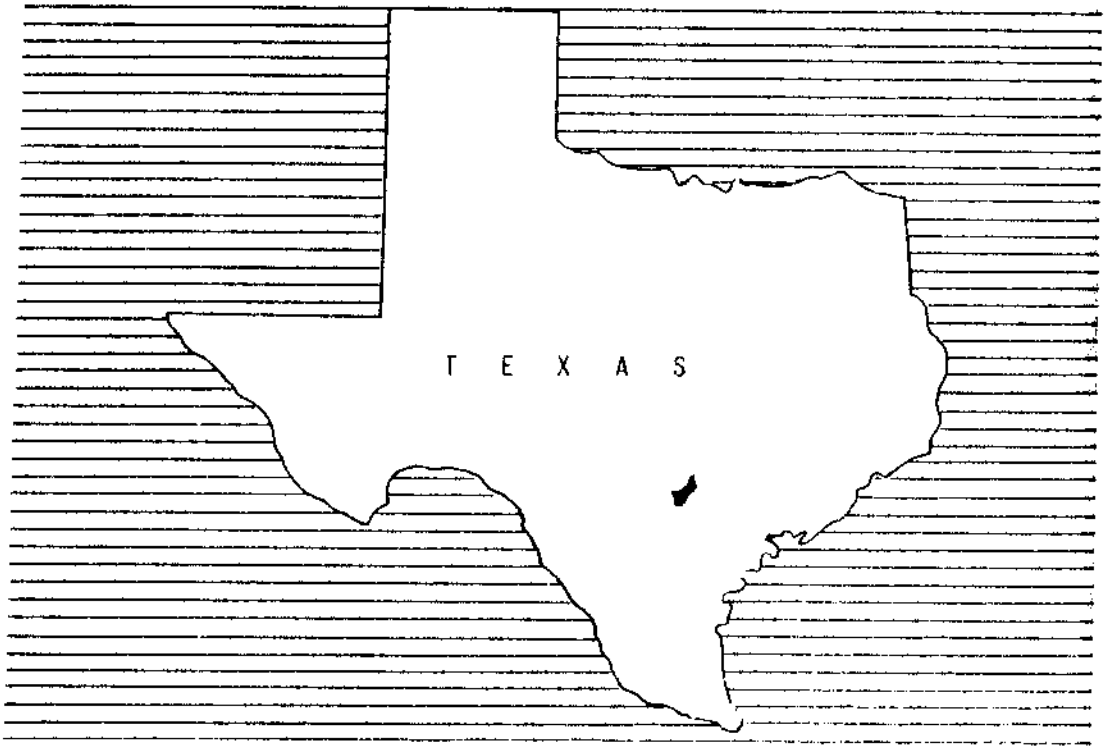
WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

NORTH CUERO WATERSHED

DeWITT COUNTY, TEXAS



JULY 1966

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WATERSHED WORK PLAN AGREEMENT

between the

DeWitt County Soil and Water Conservation District
Local Organization

DeWitt County Commissioners Court
Local Organization

DeWitt County Drainage District No. 1
Local Organization

City of Cuero
Local Organization

State of Texas
(hereinafter referred to as the Sponsoring Local Organization)

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the North Cuero Watershed, State of Texas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the North Cuero Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about three years.

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 84,940.)

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

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures (2)	0	100	84,608
Stream Channel Improvement	0	100	116,712
Grade Stabilization Structures (2)	0	100	28,419
Dike	0	100	7,323

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
Floodwater Retarding Structures (2)	0	100	15,558
Stream Channel Improvement	0	100	32,035
Grade Stabilization Structures (2)	0	100	5,527
Dike	0	100	3,080

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 3,500 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. 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.

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

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.13), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

DeWitt County Soil and Water Conservation District
Local Organization

By Erwin J. Metting
Erwin J. Metting
Title Chairman

Date February 7, 1967

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

adopted at a meeting held on June 6, 1963

Hugo Bachle
(Secretary, Local Organization)
Hugo Bachle

Date February 7, 1967

DeWitt County Commissioners Court
Local Organization

By George W. Trowell
George W. Trowell
Title County Judge

Date February 7, 1967

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

adopted at a meeting held on October 16, 1963

Lucille Pohler
(Secretary, Local Organization)
Lucille Pohler

Date February 7, 1967

DeWitt County Drainage District No. 1
Local Organization

By W. E. Cannon

Title Chairman

Date February 7, 1967

The signing of this agreement was authorized by a resolution of the governing body of the DeWitt County Drainage District No. 1
Local Organization
adopted at a meeting held on September 19, 1963

(Secretary, Local Organization)
C. L. Finch

Date February 7, 1967

City of Cuero
Local Organization

By H. E. Weatherly

Title Mayor Pro Tem

Date February 7, 1967

The signing of this agreement was authorized by a resolution of the governing body of the City of Cuero
Local Organization
adopted at a meeting held on October 10, 1963

(Secretary, Local Organization)
James L. Dill

Date February 7, 1967

Soil Conservation Service
United States Department of Agriculture

By

Date

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

NORTH CUERO WATERSHED

DeWitt County, Texas

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

Prepared By:

DeWitt County Soil and Water Conservation District
(Sponsor)

DeWitt County Commissioners Court
(Sponsor)

DeWitt County Drainage District No. 1
(Sponsor)

City of Cuero
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
July 1966

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WATERSHED WORK PLAN

NORTH CUERO WATERSHED

DeWitt County, Texas
July 1966

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for North Cuero watershed has been prepared by DeWitt County Soil and Water Conservation District, DeWitt County Commissioners Court, DeWitt County Drainage District No. 1, and the city of Cuero as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service of the United States Department of Agriculture.

North Cuero watershed covers an area of 19.7 square miles (12,608 acres). It is estimated that 14.6 percent of the watershed is cropland, 19.9 percent is pasture, 31.9 percent is rangeland, and 33.6 percent is in miscellaneous uses such as urban areas, farmsteads, public roads and railroads, cemetaries, and stream channels. There is no Federal land in the watershed.

Objectives of the proposed project are to provide flood protection for flood plain lands including the area of Cuero flooded by overflow of Gohlke Creek and to install proper land use and conservation practices in the interest of soil and water conservation. The project proposed in this work plan will accomplish these objectives.

Principal problems are the occurrence of floods almost every year that cause agricnltural damage and large floods every five to ten years that cause severe urban damage in the city of Cuero. Agricultural property damaged by floodwater include crops, pastures, fences, farmstead improvements, and cured feed and hay. Nonagricultural property damaged by floodwater include public roads and bridges, residential houses including yard improvements and automobiles, business establishments, streets, and utilities. Cumulative area flooded during an average year of the 100-year evaluation period is about 1,635 acres. Average annual flood damages are estimated to be $23,133 including indirect damages. The proposed project will reduce these damages to an estimated $2,658, an average annual reduction of 89 percent.

The work plan proposes installing, in a three-year period, land treatment measures, two floodwater retarding structures, 7.1 miles of stream channel improvement including needed erosion control measures, two grade stabilization structures, and 4,371 feet of dike at a total estimated installation cost of $530,944. Public Law 566 cost share is estimated to be $300,252, including $237,062 for construction, $60,487 for installation services, and $2,703 for accelerated technical assistance for land treatment. Other than Public Law 566 cost share is estimated to be $230,692.

Cost share to be borne by funds other than Public Law 566 consist of landowners and operators expenses for land treatment measures, including

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anticipated cost sharing by the Agricultural Stabilization and Conservation Service; Public Law 46 funds for regular technical assistance; land, easements, and rights-of-way costs for structural measures; and contract administration costs. In addition, sponsoring local organizations will bear costs of operation and maintenance.

Structural measures will be located and designed to protect the city of Cuero from flooding, due to overflows of Gohlke Creek, for all floods up to, and including, the 100-year frequency. Estimated total installation cost of structural measures is $385,989. Public Law 566 cost share is $297,549 and local cost share is $88,440.

Total average annual benefits accruing to structural measures are estimated to be $20,179, including $1,605 secondary benefits.

Ratio of total average annual benefits ($20,179), resulting from installation of structural measures, to average annual cost ($14,788) of these measures is 1.4:1.

A total of 45 farms comprising about 1,358 acres of agricultural land, and about 175 owners of approximately 104 acres of urban land in Cuero will benefit directly from installation of the structural measures. These measures also will provide flood protection to 60 acres of other miscellaneous lands, including roads and a cemetary.

Commissioners Court of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero have powers of taxation and right of eminent domain under applicable State Laws and will furnish funds for financing local cost share of structural measures.

Operation and maintenance will be carried out by sponsoring local organizations. Funds for this purpose will be adequate and available from revenue supported by existing taxes. Value of average annual operation, maintenance, and replacement expenses for structural measures is estimated to be $2,143.

The city of Cuero currently is developing a plan for improved urban drainage. These improvements should be installed in the near future or zoning used to control developments in areas subject to inundation.

DESCRIPTION OF WATERSHED

Physical Data

North Cuero watershed lies on the coastal plain of Texas in central DeWitt County and includes the city of Cuero. Gohlke Creek, the principal tributary, originates about three miles north of Cuero, flows southward, courses through the urban area, and enters the Guadalupe River about two miles south of Cuero. The watershed comprises an area of 19.7 square miles, or 12,608 acres.

The watershed occurs adjacent to the eastern bank of the Guadalupe River and lies upon two river terraces. The upper and older terrace comprises about 15 percent of the watershed along the eastern divide. Streams have incised this terrace and created rolling topography.

The lower terrace, extending almost to the Guadalupe River is nearly level, contains poorly defined water courses and comprises about 85 percent of the watershed. In general, surface drainage is very slow.

Elevations range from about 150 feet above mean sea level along the Guadalupe River to 340 feet along the eastern divide.

The watershed is underlain by Tertiary clays, sands, and poorly cemented sandstones of the Lagarto formation. The clays are dominant. Terrace deposits overlying the Lagarto formation are generally thin but range up to 15 feet in thickness. They consist of clay, silty clay, sandy clay, silty sand, sand, and gravel. The gravel occurs primarily as caps along ridges in upper river terrace. Some gravel lenses also occur close to the Guadalupe River within the alluvium of the lower terrace.

About 80 percent of the watershed is classified as Blackland Prairie Land Resource Area. The Texas Claypan Land Resource Area extends into the watershed and occupies the remaining 20 percent.

Surface soils range in texture from clay to loamy fine sand. Clay loams, sandy clay loams, and fine sandy loams of the Wilson, Crockett, and Cuero series and the gravelly phases of the Axtell series are predominant. Other soil series present in the watershed are Tabor, Lakeland, Engle, Burleson, Houston, Frio, Trinity, Guadalupe, and Gowen. All soils of the watershed are deep. About 59 percent of the soils are very slowly permeable, 2 percent slowly permeable, 23 percent moderately permeable, and 16 percent rapidly permeable.

The following tabulations show over-all land use in the watershed.

Land Use	Acres	Percent
Cropland	1,838	14.6
Pasture and Hayland	2,508	19.9
Rangeland	4,029	31.9
Miscellaneous 1/	4,233	33.6
Total	12,608	100.0

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

Range sites within the Blackland Prairie portion of the watershed are Bottomland, Grayland, Rolling Blackland, and Loam. In climax condition, this portion was grassland prairie except for scattered oak, elm, pecan, and other tree growth on the Bottomland site. Range sites of the Texas Claypan portion are Sandy Loam, Sandy, and Gravelly. This area was post oak and blackjack oak savannah with about 20 percent canopy in climax condition. Predominant climax vegetation consists of the following grasses: little bluestem, Indiangrass, switchgrass, big bluestem, purpletop, side-oats grama, brownseed paspalum, tall dropseed, Texas wintergrass, plains lovegrass, and low panicums. Perennial legumes and forbs are also included in climax vegetation. As the range is grazed too closely, many of the desirable grasses diminish or die out. They are replaced by less desirable vegetation such as mesquite, huisache, threeawns, ragweeds, red lovegrass, and post oak. Continued use of grazing at this stage increases susceptibility of the soil to water erosion. At present, the hydrologic cover condition on rangeland is generally fair.

The climate is warm and sub-humid. Normal monthly temperatures range from 54 degrees Fahrenheit in January to 85 degrees in July. Normal growing season, extending from March 1 to November 15, is 272 days. Average annual rainfall is 34 inches. Precipitation is well distributed throughout the year.

Water for livestock and rural domestic use is obtained from wells and surface ponds and is generally of good quality. Wells also are the source of water for municipal use. The water bearing sands are in the Lagarto formation and the underlying Oakville formation.

Economic Data

The economy of the area in which the watershed is located depends on production and processing and marketing agricultural products. Most agricultural activities are associated with diversified livestock operations which are supported by production of feed and grazing crops. These crops consist of sorghums, oats, barley, clover, and corn in addition to improved pastures. Some truck crops such as tomatoes, watermelons, beans, and beets are produced in the watershed. Livestock production which includes beef and dairy cattle, swine, sheep, poultry for eggs, broilers, and turkeys account for about three-fourths of the farm income.

This type of farming is expected to continue. There will be an increase in acreage devoted to improved pastures. Technological advances are expected to improve yields and quality of forage crops.

The watershed formerly included some production of rice, cotton, and peanuts. As livestock farming increased, acreage devoted to production of these cash crops was converted to production of forage crops. High yields of forage crops are significant to the watershed economy and to producers who depend on livestock production and dairying for a major portion of the family income.

There are approximately 67 operating units in the watershed and about 80 percent are owner-operated. The average size farm in the watershed is about 180 acres which is much smaller than the county average of 444 acres. According to the agricultural census, the average size farm has been increasing on a county wide basis, but has been decreasing in the watershed. Since most of the watershed farms are only a few minutes drive from Cuero, some units serve as rural residences of employed people. Most agricultural land is valued at $100 to $300 per acre. Average value of land and buildings is estimated to be $25,000 per farm.

Since many farms are small, almost half of the owners and operators need off-farm employment in order to provide a reasonable standard of living for the family. Approximately 25 percent of the operators have gross sales of less than $3,000 annually. There is a need for additional employment opportunities for the operators of smaller units and for other workers in the area. The county population has been decreasing slightly since 1950 and may continue to do so for some time. However, it is believed that the population of the city of Cuero and the watershed will soon begin to increase slightly because of new businesses and industries that will be attracted to the area.

The city of Cuero, located in the watershed, is the principal market center of DeWitt County and is the county seat. Commercial establishments include a cotton mill, cottonseed oil mill, creamery, poultry packing plant, and a livestock commission company. Cuero is the market and shipping point for a wide variety of farm products and is home of the "Turkey Trot Festival".

Some outdoor water-based recreation facilities are available in the general area. There is some business activity resulting from hunting of dove, quail, squirrel, and deer in the watershed.

Modern up-to-date transportation facilities consisting of U. S. Highways 87 and 183, Farm Roads 236 and 1447, and the Southern Pacific Railroad provide service to the watershed. Improved county roads provide good travel routes within the watershed. There is a total of sbout 17 miles of hard surface roads and about 15 miles of other county roads.

Land Treatment Data

The DeWitt County Soil and Water Conservation District is assisting farmers and ranchers of the watershed in the preparation and application of basic soil and water conservation plans on their land.

The Soil Conservation Service work unit at Cuero is assisting the district. There are 36 operating units, under district agreement, covering 79 percent of the agricultural land in the watershed.

The work unit has assisted Soil and Water Conservation District cooperators in preparing 36 basic soil and water conservation plans, covering 6,643 acres, and has given technical assistance in establishing and maintaining planned measures. Current revision is needed on 12 conservation plans. A complete soil survey of the watershed has been made.

Complete treatment has been accomplished on about 30 percent of the agricultural land. Approximately 35 percent of the needed land treatment practices have been applied.

Land treatment practices presently applied have been effective in reducing total erosion by an estimated 10 percent. Additional application of land treatment is expected to reduce erosion another 13 percent during the 3-year installation period.

WATERSHED PROBLEMS

Floodwater Damages

Flooding occurs over approximately 1,522 acres of the watershed, which is the area defined as the flood plain (figure 1). This area includes about 1,358 acres of agricultural land, excluding the area to be used for channel improvement, 104 acres of urban land, and 60 acres of miscellaneous land such as roads, farmsteads, and a cemetary. Evaluations are based on effects the proposed works of improvement will have on flooding of these 1,522 acres from all floods up to, and including, the 100-year frequency. Cumulative totals of recurrent flooding average about 1,635 acres annually during the evaluation period.

Runoff from the hill land east of Highway 77A (figure 1), in addition to accumulation of rainfall on the nearly level flood plain, causes flooding up to an estimated average depth of 0.8 foot over about 1,255 acres in reach 3. Part of the floodwater flows down Gohlke Creek into the city of Cuero where urban flooding occurs.

Minor flooding, inundating less than half the flood plain, occurs frequently. Some years minor floods have occurred two or three times. Major floods, inundating more than half the agricultural flood plain, have occurred every two or three years, on an average.

Land use in the flood plain is: Cropland - 20 percent, Pasture - 50 percent, Range - 20 percent, Urban - 7 percent, and Miscellaneous - 3 percent. Value of agricultural flood plain land is estimated to be $100 to $300 per acre.

Major floods have caused severe damage to crops, pastures, cured forage crops, fences, farm improvements, public roads, bridges and streets, and residential and business properties.

Based on flooding expected to occur during the 100-year evaluation period, total direct floodwater damage is estimated to average $19,509 annually, at long-term price levels (table 5). Included will be $7,269 damage to crops and pastures, $948 damage to other agricultural property, $1,092 damage to county roads and bridges, and $10,200 urban damages in the city of Cuero. Damages are listed by evaluation reaches in the following tabulations:

Average Annual Direct Floodwater Damage Without Project

Evaluation Reach (Figure 1) (Number)	Damage in Dollars (Based on Long-Term Prices)			
	Crop and Pasture	Other Agricultural	Non-Agricultural	Total
1	233	-	-	233
2 (Urban)	-	-	10,200	10,200
3	7,036	948	1,092	9,076
Total Watershed	7,269	948	11,292	19,509

Urban damages in Reach 2 result from overflow of Gohlke Creek into the northwest part of Cuero in the vicinity of valley cross sections G-11a through G-14 (figure 1). Flooding to a maximum depth of about 4.7 feet has occurred. Floodwaters cause damage to residential properties, business establishments, streets, and utilities. There are some other areas of the city that are flooded; however, most of this flooding, except that which has resulted from an occasional overflow of the Guadalupe River, is caused by accumulation of rainfall occurring in and near the urban area.

Studies indicate that a recurrence of a flood similar to the 1962 flood which resulted from an estimated 5-year frequency storm would cause approximately $12,500 urban damages from overflow of Gohlke Creek. A flood similar to the ones that occurred in 1960 and 1929 would cause approximately $78,500 urban damages. These floods resulted from approximately 25-year frequency storms.

The following tabulations show estimated direct floodwater damages for selected flood frequencies:

Flood Frequency	Damage in Dollars (Long-Term Price Levels)		
	Agricultural	Non-Agricultural 1/	Total
100-year	5,741	100,730	106,471
50-year	5,715	90,730	96,445
25-year	5,663	79,230	84,893
10-year	5,606	22,930	28,536
5-year	5,529	13,230	18,759
2-year	5,358	2,780	8,138
1-year	4,512	642	5,154

1/ Includes urban damages caused by overflow of Gohlke Creek.

Indirect damages such as interruption of travel and business activities, including lost work time by employees, re-routing and delays of school buses and mail deliveries, evacuation operations, and other inconveniences are estimated to average $2,971 annually.

Erosion Damage

Estimated average annual rate of gross erosion on the rolling upland (upper river terrace) is 8.46 tons per acre. Of this, sheet erosion accounts for 96 percent, gully erosion 2 percent, and streambank erosion 2 percent.

Average annual erosion on the lower river terrace is much less, amounting to about 2.8 tons per acre. Sheet erosion accounts for 96 percent and flood plain scour 4 percent. Streambank and gully erosion are insignificant on this portion of the watershed.

About one percent of the flood plain is affected by scour. This damage is light because of the low velocity of flood flows and consists of broad sheet scour depressions and shallow channels not exceeding two feet in depth. It is estimated that flood plain scour has caused a loss of productive capacity amounting to 10 percent on 12 acres and 20 percent on 8 acres. The average annual monetary value of this damage is estimated to be $157 at long-term price levels (table 5).

Flood plain scour is considered to be in equilibrium in that the extent of additional damage each year is about equal to the damage recovery from such damage.

Sediment Damage

Sediment damage is moderate to low. Runoff from the rolling upper river terrace land transports moderate amounts of sediment to the lower, nearly level river terrace. Because of the low sediment transporting capacities of stream channels on the lower terrace, most of the coarse fraction of sediment is deposited at/or near the zone of transition between the high terrace and low terrace.

Overbank deposition of sediment occurs primarily as alluvial fans and flood plain splays, ranges in texture from sandy clay to fine sand, and ranges in depth from 0.5 to 2.0 feet. These deposits, covering about nine percent of the flood plain, are of low fertility in comparison to the underlying soils. It is estimated that overbank deposition of sediment causes some loss of productive capacity on 137 acres of flood plain land and is distributed as follows: 88 acres, 10 percent; 33 acres, 20 percent; and 16 acres, 30 percent. Average annual monetary value of this damage is estimated to be $496 at long-term price levels (table 5). Flood plain damage from overbank deposition of sediment is considered to be in equilibrium.

Problems Relating to Water Management

DeWitt County Drainage District No. 1 was created for the purpose of establishing adequate outlets and storm drains for the city of Cuero. The

Typical flood scene in Cuero from an estimated 5-year frequency flood.

Floodwater beginning to spread over large cropland field from accumulation of rainfall in the area.

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PHOTO COURTESY OF CURTIS KIRBY

Inundation of County Road from accumulation of floodwater.

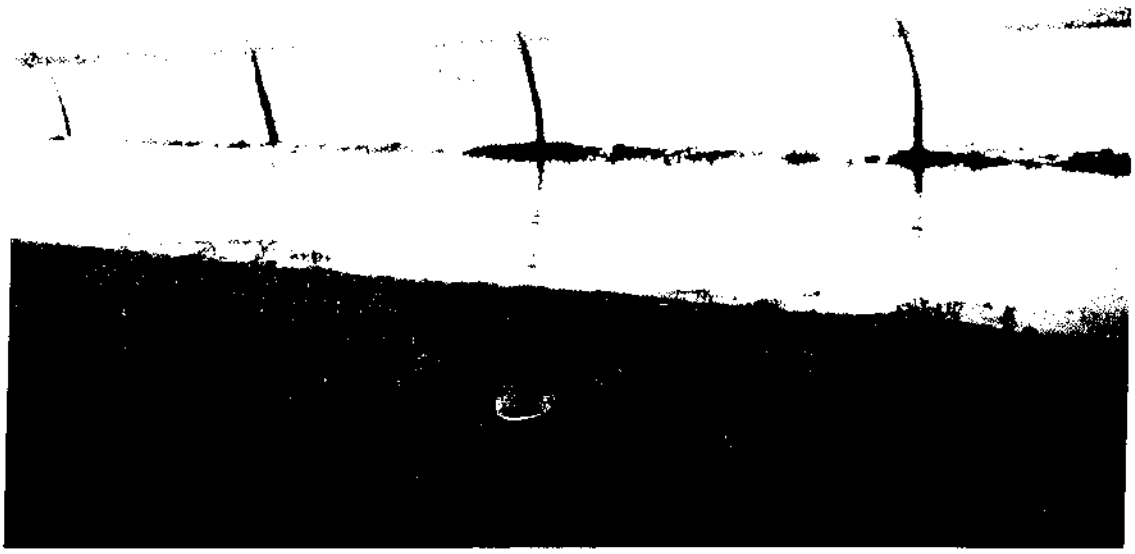

PHOTO COURTESY OF CURTIS KIRBY

Typical flooding of the nearly level flood plain.

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outlets, consisting of open and closed conduits, drain the frequently flooded low lying areas of the City; however, the present system is inadequate.

There are a few small areas of agriculture land that needs some surface drainage. Outlets are available for most of these areas and landowners plan to install drainage field ditches to alleviate the problems.

According to the local sponsoring organizations, there is no need or interest, at the present time, for additional storage in any of the floodwater retarding structures for irrigation, municipal, or industrial water supply.

PROJECTS OF OTHER AGENCIES

The city of Cuero is preparing a plan for improving the drainage systems of the city. The services of a consulting engineer have been engaged to assist in development of the plan.

The Bureau of Reclamation, United States Department of Interior, has developed a plan to construct a dam and reservoir on the Guadalupe River approximately five miles upstream from Cuero. The project will not be affected in any way by the works of improvement to be installed in the North Cuero watershed.

BASIS FOR PROJECT FORMULATION

An initial study was made by representatives of the Soil Conservation Service and sponsoring local organizations to determine watershed problems and possible solutions.

Meetings were held with the sponsoring local organizations to discuss existing flood problems and water and related land resource needs and to formulate project objectives. Watershed protection, flood prevention, and public recreational development were the desired objectives to be considered.

The following specific objectives were agreed to:

1. Establish land treatment measures that contribute directly to watershed protection and flood prevention and which would make the watershed an outstanding example of soil and water conservation.

2. Attain a reduction of 70 to 75 percent in average annual flood damages through installation of structural measures to supplement land treatment on the watershed. In addition, every effort would be made to attain protection to the urban area of Cuero such as to reduce the flood damage expected to occur on the average of once in 100 years to a relatively minor level.

3. Investigate the feasibility of including storage of water for recreational development in a floodwater retarding structure.

In selecting sites for floodwater retarding structures and stream channel improvement, consideration was given to locations which will provide the agreed upon level of protection to areas subject to damage. The size, number, design, and cost of structures were influenced by physical, topographic, and geologic conditions.

The proposed works of improvement, including both land treatment and structural measures, meet project objectives at least cost in providing the desired level of protection to agricultural and urban areas. After full consideration of existing and proposed water-based recreational facilities in the vicinity of Cuero, sponsoring local organizations determined that future recreational needs would be met without inclusion of water storage for recreation in a floodwater retarding structure on the North Cuero watershed.

Shallow flooding in Cuero, outside the Gohlke Creek flood plain, which is caused by inadequate storm drains and outlets will not be alleviated by this project. The city of Cuero, with assistance from a consulting engineer, is in the process of developing a plan for improved drainage measures to reduce or eliminate this problem. Improvements should be made soon or zoning considered to control developments in these areas.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

DeWitt County Soil and Water Conservation District is assisting farmers and ranchers of the watershed in the preparation and application of basic soil and water conservation plans on their land. Application of measures in these plans, based on the use of each acre within its capabilities and treatment in accordance with its needs, is an essential part of a sound program for watershed protection and flood prevention. The extent of needed land treatment measures which have been applied to date within the watershed represents an estimated expenditure by landowners and operators of $113,416, including reimbursements from the Agricultural Stabilization and Conservation Service (table 1A).

Table 1 includes estimates of acreage in each major land use on which land treatment measures will be installed during the 3-year project installation period. Measures will be established and maintained by landowners and operators in cooperation with DeWitt County Soil and Water Conservation District.

About 1,270 acres of cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from sheet erosion. The conservation cropping systems in this watershed include cover and green manure crops, crop residue use, and grasses, and legumes in rotation.

About 0.2 mile of terraces provided with grassed waterways or outlets will be installed to control erosion and retard runoff from the more rolling areas. There will be about 0.2 mile of diversions constructed to protect cropland from rapid runoff.

Dairy cows grazing coastal bermudagrass pasture following brush control and pasture renovation.

Cover and green manure crop of Hubam clover for soil protection and improvement.

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Range proper use following brush control and deferred grazing. Rangeland received only 12 inches of rainfall during the year preceeding this photograph and remains in good condition due to proper management.

Rangeland in good condition on Sandy Loam site, Texas Claypan Land Reeource Area.

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About 2,670 acres will be either bulldozed, chained, root plowed, or treated by aerial spray to control brush.

Pasture and hayland management will be practiced on about 1,850 acres. Approximately 810 acres of pasture and hayland will be renovated and 30 acres will receive initial plantings of adapted forage plants to attain a good base cover.

Proper use will be practiced on about 3,100 acres of rangeland to maintain adequate cover for soil protection and improve quantity and quality of vegetation. Range rotation-deferred grazing will be practiced on about 2,980 acres to allow sufficient growth periods for range grasses.

Destruction of cover caused by overuse around present watering places will be reduced by establishing 4 farm ponds on pastures and rangeland.

Approximately 0.5 mile of drainage field ditches and 3 grade stabilization structures will be installed for adequate removal of excess water from fields and pastures.

In addition to technical assistance presently available, $2,703 will be made available from Public Law 566 funds to accelerate establishment of land treatment practices. Local people will continue to install and maintain measures needed in the watershed after the 3-year installation period.

Installation of land treatment measures will reduce average annual erosion and increase infiltration of rainfall as a result of improved ground cover in cultivated areas and increased grass density and vigor in pasture areas.

Structural Measures

Two floodwater retarding structures, five segments of stream channel improvement, including two grade stabilization structures, and one dike are to be installed to provide needed flood protection for the agricultural area and for the city of Cuero. These measures are necessary because land treatment measures and city drainage measures alone will not provide sufficient flood protection for the watershed.

Because of the flat topography of approximately 85 percent of the watershed extensive stream channel improvement is necessary, in addition to floodwater retarding structures, to obtain the degree of protection desired.

Floodwater retarding structures will detain runoff from approximately 10 percent of the watershed for all storms up to, and including, the 100-year frequency.

There will be 7.1 miles of stream channel improvement consisting of five segments numbered I, IA, II, III, and IIIA (figure 6). Disposal of spoil will be in such manner that surface runoff is not blocked.

Approximately 4,371 feet of dike will be installed in connection with channel improvement No. III to insure that potantial floodwater from the larger floods is diverted from a normal flow toward the city and into the improved channel.

Stream channel improvement Nos. I, IA, and IIIA will have capacity for runoff from an estimated 2-year frequency storm. No. II and No. III, with dike in place, will have capacity for runoff from an estimated 100-year frequency storm.

Two railroad bridges will be installed in connection with stream channel improvement Nos. II and III.

Total storage capacity of the two floodwater retarding structures will be 1,112 acre-feet, including 203 acre-feet for sediment accumulation during a 100-year period and 909 acre-feet for floodwater detention. An average of 8.97 inches of runoff will be detained from approximately 10 percent of the watershed.

Principal spillways will be set at the elevation necessary to store 100-year sediment accumulation because unsatisfactory water impoundment conditions would exist with spillways at the elevation necessary for 50-year sediment accumulation.

A weir type concrete drop grade stabilization structure will be installed near the outlet ends of improved channels Nos. 1 and III (figure 6). Approximately 49 grade stabilization structures will be installed along the improved channels where needed to prevent erosion caused by water entering from side drains. These structures will be either pipe-drops or formless concrete paved inlets.

Capacity equivalents for structural measures are shown in tables 3, 3A, 3B, and 3C. Location of structural measures is shown on the project map (figure 6). Typical sections of a floodwater retarding structure is shown on figure 2 and typical cross section of channel improvement is shown on figure 4. Details on quantities and costs of structural measures are shown in tables 1 and 2.

Detention storage of floodwater retarding structures will be sufficient to permit the use of vegetation for emergency spillway protection.

Total installation cost of structural measures is estimated to be $385,989 including $114,016 for two floodwater retarding structures, $220,637 for 7.1 miles of stream channel improvement, $39,433 for two grade stabilization structures, and $11,903 for the dike.

All State laws will be complied with in design and construction of structural measures.

EXPLANATION OF INSTALLATION COSTS

Public Law 566 funds, in the amount of $2,703 for technical assistance during the three-year installation period, will be provided to accelerate application of planned land treatment for watershed protection. These funds will be in addition to $2,540 Public Law 46 funds that will be used to provide technical assistance in the land treatment program.

Local interests will apply land treatment at an estimated cost of $139,712. This amount includes anticipated cost-sharing by the Agricultural Stabilization and Conservation Service. Costs are based on present prices being paid by landowners and operators to establish land treatment measures in the area. Planned measures and unit costs were estimated by the sponsoring local organizations.

Public Law 566 funds will be provided for construction of structural measures. Included will be constructing floodwater retarding structures, excavating channels, installing grade stabilization structures, building dike, altering one State road bridge to provide for deepening of a stream channel, and constructing two railroad bridges. Public Law 566 funds will also be provided for installation services costs. All other costs involved in project installation will be borne by other than Public Law 566 funds.

Total installation cost of structural measures is estimated to be $385,989 (table 2). Public Law 566 cost share is $297,549 which includes $237,062 for construction and $60,487 for installation services. Construction cost includes $22,248 for alteration of road and railroad bridges. Local cost share is $88,440 which includes $84,940 for land, easements, and rights-of-way, and $3,500 for administration of contracts.

Cost included for land, easements, rights-of-way, legal fees, and contract administration were determined by appraisal in cooperation with representatives of sponsoring local organizations. Land, easements, and rights-of-way costs will include the following: $15,180 for value of land used for project installation; $5,000 for removal of obstacles and relocating improvements; $46,310 for construction of road bridges, low water crossings, and for ballast, ties, rails, and other expenses not directly associated with structural stability of two railroad bridges and their approaches; $14,950 for fencing and water gaps; and $3,500 for value of legal services.

Construction costs include the engineer's estimates and contingencies. The engineer's estimates were based on the unit costs of structural measures in similar areas modified by special conditions inherent to each individual site location. They include such items as permeable foundation conditions, rock excavation, wasting unsuitable material, and site preparation. Ten percent of the estimate was added as a contingency to provide funds for unpredictable construction costs.

Installation services include engineering and administrative costs. These estimates were based on analysis of previous work in similar areas.

The following is the estimated schedule of obligations for the 3-year installation period.

Fiscal Year	Measures	Public Law 566 Funds (Dollars)	Other Funds (Dollars)	Total (Dollars)
First	Land Treatment	901	41,253	42,154
	Floodwater Retarding Structure No. 1	34,380	4,800	39,180
	Stream Channel Improvement Nos. I and IA	15,116	9,050	24,166
	Grade Stabilization Structure No. 101	16,701	600	17,301
	Subtotal	67,098	55,703	122,801
Second	Land Treatment	901	46,943	47,844
	Floodwater Retarding Structure No. 2	65,786	9,050	74,836
	Stream Channel Improvement No. II	40,907	13,020	53,927
	Subtotal	107,594	69,013	176,607
Third	Land Treatment	901	54,056	54,957
	Stream Channel Improvement Nos. III and IIIA	92,724	49,820	142,544
	Grade Stabilization Structure No. 102	21,532	600	22,132
	Dike	10,403	1,500	11,903
	Subtotal	125,560	105,976	231,536
TOTAL		300,252	230,692	530,944

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

EFFECTS OF WORKS OF IMPROVEMENT

Owners and operators of approximately 45 farm units and approximately 175 property owners in the city of Cuero will benefit directly from installation of structural measures. Benefit area will total about 1,522 acres which include 1,358 acres of agricultural land, 104 acres of urban land, and 60 acres of miscellaneous land.

Cumulative totals of estimated average annual recurrent flooding will be reduced from 1,635 acres, under without project conditions, to 311 acres after project installation. This will be an average annual reduction of 81 percent. Floodwater resulting from storms of 5-year frequency and larger will inundate considerable acreage in reach 3 after project installation; however, this flooding will be shallow in depth and of short duration.

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All major floods resulting from storms up to, and including the 100-year frequency, will be reduced to minor floods after project installation. Average annual direct flood damages in the agricultural area will be reduced about 81 percent. Average annual direct floodwater damages in the city of Cuero that are caused by overflow from Gohlke Creek will be reduced an estimated 95 percent.

The following tabulations show effects of proposed project on flood damages by evaluation reaches. All figures show average annual percent reductions.

Evaluation Reach Number (Figure 1)	Damage Reduction in Percent: Crop and Pasture	Other Agricultural	Non-Agricultural	Sediment	Flood Plain Erosion	Total
1	82	-	-	91	83	83
2 (Urban)	-	-	95	-	-	95
3	80	84	81	93	81	81
Total Watershed	80	84	94	93	82	88

Direct floodwater damages in the city of Cuero resulting from recurrence of flooding similar to the Gohlke Creek overflows of 1962 will be reduced to very minor damages. Damages caused by the 1960 and 1929 floods would have been reduced by an estimated 96 percent, if the planned project had been in place.

The following tabulations show effects of proposed project on major urban damages from Gohlke Creek overflows for selected flood frequencies.

Flood Frequency	Major Urban Damages in Dollars: Without Project	With Project	Reduction in Percent
100-year	100,000	9,100	91
50-year	90,000	6,300	93
25-year	78,500	3,025	96
10-year	22,200	1,000	96
5-year	12,500	0	100
2-year	2,050	0	100

Since the drainage area of the existing partially improved Gohlke Creek channel will be reduced when the flood prevention project is installed, it will be an adequate outlet for improved urban drainage measures. Improvement of the City drainage system will alleviate flood problems that are caused by accumulation of water originating in, or near, urban areas. These measures are to be planned and applied by the city of Cuero and DeWitt County Drainage District No. 1.

It is estimated that 386 acres of low producing rangeland will be restored to pasture after structural measures are installed. Reduced flooding will

enable operators to apply a program of proper management and fertilization which will improve production.

Application of land treatment will result in a reduction of approximately 94 acres of cropland in the watershed.

Land treatment measures are expected to reduce the average annual gross erosion from 45,000 tons to 39,000 tons, a reduction of 13 percent. Average annual flood plain scour damage on 20 acres is expected to be reduced about 82 percent. Nine percent will result from land treatment and 73 percent from structural measures.

After the project is installed, a 93 percent reduction in overbank deposition on 137 acres will be effected, with 13 percent resulting from land treatment and the remaining 80 percent from structural measures.

Wildlife habitat in the flood plain areas will be improved because of reductions in frequency, depth, and duration of flooding.

Secondary benefits will accrue in the local area. Increased net income of farm families resulting from reduced flood damages will help to stimulate economic activities. Improvements of urban property after the project is installed will increase needs for additional consumer goods and services. Some additional employment opportunities will become available for local residents.

PROJECT BENEFITS

Total average annual project benefits are estimated to be $22,080 which include $1,605 secondary. Damage reduction benefits will result from reduced floodwater damages to crops, pastures, other agricultural property, roads and bridges, and urban property; from reduced sediment and erosion damages; and from reduced indirect damages (table 5).

Average annual flood damages will be reduced from $23,133 to $2,658. This is a reduction of 89 percent which includes 8 percent that will result from application of land treatment measures.

Local secondary benefits will accrue to workers, processors, handlers, and suppliers of additional goods and services that will be needed as a result of the project. These are estimated to equal 10 percent of the direct damage reduction benefits. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluations.

The following tabulations show damage reduction benefits by evaluation reaches.

Average Annual Damages and Benefits (Dollars)

Evaluation: Reach Number (Figure 1):	Damages: Without Project	Damages: With Land Treatment	Damages: With Total Project	Benefits: From Land Treatment	Benefits: From Structural Measures	Benefits: Total
1	337	305	56	32	249	281
2 1/	12,240	11,230	600	1,010	10,630	11,640
3	10,556	9,697	2,002	859	7,695	8,554
Total Watershed	23,133	21,232	2,658	1,901	18,574	20,475

1/ Includes urban damages in Cuero that result from overflow of Gohlke Creek.

Other benefits, not evaluated in monetary terms, are increased sense of security of landowners and urban property owners in the flood plain, improved wildlife habitat, and a limited amount of recreational use such as fishing and swimming by local residents having access to pools of floodwater retarding structures.

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

DeWitt County has not been designated as an area eligible for assistance under the Area Redevelopment or Economic Development Acts. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

Average annual benefits, not including secondary benefits, resulting from installation of structural measures are estimated to be $18,574. Total average annual cost, including operation and maintenance, of structural measures is estimated to be $14,788. Benefits, without secondary, will be $1.26 compared to each dollar of cost.

Total average annual benefits, including secondary benefits, are estimated to be $20,179, giving a benefit-cost ratio of 1.4 to 1 (table 6).

PROJECT INSTALLATION

Farmers and ranchers will establish planned land treatment measures in cooperation with the DeWitt County Soil and Water Conservation District during a 3-year installation period. The governing body of the District will assume aggressive leadership in completing planned land treatment. Landowners and operators within the watershed will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches.

Approximately 35 percent of needed land treatment has been applied. The goal is to treat adequately at least 75 percent of the land during the installation period. In reaching this goal, it is expected that total acreage adequately treated will progresa at the rate indicated in the following table.

Land Use	Fiscal Year		
	1st	2nd	3rd
	(acres)	(acres)	(acres)
Cropland	1,024	1,147	1,270
Pasture	1,168	1,509	1,850
Rangeland	2,462	2,781	3,100
Total	4,654	5,437	6,220

The Soil Conservation Service will provide additional technical assistance to the district in accelerating the planning and application of soil, water, and plant conservation measures.

The Extension Service will aasist with the educational phase of the program by conducting general information and local farm meetings; preparing radio, television, and press releases; and uaing other methods of getting information to landowners and operators in the watershed.

The Commissioners Court of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero will:

1. Obtain necessary land, easements, rights-of-way, and permits for structural measures to be dedicated to DeWitt County, DeWitt County Drainage District No. 1, city of Cuero, and DeWitt County Soil and Water Conservation District;

2. Determine legal adequacy of easements and permits for construction of structural measures;

3. Provide for relocation or modification of utility lines and systems, roads, and privately owned improvements necessary for the installation of structural measures and provide for necessary improvement of low water crossings on public roads to make them passable during prolonged release flows from the structures or obtain permission to inundate such roads where equal alternate routes are designated for use during periods of inundation; and

4. Provide funds necessary for replacement of grade stabilization structures during the evaluated project life.

The Commissioners Court of DeWitt County will provide necessary legal, adminiatrative, and clerical personnel, facilities, supplies, and equipment

to advertise, award, and administer contracts and be the contracting agency to let and service contracts for structural measures.

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

Structural measures will be constructed during a three-year installation period in the general sequence as follows:

First Year - Floodwater Retarding Structure No. 1, Stream Channel Improvement Nos. I, and IA, and Grade Stabilization Structure No. 101

Second Year - Floodwater Retarding Structure No. 2, and Stream Channel Improvement No. II

Third Year - Stream Channel Improvement Nos. III and IIIA, Dike, and Grade Stabilization Structure No. 102

FINANCING PROJECT INSTALLATION

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

Funds for local share of costs for structural measures will be available from tax supported revenue of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero.

It is anticipated that approximately 70 percent of easements will be donated. Out-of-pocket costs for land, easements, rights-of-way, legal expenses, and administration of contracts is estimated to be $60,000.

Sponsoring local organizations do not plan to use loan provisions of the Act.

Soil and water conservation loan program of Farmers Home Administration is available to all eligible farmers in the watershed. Educational meetings will be held in cooperation with other agencies to outline services available and explain eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

County Agricultural Stabilization and Conservation Committee will continue to provide financial assistance for selected conservation practices.

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

1. Requirement for land treatment in drainage areas of floodwater retarding structures have been met.

2. All lands, easements, rights-of-way, and permits have been obtained for all structural measures or a written statement furnished by the Commissioners Court of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero that their right of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for purchasing them.

3. Court orders have been obtained from Commissioners Court of DeWitt County showing that the county roads affected by the sediment and detention pools of floodwater retarding structures will be either relocated or raised at no expense to the Federal Government, closed, or permission granted to temporarily inundate the roads provided equal alternate routes are available.

4. Provisions have been made for improving low water crossings or bridges and/or culverts on public roads or court orders or necessary permits given to temporarily inundate the crossings, providing equal alternate routes are available for use by all people concerned, during periods when these crossings are impassable due to prolonged flow from the floodwater retarding structures. If equal alternate routes are not available, provisions will be made at no cost to the Federal Government, to make the crossings passable during periods of release flow from structures.

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

6. The contracting agencies are prepared to discharge their responsibilities.

7. Project agreements have been executed.

8. Operation and maintenance agreements have been executed.

9. Public Law 566 funds are available.

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 maintained by landowners and operators on the farms and ranches on which the measures are applied under agreement with DeWitt County Soil and Water Conservation District. Representatives of the district will make periodic inspections of the land treatment measures to

determine maintenance needs and encourage landowners and operators to perform maintenance. District-owned equipment will be available for this purpose in accordance with existing working agreements.

Structural Measures

Structural measures will be operated and maintained by DeWitt County Soil and Water Conservation District, Commissioners Court of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero. Specific operation and maintenance agreements will be completed prior to execution of project agreement and the issuance of invitations to bid on construction of any of the structural works of improvement included in the work plan.

Average annual value of operation, maintenance, and replacement expenses are estimated to be $2,143. Included will be $500 for floodwater retarding structures, $1,600 for improved channels and dike, and $43 to replace the pipe drop structures one time during the evaluated project life.

Maintenance will be accomplished through the use of contributed labor and equipment, by contracts, by force account, or by a combination of these methods. Operation and maintenance expenses will be paid out of the General Funds of DeWitt County, DeWitt County Drainage District No. 1, and the city of Cuero. The funds are adequately supported by existing tax revenue.

Structural measures will be inspected jointly, at least annually and after each heavy stream flow, by representatives of the sponsoring local organizations. A Soil Conservation Service representative will participate in these inspections for a period of, at least, three years following construction.

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

For floodwater retarding structures items of inspection will include, but will not be limited to, condition of principal spillways, earth fills, emergency spillways, vegetative cover, fences, gates, and amount of vegetative growth in reservoirs. For improved channels items of inspection will include, but will not be limited to, degree of scour and sediment deposits, bank erosion, obstructions to flow, weeds and woody plant growth, and condition of grade stabilization structures. These items listed are those most likely to require maintenance.

Provisions will be made for unrestricted access of representatives of the sponsoring local organizations and the Federal Government to operate, inspect, and maintain the structural measures at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

North Cuero Watershed, Texas

Installation Cost Items	Unit	No. to be Applied Non-Federal Land 2/	Estimated Cost (Dollars) 1/ Public Law 566 Funds	Other Funds	Total
LAND TREATMENT					
Cropland	Acre	1,270	-	26,739	26,739
Pasture and Hayland	Acre	1,850	-	87,752	87,752
Rangeland	Acre	3,100	-	25,221	25,221
Technical Assistance			2,703	2,540	5,243
TOTAL LAND TREATMENT			2,703	142,252	144,955
STRUCTURAL MEASURES					
Floodwater Retarding Structures	No.	2	84,608	-	84,608
Stream Channel Improvement	Miles	7.1	116,712	-	116,712
Grade Stabilization Structures	No.	2	28,419	-	28,419
Dike	Feet	4,371	7,323	-	7,323
Subtotal - Construction			237,062	-	237,062
Installation Services					
Engineering Services			39,406	-	39,406
Other			21,081	-	21,081
Subtotal - Installation Services			60,487	-	60,487
Other Costs					
Land, Easements, and Rights-of-Way			-	84,940	84,940
Administration of Contracts			-	3,500	3,500
Subtotal - Other			-	88,440	88,440
TOTAL STRUCTURAL MEASURES			297,549	88,440	385,989
TOTAL PROJECT			300,252	230,692	530,944

1/ Price Bsse: 1966

2/ For land treatment: Acres to be treated during installation period.

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

North Cuero Watershed, Texas

Measures	Unit	Number Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	902	2,476
Cover and Green Manure Crops	Acre	301	16,510
Crop Residue Use	Acre	952	5,229
Grasses and Legumes in Rotation	Acre	105	7,200
Terraces	Feet	4,700	188
Contour Farming	Acre	85	85
Grassed Waterway or Outlet	Acre	6	720
Diversion	Feet	2,100	210
Pasture and Hayland Management	Acre	826	45,610
Pasture and Hayland Planting	Acre	115	2,875
Pasture and Hayland Renovation	Acre	192	3,840
Brush Control	Acre	1,044	11,448
Land Clearing	Acre	16	640
Farm Pond	No.	1	600
Drainage Field Ditch	Feet	5,481	269
Grade Stabilization Structures	No.	3	1,050
Range Proper Use	Acre	2,143	11,773
Range Deferred Grazing	Acre	976	2,693
TOTAL			113,416

1/ Price Base: 1966

July 1966

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Nottb Cuero Watershed, Texas

(Dollars) 1/

Structure Site Number or Name	Installation Cost - Public Law 566 Funds				Installation Cost - Other Funds			Total Installation Cost
		Installation Services		Total Public Law 566	Adm. of Contracts	Land Easements, and R/W 2/	Total Other	
	Construction	Engineering	Other					
Floodwater Retarding Structures								
1	29,040	2,904	2,436	34,380	500	4,300	4,800	39,180
2	55,568	5,557	4,661	65,786	500	8,550	9,050	74,836
Subtotal	84,608	8,461	7,097	100,166	1,000	12,850	13,850	114,016
Stream Channel Improvement								
I and IA	10,640	3,405	1,071	15,116	500	8,650	9,050	24,166
II	31,155	6,854	2,898	40,907	500	12,520	13,020	53,927
III and IIIA	74,917	11,238	6,569	92,724	500	49,320	49,820	142,544
Subtotal	116,712	21,497	10,538	148,747	1,500	70,390	71,890	220,637
Grade Stabilization Structures								
101	12,414	3,104	1,183	16,701	250	350	600	17,301
102	16,005	4,001	1,526	21,532	250	350	600	22,132
Subtotal	28,419	7,105	2,709	38,233	500	700	1,200	39,433
Pike	7,323	2,343	737	10,403	500	1,000	1,500	11,903
GRAND TOTAL	237,062	39,406	21,081	297,549	3,500	84,940	88,440	385,989

1/ Price Base: 1966

2/ Includes $3,500 for legal services

July 1966

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

North Cuero Watershed, Texas

Item	Unit	Structure Number 1	Structure Number 2	Total
Drainage Area	Sq.Mi.	0.49	1.41	1.90
Storage Capacity				
Sediment Pool (50-yr.)	Ac.Ft.	34	58	92
Sediment Reserve (100-yr. and Top of Riser) 1/	Ac.Ft.	24	40	64
Sediment in Detention Pool	Ac.Ft.	17	30	47
Floodwater Detention	Ac.Ft.	245	664	909
Total	Ac.Ft.	320	792	1,112
Surface Area				
Sediment Pool (50-yr.)	Acre	12	20	32
Sediment Reserve Pool (100-yr. and Top of Riser) 1/	Acre	18	27	45
Floodwater Detention Pool	Acre	52	101	153
Volume of Fill	Cu.Yd.	48,240	120,420	168,660
Elevation Top of Dam	Foot	246.0	233.8	xxx
Maximum Height of Dam	Foot	20	24	xxx
Emergency Spillway				
Crest Elevation	Foot	243.6	229.9	xxx
Bottom Width	Foot	100	100	xxx
Type	xxx	Veg.	Veg.	xxx
Percent Chance of Use 2/	xxx	1.0	1.0	xxx
Average Curve No. - Condition II	xxx	83	82	xxx
Emergency Spillway Hydrograph				
Storm Rainfall 2/	Inch	10.6	10.6	xxx
Storm Runoff	Inch	8.48	8.36	xxx
Velocity of Flow (V_c) 3/	Ft./Sec.	xxx	xxx	xxx
Discharge Rate 3/	C.F.S.	0	0	xxx
Maximum Water Surface Elevation 3/	Foot	xxx	xxx	xxx
Freeboard Hydrograph				
Storm Rainfall 2/	Inch	22.8	22.8	xxx
Storm Runoff	Inch	20.51	20.36	xxx
Velocity of Flow (V_c) 3/	Ft./Sec.	6.2	8.3	xxx
Discharge Rate 3/	C.F.S.	740	1,765	xxx
Maximum Water Surface Elevation 3/	Foot	246.0	233.8	xxx
Principal Spillway				
Capacity - Low Stage	C.F.S.	14	35	xxx
Capacity Equivalents				
Sediment Volume	Inch	2.87	1.70	xxx
Detention Volume	Inch	9.37	8.84	xxx
Spillway Storage	Inch	5.11	6.06	xxx
Class of Structure	xxx	B	B	xxx

1/ Riser to be set at 100-yr. sediment pool elevation to alleviate unsatisfactory impoundment of water.

2/ Computed in accordance to Section 4, Hydrology, Part 1 - Chapter 21 - Watershed Planning of the NEH, SCS.

3/ Maximum during passage of hydrograph.

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TABLE 3A - STRUCTURE DATA

STREAM CHANNEL IMPROVEMENT

North Cuero Watershed, Texas

Channel Designation	Station Numbering for Reach: Station (ft.)	Station (ft.)	Watershed Area 1/ (acres)	Required Channel Capacity (c.f.s.)	Design Channel Capacity (c.f.s.)	Bottom Width (ft.)	Side Slope	Design Depth (ft.)	Hydraulic Gradient (ft./ft.)	Velocity in Channel (ft./sec.)	Volume of Excavation (100 cu.yd.)
Channel I	0 + 00	6 + 00	375	251	260	7	2:1	4.0	.0042	4.33	3.3
	6 + 00	24 + 00	444	285	288	8	2:1	4.0	.0042	4.51	28.1
	24 + 00	36 + 00	631	351	351	11	2:1	4.0	.0042	4.60	57.5
	36 + 00	56 + 28	796	420	446	10	2:1	5.5	.0020	3.75	127.2
Channel IA	0 + 00	14 + 54	170	118	115	5	2:1	4.0	.0012	2.22	32.4
	14 + 54	20 + 00	129	94	115	5	2:1	4.0	.0012	2.22	19.3
	20 + 00	30 + 38	129	94	103	4	2:1	3.0	.0042	3.44	7.7
Channel 11	0 + 00	25 + 00	218	678	680	26	2:1	4.0	.0040	5.00	48.2
	25 + 00	35 + 00	329	714	801	17	3:1	4.0	.0075	6.30	146.2
	35 + 00	59 + 13	329	714	710	26	2:1	6.0	.0010	3.11	233.7
	59 + 13	87 + 46	1,363	2,048	2,020	32	2:1	8.0	.0020	5.30	295.9
	2/ 87 + 46	108 + 73	-	-	-	10	2:1	-	-	-	40.4
Channel 111	0 + 00	9 + 97	194	479	479	6	3:1	4.0	.0100	6.51	14.7
	9 + 97	29 + 39	313	650	660	9	2:1	5.0	.0080	6.96	58.0
	29 + 39	36 + 28	835	1,509	1,530	22	2:1	8.6	.0015	4.55	18.8
	36 + 28	90 + 72	1,231	1,643	1,649	30	2:1	11.2	.0004	2.81	575.8
	90 + 72	130 + 22	1,719	1,830	1,838	35	2:1	11.2	.0004	2.86	905.2
	130 + 22	158 + 31	1,719	1,830	2,280	8	2:1	11.2	.0030	4.72	333.5
Channel 11IA	0 + 00	19 + 45	266	110	117	6	2:1	4.0	.0010	2.09	77.8

1/ Does not include area controlled by floodwater retarding structures.

2/ This segment of the channel is designed to zero out the channel improvement.

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TABLE 3B - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

North Cuero Watershed, Texas

Site Number	Channel	Station (feet)	Drainage Area (acres) 1/	Drop (feet)	Concrete (cu.yds.)	Type Structure
101	I	56 + 28	796	7.0	95	Weir Type Drop Spillway
	Inlet protection structures (10 structures) 2/					
	II					
	Inlet protection structures (8 structures) 2/					
102	III	159 + 54	1,719	10.0	115	Weir Type Drop Spillway
	Inlet protection structures (31 structures) 2/					

1/ Does not include area controlled by floodwater retarding structures.

2/ To be designed at time of detail for construction and will be 24 inch diameter c.m.p. asphalt coated with an operating head of 0.5 to 3.0 feet or concrete pavsd inlets.

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TABLE 3C - STRUCTURE DATA

DIKE

North Cuero Watershed, Texas

Station Numbering for Reach		Top Width	Side Slopes	Average Height	Volume of Fill 1/
Station (feet)	Station (feet)	(feet)		(feet)	(cu.yds.)
31 + 00	38 + 02	12	3:1	4.9	2,668
38 + 02	58 + 05	12	3:1	6.7	15,019
58 + 05	74 + 71	12	3:1	5.0	8,941

1/ Fill will be semi-compacted.

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TABLE 4 - ANNUAL COST

North Cuero Watershed, Texas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Floodwater Retarding Structures Nos. 1 and 2, 7.1 miles of Stream Channel Improvement, Grade Stabilization Structures Nos. 101 and 102, and 4,371 feet of Dike	12,645	2,143	14,788
TOTAL	12,645	2,143	14,788

1/ Price Base: 1966 prices amortized for 100-years at 3.125 percent interest.

2/ Price Base: Long-term prices as projected by ARS, September 1957. Includes $43 replacement cost for grade stabilization structures that are to be replaced once during the 100-year period of project life.

July 1966

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

North Cuero Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	7,269	1,458	5,811
Other Agricultural	948	150	798
Nonagricultural			
Road and Bridge	1,092	204	888
Urban Property	10,200	500	9,700
Subtotal	19,509	2,312	17,197
Sediment			
Overbank Deposition	496	36	460
Erosion			
Flood Plain Scour	157	29	128
Indirect	2,971	281	2,690
TOTAL	23,133	2,658	20,475

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

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

North Cuero Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/			Average Annual Cost 2/	Benefit Cost Ratio
	Flood Prevention Damage Reduction	Secondary	Total		
Floodwater Retarding Structures Nos. 1 and 2, 7.1 miles of Stream Channel Improvement, Grade Stabilization Structures Nos. 101 and 102, and 4,371 feet of Dike	18,574	1,605	20,179	14,788	1.4:1
GRAND TOTAL 3/	18,574	1,605	20,179	14,788	1.4:1

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

2/ From Table 4.

3/ In addition, it is estimated that land treatment measures will provide $1,901 damage reduction benefits in the flood plain.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

Status of land treatment for the watershed was developed by the DeWitt County Soil and Water Conservation District assisted by personnel from the Soil Conservation Service at Cuero. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent conservation needs of the entire watershed. The quantity of each land treatment practice, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. Acres, by land use, to be treated during the 3-year project installation period were estimated (table 1). Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

Present hydrologic cover conditions were determined by detailed mapping of a 30 percent sample of the watershed.

Present hydrologic cover conditions for pasture and rangeland were determined on the basis of percentage of desirable vegetative ground cover and litter. Present hydrologic cover conditions on cropland were determined after consultation with local Soil Conservation Service personnel concerning crops grown and rotations followed.

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

Engineering Investigations

A study was made of the watershed to determine where structural measures could be used and, if by including them in the plan, project objective of flood prevention could be attained. Procedures used in making those determinations were as follows:

1. A base map was prepared to show watershed boundary, drainage pattern, system of roads and railroads, and other pertinent data.

   A study of aerial photographs and U. S. Geological Survey Quadrangle Maps supplemented by field examinations indicated locations of probable sites for floodwater retarding structures and stream channel improvement. By making a stereoscopic study of aerial photographs and quadrangle maps, supplemented by field examination, it was possible to eliminate those sites which did not have sufficient available storage capacity.

The watershed map, showing all possible site locations which might be used to develop a system of structural measures that would meet project objectives, was submitted to the sponsoring local organizations. The sponsors provided data on ownership of land apparently involved in each site and cost estimates on necessary easements.

2. Based on apparent physical, economic, and easement feasibility, the sponsoring local organizations and the Soil Conservation Service agreed that four possible site locations for floodwater retarding structures and approximately seven miles of stream channel improvement would be investigated. Out of these investigations, a system of 2 floodwater retarding structures and 7.1 miles of channel improvement was determined to be feasible.

3. Each site location was classified for limiting design criteria according to damage that would result from a sudden major breach of the embankment. All structures were classified as "b".

4. A topographic map of each site was developed to cover pools, dam and emergency spillway areas. These maps and related surveys provided necessary information to determine if required sediment and floodwater detention storage capacity could be obtained, limit of pool areas, estimated installation costs, and the most economical design for each structure.

5. Sediment and floodwater storage, structure classification, and principal and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441. Planned detention requirement for floodwater retarding structure sites is for a 100-year frequency event.

   Multiple routings of freeboard hydrographs were made to determine spillway proportion and height of dam which would result in the most economical and feasible design of structures. Plans of a floodwater retarding structure, typical of those planned for this watershed, are illustrated by figure 2.

   A detailed investigation was made of State, county, farm roads; and city streets having crossings of streams below floodwater retarding structures and within stream channel improvement reaches. Where there are no equal alternate routes, improvements required to provide passage during periods of prolonged floodwater release from the structures were determined.

   Structure data tables were developed to show for each structure the drainage area; capacity needed for floodwater

detention and sediment storage; release rate of the principal spillway; acres inundated by sediment, sediment reserve and detention pools; volume of fill in the dam; estimated costs of the structure; and other pertinent data (tables 2 and 3).

Channel improvement will consist of approximately 329,972 cubic yards of excavation. Planned also are 2 grade stabilization structures (project map-figure 6) and about 49 pipe drop type drop structures or formless concrete paved inlets. Grade stabilization structures Nos. 101 and 102 will be a weir type drop spillway designed to carry the 50-year and 100-year frequency storms respectively. The pipe drop structures and the formless concrete paved inlets are to be located in the field by the project engineer during construction.

All excavation to be encountered for the stream channel improvement will be dry. This excavation will be placed in such a manner as shown in figure 4.

The area required for right-of-way for construction of channel improvement will be based on a width to include the planned channel, spoil area, and 50 feet outside of any construction.

An area extending downstream from the outlet ends of improved channels I, II, and III will be designated and left undistrubed in native cover for erosion control.

When structural measures for flood prevention had been determined, a table was developed to show cost of the measures (table 2). The summation of total costs for all works of improvement 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, maintenance, and replacement costs of structural measures (table 4).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from U. S. Weather Bureau Climatological Bulletins for the rainfall gage at Cuero, Texas. These data were analyzed to determine seasonal distribution of precipitation, rainfall-runoff relationships, and frequency-discharge relationships. U. S. Weather Bureau Technical Paper No. 40 was used to determine selected frequency rainfall events.

2. Present hydrologic conditions of the watershed were determined on the basis of cover conditions, land use and treatment, soil groups, and crop distribution. Condition II curve number of 84 for the hydrologic soil-cover complex was determined from a 30 percent sample of the watershed.

   After-project conditions were determined by analyzing the results of land treatment that would be applied during the installation period. This study revealed that a condition II curve number of 83 is applicable.

3. Engineering surveys were made of valley cross-sections, high water marks, bridges, and other features pertinent in determining the extent of flooding. Cross-sections were selected to represent stream hydraulics and flood plain area.

   Their final location and evaluation reaches were delineated after joint study with the economist and geologist.

   Channel cross-sections, profiles, and pertinent channel data were surveyed where channel improvement is planned as shown on the project map (figure 6).

4. Cross-section rating curves for Gohlke Creek were developed from field survey data collected in 3, above, by Manning's formula.

5. Flooding in the agricultural area was based on a storm frequency-area inundated relationship.

   The urban area flooding was calculated by a stage-frequency relationship.

6. Determinations were made of the area that would have been inundated by storms of selected frequencies under each of the following conditions:

   a. Without project condition using present soil-cover complex number.

   b. Installation of land treatment measures for watershed protection.

   c. Installation of land treatment measures and structural measures.

7. Selected frequency rainfall events for evaluation are the annual exceedance, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year frequency, 24-hour rainfall.

8. The 100-year detention requirement, for floodwater retarding structures, was based on Engineering-Hydrology Memorandum TX-2, 1965.

9. Stream channel improvement design peak discharges are based on procedures outlined in TEH-Section 4 - Hydrology-Section 4. Channels I, IA, and IIIA are designed to contain runoff from a 2-year frequency event. Channels II and III are designed to contain runoff from a 100-year frequency event.

   The dike will be built with its top 2 feet above the hydraulic gradient.

10. Appropriate emergency spillway and freeboard design storm was selected in accordance with criteria contained in NEH, Chapter 21, Section 4, Hydrology, Part I - Watershed Planning.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures as outlined in the following: "Guide to Sedimentation Investigations, South Regional Technical Service Area", March 1965, Fort Worth, Texas; Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1961; Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs", September 1959; and Technical Release No. 25, "Planning and Design of Open Channels", December 1964.

Sediment Source Studies

Detailed sediment source studies and computations to determine the 100-year sediment storage requirements were made in drainage areas of the two planned floodwater retarding structures according to the following procedures:

1. Maps were made of the two drainage areas showing soil units, percent slope, length of slope, land use, cover condition classes on rangeland and pasture, land treatment on cultivated land, and land capability classes.

2. Lengths, widths, and depths of channels were measured and old aerial photographs were studied to estimate rates of lateral erosion of gullies and streambanks.

3. Average annual gross erosion was computed by sources (sheet, gully, and streambank). The soil loss equation by Musgrave was used in sheet erosion computation.

   Estimates of annual gross erosion reflect the effect of expected land treatment on drainage areas of planned structures. A gradual improvement of watershed conditions is expected as a result of the installation of planned land treatment measures.

4. Sediment storage requirements for planned structures were determined by adjusting average annual total erosion for expected sediment delivery ratios and trap efficiency. The ratio of sediment volume submerged in pools to soil in place was based on volume weights of 76 pounds per cubic foot for submerged sediment and 108 pounds per cubic foot for soil in place. These weights are unusually high because of the high percentage of sand and gravel in soils of drainage areas of structures. Submerged sediment is expected to be partially aerated because of the prevalence of shallow water depths in sediment pools.

5. Allocation of sediment to pools of floodwater retarding structures was based on 70 percent deposition in sediment pools and 30 percent in detention pools.

Flood Plain Sediment and Scour Damages

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

1. Because of the poorly defined flood plain, small area involved, and isolated nature of sediment deposits, a field examination was made of the entire flood plain. Factors such as depth and texture of sediment deposits, soil condition, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded.

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

3. A damage table was developed to show percent damage (decreased productive capacity) by texture and depth increment for sediment and by depth and width for scour.

   Due consideration was given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages.

4. Areas of modern alluvial deposits and flood plain scour were measured and tabulated by damage categories.

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

6. The average annual sediment yield from each source (sheet erosion, gully erosion, streambank erosion, and flood plain scour) was estimated from detailed sediment source studies

of a 30 percent sample of the watershed and scour damage investigations. Sediment yields to evaluation reaches were computed for without-project conditions, with land treatment measures applied, and with the combined program of land treatment and structural measures installed.

Reduction in sediment yield was adjusted to reflect the relative importance of each sediment source as a contributor of damage. Reduction of monetary damage from overbank deposition was based on reduction of area inundated by floodwater and reduction of damaging sediment yield.

7. Estimates of reduction of scour damage due to installation of the project were based on reduction of depth and area inundated by floodwater.

Channel Stability Studies

Channel stability studies were made for the 7.1 miles of planned stream channel improvement. Hand auger borings and observations of natural exposures were made at selected locations to study the nature of soil materials. Soils involved are primarily within the weathered zone of the Lagarto formation and consist of compact, sandy clays, classified as CL in accordance with the Unified Soil Classification System. At greater depths of channel excavation, less weathered, more dense, and partially cemented clays of the formation will be encountered.

Bedload movement is of little significance where channel improvement is planned. Sandy and gravelly bedload originates in the rolling upper river terrace, but is transported only a short distance onto the nearly level lower river terrace where stream channels become poorly defined to almost nonexistent. Most bedload movement is terminated by deposition as alluvial fans and flood plain splays in the zone of transition from the rolling upper terrace to the lower nearly level terrace.

Based on estimated plasticity indices of soils involved and correction factors for design depth of flow, channel alignment, and frequency of design flow, the allowable design velocity would be approximately five feet per second for channel segment I and eight feet per second for segments II and III. Actual design velocities range from 2.22 to 4.60 feet per second for segment I and from 2.09 to 6.96 feet per second for segments II and III.

Geologic Investigations

Preliminary geologic investigations were made at each of the floodwater retarding structure sites to obtain information on the nature and extent of embankment and foundation materials, emergency spillway excavation, emergency spillway stability, and possible problems that might be encountered during construction. These investigations included surface observations of valley slopes, alluvium, channel banks, and exposed geologic formations, and hand auger borings. Geologic maps and reports concerned with the watershed vicinity were studied.

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

Description of Problems

Both floodwater retarding structure sites are located on the outcrop of the Lagarto formation of upper Miocene age. The formation consists of massive, jointed, calcareous, sandy clay. For the most part, the clay is stiff to very stiff and compact. Thin lenses of sand, somewhat consolidated and partially cemented, are common.

Foundations at both floodwater retarding structure sites consist primarily of shallow surface horizons of alluvial sandy clays and silty sands underlain by compact clays of the Lagarto formation. Exceptions to this are a buried stream channel filled with gravelly sand at Site No. 1 and a right abutment of very gravelly soil at Site No. 2.

Most emergency spillway excavation will be in stiff sandy clay soil. No blasting will be necessary. These soils are moderately resistant to erosion when exposed.

Ample materials suitable for embankments are available within short hauling distances. Alluvial soils within sediment pool areas are sandy clays, silty sands, and clayey sands. These are underlain by several feet of somewhat weathered clays of the Lagarto formation. Soils to be excavated from emergency spillway areas are also suitable for embankment use. As classified in accordance with the Unified Soil Classification System, available soils are primarily CL with lesser amounts of SM and SC.

Further Investigations

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

Economic Investigations

Selection of Evaluation Reaches

In order to determine flood damages and to determine effects of proposed structural measures, the flood plain was divided into three evaluation reaches (figure 1). Selection of areas to be included in each reach was based on frequency and extent of flooding, property values, both agricultural and nonagricultural, and depth of flooding.

Determination of Damages

Damage schedules were obtained from flood plain landowners, property owners in Cuero, county road officials, Cuero city officials, local agricultural technicians, and others having knowledge of the watershed. Approximately 30 damage schedules were obtained covering more than half the flood plain.

Information collected was used to determine crop distribution, flood free yields, production costs, trends, expected changes in the agricultural economy, past history of flooding and related damages, and other data needed to make economic evaluations. Flood plain land use and damageable values were determined. Other agricultural and nonagricultural damages, including urban damages were related to a particular size and frequency flood. Urban damage estimates from all floods up to, and including, the 100-year frequency were based on stage-frequency and stage-damage estimates for these flood events as related to the actual size and frequency of two or more past floods. Urban property values were based on estimated condition of improvements that would exist in the area without a flood threat.

A synthetic flood series for a 1-, 2-, 5-, 10-, 25-, 50-, and 100-year frequency flood was used to calculate average annual damages by using the "frequency method". Crop and pasture damages were related to depth of inundation and to growing seasons. Allowances were made to reflect less damages from recurrent flooding during the same cropping season.

Crop and pasture damage rates by depths of flooding were based on information given in Soil Conservation Economics Memorandum TX-11 and were adjusted for local watershed conditions.

Flood plain areas that will be used for project construction were excluded from areas on which damages were calculated.

Monetary value of physical damage to flood plain land from deposition of sediment and erosion was based on value of production lost. Allowances were made for time lag necessary for recovery in production. Reduction in damages from sediment deposition was based on effectiveness of land treatment, trap efficiency of planned structural measures, and average annual area flooded.

Indirect damages involved such items as interruption of travel, re-routing and delays of school buses and mail deliveries, and evacuation of flooded areas. Losses in business by business establishments and lost time of business employees during periods of flooding were considered to be indirect damages. It was determined that 10 percent of the direct floodwater damages in the agricultural area and 20 percent in the urban area would be an equitable estimate for indirect damages.

Benefits from Reduction of Damages

Floodwater, sediment, and scour damages were calculated to determine average annual damages under without project conditions, with land treatment applied, and with total project installed, including floodwater retarding structures and stream channel improvement. The difference between each progressive increment of protection constitutes damage reduction benefits assigned to each increment. It was estimated that land treatment measures will reduce floodwater damages by eight percent.

Benefits from Restoration of Former Productivity

During field investigations, farmers were asked what changes had been made in use of flood plain land as a result of past flooding. Farmers were also

asked what changes they would make in use of land if flooding were reduced by more than 50 percent.

It was found that, as a result of past flooding, some pasture land has been allowed to grow up in low quality range grasses and scattered brush.

Farmers indicated that when flooding is reduced some of this land would be restored to pasture and a program of mowing and fertilizing initiated to improve prodnction.

Statements of landowners were considered along with land capabilities and general agricultural economic conditions and trends in making estimates of benefits from restoration. Consideration was given for added damage from remaining flooding to higher damageable values. Additional costs of production and associated costs were deducted from expected increased value of production. Prices were based on long-term levels. Benefits were discounted to allow for a five-year lag in accrual. Restoration benefits have been included as crop and pasture benefits in table 5.

Appraisal of Land and Easement Values

Areas that will be used for project construction and area to be inundated by pools of reservoirs were determined. Net income from production to be lost in these areas after installation of the project was compared with appraised value of the land amortized over the period of project life. It was considered there would be no production in sediment pools or in the excavated area of improved channels and that all land involved in detention pools, dams and spillways, and spoil bank areas along the improved channels would be grassland. The value of land and easements for structural measures were determined by appraisal in cooperation with representatives of the sponsoring local organizations. Structure site costs were based on the value of easements.

Annual net loss in production and associated secondary losses, based on long-term prices, on land to be utilized by structural measures were calculated and compared with the amortized cost of sites.

Site costs exceeds value of annual loss in production and associated secondary losses; therefore, site costs were used in economic evaluations.

Secondary Benefits

Values of local secondary benefits and local secondary losses were calculated in accordance with interim procedures outlined in Watershed Memorandum SCS-57, dated October 3, 1962.

Benefits of a local nature stemming from the project were estimated to be 10 percent of direct damage reduction benefits accruing to structural measures.

Fish and Wildlife Investigations

The following is reproduced from the reconnaissance survey report for the North Cuero watershed, prepared by the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, U. S. Department of Interior:

> "The Guadalupe River is the only permanent fishing water in the watershed. The principal species of fish in the Guadalupe are channel catfish, blue catfish, flathead catfish, Texas spotted bass, longear sunfish, largemouth bass, gizzard shad, smallmouth buffalo, and gar. Where access is available, fishing on the Guadalupe River is heavy. This situation is expected to prevail in the future without the project.
>
> "There is no commercial fishing in the watershed and none is expected without the project.
>
> "Construction and operation of the floodwater retarding reservoirs would supplement fishing in the Guadalupe River by providing additional fishing in the sediment pools of the proposed structures.
>
> "Wildlife species of significance in the watershed are white-tailed deer, mourning dove, bobwhite, fox squirrel, cottontail, jackrabbit, swamp rabbit, raccoon, and opossum.
>
> "Deer populations in the watershed are moderate. Hunting for deer, which is done equally by landowners, their guests, and hunters leasing hunting rights, is light.
>
> "Bobwhite and mourning-dove populations are significant but hunting for these birds is moderate. Bobwhite and dove hunting is done primarily by landowners and their guests.
>
> "Hunting for other species of wildlife is insignificant. The above conditions would be expected to prevail in the watershed with no significant change in the future.
>
> "The application of land treatment measures generally would improve wildlife habitat. The stirring of the soil would stimulate weed production which would be beneficial to doves, bobwhites, and other seed-eating birds. Brush control, clearing for the floodwater retarding structures and reservoirs, and channel improvement would destroy needed wildlife food and cover plants. Retention of water in the sediment pools of the floodwater retarding structures could provide resting habitat for migrating waterfowl hunting.
>
> "Often, during the construction phase of a project of this type, a few minor changes in design and construction procedures could greatly reduce the destruction of, and possibly improve fish and wildlife habitat.

"To promote fertility and reduce turbidity, the basins of the floodwater retarding structures should be disked and planted to suitable grains adaptable to the area after completion and before impoundment of water.

"Floodwater retarding structures should be fenced, when practicable, to prevent damage to the dams and muddying of the water by livestock. A watering device, if required, should be installed below the dams and outside of the enclosures. These measures would not only improve the quality of the fish habitat but also would provide more desirable water and watering conditions for livestock.

"Lands in the vicinity of floodwater retarding structures which are devoid of vegetation should be planted to native grasses to prevent soil erosion and deposition of sediment in the basins of these impoundments.

"Stocking of fish in floodwater retarding reservoirs should be done only under the guidance of the Texas Parks and Wildlife Department. Unwise stocking of fish can result in the presence of undesirable species and high populations of stunted fish.

"During the construction phase of the project, timber and brush clearing should be kept to an absolute minimum. Minimal clearing would result in reduced construction costs and at the same time much of the original wildlife habitat of the area would be retained.

"Further improvement of wildlife habitat could be achieved by planting wildlife food and cover plants on eroded areas, gullies, impoundment enclosures, along fence rows and driveways. Such plantings would provide food and cover for wildlife and additionally serve as windbreaks, prevent erosion, and beautify the landscape.

"To ameliorate some of the expected damage to fish and wildlife resources and to provide additional benefits, it is recommended:

1. That the basins of the floodwater retarding structures be disked and planted to a suitable grain upon completion and prior to storage of water.

2. That floodwater retarding structures be fenced when practicable and a livestock watering device be installed below the dams and outside of the enclosures.

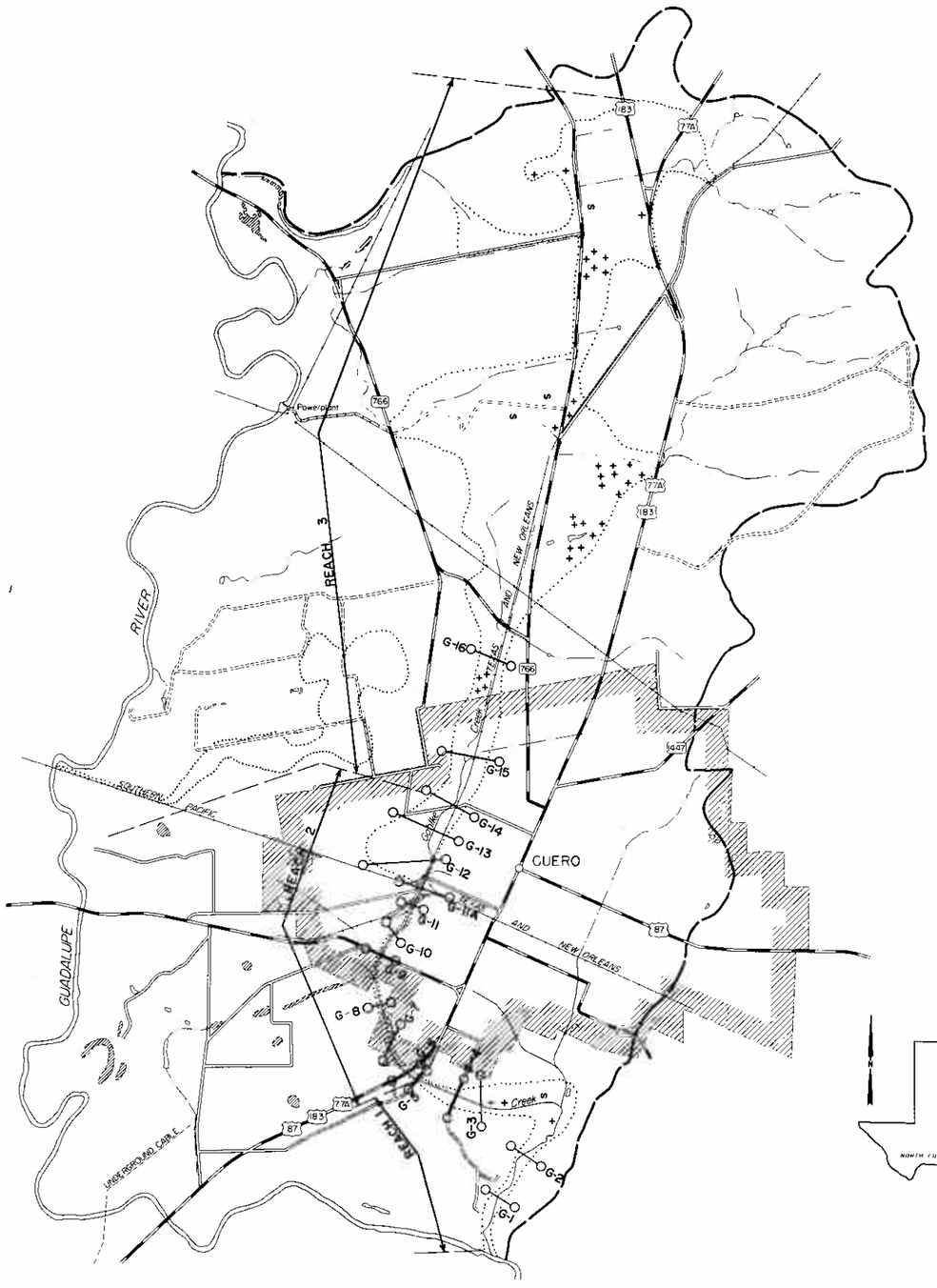
3. That lands in the vicinity of floodwater retarding structures devoid of vegetation be planted to native grasses to prevent soil erosion and deposition of sediment in the basins of these impoundments.

4. That stocking of fish in the floodwater retarding structures be done under the guidance of the Texas Parks and Wildlife Department.

5. That clearing of brush and timber be kept to s minimum throughout the construction of the project.

6. That eroded areas, gullies, steep banks, impoundment enclosures, strips along fence rows, and driveways be planted with plants of value to wildlife for food and cover and which also will prevent soil erosion, provide windbreaks, and beautify the landscape.

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



LEGEND

- PAVED ROAD
- GRAVEL ROAD
- DIRT ROAD
- PRIVATE ROAD
- RAILROAD
- POWER LINE
- CITY LIMIT BOUNDARY
- DRAINAGE
- WATERSHED BOUNDARY
- OUTLINE OF FLOODWATER AND SEDIMENT DAMAGE AREA
- 6 VALLEY CROSS SECTION
- +++++++ SEDIMENT DAMAGE
- SSSSSSS SCOUR DAMAGE
- EVALUATION REACH

Figure 1

PROBLEM LOCATION MAP
NORTH CUERO WATERSHED
DE WITT COUNTY TEXAS

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

Approximate Scale

7-66 4-R-22,063

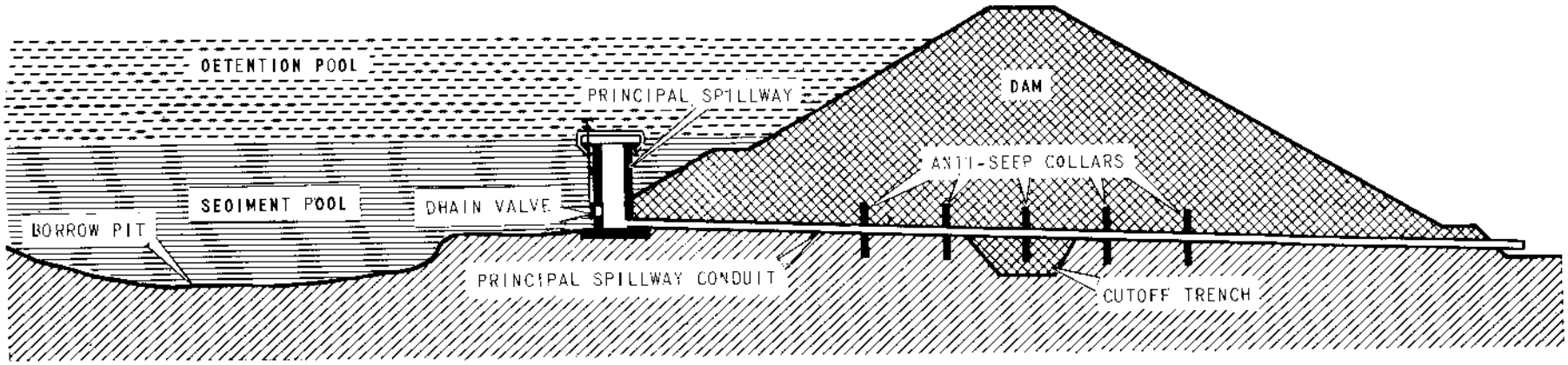
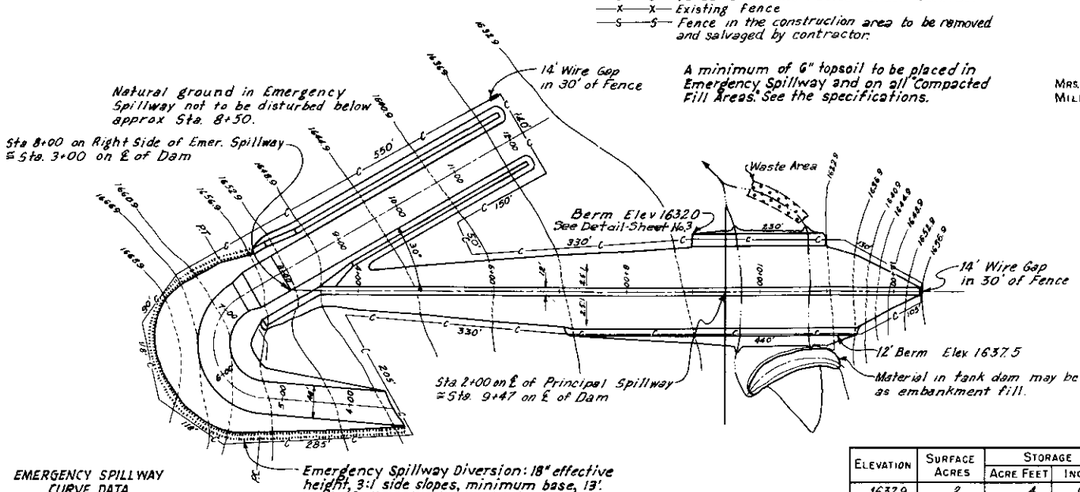


Figure 2

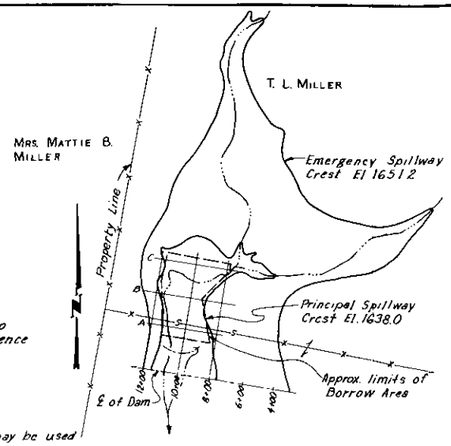
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

FENCE LEGEND
—C—C— Fence to be constructed under contract
—X—X— Existing Fence
—S—S— Fence in the construction area to be removed and salvaged by contractor.

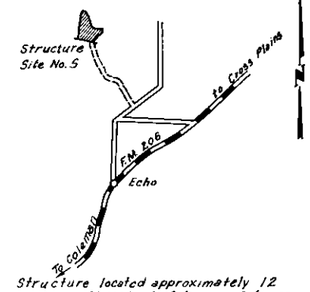


EMERGENCY SPILLWAY CURVE DATA
Δ = 144°00'
D = 71°37'
R = 80.35'
L = 201.0'
P.C. = Sta. 5+29
P.T. = Sta. 7+30

PLAN OF EMBANKMENT AND SPILLWAYS
0 100 200 300 400 500
SCALE IN FEET



GENERAL PLAN OF RESERVOIR
0 400 800 1200 1600
SCALE IN FEET

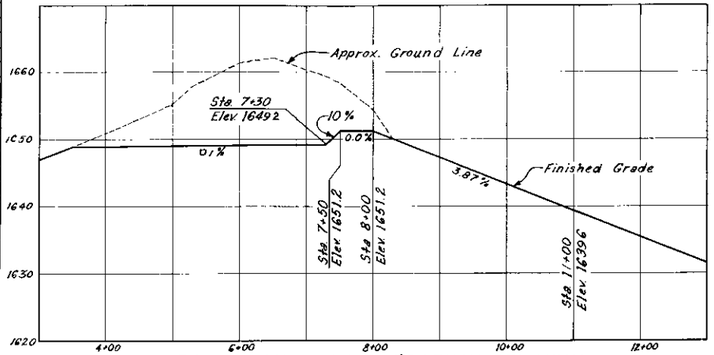


Structure located approximately 12 miles northeast of Coleman, Coleman County, Texas

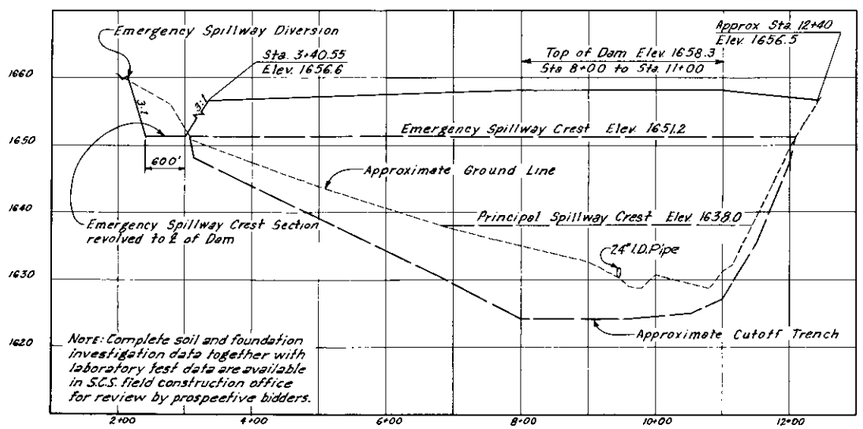
VICINITY MAP
0 1 2 3 4
SCALE IN MILES

Elevation	Surface Acres	Storage	
		Acre Feet	Inches
1632.9	2	4	0.05
1636.9	6	20	0.27
1638.0	8	28	0.37
1640.9	14	60	0.80
1644.9	20	128	1.70
1648.9	29	226	3.00
1651.2	36.4	301	3.99
1652.9	42	368	4.88
1656.9	53	558	7.40
1660.9	64	792	10.51

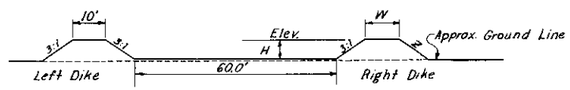
Top of Dam (Effective) Elev.	1656.5
Emergency Spillway Crest Elev.	1651.2
Principal Spillway Crest Elev.	1638.0
Sediment Pool Elev.	1638.0
Drainage Area, Acres	904
Sediment Storage, Acre Feet	32
Floodwater Storage, Acre Feet	269
Max. Emergency Spillway Cap., c.f.s.	1830



PROFILE ON ℄ OF EMERGENCY SPILLWAY



PROFILE ON ℄ OF DAM



Left Dike:
Approx. Sta. 7+75 to Sta. 8+00 Elev. 1656.6 From Sta. 8+00 to Sta. 8+50, grade uniformly to H=30.' From Sta. 8+50 to 12+00, H=3.0.'

Right Dike:
Approx. Sta. 7+40 to Embankment Elev. 1656.6, W=140', Z=2.5:1. From Embankment to Sta. 9+00 Transition Section. Sta. 9+00 to Sta. 12+00 H=3.0', W=100', Z=3:1.

Note:
Material forming both dikes to be placed and paid for as "Compacted Fill."
Natural ground in Emergency Spillway not to be disturbed below approx Sta 8+50

TYPICAL SECTION — EMERGENCY SPILLWAY

Figure 3

TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	W.E.C.	3-61	Approved by: Chief, Engineering Division, Fort Worth, Texas
Drawn	W.E.C. & H.R.T.	3-61	State Conservation Engineer, Temple, Texas
Traced	H.R.T.	3-61	Sheet No. 2 of 8 sheets
Checked	W.E.C. & G.W.T.	4-61	Drawing No. 4-E-15,357

USDA-SCS-FORT WORTH, TEX. 1965

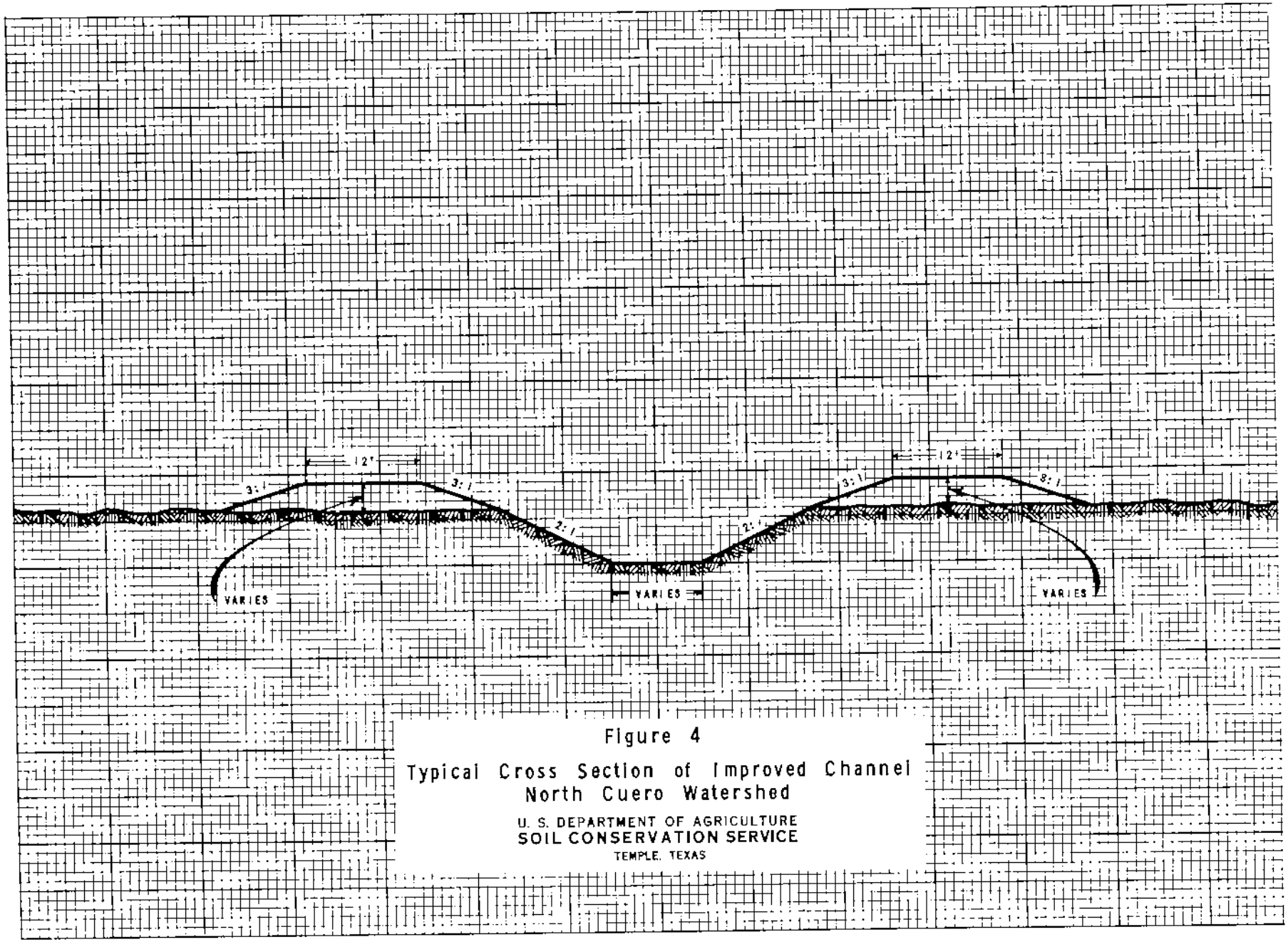
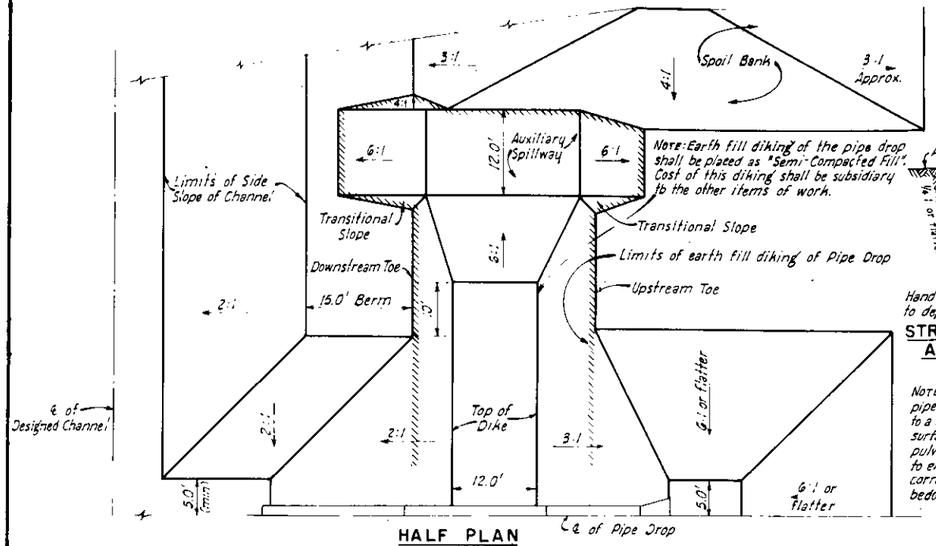


Figure 4

Typical Cross Section of Improved Channel
North Cuero Watershed

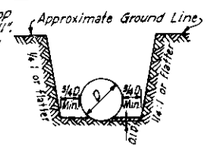
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

10-66



HALF PLAN

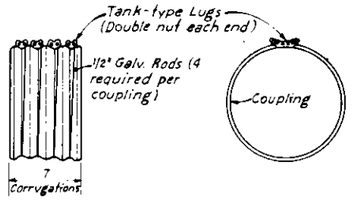
Note: Earth fill diking of the pipe drop shall be placed as "Semi-Compacted Fill". Cost of this diking shall be subsidiary to the other items of work.



Hand shape pipe bedding to depth of 0.1 D

STRUCTURE EXCAVATION AND PIPE BEDDING

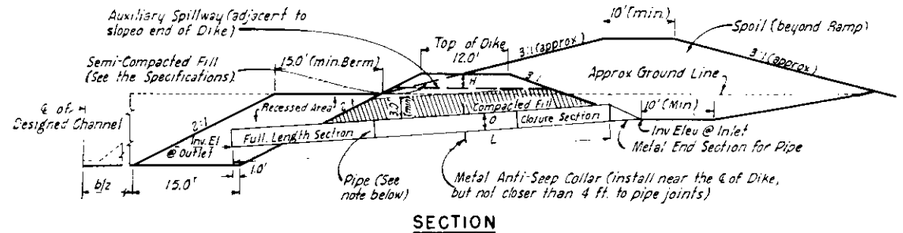
Note: The surface of the hand-shaped pipe bedding shall be loose material to a depth of approx 1 inch; the surface shall be moist and well pulverized, prepared in a manner to embed and fill in the pipe corrugations upon placing and bedding the pipe.



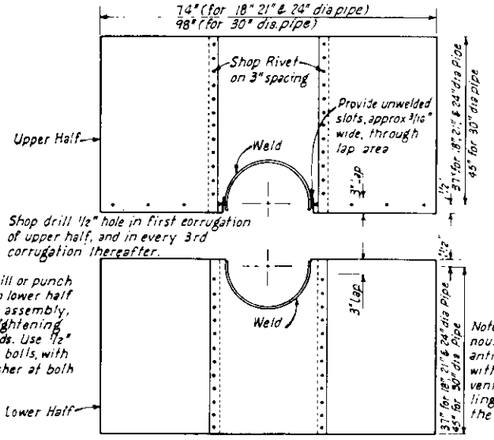
Note: Soften bituminous coating under pipe coupling bands with petroleum solvent, prior to installing and tightening the bands.

PIPE COUPLINGS

(For all corrugated pipe connections other than metal end section connection)



SECTION



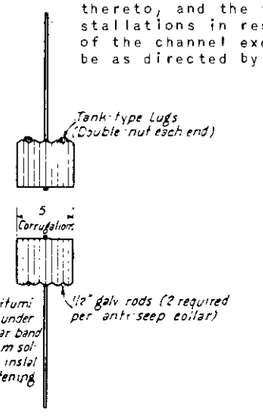
NOTE: Permissible alternate to shop riveting shown above, shall provide for spot welds one inch long, spaced every 6", with alternate and staggered spot welds of like length on the opposite face of the joined pieces. All rivets or welds shall clear the 3" lap area of the upper and lower halves of the anti-seep collar.

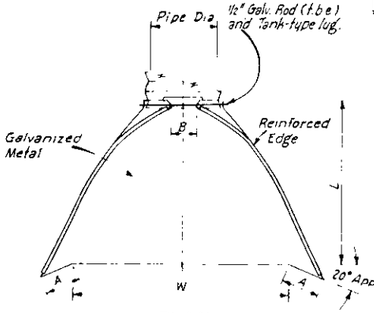
Anti-seep collar shall be 14-ga. galv. corrugated sheet metal fabricated to galv. corrugated pipe band of the same gage as the pipe, with bituminous coating after fabrication.

Install with corrugations vertical. The lap area of the lower half shall be over, and in front of, the lap area of the upper half, for the orientation shown in the drawing above. Use asphaltic mastic to seal any openings showing in the installation after the joining of the two halves of the anti-seep collar.

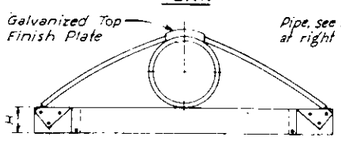
ANTI-SEEP COLLAR

The locations of the pipe drop and formless concrete paved inlet structures are not shown on the project map. Final locations of these structures will be established in the field by the Engineer during detail surveys for construction. The installation sequence of the pipe drops and concrete paved inlets and the excavations or related work thereto, and the timing of such installations in respect to the progress of the channel excavation work, shall be as directed by the Engineer.

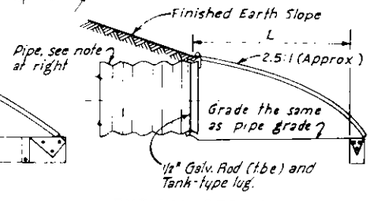




PLAN



ELEVATION



TYPICAL SECTION

DETAILS OF METAL END SECTION

PIPE DROP DETAIL

NOTE: Pipe closure or terminal sections to be installed at upper end of pipe drops; full-length pipe section to be used at outlet end.

DIMENSIONS OF METAL END SECTIONS						
Pipe Dia, in.	A, in.	B, in.	H, in.	L, in.	W, in.	Metal Gage
18	7	9	6	31	36	16
21	8 1/4	11	6	36	42	16
24	9 1/2	12	6	42	48	14
30	12	15	7 1/2	52 1/2	60	14

Note: Type I, Class 2, 16 ga (except 30" dia. pipe, which shall be 14 ga.) galv. corrugated, bituminous coated sheet metal pipe with special watertight band couplers. (Pay method #4 of Spec 12-58.)

NOTE:
Cost of Excavation and Backfill required for installing the pipe drop inlets shall be included in the unit price bid for furnishing and installing the corrugated metal pipe. Backfill shall be placed as follows:

(1) "Compacted Fill" shall extend to the vertical limits shown on the drawings and laterally to the limits of the structure excavation and shall be placed in layers not exceeding 6 in. before compaction. Compaction shall be accomplished by manually directed power tampers or plate vibrators, fully covering each layer of backfill. Moisture content of the backfill material shall be adjusted as directed by the Engineer.

(2) Earth Fill Diking shall extend vertically from the top of the "Compacted Fill" to the limits shown on the drawings and shall be placed as "Semi-Compacted Fill". See the specifications for requirements of "Semi-Compacted Fill".

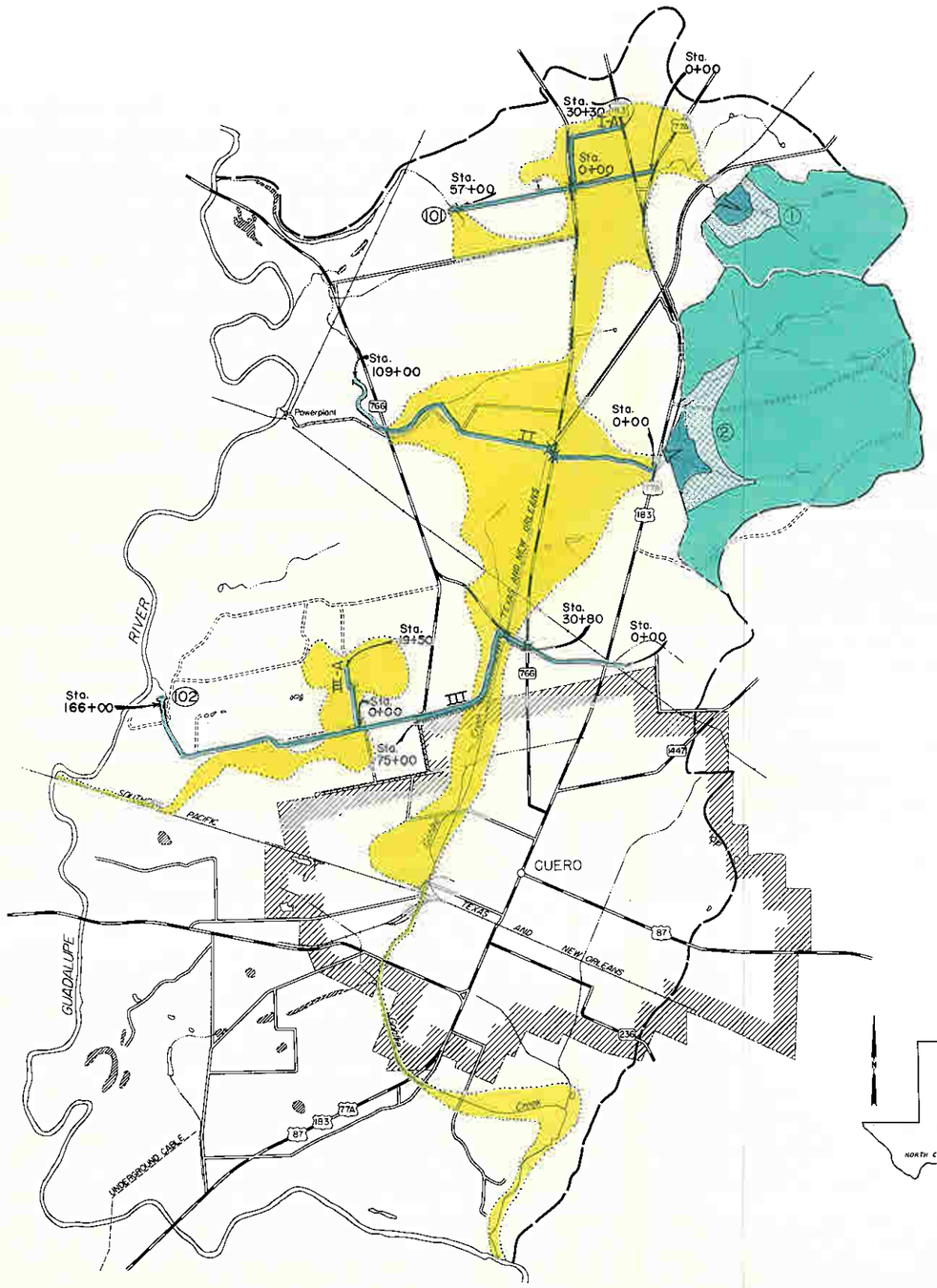
Figure 5

TYPICAL PIPE DROP SIDE INLET DETAILS
CHANNEL IMPROVEMENT
NORTH CUERO WATERSHED
IN
DEWITT COUNTY, TEXAS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	H.H.K.	9-64	Approved by: Acting
Drawn	H.H.K.	9-64	HEAD ENGINEERING & PLANNING PLANS SECTION, FORT WORTH, TEXAS
Traced	A.H.J.	11-64	STATE CONSERVATIONIST, TEMPLE, TEXAS
Checked	H.H.K. &	11-64	Sheet No. 13 of 14 sheets; Drawing No. 4-E-19,434

USDA-SCS-FORT WORTH, TEX. 1966



LEGEND

- PAVED ROAD
- GRAVEL ROAD
- DIRT ROAD
- PRIVATE ROAD
- RAILROAD
- POWER LINE
- CITY LIMIT BOUNDARY
- DRAINAGE
- WATERSHED BOUNDARY
- STREAM CHANNEL IMPROVEMENT FOR FLOOD PREVENTION
- DIKE
- BRIDGES TO BE CONSTRUCTED
- (101) GRADE STABILIZATION STRUCTURE
- DRAINAGE AREA CONTROL BY STRUCTURE
- AREA BENEFITED
- FLOODWATER RETARDING STRUCTURE

Site No.	Drainage Area-Ac.
1	314
2	902

Figure 6

PROJECT MAP
NORTH CUERO WATERSHED
DE WITT COUNTY TEXAS

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

0 1/2 1 Mile
Approximate Scale

Rev. 1 7-66 4-R-22,062