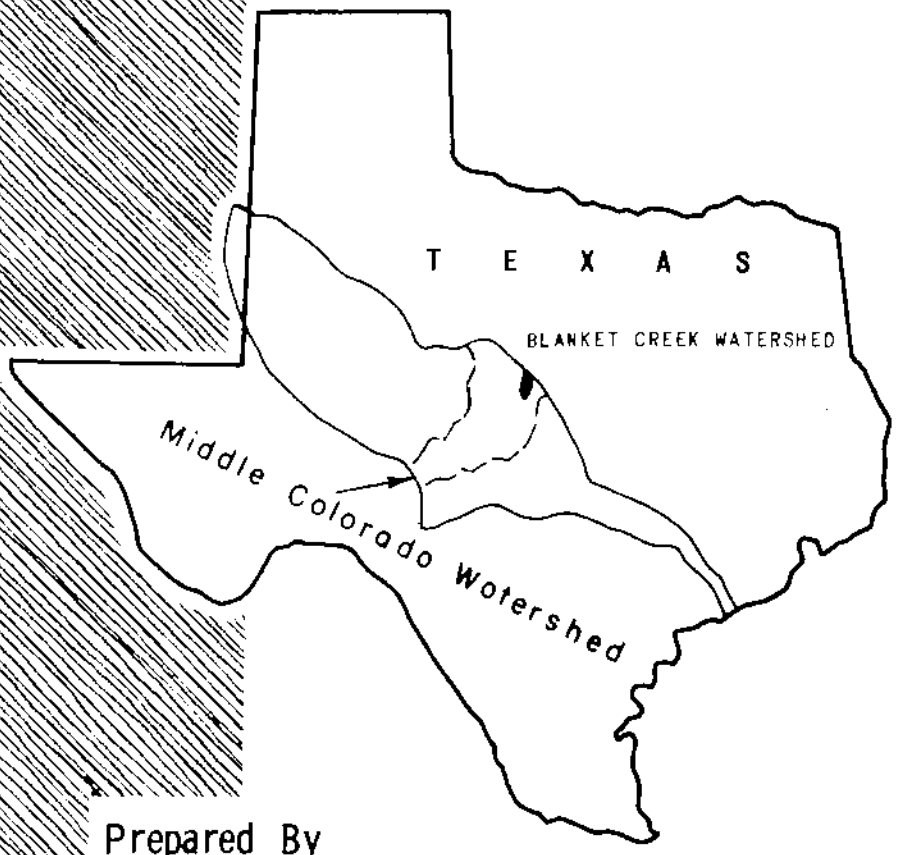
WORK PLAN

BLANKET CREEK WATERSHED

OF THE MIDDLE COLORADO RIVER WATERSHED
BROWN, COMANCHE, AND MILLS COUNTIES, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
September 1962

WATERSHED WORK PLAN AGREEMENT

between the

Brown-Mills Soil Conservation District
Local Organization

Upper Leon Soil Conservation District
Local Organization

(Hereinafter referred to as the Districts)

Brown County Commissioners Court
Local Organization

Comanche County Commissioners Court
Local Organization

Mills County Commissioners Court
Local Organization

(Hereinafter referred to as the Counties)

In the State of Texas

and the

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

Whereas, the Districts have heretofore entered into a Flood Control
plemental Memorandum of Understanding with the Soil Conservation Service
assistance in constructing Works of Improvement for the prevention of floods
the Blanket Creek Watershed, State of Texas, under the
ority of the Flood Control Act of 1944 (58 Stat. 887).

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

Whereas, there has been developed through the cooperative efforts of the
ricts and the Service a mutually satisfactory plan for Works of Improvement
the Blanket Creek Watershed, State of Texas, hereinafter
rred to as the Watershed Work Plan;

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

It is mutually agreed that in installing and operating and maintaining the Works of Improvement described in the Watershed Work Plan:

1. The Districts and /or the Counties will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the Works of Improvement.

2. The Districts will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation or the Works of Improvement.

3. The Service will provide all construction costs and installation services applicable to Works of Improvement for flood prevention.

4. The Districts will obtain agreements from owners of not less than 50 percent of the land above each floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

5. The Districts will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the Watershed Work Plan.

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

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

Brown-Mills Soil Conservation District
Local Organization

By F. Scott Lanford
F. Scott Lanford

Title Chairman

Date Feb. 14, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Brown-Mills Soil Conservation District
Local Organization

adopted at a meeting held on Jan. 31, 1963.

W. G. Bishop
(Secretary, Local Organization)
W. G. Bishop

Date Feb. 19, 1963

Upper Leon Soil Conservation District
Local Organization

By Ory Beaty
Ory Beaty

Title Authorized Representative of Board

Date February 8, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Upper Leon Soil Conservation District
Local Organization

adopted at a meeting held on January 11, 1963

H. W. Turney
(Secretary, Local Organization)
H. W. Turney

Date February 8, 1963

Brown County Commissioners Court
Local Organization

By J. N. Childs
J. H. Childs

Title County Judge, Brown County

Date 1-31-63

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

adopted at a meeting held on January 14, 1963.

Mrs Billie Porter
(Secretary, Local Organization)
Mrs. Billie Porter

Date February 14, 1963

Comanche County Commissioners Court
Local Organization

By D. F. Caraway
D. F. Caraway

Title County Judge, Comanche County

Date 1-31-63

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

adopted at a meeting held on 1-14-63

Fred Hall
(Secretary, Local Organization)
Fred Hall

Date 2-1-63

Mills County Commissioners Court
Local Organization

By Cecil Eggs
Cecil Eggs

Title County Judge, Mills County

Date 1-31-63

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

adopted at a meeting held on December 18, 1959

Walter A. Bryant
(Secretary, Local Organization)
Walter A. Bryant

Date February 1, 1963

United States Department of Agriculture
Soil Conservation Service

By _____
State Conservationist

Date _____

WORK PLAN

BLANKET CREEK WATERSHED
Of the Middle Colorado River Watershed
Brown, Comanche, and Mills Counties, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority
of the Flood Control Act of 1936
as Amended and Supplemented

Participating Agencies

Brown-Mills Soil Conservation District
Upper Leon Soil Conservation District
Brown County Commissioners Court
Comanche County Commissioners Court
Mills County Commissioners Court

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture
September 1962

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WATERSHED WORK PLAN

BLANKET CREEK WATERSHED
Of the Middle Colorado River Watershed
Brown, Comanche, and Mills Counties, Texas
September 1962

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for Blanket Creek watershed was prepared by the Soil Conservation Service in cooperation with the Brown-Mills Soil Conservation District, Upper Leon Soil Conservation District, Brown County Commissioners Court, Comanche County Commissioners Court, and the Mills County Commissioners Court. The Federal participation outlined in this work plan will be performed under the authority of the Flood Control Act of 1936, as amended and supplemented.

The primary objective of the project is to provide flood protection to the agricultural lands subject to flood damage from Blanket Creek and its tributaries. Upon completion 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 capability of the land.

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

Blanket Creek, a tributary of Pecan Bayou, is located in the Colorado River Basin in Brown, Comanche and Mills Counties, Texas. The watershed comprises an area of 196 square miles, or 125,440 ~~acres~~. Approximately 71 percent of the watershed is rangeland, 26 percent is cropland, and 3 percent is in miscellaneous uses, such as roads, highways, towns, and stream channels.

The work plan proposes installing in a 5-year period, a project for protection and development of the watershed. The cost of installing these measures, excluding work plan preparation cost, is estimated to be ~~$2,228,324~~. Of this amount, $775,928 will be borne by local interests, and $1,452,396 by flood prevention funds. In addition, local interest will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost of land treatment measures, exclusive of expected reimbursement from Agricultural Conservation Program Service or other Federal funds, is $629,350. In addition, prior to work plan preparation, landowners and

operators have established land treatment measures at an estimated non-Federal cost of $940,300. Also, prior to work plan preparation, $7,200 of flood prevention funds were used to accelerate technical assistance by the Soil Conservation Service to landowners and operators. This acceleration of technical assistance will continue during the period of installation at a cost of $13,000. The work plan includes land treatment 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 will be installed under the going programs.

Structural Measures

The structural measures included in the plan consist of 20 floodwater retarding structures having a total sediment storage and floodwater detention capacity of 17,998 acre-feet. The total primary cost of structural measures is $1,585,974. Of this amount, $146,578 will be borne by local interests and $1,439,396 by flood prevention funds. The 20 floodwater retarding structures will be installed during a 5-year period.

Secondary costs will average $724 annually.

Damages and Benefits

The reduction in floodwater, flood plain erosion, and indirect damages will directly benefit approximately 90 owners of agricultural land in the flood plain in addition to owners of nonagricultural facilities within the watershed. Processors of agricultural commodities and other businesses in the area will benefit from the project.

The estimated average annual floodwater, flood plain erosion, and indirect damages without the project total $48,512 at long-term price levels. The estimated average annual floodwater, flood plain erosion, and indirect damage with the project installed, including land treatment and structural measures, amounts to $9,089, a reduction of approximately 81 percent.

The average annual primary benefits accruing to structural measures total $53,840, and are distributed as follows:

Floodwater damage reduction	$30,413
Erosion damage reduction	5,121
Indirect damage rsduction	3,132
Incidental benefits	8,158
Changed land use benefits	12,291
Benefits outside project area	4,725

Benefits that are incidental to the project purpose amount to $8,158 annually. They are recreation $3,508, livestock water $1,420 and irrigation $3,230. No additional installation costs or extra storage is required to produce these benefits.

Secondary benefits will average $8,997 annually.

The ratio of the average annual benefits accruing to structural measures total ($72,837) to the average annual cost of these measures ($63,232) is 1.2:1.

Provisions for Financing Local Share of Installation Costs

Funds for the local share of the project will come from revenue presently being collected by Brown, Comanche and Mills Counties. These funds are adequate and available for financing the local share of the costs for 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 Brown-Mills and Upper Leon Soil Conservation Districts.

Structural measures will be maintained jointly by the Brown-Mills and Upper Leon Soil Conservation Districts and the Brown, Comanche and Mills County Commissioners Courts. Each county and each district will assume joint responsibility for those structures located within their boundaries. The average annual cost of operating and maintaining the structural measures is estimated to be $2,320 at long-term price levels.

DESCRIPTION OF WATERSHED

Physical Data

Blanket Creek rises in north Brown County about 7 miles northwest of Blanket, Texas, and flows south through Brown and Mills counties for approximately 30 miles. It discharges into Pecan Bayou about 5 miles southwest of Mullin, Texas. The largest tributaries are Pompey and Dry Blanket Creeks. The Blanket Creek watershed has an area of 125,440 acres (196 square miles), nearly all in farms and ranches.

The topography of the watershed is a moderately to gently rolling plain, although areas with rather pronounced relief occur along the eastern margin. Most of the watershed is underlain by shales, marls, impure limestones, packsands, and soft siltstones of the Trinity group of Lower Cretaceous (Comanchean) age. The Fredericksburg group, also of Comanchean age, is exposed along the eastern margin of the watershed. The Fredericksburg formations include the Walnut clay and shell conglomerate, Comanche peak limestone and Edwards limestone. A small area near the mouth of the watershed is underlain by sandstones and shales of the Strawn group of Pennsylvanian age.

The alluvial valleys of the major tributaries range from about 500 feet to about 1,600 feet in width, averaging 1,000 feet. Valley widths on the mainstem flood plain range from around 300 feet to about 2,650 feet. The average valley width on the mainstem is about 1,600 feet. Elevations above mean sea level on the flood plain range from 1,690 feet in the upper reaches to 1,230 feet near its confluence with Pecan Bayou.

The watershed is in two land resource areas. The North Central Prairie is confined to a small area representing about 2 percent of the total watershed. It is located near the confluence of Blanket Creek with Pecan Bayou. The soil in this area consists of Darnell-Owens fine sandy loams and stony clays. The remaining 98 percent of the watershed is within the Grand Prairie Land Resource Area. The soils of the Grand Prairie consist of Denton-Tarrant stony clays, Crawford-Tarrant stony clays, Denton-San Saba clays, Blanket-Denton loams and clays, Catalpa clay loam, Unnamed-Windthorst clay loams and fine sandy loams, and Unnamed stony loams and fine sandy loams. These Grand Prairie soils form a complex with scattered patches of Cross Timbers type soils produced from sandstone and siltstone facies of the Trinity group. The Cross Timbers soils include Stephenville loamy fine sand, Stephenville-Bracket loams, and Windthorst loams and very fine sandy loams.

The soils generally are in fair condition. Much small grain and many high residue producing crops are grown and help prevent rapid deterioration of the soil. Crop residue use is practiced effectively on about 54 percent of the cropland.

Hydrologic cover condition of the rangeland, in general, is fair with areas in good and poor condition. Fifteen range sites are in the watershed. They are:

Bottomland	Rocky Upland	Tightland
Deep Upland	Pink Limestone	Shallow Hardland
Rolling Prairie	Sandy	Sandstone Hills
Redland	Sandy Loam	Shaly Hills
Adobe	Deep Sandy	Low Stony Hills

The natural vegetation consists of the mixed prairie plant group. It is composed of buffalograss, Texas wintergrass, curly mesquite, sideoats grama, and bluestems. Elm and pecan trees grow near the streambanks. Invading plants, and plants which have increased with the overuse of rangeland, include perennial three-awn, hairy tridens, mesquite and oak. The range condition classes of the watershed are as follows: 3 percent, excellent; 12 percent, good; 41 percent, fair; 44 percent, poor.

The overall land use is:

Land Use	Acres	Percent
Cultivation	33,115	26
Range	88,430	71
Stream Channels	1,285	1
Miscellaneous 1/	2,610	2
Total	125,440	100

1/ Includes roads, railroads, highways, towns, etc.

The mean annual weighted rainfall for the watershed is 28.85 inches. The minimum recorded rainfall was 18.64 inches and the maximum, 38.07 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 84 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. The towns of Blanket, Zephyr and Mullin obtain ample water from wells, except for periods of extended drought.

Economic Data

The economy of the watershed depends largely upon its farms and ranches. The watershed is characterized by a predominance of ranching and livestock farming.

Principal types of livestock found in the watershed are fine-wool sheep and beef cattle. The beef cattle enterprise is principally a mother cow operation where calves are born in the late fall or winter months and sold as feeders the following fall. There are no large feed lots in the immediate area. The sheep are shorn in the early spring and lambs born in the late winter months are sold during the fall.

Oats and wheat which are grazed during the winter months and harvested for grain in June are the predominant crops. Other crops grown in the area include cotton, grain sorghum and forage crops.

The average size farm in the watershed is 405 acres and the current market price of land is $100 per acre. The estimated current price of the flood plain land is $175 to $225 per acre. Agricultural land is largely owner-operated with about 25 percent being leased or rented. Usually the leased or rented land is operated by a neighboring landowner.

Brownwood, population 16,974, which lies 12 miles west of Zephyr, is the principal banking, commercial and shipping point for the watershed. Blanket, population 320, and Zephyr, population 270, provide limited markets for farm products. These small towns are supported largely by agricultural enterprises.

From census data, it is estimated that the rural population of the watershed in 1960 was 1,200. This is a decrease of about 900 since 1940. The trend for the last 40 years has been toward a smaller population. For example, Mills County's population in 1920, 1940, and 1960 was 9,019, 7,951, and 4,467, respectively.

The changes in farm operation and farm enterprises in Mills County are typical of those which have occurred in the watershed. Listed are some census data for Mills County that indicates the magnitude of these changes.

Item	Year 1934	Year 1959
Average size farm, acres	270	553
Cropland harvested, acres	79,201	32,108
Cattle and calves, number	19,537	21,557
Sheep and lambs, number	80,057	108,922
Corn, acres	15,967	1,687
Oats, acres	17,102	12,326
Wheat, acres	2,612	1,967
Grain Sorghum, acres	2,602	4,272

In 1936, 3,799 bales of cotton were ginned in Mills County, but in 1959, only 831 bales were ginned.

For the watershed, the change from a general type of farming to livestock farming is almost complete. 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 operating units are expected to increase in size until an average of about 500 acres is reached. With this increase in size of farms, the rural population will decrease to some extent. Urban population should remain about the same as present.

The watershed is served adequately by 230 miles of roads, of which 67 miles are paved. The Gulf, Colorado and Santa Fe Railroad provides ample loading facilities at Brownwood.

Land Treatment Data

The Brown-Mills and Upper Leon Soil Conservation Districts have been very active in establishing land treatment measures and in initiating flood prevention work. The districts have obtained a high degree of psrticipation in this program from farmers, ranchers, and other interested parties in the watershed.

The watershed is served by Soil Conservation Service work units at Brownwood, Comanche and Goldthwaite, which are assisting the Brown-Mills and Upper Leon Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 214 soil and water conservation plans on 90,743 acres (74 percent of the total agricultural land) within the watershed. Technical guidance has been furnished in establishing and maintaining planned land treatment measures. Fifty-five percent of the needed measures have been applied. Where these measures have been applied and maintained as long as three years, average crop and pasture yields have increased by about one-fifth. Land treatment measures installed before the development of this flood prevention work plan are shown in table 1a.

WATERSHED PROBLEMS

Floodwater Damage

The flood plain consists of 5,602 acres, excluding 1,285 acres in stream channels. It is this area that will be inundated by the runoff from the largest storm considered in the 25-year evaluation series. This storm was a 6.15-inch rain that extended over 3 days, July 23-25, 1938. It produced 3.36 inches of runoff and has a 4 percent chance of occurrence. At the present time, about 46 percent of the flood plain is in cultivation; 53 percent in pasture or range, and 1 percent in miscellaneous uses.

The most recent major flood was in the fall of 1959. This flood inundated about 6,100 acres and was one of the largest ever witnesses on Blanket Creek. Based on information from landowners, the damage to agricultural property such as livestock and fences amounted to about $80,000. Damage to 2,800 acres of growing small grain and maturing row crops was severe.

Roads and bridges were washed out leaving some roads impassable for many days. The Gulf, Colorado and Santa Fe Railroad was washed out at Blanket and rail service was interrupted for several hours. Floodwaters entered two homes in Blanket, but damage was minor. The total damage for this storm was approximately $110,000.

During the 25-year evaluation period (1922 through 1946), 19 major floods inundated more than half the flood plain in the Blanket Creek watershed (figure 3). An additionsl 83 minor floods inundated less than half the flood plain. There were 16 major floods and 60 minor floods that occurred in April, May, June, September, and October. Floods occurring in these months caused extensive crop damage.

Floodwater damages amounts to $37,725 each year on Blanket Creek.

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Other agricultural damages, such as loss of fences and livestock and debris ramoval are estimated to be $13,169 annually.

pring floods damage growing row crops and maturing small grains, and con-
ersely, fall floods damage maturing row crops and growing small grain.
loods occurring during the winter months are less damaging to crops and
astures.

ther agricultural damage is unusually high. At least annually, farmers and
anchers suffer loss of fences and livestock. Woven wire fence, which in
ost cases cannot be salvaged after flooding, and sheep, which are easily
rowned, are the main losses.

ome farmers and ranchers, on an individual basis, have attempted to enlarge,
traighten and lavae streams with very little reduction of flood damages.
ıe adversa economic and physical effect of flooding has been felt through-
ıt the entire watershed and has prompted local participation in alleviation
f the flood problem.

›r floods experienced during the period studied, the total direct agricul-
ıral and nonagricultural floodwater damages without project were estimated
› average $37,725 annually, at long-term price levels (table 5). Of this
ount, $22,959 is crop and pasture damage, $13,169 is other agricultural
ımage, and $1,597 is nonagricultural damage such as damage to roads, bridges,
ıilroads, and residential property. Indirect damages such as interruption
: travel, rerouting of school bus and mail routes, losses sustained by

usinessmen in the area, and similar losses are estimated to average $4,027 nnually.

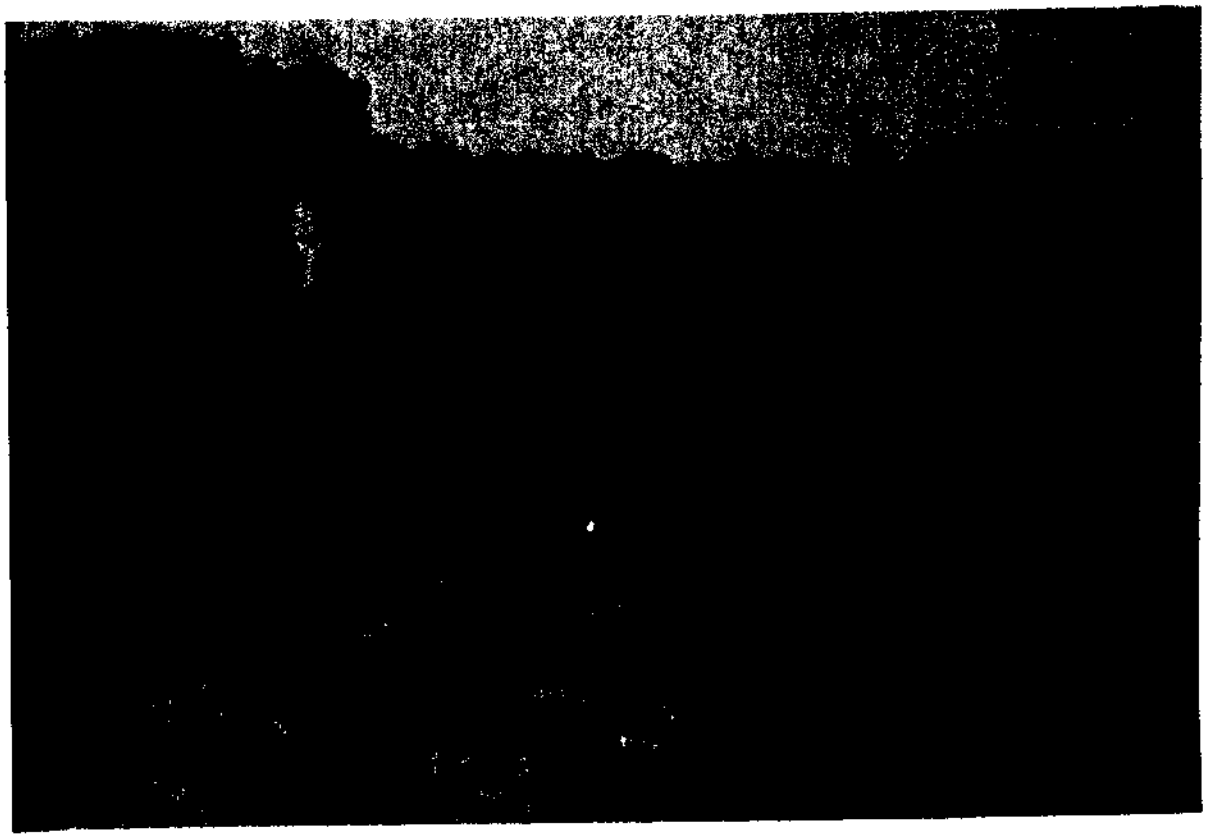
ediment Damage

eposits of silty sand are sparsely scattered on the flood plain in the lower alf of the watershed. However, damage in terms of reduced soil productivity s estimated to average less than 5 percent. The total average annual value f this damage is not significant because of the small area affected and the ow degree of damage.

n addition to the sediment deposited on the flood plain of this watershed, n estimated 169,700 tons of sediment is delivered by Blanket Creek to Pecan ayou each year. The delivery of part of this sediment to the Colorado River nd thence to Lake Buchanan decreases the storage capacity of the reservoir y an estimated 102 acre-feet per year. The average annual monetary value of his damage is estimated to be $2,700 at long-term price levels.

rosion Damage

rosion rates in this watershed are moderately low. This is due to a combi- ation of factors, including gentle slopes, a high percentage of rangeland nich generally has a fair protective cover, and extensive land treatment ractices such as contour farming, terracing and crop residue use on the ıltivated areas.



aluable topsoil has been scoured and washed away by flood water.

Upland sheet erosion accounts for approximately 79 percent of the annual gross erosion; flood plain scour, 11 percent; and streambank erosion, 10 percent.

Flood plain scour accounts for average annual damage to 1,325 acres, with damages ranging from 10 to 90 percent in terms of reduced productivity of the soil. The average annual monetary value of this damage is estimated to be $6,760 at long-term price levels. Total land damage from streambank erosion is minor.

Problems Relating to Water Management

There is no need for drainage and very little activity relative to irrigation in the watershed. At the present time, there is no known local interest in providing storage in any of the structures for irrigation, municipal water supply, fish and wildlife development, or recreation, according to the local sponsoring organizations.

PROJECTS OF OTHER AGENCIES

The works of improvement included in this and similar plans in the Colorado River Basin will have significant effects on existing downstream works of improvement and those proposed in the water resource development plan for this basin.

There are no proposed works of improvement of other agencies in this watershed.

BASIS FOR PROJECT FORMULATION

After a reconnaissance of the watershed was made by specialists of the planning party, 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. Livestock farming is the major type of operation. Moderate to severe flooding causes heavy losses of livestock and extensive damage to flood plain lands, crops, pastures, and other agricultural properties.

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 local sponsoring organizations considered the possibility of providing storage for flood prevention, agricultural and nonagricultural water management, and fish and wildlife development which might be included in the project. The sponsors determined that a project for watershed protection and flood prevention most nearly met their needs and that no other group or individual was interested in additional storage 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 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 75 to 80 percent reduction in average annual flood damages 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 protection was reasonable.

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

The recommended system of structures meets the project objectives in providing the desired level of protection for agricultural enterprises 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 soil conservation districts serving the watershed, 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. Accelerating the establishment of land treatment measures which have a measurable effect on reducing floodwater damages will be emphasized.

There are 52,311 acres above the planned floodwater retarding structures. Land treatment is especially important on these watershed lands to protect the structural measures. The only planned measures for the remaining upland area are land treatment. A conservation program on the 5,344 acres of the flood plain located outside the pools of proposed structures also is important in reducing floodwater and erosion damages.

Brush control, deferred grazing and proper use increase rangeland production and reduce soil and water loss.

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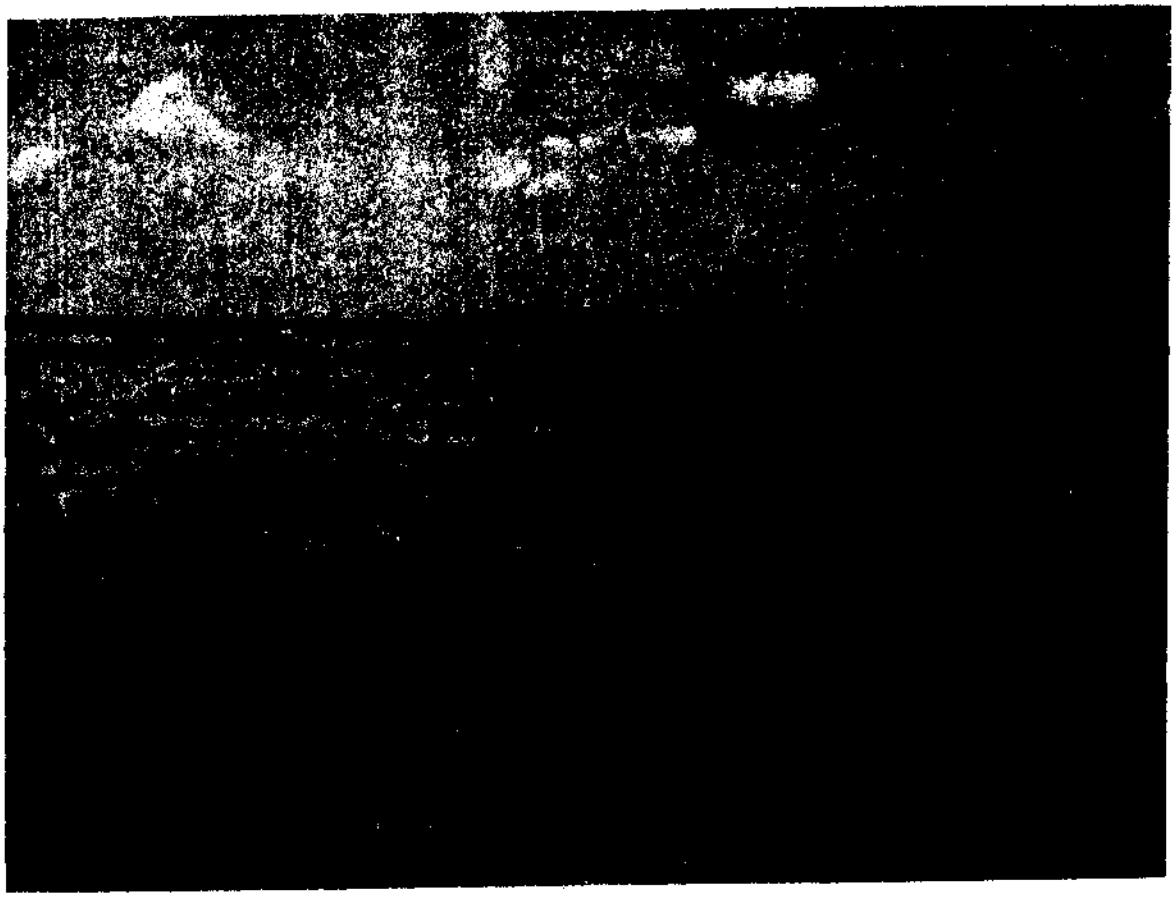


Crop residue use - a practice that prevents erosion and allows more water to soak into the ground.

The amounts and estimated cost of establishing the needed major land treatment measures that will be installed by landowners and operators during the 5-year installation period are shown on table 1. The local people will continue to install and maintain land treatment measures needed in the watershed after the 5-year installation period.

Most of the land treatment measures will function principally to decrease erosion damage 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, and diversions, all of which have a measurable effect in reducing peak discharge by slowing runoff. These measures also reduce erosion damage and sediment production.

Structural Measures

A system of 20 floodwater retarding structures, having an installation cost of $1,585,974, will be required to afford the degree of flood protection to the flood plain lands desired and mutually agreed upon by the local people. This protection cannot be provided by land treatment measures alone.

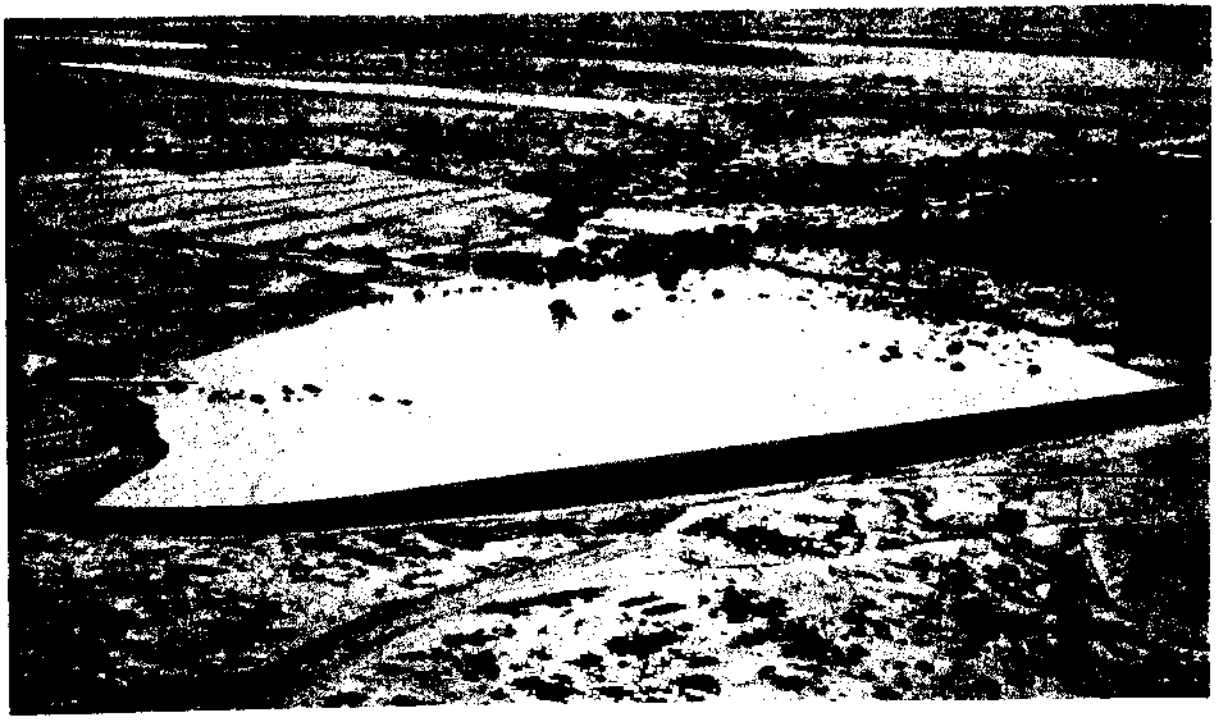
Flood detention storage in the structures will range from 3.22 to 5.46 inches of runoff, depending on local conditions. The following tabulation reflects the degree of control, detention storage in acre-feet and inches, and the equivalent detention storage for the watershed:

Item	Unit	Amount
Drainage Area of Watershed	Sq.Mi.	196.00
Drainage Area Controlled by Structures	Sq.Mi.	81.75
Drainage Area Controlled by Structures	Percent	41.71
Detention Storage	Ac.Ft.	16,158
Capacity Equivalent-Area Controlled	Inch	3.70
Capacity Equivalent-Watershed Area	Inch	1.54

To obtain the degree of protection desired by the local people, structure Site 10 was located in series with and above Site 11.

Figure 1 shows a section of a typical floodwater retarding structure. Plans of a floodwater retarding structure typical of those planned for this watershed are illustrated by figures 2 and 2a. The locations of the structural measures are shown on the Project Map (figure 4).

There are 11 low-water crossings on county roads and numerous private intra-farm low-water crossings on Blanket Creek that will be affected by the release flow from the principal spillways of floodwater retarding structures. Seven of the county crossings have either inadequate or no culverts to carry the principal spillway discharge. Under present conditions, water flows over these crossings for relatively short periods following rains. After the structures are installed, the flow will be reduced in peak, but will be greatly prolonged. The Brown, Comanche and Mills County Commissioners Courts, in cooperation with the Brown-Mills and Upper Leon Soil Conservation Districts, will install culverts or make other needed improvements to keep the crossings on county roads passable during the periods of floodwater release at no cost to the Federal government. Local interest will be responsible for the improvements of private



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.

crossings. The cost of these improvements is included in the estimated cost of land, easements and rights-of-way.

The total area of the sediment pools is 356 acres, of which 107 acres are flood plain. The detention pools will temporarily inundate an additional 1,347 acres, 151 acres of which are flood plain.

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 concrete or similar type of spillway.

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

Refer to tables 1, 2, and 3 for details on quantities, costs, and design features of the floodwater retarding structures.

EXPLANATION OF INSTALLATION COSTS

The needed land treatment measures to be installed by the landowners and operators during the 5-year installation period are shown in table 1.

The estimated cost of planning and installing these measures, exclusive of expected reimbursement from ACPS or other Federal funds, is $629,350, based on current program criteria. In addition, prior to work plan preparation, landowners and operators have established land treatment measures at an estimated non-Federal cost of $940,300 (table 1a). Prior to work plan preparation, $7,200 of flood prevention funds were used by the Soil Conservation Service for the acceleration of technical assistance to landowners and operators. This technical assistance will be continued during the period of installation at a cost of $13,000. These 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 measure were estimated by the Brown-Mills and Upper Leon Soil Conservation Districts.

Land, easements and rights-of-way, including relocation of roads, utilities and other improvements, for the floodwater retarding structures will be provided by local interests at no cost to the Federal government. The value of these is estimated to be $133,250, based on current market values estimated by local organizations. An additional $13,328 of non-Federal funds will be expended for legal and other services required in obtaining land, easements and rights-of-way.

The estimated cost of installing the structural works of improvement is $1,585,974. Of this amount, $146,578 will be borne by local interests and $1,439,396 by flood prevention funds, of which $1,141,935 are construction costs and $297,461 are installation services.

Construction costs include both the engineers estimate 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. Geological investigations included surface observations and power and hand auger borings. More detailed geologic investigations will be needed before construction. Ten percent of the engineers' estimates was added as a contingency to provide for unpredicted costs.

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

Secondary costs which will accrue from the loss of production in the pool areas of the floodwater retarding structures amount to $724 annually.

The estimated annual equivalent cost of installation is $60,188, plus an estimated annual operation and maintenance cost of $2,320 and an annual secondary cost of $724, making a total annual cost of $63,232.

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:

Fiscal Year	Measures	Federal Funds	Non-Federal Funds	Total
		(dollars)	(dollars)	(dollars)
Completed	Land Treatment	1/ 7,200	2/ 940,300	947,500
First	Structures 1, 2, 3, 4, 5	296,150	34,156	330,306
	Land Treatment	1/ 2,600	2/ 104,830	107,430
Second	Structures 6, 7, 8, 9	237,002	23,623	260,625
	Land Treatment	1/ 2,600	2/ 115,350	117,950
Third	Structures 10,11,12,13	310,440	32,918	343,358
	Land Treatment	1/ 2,600	2/ 125,870	128,470
Fourth	Structures 14,15,16,17	323,363	35,008	358,371
	Land Treatment	1/ 2,600	2/ 136,390	138,990
Fifth	Structures 18, 19, 20	272,441	20,873	293,314
	Land Treatment	1/ 2,600	2/ 146,910	149,510
Total		1,459,596	1,716,228	3,175,824

1/ Includes only accelerated technical assistance.
2/ Includes allowance for management and recurring type practices that will be applied annually.

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 program of land treatment and structural measures described above, average annual flooding, excluding the flood plain inundated by structure pools, will be reduced from 3,905 acres to 1,184 acres. Reduction in area inundated varies with respect to location within the watershed. The effect of the project in each area is shown in the following table:

Average Annual Area Inundated 1/

Evaluation Reach (Figure 3)	Without Project (acres)	With Project (acres)	Reduction (percent)
1	829	241	71
2	1,667	524	69
3	805	243	70
4	604	176	71
Total	3,905	1,184	70

1/ Exclusive of area of flood plain inundated by floodwater retarding structure pools.

The following presentation shows, by reaches, the combined program's expected reduction in area flooded from the 3-year, 10-year, and 25-year frequency floods:

Area Inundated

Evaluation Reach (Fig.3)	Average Recurrence Interval: 3 Year		10 Year		25 Year	
	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)
1	500	84	1,400	784	1,552	1,080
2	1,040	295	1,745	998	1,970	1,225
3	495	126	882	363	1,025	491
4	420	92	990	553	1,055	730
Total	2,455	597	5,017	2,698	5,602	3,526

and treatment measures will reduce the present average annual sediment yield to the 20 floodwater retarding structures from 0.48 to 0.39 acre-foot per square mile of drainage area, a reduction of 19 percent. Similar reductions are expected in other portions of the watershed.

The annual flood plain scour damage is expected to be reduced about 78 percent. Five percent will be attributable to land treatment and 73 percent to the structural measures.

The annual sediment yield to the mouth of Blanket Creek is expected to be reduced from 169,700 tons to 95,000 tons.

Erosion reduction in the drainage areas above the floodwater retarding structures plus sediment stored in structure pools will result in a reduction of 39 acre-feet of annual capacity loss in Lake Buchanan.

The project will directly benefit approximately 90 landowners in the flood plain together with the owners of nonagricultural facilities in the watershed.

Owners and operators of flood plain lands report that they will restore 197 acres of land now in poor condition pasture to cultivation when adequate flood protection is provided. This land was formerly under intensive cultivation, but is now used for grazing because of flooding. It will be used to produce oats or grain sorghum.

It is expected that landowners will convert 770 acres of pastureland to crop production. The land being converted to cropland will be used for small grains, other than wheat, grain sorghums, and hay crops.

Benefits will accrue to the planned structural measures from reduction of floodwater damages on the mainstem of Pecan Bayou and the Colorado River below Blanket Creek (table 6). The project will provide considerable reduction in flood peaks and flows originating within the project area.

In estimating project benefits from reduction of damages below the project area, consideration was given to the Fox Crossing Reservoir proposed by the U. S. Corps of Engineers. While no Federal funds have been authorized for advanced planning or construction of the reservoir, benefits to the Blanket Creek project reflect the facility in place by 2010. No benefits from reduction in Fox Reservoir sediment storage requirements were assigned to the upstream project.

Additional incidental water management benefits will result from the installation of the 20 floodwater retarding structures. The sediment pools of these structures will have a combined capacity of 1,647 acre-feet, and will cover 356 acres. It is expected that local people will spend many hours at these sites picnicking, swimming, fishing and hunting. The existence of a more dependable livestock water supply will eliminate the need for owners of land on which the structures are to be installed to haul water during drought periods. In similar watersheds, landowners have released water

downstream to replenish their neighbor's livestock water supply.

Some of the water stored in the sediment pools will be used for irrigation. It is probable that such crops as tame pasture and hay crops will be irrigated. Irrigation use will require permits from the Texas State Water Commission.

Secondary benefits will accrue to trade area businesses through increased income from processing, sales and services.

PROJECT BENEFITS

The estimated average annual monetary floodwater, erosion and indirect damages within the watershed will be reduced from $48,512 to $9,089 by the project (table 5). This is a reduction of 81 percent, 98 percent of which will result from the syatem of floodwater retarding structures.

The effect that the combined program of land treatment and structural measures will have on reduction of monetary floodwater damages caused by the 3-year, 10-year and 25-year frequency floods is presented in the following tabulation:

Direct Monetary Floodwater Damage

Evaluation Reach (Fig. 3)	Average Recurrence Interval: 3 Year Without Project (dollars)	3 Year With Project (dollars)	10 Year Without Project (dollars)	10 Year With Project (dollars)	25 Year Without Project (dollars)	25 Year With Project (dollars)
1	2,502	225	23,619	6,156	29,558	12,267
2	4,716	514	20,203	5,391	26,637	7,164
3	3,006	358	12,532	1,948	18,134	3,059
4	1,438	150	9,081	2,159	11,229	4,363
Total	11,662	1,247	65,435	15,654	85,558	26,853

The average annual damage reduction by evaluation reach is presented below:

Average Annual Damage 1/

Evaluation Reach Figure 3)	Without Project 2/ (dollars)	With Project 2/ (dollars)	Reduction (percent)
1	13,952	3,051	78
2	15,585	3,264	79
3	9,792	1,835	81
4	4,961	939	81
otal	44,290	9,089	79

/ Excludes value of restoration of former productivity.

/ Based on long-term prices.

It is estimated that the net increase in income from restoration of former productivity will amount to $4,222 (at long-term price levels) annually. This loss from the original production has been included as crop and pasture damage and its restoration a benefit in table 5.

Changed use of 770 acres of agricultural land will produce average annual benefits of $12,291.

Benefits from reduction of floodwater damages on the mainstem flood plains of Pecan Bayou and Colorado River amount to $2,182 and $1,511, respectively. The benefit from the reduction of sediment deposition in Lake Buchanan is estimated to be $1,032.

The annual monetary value of the incidental benefits is estimated to be $8,158. These are distributed as follows: recreation, $3,508; livestock water, $1,420; and irrigation, $3,230.

The project will not produce secondary benefits of National significance. However, it will increase agricultural production in the area, provide farmers and ranchers with a higher and more stable income, and stimulate business in towns and cities in and near the watershed. Incidental irrigation from the sediment pools not only will increase income and provide a market for additional equipment and supplies but will reduce risks from drouth and allow farmers to plan their operations with greater assurance. Incidental use of pools for recreation will attract visitors whose expenditures will stimulate the local economy. These secondary benefits, averaging $8,997 annually, have been used for project justification.

Some secondary costs, or negative benefits, will result from the decreased use of pool areas for agricultural production. It is estimated that such costs will average $724 annually. They have been included as a project cost in table 4.

The total average annual benefits from structural measures are estimated to be $72,837. In addition to the monetary benefits, there are other substantial benefits which will accrue to the project. These will include an increased sense of security, better living conditions and improved wildlife habitat. None of these additional benefits were evaluated in monetary terms; nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

Average annual primary benefits of $63,840 will accrue from $62,508 annual equivalent costs exclusive of secondary costs. This represents a primary benefit of $1.02 for each dollar of cost.

The average annual cost of the structural measures (amortized total installation costs plus operation and maintenance and secondary costs) is estimated

to be $63,232. The structural measures are expected to produce average annual benefits, including secondary benefits, $72,837, or a return of $1.15 for each dollar of cost (table 6).

PROJECT INSTALLATION

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by farmers and ranchers in cooperation with the Brown-Mills and Upper Leon Soil Conservation Districts during the 5-year project installation period. The districts are giving assistance in the planning and application of these measures under their going programs. These going programs will be accelerated with flood prevention funds to assure application of the planned measures within the 5-year installation period.

The governing bodies of the soil conservation districts 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 the 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 units will assist landowners and operators cooperating with the district in accelerating 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 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 bodies of the soil conservation districts 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, prepare 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.

Structural Measures

The Soil Conservation Service will contract for the construction of the 20 floodwater retarding structures. 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 Brown, Comanche and Mills County Commissioners Courts, in cooperation with the Brown-Mills and Upper Leon Soil Conservation Districts, will furnish the land, easements 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 county roads passable during periods of floodwater release.

Local interest will be responsible for the improvement of individually owned crossings.

Since all structures are needed to obtain the desired reduction in damages, no attempt was made to separate the watershed into construction units. All necessary land, easements and rights-of-way will need to be obtained prior to the expenditure of Federal funds for construction in the watershed.

The 20 floodwater retarding structures will be constructed during the 5-year installation period in the general numerical sequence of 1 through 20.

Since Site 10 is in series with Site 11, the upper structure will be constructed before or concurrently with the lower structure (figure 4).

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 1936, 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, Great Plains Conservation Program, or other Federal programs. The amount of reimbursement to be expected has been estimated, 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 will be donated. Sufficient funds are available from taxes now being collected

to meet all local obligations in completing the project.

The local sponsoring organizations do not plan to use the loan facilities of any agency.

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

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

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

3. Operation and maintenance agreements have been executed.

4. Flood prevention funds are available.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the owners and operators of the farms and ranches on which the measures are installed under agreements with the Brown-Mills and Upper Leon Soil Conservation Districts. Representatives of these districts 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

Structure numbers 2, 12, and 13 will be operated and maintained jointly by the Upper Leon Soil Conservation District and the Comanche County Commissioners Court. The operation and maintenance of structure numbers 17, 18, 19, and 20 will be performed by the Brown-Mills Soil Conservation District and the Mills County Commissioners Court. The remaining structures will be operated and maintained by the Brown-Mills Soil Conservation District and the Brown County Commissioners Court.

The estimated average annual operation and maintenance cost is $2,320, 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 these methods. Funds

for this work will be provided by the Brown, Comanche, and Mills County Commissioners Courts from taxes now being collected and which produce adequate revenue for this purpose.

All floodwater retarding structures will be inspected by representatives of all applicable sponsoring organizations after each heavy rain, or at least annually. A Soil Conservation Service representative will participate in these inspections, at least annually. Items of inspection 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 floodwater retarding structure. 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 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 any invitation to bid.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Blanket Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1961

Installation Cost Item	Unit	Number	Installation Period September 1962 - September 1967 Estimated Cost 2/ Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	3/ 24,000	-	104,000	104,000
Crop Residue Use	Acre	3/ 31,000	-	129,000	129,000
Conservation Cropping System	Acre	3/ 26,000	-	147,000	147,000
Proper Range Use	Acre	3/ 61,000	-	110,000	110,000
Deferred Grazing	Acre	3/ 17,000	-	30,800	30,800
Range Seeding	Acre	1,100	-	6,050	6,050
Brush Control	Acre	16,000	-	80,000	80,000
Terraces, Graded	Foot	480,000	-	9,000	9,000
Diversions	Foot	15,800	-	1,000	1,000
Farm Ponds	No.	50	-	12,500	12,500
Technical Assistance (Accel.)			13,000	-	13,000
SCS Subtotal			13,000	629,350	642,350
TOTAL LAND TREATMENT			13,000	629,350	642,350
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	20	1,141,935	-	1,141,935
Subtotal - Construction			1,141,935	-	1,141,935
Installation Services					
Soil Conservation Service					
Engineering Services			191,764	-	191,764
Other			105,697	-	105,697
SCS Subtotal			297,461	-	297,461
Subtotal - Installation Services			297,461	-	297,461
Other Costs					
Land, Easements & Rights-of-way			-	133,250	133,250
Legal Fees			-	13,328	13,328
Subtotal - Other			-	146,578	146,578
TOTAL STRUCTURAL MEASURES			1,439,396	146,578	1,585,974
WORK PLAN PREPARATION			42,000	-	42,000
TOTAL PROJECT			1,494,396	775,928	2,270,324
SUMMARY					
Subtotal - SCS			1,494,396	775,928	2,270,324
TOTAL PROJECT			1,494,396	775,928	2,270,324

1/ Does not include prior expenditures of flood prevention funds or accomplishments resulting therefrom (see table 1a).
2/ Excludes costs that will be reimbursed from other Federal funds.
3/ It is expected that this level of application of the management and recurring-type practices will be reached annually by the end of the project period and are not cumulative.
NOTE: There are no Federal lands in the watershed.

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/
Blanket Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1961

Installation Cost Item	Unit	Number	Prior to September 1962 Estimated Cost Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	4/ 16,000	-	160,000	160,000
Crop Residue Use	Acre	4/ 18,000	-	180,000	180,000
Conservation Cropping System	Acre	4/ 10,000	-	150,000	150,000
Proper Range Use	Acre	4/ 46,000	-	104,000	104,000
Deferred Grazing	Acre	4/ 13,000	-	52,000	52,000
Range Seeding	Acre	700	-	3,800	3,800
Brush Control	Acre	13,000	-	65,000	65,000
Terraces, Graded	Foot	2,639,000	-	49,000	49,000
Diversions	Foot	217,000	-	14,000	14,000
Farm Ponds	No.	650	-	162,500	162,500
Technical Assistance (Accel.)			7,200	-	7,200
SCS Subtotal			7,200	940,300	947,500
TOTAL LAND TREATMENT			7,200	940,300	947,500
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	-	-	-	-
Subtotal - Construction			-	-	-
Installation Services					
Soil Conservation Service					
Engineering Services			-	-	-
Other			-	-	-
Subtotal - Installation Services			-	-	-
Other Costs					
Land, Easements & Rights-of-way			-	-	-
Legal Fees			-	-	-
Subtotal - Other			-	-	-
TOTAL STRUCTURAL MEASURES			-	-	-
WORK PLAN PREPARATION			-	-	-
TOTAL PROJECT			7,200	940,300	947,500
SUMMARY					
Subtotal - SCS			7,200	940,300	947,500
TOTAL PROJECT			7,200	940,300	947,500

1/ At time of work plan preparation.
2/ Flood Prevention funds only.
3/ Excludes costs that were reimbursed from other Federal funds.
4/ The level of application of the management and recurring-type practices reached at time of work plan preparation and are not cumulative.

September 1962

TABLE 1b - TOTAL ESTIMATED INSTALLATION COSTS

Blanket Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1961

Total Project 1/

Installation Cost Item	Unit	Number	Estimated Cost Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	4/ 24,000	-	264,000	264,000
Crop Residue Use	Acre	4/ 31,000	-	309,000	309,000
Conservation Cropping System	Acre	4/ 26,000	-	297,000	297,000
Proper Range Use	Acre	4/ 61,000	-	214,000	214,000
Deferred Grazing	Acre	4/ 17,000	-	82,800	82,800
Range Seeding	Acre	1,800	-	9,850	9,850
Brush Control	Acre	29,000	-	145,000	145,000
Terraces, Graded	Foot	3,119,000	-	58,000	58,000
Diversions	Foot	232,800	-	15,000	15,000
Farm Ponds	No.	700	-	175,000	175,000
Technical Assistance (Accel.)			20,200	-	20,200
SCS Subtotal			20,200	1,569,650	1,589,850
TOTAL LAND TREATMENT			20,200	1,569,650	1,589,850
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	20	1,141,935	-	1,141,935
Subtotal - Construction			1,141,935	-	1,141,935
Installation Services					
Soil Conservation Service					
Engineering Services			191,764	-	191,764
Other			105,697	-	105,697
SCS Subtotal			297,461	-	297,461
Subtotal - Installation Services			297,461	-	297,461
Other Costs					
Land, Easements & Rights-of-way			-	133,250	133,250
Legal Fees			-	13,328	13,328
Subtotal - Other			-	146,578	146,578
TOTAL STRUCTURAL MEASURES			1,439,396	146,578	1,585,974
WORK PLAN PREPARATION			42,000	-	42,000
TOTAL PROJECT			1,501,596	1,716,228	3,217,824
SUMMARY					
Subtotal - SCS			1,501,596	1,716,228	3,217,824
TOTAL PROJECT			1,501,596	1,716,228	3,217,824

1/ Tables 1 and 1a combined.
2/ Flood Prevention funds only.
3/ Excludes costs that will be reimbursed from other Federal funds.
4/ It is expected that this level of application of the management and recurring-type practices will be reached annually by the end of the project period and are not cumulative.

September 1962

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Blanket Creek Watershed, Texas
Middle Colorado River Watershed
(Dollars) 1/

Structure Site Number	Federal Installation Cost				Non-Federal Installation Cost			Total Installation Costs
		Installation Service						
	Construction	Engineering	Other	Total Federal	Easement and R/W	Legal Fees and Other	Total Non-Federal	
Floodwater Retarding Structure								
1	48,996	8,819	4,408	62,223	8,300	830	9,130	71,353
2	56,921	10,246	5,121	72,288	7,325	733	8,058	80,346
3	33,122	7,287	3,081	43,490	3,475	348	3,823	47,313
4	40,100	7,218	3,608	50,926	3,550	355	3,905	54,831
5	52,932	9,528	4,763	67,223	8,400	840	9,240	76,463
6	82,650	12,397	7,247	102,294	8,675	868	9,543	111,837
7	19,800	5,940	2,574	28,314	2,250	225	2,475	30,789
8	37,495	7,499	4,500	49,494	4,750	475	5,225	54,719
9	44,804	8,065	4,031	56,900	5,800	580	6,380	63,280
10	39,721	6,826	4,655	51,202	4,250	425	4,675	55,877
11	76,450	11,468	6,704	94,622	10,950	1,095	12,045	106,667
12	67,453	10,118	5,915	83,486	7,850	785	8,635	92,121
13	65,550	9,832	5,748	81,130	6,875	688	7,563	88,693
14	53,440	9,619	4,808	67,867	4,700	470	5,170	73,037
15	71,458	10,719	6,266	88,443	7,725	773	8,498	96,941
16	32,936	7,246	4,018	44,200	2,950	295	3,245	47,445
17	99,440	14,464	8,949	122,853	16,450	1,645	18,095	140,948
18	55,752	10,035	5,016	70,803	3,750	375	4,125	74,928
19	96,378	14,457	8,451	119,286	10,875	1,088	11,963	131,249
20	66,537	9,981	5,834	82,352	4,350	435	4,785	87,137
Grand Total	1,141,935	191,764	105,697	1,439,396	133,250	13,328	146,578	1,585,974

1/ Price Base: 1961

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Blanket Creek Watershed, Texas
Middle Colorado River Watershed

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Drainage Area	Sq.Mi.	3.87	3.30	1.34	1.06	3.65	5.37	1.11	2.27	2.23	2.56	3/ 5.68
Storage Capacity												
Sediment Pool	Ac.Ft.	76	122	27	23	66	99	24	51	88	72	94
Sediment in Detention Pool	Ac.Ft.	6	10	3	2	14	27	5	7	7	6	12
Floodwater Detention	Ac.Ft.	805	567	382	309	706	940	195	418	473	505	1,132
Total	Ac.Ft.	887	699	412	334	786	1,066	224	476	568	583	1,238
Surface Area												
Sediment Pool	Acre	21	23	9	9	18	17	7	12	19	15	24
Floodwater Detention Pool	Acre	104	82	53	43	90	100	31	58	78	56	131
Volume of Fill	Cu.Yd.	98,000	107,000	59,000	77,000	105,000	175,000	36,000	70,000	82,000	92,000	166,000
Elevation Top of Dam	Foot	1,714.2	1,699.2	1,683.9	1,688.7	1,638.7	1,583.8	1,580.1	1,528.7	1,486.6	1,664.3	1,562.2
Maximum Height of Dam	Foot	26.2	29.2	23.9	20.7	26.7	35.8	20.1	24.7	26.6	26.8	30.9
Emergency Spillway												
Crest Elevation	Foot	1,708.6	1,694.0	1,678.6	1,684.0	1,632.7	1,577.7	1,576.2	1,524.7	1,482.6	1,658.8	1,556.0
Bottom Width	Foot	100	150	100	100	100	150	100	175	150	100	225
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 2/		3.9	4.3	1.8	1.9	3.8	4.0	4.0	4.0	3.9	4.0	3.8
Average Curve No. - Condition II		82	79	78	78	79	77	76	77	81	80	80
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour)	Inch	6.38	6.37	9.96	10.03	6.40	6.27	6.68	6.52	6.53	6.49	6.25
Storm Runoff	Inch	4.33	4.00	7.23	7.30	4.04	3.71	3.97	3.94	4.37	4.22	4.00
Velocity of Flow (V_c) 1/	Ft./Sec.	2.1	3.9	4.2	4.1	2.4	2.7	2.1	1.8	1.7	2.5	1.9
Discharge Rate 1/	C.F.S.	31	267	234	212	43	96	29	37	28	50	48
Maximum Water Surface Elev. 1/	Foot	1,709.0	1,695.1	1,679.9	1,685.2	1,633.2	1,578.3	1,576.7	1,525.0	1,482.9	1,659.4	1,556.3
Freeboard Hydrograph												
Storm Rainfall (6-hour)	Inch	15.06	15.03	22.38	22.55	15.17	14.87	15.77	15.49	15.51	15.37	14.48
Storm Runoff 1/	Inch	12.70	12.20	19.32	19.49	12.38	11.80	12.53	12.40	13.00	12.74	11.90
Velocity of Flow (V_c) 1/	Ft./Sec.	10.2	9.9	10.0	9.3	10.7	10.8	8.4	8.6	8.6	10.4	10.7
Discharge Rate 1/	C.F.S.	3,361	4,467	3,059	2,487	3,818	5,776	1,849	3,412	2,948	3,474	8,718
Maximum Water Surface Elev. 1/	Foot	1,714.2	1,699.2	1,683.9	1,688.7	1,638.7	1,583.8	1,580.1	1,528.7	1,486.6	1,664.3	1,562.2
Principal Spillway												
Capacity - Low Stage	C.F.S.	39	33	16	13	37	54	11	23	22	26	82
Capacity Equivalents												
Sediment Volume	Inch	0.37	0.69	0.38	0.40	0.34	0.35	0.41	0.42	0.74	0.53	0.31
Sediment in Detention Pool	Inch	0.03	0.06	0.04	0.04	0.07	0.09	0.08	0.06	0.06	0.04	0.04
Detention Storage	Inch	3.90	3.22	5.32	5.46	3.63	3.28	3.31	3.45	3.97	3.70	3.74
Spillway Storage	Inch	3.68	2.89	4.76	4.30	3.65	2.76	2.56	2.28	3.25	1.83	3.77
Class of Structure		A	A	B	B	A	A	A	A	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Blanket Creek Watershed, Texas

Middle Colorado River Watershed

Item	Unit	STRUCTURE NUMBER 12	13	14	15	16	17	18	19	20	Total
Drainage Area	Sq.Mi.	6.93	4.36	3.36	4.14	1.70	11.93	4.27	7.81	4.81	81.75
Storage Capacity											
Sediment Pool	Ac.Ft.	143	93	75	124	20	191	66	108	85	1,647
Sediment in Detention Pool	Ac.Ft.	11	8	13	10	3	15	9	12	13	193
Floodwater Detention	Ac.Ft.	1,250	843	659	866	339	2,134	814	1,820	1,001	16,158
Total	Ac.Ft.	1,404	944	747	1,000	362	2,340	889	1,940	1,099	17,998
Surface Area											
Sediment Pool	Acre	28	18	14	24	6	40	12	26	14	356
Floodwater Detention Pool	Acre	115	87	66	92	40	195	79	142	61	1,703
Volume of Fill	Cu.Yd.	145,000	140,000	120,000	145,000	70,000	180,000	110,000	222,000	130,000	2,329,000
Elevation Top of Dam	Foot	1,636.9	1,622.5	1,594.6	1,533.8	1,497.9	1,567.7	1,518.3	1,486.0	1,422.2	xxx
Maximum Height of Dam	Foot	32.9	34.5	34.6	29.8	25.9	35.7	34.3	38.0	42.0	xxx
Emergency Spillway											
Crest Elevation	Foot	1,630.3	1,616.3	1,589.2	1,528.0	1,493.0	1,561.0	1,512.5	1,480.0	1,416.0	xxx
Bottom Width	Foot	200	150	150	150	100	300	150	200	170	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Rock	Veg.	xxx
Percent Chance of use 2/		4.0	4.0	4.0	3.4	3.3	4.0	3.3	2.8	3.0	xxx
Average Curve No. - Condition II		78	80	80	80	78	78	78	79	78	xxx
Emergency Spillway Hydrograph											
Storm Reinfall (6-hour)	Inch	6.23	6.39	6.46	6.45	6.68	6.08	6.44	6.26	6.40	xxx
Storm Runoff	Inch	3.80	4.13	4.19	4.19	4.20	3.66	3.98	3.91	3.94	xxx
Velocity of Flow (Vc) 1/	Ft./Sec.	2.4	2.1	2.9	1.3	2.2	2.7	2.5	0	0	xxx
Discharge Rate 1/	C.F.S.	80	106	116	9	33	180	67	0	0	xxx
Maximum Water Surfece Elev. 1/	Foot	1,630.8	1,616.9	1,589.8	1,528.3	1,493.4	1,561.7	1,513.0	-	-	xxx
Freeboard Hydrograph											
Storm Rainfall (6-hour)	Inch	14.77	15.14	15.31	15.35	15.89	14.46	15.33	14.89	15.23	xxx
Storm Runoff 1/	Inch	11.86	12.51	12.68	12.72	12.95	11.56	12.41	12.12	12.31	xxx
Velocity of Flow (Vc) 1/	Ft./Sec.	11.1	10.9	10.3	10.4	9.7	11.0	10.4	10.7	10.9	xxx
Discharge Rate 1/	C.F.S.	8,780	5,856	5,016	5,259	2,743	12,680	5,357	7,642	6,952	xxx
Maximum Water Surface Elev. 1/	Foot	1,636.9	1,622.5	1,594.6	1,533.8	1,497.9	1,567.7	1,518.3	1,486.0	1,422.2	xxx
Principal Spillway											
Cspecity - Low Stage	C.F.S.	70	44	34	41	17	120	43	78	48	xxx
Capacity Equivalants											
Sediment Volume	Inch	0.39	0.40	0.42	0.56	0.22	0.30	0.29	0.26	0.33	xxx
Sediment in Detention Pool	Inch	0.03	0.03	0.07	0.05	0.03	0.02	0.04	0.03	0.05	xxx
Detention Storage	Inch	3.37	3.63	3.68	3.91	3.73	3.35	3.58	4.37	3.89	xxx
Spillway Storage	Inch	2.43	2.71	2.23	2.88	2.64	2.41	2.40	2.47	1.56	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	xxx

1/ Maximum during passage of hydrograph.

2/ Based on frequency analysis of stream gage records. (Hydrology Memorandum EWP-2, revised.)

3/ Exclusive of watershed from which runoff is controlled by other structures in series. Entire drainage area considered in design of emergency spillway.

TABLE 4 - ANNUAL COST 1/
Blanket Creek Watershed, Texas
Middle Colorado River Watershed

Evaluation Unit	Amortization of Installation Costs 2/	Operation and Maintenance Costs 3/	Secondary Costs 3/	Total
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures				
1 through 20	60,188	2,320	724	63,232
Total	60,188	2,320	724	63,232

1/ Does not include work plan preparation cost.

2/ 1961 prices amortized for 50 years at 2.875 percent.

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

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Blanket Creek 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	22,959	5,191	17,768
Other Agricultural	13,169	1,491	11,678
Nonagricultural			
Road, Bridge, Railroad and Residential Property	1,597	118	1,479
Subtotal	37,725	6,800	30,925
Erosion			
Flood Plain Scour	6,760	1,463	5,297
Indirect	4,027	826	3,201
Total	48,512	9,089	39,423

1/ As projected by ARS, September 1957.

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Blanket Creek Watershed, Texas
Middle Colorado River Watershed

Evaluation Unit	Average Annual Benefits 1/						Average Annual Cost 4/	Benefit Cost Ratio
	Flood Prevention							
	Damage Reduction	Secondary	Changed Land Use	Incidental 2/	Outside Watershed 3/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 1 through 20	38,666	8,997	12,291	8,158	4,725	72,837	63,232	1.2:1
GRAND TOTAL	5/ 38,666	8,997	12,291	8,158	4,725	72,837	63,232	1.2:1

1/ Long-term price levels as projected by ARS, September 1957,

2/ Includes $1,420 benefits from livestock water, $3,230 benefits from incidental irrigation, and $3,508 from recreation.

3/ Includes $2,182 and $1,511 from reduction of flood damages to mainstem, Pecan Bayou and Colorado River, respectively, and $1,032 from reduction of sediment damage to Lake Buchanan.

4/ Installation costs based on 1961 prices; operation and maintenance and secondary costs on long-term prices as projected by ARS, September 1957.

5/ In addition, it is estimated that land treatment will provide flood damage reduction benefits of $757 annually.

INVESTIGATIONS AND ANALYSES

Project Formulation

and Treatment Measures

oil conditions and land use on the upland were determined by expsnding a 5 percent sample of the watershed to the entire upland area. The current and use of the flood plain was determined by field investigations.

over conditions and range sites were determined from available range surveys nd other cover information obtained from the records of the soil conservaion districts and expanded, with assistance from personnel of the Soil Conseration Service work units at Brownwood, Comanche and Goldthwaite, to the entire atershed.

he status of land treatment measures and practices effectively applied and he current conservation needs, based on range condition and land capability lasses developed from soil surveys, were secured from records of the Brownills and Upper Leon Soil Conservation Districts. From this information, stimates were made of the various practices contributing directly to flood revention which will be applied on the watershed during the 5-year installaion period.

tructural Measures

he hydraulic, hydrologic, sedimentation, and economic investigations proided data on the effect land treatment measures would have on reduction of lood damages. Although significant benefits would result from application f needed land treatment measures, it was apparent that other flood prevenion measures would be required to attain the degree of watershed protection nd flood damage reduction desired by the local people.

tructural measures for watershed protection snd flood prevention which would e feasible to install to meet the objectives of the local sponsoring organzations were then determined. The study made and the procedures used in hat determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads and other pertinent information. 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 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. Using a copy of the base map, a current ownership map of all farms in the watershed was prepared by the Brown-Mills and Upper Leon Soil Conservation Districts.

3. 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 2 and 2a.

4. To obtain the desired degree of control and give adequate protection to flood plain lands, it was necessary to locate Site 11 in series with Site 10 (figure 4).

5. The cross sections of the flood plain, previously located stereoscopically, were examined in the field, locations adjusted to give the best representation of hydraulic characteristics and surveyed at the selected locations (figure 3). 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.

6. 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 flood plain and upland that would be inundated by the sediment and dstention pools. Maps of 14 structure sites were developed by use of the stereoplotter and the remaining by other 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 a study of the physical and vegetative conditions of the drainage area above that 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, Hydrology Memorandum EWP-2 (revised), Technical Release No. 2, 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.

7. The limits of the detention and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, the storage capacity needed for floodwater detention and sediment, storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the emergency spillway, width and depth of flow, maximum height of dam, the acres inundated by the sediment and detention pools, the volume of fill in the dam, and the estimated cost of the structure (tables 2 and 3).

8. Damages resulting from floodwater, sediment, and erosion were determined from damage schedules and survey of sample areas. Reductions 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 individual measures or group of interrelated measures on the basis of the effect of each on reduction of damages. In this manner, it was determined that floodwater retarding structures could be economically justified. By further analysis, the individual floodwater retarding structures which had favorable benefit-cost ratios were determined. Alternate sites were sought for those which had unfavorable individual benefit-cost ratios. Such alternates were investigated until a system of floodwater retarding structures was developed which would give the minimum degree of control desired at lowest cost. These works were included in the plan.

When the land treatment measures and the structural measures for flood prevention had been determined, a table was developed to show the total cost of each type of measure. The summation of the total costs of all needed 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 meteorologic and hydrologic data were tabulated from Climmatological Bulletins, United States Weather Bureau and Water Supply Papers, United States Geological Survey, and local records. These data were snalyzed to determine average precipitation, depth-duration relationship, seasonal distribution 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 the 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 8 representative structure sites and a 15 percent random sample of the uncontrolled drainage area (25 percent of the drainage area of the watershed) and used with figure 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 to nearby actual gaged runoff on similar watersheds. The percent chance of occurrence of meteorological events was determined by computing the plotting position 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. (3-18-1-24, NEH, Section 4, Supplement A.)

5. An isohyetal map of the October 1959 storm was prepared and used to study the hydrologic and hydraulic characteristics of the watershed.

6. Rating curves for the cross sections were computed by Mannings formula and concordant flow (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.

7. Determination was made of peak discharges, area inundated, and damages caused by the various amount 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.

8. Floodwater retarding structures were classified on the basis of potential downstream damages in accordance with Engineering Memorandum SCS-27. Where extent of damage was a question, this classification was made by assuming failure of the structure and routing by storage indication as outlined in the Texas State Office's "Guideline for Structure Classification" and NEH 4, Supplement A.

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

rom a graph showing cumulative departures from normal precipitation, the ainfall for the period 1922 to 1946, inclusive, was selected as most repreentative of normal rainfall for this watershed. Rainfall information for ne historical evaluation series used in these studies was obtained by applyng the Thiessen polygon method of weighting to the rainfall data tabulated or the Brownwood, Blanket, and Mullin stations (NEH, Section 4, Hydrology).

ne largest rainfall which occurred during the 25-year period was a storm of .15 inches. An average rain of this magnitude, assuming moisture condition II ould produce the equivalent of 3.36 inches of runoff under present conditions fter adjustment for transmission losses.

From a study of the relationship between runoff and flood stage for this watershed, it was determined that 0.04 inch of runoff was the minimum volume that would produce flooding to a depth of six inches at the smallest valley section. Therefore, no storm producing less than this volume of runoff was considered for flood-routing purposes. Due to changes in runoff-producing characteristics at different antecedent moisture conditions, weighted rainfall amounts of 0.33 inch to 1.75 inches would be required, on an average, to produce 0.04 inch of runoff.

The channel capacity at the reference section (No. 3) is 9,800 cubic feet per second. This section is located about one mile north of the confluence of Blanket Creek with Pecan Bayou (figure 3). The peak discharge at this point for a 6.15-inch rain under present conditions is estimated to be 36,100 cubic feet per second. After installation and full functioning of all planned measures on the Blanket Creek watershed, the discharge at the same point would be reduced to 21,800 cubic feet per second.

The 6-hour design storm rainfall was taken from figure 3.21-1, NEH, Section 4, Hydrology, Supplement A. The emergency spillway and freeboard storm hydrographs were computed using rainfall as modified by Section 2441, Texas State Manual and Hydrology Memorandum EWP-3, and adjusted to the drainage area of each site. Routing the emergency spillway hydrographs resulted in either no flows or very shallow flows through the emergency spillways. Therefore, the dimensions of the emergency spillways were determined by graphically routing the freeboard hydrographs. Composite hydrographs were developed for those sites in series using the storage indication method to flood route between structures. The criteria and procedures used are set forth in Engineering Memorandum SCS-27, Technical Release No. 2; Hydrology Memoranda EWP-1, EWP-2, EWP-3, and EWP-4; NEH, Section 4, Supplement A; NEH, Section 4; and Section 2441, Texas State Manual.

Frequency of use of emergency spillways was based on regional analysis of gaged runoff from this and similar watersheds. 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 Watershed Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", dated August 21, 1959.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 20 planned floodwater retarding structures using the following procedures:

1. Detailed investigations were made in the drainage areas of 8 of the planned floodwater retarding structures. These

investigations included: mapping soil units by slope in percent; slope lengths; 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 affected 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 formulas for computation of gross annual erosion in tons for conversion to acre-feet.

3. Field surveys and office computations to determine sediment volumes under present conditions for the remaining 12 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.

4. The sediment rates were then adjusted to reflect the effect of expected land treatment on the drainage areas of the 20 planned floodwater retarding structures. The computed sediment storage requirement for each site is based on a gradual improvement of watershed conditions due to the installation of needed land treatment measures expected to be installed during the first five years and maintained at 75 percent effectiveness during the next 45 years.

5. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 57-73 pounds per cubic foot for submerged sediment, and 80-89 pounds per cubic foot for aerated sediment.

6. The allocation of sediment to the structure pools was based on a range of 10 to 20 percent deposition in the detention pool and 80 to 90 percent deposition in the sediment pool. This allocation was determined on the basis of topography and texture of sediment after allowing for 10 percent of the sediment being carried in suspension through the outlet structure.

he sediment source studies indicated that the erosion rates in the waterhed were low. A summation of the annual sediment yields above the 20 lanned floodwater retarding structures was found to be 39.27 acre-feet or n average of 0.48 acre-foot per square mile.

lood Plain Sedimentation and Scour

he following sedimentation and scour damage investigations were made to valuate the nature and extent of physical damage to flood plain land,

giving due consideration to agronomic and other land treatment practices, soils, crop yields, and land capabilities.

1. Field examination and aerial photograph studies were made along representative valley cross sections (figure 3) making note of depth and texture of deposits, scour channels, 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.

3. A damage table was developed to show percent damage by texture and depth increment for deposition and percent damage by depth and width for 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 of productive capacity 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 this reduction of sediment load and reduction of area inundated by floodwater. The reduction of scour damage due to the installation of the complete project is based on a reduction of depth of flooding and area inundated.

Geological Investigations

Preliminary geologic dam site investigations were made at each of the 20 planned floodwater retarding structure sites in accordance with Watershed Memorandum EWP-1, "Geological Reconnaissance of Dam Sites for Watershed Work Plans", dated December 12, 1958. The following procedure was 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 possible spillway areas as determined from exposures and from hand auger and power auger borings.

c. General topography.

d. Stream channel dimensions, bed load, 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 exact spillway excavation volumes, embankment dimensions and volumes, physiographic description, etc. were used to complete Form SCS-375, "Preliminary Geologic Investigations of Dam Sites".

Description of Problems

All of the planned floodwater retarding structures are located on one or both of two facies of the Trinity group of Lower Cretaceous age. Sites 3, 4, 5, 10, and 20 are underlain by sandstones, packsands and siltstones, which contain a few impure limestones. Sites 1, 6, 7, 8, 11, 12, 13, 15, 18, and 19 are underlain by alternating beds of chalky limestone and soft marl. Sites 2, 9, 14, 16, and 17 are underlain by both facies.

All the beds dip at an average rate of approximately 40 feet per mile to the southwest. Rapid lateral changes due to variation in thickness of strata and pinching out of strata are common. A water table exists within a few feet of the ground surface at the sites underlain by packsand.

Soils which overlie the geologic strata are primarily CL, SC, GC, and SM according to the Unified Soil Classification System.

The sites have strong foundations and excellent building materials, usually very close to the dam. However, seepage control will be necessary on the sites with packsand formations and any limestone sites with joints, open bedding planes or other passages for water. Other significant problems due to geologic conditions include rock within the excavation areas, erodible

emergency spillways and differential settlement due to rather deep flood plain soils adjacent to rock at shallow depths in the abutments.

Special characteristics and problems observed are summarized below:

Special Characteristics or Problems	Site(s)
Erodible emergency spillway	2, 5, 8, 10, 13, 20
Rock excavation	1, 2, 3, 4, 12, 14, 15, 17, 18, 19, 20
Foundation seepage	2, 3, 4, 5, 9, 10, 14, 16, 17, 20
Differential settlement	6, 11, 16

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

Economic Investigations

Determination of Damages

Agricultural damage estimates were based on schedules obtained in the field covering approximately 40 percent of the flood plain of Blanket Creek. These schedules covered land use, crop distribution, yields and historical data on flooding and flood damages. Analysis of this information formed the basis for determining damage rates at various depths and seasons of flooding. The applicable rates of damages were applied, flood by flood, to the floods occurring in the period 1922 through 1946. An adjustment was made to account for the effect of recurrent flooding when several floods occurred within one year.

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

Estimates of normal yields were based on data obtained from landowners and operators and agricultural workers familiar with the area. These yields were adjusted to allow for expected yield increases resulting from advances in technology. The adjustments were based on the assumption that management and production practices now used by the better farmers would be in general use over the life of the project.

Estimates of damages to other agricultural property, such as fences, livestock, and farm equipment, were made from analysis of flood damage schedules and correlated with size of flood. Estimates of damages to roads, bridges, and railroad facilities in the flood plain were obtained from county commissioners, State highway officials and railroad officials and supplemented

by information from local farmers.

The estimated monetary value of the physical damage to the flood plain from erosion was based on the value of the production lost, taking into account the lag in recovery of productivity and the cost of farm operations to speed recovery. Damage was related to depth of flooding, with weight given to increased velocity from the deeper flows.

Indirect damages involve such items as additional travel time for farmers, re-routing of school buses and mail deliveries, costs of extra feed for livestock following floods, and the like. Based on information obtained and data from watersheds previously analyzed, it was determined these damages approximate 9 percent of the direct damage for all evaluation reaches.

Selection of Evaluation Reaches

In order to simplify evaluation of the effects that various combinations of structural measures would have on the reduction of damages, the flood plain was divided into four evaluation reaches (figure 3).

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

Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effect of reduction in area inundated and reduced depth of inundation.

Reduction in the monetary value of sediment damage to Lake Buchanan was calculated through straight line depreciation.

Installation of this project will provide benefits downstream on the main stem of Pecan Bayou and Colorado River. Data from Corps of Engineers reports were analyzed and benefits per acre-foot of floodwater detention capacity amounted to $0.13 for Pecan Bayou and $0.09 for Colorado River.

Restoration of Former Productivity and Changed Land Use Benefits

Farmers in the flood plain were asked what changes in land use had taken place as a result of past flooding. They were asked also what changes in land use and crop distribution might be expected if floods were reduced in extent and frequency.

Their responses were analyzed, together with the capability of the land and the size and accessibility of the fields, as a basis for estimating

benefits from restoration of productivity and from land use change. Consideration was given to the effect of higher values on the damage from the remaining flooding. Added production, harvesting and other costs were deducted from the increased value of production. Benefits were discounted over a 5-year period for lag in accrual.

As a result of this analysis it was determined that benefits from resotration of former productivity would average $4,222 annually. These benefits have been credited to the reduction of crop and pasture damage in table 5.

The following table, covering Evaluation Reach 1, shows the cropping pattern, typical adjusted yields, cost of production, and the value of restoration of productivity. Similar tables were developed for the other evaluation reaches.

Land Use	Acres	Yield	Unit	Value of Production 1/	Direct Production Cost 1/	Net Return 1/
				(dollars)	(dollars)	(dollars)
Without Project						
Oats (Grain)	488	40	Bu.	16,006	6,339	9,667
Oats (Grazing)	-	2	AUM	2,987	49	2,938
Hay	184	1.8	Ton	7,448	4,386	3,062
Tame Pasture	29	4.3	AUM	382	227	155
Formerly Cultivated (Now Grazed)	31	.25	AUM	24	3	21
Maize	41	18	Cwt	1,351	669	682
Pasture	547	1	AUM	1,674	55	1,619
Miscellaneous	12	-	-	-	-	-
Total	2/ 1,332			29,872	11,728	18,144
With Project						
Oats (Grain)	519	40	Bu.	17,023	6,741	10,282
Oats (Grazing)	-	2	AUM	3,176	52	3,124
Hay	184	1.8	Ton	7,448	4,386	3,062
Tame Pasture	29	4.3	AUM	382	227	155
Maize	41	18	Cwt	1,351	669	682
Pasture	547	1	AUM	1,674	55	1,619
Miscellaneous	12	-	-	-	-	-
Total	2/ 1,332			31,054	12,130	18,924
Increase in net return						780
Deduction for added damage						23
Discount for delay in benefit accrual						64
Benefit to restoration						693

1/ Long-term prices, September 1957 projection.
2/ Area flooded by largest storm in series, 1,552 acres.

Flood plain farm operators were questioned regarding what changes in land use and crop distribution might be expected if floods were reduced in extent and frequency. The answers received were the basis for estimating benefits from changed land use. The average annual benefits from this source, after deduction of additional damage, associated costs and added overhead, and discounting for lag in accrual is estimated to be $12,291. After careful review of former reports, it was found that benefits to structural measures from more intensive land use would be negligible. It is not expected that the acreage of crops under allotment will be increased in the watershed as a result of the project. The benefits from restoration of former productivity and changed land use are not dependent upon the production of restricted crops.

Incidental Water Management Benefits

Water management benefits will occur incidental to the installation of the floodwater retarding structures included in this plan. Flood prevention was the only purpose considered in the location, capacity and design of these structures and no additional installation costs are involved in obtaining incidental benefits from the storage in the sediment pools of the structures. When the structures are installed, it is estimated that the sediment pools will have an initial total capacity of 1,647 acre-feet and will cover 356 acres. With the expected sediment deposition in the sediment pools, the capacity will decline to zero at the end of 50 years. All incidental benefits were properly discounted to allow for the sediment deposition.

Evaluation of incidental recreation benefits are based on an economic analysis of similar benefits which have accrued on Green Creek watershed. This watershed, a pilot project, lies about 40 miles northeast of Blanket Creek and has had a structural program installed since 1957. The use of sediment pools in Green Creek watershed was studied. The estimate of probable use of pools in Blanket Creek watershed was derived from this study after consideration had been given to accessibility of the sites, and proximity to population concentrations and possible competing facilities. Values assigned per uses day were in accord with those suggested in the Watershed Protection Handbook.

The incidental benefits from use of the sediment pools as a water supply was based on the Green Creek study.

Data developed for similar areas by the United States Study Commission-Texas were used for evaluation of incidental irrigation benefits. These data were adjusted to fit the local conditions with regard to soils, crops to be irrigated, and water supply. Costs of water application were deducted as associated costs in arriving at net benefits.

The total net incidental benefits in Blanket Creek watershed amount to $8,158 annually. Costs associated with obtaining these benefits were recognized in determination of the net values. The following tabulation is the summarization of the findings.

Item	Per Surface Acre (dollars)	Per Acre-Foot (dollars)
Recreation	9.85	2.13
Irrigation	9.07	1.96
Water Supply	3.99	.86
Total	22.91	4.95

Secondary Benefits

Secondary benefits induced by or stemming from the project will be realized by workers, processors and business establishments in the trade area because of the increased production and income resulting from the project. The evaluation of these benefits was limited to those that would occur locally.

Secondary benefits were estimated to equal 10 percent of the primary direct benefits plus 10 percent of the cost of the additional agricultural production and associated costs incurred in obtaining the increased production.

Appraisal of Land and Easement Values

Areas that will be inundated by the sediment and detention pools of the floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of the production that would be lost in those areas after installation of the project. In this appraisal, it was considered that there would be no production in the sediment pools. The land covered by the detention pools was assumed to be converted to grassland under project conditions. The costs of land, easements and rights-of-way for the 20 floodwater retarding structures were determined by individual appraisals in cooperation with local people. The average annual net loss of production within the sites was calculated and this value was compared with the amortized cost of the land required for the structures. The larger amount, the value of the land, was used in the economic evaluation of the project to insure conservative appraisal.

Secondary Costs

Secondary costs are the net decrease in the value of goods and services brought about by the project as a result of the loss of production in the areas that will be inundated by the sediment and detention pools of the floodwater retarding structures.

Secondary costs were derived in much the same manner as secondary benefits. This procedure was followed for conditions without a project and after installation of the structural measures. The difference in the values constituted the secondary costs creditable to the structural measures.

Details of Methodology

The evaluation of damages was made by flood routing a historical storm series for the period from 1922 through 1946. Details of the procedures used in this method of evaluation are described in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, December 1958.

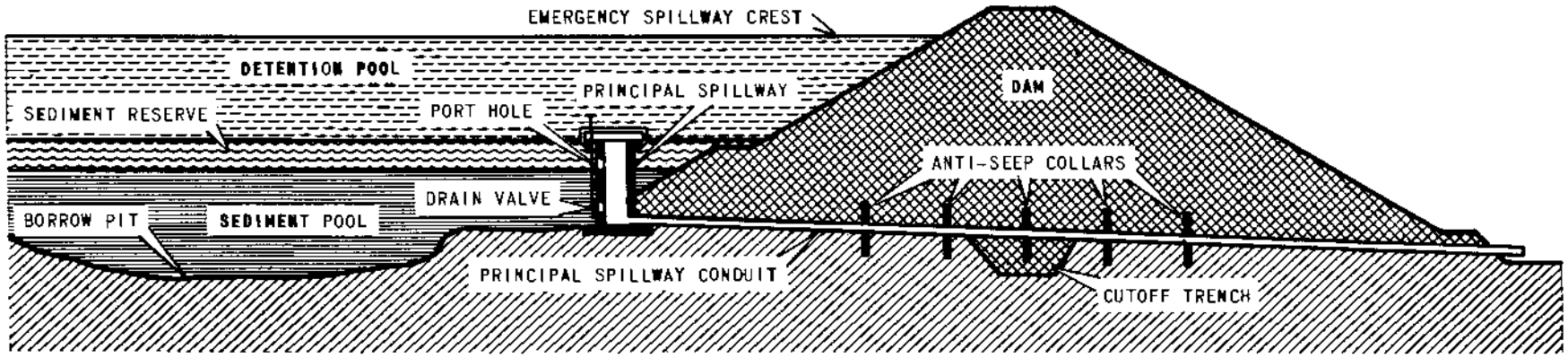


Figure 1

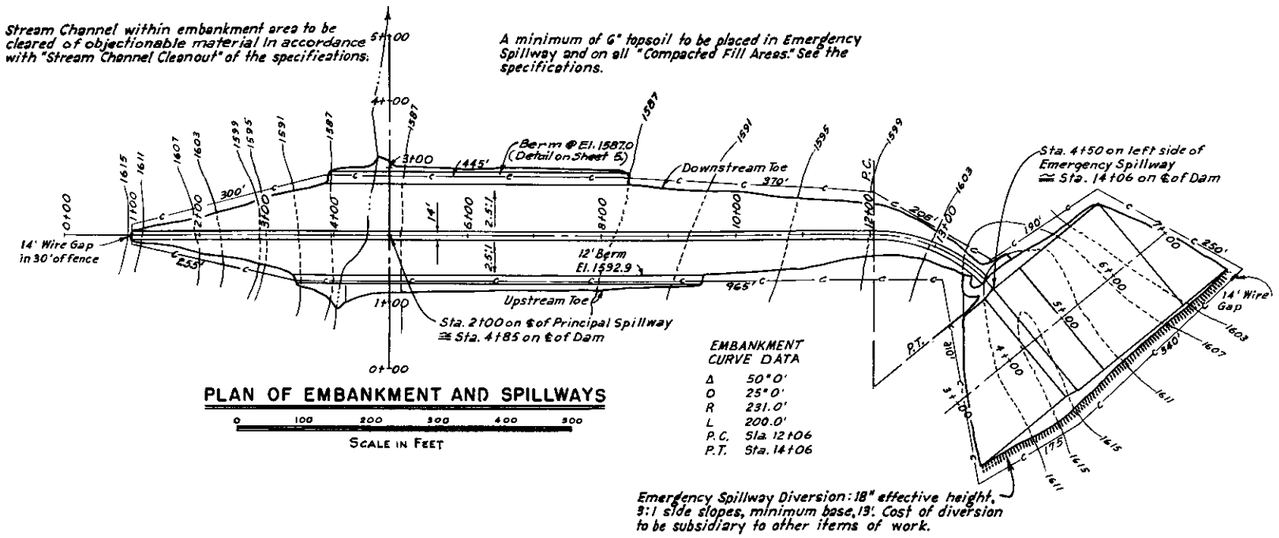
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised LO-93-60 A-L-70,071

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

A minimum of 6" topsoil to be placed in Emergency Spillway and on all "Compacted Fill Areas." See the specifications.



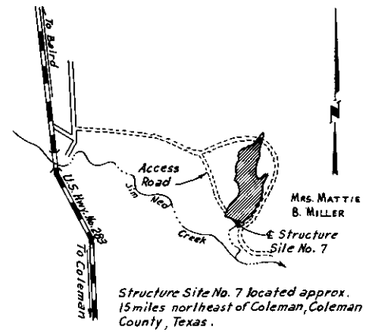
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

SCALE IN FEET

EMBANKMENT CURVE DATA

Δ	50°0'
D	25°0'
R	231.0'
L	200.0'
P.C.	Sta. 12+06
P.T.	Sta. 14+06

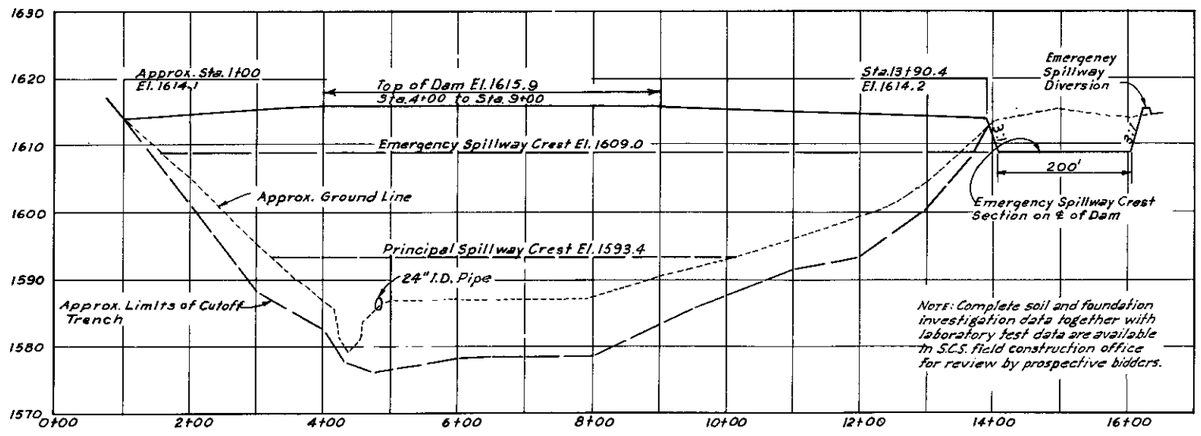


Structure Site No. 7 located approx. 15 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

0 1 2 3 4

SCALE IN MILES

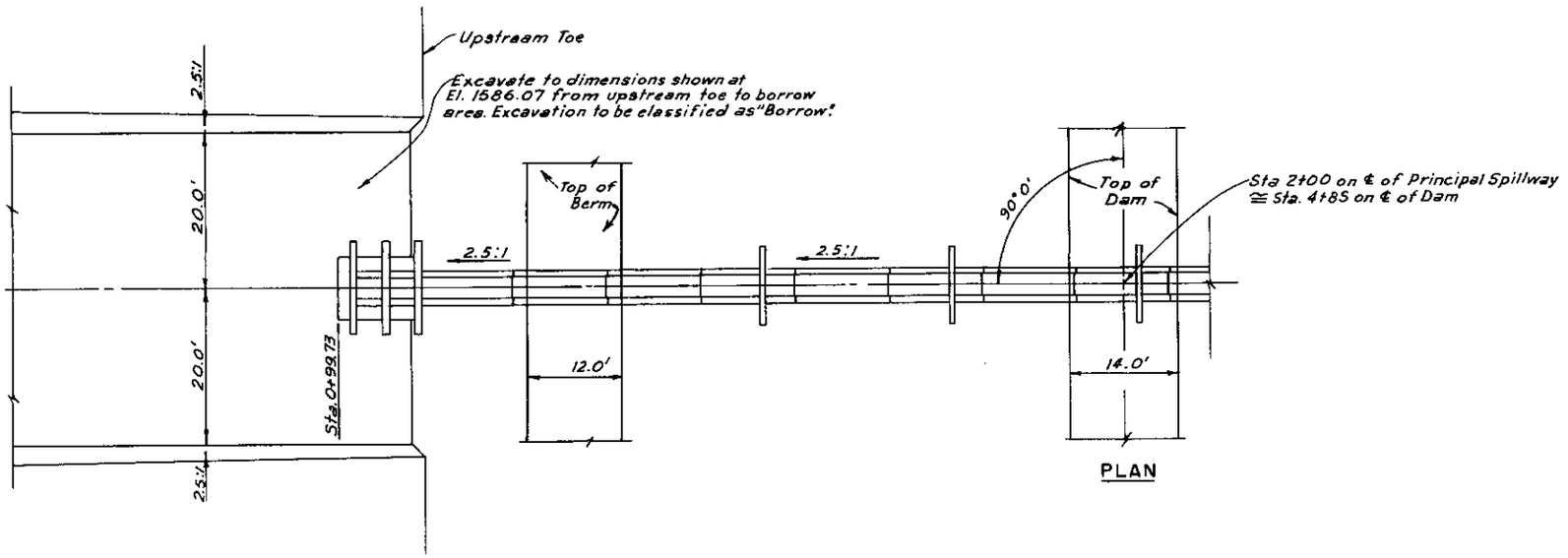


PROFILE ON ℄ OF DAM

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed M.D.K.	3-61	Approved by ... AREA ENGINEERING & SOIL SURVEY PLANNING UNIT FORT WORTH, TEXAS	
Drawn M.D.K. & M.G.C.	3-61	STATE CONSERVATION ENGINEER	
Traced M.G.C.	3-61	TEMPLE, TEXAS Sheet No. 2 of 10	Drawing No. 4-E-15,400
Checked M.D.K. & G.W.T.	4-61		



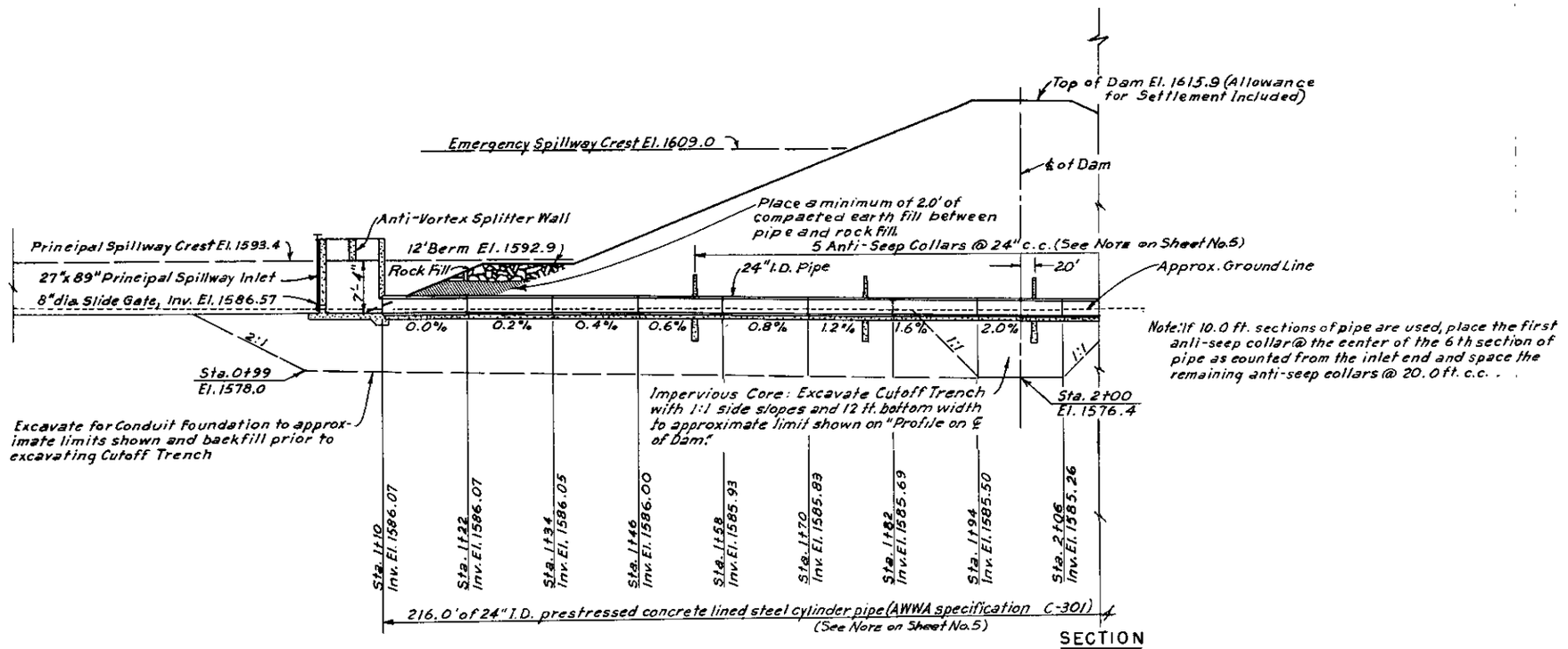
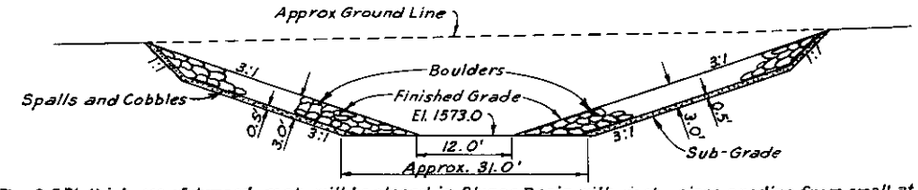


Figure 2a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

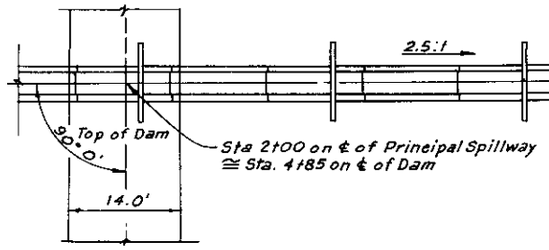
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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

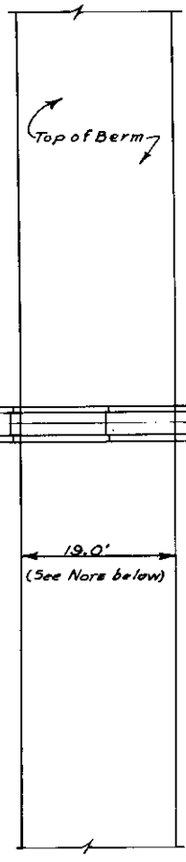


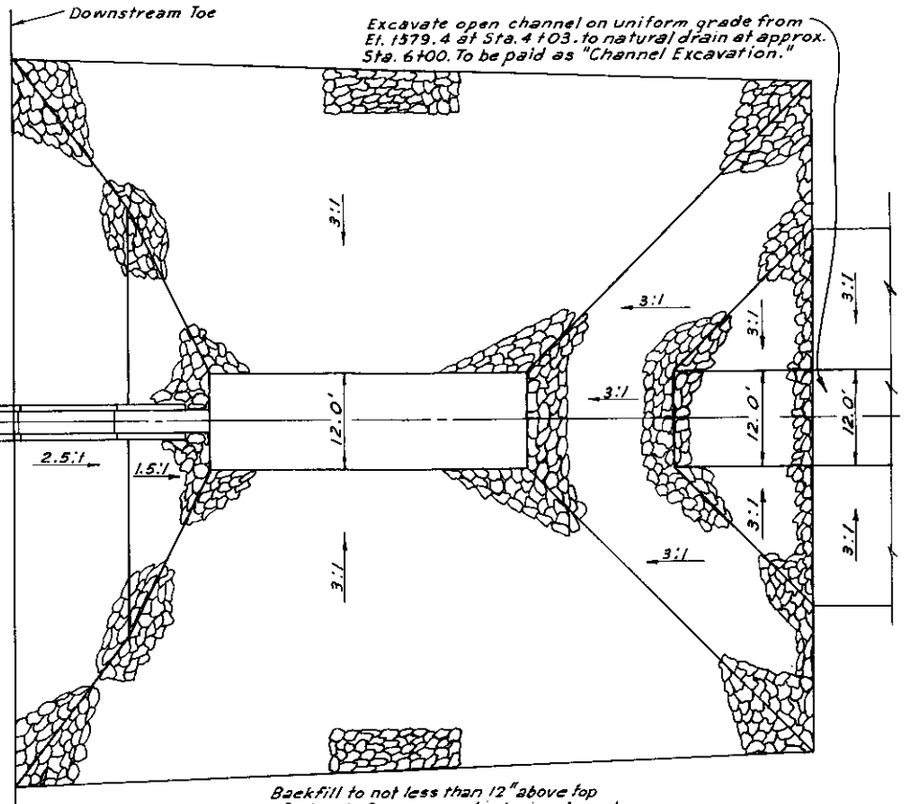
The 2.5 ft. thickness of dumped rock will be placed in Plunge Basin with rock sizes grading from small at sub-grade to large at finished grade. Placement of spalls and cobbles will preeede dumping and placement of boulders. Boulders will be placed to reasonable neat lines of the finished grades, as shown 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.

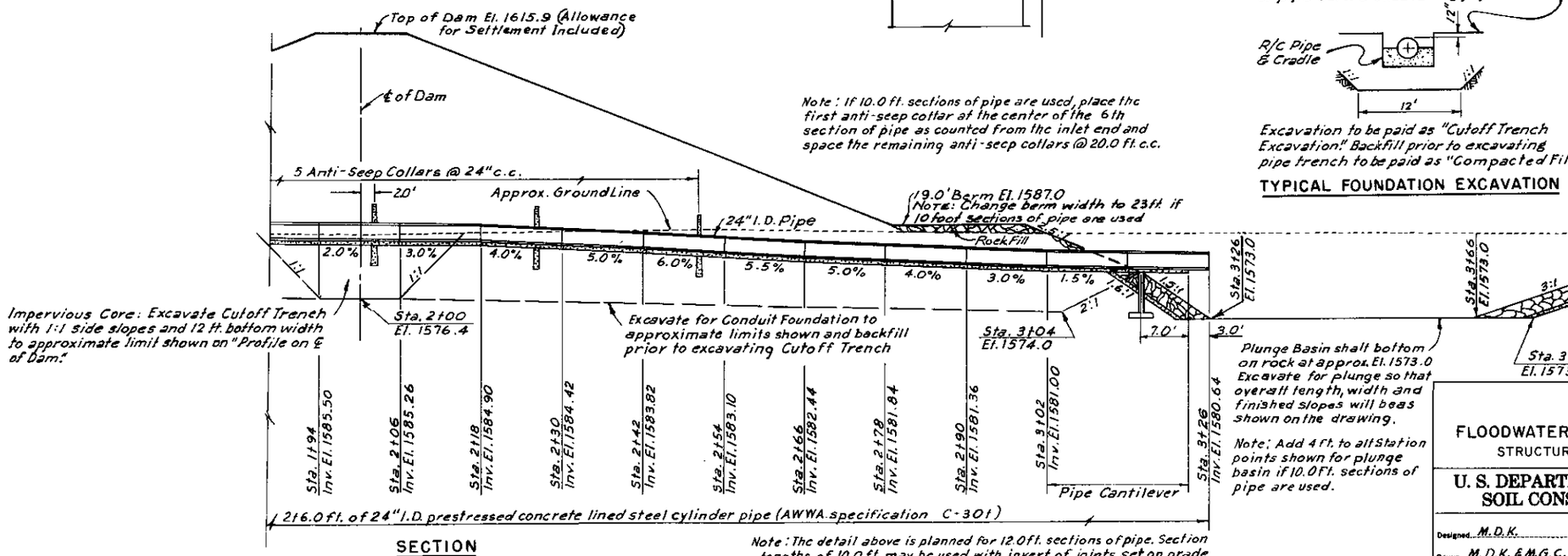
TYPICAL SECTION – PLUNGE BASIN



PLAN







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.

SECTION
PRINCIPAL SPILLWAY

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 permitted.

Excavation to be paid as "Cutoff Trench Excavation." Backfill prior to excavating pipe trench to be paid as "Compacted Fill"

TYPICAL FOUNDATION EXCAVATION

Figure 2a

TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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

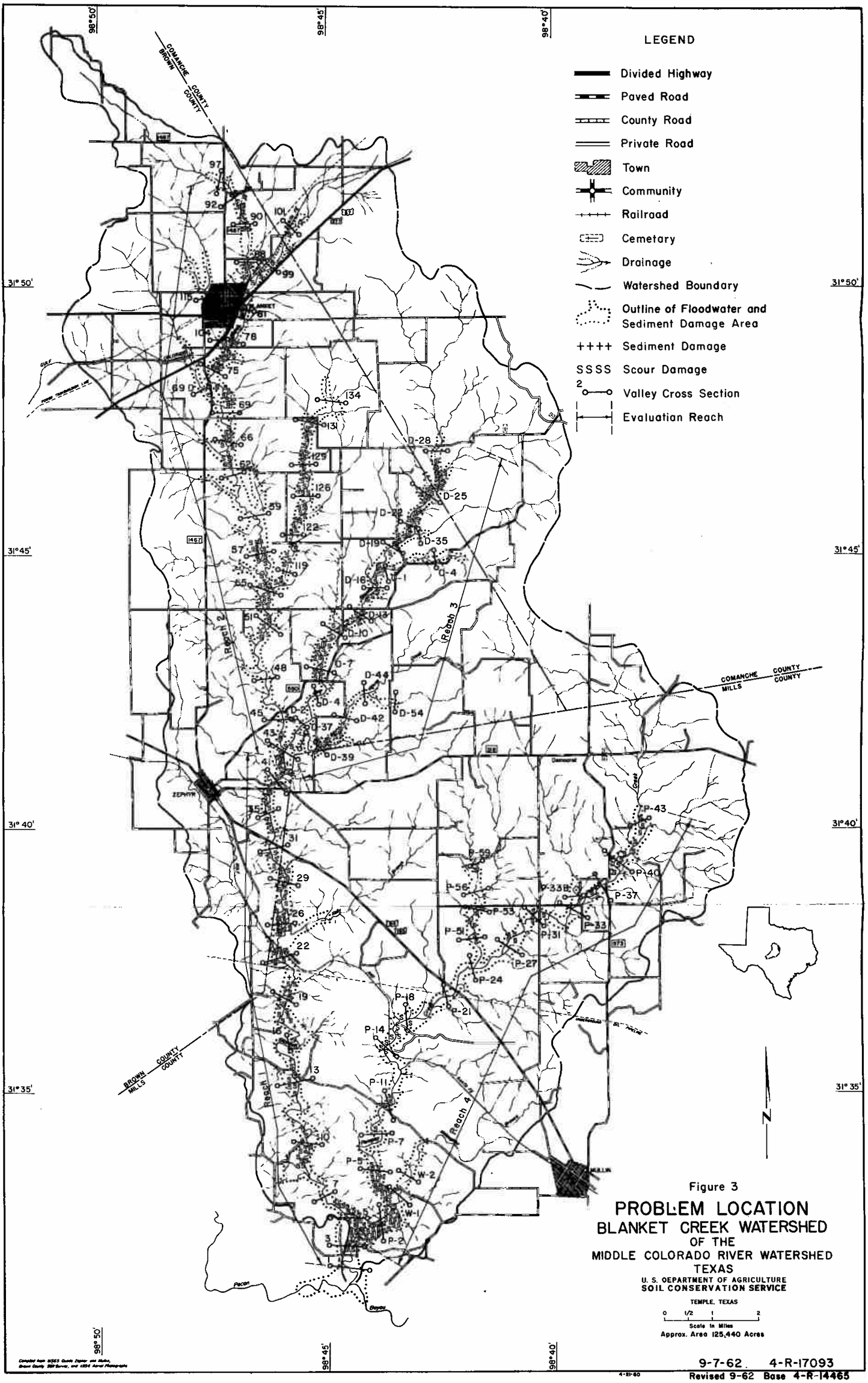


Figure 3

PROBLEM LOCATION
BLANKET CREEK WATERSHED
OF THE
MIDDLE COLORADO RIVER WATERSHED
TEXAS

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

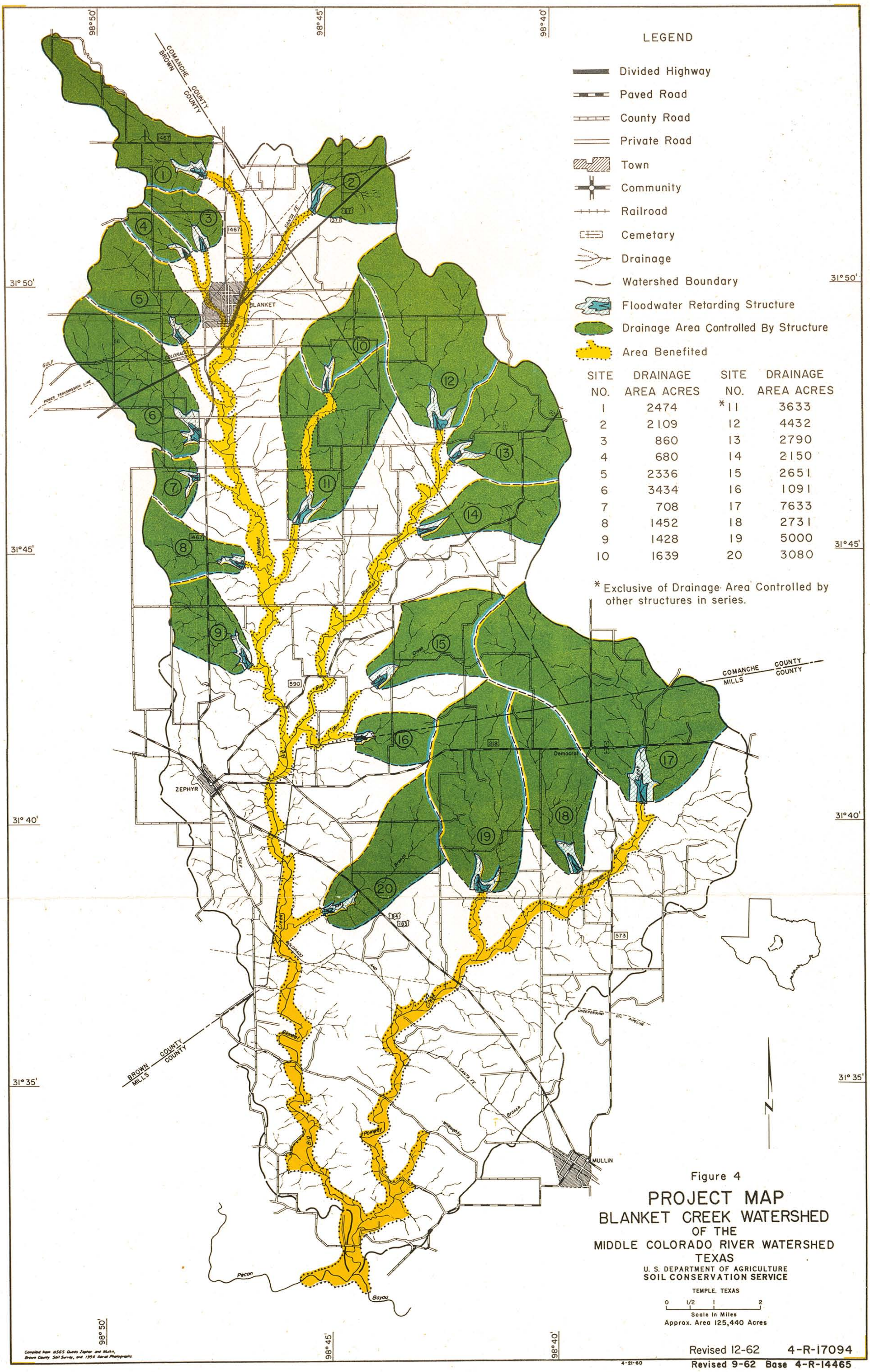
0 1/2 1 2
Scale in Miles

Approx. Area 125,440 Acres

Compiled from USGS Quads Zephyr and Mullin, Brown County SCS Survey, and 1954 Aerial Photographs

9-7-62. 4-R-17093
Revised 9-62 Base 4-R-14465

4-51-60



SITE NO.	DRAINAGE AREA ACRES	SITE NO.	DRAINAGE AREA ACRES
1	2474	*11	3633
2	2109	12	4432
3	860	13	2790
4	680	14	2150
5	2336	15	2651
6	3434	16	1091
7	708	17	7633
8	1452	18	2731
9	1428	19	5000
10	1639	20	3080

* Exclusive of Drainage Area Controlled by other structures in series.

Figure 4

PROJECT MAP
BLANKET CREEK WATERSHED
OF THE
MIDDLE COLORADO RIVER WATERSHED
TEXAS

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

Scale in Miles
Approx. Area 125,440 Acres

Revised 12-62 4-R-17094
Revised 9-62 Base 4-R-14465