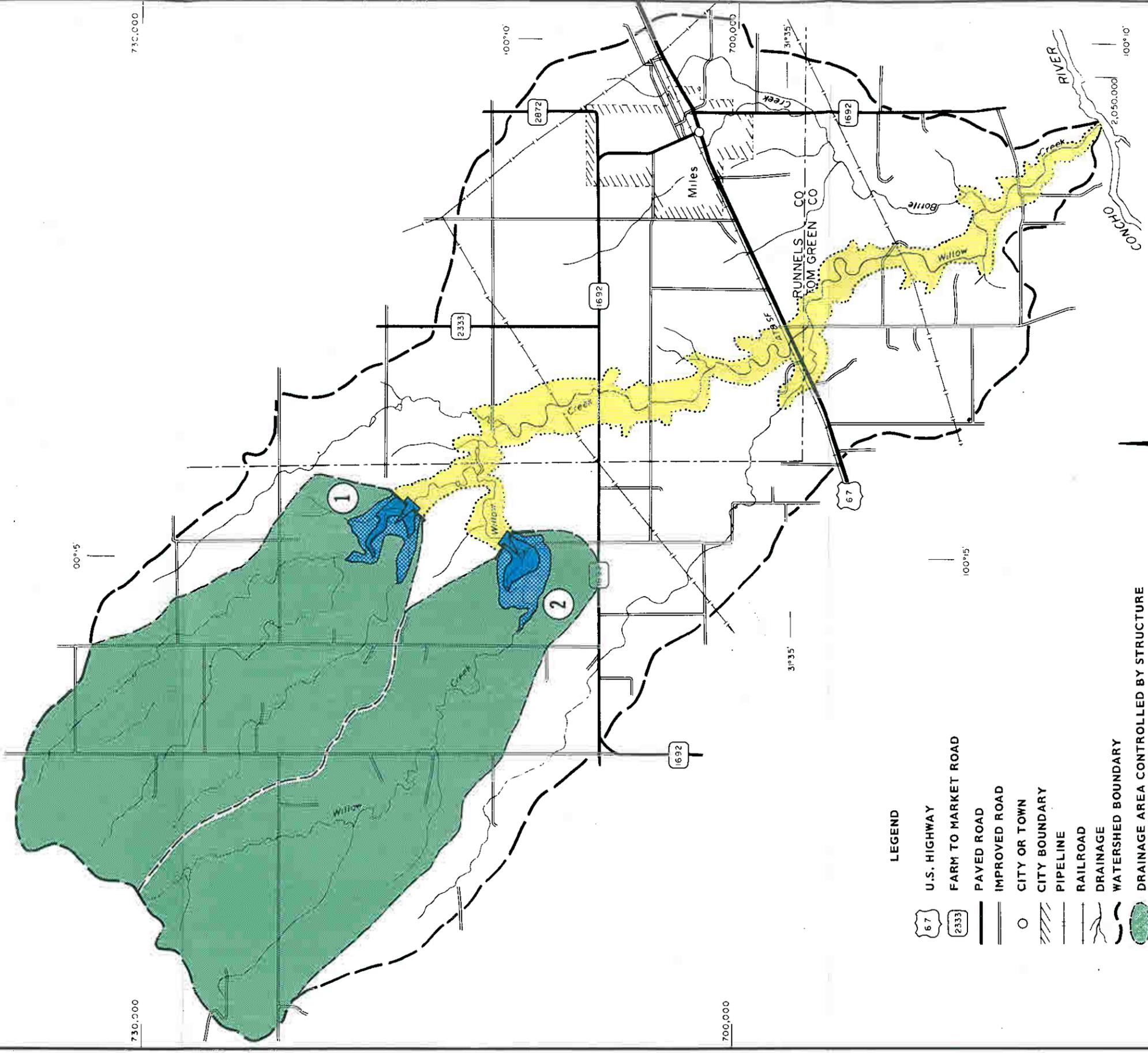
Figure 4  
RANGE SITE MAP

**WILLOW CREEK WATERSHED  
RUNNELS AND TOM GREEN  
COUNTIES, TEXAS**



Approximate Scale - Miles  
1:63,360 or 1" = 1 Mile

Base Map compiled from USGS Quadrangles and General Highway Map. All Planimetric features as well as Lat. and Long. and State Plane Coordinates taken from these sources.



LEGEND

- 67 U.S. HIGHWAY
- 2333 FARM TO MARKET ROAD
- PAVED ROAD
- IMPROVED ROAD
- O CITY OR TOWN
- City Boundary
- PIPELINE
- RAILROAD
- DRAINAGE
- WATERSHED BOUNDARY
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- BENEFITED AREA
- FLOODWATER RETARDING STRUCTURE
- 1 SITE NUMBER

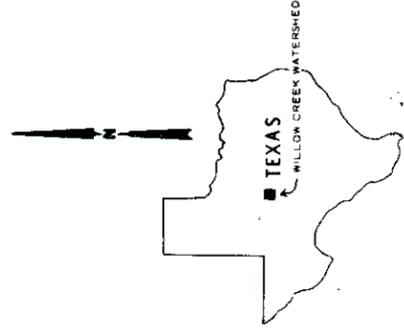


Figure 5  
**PROJECT MAP**  
**WILLOW CREEK WATERSHED**  
**RUNNELS AND TOM GREEN**  
**COUNTIES, TEXAS.**

Approximate Scale - Miles  
 1:43,340 or 1" = 1 Mile

Base Map compiled from USGS Quadrangles and General Highway Map. All Planimetric features as well as Lat. and Long. and State Plane Coordinates taken from these sources.