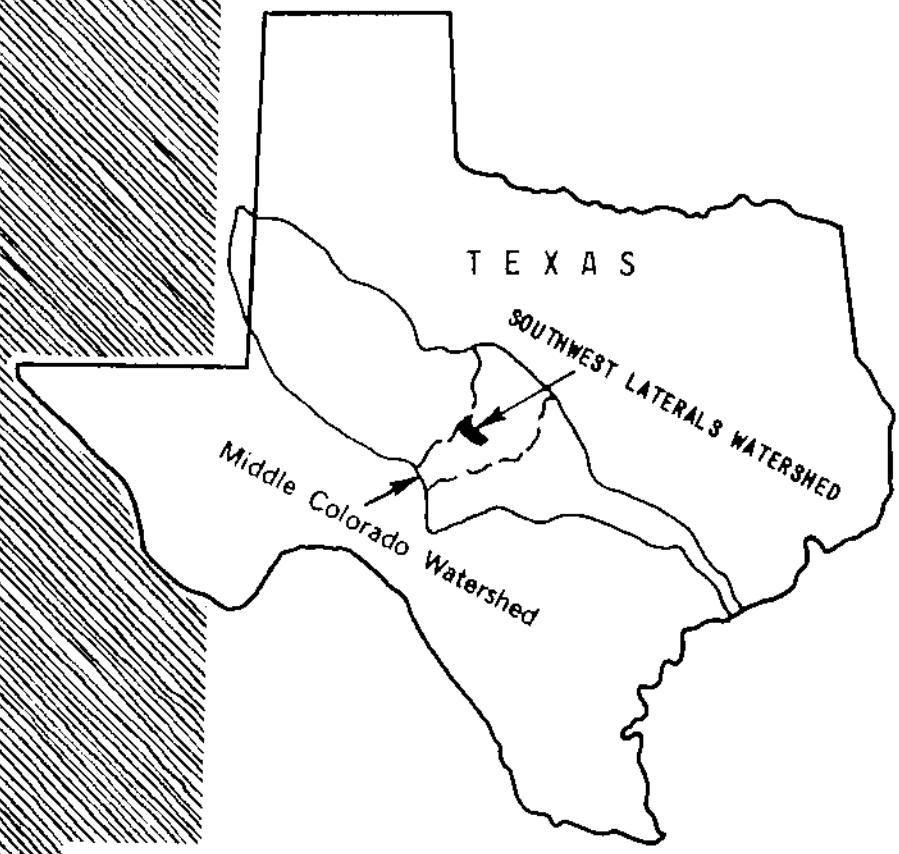
WORK PLAN

SOUTHWEST LATERALS WATERSHED

OF THE MIDDLE COLORADO RIVER WATERSHED CONCHO AND McCULLOCH COUNTIES, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
December 1975

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ADDENDUM

SOUTHWEST LATERALS WATERSHED, TEXAS
(Middle Colorado River Watershed)

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 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. It is an alternate plan to the selected plan and is formulated to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. 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 $3,133,730 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

BENEFITS TO COST COMPARISON

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

This addendum shows the project costs, benefits, and benefit-cost ratio based on a 6.125 percent interest rate, current normalized prices, and the 1975 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1.	Project costs are	$ 87,900
2.	Project benefits are	$ 218,260
3.	The project benefit-cost ratio is	2.5 to 1.0
4.	Project benefit-cost ratio excluding secondary benefits is	1.3 to 1.0

PART II

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects[1/]	Components	Measures of effects[1/]
Beneficial effects:		Adverse effects:	
A. The value to users of increased outputs of goods and services		A. The value of resources required for a plan	
1. Flood prevention	$117,260	1. Seven floodwater retarding structures	
Total beneficial effects	$117,260	a. Project installation	$75,760
		b. Project administration	10,740
		c. Operation and maintenance	1,400
		Total adverse effects	87,900
		Net beneficial effects	29,360

1/ Average annual

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Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. Create 226 surface acres of water.
	2. Reduce upland erosion from 494,010 tons per year to 468,430 tons per year.
	3. Restore and improve the native prairie and savannah ecosystem on about 71,000 acres of rangeland.
B. Quality considerations of water, land, and air resources	1. Redute erosion on 116 acres of flood plnin land by 79 percent.
	2. Temporarily increase air and water poliution from dust and aediment inherent to the conatruction process during construction of the structural works of improvement.
	3. Reduce sedlmcnt deposition in Lake Buchanan by 15 acre-feet annually.
	4. Reduce the average annual volume of sediment delivered from the watershed from 123,500 tona to 104,850 tons.
	5. Initially reduce the average annual runoff from the watershed by about 0.43 percent.
	6. Reduce inflow to Lake Buchanan by 0.088 percent during a dry year, 0.060 percent during an average year, and 0.033 percent during a wet year.
	7. Reduce suspended sediment vield concentration in the Colorado River by 40 milligrams per liter annually.
C. Biological resources and selected ecosystems	1. Create additional surface water areas that will provide drinking water for wildlife.
	2. Create 226 surface acres of lake fish habitat.
	3. Provide 226 surface acres of water at the reservoirs for migratory waterfowl resting areas.

Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. Create 226 surface acres of water.
	2. Reduce upland erosion from 494,010 tons per year to 468,430 tons per year.
	3. Restore and improve the native prairie and savannah ecosystem on about 71,000 acres of rangeland.
B. Quality considerations of water, land, and air resources	1. Reduce erosion on 116 acres of flood plain land by 79 percent.
	2. Temporarily increase air and water pollution from dust and sediment inherent to the construction process during construction of the structural works of improvement.
	3. Reduce sediment deposition in Lake Buchanan by 15 acre-feet annually.
	4. Reduce the average annual volume of sediment delivered from the watershed from 123,500 tons to 104,850 tons.
	5. Initially reduce the average annual runoff from the watershed by about 0.43 percent.
	6. Reduce inflow to Lake Buchanan by 0.088 percent during a dry year, 0.060 percent during an average year, and 0.033 percent during a wet year.
	7. Reduce suspended sediment yield concentration in the Colorado River by 40 milligrams per liter annually.
C. Biological resources and selected ecosysrems	1. Creste additional surface water areas that will provide drinking water for wildlife.
	2. Create 226 surface acres of lake fish habitat.
	3. Provide 226 surface acres of water at the reservoirs for migratory waterfowl resting areas.

Components	Measures of effects
	4. Require the removal of approximately 176 acres of shrubby wildlife habitat for construction of dams and emergency spillways.
	5. Require the destruction of 226 acres of open wildlife habitat to be covered by water and eventually covered with sediment.
	6. Occasionally inundate 700 acres of wildlife habitat in the detention pools and sediment reserve of the floodwater retarding structures.
D. Irreversible or irretrievable commitments	1. Installation of the structural measures will require 1,102 acres of rangeland, pastureland, and intermittent stream channels for dams, emergency spillways, sediment pools, and detention pools.

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REGIONAL DEVELOPMENT ACCOUNT

Southwest Laterals Waterahed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects 1/ Region 2/	Rest of Nation
A. Income:		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region		
a. Flood prevention	$117,260	---
b. Secondary	101,000	---
Total beneficial effects	$218,260	---

Components	Measures of effects 1/ Region 2/	Rest of Nation
A. Income:		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Seven floodwater retarding structures		
Project installation (structural measures)	$ 7,650	$68,110
Project administration	210	10,530
Operation and maintenance	1,400	---
Total adverse effects	$ 9,260	$78,640
Net beneficial effects	$209,000	- $78,640

1/ Average annual
2/ The region consists of Concho and McCulloch Counties, Texas

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Selected Plan

REGIONAL DEVELOPMENT ACCOUNT (continued-2)

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects: Region 1/	Measures of effects: Rest of Nation
B. Employment:		
Beneficial effects:		
1. Increase in the number and types of jobs		
a. Agricultural employment	17 permanent semi-skilled jobs	---
b. Employment for project construction	51 man-years of semi-skilled employment during the installation period (6 years)	---
Total beneficial effects	17 permanent semi-skilled jobs	---
	51 man-years of semi-skilled employment over the installation period (6 years)	---

Components	Measures of effects: Region 1/	Measures of effects: Rest of Nation
B. Employment:		
Adverse effects:		
1. Decrease in the number and types of jobs	1 permanent semi-skilled job	---
Total adverse effects	1 permanent semi-skilled job	---
Net beneficial effects	16 permanent semi-skilled jobs	---
	51 man-years of semi-skilled employment over the installation period (6 years)	---

1/ The region consists of Concho and McCulloch Counties, Texas

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT (continued-3)

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Components	Measures of effects		Components	Measures of effects	
	Region 1/	Rest of Nation		Region 1/	Rest of Nation
C. Population distribution			C. Population distribution		
Beneficial effects	Create 16 permanent semi-skilled jobs in a rural area and 51 man-years of semi-skilled employment over the installation period (6 years)	---	Adverse effects	---	---
D. Regional economic base and stability			D. Regional economic base and stability		
Beneficial effects	Create 16 permanent semi-skilled jobs and 51 man-years of semi-skilled employment over the installation period (6 years). Reduce flood hazard on about 5,600 acres of flood plain.	---	Adverse effects	---	---

1/ The region consists of Concho and McCulloch Counties, Texas

Selected Plan

SOCIAL WELL-BEING ACCOUNT

Southwest Laterals Watershed, Texas
(Middle Colorsdo River Watershed)

Components	Measures of effects
Beneficial and adverse effects:	
A. Real income distribution	1. Create 16 permanent semi-skilled jobs and 43 man-years of semi-skilled employment over the installation period (6 years).
	2. Create regional income benefit distribution of $218,260 benefits by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentnge Benefits in Class
Less than 3,000	9	32
3,000 - 10,000	49	51
More than 10,000	42	17

	3. Local average annual costs of $9,260 will be borne by the Concho and McCulloch County Commissioners Courts from general funds. The percentage of contributions to local costs, by income classes, is not readily available.
B. Life, health, and safety	1. Provide protection to users of the transportation system.
C. Recreational opportunities	1. Create 226 acres of surface water which can be used for recreation, lake fisheries, and waterfowl resting areas.

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d. Prevent destruction of agricultural properties, and source of livelihood for about 40 owners of property on the flood plain of Salt and Cow Creeks.
e. Reduce the interruption of the transportation systems at crossings along the flood plain.
f. Result in initial reduction in average annual runoff of about 0.5 percent from the watershed due to evaporation and seepage losses from the sediment pools.
g. Reduce sediment load carried downstream into the Colorado River and deposited in Lake Buchanan.

3. Biological Resources and Selected Ecological Systems

a. Restore and stabilize the vegetative composition of the native prairie and the oak-grass savannah and prairie ecosystems.
b. Enhance the fishery habitat in the Colorado River and in farm and ranch ponds by reducing sediment content of runoff.
c. Improve habitat for wildlife species as the result of improvement of plant composition.
d. Improve wildlife habitat on the upland through special plantings and fencing of certain areas near floodwater retarding structures and near favorable farm and ranch ponds.
e. Change 285 acres of fair to poor wildlife habitat to fish habitat and waterfowl resting areas.

4. Archeological Resources

Provide for location, study, and preservation of important archeological sites to prevent the loss of information contained therein.

5. Irreversible or Irretrievable Commitments

a. Require loss of 401 acres of rangeland, and 9 miles of intermittent stream channels.

b. Interrupt agricultural use on 972 acres of rangeland.

WATERSHED WORK PLAN AGREEMENT

between the

San Saba-Brady Soil and Water Conservation District

Concho Soil and Water Conservation District

McCulloch County Commissioners Court

Concho County Commissioners Court

(hereinafter referred to as the Sponsoring Local Organization)

State of Texas

and the

Soil Conservation Service
United State 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 Southwest Laterals Watershed, State of Texas, under the authority of the Flood Control Act of 1944, (P. L. 534,78th Congress), as amended and supplemented; and

Whereas, the responsibility for administration of the Flood Control 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 Southwest Laterals 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 considerstions, 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 6 years.

It is mutually agreed that in installing and opersting 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 Public Law 78-534 funds, such land rights as will be needed in connection with the works of improvement. (Estimated Cost $ 124,500).

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:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs[1/] (dollsrs)
Relocation Payments	44.0	56.0	$0.00

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.

3. The Sponsoring Local Organization will acquirc or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures	-	100.00	1,049,300

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
Floodwater Retarding Structures	-	100.00	59,840

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $3,500 and $171,490 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 witn the legal rights and liabilities of the parties.

An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsors(s) having specific responsibilities for the particular structural measure involved.

14. No member of or delegate to congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

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

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

San Saba-Brady Soil and Water Conservation District
Local Organization

By Robert F. Smith

Title Chairman

San Saba, Texas 76877
Address Zip Code

Date March 15, 1976

The signing of this agreement was authorized by a resolution of the governing body of the San Saba-Brady Soil and Water Conservation District
Local Organization
adopted at a meeting held on March 15, 1976

Jack Edmiston
Secretary, Local Organization

San Saba, Texas 76877
Address Zip Code

Date March 15, 1976

Concho Soil and Water Conservation District
Local Organization

By [signature]

Title Chairman

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

Date March 4, 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 February 12, 1976

[signature]
Secretary, Local Organization

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

Date March 4, 1976

McCulloch County Commissioners Court
Local Organization

By [signature]

Title County Judge

Brady, Texas 76825
Address Zip Code

Date March 9, 1976

The signing of this agreement was authorized by a resolution of the governing body of the McCulloch County Commissioners Court
Local Organization
adopted at a meeting held on March 8, 1976

[signature]
Secretary, Local Organization

Brady, Texas 76825
Address Zip Code

Date March 9, 1976

Concho County Commissioners Court
Local Organization

By [signature]

Title County Judge

Paint Rock, Texas 76866
Address Zip Code

Date March 11, 1976

The signing of this agreement was authorized by a resolution of the governing body of the Concho County Commissioners Court
Local Organization
adopted at a meeting held on March 9, 1976

[signature]
Secretary, Local Organization

Paint Rock, Texas 76866
Address Zip Code

Date March 11, 1976

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

Soil Conservation Service
United States Department of Agriculture

Approved by:

George C Martin
State Conservationist

3-29-76
Date

WATERSHED WORK PLAN

SOUTHWEST LATERALS WATERSHED
Of the Middle Colorado River Watershed
Concho and McCulloch Counties, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority
of the Flood Control Act of 1944
as Amended and Supplemented

Participating Agencies

San Saba-Brady Soil and Water Conservation District
Concho Soil and Water Conservation District
McCulloch County Commissioners Court
Concho County Commissioners Court

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture

December 1975

WATERSHED WORK PLAN
SOUTHWEST LATERALS WATERSHED
Of The Middle Colorado River Watershed
Concho and McCulloch Counties, Texas

General Summary

This work plan for flood prevention and watershed protection for the Southwest Laterals wstershed was prepared by the Soil Conservation Service with the San Saba-Brady and the Concho Soil and Water Conservation Districts and the Commissioners Courts of McCulloch and Concho Counties as the local sponsoring organizations.

Southwest Laterals watershed, comprising 443 square miles (283,240 acres), is located in the western part of Central Texas approximately 5 miles north of Brady. The msjor portion of the watershed is in the northern part of McCulloch County with its western extremity in northeast Concho County.

The watershed is composed of seven separate stream systems located on the south side of the Colorado River. These systems are the Salt, Saddle, Elm, Cow, Bluff, Cedar, and Corn Creeks, all of which flow generally north and outlet into the Colorado River. Approximately 25 percent of the watershed is cropland, 74 percent is rangeland, and 1 percent is in miscellaneous uses such as urban areas, farmsteads, roads, and stream channels.

There is no federal land in the watershed.

The major soil and water problems in the watershed are erosion on the uplands and damages caused by floodwater and scour on about 8,160 acres of intensively managed agricultural land in the flood plains of Salt and Cow Creeks, with 5,600 acres along Salt Creek and 2,550 acres along Cow Creek.

An additional 14,550 acres of less intensively managed land are located along the flood plains of Saddle, Elm, Bluff, Cedar, and Corn Creeks.

The estimated average annual damages along Salt Creek and its tributaries without the project total $165,260 at current normalized prices.

The objectives of the project are to provide proper land use on the entire watershed area and flood protection on those flood plain lands having significant flood problems.

The sponsoring local organizations have determined that no individual or organized group is interested in including water storage or other works of improvement for agricultural or nonagricultural management purposes.

Neither Concho nor McCulloch County is eligible for assistance under provisions of the Area Redevelopment Act.

The work plan proposes installing, during a 6-year installation period, a project for the protection and development of the watershed at a total estimated installation cost of $2,372,360. The share of this cost to be borne by flood prevention funds is $1,328,660. The share to be borne by other than flood prevention funds is $1,043,700. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

Land treatment measures will be applied on private lands throughout the watershed. Conservation plans have been developed on approximately 92 percent of the land in the watershed with about 51 percent of the planned practices applied to date. Additional land treatment measures are to be applied on 11,270 acres of cropland, 70,980 acres of rangeland, and 500 acres of pastureland during the 6-year installation period in addition to the maintenance of those measures already applied. These measures will improve the hydrologic condition of both cropland and rangeland. This improvement in soil condition and cover will reduce erosion and the sediment yield to floodwater retarding structures below and will effect some reduction in flooding.

The installation cost of these land treatment measures is estimated to be $963,730, of which $915,700 will be from funds other than flood prevention. Flood prevention funds will provide $48,030 for accelerated technical assistance during the project installation period.

Structural Measures

No structural measures are planned for installation on Saddle, Elm, Bluff, Cedar, Corn, or Cow Creeks. A system of seven floodwater retarding structures will be installed to provide protection to the flood plain lands of Salt Creek. The total estimated cost of structural measures is $1,408,630, of which the local share is $128,000, the flood prevention share is $1,280,630. Local share of the cost consists of $124,500 for land rights and $3,500 for project administration.

The structural measures will be installed during a 6-year period.

Although significant floodwater, sediment, and flood plain erosion damages occur on the flood plain of Cow Creek and its tributaries, no structural measures for flood prevention are included in the project plans for the Cow Creek system. The installation of floodwater retarding structures would require a commitment of resources far greater

than the benefit to be delivered. The relatively minor damages associated with floodwater on the flood plain lands of the Saddle, Elm, Bluff, Cedar, and Corn Creek stream systems do not warrant structural works of improvement.

Environmental Impact

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

The project will reduce flooding to agricultural land and the transportation system.

The watershed lands will be protected from erosion and the productivity maintained or increased. Sediment contributed to the Colorado River and to the flood plain of Salt Creek will be reduced. The ecosystem of the Rolling Plains grass prairie and the Edwards Plateau oak-grass savannah will be restored and enhanced. Additional water impoundment areas will be created and can be used for waterfowl feeding and resting areas, development of fisheries, and livestock watering areas.

The project will preserve and enhance the habitat for most species of wildlife.

Additional opportunities for employment will be created, and income to households and demand for services will be increased.

Installation of the project will require the use of 1,102 acres of land, of which 176 acres are needed for dams and emergency spillways, 226 acres are needed for sediment pools at the lowest ungated outlet, and 700 acres are needed for detention pools and sediment reserve.

The existing vegetation will be destroyed on the 176 acres of land needed for construction of dams and emergency spillways and on most of the 226 acres of land to be inundated by the sediment pools. All land exposed by construction and not permanently inundated by water in the sediment pools will be revegetated.

Initially, the project will cause a minor reduction in the volume of average annual streamflow because of seepage and evaporation losses in the sediment pools. However, as sediment accumulates in the sediment pools, the streamflow is expected to again approach pre-project conditions.

Benefits

The reduction in floodwater, sediment, flood plain scour, and streambank erosion damages will directly benefit the owners and operators

of about 25 farms and ranches in the Salt Creek portion of the watershed. Benefits will accrue to the project from some reduction in floodwater and sediment damages outside the project area. These benefits will occur on the Colorado River mainstem immediately below the watershed and to Lake Buchanan.

The estimated average annual floodwater, sediment, erosion, and indirect damages along Salt Creek, without the project, total $165,260 at current normalized prices. With proposed land treatment and structural measures installed, damages from these sources will be reduced to an estimated $42,500. This will be a reduction of 74 percent.

The average annual benefits accruing to the structural measures are estimated to be $218,260, of which $116,620 are damage reduction benefits, $640 are benefits outside the watershed, and $101,000 are secondary benefits.

The ratio of the total annual benefits ($218,260) resulting from the installation of the structural measures to the annual cost ($87,900) is 2.5 to 1.0.

Provisions for Financing Local Share of Installation Cost

The Commissioners Courts of Concho and McCulloch Counties have the power of taxation and eminent domain under applicable state laws. Funds for the local share of the cost of installing the structural measures will be provided by these counties.

Operation and Maintenance

Land treatment measures will be operated and maintained by the owners and operators of the farms and ranches on which the measures are installed under agreement with the San Saba-Brady and Concho Soil and Water Conservation Districts.

Each of the conservation districts will have operation, maintenance, inspection, and coordinating responsibility for all structural measures within its boundary. The county commissioners court of the county in which the various structures are located will be responsible for accomplishment and financing of necessary maintenance.

The average annual value of operation and maintenance is estimated to be $1,400.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

The Southwest Laterals watershed comprises an area of 283,240 acres, or 443 square miles, in northern McCulloch County and northeastern

Concho County. Approximately 89 percent (251,240 acres) of the watershed area is in McCulloch County, and the remaining 11 percent (32,000 acres) is in Concho County.(1)

The watershed is composed of seven large streams which drain into the Colorado River from the south side. These streams are Salt, Saddle, Elm, Cow, Bluff, Cedar, and Corn Creeks. In addition, several small unnamed intervening tributaries are also included.

There are no towns or major urban centers within the watershed. An estimated total population of about 900 people live in the sparsely populated rural areas and in the small community centers of Lohn, Salt Gap, Pear Valley, Stacy, Mercury, Placid, Doole, and Fife. Brady, population 5,325, lies about 5 miles south from the watershed and Eden, population 1,420, lies about 10 miles southwest. The large metropolitan center of San Angelo, population 77,500, lies about 45 miles west.(2)

The watershed lies within the Texas Gulf Water Resource Region.(3) The streams flow into the Colorado River upstream from Lake Buchanan, the first major downstream reservoir.

The watershed lies within two land resource areas. Approximately 90 percent of the watershed is in the Rolling Plains Land Resource Area, with the remaining area in the Edwards Plateau Land Resource Area.

The topography of the watershed consists of a broad, gently rolling plain bordered on the north by a deeply incised narrow valley and on the south by a prominent escarped plateau. The southern watershed divide lies on the northern margin of the almost level surface of the Edwards Plateau physiographic area. The steeply escarped margin of the plateau rises several hundred feet above gently rolling plains and forms an area of scenic contrast. The headwaters of the major streams originate in deep narrow canyons incised into the steep edge of the plateau. The valleys of the streams broaden and become flatter on the gently rolling plain. Maximum flood plain development occurs in the central reaches of the streams with widths of up to 2,000 feet occurring on Salt and Cow Creeks. In the lower reaches near the Colorado River, the streams again become deeply incised in narrow valleys before flowing into the river. Elevations above mean sea level range from slightly over 2,000 feet on the Edwards Plateau to about 650 feet on the Colorado River.

The watershed is underlain by sedimentary rocks of the Pennsylvanian and Cretaceous Systems.(4) The rocks of the Pennsylvanian System predominate and underlie most of the gently rolling plain portion of the watershed. These rocks consist of thick beds of shale interbedded with thinner beds of limestone and sandstone. These beds lie on the northwest flanks of the Llano Uplift and were subjected to the stresses and strains of this regional disturbance. The dip is northwest at about 50

feet per mile. The rocks of the Cretaceous System were deposited on the eroded and weathered surface of the Pennsylvanian rocks. These rocks form the escarped plateau portion of the watershed and consist of soft sandstone, marly limestone, and hard cherty limestone. The escarpment is capped by hard limestone of the Edwards Limestone Formation. The dip of these beds is southeast at slightly less than 50 feet per mile.

Quaternary age deposits occur in narrow bands as alluvium along the streams of the watershed and along the Colorado River and as terrace remnants near the Colorado River.

The soils of the Rolling Plains area and the Edwards Plateau area occur within the watershed.[5] About 94 percent of the soils are fine textured, with variations from deep to very shallow. The remaining 6 percent is comprised of medium and coarse textured soils that occur adjacent to the Colorado River. About 40 percent of the area is non-arable due to shallow depth, stoniness and steepness of slope.

The principal soils are grouped into 5 soil associations. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of two or more major soils and at least one minor soil and it is named for the major soils. The soils in one association may occur in another, but in different patterns or proportions.

A brief description of the 5 soil associations with approximate acreage and percent follows:

1. Rowena-Mereta Association (144,000 acres; 51 percent)
   Moderately deep and shallow, well drained, loamy soils, over limy earth on nearly level to gently undulating upland.

   This association is made up of fertile soils on broad areas of outwash plains or old stream terraces.

   Rowena soils have a clay loam surface layer, blocky clay lower layers, and are underlain by soft caliche at a depth of about 30 inches.

   Mereta soils have clay loam surface layers over caliche with a hardened upper crust at depths of less than 20 inches.

2. Tarrant-Kavett Association (102,000 acres; 36 percent)
   Dominantly very shallow and shallow, stony, well drained, clayey soils over limestone on undulating upland.

   This association consists of broad ridges and shallow valleys. Slopes are dominantly 1 to 8 percent, but exceed 20 percent along scarps which rim much of the association.

Tarrant soils are stony clays that overlie hard limestone at depths of 6 to 20 inches. Limestone fragments, stones, and boulders are common on the surface.

Kavett soils are silty clays less than 20 inches deep over hard limestone.

3. Pedernales-Sagerton-Clairemont Association (19,740 acres; 7 percent). Deep, well drained, loamy, nearly level to gently sloping terrace and bottomland soils of the Colorado River.

   Pedernales soils have fine sandy loam surface layers about 7 inches thick and sandy clay subsoil layers about 51 inches thick.

   Sagerton soils have clay loam surface layers about 7 inches thick and clay loam subsoil layers about 63 inches thick.

   Clairemont soils have silt loam surface layers about 10 inches thick and are underlain to depths of about 60 inches with thin layers of variable textured material that was recently deposited by the Colorado River.

4. Randall-Reap Association (10,000 acres; 3 percent)
   Deep, clayey, nearly level to gently sloping, slowly permeable, upland soils that are well drained to somewhat poorly drained.

   Soils of this association have very high shrink-swell characteristics and have gilgai microrelief.

   Randall soils are somewhat poorly drained clays about 54 inches thick.

   Reap soils are well drained clays about 58 inches thick.

5. Owens-Krum Association (7,500 acres; 3 percent)
   Clayey, shallow and deep, well drained soils on rolling upland.

   This soil association is on the short, steep scarps and in the narrow valleys that form a break between the uplands and the alluvial soils of the Colorado River.

   The steep breaks are Owens soils which are clays that are underlain with platy shale at depths of less than 20 inches.

   The narrow valleys are mainly Krum soils which are silty clays about 42 inches thick over silty clay sediments.

A detailed survey has been completed of the McCulloch County portion of the watershed and has been published. This survey is a valuable tool in managing farms and ranches, in selecting sites for roads, ponds, buildings, and other structures and in judging the suitability of tracts of land for agriculture, industry, and recreation. Work is progressing on the soil survey of the Concho County portion of the watershed.

The present land use in the watershed is as follows:

Land Use	Acres	Percent of Watershed
Cropland	71,469	25.2
Rangeland	208,516	73.6
Pastureland	400	0.2
Miscellaneous 1/	2,855	1.0
Total	283,240	100.0

1/ Miscellaneous includes urban areas, farmsteads, and roads.

The flood plain land use varies from high intensity use along Salt and Cow Creeks to low intensity use along Saddle, Elm, Bluff, Cedar, and Corn Creeks and along the Colorado River. The land use on the Salt Creek flood plain is 55 percent in cropland, 43 percent in rangeland, and 2 percent in miscellaneous. The land use on the Cow Creek flood plain is 41 percent in cropland, 58 percent in rangeland, and 1 percent in miscellaneous. The land use in the flood plain along the other streams is predominantly rangeland.

Mineral production in the watershed is minor and is limited to the production of sand and gravel from river terrace deposits. The area has also produced caliche, limestone, dolomite, petroleum, natural gas, and bituminous coal. The petroleum and natural gas were produced from the now inactive Siler and Johnson field near Salt Gap and the smaller Big Chief gas field near Lohn. These fields are part of a large number of structural gaps occurring along a geologic structure known as the Bend Arch.[6] This structural area extends across the watershed and is subject to renewed explorational activities due to recent awareness of national energy needs.

Bituminous coal was mined in the Chaffin mine, located 2 miles east of Waldrip, in the northern part of the watershed.[6] The Chaffin coalbed is about 20 inches thick, and its occurrence is confined to the Pennsylvanian age strata lying in this locality of the state.[7] Two other coalbeds, the Thurber coal and the Bridgeport coal, occur in the Pennsylvanian age strata below the Chaffin coalbed. These beds are of about the same thickness as the Chaffin coal but have not been mined in or near the watershed. They are of wider occurrence than the Chaffin coal and have been mined in other parts of the state.

The ground water resources include highly mineralized water available at shallow depths and good quality water available at depths of 2,500 feet or more.[8] The shallow ground water aquifers, located mainly in Quaternary age sand and gravel deposits, are generally low yielding and not considered to be dependable sources of water, as they often go dry during periods of prolonged drouth. The quality varies in quantity and kind of mineral content, with some of the water usable for domestic and livestock uses and some unfit for any use. The deep water aquifer is the Hickory Sandstone Member of the Riley Formation (Cambrian age). This aquifer yields dependable quantities of good quality water.

Streamflow is ephemeral throughout the watershed. Some isolated waterholes store water for short periods following runoff and for longer periods of time in areas where alluvial gravels provide seepage during the wettest seasons of the year. Streamflow on the Colorado River is perennial. Approximately 150 ponds provide fairly dependable surface water supplies except during periods of long drouth.

The quality of the surface water, as runoff, in the watershed is unknown. The ephemeral streamflow characteristic precludes water sample collection and analysis that would provide meaningful data. Generalized information indicates that the prevalent chemical in the streamflow is the calcium-magnesium carbonate-bicarbonate type.[9] There is no known serious pollution problem resulting from the present agricultural activity. There are no urbanized areas and the rural population is low. Erosion on the agricultural lands contributes an average concentration of about 1,900 milligrams per liter of sediment in the annual runoff.

The quality of impounded water at Brady Lake is considered to be the best indicator of the qualities of surface water within the Southwest Laterals watershed. Brady Lake is located within the adjoining Brady Creek watershed.

Soils, geology, and land use are very similar within the watersheds. Brady Creek watershed has 41 floodwater retarding structures and 1 multiple-purpose structure (Brady Lake) installed.

The quality of water at Brady Lake as indicated by a test made in November, 1972,[10] is shown below.

Dissolved silica (milligram per liter)	8.1
Dissolved calcium (milligram per liter)	52
Dissolved magnesium (milligram per liter)	12
Dissolved sodium (milligram per liter)	47
Dissolved potassium (milligram per liter)	8.3
Bicarbonate (HCO_3) (milligram per liter)	156
Dissolved sulfate (milligram per liter)	40
Dissolved chloride (milligram per liter)	87
Dissolved fluoride (milligram per liter)	.2

Total nitrate (N) (milligram per liter)	.20
Dissolved solids (milligram per liter)	333
Hardness (Ca, Mg) (milligram per liter)	180
Non-carbonate hardness (milligram per liter)	51
Sodium absorption ratio	1.5
Specific conductance (micromhos)	614
pH (units)	7.9
Temperature (^{o}C)	14.0
Dissolved boron (UG/L)	250

Water quality and stream discharge information for the Colorado River is being collected near Stacy in the northwestern part of the watershed by the Geological Survey, U. S. Department of the Interior.(11) Water quality weighted average mean values and loads for water year October 1972 to September 1973 are as follows:

Specific conductance (micromhos)	1,750
Dissolved solids (milligram per liter)	1,040
Dissolved chlorides (milligram per liter)	330
Dissolved sulfate (milligram per liter)	260
Hardness (Ca, Mg) (milligram per liter)	530

The maximum water temperature recorded was 32^{o} C. in August and 2^{o} C. in December and January.

Stream discharge records for water year October 1972 to September 1973 show a mean flow of 160 cubic feet per second with continuous flow occurring in all months. However, flows of less than 10 cubic feet per second were recorded on 14 days during the year. These occurred in the months of October, August, and September.

The climate in the watershed is sub-humid, with a mean annual precipitation of 25 inches. The wettest months, generally, are April, May, June, and October. Temperature means range from 45^{o} F. in January to 81^{o} F. in July. Freezes of short duration occur frequently in the winter months and temperatures exceeding 100^{o} F. are common in the summer. An average frost-free growing period of 229 days occurs between late March and early November.(12)

Present and Projected Population

The population of the two counties in which the watershed lies declined from 21,528 people in 1930 to 11,508 people in 1970.(2) A similar decline probably occurred within the watershed, and the present population is estimated to be 900 people. This population has remained static in recent years. No significant changes in the population are anticipated due to the rural setting and existing land ownership patterns.

Economic Data

The watershed economy depends primarily upon agriculture. Most of the agricultural activities are associated with the production of small grain, grain sorghum, cotton, hay, and diversified livestock operations. Principal crops grown and average yields per acre are: Cotton, 300 pounds of lint; grain sorghum, 1,700 pounds; oats, 50 bushels and 2.5 animal unit months of grazing; hay, 3.0 tons; and range, 1.2 animal unit months of grazing. Cotton has been decreasing as a major crop during past years.

There are approximately 358 operating units in the watershed, averaging 791 acres in size. The current market price of agricultural land ranges from $150 to $300 per acre, depending on soil capability and location. Approximately 80 percent of the operating units are owner-operated, while most of the leased land is operated by neighboring landowners.

It is estimated that less than 5 percent of the agricultural land is in operating units using 1-1/2 man-years or more of hired labor.

Approximately 90 percent of the flood plain is operated as family-type farms.

There has been a change in recent years from a diversified-type farming to a more specialized livestock enterprise. In the future, it is expected that more emphasis will be placed on growing small grains and hay crops. These are well suited to the soils and climate, and are important to supplement range when native grasses are dormant. The size of the operating units will continue to expand, with a gradual decrease in the number of farm units. The population and concentration of inhabitants in the watershed should remain about the same.

The cities of Brady and Eden are the principal market centers serving the watershed. Modern transportation facilities consisting of bus, motor freight, and railroads provide service to the area. The watershed is served adequately by approximately 110 miles of farm-to-market roads and 150 miles of county roads, which provide all-weather travel within the watershed.

Plant and Animal Resources

There are two major vegetative communities in the watershed: the oak-grass savannah of the Edwards Plateau, often called the "hill country savannah," and the grass prairies of the Rolling Plains portion of the watershed.(13)

The Edwards Plateau savannah consisted originally of a mixture of live oak, shin oak, ashe juniper, and a number of other species of shrubs

in mottes or bands, interspersed with open glades or areas of grassland (see Appendix A for scientific names of plants). Little bluestem, indiangrass, big bluestem, sideoats grama, hairy grama, tall dropseed, and green sprangletop predominated. Numerous forbs such as bushsunflower, engelmanndaisy, halfshrub sundrops, and prairieclover were found in lesser amounts.

The Rolling Plains grassland included primarily sideoats grama, vinemesquite, cane bluestem, texas wintergrass, curlymesquite, and numerous forbs. Switchgrass was found along the waterways. Woody plants were sparse, mostly confined to the waterways or draws, or an occasional tree on the open prairie. Mesquite and live oak were most common though not abundant. Cedar elm, hackberry, and a few other woody species were found on the waterways. Shrub type vegetation was found in small amounts, primarily on rocky or shallow soil areas. Lotebush and littleleaf sumac were the major shrub species.

Vegetation on rangelands has undergone a great change. Cattlemen first moved into the area beginning about 1850, first grazing their herds on open range. They found the area to be a wonderful livestock producing country with its rich growth and variety of forage plants, and the numbers of livestock steadily increased. H. L. Bentley recorded that a stockman traveling in the area in 1876 reported "Grass everywhere 1-3 feet high, sometimes as high as a cow's back on uplands as well as bottoms."(14)

Bentley stated that in 1898 the rangeland grasses had been greatly reduced. Where once as many as 300 head per section had been grazed, no more than 64 head of livestock per section could then be carried. Drouth was an important factor in the range deterioration. Early writers have recorded several severe drouths in the 1880's and again in the period 1893-1894. Continuous close grazing of the forage plants weakened them, causing many to die, and opening up the ground cover to let lightly grazed plants, or those not grazed, to increase and spread. Annual weeds increased manyfold. Where occasional wildfires started by lightning or by Indians had previously kept woody plants from increasing, there now was not enough fuel to carry a hot fire, and the woody plants were able to germinate and spread. Mesquite and junipers spread out upon the range. Bentley noted that pricklypear cactus had greatly thickened.

Settlement of the area by farmers began in the late 1800's, and continued in the early 1900's. The deeper, more fertile soils began to be plowed out for cropland. By 1930, a large part of the Rolling Plains portion of the watershed was in cropland. The more shallow soils, and the Edwards Plateau portion, because of rocky soils and steep slopes, remained largely in rangeland.

Deterioration of the range condition continued on those lands remaining in grassland through continued heavy grazing. Sheep were introduced into the area in the late 1800's and now are grazed extensively. Buffalograss, curlymesquite, and texas wintergrass, three plants that can tolerate some close grazing, increased and now are the most common grasses. Other grasses that occur in lesser amounts and are low in palatability and productivity are red threeawn, red grama, texas grama, and hairy tridens. Numerous weedy forbs which are of little forage value have replaced the more palatable forbs. Mealycup sage, western ragweed, and numerous annuals are the most common. The natural ground cover has been greatly reduced and surface crusting, runoff and loss of rainfall, and erosion have become problems on rangeland.

A more evident phase of the range deterioration has been the increase in the woody plants. Mesquite, junipers, lotebush, and others have increased and spread to open grasslands, forming areas of dense thickets. Many of the woody plants have little value for browse or wildlife food, though they do furnish cover and nesting habitat for birds. The woody plants tend to shade or crowd out the grass and forb forage plants and compete for water and soil nutrients.

Since the 1940's, many landowners have attempted to arrest the spread of the noxious plants and increase forage production. However, woody plant control measures are only partially successful, since no treatment presently used or known obtains a complete kill. Reinfestation occurs rapidly from seed and rootsprouts, and treatment must be repeated every 5 to 10 years to maintain control. Brush management has been applied on about 61,000 acres (about 30 percent) of the rangelands, and range seeding to reestablish desirable grasses on about 4,800 acres. Brush management has been carried out on many units so as to leave more desirable plants, or to leave mottes or strips of woody plants for wildlife food and cover. Grazing management to permit the improvement of better forage plants has been applied on about 66 percent of the rangeland, and it is now estimated that more than half is in "fair condition," having 25 to 50 percent of the better forage plants.

The most common gamebirds in the watershed are mourning doves and bobwhite quail. Populations of these birds vary each year due to availability of food and cover. There have been small numbers of turkey crossing the area during the spring and summer months; however, the habitat is marginal within the watershed.

White-tailed deer are present in varying numbers throughout the watershed. Population ranges from extremely sparse (one deer per 250 acres) in the Rolling Plains portion of the watershed to heavy (one deer per 20 acres) in the Edwards Plateau portion. Limited numbers of opossum, raccoon, skunk, cottontail rabbit, jackrabbit, field mice, snakes, lizards, and songbirds are found throughout the area.

Fishery resources are limited to farm and ranch ponds and the Colorado River, which is the northern boundary of the watershed.

The area is within the migration range of the southern bald eagle and the Arctic and American peregrine falcon. No other threatened or endangered species of vegetation, fish, birds, mammals, reptiles, or amphibians are known to occur in the watershed.[15]

Recreational Resources

Recreational resources within the watershed are limited to fishing at 150 ponds and the Colorado River. Most of these areas are on privately owned lands and access is by invitation or on a fee basis. A very limited area is leased on a fee basis for the hunting of deer. Excellent opportunities are available for most forms of water-based recreation at the nearby Brady Reservoir, which is located about 5 miles south from the watershed.

Archeological and Historical Resources and Unique Scenic Areas

The Colorado River valley area is known to contain an abundance of archeological evidence even though very little archeology has been done in the vicinity of the watershed.[16] A reconnaissance archeological study by L. M. Green[17] and a detailed archeological investigation by archeologists of the Archaeology Research Program of Southern Methodist University[18] have documented the existence of archeological sites within the Salt Creek portion of the watershed.

Two prehistoric sites and scattered lithic debris were found during the preliminary archeologic investigation of the areas to be affected by planned floodwater retarding structures Nos. 1, 2, 4, and 5. One of the prehistoric sites, numbered X41CC1, occurs at floodwater retarding structure site No. 1 and the other, No. X41CC2, occurs at structure site No. 5. Both archeological sites are on privately owned land and show evidence of disturbance due to agricultural activity. The following is quoted from the unpublished report, Prehistoric Archaeology in the Southwest Laterals Sub-Watershed, by Skinner and Mahoney:

> On the basis of the physical remains at site X41CC1, this mound site was occupied by dart using hunting and gathering people and subsequently by arrow using hunting and gathering people. The site was intermittently used by a task group that was concerned with cooking (mound, mussel shell), hunting (projectiles), food processing (scrapers, retouched pieces), and tool manufacturing (lithic debris, cores, hammerstones).
>
> The mound was the location where cooking was carried out while the living/work area at the site is adjacent to the mound on the south

and east side. It is expected that the site was occupied either during a season when water was available in the creek or at some point in the past when the creek carried a regular flow of water.

Site X41CC2 is similar to site X41CC1 in that they both include a mound and living area and both contain dart and arrow points which are normally considered evidence of multiple occupation of the site. Recent excavation of burned rock mounds near Kerrville has shown that arrow points and dart points occur in mounds and must in part be contemporaneous (Skinner 1974). The two sites have similar artifact assemblages, although ground stone tools were not noted at the first site, and it is expected that they were occupied repeatedly for short periods of time and for the same purposes.

Subsequent investigation by the Archaeology Research Program at Southern Methodist University revealed that site X41CC1 does not warrant nomination to the National Register of Historic Places. The Research Program archeologists did recommend site X41CC2 for placement on the National Register and are in the process of preparing the nomination. Their tests revealed that the site covers an area of 6,875 square meters and that the subsurface deposit is well preserved. They suggested that excavation of the site is warranted if alternate structural measures are not feasible.

Soil, Water, and Plant Management Status

Trends in land use changes in the watershed have been toward more rangeland and improved pastureland and less cropland.

The land treatment program is progressing steadily with committed factors of production being employed more efficiently on marginal land.

There is little, if any, need for drainage and not a large enough supply of water for irrigation in the watershed.

The Concho and the San Saba-Brady Soil and Water Conservation Districts, which operate in this watershed, have been very active. Approximately 92 percent of land in the watershed is in conservation plans, while about 51 percent of the planned practices have been applied to date (table 1A).

Soil and water conservation plans have been developed on 289 of the approximately 358 operating units located wholly or partially within the watershed.

water. One small rural community, Lohn, has an adequate supply of municipal water. This is obtained from the Hickory Formation at a depth of 2,800 feet. Plans have been made for a rural water cooperative to supply water to the rural area.

Recreation Problems

There are no public recreational facilities within the watershed. The Colorado River provides recreational opportunities; however, public access is limited. At present there are no individuals or groups interested in developing recreational enterprises for public use. However, excellent opportunities for outdoor and water-based recreation are available at nearby Brady Lake, which is less than 25 miles from the most distant point in the watershed.

Plant and Animal Problems

Fish and wildlife problems are primarily those of reduced food and cover and sedimentation of ponds stocked with fish.

Parts of the watershed are in cropland, with turnrows and field boundaries kept clean of vegetation. Cover, nesting sites, and food are inadequate in such areas, except where the field edges are allowed to remain in vegetation.

Food, cover, and water are problems for wildlife on the rangelands and pasturelands. Low condition, closely grazed grasslands provide poor cover and only limited food for birds and deer. Some of the annual weeds, such as oneseed croton, produce seed that is good food for doves and quail; and others, such as texas filaree, redseed plantain, and huisachedaisy, are good forage for deer. However, they generally have replaced more productive perennial forbs on poor rangelands, and furnish only seasonal use. The deer population on the Edwards Plateau portion of the watershed has caused excessive browsing of the deer forage plants, and a reduction in the more favored deer food plants. Rangelands heavily grazed by sheep and goats are especially low in browse and forage for deer, and deer populations are reduced either by die-off or by moving to nearby better-managed ranges.

Economic and Social

Most of the operating units in the watershed are family farms and ranches. Of approximately 358 operating units in the watershed, 32 percent earned less than $5,000 in 1970. The median income in 1970 was about $3,900, with some 23 percent earning from $2,500 to $3,999 and 28 percent earning less than $2,499.

There is a need for additional employment of one or more members of a farm family in more than 24 percent of the families in the watershed.

It is estimated that less than 5 percent of the agricultural land is in operating units using 1-1/2 man-years or more of hired labor.

There are needs for rural water systems and better housing.

Other

Other problems closely related to the agricultural flood damage include fears associated with possible future floods, and indirect losses such as the decline in property values, tax revenues, and community services.

PROJECTS OF OTHER AGENCIES

There are no known existing or soon to be constructed water resource development projects within the watershed which have a direct relationship to the works of improvement in the plan.

Lake Buchanan, an existing facility on the Colorado River, is located about 75 miles downstream from this watershed and will benefit from a reduction in sediment delivered to it from the project area.

The Texas Water Plan[18] includes the Stacy site as a proposed or potential reservoir to be constructed on the Colorado River near the Runnels, Concho, and Coleman County lines. The works of improvement included herein will not have any detrimental effects on any existing or proposed facility included in the water resource development plan for the Colorado River Basin.

Plans have been developed for installation of a rural water system to supply water to the residents of the area. The water is to be obtained from the Hickory Sandstone aquifer.

PROJECT FORMULATION

Objectives

After a reconnaissance of the watershed was made by specialists of the watershed planning staff, meetings were held with the sponsoring local organizations to discuss existing problems and to formulate objectives for a watershed protection and flood prevention program. This watershed depends almost entirely on agricultural enterprises for its income. Livestock farming is the major type of operation. Moderate to severe flooding causes extensive damage to flood plain lands, improvements, and crops.

The Texas Parks and Wildlife Department and the Fish and Wildlife Service, U. S. Department of the Interior, made a reconnaissance study of the watershed and made recommendations for the preservation and enhancement of the fish and wildlife resources.

Archeologists from the Department of Anthropology, Archaeology Research Program, Southern Methodist University, made an archeological assessment of the seven planned floodwater retarding structure sites.

Public meetings were held with the sponsoring local organizations. It was recognized by the sponsoring local organizations and planning staff personnel that development of a sound watershed protection and flood prevention project would present many problems due to the wide variation of soil types, treatment needs, and topography of the potential structure site locations.

The opportunities for including storage capacities for purposes other than flood prevention were explained, as were the local responsibilities in connection with completing the project. The sponsors determined that a project for watershed protection and flood prevention would most nearly meet their needs, and that no group or individual was interested in additional storage for other purposes.

In addition to expressing their desire for the establishment of a complete program for soil and water conservation in the watershed, the following specific objectives were named by the local interests:

1. Establish the remaining needed land treatment measures which contribute directly to watershed protection and flood prevention.

2. Attain a 65 to 70 percent reduction in average annual flood damages on tributaries where structural measures could be used to supplement land treatment to insure sustained agricultural production on flood plain lands and to maintain the economy of the watershed.

The Soil Conservation Service agreed that the desired level of flood protection and watershed improvement was reasonable. Although some reduction in flooding would result from the application of needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

In selecting potential sites for floodwater retarding structures in the Salt Creek portion of the watershed, consideration was given to the locations which would provide the desired level of protection for the areas subject to flood damage.

Preliminary surveys indicated that 11 locations above flood plain areas subject to significant floodwater and erosion damage had favorable topographic features for the installation of floodwater retarding structures. The 11 potential site locations provided for two alternate

systems of floodwater retarding structures to be evaluated. One system included nine floodwater retarding structures and the other system included seven structures. An evaluation of each of these systems indicated the system of seven floodwater retarding structures would provide a higher level of floodwater and erosion damage reduction at less monetary cost and commitment of land resources.

An intensive study of Cow Creek indicated that potential floodwater retarding site locations were not available at locations that would provide protection to much of the flood plain having a major problem. An analysis of topography indicated that only two locations had storage capacity adequate for installation of floodwater retarding structures. Detailed studies of the two sites and an evaluation of effects on flood problems indicated that benefits that would be derived from installation of floodwater retarding structures at the two available locations would not be commensurate with the monetary costs and commitment of land resources.

Studies of preliminary investigation scope were made of Saddle, Elm, Bluff, and Cedar Creeks. These studies indicated that problems associated with floodwater, overbank deposition of sediment, and flood plain erosion are minor and do not warrant structural works of improvement because of low frequency of flooding, limited areas subject to flooding, and the low intensity of land use.

The proposed works of improvement, including both land treatment and structural measures, most nearly meet objectives in providing the desired level of protection for agricultural enterprises and satisfying the needs of the watershed at the least cost.

Environmental Considerations

The sponsors carefully considered the impacts, both favorable and adverse, in developing the plan for meeting the project objectives. Adverse effects were avoided when possible if the project objectives could be achieved. The sponsors recognized that a certain amount of land would need to be committed to the project. The structure sites were selected and structures were planned to minimize adverse effects to farming and ranching operations, transportation networka, utility lines, fish and wildlife habitat, etc., as much as was practical.

Multiuse plants will be used in vegetating the structures, disturbed areas, and idle areas around the sites for use by livestock and wildlife and to prevent erosion.

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 direct livestock watering and lake fisheries. The

sediment pools of all structures are expected to hold water and offer an opportunity for recreational use. However, the problems, expenses, and liability associated with the landowners' opening their property to public use limit the acceptance of this activity. The costs associated with land rights acquisition for this purpose by the sponsoring organizations exceed their financial ability. For these reasons, the sponsors do not plan to assure public access to any of the structures. If, at some future time, the sponsors do assure public access, they will provide adequate sanitary facilities in compliance with public health laws prior to making the areas available for recreational use.

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 habitat for the existing fish and wildlife resources of the watershed.

Archeologists from the Archaeology Research Program of Southern Methodist University investigated two prehistoric sites located within the areas required for the floodwater retarding structures. As a result of these investigations, it was recommended that one site, numbered X41CC2, be nominated to the National Register of Historic Places and that alternative structure measures be used if feasible. To prevent project disturbance of this archeological site, the structure was redesigned with the centerline of the dam moved about 700 feet upstream. This new location will not adversely effect project objectives and will preserve the archeological site.

The Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, made the following recommendations for consideration by the sponsors and the Service for installation of the project measures included in the work plan:

1. Landowners be encouraged to consult with biologists of the Texas Parks and Wildlife Department concerning management of watershed farm ponds and floodwater retarding structures for fish and wildlife.

2. To compensate for wildlife habitat losses, trees, shrubs, and forbs such as russianolive, bumelia, shin oak, hackberry, western soapberry, black locust, persimmon, saltbush, skunkbush, littleleaf sumac, engelmanndaisy, maximilian sunflower, common sunflower, and other plants of wildlife value be planted below the dams, around the spillways, and other areas disturbed by project construction.

3. All dams and spillways be vegetated with grasses such as kleingrass, plains bristlegrass, switchgrass, blue panicum, johnsongrass, vine-mesquite, dallisgrass, and other erosion resistsnt species which provide a food and cover source for wildlife.

4. To provide wildlife cover, brush cleared from the sediment pools, dams, and spillways be placed in open areas just outside the detention pools.

5. The Soil Conservation Service should encourage landowners to implement brush control and pasture and hayland planting to include, as a minimum, the retention of 200- to 300-foot-wide brush strips separated by a maximum spacing of 800 feet with connecting screening blocks on flat and rolling terrain and complete retention of brush on steep sites, draws, and along stream courses.

6. To preserve wildlife habitat at the detention reservoir sites, specific vegetation should be retained and plantings made as follows:

   A. At Site 1, brush disturbance along the east slope should be minimal. Plains bristlegrass, switchgrass, littleleaf sumac, and hackberry should be planted behind the dam.

   B. At Site 2, disturbance of lotebush and cstclaw acacia stands along the slopes should be minimal. Johnsongrass, plains bristlegrass, blue panicum, switchgrass, littleleaf sumac, and bumelia should be planted on appropriate sites below the dam.

   C. At Site 3, mature stands of mesquite above the sediment pool and scrub brush growth along the slopes should be left intact. Supplemental plantings of bumelia, western soapberry, and blue panicum should be made on odd areas.

   D. At Site 4, the two largest live oak groves near the dam site should not be disturbed as both are active roosts for wild turkeys. A protective levee or other structural device should be installed to prevent permanent inundation of these trees by sediment pool waters. The oak grove south of the channel plus a minimum of five associated acres extending upstream along the south margin of the channel should be maintained in its natural state as a refuge for wildlife. Also, a 10-acre tract incorporating the vegetated area and extending below the dam for 300 yards should be protected as above. Supplemental

plantings of switchgrass and blue panicum should be made on this 10-acre area.

E. At Site 5, live oak mottes and scrub brush stands outside of the sediment pool and on miscellaneous sites below the dam should be preserved for wildlife. Supplemental plantings of bumelia, switchgrass, blue panicum, and plains bristlegrass should be made on these areas.

F. At Site 6, all timber outside of the siltation pool and dam location should be preserved. The five-acre thicket of mixed vegetation on the west bank along the upper slope and immediately above the dam should be left for wildlife. Also, a five-acre area below the dam and on the lower slope of the east bank should be preserved for wildlife. Supplemental plantings of switchgrass, blue panicum, and plains bristlegrass should be made on this area.

G. At Site 7, the soapberry mottes and mature stands of mesquite should be preserved. A fence should enclose a 15-acre area along the upper shoreline of the detention pool including shallow pools for wildlife feeding, watering, and resting areas. Plantings of bumelia, switchgrass, plains bristlegrass, maximilian sunflower, and vine-mesquite should be made within the enclosures.

The sponsoring local organizations and the Service considered the recommendations made by the Fish and Wildlife Service and the Texas Parks and Wildlife Department in formulating the land treatment and structural measures to be included in the work plan.

The recommendations in item No. 5, which concern land treatment measures on rangeland and pastureland, have been incorporated in the planned land treatment. The recommendations contained in items Nos. 2, 3, 4, and 6 for enhancement of wildlife habitat on the fenced and revegetated areas and around the dams, emergency spillways, and areas disturbed during construction have been included in the plans for the floodwater retarding structures. Item 6.D. recommends that two live oak mottes near the centerline of the dam at Site 4 not be disturbed by construction and that a grove of live oaks in the upper edge of the sediment pool, as well as a larger grove of live oaks downstream from the dam, should be preserved. All of these areas are present or potential roost areas for wild turkey. It is not physically feasible to preserve the two small mottes located near the dam without moving the dam. Moving the dam upstream will destroy more trees in the grove which extends upstream from the upper end of the sediment pool. Moving the dam downstream will destroy a larger number of oak trees in the grove which extends downstream from

the dam. The grove located in the upper part of the sediment pool will be preserved by establishing the elevation of the lowest ungated outlet to assure that none of these trees are killed by the impoundment.

The sponsors will encourage the land users to apply the recommendations in item No. 1 for fish habitat improvement in the sediment pools and in items Nos. 6.A., 6.B., 6.C., 6.D., 6.E., and 6.F. for wildlife habitat improvement in the detention pools and in areas downstream from the structures.

There will be no project actions, either direct or induced, that will destroy the wildlife habitat value of the 15 acres along the detention pool shoreline of floodwater retarding structure No. 7. Therefore, acquisition and fencing are not considered necessary for mitigation. It is doubtful that some of the plant species recommended could tolerate the periodic inundation that will occur. Vegetation in the area will change slightly but various paspalums, sedges, and weeds that provide food and cover for wildlife are well adapted to this area and will establish through natural selection. The sponsors did not believe mitigation was necessary since the wildlife habitat value will not be destroyed and did not elect to acquire, at considerable cost, the 15 acres to fully implement recommendation 6G. However, they plan to encourage landowners to apply wildlife habitat management practices to the area as dual land treatment for beautification, environmental enhancement, and wildlife habitat improvement.

The minor reduction in streamflow of the Colorado River caused by evaporation and seepage losses in the sediment pools of the floodwater retarding structures was determined not to be significant enough to consider initially storing a lesser amount of permanent water in the sediment pools. All of the structures will have provisions to release impounded floodwater if it becomes necessary to avoid encroachment upon prior downstream water rights.

There will not be any displacement of people, businesses, or farm operations by the installation of the works of improvement.

Alternatives

The considered alternatives to the proposed action were: (1) An accelerated program of applying land treatment measures and changing the land use on the Salt Creek flood plain to a less intensive use; and (2) foregoing the implementation of a project. A discussion of each alternative follows.

Alternative No. 1 - Alternative No. 1 consists of applying the land treatment measures as proposed in the project action and changing the land use on Salt Creek and Cow Creek flood plains to a less intensive use.

The land treatment measures to be applied and the environmental impacts of these measures are the same as those of the selected plan. This alternative would reduce the sediment load carried into the Colorado River from 123,500 tons to 117,000 tons annually.

This alternative would require changing the land use of all the cropland located in the flood plain of Salt Creek and Cow Creek to rangeland. This less intensive use of the land would reduce the monetary damage caused by floodwater and flood plain scour.

The damages to the transportation system would continue and the damage to other agricultural property, livestock, fences, etc., would increase. This alternative would reduce the annual net income on the cropland changed to rangeland by $19 per acre and would cost about $2,526,700 to implement. This includes $137,000 for the cost of seeding the cropland to rangeland vegetation, $963,700 for installation of land treatment measures, and $1,426,000 as the capitalized present value of the loss in net income. The families that maintain an adequate level of income with a row crop agricultural system would find it necessary to expand their ranching operation to maintain the same level with the grassland.

The habitat for wildlife, primarily dove, which depend upon the waste grains that are produced seasonally in a row crop environment would be adversely impacted. However, the habitat of the species of wildlife which depend on rangeland would be improved.

Alternative No. 2 - Alternative No. 2 consists of foregoing the implementation of the project. Land treatment measures would continue to be applied for watershed protection. It is reasonable to expect that land users would eventually install many of these measures to maintain the productivity of their lands. However, the level and rate of application of these measures would be lower than in the selected plan due to limited availability of technical assistance and associated motivation.

The environmental impacts of installing the land treatment measures under the going program would be generally the same as those discussed under "Environmental Impacts - Land Treatment Measures." However, the magnitude of the impact of these measures would be less due to the lower level and rate of application.

Average annual floodwater damages would be reduced by about 5 percent as a result of the land treatment measures expected to be applied without accelerated technical assistance.

The selection of alternative No. 2 would forego the opportunity to realize about $130,360 in average annual net benefits.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The planned land treatment measures (conservation practices) will be applied on private lands in the watershed by land users on a voluntary basis. These measures are based upon a resource conservation plan developed by the land user in cooperation with the Concho and the San Saba-Brady Soil and Water Conservation Districts. The Soil Conservation Service will provide technical assistance to the land user in the planning and application of all soil, plant, and water conservation measures.

Land treatment measures which the sponsors plan to encourage the users of watershed lands to install are those that will reduce soil and water losses, assure proper functioning of the project structural measures, reduce flooding, and preserve and improve the fish and wildlife resources. The goal is to complete the application of needed treatment measures on 11,270 acres of cropland, 500 acres of pastureland, and 70,980 acres of rangeland during the 6-year installation period in addition to maintaining those measures which have already been applied.

Land treatment measures expected to be installed on cropland include conservation cropping systems, crop residue management, diversions, terraces, contour farming, and grassed waterways. Conservation cropping systems consist of rotation systems which incorporate high residue crops and soil improving crops in the cropping pattern. Crop residue management consists of leaving plant residues, including waste grain from grain crops, on or near the soil surface for protection against raindrop energy and the resultant erosion of the detached soil. The other cropland practices consist of water control measures designed to control erosion by disposing of runoff into stable outlets.

Land treatment measures which are expected to be applied on pastureland include pasture and hayland planting, pasture and hayland management, and critical area planting. Pasture and hayland planting consists of establishing adapted soil protecting forage plants for livestock grazing use on land formerly used as cropland. Pasture and hayland management consists of management practices designed to maintain an effective soil protecting cover of vegetation on the land throughout all seasons of the year. Practices used to achieve this objective include fertilization, control of grazing, control of undesirable plants, etc. Critical area treatment consists of practices somewhat similar to pasture and hayland planting.

Land treatment measures expected to be applied on rangeland include proper grazing use and deferred grazing. These practices are designed to control grazing by livestock in order to maintain an effective soil

protecting cover of vegetation on the land at all times and to maintain a variable plant community of the more desirable forage grasses and forb plants of the native prairie.

Additional measures which are expected to be applied to the rangeland include ponds for livestock water supply and brush management to prevent woody plant takeover of lands used for grazing. Land users are encouraged to apply this practice with consideration for needs of wildlife by leaving strips and mottes for cover and travel lanes.

Land treatment measures planned to permanently benefit fish and wildlife resources in the watershed are wildlife upland habitat management and fishpond management. Land users will be encouraged to seek the advice of the Texas Parks and Wildlife Department or the Soil Conservation Service in the management and stocking of the reservoirs for fish and the management of those waters for wildlife. Land users will be encouraged to retain or create wildlife habitat and apply proper management to preserve and enhance the wildlife resources of the watershed. Wildlife upland habitat management will include the preservation of woody plant cover along watercourses and fence rows, special cover plantings, and seeding of food plants.

Structural Measures

No structural measures are planned for installation on Saddle, Elm, Bluff, Cedar, Corn, or Cow Creeks. A system of seven floodwater retarding structures will be installed to provide protection to the flood plain lands of Salt Creek. The locations of structural measures are shown on the project map (figure 4).

The combined capacities of the seven floodwater retarding structures total 8,284 acre-feet. Of this amount, 1,172 acre-feet are provided for sediment accumulation and 7,112 acre-feet for floodwater detention. Installation of the structural measures will require 1,102 acres of land. Construction of the dams and spillways will require 176 acres of land. Sediment pools will initially impound water on 226 acres of land, and floodwater will be temporarily impounded on an additional 700 acres of land. The area on which the dams and spillways will be constructed and on which sediment and floodwater will be impounded consists of 1,078 acres of rangeland and 24 acres (9 miles) of ephemeral stream channels under present land use conditions.

Runoff will be retarded from 36.70 percent of the Salt Creek drainage area above valley section 101 (figure 4). Floodwater detention represents an average of 3.80 inches of runoff from the area upstream from the structures. The amount of runoff controlled by each structure is shown in table 3.

The planned floodwater retarding structures will be located on an outcrop of the Upper Pennsylvanian strata consisting of hard limestone, sandstone, and shale.

The principal spillways of the seven structures will bottom on unyielding foundations. The inlets will be standard monolithic rectangular reinforced concrete structures.

The outlets of the structures will be of prestressed, concrete-lined steel cylindrical pipe. Due to the favorable foundation conditions, a minimum of camber will be required in the principal spillway conduits.

From 30 to 40 percent of the materials to be excavated from the emergency spillways of structures Nos. 1, 2, 3, 4, 6, and 7 consists of thinly bedded limestone. This rock will be used to face the front slopes of the embankments for protection against wave action. The remaining materials consist primarily of soft shales interbedded with the limestone. Generally, the finished emergency spillways will be in earth and will be vegetated.

Preliminary investigations indicate that most of the needed fill material will be available from the sediment pool areas. The material consists of silty, gravelly clay with seams of caliche. This will be satisfactory material for fill on the type of foundations existing at each site.

A combination of principal spillway capacity and retarding storage will assure that emergency spillways of the structures will have a maximum of 3.5 percent chance of functioning in any given year at the end of their design life.

Due to highly weathered bedrock, slight to moderate seepage can be expected from the sediment pools. The structural designs for structures Nos. 3, 5, 6, and 7 have provided foundation drains for the seepage problems at their locations. Seepage problems at structures Nos. 1, 2, and 4 were found to be insignificant.

The sediment pools are designed to store the 100-year sediment yield. The sediment yield to the floodwater retarding structures is allocated 85 percent submerged and 15 percent aerated. Pools exceeding 200 acre-feet in capacity will have the principal spillway ported at the 200 acre-feet elevation including borrow excavation.

Provisions have been included in the plans for the floodwater retarding structures to preserve and enhance the fish and wildlife resources. These provisions include the planting of multiuse plants within the fenced-in portions of the dams, emergency spillways, and areas disturbed during construction and encouraging the land users

to retain and enhance the mottes, strips, and small groves of live oak vegetation which occur in the detention pools and areas surrounding the structures. Much of this woody vegetation consists of live oak trees which the land user retained when he cleared other invading brushy species from the rangeland. A grove of live oak trees and brush on the upper edge of the sediment pool at structure No. 4 will be preserved for use by wild turkey by establishing the elevation of the lowest ungated outlet to assure that these trees are not permanently inundated. Brush cleared from the area required for dams, emergency spillways, and borrow will be placed in piles for utilization by wildlife in certain areas of detention pools where risk of interference of this material in the operation of the principal spillways is minimal. The multiuse plants from which planting selections will be made, based on availability of seed stock, include the following grasses for seeding of the dams and emergency spillways: kleingrass, plains bristlegrass, switchgrass, blue panicum, johnsongrass, vine-mesquite, dallisgrass, and other erosion resistant grasses. Forbs and woody plants to be used inside the fenced areas surrounding the embankments and emergency spillways will be selected from the following species as plant and/or seed stock is available: russian-olive, bumelia, shin oak, hackberry, western soapberry, black locust, persimmon, saltbush, skunkbush, littleleaf sumac, engelmanndaisy, maximilian sunflower, common sunflower, and other similar plants.

The initial impoundment below the crest of the principal spillway will be equal to the submerged sediment volume, except for floodwater retarding structures Nos. 1, 4, and 6 which will be ported to limit storage to 200 acre-feet.

To install the structural measures, it will be necessary to alter, relocate, or close a county road in the upper reaches of structure No. 1. In the reservoir areas of structures Nos. 1, 3, and 6, it will be necessary to alter or relocate utility lines.

The Commissioners Courts of McCulloch and Concho Counties will provide and maintain crossings on public roads to permit passage of traffic during periods when the structures are releasing water.

Under present conditions no farm or ranch operation, business, or person will be displaced by the installation of the planned floodwater retarding structures. However, 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.

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the works of improvement; to provide for flowage of water in or upon or through the structures; and to

provide for the permanent storage and temporary detention, either or both, of any sediment or water.

The environment will be protected from soil erosion and water and air pollution during construction. Contractors will be required to adhere to strict guidelines set forth in each construction contract to minimize soil erosion and water and air pollution during construction. Excavation and construction operations will be scheduled and controlled to prevent exposure of excessive amounts of unprotected soil to erosion and the resulting translocation of sediment. Measures to control erosion will be uniquely specified at each work site and will include, as applicable, use of temporary vegetation or mulches, diversions, mechanical retardation of runoff, and traps. Motors of construction equipment will be required to have mufflers to reduce noise. 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.

Necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such facilities being injuriously adjacent to live streams, wells, or springs in conformance with federal, state, and local water pollution control regulations. 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.

The environment will continue to be protected from erosion and water pollution following completion of construction. Project sponsors will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution.

The sediment pools of all floodwater retarding structures are expected to hold water. The pools and surrounding areas have a good potential for incidental recreational use. However, the sponsors do not plan to assure public access to any of the structures; 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 will

assure that adequate sanitary facilities, in compliance with public health laws, are installed prior to making the areas available for public use.

Figures 1, 2, and 2A show structures which are typical of those planned for the watershed. Table 3 shows details on quantities and design features of the structural measures.

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

The project has been coordinated with the Texas State Historical Commission and the National Park Service, U. S. Department of the Interior, in accordance with Public Law 86-665 (Historic Preservation Act of 1966), the President's Executive Order No. 11593, and the Advisory Council on Historic Preservation's "Procedure for Protection of Historical and Cultural Properties." The installation of the project will not encroach upon any known historic places or any planning by the Commission for historic preservation. There are no historic places or properties listed in the National Register of Historic Places.

Investigations by the Archaeology Research Program, Southern Methodist University, indicate that archeological resources exist at floodwater retarding structure sites Nos. 1 and 5. Recommendations for excavation and estimates of cost for salvaging these sites were prepared by S. Alan Skinner and Sharron Mahoney, archeologists with the Archaeology Research Program at Southern Methodist University.[16] More detailed investigations were performed prior to finalization of the watershed plan.

The following is quoted from the final report[19] of the archeological investigations.

> Based on our testing operations, we recommend the following measures for mitigation of impact to the cultural resources in the Southwest Laterals Sub-Watershed. Work at X41CC1 has indicated that the site contains only a shallow subsurface deposit. Artifacts are sparse, indicating transient occupation of the site. Furthermore, the burned rock midden has been extensively damaged by bulldozing. Therefore, this site does not need further work.
>
> Site X41CC2, on the other hand, has been shown to be significant on the basis of testing, and we are presently nominating it to the National Register of Historical Places. The site has considerable subsurface depth, in some instances extending to 40 cm, and is rich in artifactual content. The burned rock mound has not been disturbed, which makes the potential high

> for understanding its function. In our letter to the Soil Conservation Service dated July 24, 1975, we recommended that this site be excavated if alternative measures were not feasible. Our estimated cost for excavation was about fifty thousand dollars. Subsequently, structural modifications were made in Structure No. 5 moving the dam approximately 250 m up stream. . . This procedure moved the site outside the immediate dam area and allowed this important archaeological resource to be saved for future generations.

As an additional precautionary measure, the location of haul roads, equipment park area, and easement line will be closely monitored by the construction inspector to avoid damage to the site during installation.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures listed in table 1 will be applied by local interests at an estimated cost of $963,730. Technical assistance will be provided by the Soil Conservation Service and cost-sharing for the establishment of approved conservation measures will be under the Great Plains Conservation Program and the Rural Environmental Conservation Program. Included in the above sum is $48,030 of flood prevention funds for technical assistance in planning and application of needed land treatment measures. The estimated cost for application of the various measures is based on current prices being paid by landowners and operatora in the area.

The total installation cost of the structural measures is estimated to be $1,408,630. The share of costs to be borne by flood prevention funds is $1,280,630, and the share to be borne by other than flood prevention funds is $128,000. The flood prevention funds include $1,049,300 for construction; $59,840 for engineering services; and $171,490 for project administration.

The local cost includes $119,070 for value of land; $2,200 for surveys and legal fees; $1,320 for moving a powerline; and $1,910 for raising a county road at floodwater retarding structure No. 1. Total land rights cost will be $124,500. Local project administration cost is estimated to be $3,500.

All land rights will be obtained by local interests at no cost to the federal government.

Investigations have disclosed that under current conditions the project measures will not result in the displacement of any person, business, or farm operation.

No relocations are expected as the result of acquisition of land rights for structural measures; however, if such occur during project installation, the cost of such relocations will be shared with flood prevention

funds providing 56.0 percent of the costs and local funds providing 44.0 percent of such costs.

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

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

Flood prevention project administration costs consist of construction inspection, contract administration, and maintenance of Soil Conservation Service records and accounts.

The local costs for project administration include costs for overhead and organizational administrative costs, and whatever construction inspection the sponsors desire to make at their own expense.

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

The following is the estimated schedule of obligations for the 6-year installation period:

Schedule of Obligations

Fiscal Year	Measures	Flood Prevention Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	8,658	146,783	155,441
Second	Land Treatment	8,618	147,003	155,621
	Floodwater Retarding Structure No. 7	152,600	22,100	174,700
Third	Land Treatment	7,318	148,093	155,411
	Floodwater Retarding Structures Nos. 2 and 3	238,310	32,600	270,910
Fourth	Land Treatment	7,708	155,963	163,671
	Floodwater Retarding Structures Nos. 4 and 6	596,330	41,700	638,030
Fifth	Land Treatment	7,749	156,644	164,393
	Floodwater Retarding Structures Nos. 1 and 5	293,390	31,600	324,990
Sixth	Land Treatment	7,979	161,214	169,193
TOTAL		1,328,660	1,043,700	2,372,360

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

EFFECTS OF WORKS OF IMPROVEMENT

Conservation Land Treatment

The application of land treatment measures to complete the treatment on 11,270 acres of cropland, 500 acres of pastureland, and 70,980 acres of rangeland during the 6-year installation period will increase land adequately treated in the watershed to 80 percent.

Installation of conservation treatment on the land which is to remain in cropland in the future will provide for a continuous soil cover of growing vegetation and plant residues on or near the surface of the soil. This will reduce erosion to within the tolerable soil loss rate of 4 tons or less per acre annually by protecting the soil from the

impact of the energy of the falling raindrops, and in conjunction with contouring and terracing, prevent the washing of soil from the fields. Needed plant residues will also be returned to the soil to sustain the biological activity necessary for maintenance and improvement of the soil resource.

The completion of application of pastureland and conservation treatment measures on 500 acres of former cropland and areas of intensively used former rangeland will beneficially modify an already disrupted or degraded ecosystem on these lands. The environment will be improved on this land through the establishment of a denser and more productive soil cover which will reduce soil erosion and return the needed volume of plant residues for biological activity in the soil.

The conservation land treatment and management practices to be applied to rangeland will improve the quantity and quality of the native vegetation. Reseeding of about 14,000 acres will be accomplished with seeding mixtures of plants compatible with the native plant community on adjacent areas in the same grazing units. Components of seeding mixtures available for reseeding often do not contain all of the desirable species of forbs and browse plants associated with the surrounding native vegetation. The application of brush management on about 40,000 acres of rangeland will restore open areas for recovery of the desirable native grasses, forbs, and browse plants. Planning for leaving woody vegetation in patterns adjoining the open areas will provide for greater edge effect for deer habitat as well as providing open areas for other wildlife. The use of grazing management practices to control grazing by livestock during specified periods during the growing season will allow natural reseeding of the rangeland by the native plants. These practices will also allow the restoration of a denser and more productive soil cover for erosion prevention while improving the savannah and prairie ecosystem.

The use of fertilizer is expected to continue on both the cropland and pastureland in the future. Fertilization is needed to maintain the productivity of the soil by replacing elements removed from the soil by crops and the forage plants consumed by livestock. The rates of fertilization, however, are not expected to be high in this subhumid climatic area, and no significant increase is anticipated as a result of project action. Fertilization should have no significant adverse impacts on the quality of water impounded in the structures. Similarly it is not anticipated that the use of agricultural chemicals and insecticides will be affected by installation of the project.

Improvements in watershed cover conditions during the installation period are expected to reduce annual gross erosion by about 5 percent, or 6,500 tons annually. These measures are also expected to reduce peak runoff from the uplands and reduce downstream floodwater damages by about 5 percent.

Most of the land treatment measures to be applied will generally benefit wildlife. The application of wildlife upland habitat management practices on about 250 acres of agricultural land will improve wildlife habitat by the following means:

1. Use of seed producing grasses in pasture planting to furnish seed eaten by many species of birds and small mammals.

2. Application of brush management by leaving patterns of brush surrounding open areas for edge habitat for deer.

3. Retention and improvement of woody vegetation along creeks, fence rows, etc., to improve food supply and cover in cropland and pastureland areas.

The application of fishpond management in ponds will benefit the fisheries.

Structural Measures

With the installation of the project on Salt Creek, 9 of the 14 major floods such as those which occurred during the 20-year evaluation period (1923-1942) would be reduced to minor floods. Of the 57 minor floods that occurred during this period, 14 floods would be contained within the channels of Salt Creek and the remainder reduced to flooding of small areas at shallow depths.

This project will benefit directly approximately 25 owners and operators of agricultural flood plain lands on the Salt Creek tributary. Average annual flooding will be reduced from 5,956 to 2,157 acres. Including recurrent flooding, average annual area flooded 3 feet or more in depth without project is 381 acres and will be reduced to 97 acres after project installation. The owners and operators of flood plain land reported that they will restore about 600 acres of open, poorly vegetated, formerly cultivated flood plain land to production of higher value crops when flood protection is provided. The primary crops will be oats and hay. Oats will be planted for the production of grain but will also provide temporary grazing during winter months which will help achieve a balanced grazing program for livestock management.

The following tabulation shows the present land use of the Salt Creek flood plain and the projected land use for without and with project conditions:

Land Use	Present (acres)	Projected Conditions Without Project (acres)	Projected Conditions With Project (acres)
Oats	1,780	1,780	2,080
Grain Sorghum	520	520	520
Cotton	410	410	410
Hay	410	410	710
Range	2,400	2,400	1,800
Miscellaneous	80	80	80
Total	5,600	5,600	5,600

With the project installed, the peak discharge at valley section No. 101 will be reduced from 16,930 cubic feet per second to 10,890 cubic feet per second and the inundated area from 5,600 acres to 3,600 acres for the 25-year frequency flood event.

The installation of the planned structural measures will reduce flooding from a flood similar to that of June 13-15, 1960, by approximately 2,050 acres on the benefited flood plain. Figure 3 graphically illustrates the reduction in flooding in valley section No. 104 on Salt Creek.

The following table illustrates the acres flooded by storms of specified frequencies without the project and with the complete project installed:

Area Inundated Below Site Locations

Evaluation Reach (Figure 4)	Average Recurrence Interval: 2-Year Without Project (acres)	2-Year With Project (acres)	10-Year Without Project (acres)	10-Year With Project (acres)	25-Year Without Project (acres)	25-Year With Project (acres)
1	379	100	721	511	776	608
2	626	273	1,272	815	1,450	1,101
3	502	87	783	389	891	473
4	401	190	662	386	768	473
5	264	117	424	235	499	261
6	295	145	419	284	437	322
7	399	102	701	259	784	360
Total	2,866	1,014	4,982	2,879	5,605	3,598

The application of planned land treatment practices is expected to reduce the total average annual gross erosion from 285 acre-feet to 270 acre-feet, or 494,010 tons/year to 468,430 tons/year, a reduction of 5 percent.

The average annual flood plain scour damage is expected to be reduced about 79 percent. Five percent will be attributable to land treatment, and 74 percent to structural measures.

The average annual sediment yield from the entire watershed to the Colorado River is expected to be reduced from 123,500 tons to 104,850 tons with the project installed. The sediment pollution in the Colorado River in the form of suspended sediment load will be lowered from 1,914 milligrams per liter to 1,874 milligrams per liter. Sediment derived from the watershed and deposited in Lake Buchanan will be reduced from 95 to 80 acre-feet annually.

Initially, installation of the project will cause a 1.96 percent reduction in the average annual volume of streamflow at VS 101 on the Salt Creek portion of the watershed because of evaporation and seepage losses in the sediment pools. This initial reduction in the Salt Creek portion represents a 0.42 percent reduction of average annual streamflow from the total watershed. These estimates are based on an anticipated 9.2 percent reduction in average annual streamflow at the structure sites, which control 36.77 percent of the drainage area in Salt Creek above VS 101 and only 7.9 percent of the total drainage area of the watershed. The magnitude of the 9.2 percent reduction at the structure sites diminishes downstream from the structures because part of this flow is lost into the alluvium. The channel loss factor is estimated to be 0.58.

The following tabulation shows the effects of the project on inflow to Lake Buchanan:

Watershed Data	Units	1981 Dry	1981 Average	1981 Wet
Drainage Area Contributing (Below Major Reservoirs and above Lake Buchanan)	Sq. Mi.	8,141	8,141	8,141
Average Annual Precipitation	Inches	17.5	25.0	32.5
Average Annual Runoff	Ac. Ft.	227,400	505,300	1,010,600
Part of On-Site Runoff Reaching Gage	Ratio	0.30	0.46	0.57

EFFECTS OF FLOODWATER RETARDING STRUCTURES

Total Sediment Pool Surface Area Without Sediment	Acres	253	253	253
Sediment Pool Percent of Total	Percent	97	97	97
Total Sediment Pool Surface Area With Sediment	Acres	245	245	245
Average Sediment Pool Surface Area Percent Of Total	Percent	44	54	62
Average Sediment Pool Surface Area With Sediment	Acres	108	132	152
Net Evaporation Rate	Ft./Yr.	6.2	5.0	3.8
Average Annual Evaporation Depletion	Ac. Ft.	670	660	578
Average Annual Depletion At Gage	Ac. Ft.	201	304	329
Average Annual Depletion At Gage	Percent	0.088	0.060	0.033

The project, when installed, will reduce the unregulated inflow to Lake Buchanan by 0.088 percent during a dry year, 0.060 percent during an average year, and 0.033 percent during a wet year. The reduction will decrease as sediment accumulates in the floodwater retarding structures.

Installation of the seven proposed floodwater retarding structures will, in general, be beneficial to fish and wildlife. About 176 acres of brushy habitat and 226 acres of open land habitat will be destroyed or altered. The existing vegetation on 176 acres will be destroyed by construction of the dams and emergency spillways and replaced with vegetation suitable for erosion control, grazing use, and wildlife food value. The existing vegetation on 226 acres will be destroyed through inundation by water impounded in the sediment pools. These water areas will furnish good quality habitat, watering spots, and feeding and resting areas for migratory waterfowl, shore birds, and wading birds.

During construction of the structural works of improvement, air and water pollution will increase from dust and sediment inherent to the construction process. This increase will be kept within tolerable limits. Permanent vegetation for erosion control will be established on the embankments and any disturbed areas not permanently inundated by wster in the scdiment pools.

Installation of the structural measures included in this project will not affect any known historical sites.

The two archeological sites located during the planning process are affected as follows:

Site X41CC1 - Site X41CC1 at floodwater retarding structure No. 1 has been located and recorded by the archeologists from Southern Methodist University. Subsequent testing revealed that the site was not worthy of nomination to the National Register of Historic Places. Following construction the site will be subject to periodic inundation.

Site X41CC2 - Site X41CC2 at floodwater retarding structure No. 5 has been located and recorded by the archeologists from Southern Methodist University. Subsequent testing revealed that this site is worthy of nomination to the National Register of Historic Places. Southern Methodist University is in the process of nominating this site. Redesign of the structure has avoided involvement of this site. As an additional precautionary measure, the location of haul roads, equipment park area, and easement line will be closely monitored by the construction inspector to avoid damage to the site during installation.

The State Historic Preservation Officer has concurred in these findings, recommendations, and actions.

If archeological sites are located at any other structure during construction activities, a trained archeologist will be called to the site to investigate, record, and collect material to mitigate any possible loss of information.

The sediment pools at the lowest ungated outlets will take 226 acres of rangeland out of further agricultural production. Another 176 acres of rangeland will be converted to use for dams and emergency spillways and will have restricted agricultural use as pastureland. It is expected that most of the 700 acres of rangeland in the detention and sediment reserve pools will remain in present use with only limited interruption when inundated. The total net loss of agricultural production resulting from installation of the structural measures is about $2,550. No measurable effect is anticipated on the management operation of the individuals affected.

Economic and Social

The total economic impact of the project on the local economy from the increased production resulting from the reduction of crop and pasture and erosion damages will amount to an increase in household income of over $101,000 annually and will provide employment opportunities for local residents by creating approximately 16 new jobs.[20] In addition, the expenditure of funds for the construction of the works of improvement will create approximately 51 man-years of employment.

The reduction of flooding in the agricultural flood plain will ensure more dependable crop yields and help to stabilize the agricultural sector of the local economy. This improvement in farm income will help the local ranchers and farmers maintain an adequate standard of living. Also, farmers will be able to shift funds previously used to repair flood damages to other items that improve their standard of living.

Installation of the floodwater retarding structures will not involve any known abandoned or dry wells. Renewed exploration of the watershed area due to the recent national awareness of energy needs could possibly result in discovery of petroleum resources in vicinity of the planned structures. Knowledge of structure and pool locations and elevations of the detention pools will help prevent development of a well in these committed areas but would not prevent offsetting of wells for development of these possible resources.

The Chaffin coal is the uppermost coalbed of the three coalbeds which could occur under the structural measures. It is expected to occur closest to the surface at floodwater retarding structure No. 7 where it is estimated to exist at a depth of greater than 300 feet. Depth of coalbeds below the other structures would be expected to be much greater, ranging from 400 feet to 800 feet. The Bridgeport and Thurber coalbeds occur at estimated depths of 450 feet and 600 feet, respectively, below the Chaffin coalbed. If these resources are ultimately proven to exist under these structures, the coal located under the structures and pool areas would be committed. It is doubtful, however, that these resources have a high development potential.

PROJECT BENEFITS

The estimated average annual floodwater, erosion, and indirect damages in the Salt Creek portion of the watershed will be reduced from $165,260 to $42,500, a reduction of 74 percent. Annual damage reductions attributable to the project, including those from land treatment, average $72,280 for crop and pasture damages, which includes $27,350 from restoration of former productivity on 600 acres of low yielding native grass; $34,440 for other agricultural damage; $6,040 for road and bridge damage; $880 for flood plain scour; $440 for sediment reduction to Lake Buchanan; and $8,680 for indirect damage (table 5).

The total average annual damage reduction benefits, including floodwater damage reduction, reduction in flood plain scour damage, and reduction of indirect damages, are estimated to be $122,760.

Benefits from reduction of floodwater and sediment damages outside the project area are estimated to average $640 annually. These reductions will occur along the Colorado River mainstem below the watershed.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluations. The project will, however, provide a higher level of income to farmers and stimulate business in towns and marketing centers in and adjacent to the watershed. The monetary value of secondary benefits, as an increase in household income, is estimated to be $101,000 annually.

Consideration was given to decreased production in pool areas resulting from the project installation. The amortized value of land in pool areas exceeded the net loss in pool area production plus associated secondary losses. Consequently, the higher value was used to assure a conservative evaluation.

Other benefits not evaluated in monetary terms are an increased sense of security for farmers and improved wildlife habitat.

Concho and McCulloch Counties have not been designated as areas eligible for assistance under the Area Redevelopment Act. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

The total average annual amortized installation cost plus operation and maintenance is $87,900. These measures are expected to produce average annual benefits, excluding secondary benefits, of $117,260, resulting in a benefit-cost ratio of 1.3:1.0.

The total average annual project benefits, including secondary benefits, accruing to structural measures is estimated to be $218,260, giving a benefit-cost ratio of 2.5:1.0 (table 6).

PROJECT INSTALLATION

The land treatment measures needed to protect both the cropland and rangeland, as shown in table 1, will be established by farmers and ranchers in cooperation with the Concho and San Saba-Brady Soil and Water Conservation Districts during their 6-year installation period. The districts are giving assistance in planning and application of these measures under their going program.

The governing bodies of the soil and water conservation districts will arrange for meetings in accordance with definite schedules. By this means and by individual contacts they will encourage the land users within the watershed to adopt and carry out soil and water conservation plans on their farms and ranches. District-owned equipment will be made available to the land users in accordance with existing arrangements for equipment usage in the district.

The Soil Conservation Service field office personnel will assist cooperators of the district in the preparation of soil and water conservation plans and in the application of conservation practices.

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

Financial assistance for the installation of land treatment measures is available to land users through the Rural Environmental Conservation Program (RECP) administered by the Agricultural Stabilization and Conservation county committees and the Great Plains Conservation Program (GPCP) administered by the Soil Conservation Service.

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings; preparing radio, television, and press releases; and using other methods of getting information to land users within the watershed. This activity will help get the land treatment practices and structural measures for flood prevention established.

The Soil Conservation Service will provide the necessary administrative and clerical personnel, facilities, supplies, and equipment to advertise, award and administer contracts, and will be the contracting agency to let and service contracts.

The Concho County Commissioners Court is responsible for the installation of floodwater retarding structures Nos. 1, 2, 3, 4, and 5; and the McCulloch County Commissioners Court is responsible for the installation of floodwater retarding structures Nos. 6 and 7.

The Concho and McCulloch County Commissioners Courts, in cooperation with the Concho Soil and Water Conservation District, will furnish the land rights and arrange for road, utility, and improvement changes for all structural measures.

The Concho and McCulloch County Commissioners Courts have the right of eminent domain under applicable state laws and each has the financial resources necessary to fulfill its responsibilities.

The Concho County Commissioners Court is responsible for obtaining all necessary land rights for the structural measures located in Concho County. These are floodwater retarding structures Nos. 1 through 5.

The McCulloch County Commissioners Court is responsible for obtaining all necessary land rights for the structural measures located in McCulloch County. These are floodwater retarding structures Nos. 6 and 7.

The counties will make needed improvements to keep crossings on public roads passable while the floodwater retarding structures are operating. The cost of these improvements is included in the estimated cost of land rights.

Construction could start with any structure in the watershed. All necessary land rights, including modification of a county road, utilities, and other improvements, or adequate assurance that they will be provided in a timely manner, will be obtained for all structures in the watershed by the Concho and McCulloch County Commissioners Courts before federal financial assistance is made available.

It is anticipated that the necessary archeological studies and salvage will be accomplished by the National Park Service.

The seven floodwater retarding structures will be constructed during the 6-year installation period in the general sequence of Sites 7, 2, 3, 4, 6, 1, and 5.

The sequence of obtaining land rights can be generally as follows:

Year	Floodwater Retarding Structure
First	Nos. 2, 3, 4, and 7
Second	Nos. 1, 5, and 6

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

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement, as described in this work plan, will be provided under the authority of the Flood Control Act of 1944, as amended and supplemented.

1. The requirements for land treatment in the drainage area above the structures have been satisfied.

2. Land rights have been obtained for all structural measures, or written statements are furnished by the appropriate sponsoring local organization that its right of eminent domain will be used, if needed, to secure any remsining land rights within the

project installation period, and that sufficient funds are available and will be used to pay for these land rights.

3. Operation and maintenance agreements have been executed.

4. Flood prevention funds are available.

The majority of the land users were contacted by the local sponsors during the development of the work plan, and it is expected that the major portion of the land rights for the floodwater retarding structures will be donated.

Out-of-pocket costs for land rights, operation and maintenance, and project administration will be financed by the Concho and McCulloch County Commissioners' general funds for structural measures located in their respective counties.

The cost of installing the needed land treatment measures during the 6-year installation period will be borne by the land users of the land on which these measures are installed. Cost-share assistance for eligible land treatment measures may be available through the Rural Environmental Conservation Program and the Great Plains Conservation Program.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the landowners and operators of farms and ranches on which the measures are installed under agreements with the San Saba-Brady and Concho Soil and Water Conservation Districts. Representatives of the districts will encourage land users to maintain land treatment measures.

The Concho County Commissioners Court will be responsible for the operation and maintenance of structures Nos. 1 through 5. The McCulloch County Commissioners Court will be responsible for the operation and maintenance of structures Nos. 6 and 7. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. Funds for this work will be provided by the Concho and McCulloch County Commissioners Courts. The estimated average annual cost of operation and maintenance is $1,400, based on current prices.

The Service and the sponsors will make a joint inspection annually or after unusually severe floods, or in the event of other unusual conditions that may adversely affect the works of improvement, for three years following installation of each structure. Inspection after the third year will be made annually by the sponsors. The Service will participate in annual inspections as often as it elects to do so after the third year. Inspection items are those items which may need maintenance. Items of inspection and maintenance will include, but will not be limited to,

condition of principal spillways, earth fills, emergency spillways, vegetative cover, fences, gates, and vegetative growth in reservoirs.

Immediately following completion of the structures by the contractor, the sponsors will be responsible for and promptly perform, or have performed, without cost to the Service, all maintenance of the structural measures as determined to be needed by either the sponsors or the Service. The sponsors will be responsible for maintenance of vegetation associated with structural measures after the initial vegetation work is adequately completed, as determined by the Service, but no later than three years following completion of each structural measure.

Maintenance of the floodwater retarding structures will consist of items such as controlling undesirable vegetation by mowing, hand cutting, or using herbicides; painting metal parts; and repairing eroded areas. The mowing operations for the most part will be done with a farm-type tractor and shredder. Use of herbicides will be in accordance with state regulations.

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

The responsible sponsoring local organizations will prepare a report of all maintenance inspections. A copy of this report will be submitted to the Service representative. The sponsoring local organizations will keep summary control records in support of proper maintenance having been performed on these works of improvement.

An operation and maintenance agreement will be executed by the parties hereto prior to the issuance of invitations to bid on construction of the structural measures. The operation and maintenance agreement will be in accordance with guidelines contained in the Texas Operation and Maintenance Handbook. An operation and maintenance plan will be developed for each structural measure. The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with financial assistance from authorized watershed funds.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars)1/ Flood Prevention Funds Non-Federal Land SCS2/	Other Funds Non-Federal Land SCS2/	Total
LAND TREATMENT					
Land Areas3/					
Cropland	Acre	11,270	-	101,850	101,850
Pastureland	Acre	500	-	19,950	19,950
Rangeland	Acre	70,980	-	682,410	682,410
Technical Assistance			48,030	111,490	159,520
TOTAL LAND TREATMENT		82,750	48,030	915,700	963,730
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	7	1,049,300	-	1,049,300
Engineering Services			59,840	-	59,840
Project Administration					
Construction Inspection			80,260	700	80,960
Other			91,230	2,800	94,030
Subtotal - Administration			171,490	3,500	174,990
Other Costs					
Land Rights			-	124,500	124,500
Subtotal - Other			-	124,500	124,500
TOTAL STRUCTURAL MEASURES			1,280,630/	128,000	1,408,630
TOTAL PROJECT			1,328,660	1,043,700	2,372,360

1/ Price Base: 1975
2/ Federal agency responsible for assisting in installation of works of improvement.
3/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

Measures	Unit	Applied to Date 1/	Total Cost (Dollars) 2/
LAND TREATMENT			
Brush Management	Acre	61,500	615,480
Conservation Cropping System	Acre	31,800	63,500
Contour Farming	Acre	18,500	37,780
Crop Residue Management	Acre	47,600	94,850
Deferred Grazing	Acre	26,500	13,260
Diversion	Foot	137,800	22,050
Grassed Waterway or Outlet	Acre	30	2,800
Pasture and Hayland Management	Acre	400	5,000
Pasture and Hayland Planting	Acre	400	10,000
Pond	Number	150	93,000
Proper Grazing Use	Acre	133,000	66,480
Range Seeding	Acre	4,800	66,980
Planned Grazing System	Acre	25,000	12,500
Terrace, Level	Foot	3,264,000	163,200
Terrace, Parallel	Foot	47,100	4,710
Wildlife Upland Habitat Management	Acre	200	2,000
TOTAL LAND TREATMENT			1,263,590

1/ As of June 1974
2/ Price Base: 1975

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

(Dollars)[1/]

Item	Installation Cost Flood Prevention Funds			Installation Cost Other Funds		Total Installation Cost
	Construction	Engineering	Total Flood Prevention	Land Rights	Total Other	
Floodwater Retarding Structures:						
1	139,300	8,360	147,660	21,200	21,200	168,860
2	103,260	6,200	109,460	21,600	21,600	131,060
3	88,410	6,190	94,600	10,000	10,000	104,600
4	293,820	14,690	308,510	24,700	24,700	333,210
5	96,910	6,780	103,690	9,400	9,400	113,090
6	203,800	10,190	213,990	16,000	16,000	229,990
7	123,800	7,430	131,230	21,600	21,600	152,830
Subtotal	1,049,300	59,840	1,109,140	124,500[2/]	124,500	1,233,640
Project Administration	-	-	171,490	-	3,500	174,990
GRAND TOTAL	1,049,300	59,840	1,280,630	124,500[2/]	128,000	1,408,630

1/ Price Base: 1975 prices

2/ Includes $1,320 for relocating powerline and $1,910 to raise county road

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TABLE 3 - STRUCTURE DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

ITEM	UNIT	STRUCTURE NUMBER 1	2	3	4
Class of Structure		A	A	A	A
Drainage Area	Sq.Mi.	6.86	5.15	2.04	7.69
Controlled	Sq.Mi.	-	-	-	-
Curve No. (1-day) (AMC II)		78	81	81	79
TC	Hrs.	1.83	1.01	0.98	1.55
Elevation Top of Dam	Ft.	1647.7	1604.3	1566.4	1704.6
Elevation Crest Emergency Spillway	Ft.	1642.0	1599.5	1563.0	1700.0
Elevation Crest - Principal Spillway	Ft.	1626.5	1589.4	1553.0	1687.0
Elevation Crest Lowest Ungated Outlet	Ft.	1625.5	1589.4	1553.0	1685.0
Maximum Height of Dam	Ft.	36	27	34	30
Volume of Fill	Cu.Yds.	173,300	105,400	63,000	279,500
Total Capacity[1]	Ac.Ft.	1,617	1,189	547	1,724
Sediment Pool (Lowest Ungated Outlet)[2]	Ac.Ft.	[3]200	148	90	[3]200
Sediment Submerged 100 Years	Ac.Ft.	176	148	90	194
Sediment Aerated	Ac.Ft.	18	14	9	20
Retarding	Ac.Ft.	1,423	1,027	448	1,510
Surface Area					
Sediment Pool (Lowest Ungated Outlet)	Acres	34	45	24	34
Sediment Pool-Principal Spillway Crest	Acres	38	45	24	55
Retarding Pool	Acres	164	170	73	188
Principal Spillway					
Rainfall Volume (areal) (1-day)	In.	7.75	7.10	7.00	7.85
Rainfall Volume (areal) (10-day)	In.	12.30	11.30	11.20	12.03
Runoff Volume (10-day)	In.	5.49	6.84	6.14	5.61
Capacity (Maximum)	C.F.S.	70	59	28	106
Frequency Operation - Emer. Spillway	% Chance	2.2	3.4	3.5	2.3
Size of Conduit	In.	24	24	18	30
Emergency Spillway					
Rainfall Volume (ESH) (areal)	In.	7.70	6.20	6.20	7.70
Runoff Volume (ESH)	In.	5.12	4.06	4.06	5.23
Type		Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	150	100	100	400
Velocity of Flow (V_e)	Ft./Sec.	8.0	2.0	-	1.9
Slope of Exit Channel	Ft./Ft.	0.050	0.030	0.054	0.023
Maximum Water Surface Elevation	Ft.	1644.3	1599.8	1562.9	1701.9
Freeboard					
Rainfall Volume (FH) (areal)	In.	12.90	12.90	12.90	12.90
Runoff Volume (FH)	In.	10.59	10.45	10.45	10.45
Maximum Water Surface Elevation	Ft.	1647.7	1604.3	1566.4	1704.6
Capacity Equivalents					
Sediment Volume	In.	0.53	0.59	0.91	0.52
Retarding Volume	In.	3.89	3.74	4.12	3.68

(See footnotes at end of table)

TABLE 3 - STRUCTURE DATA -STRUCTURES WITH PLANNED STORAGE CAPACITY - contd.
Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

ITEM	UNIT	STRUCTURE NUMBER 5	6	7	Total
Class of Structure		A	A	A	xxx
Drainage Area	Sq.Mi.	2.39	7.24	3.70	35.07
Controlled	Sq.Mi.	-	-	-	xxx
Curve No. (1-day) (AMC II)		79	78	81	xxx
TC	Hrs.	1.40	0.58	0.74	xxx
Elevation Top of Dam	Ft.	1696.6	1785.9	1606.0	xxx
Elevation Crest Emergency Spillway	Ft.	1691.5	1780.0	1602.0	xxx
Elevation Crest - Principal Spillway	Ft.	1680.7	1760.0	1593.7	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	1680.7	1756.5	1593.7	xxx
Maximum Height of Dam	Ft.	30	50	21	xxx
Volume of Fill	Cu.Yds.	110,200	181,400	101,500	1,014,300
Total Capacity[1]	Ac.Ft.	558	1,745	904	8,284
Sediment Pool (Lowest Ungated Outlet)[2]	Ac.Ft.	69	[3]200	158	1,065
Sediment Submerged 100 Years	Ac.Ft.	69	235	158	1,070
Sediment Aerated	Ac.Ft.	6	19	16	102
Retarding	Ac.Ft.	483	1,491	730	7,112
Surface Area					
Sediment Pool (Lowest Ungated Outlet)	Acres	20	25	44	226
Sediment Pool-Principal Spillway Crest	Acres	20	33	44	259
Retarding Pool	Acres	74	122	135	926
Principal Spillway					
Rainfall Volume (areal) (1-day)	In.	7.00	7.85	7.00	xxx
Rainfall Volume (areal) (10-day)	In.	11.20	12.30	11.18	xxx
Runoff Volume (10-day)	In.	6.47	5.49	5.65	xxx
Capacity (Maximum)	C.F.S.	30	74	53	xxx
Frequency Operation - Emer. Spillway	% Chance	3.5	2.3	3.5	xxx
Size of Conduit	In.	18	24	24	xxx
Emergency Spillway					
Rainfall Volume (ESH) (areal)	In.	6.30	7.70	6.20	xxx
Runoff Volume (ESH)	In.	3.95	5.12	4.06	xxx
Type		Veg.	Veg.	Veg.	xxx
Bottom Width	Ft.	50	300	150	xxx
Velocity of Flow (V_e)	Ft./Sec.	-	7.6	2.8	xxx
Slope of Exit Channel	Ft./Ft.	0.045	0.036	0.060	xxx
Maximum Water Surface Elevation	Ft.	1691.5	1782.4	1602.4	xxx
Freeboard					
Rainfall Volume (FH) (areal)	In.	13.10	12.90	12.90	xxx
Runoff Volume (FH)	In.	10.37	10.59	10.45	xxx
Maximum Water Surface Elevation	Ft.	1696.6	1785.9	1606.0	xxx
Capacity Equivalents					
Sediment Volume	In.	0.59	0.66	0.88	xxx
Retarding Volume	In.	3.79	3.86	3.70	xxx

1/ Crest of Emergency Spillway
2/ Volume included in Sediment Submerged, 100-year.
3/ Volume includes anticipated borrow to be excavated below lowest ungated outlet elevation. This borrow volume is not included in the submerged sediment.

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TABLE 4 - ANNUAL COST
Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

(Dollars)[1/]

Evaluation Unit	Amortization of Installation Cost[2/]	Operation and Maintenance Cost	Total
Salt Creek including Sites 1, 2, 3, 4, 5, 6, and 7	75,760	1,400	77,160
Project Administration	10,740	-	10,740
GRAND TOTAL	86,500	1,400	87,900

1/ Price Base: 1975

2/ 100 years at 6.125 percent interest.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Southwest Laterals Watershed, Texas (Salt Creek Portion)
(Middle Colorado River Watershed)

(Dollars)[1/]

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop snd Pasture	96,350	24,070	72,280
Other Agricultural	45,860	11,420	34,440
Nonagricultural			
Road and Bridge	8,570	2,530	6,040
Subtotal	150,780	38,020	112,760
Sediment			
Lake Buchanan	800	360	440
Erosion			
Flood Plain Scour	1,140	260	880
Indirect	12,540	3,860	8,680
TOTAL	165,260	42,500	122,760

1/ Price Base: Current normalized prices for agricultural commodities (WRC-October 1974) and 1974 prices for nonagricultural.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Southwest Laterals Watershed, Texas
(Middle Colorado River Watershed)

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS[1]				Average Annual Cost[3]	Benefit-Cost Ratio
	Flood Prevention					
	Damage Reduction	Secondary	Outside Watershed[2]	Total		
Floodwater Retarding Structures Nos. 1, 2, 3, 4, 5, 6, and 7	116,620	101,000	640	218,260	77,160	2.8:1.0
Project Administration	xxx	xxx	xxx	xxx	10,740	xxx
GRAND TOTAL	[4]116,620	101,000	640	218,260	87,900	2.5:1.0

1/ Price Base: Current normalized prices for agricultural benefits (WRC-October 1974) and 1974 prices for nonagricultural benefits.
2/ Benefits from reduction of flood damage on the mainstem of the Colorado River.
3/ Average annual cost includes installation costs based on 1975 prices amortized for 100 years at 6.125 percent interest and operation and maintenance costs based on 1975 prices.
4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $6,140 annually.

December 1975

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment measures was developed by the soil and water conservation districts with assistance from the Soil Conservation Service field office personnel at Brady and Eden.

At a meeting held in Brady, the measures for land treatment required to establish a sound soil, water, and plant conservation program for the watershed were determined. Trends in farm and ranch operations, expected changes in land use, soil conditions, land tenure, and pertinent data were used. From these data, land treatment measures expected to be applied during the 6-year installation period were selected. Past rates of application were examined and the need for funds to be used for accelerated technical assistance was determined.

Data on land treatment practices that have been applied on farms and ranches under soil and water conservation plans, obtained from accomplishment records maintained by the Soil Conservation Service, were expanded to represent those applied to date within the watershed.

Based on conservation needs, an estimate was made of the measures to be applied in the 6-year installation period. The acres to be treated and the cost of treatment measures are shown in table 1.

Engineering

The following steps were taken in making the engineering investigations:

1. An up-to-date base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of 4-inch photographs and a study of USGS quadrangle sheets and the base map were used to locate all possible floodwater retarding structure sites in close proximity to the damage areas. Locations of the structure sites and valley cross sections were plotted on the base map for use in field surveys.

2. A field examination was made of the possible structure sites. Sites which did not show adequate storage possibilities or in which obstacles were encountered, making the site unfeasible from an economic standpoint, were dropped from further consideration.

   A system of floodwater retarding structures was selected from the remaining sites for further consideration and detailed surveys. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 2 and 2A.

3. Engineering surveys were started after agreement was reached with the sponsoring local organizations on location of floodwater retarding structure sites to be studied. Topographic maps with 4-foot contour intervals and a scale of 1 inch equals 660 feet were developed on aerial photographs from engineering surveys of the pool areas. Topography with a 2-foot contour interval and a scale of 1 inch equals 100 feet was developed for each emergency spillway. These surveys provided the necessary data to determine if the required sediment and floodwater detention storage could be obtained, the installation cost, and the most economical design for each structure. Criteria outlined in Engineering Memorandum SCS-27 (Revised), Earth Dams, USDA, Soil Conservation Service, March 1965, and Texas State Manual Supplement 2441, Limiting Criteria For The Design Of Earth Dams, USDA, Soil Conservation Service, February 1966, and March 1971, were used to determine the sediment and floodwater detention storage requirements, structure classification, and principal and emergency spillway design.

4. Structure data tables were developed to show the drainage area, storage capacity planned for floodwater detention and sediment storage, release rate of the principal spillway, area inundated by the pools, volume of fill in the dam, estimated cost, and other pertinent data for each floodwater retarding structure (tables 2 and 3).

5. All structures have a design classification of "a." The minimum floodwater detention volume is as determined from the methods set forth in chapter 21 of the National Engineering Handbook, Section 4, Hydrology, USDA, Soil Conservation Service, August 24, 1972. The percent chance of use of the emergency spillways was based on the above minimum detention requirements.

6. Appropriate spillway design and freeboard storms were selected from ES 1020, sheets 1 through 5, as outlined in chapter 21 of the National Engineering Handbook, Section 4, Hydrology. Inflow hydrographs were developed by the methods set forth in the above handbook. All emergency spillway design data meet or exceed the criteria contained in Engineering Memorandum SCS-27 (Revised). The emergency spillway and freeboard hydrographs were routed, using the storage indication method. Various combinations of spillway widths and depths were computed to determine the most economical structure.

7. Estimates were made of the volume of fill in the dams and the costs of the structures. Total costs were determined from a preliminary design and cost estimate of significant individual items such as volume of embankment, principal spillway, clearing, and fencing. Unit prices were determined from recent contracts of structures in

similar areas. Conditions peculiar to an individual site, such as rock excavation, were considered. Cost distribution tables were developed (table 2).

Hydrologic and Hydraulic

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

1. Basic meteorologic and hydrologic data were tabulated from climatological bulletins of Environmental Science Services Administration, U. S. Geological Survey water supply papers, and local records. These data were analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, frequency of occurrence of meteorological events, historical flood series, rainfall-runoff-peak discharge relationships, and the relationship of geology, soils, and climate to runoff depth for single storm events.

2. Valley cross sections were selected to represent the stream hydraulics and flood plain area. Evaluation reaches were established after a joint study.

   Engineering surveys of valley cross sections, bridges, high water marks, and other pertinent data were prepared and used during this study to determine flood and sediment damages.

3. The watershed hydrologic conditions were determined from a 36 percent sampling of soil and cover conditions. A special study of the rainfall-runoff relationship at stream gages in the vicinity of the watershed was made to determine the runoff curve number based on soil and cover complex conditions was used for structure design.

4. Water surface profiles were developed by a computer program based on the modified step method, as outlined in the National Engineering Handbook, Section 5, Supplement A, Hydraulics, USDA, Soil Conservation Service, July 6, 1954, which takes into account velocity head changes. The effects of bridges on the stream hydraulics were determined by use of the Bureau of Public Roads (BPR) method.[21] Computations were made by the Automatic Data Processing Unit, South Technical Service Center, Ft. Worth, Texas. Using the water surface profile data, rating curves were plotted for each valley section. These showed the relationship between stage and discharge, and stage and area flooded.

5. The relationship of peak discharge to runoff volume was developed at each proposed floodwater retarding structure and at each

valley section by routing the runoff from the 25-year storm. The peak discharges for 8 other storms used in the evaluations were determined by multiplying the peak discharge per inch of runoff for the routed storm by the runoff for each of these storms to obtain the peaks at each structure site and at each valley section. The routings were accomplished by the Automatic Data Processing Unit, South Technical Service Center, Soil Conservation Service, Ft. Worth, Texas. Technical Release No. 20, Computer Program For Project Formulation - Hydrology, USDA, Soil Conservation Service, May 1965, was used. Various combinations of structural measures were analyzed to determine the system of structural measures which would accomplish the project objectives most efficiently. The routing results were substantiated by studies of major storms that have occurred in the watershed. Rainfall information was obtained from climatological data publications. Flood information was obtained from local residents.

6. Stage-area inundated curves were developed for each portion of the agricultural flood plain represented by a single valley cross section. Acres inundated by 0-1, 1-3, and 3 feet plus depth increments were determined for the routed floods. Composite runoff-area inundated curves were developed for without and with project conditions to reflect the effects of planned works of improvement.

7. From a tabulation of cumulative departure from normal precipitation, the 20-year period, 1923 through 1942, was determined to be representative of normal precipitation on the watershed. The historical evaluation series was developed from that period, with individual events limited to a period of two days. The frequencies associated with the individual events from the historical evaluation series were applied to the composite runoff-area inundated curves for each evaluation reach to determine the average annual area flooded.

8. Determinations were made of the area that would be flooded by each routed flood under each of the following conditions:

   a. The present conditions remaining static.

   b. The needed land treatment practices applied.

   c. The needed land treatment practices applied and various combinations of floodwater retarding structures installed.

9. The evaluation series contained 68 storms that would cause flood damage at the smallest cross section, an average of approximately three floods per year.

10. The runoff from the 25-year frequency storm was routed to determine the maximum flood plain area that would be used in the computations of damages and benefits.

11. The principal spillway design hydrographs used to determine retarding storage volume were developed using the procedures shown in chapter 21 of the National Engineering Handbook, Section 4, Hydrology, USDA, Soil Conservation Service, August 24, 1972.

12. The emergency spillway design and freeboard hydrographs used to determine the dimensions of the emergency spillways and elevations of top of dam were developed using the procedures shown in chapter 21 of the National Engineering Handbook, Section 4, Hydrology.

13. The effects that floodwater retarding structures in Southwest Laterals watershed will have on the inflow of water and sediment to Lake Buchanan were determined. Also, the combined effects of presently installed structures in the drainage area above Lake Buchanan and downstream from other major reservoirs were determined. It is estimated that the remaining planned structures will be constructed by 1984. The expected 1984 effects were determined.

    The method[22] of determination was developed by the Ft. Worth Engineering and Watershed Planning Unit.

Sedimentation

Sedimentation investigations were made in accordance with procedures as outlined in the following: Technical Release No. 17, Geologic Investigations For Watershed Planning, USDA, Soil Conservation Service, March 1961; Technical Release No. 12 (Revised), Sediment Storage Requirements For Reservoirs, USDA, Soil Conservation Service, January 1968; and the National Engineering Handbook, Section 3, Sedimentation, USDA, Soil Conservation Service.

Sediment Source Studies

Sediment source studies to determine 100-year storage requirements were made in drainage areas of the seven planned floodwater retarding structures. Detailed investigations were made at all seven sites and studies included:

1. Mapping soils by units, percent slope, length of slope, land use, cover condition classes on rangeland, land treatment on cultivated land, and land capability classes.

2. Measuring lengths, widths, and depths of channels on aerial photographs to estimate rates of gully and streambank erosion.

3. Computing annual gross erosion by sources (sheet, gully, and streambank). The soil loss equation by Musgrave was used in sheet erosion computations. The results of using this method are comparable to the results obtained by using the universal soil loss equation.[23]

4. Sediment delivery ratios of 30 to 35 percent, depending on the size of the drainage areas, were applied to the gross annual erosion above each floodwater retarding structure to determine the actual amount of sediment delivered to the sites. A delivery ratio of 19 percent was used to determine the amount of sediment delivered to Lake Buchanan from the Salt Creek portion of the watershed. A delivery rate of 25 percent was used to compute the sediment yield to the Colorado River from all other tributaries in the watershed.

5. One hundred and twenty-three representative sample areas were selected within the watershed. These areas averaged 314 acres in size and the total area represented 14 percent of the watershed. The sample areas were studied individually and information such as slope length, soil cover, and other pertinent data was recorded. Summary sheets were prepared of the annual gross erosion. These erosion rates were expanded for the total watershed.

6. The computed sediment storage requirements for each site are based on a gradual improvement of watershed conditions due to installation of needed land treatment measures to be installed during the installation period and maintained at 60 to 70 percent effectiveness during the remaining life of the project.

7. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 40 to 46 pounds per cubic foot for submerged sediment, and 80 to 86 pounds per cubic foot for aerated sediment.

8. Allocation of sediment to the structure pools was based on a range of 10 to 15 percent deposition in the detention pools and 85 to 90 percent deposition in the sediment pools. This allocation was determined on the basis of topography and texture of sediment, after allowing 95 percent of the sediment to be trapped. The remaining 5 percent in suspension is passed through the principal spillway.

Flood Plain Sediment and Scour Damages

The following investigations were made to determine the nature and extent of physical damage to the flood plain:

1. Examinations were made along each of the valley cross sections (figure 4) making note of the depth and texture of deposits, soil conditions, scour channels, stream channel aggradation or degradation, and other pertinent factors contributing to flood plain damage.

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

3. Damage tables were developed to show percent damage by texture and depth increments for sediment and by depth and width for scour.

4. The areas of scour and sediment damages were measured and tabulated by percent for each type damage.

5. The damage to the productive capacity of the flood plain was assessed by percent for each type damage.

6. Damages were summarized by evaluation reaches. Estimates of recoverability of productive capacities were developed from field studies and interviews with farmers.

7. The monetary damages from overbank deposition are negligible and were not evaluated. The reduction of scour damages is based on reduetions in depth and area inundated.

Geology

Preliminary geologic investigations were made at each of the proposed floodwater retarding structure sites. These included studies of valley slopes, alluvium, channel banks, and exposed geologic formations. Hand auger borings and logs of borings from water well drilling were studied. The nature of the formation and depth to foundation bedrock were closely estimated from numerous outcrops. Alluvial soils occurring in the areas of possible borrow pits are predominantly silty gravelly clays (CL) to sandy, clayey gravels (GC). Caliche seams are present in many alluvial soil profiles. Also, cobble and boulder content will be significant in the flood plain soil materials.

All planned structures are located on formations comprising the Upper Pennsylvanian system. Limestone, sandstone, and shale stratigraphy predominate. Extensive weathering of the exposed hard beds of limestone and sandstone is visible. Jointing and open bedding planes are common.

Description of Problems

The entire geologic regime has been affected by the forces causing the Llano Uplift. Faults and downstream dipping strata may occur locally in

proposed site areas. A partial cutoff can be obtained at shallow depths on the abutment areas and at moderate depths extending to less weathered bedrock in most of the flood plain locations. Removal of severely weathered strata in the embankment cutoff trenches should be accomplished for a more stable foundation.

Embankment fill materials will be difficult to work due to the occurrence of flagstones, gravel lenses, and boulders. Special soils testing and compaction control will be needed due to the large quantities of over 3-inch rock estimated in alluvium profiles.

Seepage from abutment and flood plain areas of the proposed embankment, largely due to severely eroded bedrock, is inherent in this geologically disturbed strata.

These problems are not of major proportions, but are considerations that will require special attention during detail design and construction.

Further Investigations

Detailed investigations, including exploration with core drilling equipment, will be made at all sites prior to construction. Special soils tests will be performed on samples and soil and foundation testing will be accomplished to determine needs for adequate design of the proposed structures.

Economics

Basic methods used in economic investigations and analyses are outlined in the Economic Guide for Watershed Protection and Flood Prevention, USDA, Soil Conservation Service, March 1964.

Evaluation of Damages

For evaluation purposes, the flood plain was divided into reaches based on significant differences in land use, drainage patterns, and characteristics of flooding. Owners and operators of flood plain land in each reach were interviewed concerning flooding and flood damage, land use in flood plain, yield data, and expected changes in land use with structural measures installed.

This information was recorded on schedules covering approximately 60 percent of the flood plain. Data from these schedules, as well as information from local agricultural technicians, were used as a basis for making the necessary estimates used in economic evaluations.

The flood plain of Salt Creek was divided into seven reaches for evaluation purposes.

Flood plain land use was mapped in the field, and each reach was evaluated separately on the basis of its own composite damageable value and characteristics of flooding. Crop and pasture damages were calculated from the combined effects of area and depth of flooding and season of occurrence.

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

Other agricultural damage to fences, levees, and farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected. Damage was associated with area and depth of flooding for each storm in the 20-year series by reaches.

Road and bridge damages were based on information from the county commissioners, Texas Highway Department employees, and residents of the watershed.

Monetary damages to the flood plain from scour were based on the value of production losses. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows.

Indirect damages involve such items as additional travel time for farmers in transporting products and farm equipment, delay of school buses and mail deliveries, cost of extra feed for livestock, loss of benefits from grazing, and other related items. Based upon information obtained and data from other watersheds previously analyzed, it was decided that 10 percent of the direct damage be used for this estimate.

Floodwater, scour, and indirect damages were calculated under the following conditions: Without project, with land treatment, and with land treatment and floodwater retarding structures. The reduction in average annual damages by each progressive increment of protection evaluated constitutes the benefits assigned to that increment.

Evaluation of Restoration to Former Productivity

During field investigations, farmers were asked what changes have been made in their flood plain land use as a result of past flooding. It was found that some cropland has been returned to rangeland as a result of flooding and crops less susceptible to damage were being planted. They were also asked what changes they would make in their use of the flood plain if flooding were reduced by 50 percent or more. Farmers indicated that when flooding is reduced some former cropland now in rangeland will be returned to cropland.

Estimates of benefits from restoration to former productivity were based on changes indicated by farmers, land capabilities, and the general agricultural economy. Consideration was given for added damage expected to

the higher value production from the remaining flooding. Additional costs of production, harvesting, and associated costs were deducted from the expected increase in production. Benefits were discounted to allow for a 5-year lag in accrual. Prices were current normalized prices.

Secondary Benefits

Secondary benefits and losses were estimated by an adaptation of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in the Input-Output Model Of The South Central Region Of Texas, which was developed as part of the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, March 1974.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over a period of 100 years. No production in sediment pools was considered and the land covered by detention pools was assumed to be grassland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification. The value of agricultural production lost in the pool areas was used in the calculation of secondary losses.

Archeological and Historical

A reconnaissance archeological investigation of the Salt Creek portion of the watershed was made by L. M. Green, amateur archeologist, of Richland Springs, Texas, in 1972. A detailed archeological investigation of this area was made in 1974 by the Archaeology Research Program of Southern Methodist University under funding by the Soil Conservation Service. The National Park Service, the agency which is responsible for archeological resources, was unable to make this investigation.

Very little archeology had been done in the general area of the watershed prior to the work by L. M. Green in 1972. The work by Green was published in 1974, in the Lower Plains Archeological Society Bulletin No. 4, under the title Archeological Survey Report of the Flood Control Project; Salt Creek Sub-watershed of the Southwest Laterals, Concho and McCulloch Counties. The investigation by archeologists S. Alan Skinner and Sharron Mahoney of the Archaeology Research Program, Department of Anthropology, Southern Methodist University, May 1974, is contained in an unpublished report submitted to the USDA, Soil Conservation Service, Temple, Texas 76501. The following is taken from the unpublished report by Skinner and Mahoney:

> Two prehistoric sites and several artifact scatters were recorded during the investigation of the Southwest Laterals Watershed. . . . Examination of the floodwater retarding structures was completed with the aid of Soil Conservation Service personnel.
>
> Scattered lithic debris which was unassociated with any recognizable cultural features was noted within the areas of floodwater retarding structures 1, 2, 4, and 5. The scatters in structures 1 and 5 may be attributed to the sites described below, but all the artifact scatters represent limited activities. Sites are numbered according to the Smithsonian site numbering system. A site number, such as X41CC1, shows that the site is located in Concho County (CC), Texas (41). The number following the county abbreviation, 1 in this case, indicates that this is the first site recorded in Concho County by Southern Methodist University (X).

A more detailed investigation was made of the two identified prehistoric sites by the Archaeology Research Program, Department of Anthropology, Southern Methodist University. The findings of this investigation are contained in an unpublished report by James E. Bruseth submitted October 1975 to the USDA, Soil Conservation Service, Temple, Texas 76501.

Fish and Wildlife Resources

The Fish and Wildlife Service, U. S. Department of the Interior, the Texas Parks and Wildlife Department, and the Soil Conservation Service made a reconnaissance study of the Southwest Laterals watershed. This report, along with a detailed biological study conducted by a Service biologist during the development of the project plan, was used in an interdisciplinary approach to planning for the conservation and development of the fish and wildlife resources in the watershed.

Detailed data on fish and wildlife habitat conditions on the agricultural lands in the watershed were developed by making a detailed study of samples of the uplands. A less detailed, reconnaissance-type survey of the flood plain was made to determine vegetative composition. Results from these studies were summarized for the watershed to arrive at acreages and quality of the various types of wildlife habitat and major factors limiting the agricultural land for wildlife habitat and stream fisheries.

Data on wildlife populations were obtained from biologists of the Texas Parks and Wildlife Department.

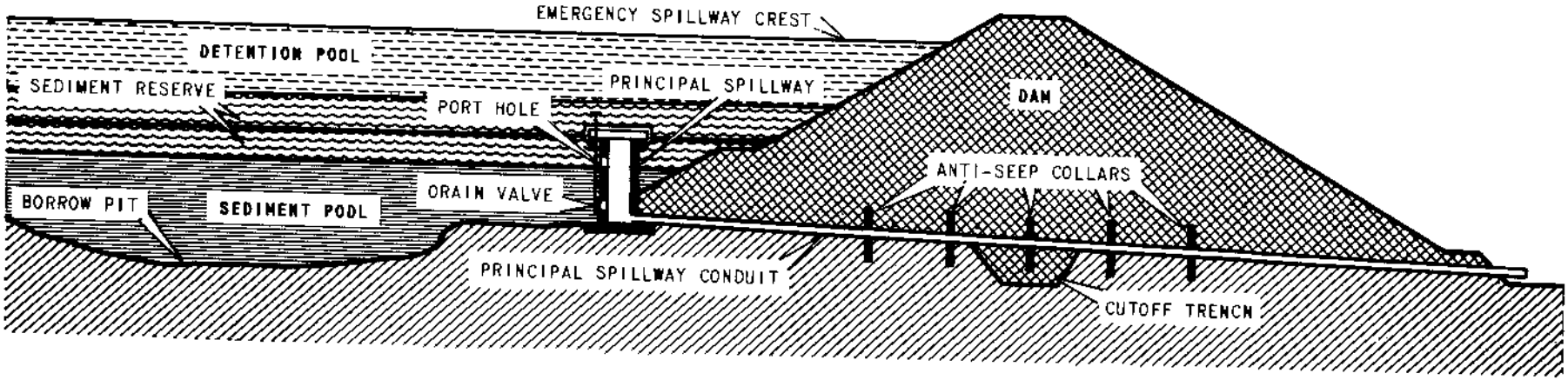
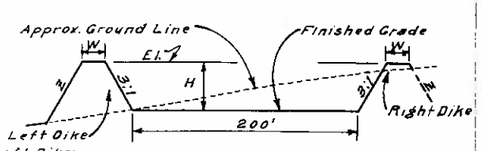


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



Left Dike:
From Sta. 4+30 to Sta. 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta. 5+00 to Sta. 5+50 - a transition section.
From Sta. 5+50 to approx. Sta. 6+30-W=10.0', Z=3:1, H=4.5'.
Right Dike:
From Sta. 4+30 to Sta. 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta. 5+00 to Sta. 5+50 - transition to W=10.0', Z=3:1, H=4.5'.
Material forming dikes shall be placed and paid as "Earth Fill, Embankment".

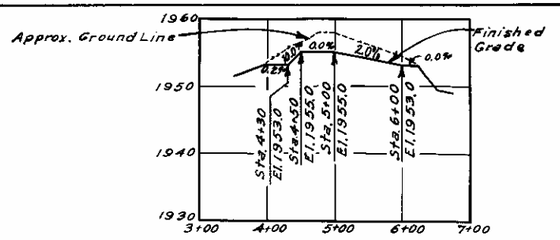
TYPICAL SECTION — EMERGENCY SPILLWAY

Emergency Spillway Diversions and Stub Diversions (S.D.): 18" effective height, 3:1 side slopes and 13 ft., minimum base, shall be constructed at the approximate locations shown on the plans. Final locations of the Stub Diversions shall be determined by the Engineer (See Construction Specification 5).

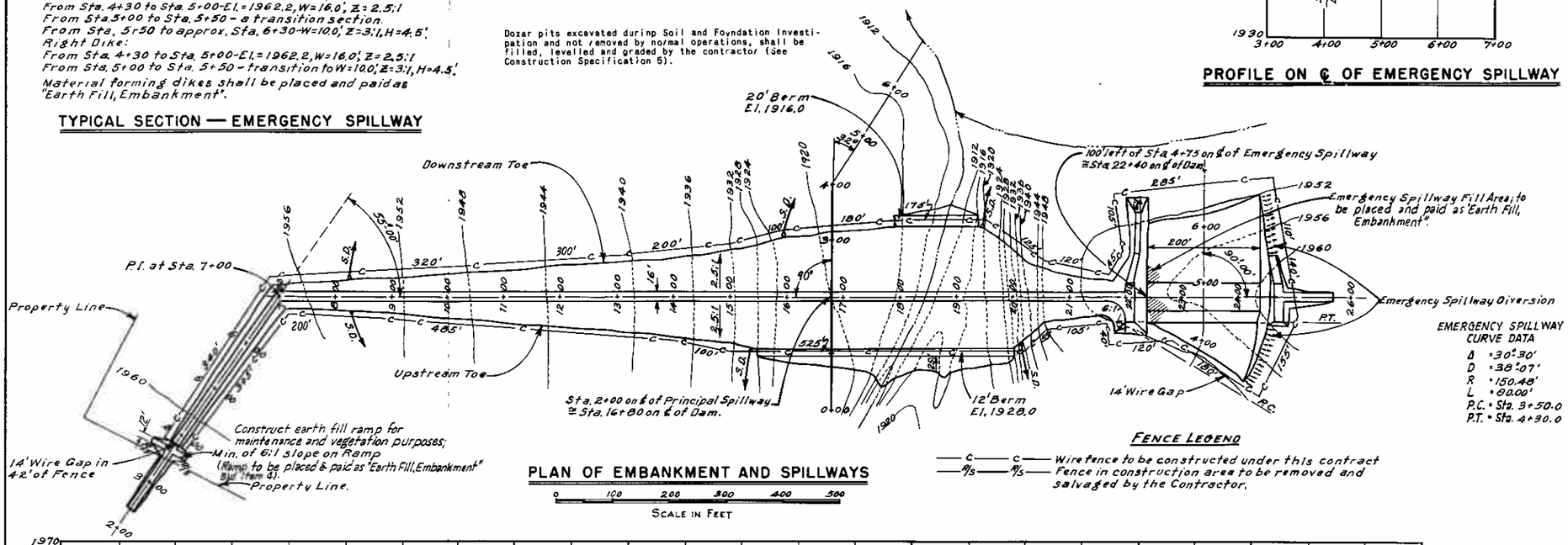
A minimum of 6" topsoil shall be placed in Emergency Spillway and on all Earth Fill Areas (See Construction Specification 20C).

Stream Channel within embankment area shall be shaped and cleared of objectionable material (see sheet 12 and Construction Specification 4).

Dozar pits excavated during Soil and Foundation Investigation and not removed by normal operations, shall be filled, levelled and graded by the contractor (See Construction Specification 5).



PROFILE ON ℄ OF EMERGENCY SPILLWAY



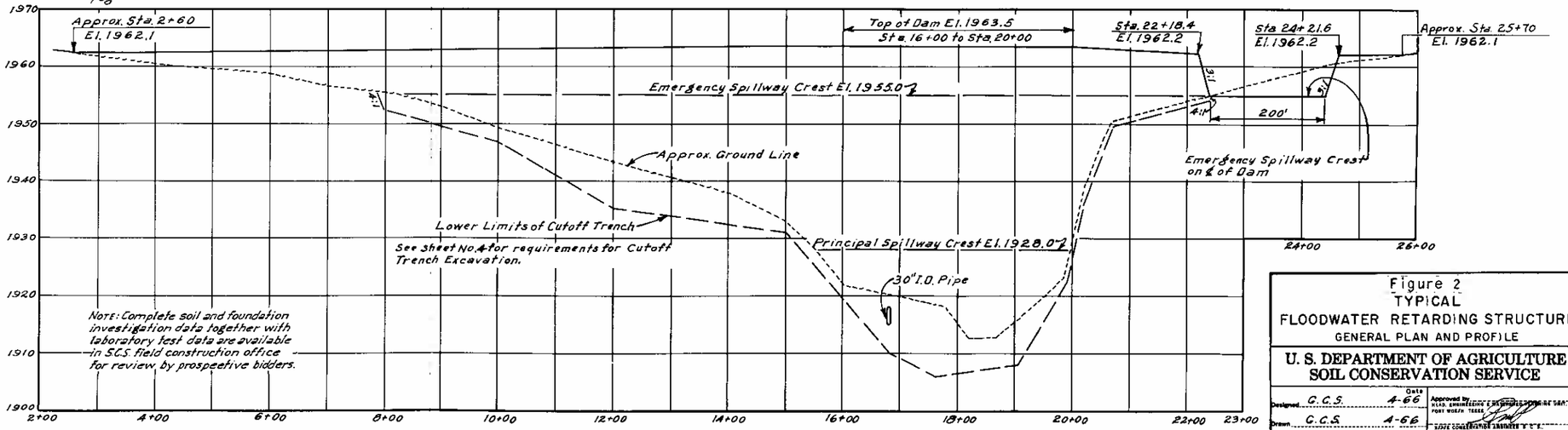
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

EMERGENCY SPILLWAY CURVE DATA
Δ = 30°30'
D = 38°07'
R = 150.48'
L = 80.00'
P.C. = Sta. 3+50.0
P.T. = Sta. 4+30.0

FENCE LEGEND

—C—C— Wire fence to be constructed under this contract
—⅝—⅝— Fence in construction area to be removed and salvaged by the Contractor.



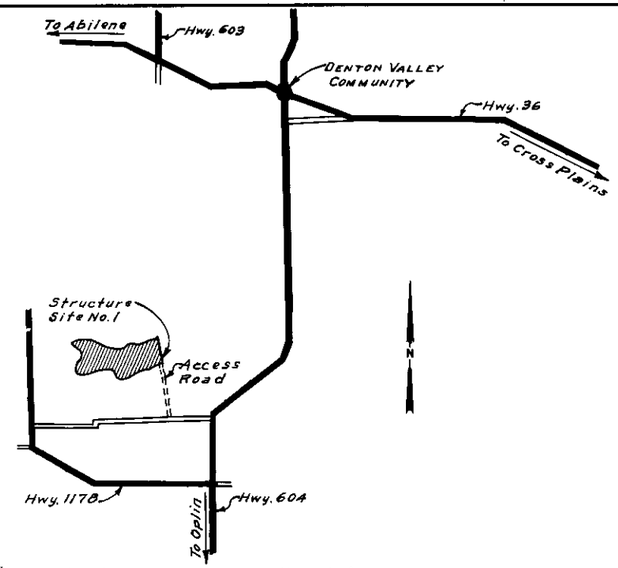
PROFILE ON ℄ OF DAM

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	C.C.S.	4-66
Drawn	C.C.S.	4-66
Traced	T.F.R.	5-66
Checked	C.C.S.	5-66

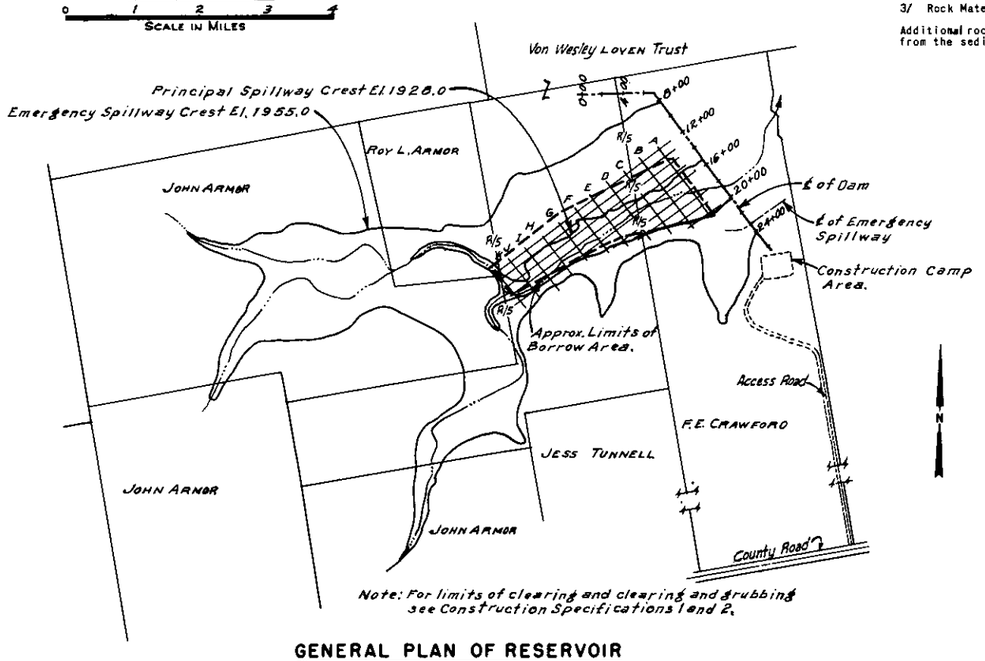
Approved by: U.S.D.A. SOIL CONSERVATION SERVICE, FORT WORTH, TEXAS
TEMPLE, TEXAS
Sheet No. 2 of 13
Drawing No. 4-E-21,594



Structure site is located approx. 7 miles southwest of Denton Valley Community, Callahan County, Texas.

VICINITY MAP

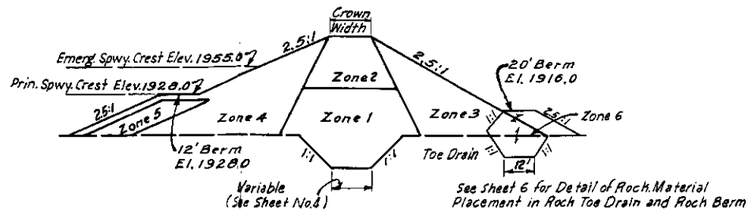
0 1 2 3 4
SCALE IN MILES



Note: For limits of clearing and clearing and grubbing see Construction Specifications 1 and 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640
SCALE IN FEET



See Sheet 6 for Detail of Rock Material Placement in Rock Toe Drain and Rock Berm

TYPICAL SECTION - ZONED EMBANKMENT

MATERIALS PLACEMENT DATA

Embankment Zone No. 1/	Source of Fill Materials: Material Location 2/	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow	0	3	CL	D698	A or B	6"	9"	A	95	-2	+4	D698	A	5	101.5	20.5
	Borrow	0	6	CL	D698	A or B	6"	9"	A	95	-2	+3	D698	A	6	113.0	14.0
	Borrow	0	4	SC	D698	A or B	6"	9"	A	95	-1	+3	D698	A	3	116.5	13.0
2 & 3	Borrow	4	12	GC	D698	D	6"	9"	A	95	Opt.	+4	D698	C	2	130.0	7.0
4	Borrow	0	7	SM	D698	A or B	6"	9"	A	95	-1	+4	D698	A	4	121.5	11.0
5	Borrow	0	4	SM	D698	A or B	6"	9"	A	95	Opt.	+4	D698	A	1	116.0	11.5
2 & 3	Emerg. Spwy.	0	Grade	GC	D698	0	6"	9"	A	95	Opt.	4	Not Tested				
6	3/	Durable Rock					24"	36"									

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

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

3/ Rock Material to be used for the Rock Toe Drain, Berm, and Channel liner shall be procured from required excavations.

Additional rock materials required in excess of that obtained from specified excavations shall be combed, raked or otherwise harvested from the sediment pool, detention pool, or surrounding areas. (See Construction Specification 5).

ZONED EMBANKMENT DATA

All useable material from within the sediment pool shall be used prior to enlarging borrow area outside these limits. Borrow from outside the sediment pool shall be obtained only as directed by the Engineer.

Elevation	Surface Acres	Storage: Acre Feet	Inches
1916	1	3	.0
1920	3	11	.82
1924	9	35	.05
1928	13	79	.12
1932	22	149	.23
1934.1	27	207	.32
1936	32	257	.40
1940	47	415	.65
1944	71	651	1.01
1948	96	985	1.53
1952	130	1437	2.24
1955	155	1864	2.90
1956	163	2023	3.15
1960	197	2743	4.27
1962.1	221	3182	4.95
1964	243	3623	5.64

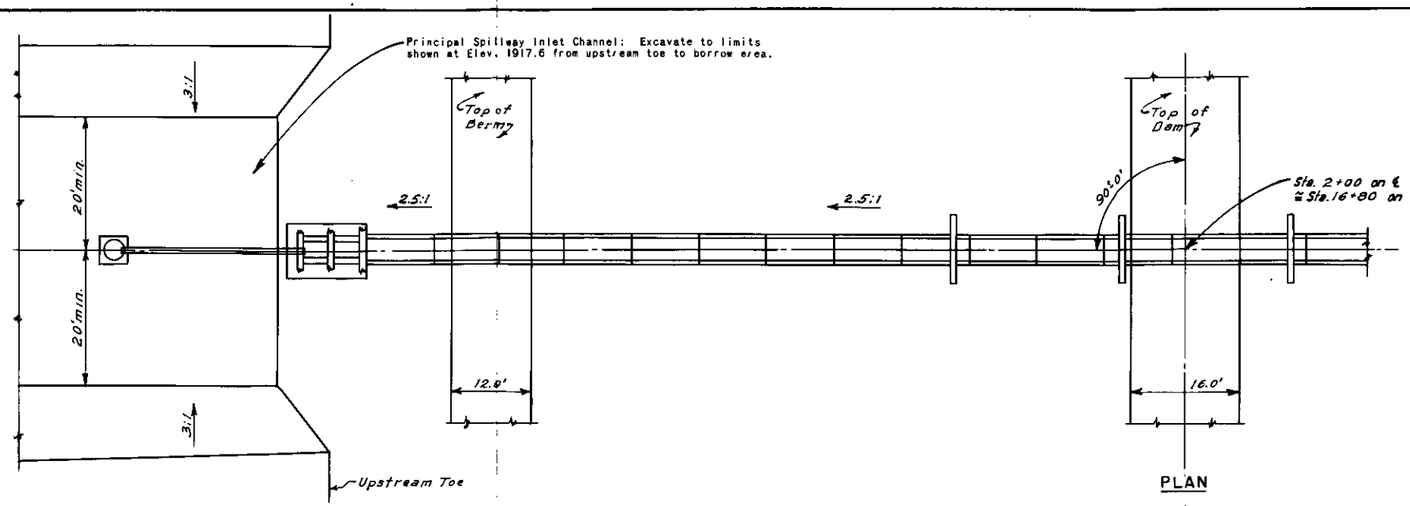
Top of Dam (Effective) Elev.	1962.1
Emergency Spillway Crest Elev.	1955.0
Principal Spillway Crest Elev.	1928.0
Sediment Pool Elev.	1928.0
Drainage Area, Acres	7706.
Sediment Storage, Acre Feet	207.
Floodwater Storage, Acre Feet	1657.
Max. Emergency Spillway Cap., c.f.s.	14,820.

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

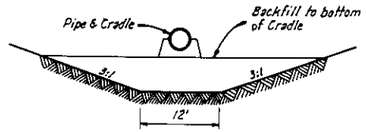
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	G.C.S.	4-66
Drawn	G.C.S.	4-66
Traced	T.F.R.	5-66
Checked	G.C.S.	5-66

Approved by: [illegible] State Conservationist
TEMPLE, TEXAS
Sheet No. 3 of 13
Drawing No. 4-E-21,594



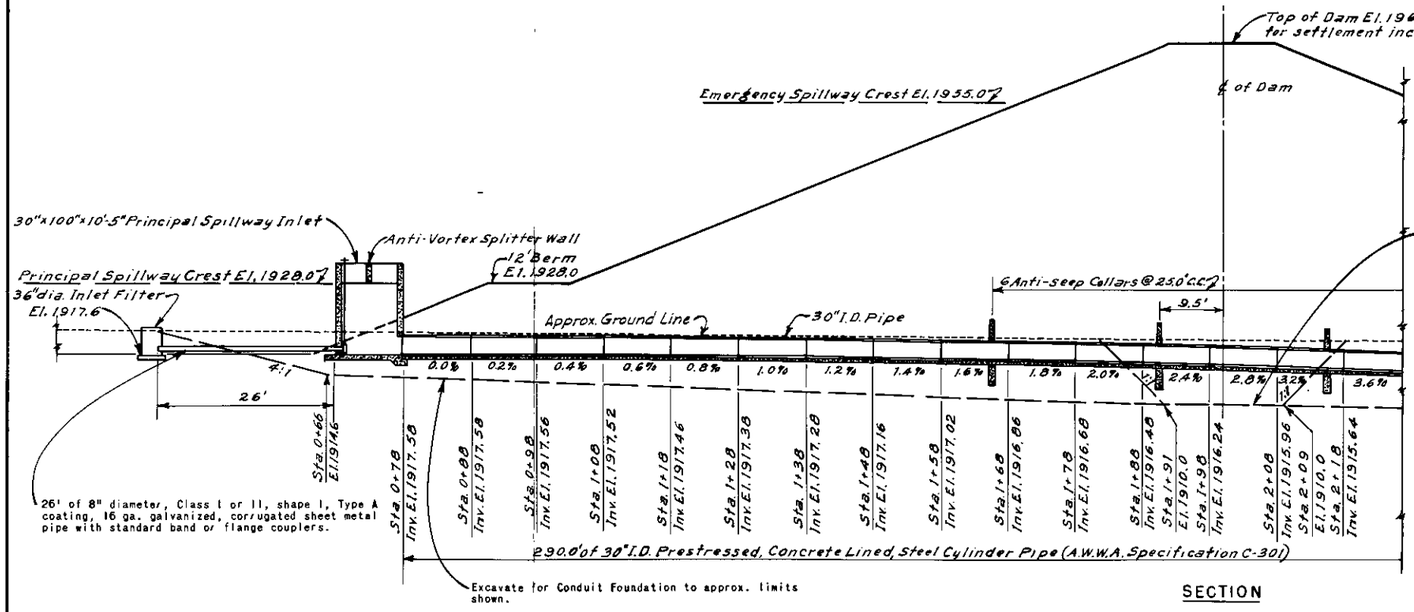
PLAN



Excavation to be paid as "Excavation, Unclassified".

Prior to placing backfill around the structure, the surface layer of the in-place fill material shall be reworked as necessary, and to the depth neeessary, to restore and satisfy the density and moisture requirements specified for that fill material.

TYPICAL CONDUIT FOUNDATION EXCAVATION



Excavate Cutoff Trench with 1:1 side slopes and 18 ft. bottom width to approximate limit shown on "Profile on Centerline of Dam" from Sta. 8+00 to approximate sta. 19+75.

Remove all of the slide rock, boulders, flags, cobbles, common and organic material to hard unfragmented rock in preparation for base of dam on the right abutment, approx. Sta. 19 75 to Sta. 22 40. Remove the right abutment scarp and slope to not steeper than 2 horizontal to 1 vertical. (See Construction Spec. 4).

SECTION

PRINCIPAL SPILLWAY

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

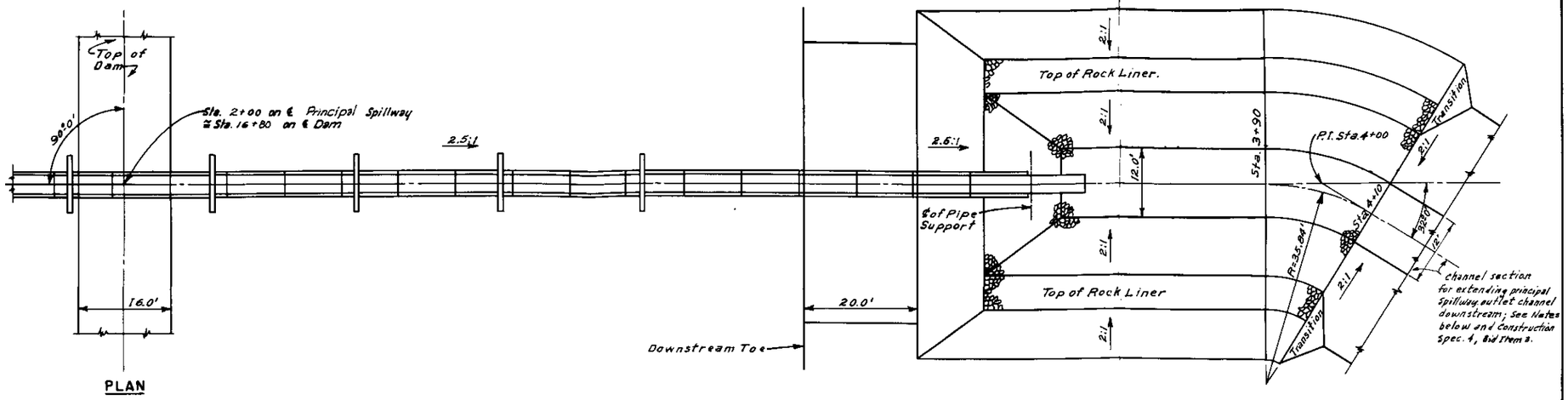
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	G. C. S.	4-66
Drawn	G. C. S.	4-66
Traced	T. F. A.	5-66
Checked	G. C. S.	5-66

Approved by: HEAD ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
STATE CONSERVATIONIST TEMPLE, TEXAS

Sheet No. 4 of 13

Drawing No. 4-E-21,594



NOTE: Excavation for the Rock lined Channel shall be paid as "Excavation, Unclassified". Place a 3.0 ft. thickness of dumped rock to dimensions shown in the drawings with rock size grading from small at subgrade to large at finished grade. Placement of spalls and cobbles shall precede dumping of boulders. Rock material shall be placed to reasonably neat lines of the finished grade. Payment for placing rock fill in channel is not a separate item; such cost shall be considered "Earth Fill, Embankment" and paid for as such. Rock against Principal Spillway shall be placed so as to avoid damage to pipe and other structural works. See sheet 3 for sources of Rock Material.

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

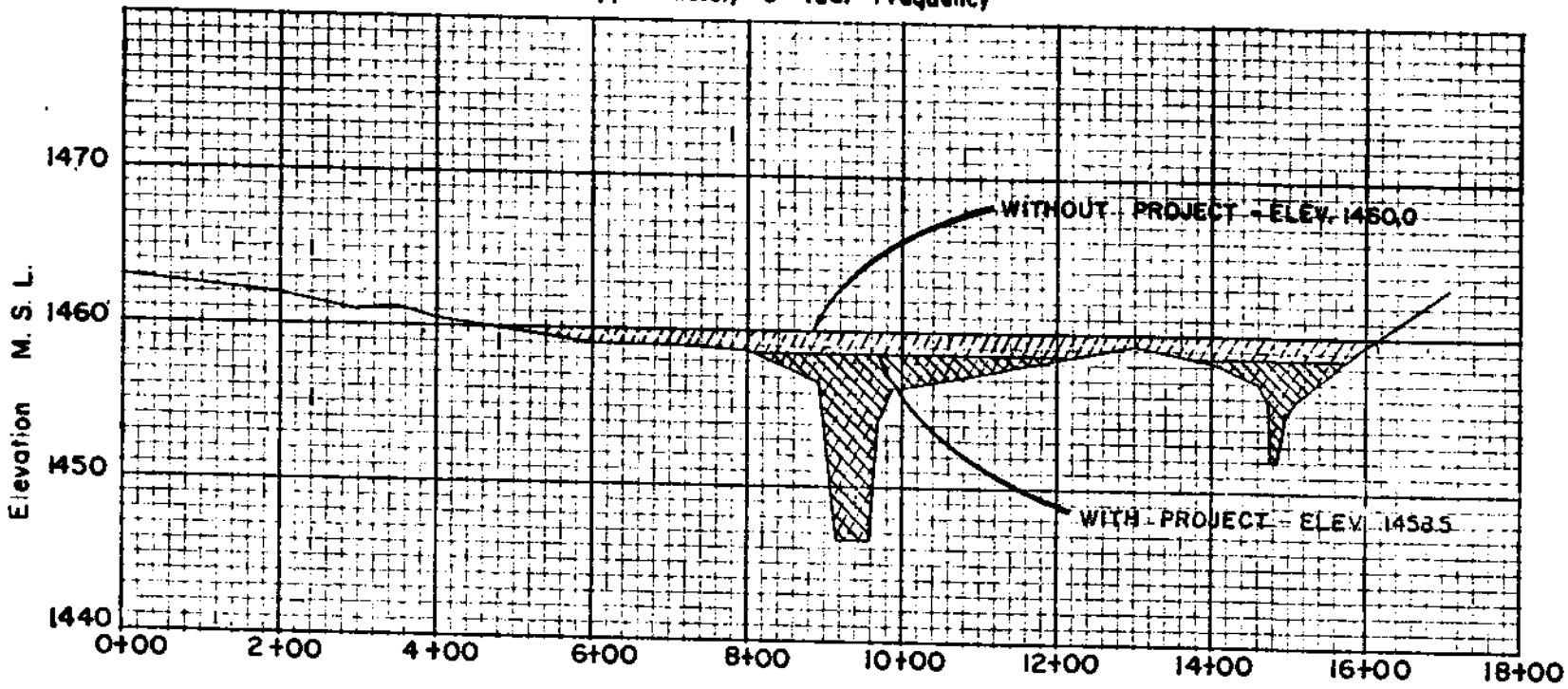
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	G.C.S.	4-66	Approved by: KERR COUNTY SOIL AND WATER CONSERVATION DISTRICT, FORT OGDEN, TEXAS
Drawn	G.C.S.	4-66	STATE CONSERVATIONIST, SCS, TEMPLE, TEXAS
Traced	T.F.R.	5-66	Sheet No. 5 of 13
Checked	G.C.S.	5-66	Drawing No. 4-E-21,594

Figure 3

DEGREE OF FLOOD PROTECTION
SOUTHWEST LATERALS WATERSHED, TEXAS
(Middle Colorodo River Watershed)

Storm of June 13-15, 1960 – 2.19 Inches Rainfall With 1.49 Inches Runoff
Approximately 3-Year Frequency

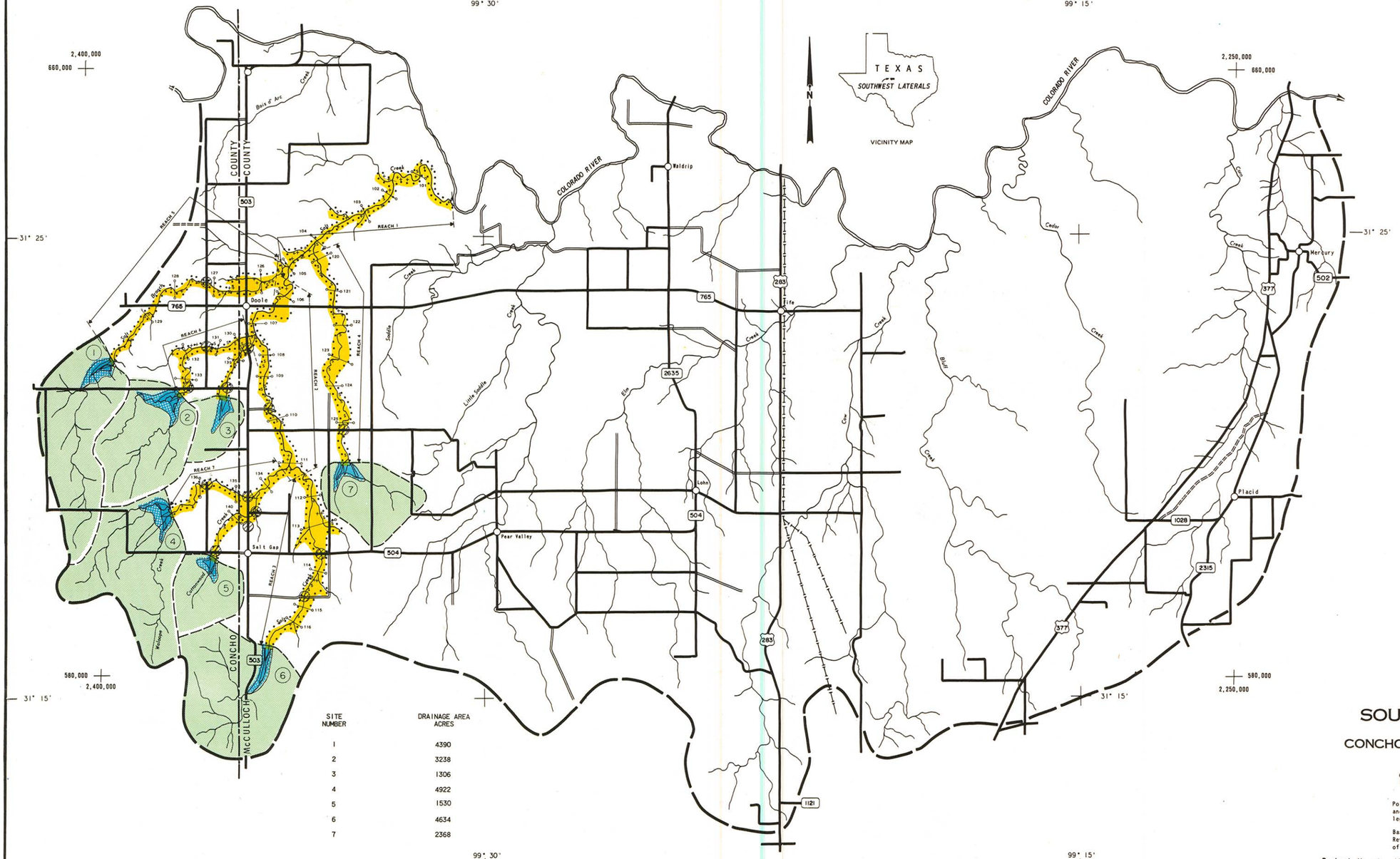


VALLEY SECTION 104

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

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, TEMPLE, TEXAS



SITE NUMBER	DRAINAGE AREA ACRES
1	4390
2	3238
3	1306
4	4922
5	1530
6	4634
7	2368

LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- UNIMPROVED ROAD
- 377 U. S. HIGHWAY
- 503 FARM TO MARKET ROAD
- COUNTY LINE
- DRAINAGE
- TOWN
- PIPELINE
- WATERSHED BOUNDARY
- FLOODWATER RETARDING STRUCTURE
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- AREA BENEFITED
- (1) SITE NUMBER
- LOW WATER CROSSING
- + + + + SEDIMENT DAMAGE
- $ $ $ $ $ $ SCOUR DAMAGE
- 123 VALLEY CROSS SECTION
- 3 EVALUATION REACH

FIGURE 4

PROJECT MAP

SOUTHWEST LATERALS

PORTIONS OF

CONCHO AND MC CULLOCH COUNTIES

TEXAS

0 1 2 3 4

Approximate Scale - Miles

Polyconic Projection compiled at 1:63,360 (1"=1 Mile) and reproduced at 1:145,000 (.43"=1 Mile) for maximum legibility within sheet size

Base compiled from General Highway Map, 1972 and 1973 Revision, Texas State Highway Dept. and USDC, Bureau of Public Roads.

Revised November 1975

4-R-33784

REVISED MARCH 1974

4-R-29080

USDA-SCS-FORT WORTH, TEX. 1974

APPENDIX A

PLANT NAMES

Common	*Scientific*
ashe juniper	*Juniperus ashei*
big bluestem	*Andropogon gerardi*
black locust	*Robinia pseudoacacia*
blue panicum	*Panicum antidotale*
buffalograss	*Buchloe dactyloides*
bumelia	*Bumelia (sp.)*
bushsunflower	*Simsia (sp.)*
cane bluestem	*Andropogon barbinodis*
catclaw acacia	*Acacia greggii*
cedar elm	*Ulmus crassifolia*
common sunflower	*Helianthus annuus*
curlymesquite	*Hilaria belangeri*
dallisgrass	*Paspalum dilatatum*
engelmanndaisy	*Engelmannia pinnatifida*
green sprangletop	*Leptochloa dubia*
hackberry	*Celtis (sp.)*
hairy grama	*Bouteloua hirsuta*
hairy tridens	*Tridens pilosus*
halfshrub sundrop	*Oenothera serrulata*
huisachedaisy	*Amblyolepis setigera*
indiangrass	*Sorghastrum (sp.)*
johnsongrass	*Sorghum halepense*
kleingrass	*Panicum coloratum*

PLANT NAMES - continued

Common	*Scientific*
tall dropseed	*Sporobolus asper*
texas filaree	*Erodium texanum*
texas grama	*Bouteloua rigidiseta*
texas wintergrass	*Stipa leucotricha*
vine-mesquite	*Panicum obtusum*
western ragweed	*Ambrosia psilostachya*
western soapberry	*Sapindus drummondii*

PLANT NAMES - continued

Common	*Scientific*
little bluestem	*Andropogon scoparius*
littleleaf sumac	*Rhus microphylla*
live oak	*Quercus virginiana*
lotebush	*Condalia obtusifolia*
maximilian sunflower	*Helianthus maximiliani*
mealycup sage	*Salvia farinacea*
mesquite	*Prosospis (sp.)*
oneseed croton	*Croton monanthogynus*
paspalum	*Paspalum (sp.)*
persimmon	*Diospyros (sp.)*
plains bristlegrass	*Setaria macrostachya*
prairieclover	*Petalostemum (sp.)*
pricklypear cactus	*Opuntia (sp.)*
red grama	*Bouteloua trifida*
redseed plantain	*Plantago rhodosperma*
red threeawn	*Aristida longiseta*
russianolive	*Elaeagnus angustifolia*
saltbush	*Atriplex (sp.)*
sedge	*Carex (sp.)*
shin oak	*Quercus (sp.)*
sideoats grama	*Bouteloua curtipendula*
skunkbush	*Rhus trilobata*
switchgrass	*Panicum virgatum*

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