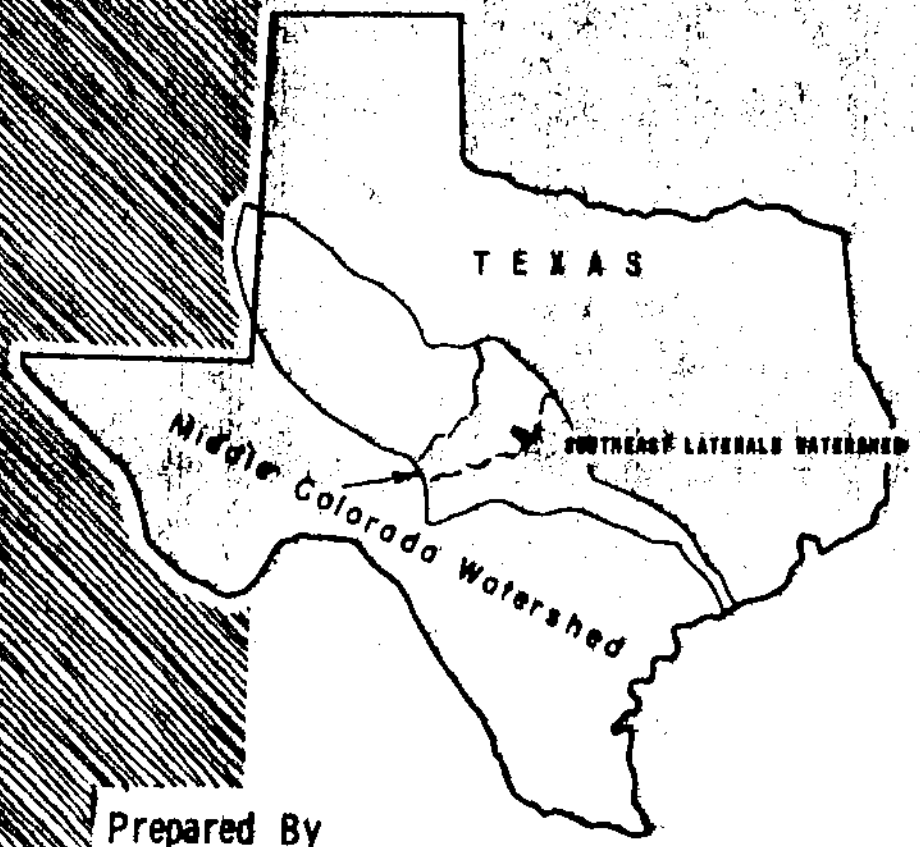
WORK PLAN

SOUTHEAST LATERALS WATERSHED

OF THE MIDDLE COLORADO RIVER WATERSHED SAN SABA COUNTY, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
August 1966

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WATERSHED WORK PLAN AGREEMENT

between the

San Saba-Brady Soil and Water Conservation District
Local Organization

(Hereinafter referred to as the District)

San Saba County Commissioners Court
Local Organization

(Hereinafter referred to as the County)

In the State of Texas

and the

United States Department of Agriculture
Soil Conservation Service
(Hereinafter referred to as the Service)

Whereas, the District has heretofore entered into a Flood Control Supplemental Memorandum of Understanding with the Soil Conservation Service for assistance in constructing Works of Improvement for the prevention of floods in the Southeast Laterals Watershed, State of Texas, under the authority of the Flood Control Act of 1944 (58 Stat. 887).

Whereas, the responsibility for carrying out all or a portion of the works of the Department on the Watershed has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the District and the Service a mutually satisfactory plan for Works of Improvement for the Southeast Laterals Watershed, State of Texas, hereinafter referred to as the Watershed Work Plan;

Whereas, the County will benefit from the carrying out of the plan for Works of Improvement through the reduction of damages to property, including County roads and bridges in the County that are located within the flood plain of the watershed;

Now, therefore, in view of the foregoing considerations, the District and the County 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 5 years.

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

1. The District and the County will acquire all land, easements, and rights-of-way needed for installation of structural works of improvement (estimated at $172,228).

Works of Improvement	District and County (percent)	Service (percent)	Estimated Land, Easements, and Rights-of-Way Cost (dollars)
Floodwater Retarding Structures and Stream Channel Improvement	100	0	1/ $172,228

1/ Includes legal fees ($15,660).

2. The Service will provide all construction costs.

Works of Improvement	District and County (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures and Stream Channel Improvement	0	100	$553,979

3. The Service will provide all costs for installation services.

Works of Improvement	District and County (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
Floodwater Retarding Structures and Stream Channel Improvement	0	100	$157,854

4. The District will obtain agreements from owners of not less than 65 percent of the land above each floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

5. The District will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

6. The District will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

7. The District and the County 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 an Operation and Maintenance Agreement which is to be entered into.

8. 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.

9. The program conducted will be in compliance with all requirements respecting non-discrimination as contained in the Civil Rights Act of 1964, and the regulations of the Secretary of Agriculture (7C F.R. Sec. 15.1-15.13), 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.

10. No member of 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.

San Saba-Brady Soil and Water Conservation District
(Local Organization)

By Kenneth Ruykendall

Title Chairman

Date 2/17/67

The signing of this agreement was authorized by a resolution of the governing body of the San Saba-Brady Soil and Water Conservation District adopted at a
(Local Organization)

meeting held on 2-17-1967,

Geo. A. Johnson
(Secretary, Local Organization)

Date 2-17-1967

4-29288 3-67

San Saba County Commissioners Court
(Local Organization)

By John R. McRae

Title County Judge

Date February 17, 1967

The signing of this agreement was authorized by a resolution of the governing body of the San Saba County Commissioners Court adopted at a
(Local Organization)
meeting held on Feb. 17, 1967.

Elvis Lethetter
(Secretary, Local Organization)

Date Feb. 17, 1967

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WORK PLAN

SOUTHEAST LATERALS WATERSHED
of the Middle Colorado River Watershed
San Saba County, 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

San Saba County Commissioners Court

Prepared By:

Soil Conservation Service
U. S. Department of Agrioulture

August 1966

4-23256 12-66

USDA-SCS-FORT WORTH, TEX. 1667

WATERSHED WORK PLAN

SOUTHEAST LATERALS WATERSHED
of the Middle Colorado River Watershed
San Saba County, Texas

August 1966

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Southeast Laterals watershed was prepared by the Soil Conservation Service in cooperation with the San Saba-Brady Soil and Water Conservation District and the San Saba County Commissioners Court.

The primary objectives of the project are to provide flood protection to the agricultural lands subject to flood damages from Antelope and Wilbarger Creeks, and proper land use and treatment in the interest of soil and water conservation. Upon installation and continued maintenance of the measures set forth in this plan, a material contribution will be made toward increasing agricultural production to the maximum level consistent with the capabilities of the land.

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

The Southeast Laterals watershed comprises the drainage of that portion of the Middle Colorado River Watershed south of the Colorado River and extending from the confluence of the San Saba River on the east to the confluence of Deep Creek on the west. All of the streams in this watershed originate in the north and northwest portions of San Saba County, Texas, and flow in a northerly direction, discharging directly into the Colorado River. The watershed has a drainage area of 227 square miles, or 145,280 acres. Approximately 71 percent of the watershed is rangeland, 27 percent is cropland, and 2 percent is in miscellaneous uses, such as roads, highways, and stream channels.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, a project for protection and development of the watershed areas feasible for structural works of improvement. The cost of installing these measures, excluding work plan preparation, is estimated to be $1,300,235. Of this amount, $583,402 will be borne by local interests and $716,833 by flood prevention funds. In addition, local interests will bear the entire cost of operation and maintenance.

4-23288 12-66

Land Treatment Measures

Landowners and operators will establish land treatment measures which will help accomplish the project objectives. Primarily, this treatment will consist of measures, or a combination of measures, which contribute directly to watershed protection, flood prevention, and sediment control.

Costs of land treatment measures, exclusive of expected reimbursement from Agricultural Conservation Program Service or other Federal funds, is $411,174. In addition, prior to work plan preparation, landowners and operators have established land treatment measures at an estimated non-Federal cost of $764,018. Also, prior to work plan preparation, $7,500 of flood prevention funds were used by the Soil Conservation Service to accelerate technical assistance to landowners and operators. The work plan includes land treatment measures that will be installed during the 5-year installation period, and those management and recurring-type practices that are necessary for the project to be successful. Remaining land treatment measures will be installed under the going programs.

Structural Measures

The structural measures included in this plan consist of 2.50 miles of stream channel improvement and 11 floodwater retarding structures, having a total sediment storage and floodwater detention capacity of 9,465 acre-feet. The total estimated installation cost of the structural measures is $884,061. Of this amount, $172,228 will be borne by local interests, and $711,833 by flood prevention funds. The 2.50 miles of stream channel improvement and the 11 floodwater retarding structures will be installed during the 5-year installation period.

Damages and Benefits

The reduction in floodwater, sediment, flood plain erosion, and indirect damages will directly benefit approximately 50 owners and operators of 3,368 acres of agricultural flood plain in addition to owners of nonagricultural facilities within the watershed. Flood plain owners and operators below the project area also will benefit from reduced flooding. Processors of agricultural commodities and other businesses in the area will benefit from the project.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damages without this project total $46,871, at long-term price levels. With the proposed land treatment and structural measures installed, average annual damages from these sources are estimated to be $15,754, a reduction of approximately 66 percent.

The average annual benefits, excluding secondary benefits, accruing to structural measures total $39,796, and are distributed as follows:

Floodwater damage reduction	$21,245
Sediment damage reduction	2,246

Erosion damage reduction	$2,295
Indirect damage reduction	2,579
Incidental benefits	2,584
More intensive land use	7,623
Benefits outside project area	1,224

Benefits that are incidental to the project purpose amount to $2,584, annually. They are: recreation, $1,696; and livestock water, $888. No additional project installation costs or extra storage are required to produce these benefits.

Net secondary benefits will average $4,574, annually.

The total benefits of land treatment measures were not evaluated in monetary terms since experience has shown that these soil and water conservation measures produce benefits in excess of their costs.

The ratio of the total average annual benefits accruing to structural measures ($44,370) to the average annual cost of these measures ($30,354) is 1.5:1.

Provisions for Financing Local Share of Installation Costs

Funds for the local share of the project costs will come from revenue presently being collected by San Saba County. These funds will be adequate and available for financing the local share of the costs for the structural works of improvement.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by landowners and operators of the farms and ranches on which the measures will be installed under agreements with the San Saba-Brady Soil and Water Conservation District.

Structural measures will be maintained jointly by the San Saba-Brady Soil and Water Conservation District and the San Saba County Commissioners Court. The value of the average annual cost of operating and maintaining the structural measures is estimated to be $1,392, at long-term price levels.

DESCRIPTION OF WATERSHED

Physical Data

The Southeast Laterals watershed comprises the drainage of that portion of the Middle Colorado River Watershed south of the Colorado River and extending from the confluence with the San Saba River on the east to the confluence of Deep Creek on the west. The principal tributaries, from east to west, are Horse, Spring, Turkey, Cottonwood, Mesquite, Wilbarger, and

Antelope Creeks. All of these streams originate in the north and northwest portions of San Saba County, Texas, and flow in a northerly direction, discharging directly into the Colorado River. The watershed drains a total of 145,280 acres (227 square miles), and is served by the towns of Richland Springs and San Saba, located about 2 to 5 miles south of the southern edge of the watershed.

The topography of the watershed ranges from very steep in the northern and eastern portions along the Colorado River, to gently rolling in the south and western portions. Most of the watershed is underlain by shales and sandstones of the Strawn group of Pennsylvanian age. A small amount of Trinity sand remains as erosion remnants at higher elevations along the southern border of the watershed.

The alluvial valleys of the major tributaries range in width from about 350 feet to about 2,500 feet, averaging 1,200 feet. Elevations above mean sea level on the flood plain range from 1,350 feet in the upper tributary reaches to 1,200 feet at the Colorado River. Upland elevations in the watershed are about 1,640 feet on the southwest portion.

The Southeast Laterals watershed is located entirely within the Central Rolling Red Prairie land resource area. Soils consist of Bonti, Exray, Darnell and Yahola fine sandy loams, Norwood silty clay loams, Owens clay, Nimrod-like Owens-Darnell soils, and Nimrod loamy fine sand.

The soils generally are in poor condition, having lost much of their organic matter. Adequate conservation treatment is being applied effectively on about 60 percent of the cropland.

Hydrologic cover conditions of the rangeland varies from poor to good. Range sites in the watershed are as follows:

Sandy	Shallow Hardland
Bottomland	Sandstone Hills
Sandy Bottomland	

The natural vegetation consists of the mixed prairie plant group. It is composed of buffalo grass, little bluestem, Texas wintergrass, Texas bluestem, vine mesquite, sideoats grama, curly mesquite, purple top, and Arizona cotton top. Invading plants and plants which have increased with overuse of rangeland include: mesquite, catclaw, tasajillo, hood windmill, and scrubby post oak. The range condition classes of the watershed are as follows: 5 percent, excellent; 20 percent, good; 35 percent, fair; and 40 percent, poor.

The overall land use is:

Land Use	Acres	Percent
Cultivated	39,200	27
Range	103,180	71
Miscellaneous 1/	2,900	2
Total	145,280	100

1/ Includes roads, highways, stream channels, and farmsteads.

The mean annual weighted rainfall for the watershed is 27.28 inches. The minimum recorded weighted rainfall was 15.39 inches, and the maximum 39.60 inches. Rainfall is fairly well distributed. The wettest months are April, May, September, and October. Individual excessive rains may occur in any season, but are most frequent in the spring and fall months.

Average temperatures range from 85 degrees Fahrenheit in the summer to 46 degrees in the winter. The normal frost-free season of 234 days extends from March 24 to November 13.

Wells and farm ponds supply a majority of the farmers and ranchers with adequate water for domestic and livestock use.

Economic Data

The Southeast Laterals watershed is located in a county which is dependent upon a highly diversified agriculture for approximately 70 percent of its total income. The average value per farm of all products sold in 1959 was $9,671. Ninety-one percent of this agricultural income is derived from livestock and poultry. Cattle and calves provide 55 percent; sheep and lambs, 13 percent; poultry and poultry products, 10 percent; swine, 4 percent; and other products, including dairy, goats, mohair, wool, etc., 9 percent, of the total farm income.

The remaining 9 percent of farm income is from crops such as oats, wheat, grain sorghum, corn, barley, hay, cotton, peanuts, and pecans.

The flood plain of the watershed is used primarily for grazing and for production of livestock feed such as oats and grain sorghum. Crops in excess of the operators requirements for livestock feed are sold.

Present flood plain land use is as follows: oats (for grain and temporary winter grazing), 16 percent; peanuts, 9 percent; grain sorghum, 5 percent; wheat (for grazing and temporary winter grazing), 2 percent; hayland, 1 percent; rangeland and pasture, 66 percent; and miscellaneous uses, 1 percent. Future trends are toward increased production of grain and pasture for livestock production. It is not expected that crops subject to acreage allotments will be increased as a result of the project.

The changes in farm operation and farm enterprises in San Saba County are typical of those which have occurred in the watershed.

Listed below are some selected census data for San Saba County that indicates the magnitude of these changes:

Item	Year 1949	Year 1959
Cropland harvested, acres	68,488	30,768
Corn, acres harvested, for grain	3,514	427
Oats, acres harvested	13,774	8,477
Wheat, acres harvested	9,441	733
Grain sorghum, acres harvested for grain	7,756	5,308
Peanuts, acres harvested, all purposes	8,809	4,406
Cotton, acres harvested	12,694	3,789
Cattle and calves, number	47,494	47,673
Sheep and lambs, number	99,907	123,318

The change from a general type of farming to livestock farming is almost complete for the watershed. In the future, it is expected that more emphasis will be placed on growing crops that can be grazed. Oats and other small grains are well suited to the soils and climate, and are important to supplement range when native grasses are dormant. These crops will continue to be planted in the alluvial valleys and on the deeper upland soils. The size of operating units will continue to expand, with a gradual decrease in the number of farm units. Urban population should remain about the same. The watershed is not an economically depressed area.

The Southeast Laterals watershed has approximately 300 operating farm units, averaging 475 acres in size. The current market price of land is $75 to $100 per acre, with flood plain lands ranging from $150 to $200 per acre. Agricultural land is largely owner-operated, with about 15 percent being leased or rented. Usually, the leased land is operated by a neighboring landowner.

The City of San Saba, estimated population 2,839 in 1965, is the principal banking, commercial, and shipping point for the watershed. Richland Springs, population 350, also serves as a limited marketing and trading center for farm products.

The watershed is served adequately by Farm-to-Market roads 45, 500, and 502. These roads and other county roads provide all-weather travel within the watershed.

The Gulf, Colorado and Santa Fe Railway has loading facilities at San Saba and Richland Springs.

The rural population of San Saba County decreased from 5,266 in 1950 to 3,653 in 1960, a decline of 30.6 percent. The total population for the

county declined 26.4 percent during the same period.

Land Treatment Data

The San Saba-Brady Soil and Water Conservation District has been very active in establishing land treatment measures and initiating flood prevention work. It has obtained a high degree of participation in this program from farmers, ranchers, and other interested parties in the watershed.

The watershed is served by the Soil Conservation Service work unit at San Saba, which is assisting the San Saba-Brady Soil and Water Conservation District. This work unit has assisted farmers and ranchers in preparing 210 soil and water conservation plans on 67,416 acres (49 percent of the total agricultural land)within the watershed. Of these, 192 are basic conservation plans.

Technical guidance has been furnished in establishing and maintaining planned land treatment measures. There are 112 conservation plans in need of current revision. About 48 percent of the needed measures have been applied. Where these measures have been applied and maintained for as long as three years, average crop and pasture yields have increased about one-fifth.

Satisfactory soil surveys have been completed on 72,100 acres. Surveys needed on the remaining agricultural land will be accomplished under the going district program. Land treatment measures installed before the development of this flood prevention work plan are shown in table 1a.

WATERSHED PROBLEMS

Floodwater Damage

The total flood plain area in the Southeast Laterals watershed consists of approximately 8,800 acres along its tributaries and the south side of the Colorado River. Very little of the flood plain area along the Colorado River is inundated by runoff from the Southeast Laterals watershed. It was determined that structural measures were not feasible on tributaries other than Antelope and Wilbarger Creeks, either because of insufficient damage or the lack of economical structure sites.

The flood plain of Wilbarger and Antelope Creeks consists of 3,368 acres, excluding 264 acres in stream channels (figure 2). This flood plain land comprises the areas that will be inundated by runoff from the largest storm considered in the 42-year evaluation series. The runoff from this storm approximates a two percent chance of occurrence storm.

At the present time, about 33 percent of the flood plain is in cultivation; 66 percent is in pasture or range; and one percent is in miscellaneous uses.

Some farmers and ranchers, on an individual basis, have attempted to enlarge, straighten, and levee some streams with very little reduction of flood damage. The adverse economic and physical effect of flooding has been felth throughout the entire watershed, and will prompt local participation in the alleviation of the flood problem.

Flooding along Wilbarger and Antelope Creeks occurs frequently, covering an average of 3,851 acres annually, including areas flooded more than once a year. This causss severe damage to growing crops and to other agrioultural and nonagrioultural properties. Small overflows occur at least once or twice annually, causing some damage to crops, livestock, fences, roads, and bridges. In addition, severe erosion takes place, especially on recently plowed land. Productivity has been reduced, causing some cropland to be converted from cash crops to pasture.

The largest recent damaging flood occurred on Ssptember 19-23, 1964, when approximately 3,000 acres were flooded in the Wilbarger and Antelope Creek tributaries. Information obtained from farmers and ranchers showed damages in these reaches to be in excess of $39,200. Damage to crops and pasture was approximately $17,500, and livestock losses and damage to fences were estimated to be $15,600. Nonagricultural damages to roads and bridges were estimated at $6,100. Damage from the October 4-5, 1959 flood, which is included in the flood series used for evaluation purposes, were almost identical to this.

Spring floods damage seedbeds, growing row crops, and maturing small grains, and, conversely, fall floods damage maturing grain sorghums and growing small grain. Other agrioultural damages are high in this watershed. Some fences have to be completely reconstructed as often as every five years. Interviews with farmers and ranchers indicate that livestock losses are heavy from the larger floods.

For floods expected to occur during the evaluation period, the total direct average annual floodwater damage is estimated to be $35,850, at long-term price levels (table 5). This includes crop and pasture damages ($17,118), and other agricultural damages ($10,970), and nonagricultural damages to roads and bridges ($7,762).

Indirect damages, such as interruption of travel to and from school and work, and interruption of community activities, are estimated to average $4,261, annually.

Sediment Damage

Deposits of silty sand, sandy silt, and clayey sand are deposited on 757 flood plain acres annually. Loss of productivity due to this sediment results in an average annual monetary damage of $3,424.

In addition to the sediment deposited on the flood plain of this watershed, an estimated 281,000 tons of sediment is delivered from the Southsast

Approximately 1,800 acres of crop and pasture land flooded by Wilbarger Creek as a result of 4.15 inches of rain September 23-24, 1955.

4-7723.8 12-4b
EDDA-ACE-PORT WORTH, TEX. 1966

Heavy agricultural and nonagricultural damages as a result of 10 to 12 inches of rain September 19-23, 1964.

USDA-SCS-FORT WORTH, TEX. 1967

Crop and pasture land damaged by scour and sediment as a result of 10 to 12 inches of rain September 19-23, 1964.

USDA-SCS-FORT WORTH, TEX. 1899

Laterals watershed to the Colorado River each year, of which 100,200 tons are derived from Antelope and Wilbarger Creeks. The delivery of part of this latter tonnage to Lake Buchanan decreases the storage capacity of the reservoir by an estimated 49 acre-feet per year. The average annual monetary value of this damage is estimated to be $1,444, at long-term price levels.

Erosion Damages

Erosion rates in this watershed are moderate. This is due to a combination of factors, including gentle slopes, a high percentage of rangeland, and extensive land treatment practices, such as contour farming, terracing, and crop residue use on the oultivated areas.

Flood plain scour acoounts for average annual damage to 860 acres, with damages ranging from 10 to 70 percent in terms of reduced productivity of the soil. The average annual monetary value of this damage is estimated to be $3,336, at long-term price levels. Total land damage from streambank erosion is minor.

PROJECTS OF OTHER AGENCIES

In evaluating this plan, consideration was given to the proposed U. S. Corps of Engineers' Fox Crossing Reservoir, located just downstream from the mouth of Pecan Bayou on the Colorado River. While no Federal funds have been authorized for advance planning or construction of the reservoir, benefits to the Southeast Laterals watershed project reflect the facility in place by 2010.

The works of improvement included in this and similar plans in the Colorado River Basin will have significant effect, none of which are deterimental, on existing and proposed downstream works of improvement included in the water resource development plan for this basin.

BASIS FOR PROJECT FORMULATION

After a reconnaissance of the watershed was made by specialists of the watershed planning staff, meetings were held with the local sponsoring 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. Liveetock farming is the major type of operation. Moderate to severe flooding causes extensive damage to flood plain lands, crops, pastures, and other agricultural properties.

It was recognized by the local sponsoring organizations and planning personnel that development of a sound watershed protection and flood prevention project will present many problems due to the wide variation of soil types and treatment needs and the topography of the 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 a 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 capacities for other purposes.

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

1. Establish the remaining land treatment measures which contribute directly to watershed protection and flood prevention, based on current needs.
2. Attain a 65 to 70 percent overall 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 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. It was recognized that a complete watershed program would result in a reduction of land devoted to crop production and in acreages of crops now in surplus supply.

Structural measures for watershed protection and flood prevention which would be feasible to install to meet the objectives of the local sponsoring organizations were then determined.

In selecting the sites for floodwater retarding structures, consideration was given to locations which would provide the desired level of protection for the areas subject to flood damage. The size, number, design, and cost of the structures was influenced by the location of the damaged areas, the complex topography, and the geologic condition of the watershed, together with the availability of embankment fill material.

The recommended system of structures most nearly meets the project objectives in providing the desired level of protection for agricultural enterprises and satisfying the needs of the watershed at least cost.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the San Saba-Brady Soil and

Contour farming, strip cropping and crop residue use - practices that prevent erosion and allow more water to soak into the ground.

Establishing weeping lovegrass on land converted to improved pasture.

SCS-FORT WORTH, TEX. 1977

Runoff from heavy rains being controlled by floodwater retarding structures in a nearby watershed.

Floodwater retarding structures releasing water slowly through the principal spillway following heavy rains.

Water Conservation District, is essential for a sound flood prevention program on the watershed. The establishment and maintenance of all applicable soil and water conservation and management practices necessary to proper land use is basic to this objective.

There are 23,866 acres above the planned floodwater retarding structures. Land treatment is especially important on these watershed lands to conserve the land resources and to protect the structural measures. On the remaining 114,882 acres of upland, land treatment measures are all important since they constitute the only measures planned for watershed protection. A conservation program on the 3,368 acres of agricultural flood plain is also important in reducing floodwater and erosion damages.

The acreage to be treated in each major land use and the estimated cost of the needed major land treatment measures to be installed by landowners and operators during the 5-year installation period are shown in table 1. The installation and maintenance of land treatment measures needed after the installation period will be carried out under the going program. Remaining standard soil surveys on agricultural land will be completed during the installation period.

There is a trend toward conversion of small fields of rolling, eroded cropland to hay or pasture usage. Most of the cropland in the watershed has a high productive capability, and in recent years, the trend has been toward better management and fertilization to increase cover and residues. Also, the use of small grains is increasing considerably.

Most of the land treatment measures will function principally to decrease erosion damages to crop and pasture lands by improving soil-cover conditions. These include conservation cropping systems and crop residue use for the cropland, and range seeding to establish good cover on grassland. They also include brush control to allow grass stands to improve and replace the poor brush cover on grassland; construction of farm ponds to provide adequate watering places to prevent cover-destroying concentrations of livestock; and proper use and deferred grazing of rangeland to provide improvement, protection, and maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

Other beneficial land treatment measures include contour farming, terracing, diversions and irrigation and water management practices, all of which have a measurable effect in reducing peak discharges by slowing runoff. These measures also reduce erosion and sediment damage. The total benefits of land treatment measures were not evaluated in monetary terms since experience has shown that these soil and water conservation measures produce benefits in excess of their costs.

Structural Measures

A system of 11 floodwater retarding structures and 2.50 miles of stream channel improvement will most nearly afford the degree of flood protection

deeired, and mutually agreed on by the local people. This flood protection cannot be provided by land treatment measures alone.

Flood detention storage in the structures will range from 2.98 to 5.40 inches of runoff, depending on local conditions.

The following tabulation reflects the degree of control, detention storage in acre-feet and inchee, and the equivalent detention storage for Wilbarger and Antelope Creeks:

Item	Unit	Amount
Drainage Area of Wilbarger and Antelope Creeks	Sq.Mi.	81.38
Drainage Area Controlled by Structures	Sq.Mi.	37.29
Drainage Area Controlled by Structures	Percent	45.82
Detention Stcrage	Acre-Feet	7,697
Capacity Equivalent - Area Controlled	Inch	3.87

Capacity was provided in the floodwater retarding structures to store the 100-year accumulation of eediment. However, the principal spillways of all sites will be eet at the 50-year sediment volume elevation.

Figure 1 showe a section of a typical floodwater retarding structure. Plans of a flcodwater retarding structure typical of those planned for this watershed are illustrated by figuree 3 and 3a. The locations of the structural meaeures are shown on the Project Map (figure 4).

There are numerous private intrafarm lowwater crossings on Wilbarger and Antelope Creeks that will be affected by the release flow from the principal spillways of floodwater retarding structures. Under present conditions, water flows over theee croseings for relatively short periods following rains. After the structures are installed, the flow will be reduced in peak, but will be greatly prolonged.

The 2.50 miles of stream channel improvement in conjunction with the floodwater retarding structures will provide additional flood protection to the flood plain lands of Sand Branch. The capacity of the improved channel will be more than the combined release flow from the floodwater retarding structures and the peak discharge of the cne-year frequency storm event. Inlets will be installed as appurtenancee tc conduct local runoff intc the improved channel. Three existing bridges will be replaced by the county when the channel is constructed.

The total area of the sediment poole, including the reserve pools, is 373 acres, of which 249 acres are flood plain. The detention pools will temporarily inundate an additional 816 acree, and 350 of those aores are flood plain.

Proper range use and deferred grazing increase cover and species of better grasses by allowing ranges to seed. Note the seed crop of little bluestem and Indiangrass and the good cover being provided.

Brush control on rangeland allows better species of forage grasses to increase thereby improving cover conditions of the ranges.

Sufficient detention storage can be developed at all structure sites to make possible the use of natural rock or vegetative emergency spillways, thereby effecting a substantial reduction in cost over a concrete or similar type spillway.

All applicable State water laws will be complied with in the design and construction of the planned structural measures.

The details on quantities, costs, and design features of the floodwater retarding structures and the stream channel improvement are shown in tables 2, 3, and 3a.

EXPLANATION OF INSTALLATION COSTS

The estimated cost of planning and installing land treatment measures, exclusive of Federal funds, is $411,174, based on current program criteria (table 1). In addition, prior to work plan preparation, landowners and operators have established land treatment measures at an estimated non-Federal cost of $764,018 (table 1a).

Prior to work plan preparation, $7,500 of flood prevention funds were used by the Soil Conservation Service for the acceleration of technical assistance to landowners and operators. Land treatment costs are based on present prices being paid by landowners or operators to establish the individual measures in the area. The land treatment measures to be applied and the unit cost of each measures was estimated by the San Saba-Brady Soil and Water Conservation District. Technical assistance in the amount of $5,000 will be provided from flood prevention funds to assure timely completion of standard soil surveys for the watershed.

The estimated cost of installing the 11 floodwater retarding structures and the 2.50 miles of stream channel improvement is $884,061. Of this amount, $172,228 will be borne by local interests, and $711,833 by flood prevention funds, of which $553,979 is construction costs, and $157,854 is installation services.

Land, easements, and rights-of-way, and relocation of roads, bridges, utilities, and other improvements for the floodwater retarding structures and the stream channel improvement will be provided by local interests at no cost to the Federal government. The value of these is estimated to be $156,568, based on current market value estimated by local organizations. An additional $15,660 of non-Federal funds will be provided for legal and other services required in obtaining land, easements, and rights-of-way.

Construction costs include both the engineers' estimates and the contingencies. The engineers' estimates were based on the unit costs of floodwater retarding structures in similar areas, modified by special conditions peculiar to each individual site location. They include such items as rock excavation, permeable foundation conditions, and site preparation. Ten

cent of the engineers' estimates was added as a contingency to provide for unpredictable costs.

Installation services include engineering and administrative costs. These estimates were based on an analysis of previous work in this area.

The tentative schedule of obligations for the complete 5-year project installation period, including installation of both land treatment and structural measures, is as follows:

SCHEDULE OF OBLIGATIONS

Fiscal Year	Measures	Federal Funds	Non-Federal Funds	Total
		(dollars)	(dollars)	(dollars)
First	Land Treatment	1,000	85,000	86,000
Second	Land Treatment	1,000	85,000	86,000
	Structure Nos. 1, 2, 3, 4, and 5	278,459	37,457	315,916
Third	Land Treatment	1,000	80,000	81,000
	Structure Nos. 6, 7, and 8	239,453	63,086	302,539
Fourth	Land Treatment	1,000	80,000	81,000
	Structure Nos. 9, 10, and 11	157,538	30,498	188,036
	Stream Channel Improvement	36,383	41,187	77,570
Fifth	Land Treatment	1,000	81,174	82,174
TOTAL		716,833	583,402	1,300,235

This schedule will be adjusted from year-to-year on the basis of any significant changes in the plan found to be mutually desired, and in light of appropriations and accomplishments actually made.

EFFECTS OF WORKS OF IMPROVEMENT

After installation of the combined programs of land treatment and structural measures described above, average annual flooding will be reduced from 3,851 acres to 1,954 acres. This project will benefit directly approximately 50 owners and operators of agricultural flood plain lands.

Owners and operators of flood plain lands reported they would restore 301 acres now in low-yield pastures to production of higher value crops when adequate flood protection is provided. This land was formerly cultivated, but is now used only for grazing. It will be used to produce hay and small grains, primarily oats. Some small grains and grain sorghums now grown on upland soils would be shifted to more productive bottomlands.

It was estimated from discussions with farmers and local agricultural technicians that about 1,416 acres of flood plain lands would be farmed more

intensively with flooding reduced. The timeliness of farm operations and a more secure feeling with the project installed will result in the application of better farming techniques. More fertilizer will be used, more insecticides applied, and the use of certified and treated seed will be more common.

Shifts in upland land use will reduce the total acreage of cropland in the watershed during the project installation period. Allotment crops of cotton and wheat will be reduced. Decreases in cropland will result from the conversions of cropland to grassland and grassed waterways as a result of the planned land treatment program.

Some loss of wildlife habitat will result from the clearing of sediment pools at a few of the structural sites, but these losses will be offset by fish production and habitat for wild fowl. Wildlife habitat in the flood plain areas will be improved by reduction of frequency, depth, and duration of flooding.

Incidental benefits will result from use of the sediment pools of floodwater retarding structures. It was indicated that these 11 structures, with a combined total of 239 surface-acres in sediment pools, will be open to the general public for recreation on a fee basis or with permission of the landowners. Recreation, such as camping, picnicking, fishing, and hunting, will be available to local people throughout the year. Based on the use of existing nearby structures, it is expected that the project will have an average use of approximately 4,300 visitor days annually. Recreational use of sediment pools will continue for 40 years and diminish to zero after 50 years because of sediment deposition.

Sediment pools of the 11 floodwater retarding structures also will provide a more dependable water supply for livestock.

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 main stem immediately below the watershed and to Lake Buchanan. It was recognized that these benefits will cease with installation or the proposed Fox Crossing Reservoir (2010). Benefits from reduction of sediment to Fox Crossing Reservoir will accrue to the upstream project when that facility is in place. Estimated benefits to the Fox Crossing Reservoir were in excess of those to Lake Buchanan and the Colorado River main stem.

Secondary benefits will result from installation of the complete project. The increased farm production will provide an outlet for sale of products used in agricultural production. These will include farm equipment, fertilizers, seed, feed, and insecticides. It will provide added income to farm families, and improve their standard of living. It also will stimulate local business establishments in the sale of sporting goods, boats, motors, and other goods and services associated with recreation.

Land treatment measures will reduce the present average annual sediment yield to the 11 floodwater retarding structures sites from 1.48 to 1.21 acre-feet per square mile of drainage area, a reduction of 18 percent. Similar reductions are expected in other portions of the watershed.

The annual flood plain scour damage is expected to be reduced about 60 percent. Six percent will be attributable to land treatment, and 54 percent to the structural measures.

The annual sediment yield to the mouth of the watershed is expected to be reduced from 281,000 tons to 188,500 tons with the project installed. The complete program will result in a reduction of 24 acre-feet of annual capacity loss to Lake Buchanan.

The flood prevention program will result in minor reduction in average annual runoff from the watershed. Reduction in average annual runoff at the floodwater retarding structures sites is eight percent. This is an equivalent reduction of two percent over the watershed.

PROJECT BENEFITS

The estimated average annual monetary damages (table 5) for Wilbarger and Antelope Creeks will be reduced from $46,871 to $15,754, a reduction of 66 percent.

Crop and pasture damage will be reduced from $17,118 to $6,035, or 65 percent. Other agricultural damages, such as loss of fences, farm equipment, livestock, and other property will be reduced from $10,970 to $2,634, or 76 percent. Road and bridge damage will be reduced from $7,762 to $3,994, or 49 percent. Flood plain sediment damage will be reduced from $3,424 to $818, or 76 percent. Flood plain scour damage will be reduced from $3,336 to $841, or 75 percent.

Of the $31,117 damage reduction benefits attributable to the project, $28,365, or 91 percent, are the result of structural measures, with the remaining 9 percent reduction the result of land treatment.

The estimated net increase in farm income due to restoration of former productivity will amount to $3,977 annually, at long-term price levels. The loss of the original productivity of this land has been included in the crop and pasture damage and its restoration a benefit in table 5.

The net increase in income due to more intensive use of flood plain lands will amount to $7,623 annually.

No increase in allotted crops is expected to result from the project.

Benefits from reduction of floodwater and sediment damages outside the project area are estimated to average $1,224 annually. These reductions

will occur along the Colorado River main stem below the watershed, and to Lake Buchanan.

Benefits incidental to project purposes will amount to $2,584 annually. These will include $1,696 recreation and $888 livestock.

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 adjacent to the watershed. The monetary value of secondary benefits is estimated to be $4,574 annually.

Consideration was given to decreased production in pool areas resulting from project installation. The amortized value of land in pool areas ($6,141) exceeded the net loss in pool area production plus associated secondary losses ($5,486), consequently, the higher value was used to assure a conservative evaluation.

The total average annual benefits from structural works of improvement are estimated to be $44,370.

Since San Saba County has not been designated as eligible for assistance under the Area Redevelopment Act, no redevelopment benefits were estimated as a result of project installation.

In addition to monetary benefits, other benefits will accrue to the project, such as an increased sense of security, better living conditions, and improved habitat for wildlife. None of these benefits were given a monetary value and used for project justification.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures is $30,354. These measures are expected to produce average annual benefits, excluding secondary benefits, of $39,796, resulting in a benefit-cost ratio of 1.3:1.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($44,370) to the average annual cost of structural measures ($30,354) is 1.5:1 (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 San Saba-Brady Soil and Water Conservation District during their 5-year installation period. The district is giving assistance in the planning and application of these measures under its going programs.

In reaching the goal for establishing land treatment measures during the installation period, it was agreed that accomplishments would be as follows:

Land Use	FISCAL YEAR					Total
	1st	2nd	3rd	4th	5th	
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Cropland	2,910	2,910	2,632	2,632	2,771	13,855
Rangeland	8,003	8,003	7,241	7,241	7,622	38,110
Total	10,913	10,913	9,873	9,873	10,393	51,965

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

The Soil Conservation Service work unit will assist landowners and operators cooperating with 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 and eligibility requirements. Present FHA clients will be encouraged to cooperate in the project.

The county Agricultural Stabilization and Conservation committees will cooperate with the governing body of the soil and water conservation district by selecting and recommending financial assistance for those ACPS practices that will accomplish the conservation objectives in the shortest possible time.

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 landowners and operators in the watershed. This activity will help get the land treatment practices and structural measures for flood prevention established.

The Soil Conservation Service will contract for the construction of the 11 floodwater retarding structures and the 2.50 miles of stream channel improvement. It also will provide technical specialists to prepare plans and specifications, supervise construction, prepare contract payment estimates, make contract payments, make final inspections, certify completion, and perform related duties for the installation of the structural measures.

The San Saba County Commissioners Court, in cooperation with the San Saba-Brady Soil and Water Conservation District, will furnish the land, ease-

ments, and rights-of-way and arrange for road, utility and improvement changes for all structural measures. They will install culverts or make other needed improvements to keep crossings on public roads passable, while the floodwater retarding structures are operating. Local sponsors will be responsible for the improvement of individually-owned crossings, where required. The cost of these improvements is included in the estimated cost of land, easements, and rights-of-way.

There are two construction units in the watershed. Each group of measures has a favorable benefit-cost ratio (table 7).

Construction may start with either construction unit. All necessary land, easements, and rights-of-way, including relocation of roads, utilities, and other improvements, will be obtained for each construction unit before Federal financial assistance is made available for installation of any part of that construction unit.

The upstream structure of sites in series will be constructed before or concurrently with the lower structure (figure 4).

The 11 floodwater retarding structures will be constructed during the 5-year installation period in the general sequence of Sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11. The 2.50 miles of channel improvement will be constructed after structures 9 and 10 are completed.

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 plan will be provided under the Flood Control Act of 1944, as amended and supplemented.

The cost of establishing land treatment measures will be borne by the owners and operators of the land. It is expected that the owners and operators will be reimbursed for a portion of this cost through the existing Agricultural Conservation Program Service, or other Federal programs. The amount of reimbursement to be expected had been established, based on current program criteria, and this amount has not been included in the total estimated non-Federal cost for land treatment listed in table 1.

Based on experience in this area, the local sponsors have estimated that more than 90 percent of the needed land, easements, and rights-of-way for the floodwater retarding structures and stream channel improvement will be donated. Sufficient funds will be made available from taxes now being collected to meet all local obligations in completing this project.

Federal assistance will be made available pursuant to the following conditions:

1. The required land treatment in the drainage area above structures has been or is in the process of being installed.

2. All required land, easements, and rights-of-way have been obtained.

3. Operation and maintenance agreements have been executed.

4. Flood prevention funds are available.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

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 agreements with the San Saba-Brady Soil and Water Conservation District. Representatives of this district will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage landowners and operators to perform maintenance. District-owned equipment will be made available for this purpose in accordance with existing arrangements for equipment usage.

Structural Measures

All 11 of the proposed floodwater retarding structures and the 2.50 miles of channel improvement will be operated and maintained jointly by the San Saba County Commissionsrs Court and the San Saba-Brady Soil and Water Conservation District.

The estimated average annual operation and maintenance cost is $1,392, based on long-term prices. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of thess methods. Funds for this work will be provided by the San Saba County Commissioners Court.

All floodwater retarding structures and stream channel improvement will be inspected by representatives of the local sponsoring organizations after each heavy rain, or at least annually. A Soil Conservation Service representative will participate in these inspections at least annually, for a period of at least three years. Items of imspection for the floodwater retarding structures will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as part of the structures. Items of inspection for the stream channel improvement will include the degree of scour, sediment deposition, and bank erosion; obstruction to flow caused by debris lodged against fences, and water gates; excessive brush and tree growth within the ohannel; and the condition of side inlets and appur-

tenances.

The sponsoring local organizations will maintain a record of the inspections and maintenance work performed and have it available for review by Soil Conservation Service personnel.

Provisions will be made for free access of representatives of the sponsoring organizations and the Federal government to inspect the floodwater retarding structures and the stream channel improvement and their appurtenances at any time.

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

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/
Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

Installation Cost Item	Unit	Number	Estimated Cost 2/ Federal	Non-Federal	Total
			(dollars)	(dollars)	(dollars)
Land Treatment					
Soil Conservation Service					
Cropland	Acre	13,855	-	354,314	354,314
Grassland	Acre	38,110	-	56,860	56,860
Technical Assistance (Acoel.)			5,000	-	5,000
SCS Subtotal			5,000	411,174	416,174
TOTAL LAND TREATMENT			5,000	411,174	416,174
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	11	527,029	-	527,029
Stream Channel Improvement	Mile	2.50	26,950	-	26,950
Subtotal - Construction			553,979	-	553,979
Installation Services					
Soil Conservation Service					
Engineering Services			105,124	-	105,124
Other			52,730	-	52,730
SCS Subtotal			157,854	-	157,854
Subtotal - Installation Services			157,854	-	157,854
Other Costs					
Land, Easements, and Rights-of-Way			-	156,568	156,568
Legal Fess			-	15,660	15,660
Subtotal - Other			-	172,228	172,228
TOTAL STRUCTURAL MEASURES			711,833	172,228	884,061
WORK PLAN PREPARATION			41,000	-	41,000
TOTAL PROJECT			757,833	583,402	1,341,235
SUMMARY					
Subtotal - SCS			757,833	583,402	1,341,235
TOTAL PROJECT			757,833	583,402	1,341,235

1/ Does not include prior expenditures of flood prevention funds or accomplishments resulting therefrom (see table 1a). Price Base: 1965.

2/ Excludes costs that will be reimbursed from other Federal funds.

August 1966

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/
Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

Prior to August 1966

Installation Cost Item	Unit	Number	Estimated Cost		
			Federal 2/	Non-Federal 3/	Total
			(dollars)	(dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Contour Farming	Acre	4/ 4,619	-	46,190	46,190
Crop Residue Use	Acre	4/ 14,493	-	144,930	144,930
Conservation Cropping System	Acre	4/ 13,487	-	202,305	202,305
Proper Range Use	Acre	4/ 25,104	-	35,146	35,146
Deferred Grazing	Acre	12,183	-	91,373	91,373
Range Seeding	Acre	769	-	7,690	7,690
Brush Control	Acre	21,635	-	151,445	151,445
Terraces, Graded	Foot	1,036,137	-	51,807	51,807
Diversions	Foot	60,944	-	8,532	8,532
Farm Ponds	No.	41	-	24,600	24,600
Technical Assistance (Accel.)			7,500	-	7,500
SCS Subtotal			7,500	764,018	771,518
TOTAL LAND TREATMENT			7,500	764,018	771,518
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.		-	-	-
Stream Channel Improvement	Mile		-	-	-
Subtotal - Construction			-	-	-
Installation Services					
Soil Conservation Service					
Engineering Services			-	-	-
Other			-	-	-
Subtotal - Installation Services			-	-	-
Other Costs					
Land, Easements, and Rights-of-Way			-	-	-
Legal Fees			-	-	-
Subtotal - Other			-	-	-
TOTAL STRUCTURAL MEASURES			-	-	-
WORK PLAN PREPARATION			-	-	-
TOTAL PROJECT			7,500	764,018	771,518
SUMMARY					
Subtotal - SCS			7,500	764,018	771,518
TOTAL PROJECT			7,500	764,018	771,518

1/ At time of work plan preparation. Price Base: 1965

2/ Flood prevention funds only.

3/ Excludes costs that were reimbursed from other Federal funds.

4/ The level of application of the management and reocurring-type practices reached at time of work plan preparation and are not cumulative.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

(Dollars) 1/

Structure Number or Name	Federal Installation Cost				Non-Federal Installation Cost			Total Installation Cost
		Installation Services						
	Construction	Engineering	Other	Total Federal	Easements & Rights-of-Way	Legal Fees and Other	Total Non-Federal	
1	59,123	10,624	5,580	75,327	14,775	1,478	16,253	91,580
2	35,651	7,843	3,479	46,973	4,875	488	5,363	52,336
3	44,832	8,070	4,232	57,134	5,175	518	5,693	62,827
4	38,910	8,560	3,798	51,268	4,950	495	5,445	56,713
5	36,245	7,974	3,538	47,757	4,275	428	4,703	52,460
6	69,323	10,398	6,378	86,099	8,175	818	8,993	95,092
7	80,474	12,071	7,404	99,949	33,450	3,345	36,795	136,744
8	41,906	7,543	3,956	53,405	15,725	1,573	17,298	70,703
9	38,430	8,455	3,751	50,636	6,000	600	6,600	57,236
10	29,476	7,369	2,948	39,793	6,650	665	7,315	47,108
11	52,659	9,479	4,971	67,109	15,075	1,508	16,583	83,692
Subtotal	527,029	98,386	50,035	675,450	119,125	11,916	131,041	806,491
Sand Branch Channel Improvement	26,950	6,738	2,695	36,383	37,443	3,744	41,187	77,570
GRAND TOTAL	553,979	105,124	52,730	711,833	156,568	15,660	172,228	884,061

1/ Price Base: 1965

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12-65

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES
Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11	Total
Drainage Area	Sq.Mi.	4.05	1.61	1.25	1.30	1.25	2.21	9.31 3/	6.34	1.41	1.62	6.94	37.29
Storage Capacity													
Sediment Pool (50-year)	Ac.Ft.	119	52	48	51	59	67	189	88	14	16	104	807
Sediment Reserve Pool	Ac.Ft.	95	50	39	56	65	53	168	94	14	14	100	748
Sediment in Detention Pool	Ac.Ft.	22	14	9	21	24	13	40	34	3	4	29	213
Floodwater Detention	Ac.Ft.	681	319	248	257	248	481	2,681	1,018	310	351	1,103	7,697
Total	Ac.Ft.	917	435	344	385	396	614	3,078	1,234	341	385	1,336	9,465
Surface Area													
Sediment Pool	Acre	32	12	12	15	12	18	60	34	7	7	30	239
Sediment Reserve Pool	Acre	51	18	22	23	20	27	90	50	11	12	49	373
Floodwater Detention Pool	Acre	127	50	52	48	42	81	349	149	63	70	158	1,189
Volume of Fill	Cu.Yds.	118,600	62,000	76,000	68,280	64,000	164,900	132,140	76,800	65,100	45,500	85,200	958,520
Elevation Top of Dam	Foot	1,441.9	1,461.3	1,371.7	1,395.1	1,385.8	1,530.6	1,399.2	1,368.6	1,371.7	1,370.3	1,295.6	xxx
Maximum Height of Dam	Foot	31.9	38.0	27.6	24.1	35.4	32.6	39.4	25.7	21.1	25.6	34.1	xxx
Emergency Spillway													
Crest Elevation	Foot	1,436.8	1,457.4	1,368.6	1,391.7	1,382.5	1,526.3	1,393.0	1,361.8	1,368.6	1,367.0	1,290.1	xxx
Bottom Width	Foot	100	100	100	100	100	200	200	100	100	100	200	xxx
Type		Veg.	Rock	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 1/		4.0	4.0	4.0	4.0	4.0	4.0	1.0	4.0	4.0	4.0	4.0	xxx
Average Curve No. Cond. II		75	75	75	75	75	79	78	75	78	78	75	xxx
Emergency Spillway Hydrograph													
Storm Rainfall (6-hour)	Inch	6.6	6.6	6.6	6.6	6.6	9.6	9.5	6.6	6.6	6.6	6.6	xxx
Storm Runoff	Inch	3.8	3.8	3.8	3.8	3.8	7.0	6.8	3.8	4.1	4.1	3.8	xxx
Velocity of Flow (Vo) 2/	Ft./Sec.	2.7	0	0	0	0	5.2	4.9	4.0	0	0	4.0	xxx
Discharge Rate 2/	c.f.s.	60	0	0	0	0	890	750	200	0	0	400	xxx
Max.Water Surf.Elevation 2/	Foot	1,437.4	-	-	-	-	1,528.1	1,394.6	1,362.9	-	-	1,291.2	xxx
Freeboard Hydrograph													
Storm Rainfall (6-hour)	Inch	13.6	13.6	13.6	13.6	13.6	16.4	16.2	13.6	13.6	13.6	13.6	xxx
Storm Runoff 2/	Inch	10.3	10.3	10.3	10.3	10.3	13.6	13.3	10.3	10.7	10.7	10.3	xxx
Velocity of Flow (Vo) 2/	Ft./Sec.	9.8	8.0	7.3	7.6	7.6	8.7	11.0	11.6	7.4	7.5	10.2	xxx
Discharge Rate 2/	c.f.s.	2,960	1,590	1,210	1,340	1,360	4,160	8,280	4,800	1,230	1,300	6,600	xxx
Max.Water Surf.Elevation 2/	Foot	1,441.9	1,461.3	1,371.7	1,395.1	1,385.8	1,530.6	1,399.2	1,368.6	1,371.7	1,370.3	1,295.6	xxx
Principal Spillway Capacity	c.f.s.	70	78	28	28	28	33	186	108	62	66	123	xxx
Capacity Equivalents													
Sediment Volume	Inch	1.09	1.36	1.44	1.84	2.22	1.13	0.80	0.64	0.41	0.39	0.63	xxx
Detention Volume	Inch	3.15	3.72	3.72	3.72	3.72	4.08	5.40	3.01	4.12	4.07	2.98	xxx
Spillway Storage	Inch	3.65	2.64	2.64	2.67	2.36	3.52	5.54	3.01	3.00	2.89	3.69	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	A	A	xxx

1/ Based on Engineering-Hydrology Memorandum TX-2.

2/ Maximum during passage of hydrograph.

3/ Exclusive of area controlled by other floodwater retarding structures.

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TABLE 3a - STRUCTURE DATA - STREAM CHANNEL IMPROVEMENT
Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

Channel Designation	Station Numbering For Reach: Station	Station	Watershed Area 1/	Required Channel Capacity 2/	Planned Channel Capacity	Average Bottom Width	Average Side Slope	Average Depth	Average Grade	Average Velocity at Design Section	Volume of Excavation
	(100 ft.)	(100 ft.)	(Acres)	(c.f.s.)	(c.f.s.)	(ft.)	(H:V)	(ft.)	(ft./ft.)	(ft./sec.)	(1,000 cu.yd.
Sand Branch	47+70	81+20	1,638	220	220	4	3:1	4.0	.00397	3.50	13,780
	81+20	101+10	2,880	380	380	10	3:1	4.6	.00281	3.46	14,560
	101+10	139+50	4,032	420	440	10	3:1	6.0	.00116	2.60	24,790
										Subtotal	53,130
South Tributary	40+90	81+20	742	130	150	4	3:1	3.2	.00483	3.40	12,870
										Subtotal	12,870
										Total	66,000

1/ Uncontrolled drainage area.

2/ Includes release from floodwater detention structures.

TABLE 4 - ANNUAL COST 1/

Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

(Dollars)

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost 3/	Total
All Floodwater Retarding Structures and Stream Channel Improvement	28,962	1,392	30,354
TOTAL	28,962	1,392	30,354

1/ Does not include work plan preparation cost.

2/ 1965 prices amortized for 100 years at 3-1/8 percent.

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

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Southeast Laterals Watershed, Texas
Middle Colorado River Watershed
Price Base: Long-term 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
	(dollars)	(dollars)	(dollars)
Floodwater			
Crop and Pasture	17,118	6,035	11,083
Other Agricultural	10,970	2,634	8,336
Roads and Bridges	7,762	3,994	3,768
Subtotal	35,850	12,663	23,187
Sediment			
Overbank Deposition	3,424	818	2,606
Erosion			
Flood Plain Scour	3,336	841	2,495
Indirect	4,261	1,432	2,829
Total	46,871	15,754	31,117

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

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Southeast Laterals Watershed, Texas
Middle Colorado River Watershed
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/						Average Annual Cost	Benefit-Cost Ratio
	Flood Prevention							
	Damage Reduction	Intensification	Incidental 2/	Secondary	Outside Watershed 3/	Total		
All Floodwater Retarding Structures and Stream Channel Improvement	28,365	7,623	2,584	4,574	1,224	44,370	30,354	1.5:1
GRAND TOTAL	4/ 28,365	7,623	2,584	4,574	1,224	44,370	30,354	1.5:1

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

2/ Includes $888 benefits from livestock water and $1,696 benefits from recreation.

3/ Includes $693 benefits from reduction of flood damage to the mainstem of the Colorado River, and $531 benefits for reduction of sediment damage to Lake Buchanan.

4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $2,752 annually.

TABLE 7 - CONSTRUCTION UNITS

Southeast Laterals Watershed, Texas
Middle Colorado River Watershed

(Dollars)

Measures in Construction Unit	Annual Benefits Within Unit	Annual Cost 1/
1. Structure Nos. 1, 2, 3, 4, and 5	14,896	10,812
2. Structure Nos. 6, 7, 8, 9, 10, 11, and Sand Branch Channel Improvement	29,474	19,542

1/ Price Base: 1965

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

Soil conditions and land use on the upland were determined by expanding a 25 percent sample of the watershed to the entire upland area. The current land use of the flood plain was determined by field investigations.

Cover conditions and range sites were determined from available range surveys and other cover information obtained from records of the soil conservation district and expanded, with assistance from personnel of the Soil Conservation Service work unit to the entire watershed.

The status of land treatment measures and practices effectively applied and the current conservation needs, based on range conditions and land capability classes developed from soil surveys, were secured from records of the San Saba-Brady Soil and Water Conservation District. From this information, with assistance of personnel from the Soil Conservation Service work unit at San Saba, estimates were made of the various practices contributing directly to flood prevention which will be applied on the watershed during the 5-year installation period. The hydraulic, hydrologic, sedimentation, and economic investigations provided data on the effect land treatment measures would have on reduction of flood damages.

Although measurable benefits would result from application of the 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.

Engineering Investigations

The study made and the procedures used in planning structural measures were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs was used to locate all probable floodwater retarding structure sites, the limits and the area of the flood plain, and other points where valley cross-sections should be taken for the determination of hydraulic characteristics and for flood routing purposes. This information was placed on the watershed base map for use in field surveys.

2. Field examinations were made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not show good storage possibilities or which would inundate highways or improvements for which the cost of relocation could not be economically justified, were

dropped from further consideration. From the remaining sites, a system of floodwater retarding structure sites was selected, based on the degree of control desired, for further consideration and detailed survey. Plans of a floodwater retarding structure typical of those planned for this watershed are illustrated by figures 3 and 3a.

3. The cross-section of the flood plain, previously located stereoscopically, were examined in the field, adjusted to give the best representation of hydraulic characteristics and surveyed at the selected locations (figure 2). Data developed from these cross-sections permitted the computation of peak discharge-stage-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross-section locations and other pertinent information were recorded.

4. A topographic map with 4-foot contour intervals was made of the pool area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the structure, and the areas of the flood plain and upland that would be inundated by the sediment and detention pools. Maps of the structure sites were developed by standard survey procedures. Topographic maps with one-foot contour intervals and a scale of one inch equals 50 feet were developed for each emergency spillway to determine spillway design. Sediment storage requirements were determined for each site through the study of the physical and vegetative conditions of the drainage area above the site. Spillway widths, depths of flow, embankment yardage, and volume of excavation in spillways were computed for each structure, starting with the storage volume needed to temporarily detain the minimum runoff as determined from criteria set forth in Soil Conservation Service Engineering Memorandum SCS-27, and Section 2441, Texas State Manual. The runoff to be stored was then increased by increments to determine the amount of storage that would result in the most economical structure.

5. The limits of the detention and sediment pools of all satisfactory sites, and the flood plain of the streams were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, floodwater detention and sediment storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, emergency spillway width and depth of flow, maximum height of dam, area inundated by the sediment

and detention pools, and the volume of fill in the dam and the estimated cost of the structures (tables 2 and 3).

6. Damages resulting from floodwater, sediment, and erosion were determined from damage schedules and a survey made of sample areas. Reduction in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of peak discharges, stages, and volume of runoff in inches for various frequency storms, as determined by flood routings. These flood routings were made for conditions without the project, with land treatment, and for conditions with all works of improvement installed. Benefits so determined were allocated to groups of interrelated measures including existing works of improvement on the basis of the effect of each on reduction of damages. In this manner, it was determined which system of structural measures could be the most economically justified.

When the structural measures for flood prevention had been determined, a table was developed to show the cost distribution of structural measures (table 2). The summation of the total costs of all needed land treatment and structural measures represented the estimated cost of the planned watershed protection and flood prevention project (table 1). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 4).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorological and hydrologic data were tabulated from Climatological Bulletins, United States Weather Bureau and Water Supply Papers, United States Geological Survey and local records. These data were analyzed to determine average precipitation, depth-duration relationships, seasonal distributions of precipitation, the frequency of occurrence of meteorological events, the historical flood series, rainfall-runoff peak discharge relationships, and the relationship of geology, soils and climate to runoff depth for single storm events.

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross-sections, channel capacities, highwater elevations of selected storms, bridge capacities, and other hydraulic characteristics, and on proposed structure sites to collect data used in design. Cross-sections and evaluation reaches

were selected on the ground in collaboration with the economist and geologist.

3. Present hydrologic conditions of the watershed were determined, taking into consideration such factors as soils, land use, topography, cover and climate. Future hydrologic conditions were determined by obtaining from work unit conservationists and local landowners estimates of the changes in land use and cover conditions that could be expected during the installation period of the project. Runoff curve numbers were computed from soil-cover complex data obtained from the drainage area of representative structure sites and a 10 percent random sample of the uncontrolled drainage area (about 25 percent of the drainage area of the watershed) and used with figures 3.10-1, Soil Conservation Service, National Engineering Handbook, Section 4, Supplement A, to determine depth of runoff from individual storms in the evaluation series and the design storms.

4. Rainfall-runoff relationships were determined and compared with nearby gaged runoff on similar watersheds. The percent chance of occurrence of meteorological events was determined by computing the plotting of values taken from Climatological Papers and Water Supply Bulletins, and plotting rainfall, runoff, and peak discharges against their respective plotting positions on Hazen probability paper. The relationships of runoff, peak discharges, and damages were determined for various frequencies (3-10-1-24, NEH, Section 4, Supplement A).

5. Rating curves for the cross-sections were computed by Mannings formula (4.2-1-9, NEH, Section 4, Supplement A). Stage-area inundated curves were developed for each cross-section. From these, composite runoff-area inundated curves were developed for each evaluation reach.

6. Determination was made of peak discharges, area inundated, and damages caused by the various amounts of runoff which would exist due to:

    a. Present conditions of the watershed.

    b. Effect of land treatment measures.

    c. Effect of land treatment measures and floodwater retarding structures.

d. Consideration of alternative and various combinations of measures.

7. Floodwater retarding structures were classified on the basis of potential downstream damages in accordance with Engineering Memorandum SCS-27, and Section 2441, Texas State Manual.

8. Emergency spillway design storm inflow hydrographs were developed for all structure sites. Spillway widths and depths of flow were determined by the Goodrich-Wisler graphical routing method in accordance with procedures set forth in Engineering Memorandum SCS-27; NEH, Section 4, Hydrology, Supplement A; NEH, Section 5, Hydraulics; Technical Release No. 2, and Section 2441, Texas State Manual.

The rainfall for the period 1922 to 1963, inclusive, was selected for evaluating damages in this watershed. Rainfall information for the historical evaluation series used in these studies was obtained by applying the Thiessen polygon method of weighting to the rainfall data tabulated for the Goldthwaite and Mullin Stations.

The 6-hour design storm rainfall and the emergency spillway and freeboard hydrographs were computed for each site in accordance with Section 2441, Texas State Manual. The dimensions of the emergency spillways were determined by graphically routing the freeboard hydrographs. The criteria and procedures used are set forth in Engineering Memorandum SCS-27; Technical Release No. 2; NEH, Section 4, Hydrology, Supplement A; NEH, Section 5, Hydraulics, and Section 2441, Texas State Manual.

Frequency of use of emergency spillways was based on Engineering-Hydrology Memorandum TX-2. Detention storage, embankment yardage, rock excavation, and spillway depth, width, and alignment were balanced to give the most economical structure, which was included in the watershed plan.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures in "Guide to Sedimentation Investigations, South Regional Service Area", dated April 1965.

Sediment Source Studies

Sediment source studies to determine the 100-year sediment storage requirements were made in the drainage areas of the 11 planned floodwater retarding structures.

1. Detailed investigations were made in the drainage areas of four of the planned floodwater retarding structures.

These investigations included: mapping soil units by slope in percent; slope length; present land use; present land treatment on cultivated land; present cover condition classes on rangeland and pasture; land capability classes; lengths, widths, and depths of all stream channels and scour channels and sheet scour effected by erosion; and the estimated annual lateral erosion of stream channels.

2. Office computations included summarizing erosion by sources (sheet erosion, flood plain scour, and streambank erosion) in order to fit these data into the Musgrave equation for computation of gross annual erosion in tons.

3. Sediment delivery ratios of 37 to 50 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 85 percent was used to determine the amount of sediment delivered to Lake Buchanan from the mouth of the watershed.

4. Field surveys and office computations to determine sediment volumes under present conditions for the remaining seven structures not surveyed in detail consisted of mapping the land use and arranging the sites into homogeneous groups. Sediment source summary sheets were prepared, based on similar sites which were surveyed in detail. The combined sediment source studies, both detailed and otherwise, represent 7 percent of the watershed area.

5. The sediment rates were then adjusted to reflect the effect of expected land treatment on the drainage areas of the 11 planned floodwater retarding structures. The computed sediment storage requirements for each site is based on a gradual improvement of watershed conditions due to installation of needed land treatment measures to be installed during the first five years and maintained at 60 to 70 percent effectiveness during the next 95 years.

6. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 64-89 pounds per cubic foot for submerged sediment, and 86-96 pounds per cubic foot for aerated sediment.

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7. The allocation of sediment to the structure pools was based on a range of 10 to 15 percent deposition in the detention pool area and 85 to 90 percent deposition in the sediment pool. This allocation was determined on the basis of topography and texture of sediment after allowing for 90 percent of the sediment being carried in suspension through the outlet structure.

The sediment source studies indicated that the erosion rates in the watershed were moderate. A summation found the annual sediment yields above the 11 planned floodwater retarding structures to be 55.18 acre-feet, or an average of 1.48 acre-feet per square mile.

Flood Plain Sedimentation and Scour

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

1. Field examinations and aerial photograph studies were made along representative valley cross-sections (figure 2), making note of depth and width of scour channels and sheet scour areas, stream channel aggradation or degradation, and other important factors.

2. Estimates of past physical flood plain damages were obtained through interviews with the landowners and operators and by comparison of damages with non-damaged areas.

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

4. The sediment and scour damages were summarized by evaluation reaches for the entire flood plain and adjusted for recoverability of productive capacity. Estimates for recoverability were developed from field studies and interviews with farmers.

5. Using the average annual erosion rates as a basis, the average annual sediment yields to selected reaches of the flood plain were estimated for present conditions, with land treatment, and with structural measures installed. The results were compared to show the average annual reduction of sediment load contributing to overbank deposition. The reduction of overbank deposition is based on the reduction of sediment load and reduction of area inundated by floodwater. The reduction of scour damages due to the installation of the complete project

is based on a reduction of depth of flooding and area inundated.

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the 11 planned floodwater retarding structure sites in accordance with "Guide to Geologic Site Investigations", Fort Worth Engineering and Watershed Planning Unit area, dated July 1965, and Section 8, Engineering Geology, National Engineering Handbook. The following proosdures were used:

1. Available pertinent geologic maps and literature were gathered and studied.

2. Stereoscopic studies were made of aerial photographs to determine the location of rock outcrops and to help trace the strata through the site areas.

3. A field investigation was made of each site and notes were made of the following:

    a. Lithology, thickness, structure, and sequence of rock strata.

    b. The nature and thickness of the soil mantle in the foundation, borrow, and spillway areas as determined from exposures and from hand auger and power auger borings.

    c. General topography.

    d. Stream channel dimensions, type of bedload, and stability of the bed and banks.

    e. Springs, open bedding planes, erodible areas, water tables, faults, caverns, and any other geologic characteristics that might have a bearing on the design and construction of a dam.

4. The field notes, along with information pertaining to spillway excavation volumes, embankment dimensions and volumes, physiographic descriptions, etc., were used to complete form SCS-375, "Preliminary Geologic Investigations of Dam Sites".

Channel Stability Investigations

The channel stability investigations began as a reconnaissance to determine the need for further investigation. The observed conditions led to a more

intensive study involving the use of power drilling equipment, logging of materials, and sampling at selected locations for laboratory analysis. The samples were selected so as to represent major soil types in the upland sediment source areas and major textural conditions in the bottom of the channel proposed for improvement. All samples were of the disturbed type and the laboratory testing included sieve analysis, hydrometer analysis, total salt, dispersion, and Atterburg limits.

The stretch of channel under consideration was divided into three reaches according to slope and type of material and a stability analysis was made based on permissible velocities of materials. This was followed by a bedload transport study based on the Schoklitsch and Musgrave equations. The studies indicate that some erosion will occur on the upper reaches of the channel and that deposition will occur on the lower reaches. Periodic maintenance will be necessary to keep the lower reaches fully open.

Description of Problems

All of the planned floodwater retarding structures are located on the Strawn group of the Middle Pennsylvanian age. The Strawn group in this area consists of shale and sandstone, the latter varying considerably in thickness and hardness. The shale and sandstone are overlain by moderate thicknesses of sandy clays, clayey sands, and silty sands. These soils are CL, SC, and SM, according to the Unified Soil Classification System.

The structure sites should provide sound foundations at moderate depths. Erodible emergency spillways are present on Sites 1, 3, 4, 5, 6, 9, 10, and 11, and will need a protective cover of grass. Rock excavation appears likely on Sites 2, 7, and 8. Site 11 will present a seepage condition through deep sandy soils; however, a deep positive cut-off and/or foundation drains would alleviate the problem. Also, the soils at the site have accumulated salt from use of slightly salty irrigation water from an Artesian well. This should be investigated further before construction.

Detailed investigations, including explorations with core drilling equipment, will be made at all floodwater retarding structure sites prior to construction. Laboratory tests will be made to help determine precise treatment of soil materials in the foundation and embankments.

Economic Investigations

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

Selection of Reaches

The flood plain was divided into four evaluation reaches (figure 2) due to the difference in damageable values and flood plain characteristics. This break simplified the evaluation of the effects that various components of the overall program and combination of structural measures would have on

the reduction of damages.

Determination of Damages

Agricultural damage estimates were based on historical data contained in approximately 35 flood damage schedules taken in the field, and covering about 70 percent of the flood plain ownership or approximately 75 percent of the total flood plain area. Historical data obtained included flood damages to crops, fences, livestock, farm equipment, and roads and bridges. Cropping systems, average flood free yields, production costs, land values, and land use were collected from farmers, ranchers, local bankers, and agricultural specialists in the field. This data was used as a basis for determining the damageable value and damage rates at various depths and seasons of flooding.

The applicable rates of damage were applied to each flood occurring in the flood series for the period 1922 through 1963. Adjustments were made on each reach to account for the effect of recurrent flooding when several floods occurred within one year.

Estimates of damages to other agricultural properties such as fences, livestock and farm equipment were made from information in flood damage schedules and correlated with size of flood. Estimates of damages to roads and bridges were obtained from county commissioners, State highway officials and local farmers.

On the calculation of crop and pasture damages, expenses saved, such as costs of harvesting and production inputs, were deducted from the gross value of the damage. Current flood plain land use was mapped in the field.

Estimates of flood-free yields obtained from owners and operators of farms and agricultural workers in the area were adjusted to allow for increased technology and the assumption was made that production practices now used by the better farmers would be in general use over the life of the project.

Monetary values of physical damage to flood plain lands from scour and sediment were based on the net value of production lost, taking into account the time for recovery, and discounted.

Indirect damage from floods included re-routing of school buses, isolation of farmers from some fields due to farm road damage, delays and extra travel in rural mail delivery, additional travel time for farmers, and extra feed for livestock following floods. Based on information obtained from watersheds previously analyzed, it was estimated that these indirect damages would approximate 10 percent of all direct damages.

Benefits from Reduction of Damages

Average annual damages within the watershed were calculated for conditions without a project, with land treatment installed, and after installation of the complete project. The difference between the damage at the time of the

initiation of each project increment and that expected after its installation constituted the benefits brought about by that increment through reduction in damages.

Installation of this project will provide flood reduction benefits on the Colorado River below the watershed. These benefits were evaluated and included as a project benefit in this watershed.

Restoration of Former Productivity and More Intensive Land Use Benefits

Farmers in the watershed were asked what changes in cropping systems and land use had been made as a result of frequent flooding and what changes in land use and cropping practices might be expected in the future with these floods reduced in extent and frequency. Using their predictions as a guide, it was estimated that approximately 301 acres of formerly cultivated land now in low-yielding pasture would be returned to more productive cash crops. It was determined from this analysis that the average annual benefits from restoration of former crop use would amount to $3,977. Added damage to higher damageable values from the remaining floods was calculated and subtracted.

Field studies indicated that 1,416 acres of flood plain would be farmed more intensively with flooding reduced. The timeliness of farm operations with flooding reduced will result in the use of better farming techniques. More fertilizers will be applied and wider use will be made of insecticides and weed control measures. The use of certified and treated seed is expected to become more common. The benefits from more intensive use of flood plain lands were estimated to be $7,623, annually.

Incidental Benefits

Evaluation of incidental recreation benefits was based on an economic analysis of existing structures and from past experience. This analysis indicated that the project will have an average of 4,300 visitor days annually and net benefits of $0.50 per visitor day, after allowances for associated costs. It was estimated that the capacity of the sediment pools would remain adequate for recreational purposes after 40 years and decline to zero at the end of 50 years. The incidental recreational benefits were discounted to allow for this depletion in capacity.

Benefits accruing from use of sediment pools for livestock water were based on studies made on watersheds where structures have been installed for several years. Using data from the Green Creek project and other nearby watersheds, it was estimated that annual stockwater benefits would be about $888.

No irrigation or other agricultural water management benefits were evaluated.

Seoondary Benefits

The value of local seoondary benefits induced by or stemming from the project were estimated to be equal to 10 percent of the direct primary benefits plus 10 percent of the oost of the additional agrioultural production and assooiated costs incurred in obtaining the increased production. This excludes all indirect benefits from the computation of secondary benefits.

Appraisals of Land Easement Values

The value of easements was determined through local appraisal, giving full credit to the ourrent real estate market values. Areas inundated by sediment pools of the floodwater retarding structures were excluded from the damage oaloulations. An estimate was made of the value of production lost in the pool areas after installation of the project. The average annual loss in value of production within pool areas, plus se ondary costs therefrom ($5,486), were compared with the amorrized value of land ($6,141). The amortized land value was greater and was used in economio justification to assure a more conservative evaluation.

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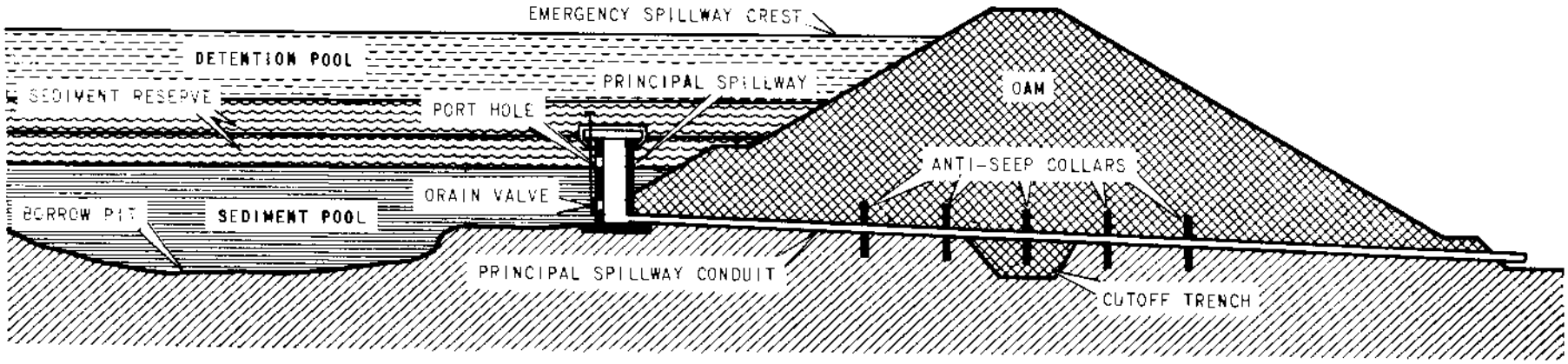


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

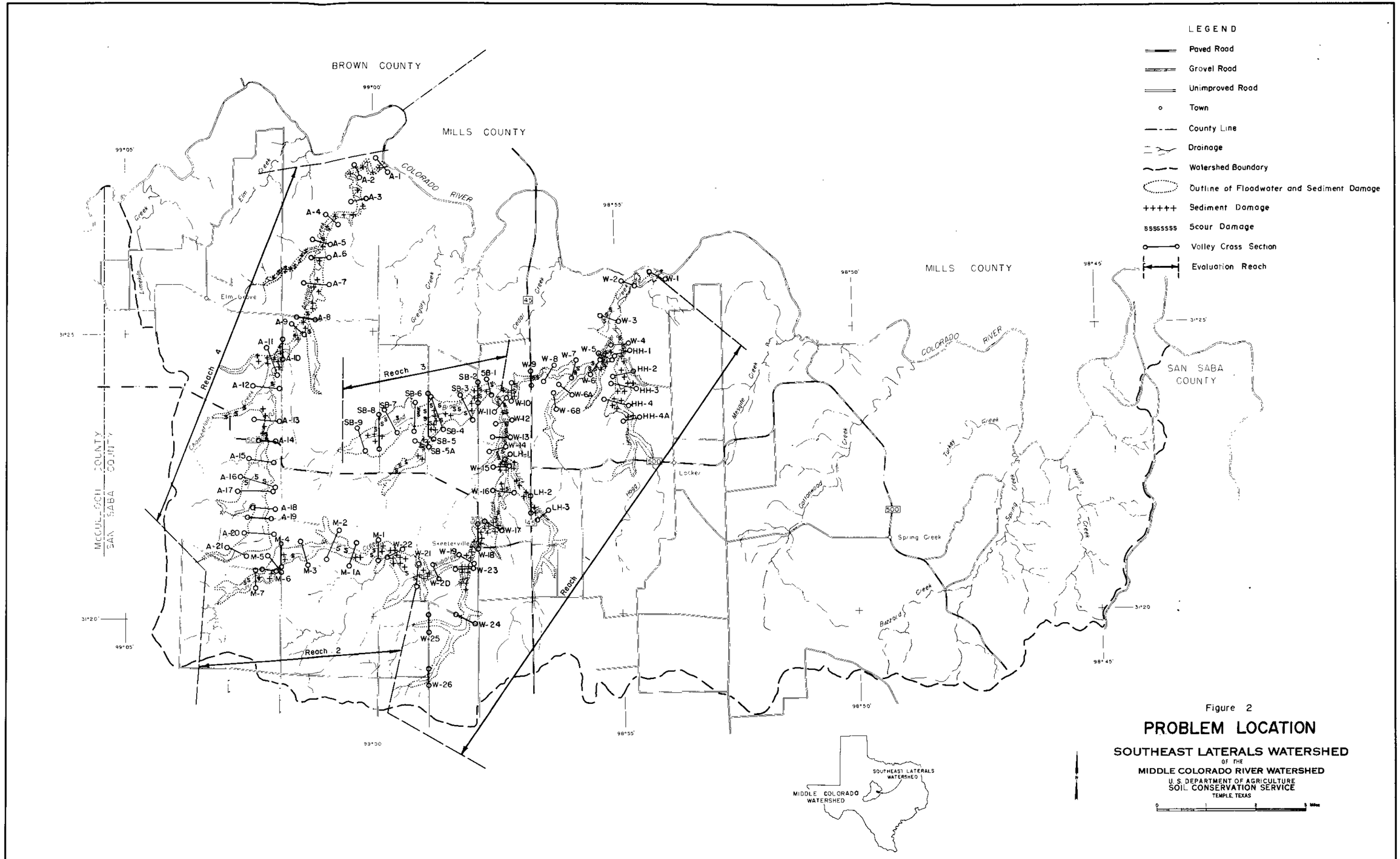


Figure 2

PROBLEM LOCATION

SOUTHEAST LATERALS WATERSHED

OF THE

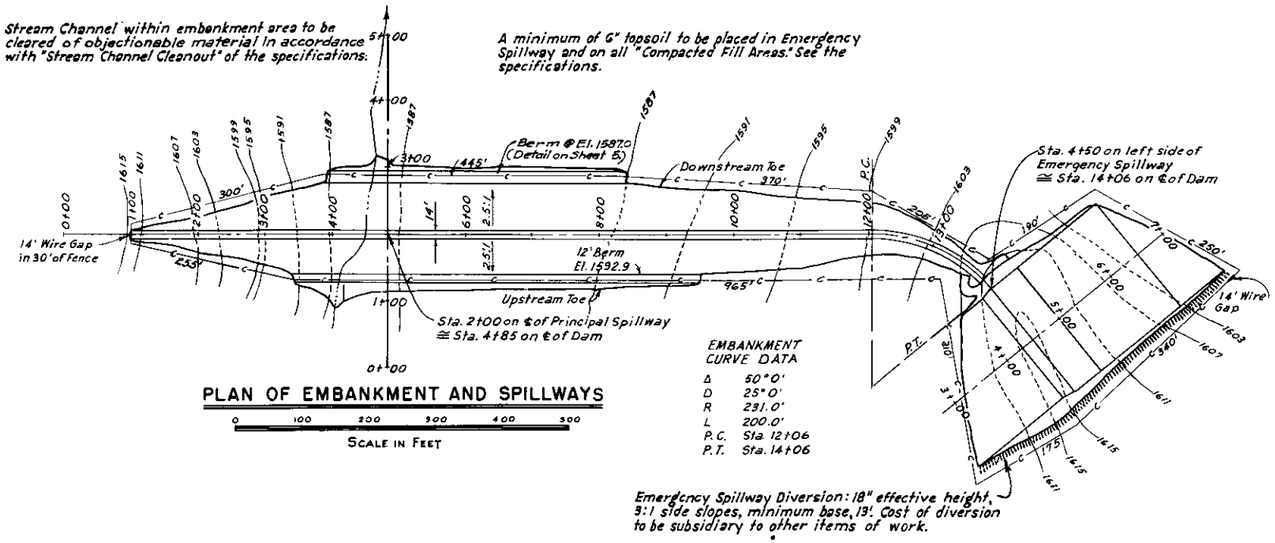
MIDDLE COLORADO RIVER WATERSHED

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

6-66 4-R-22016

March 3, 1965 Revised 6-66 4-R-19823

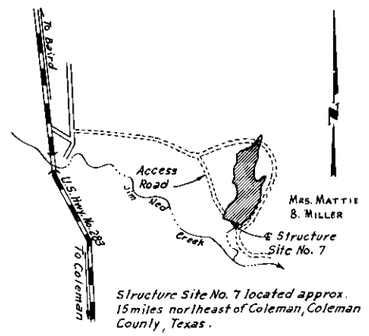
USDA-SCS FORT WORTH TEX 1744



PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

SCALE IN FEET

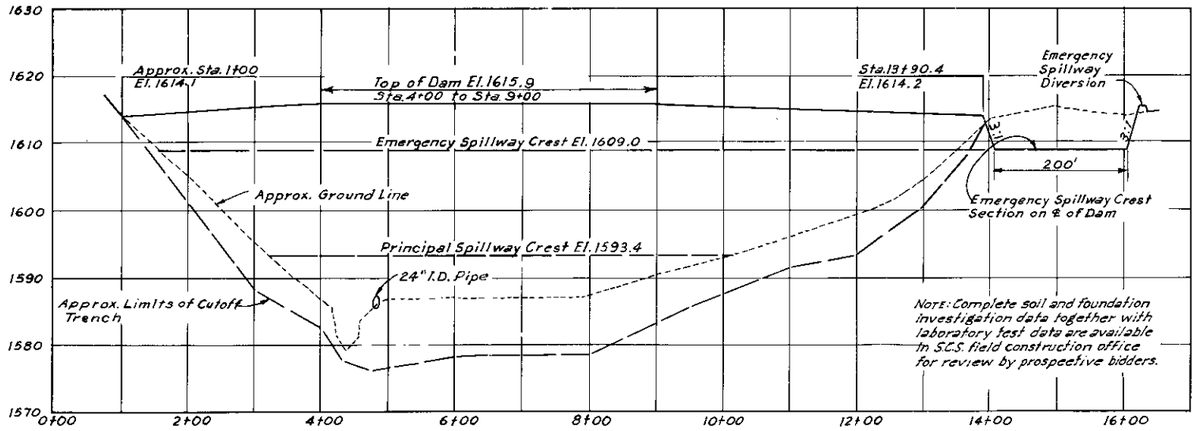


Structure Site No. 7 located approx. 15 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

0 1 2 3 4

SCALE IN MILES

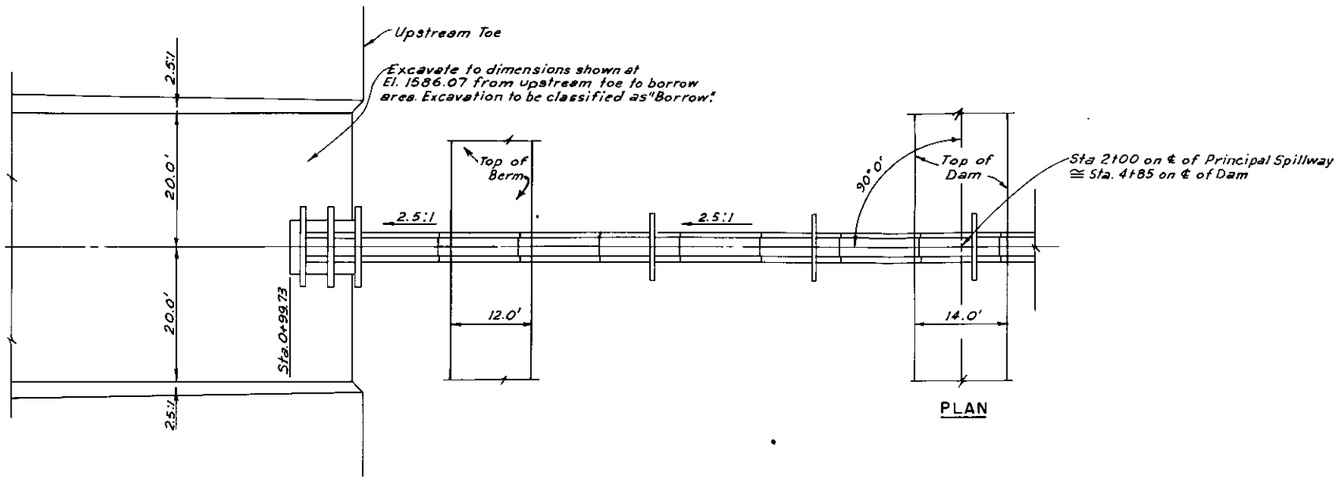


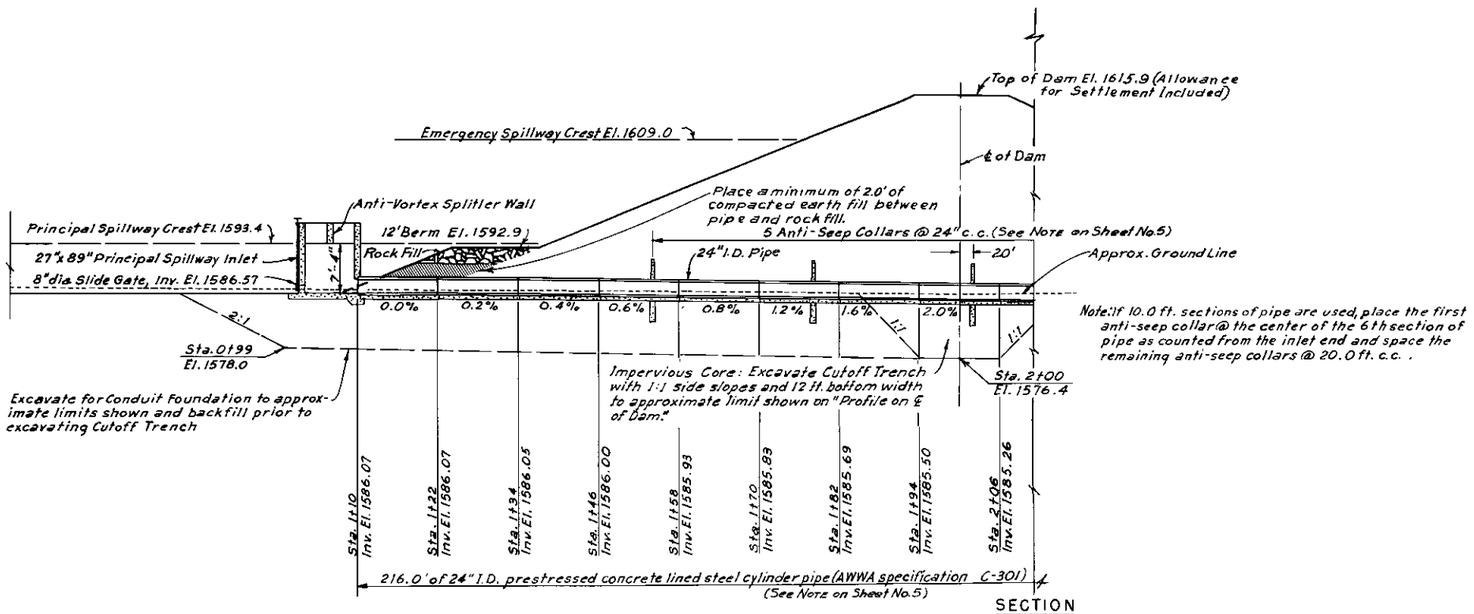
PROFILE ON ℄ OF DAM

Figure 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.D.K.	Date 9-61	Approved by: Acting Head, Engineering & Watershed Planning Unit, Fort Worth, Texas	
Drawn M.O.K. & M.G.C.	9-61	State Conservation Engineer	
Traced M.G.C.	3-61	Sheet No. 2 of 10	Drawing No. 4-E-15,400
Checked M.O.K. & G.W.T.	4-61		





SECTION

PRINCIPAL SPILLWAY

Figure 3A

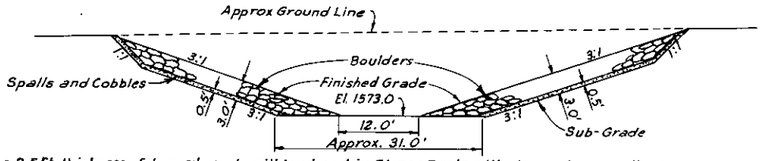
TYPICAL

FLOODWATER RETARDING STRUCTURE

STRUCTURE PLAN AND SECTION

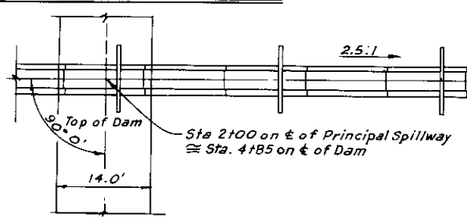
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.D.K.	Date 3-61	Approved by: [signature] REGD. ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS	
Drawn M.D.K. & M.G.C.	3-61	STATE CONSERVATION ENGINEER, S.C.S. TEMPLE, TEXAS	
Traced M.G.C.	3-61	Sheet No. 4 of 10 sheets	Drawing No. 4-E-15,400
Checked M.D.K. & G.W.T.	4-61		

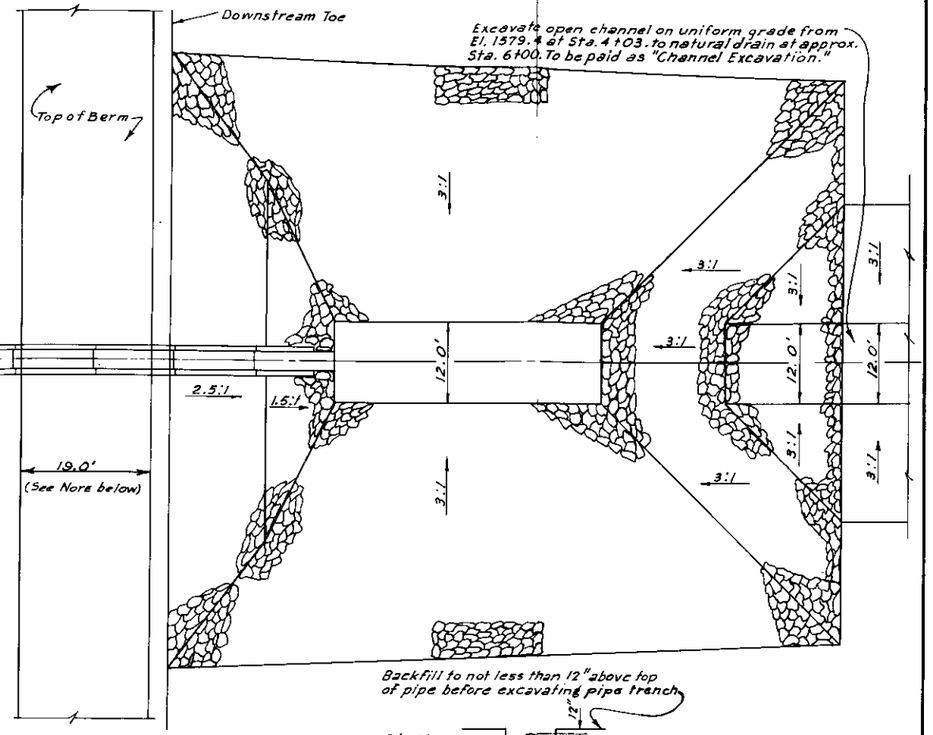


The 2.5 ft. thickness of dumped rock will be placed in Plunge Basin with rock sizes grading from small at sub-grade to large at finished grade. Placement of spalls and cobbles will precede dumping and placement of boulders. Boulders will be placed to reasonable neat lines of the finished grades, as shown on drawings. Cost of excavating and preparing Plunge Basin for placement of rock will be paid as "Channel Excavation". Rock against Principal Spillway will be hand placed to avoid damage to pipe or other structural works. Any damage to pipe or other structural works caused by the Contractor during construction of the Plunge Basin shall be repaired by the Contractor without compensation. Source of rock will be from the Emergency Spillway Excavation. Rock shall be quarry-run size. Placement of the rock in the Plunge Basin is not a direct pay item; such cost is to be considered subsidiary to other items of work. Approximately 560 cu yd of rock will be required to construct the Plunge Basin.

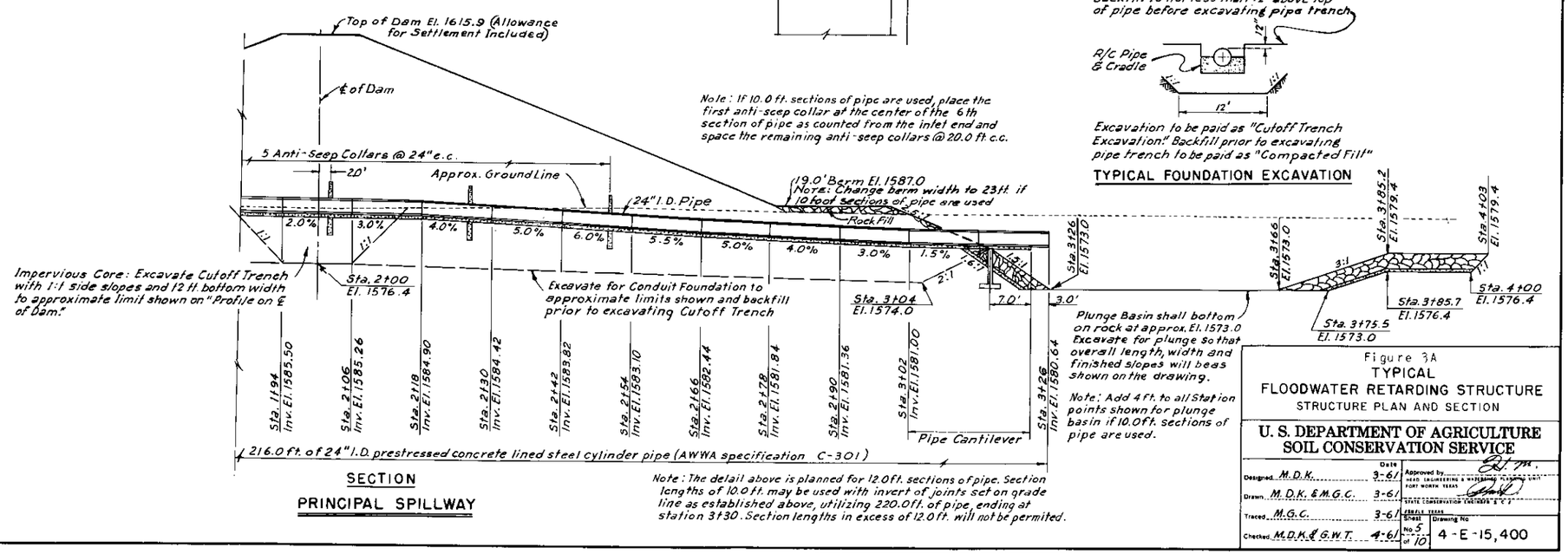
TYPICAL SECTION – PLUNGE BASIN



PLAN



TYPICAL FOUNDATION EXCAVATION



Impervious Core: Excavate Cutoff Trench with 1:1 side slopes and 12 ft. bottom width to approximate limit shown on "Profile on ℄ of Dam."

Excavate for Conduit Foundation to approximate limits shown and backfill prior to excavating Cutoff Trench

Note: If 10.0 ft. sections of pipe are used, place the first anti-seep collar at the center of the 6th section of pipe as counted from the inlet end and space the remaining anti-seep collars @ 20.0 ft. c.c.

Plunge Basin shall bottom on rock at approx. El. 1573.0 Excavate for plunge so that overall length, width and finished slopes will be as shown on the drawing.

Note: Add 4 ft. to all Station points shown for plunge basin if 10.0 ft. sections of pipe are used.

Note: The detail above is planned for 12.0 ft. sections of pipe. Section lengths of 10.0 ft. may be used with invert of joints set on grade line as established above, utilizing 220.0 ft. of pipe, ending at station 3+30. Section lengths in excess of 12.0 ft. will not be permited.

SECTION
PRINCIPAL SPILLWAY

Figure 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	3-61	Approved by ____ HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn M.D.K. & M.G.C.	3-61	
Traced M.G.C.	3-61	STATE CONSERVATION ENGINEER, TEXAS
Checked M.D.K. & G.W.T.	4-61	ABILENE, TEXAS — Sheet No. 5 of 10 — Drawing No. 4-E-15,400

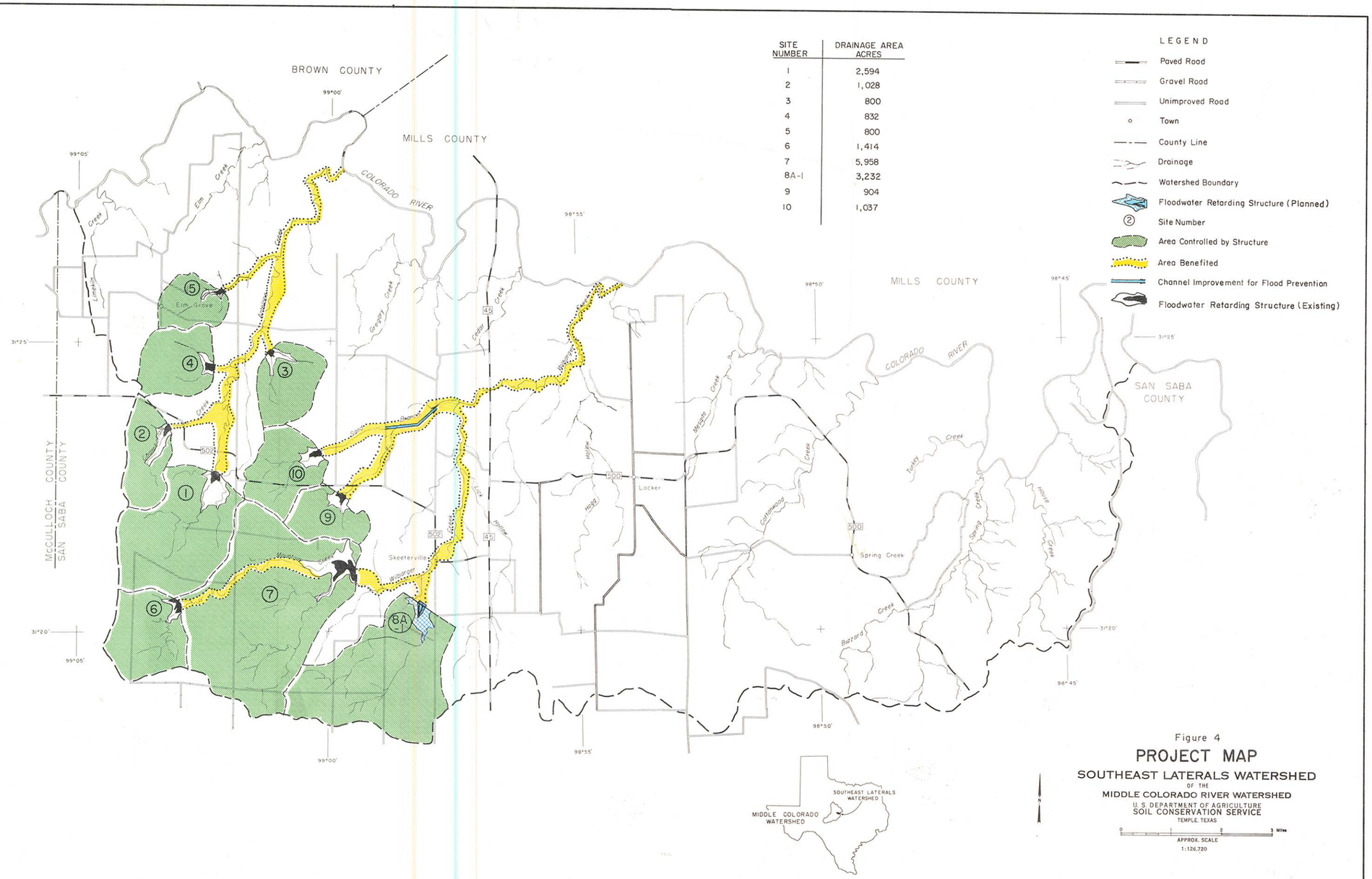


Figure 4

PROJECT MAP

SOUTHEAST LATERALS WATERSHED

OF THE

MIDDLE COLORADO RIVER WATERSHED

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

USDA SCS-FORT WORTH, TEX. 1973

Rev. 6-73

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March 3, 1965 Revised 6-66

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