COMPREHENSIVE STUDY AND PLAN OF DEVELOPMENT LOWER RIO GRANDE BASIN, TEXAS

By
THE UNITED STATES DEPARTMENT OF AGRICULTURE
In Cooperation With
THE TEXAS WATER DEVELOPMENT BOARD
THE TEXAS STATE SOIL AND WATER CONSERVATION BOARD
and
THE TEXAS WATER RIGHTS COMMISSION
July 1969

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COMPREHENSIVE STUDY AND PLAN OF DEVELOPMENT

LOWER RIO GRANDE BASIN, TEXAS

MAIN REPORT

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, Post Office Box 648, Temple, Texas 76501

SUBJECT: Report on Comprehensive Study and Plan of Development - Lower Rio Grande Basin, Texas

DATE: July, 1969

TO: Administrator
Soil Conservation Service
Washington, D. C. 20250

Transmittal

This report is transmitted as the basis for securing congressional authorization of the potential Lower Rio Grande Basin Project, Texas.

The investigations were carried out and the report was prepared under the authority of Section 6 of Public Law 83-566 in cooperation with the Texas Water Development Board, the Texas Water Rights Commission, and the Texas State Soil and Water Conservation Board.

Summary

The United States Department of Agriculture was requested by and cooperated with the Texas Water Development Board, the Texas Water Rights Commission, and the Texas State Soil and Water Conservation Board in a comprehensive study of the water and related land resources of the Lower Rio Grande Basin. The request was supported by the Willacy-Hidalgo and Southmost Soil and Water Conservation Districts, and the Commissioners Courts of Cameron, Hidalgo, and Willacy Counties. The study, made under the authority of Section 6, Public Law 83-566, as amended, was requested because existing measures for flood protection and surface and subsurface drainage are inadequate.

The study was conducted under the guidance of a steering committee composed of representatives of USDA and the three State agencies. The committee was chaired by the Soil Conservation Service. The USDA conducted its investigations under the direction of a field advisory committee composed of the Economic Research Service, the Forest Service, and the Soil Conservation Service as the chair agency. Other Federal and State agencies which contributed to the study were the International Boundary and Water Commission, Bureau of Sport Fisheries and Wildlife, Bureau of Reclamation, Farmers Home Administration, Agricultural Stabilization and Conservation Service, Corps of Engineers, Agricultural Research Service, Extension Service, Texas Parks and Wildlife Department, Texas State Department of Health, Texas Highway Department, Texas A&M University, and Texas Water Quality Board. Close contact was maintained with, and special assistance was obtained from, water districts, commissioners courts, other local governmental entities, private firms, and individuals. In making the study, consideration was given to all known previous studies, existing measures, and to the desires and objectives of local interests.

The Lower Rio Grande Basin comprises the entire area of Cameron, Hidalgo, and Willacy Counties in the southern tip of Texas. This represents a three-county portion of the area constituting Zone 3 of the Nueces-Rio Grande Coastal Basin as designated by the State of Texas. The total area is 2,209,300 acres. Normally, this consists of 1,038,000 acres of cropland, 694,600 acres of grassland, 270,300 acres of large water areas, and 206,400 acres of land in miscellaneous use. Normally, about 689,800 acres of cropland and 60,200 acres of pasture are irrigated.

Population in 1960 was 352,000, of which 28,500 were classed as rural farm residents. Total population is projected to increase to 486,600 in 1980, 642,700 in 2000, and 848,900 in 2020. Rural farm population is projected to follow recent trends and decrease to 15,800 in 1980, 11,800 in 2000, and 10,700 in 2020.

Agricultural production from crop and grazing land with a normal gross value in excess of $100 million annually is the primary economic activity of the basin. Principal crops include cotton, grain sorghum, vegetables, and citrus. The value of mineral production is significant, amounting to approximately $44 million annually. The value of all manufacturing adds about $56 million annually to the economy. Food and kindred products accounted for the major portion of this value. Tourism, petroleum, and fish industries also make sizable contributions.

The fertile irrigated lands of the Lower Rio Grande Basin are presently dependent on the flows of the Rio Grande. Periodic water shortages hamper full utilization of the basin's land resources and the social and economic development of the area. The proposed Texas Water Plan provides for additional water to be delivered to the area via canal from areas of water surplus. Present flood and drainage problems will not permit optimum use of existing land and related water resources. These unfavorable conditions will be aggravated further with additional irrigation developments and must be eliminated or greatly reduced before full physical, economic and social potential of the area can be realized. Measures needed to alleviate these conditions in Cameron County are included in work plans developed under the authority of Public Law 566 for three

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watersheds comprising all of Cameron County. The solution to problems in the remainder of the basin can be accomplished only through the installation of a complex system of measures to reduce flooding and provide adequate drainage.

The planning effort was directed toward meeting the following objectives:

1. Determine the future direction and magnitude of the basin economy.

2. Evaluate the agricultural and nonagricultural damages caused by floodwater, salinity, erosion,sediment, high-water tables, and pollution.

3. Appraise land use and land treatment practices as they relate to soils, erosion, and the use of land within its capabilities.

4. Determine the most efficient system of land treatment and structural measures needed to alleviate problems relating to flood prevention, drainage, management of water supplies, salinity control, pollution, fish and wildlife, water quality control, and recreation.

5. Identify those elements of the plan needed to satisfy immediate and long range objectives.

6. Identify those elements of the plan which can be carried out under existing authorities, as well as those requiring amended or new authorities.

7. Evaluate the physical, economic, and social impact of the proposed programs on the area and State.

Principal problems affecting the land resource of the Basin are: (1) a lack of suitable natural channels for removal of floodwaters, (2) inadequate surface and subsurface drainage systems, (3) inefficient use of irrigation water, and (4) an inadequate supply of water during critical drought periods. The flood problem is especially severe in Willacy and Hidalgo Counties where most of the surface runoff from Hidalgo County must flow overland through Willacy County to the Laguna Madre. The flow of floodwaters is impeded by inadequate drainage structures under roads, railroads, and irrigation canals. Flooding becomes even more acute when the gated levee structures into the Rio Grande floodway system are closed. Salinity problems, which restrict production on fertile soils in many areas, are aggravated by inadequate surface and subsurface drainage, high-water tables, and the excessive use of variable quality irrigation water. The lack of natural channels prevents installation of on-farm systems for surface and subsurface drainage; thereby, restricting farming efficiency. This depresses farm income, which in turn adversely affects the economic growth of the Basin.

The study indicated that an action program is needed in Willacy and Hidalgo Counties to reduce flood damages to urban and agricultural areas and to provide adequate outlets for surface and subsurface drainage. An accelerated land treatment program is needed in the entire area to protect and improve agricultural lands, permit increased efficiency of land and water management, and to insure higher sustained agricultural yields. Several alternatives for the removal of floodwater were compared for applicability, effectiveness, and relative economy, giving consideration to local views and desires.

The proposed plan of development provides a framework for the protection and improvement of the land resource of the Lower Rio Grande Basin consistent with the best interests of the local people, the State, and the Nation. Basic elements of the plan consist of structural measures to be installed through project-type action and land treatment measures to be installed by individual landowners and operators. Elements of the plan for Cameron County will be carried out under the authority of Public Law 83-566 as amended. It is proposed that the remaining elements of the plan of development be carried out in three phases.

Phase I. This would consist of 164 miles of floodwater channels to be installed with Federal assistance during the first three years after authorization. The proposed channels are the Willacy-Hidalgo Floodwater Bypass, the Laguna Madre Floodwater Channel, and the North Floodway Channel. These are interrelated with, and essential to the development of subwatershed projects.

The Willacy-Hidalgo Floodwater Bypass would divert floodwaters from the west central part of Hidalgo County toward the northeast and away from the highly developed areas in Hidalgo and Willacy Counties. The Laguna Madre Floodwater Channel would convey floodwaters from east central Hidalgo County and southern Willacy County to the Laguna Madre. The North Floodway Channel would provide an outlet for removing runoff at an increased rate from the area lying west of Mercedes and between the Rio Grande and Spur Highway 374. Apportionment of flows between the North Floodway and the Arroyo Colorado would be as determined by the International Boundary and Water Commission.

Installation of floodwater channels will provide positive outlets from highly developed agricultural and urban areas in most of Willacy and Hidalgo Counties. This is the key to the entire water disposal system. Without adequate outlets, other good features of the proposed plan will be of little value. Once Phase I is underway, local groups such as water districts, cities, drainage districts, or others can take steps to solve their own floodwater and drainage problems. Small subwatershed projects can be developed, existing systems of channels can be improved, or new systems installed.

Phase II. This would provide Federal assistance to local units of government who want to initiate and carry out small subwatershed projects. Works needed in Phase II would consist of some 1,394 miles of multiple-purpose channels for flood prevention and agricultural water management including: enlargement and extension of existing channels; construction of channels in areas without outlets; structures for water control; and other works of improvement in subwatershed projects in Willacy and Hidalgo Counties. These subwatersheds would be delineated and projects initiated and carried out by local sponsors. Phase II provides the flexibility needed to cope with localized problems. Individual subwatershed projects can be started as soon as an adequate outlet is available.

Phase III. This would consist of an accelerated land treatment program to protect and improve agricultural lands, permit efficient and effective water management, and insure higher sustained agricultural yields. These measures would be installed by landowners and operators with Federal technical and cost-sharing assistance. Concurrent with or following the installation of appropriate multiple-purpose project channels. Under Phase III, funds for accelerating the land treatment program would be provided to: (1) the Soil Conservation Service for technical assistance in the planning and application of the land treatment measures and (2) the Agricultural Stabilization and Conservation Service for cost-sharing under the ACP program.

The estimated cost of all measures to be installed is $193,048,000. It is proposed that $94,217,000 of this amount be assumed by the Federal government and $98,831,000 by other interests. Of these amounts about $14,084,000 of Federal funds and $14,356,000 of other funds would be required after 1980 to complete the Phase III program. The costs of various elements of the proposed plan of development are as follows:

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	Federal Funds (dollars)	Other Funds (dollars)	Total (dollars)
Phase I Program	16,795,000	8,096,000	24,891,000
Phase II Program	20,695,000	30,275,000	50,970,000
(Structural Measures)	(20,275,000)	(30,275,000)	(50,550,000)
(Work Plan Development)	(420,000)	-	(420,000)
Phase III Program	47,315,000	49,524,000	96,839,000
(Before 1980)	(33,231,000)	(35,168,000)	(68,399,000)
(After 1980)	(14,084,000)	(14,356,000)	(28,440,000)
Subtotal	84,805,000	87,895,000	172,700,000
PL 566 Projects	9,412,000	10,936,000	20,348,000
TOTAL	94,217,000	98,831,000	193,048,000

It is also proposed that the Farmers Home Administration be provided $33,000,000 to make loans to local organizations to finance their share of the cost of the Phase I and Phase II programs and for conservation loans to individual landowners in carrying out Phase III.

The total average annual cost of structural measures included in the proposed plan of development is as follows:

	Installation (dollars)	Operation & Maintenance (dollars)	Total (dollars)
Phase I	1,224,000	92,000	1,316,000
Phase II	2,485,000	783,000	3,268,000
Subtotal	3,709,000	875,000	4,584,000
PL-566 Projects	999,000	309,000	1,308,000
TOTAL	4,708,000	1,184,000	5,892,000

Installation costs based on 1966 prices were amortized for 100 years at 4-7/8 percent interest.

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Monetary benefits are estimated to total $17,620,000 annually, of which $17,457,000 is due to structural measures and $163,000 to land treatment. Irrigation, water control, recreation, area redevelopment, and secondary benefits are estimated to be $1,975,000 annually. Flood damage reduction benefits accruing to structural measures are estimated to be $8,084,000 annually. Estimated benefits from improved drainage are $7,398,000 annually.

The structural measures included in Phase I and Phase II will produce estimated average annual benefits of $12,676,000 of which $5,872,000 will be from reduced flood damages; $5,402,000 from increased income due to improved drainage; $1,152,000 from secondary benefits; and $250,000 from increased employment.

In addition, the effect of an increase in agricultural production resulting from the investment in the total plan will pervade the entire economy of the Basin. Total impact on local business volume is expected to be $79.7 million annually by 1980, $96.2 million by 2000, and $106.8 million by 2020.

The average annual cost of structural measures included in the proposed plan of development is about $5,892,000. These measures are expected to produce average annual benefits of $17,457,000 providing a benefit-cost ratio of 3.0:1.0. Primary benefits are expected to be $15,887,000 annually.

The total average annual cost of structural measures included in Phase I and Phase II of the recommended plan of development is $4,584,000. These measures are expected to produce average annual primary benefits of $11,524,000 or $2.51 for each dollar of cost. The ratio of total average annual project benefits accruing to structural measures, $12,676,000, to the average annual cost of structural measures, $4,584,000,is 2.8 to 1.0.

The study concludes that an integrated plan for installation of interrelated measures is needed, desirable, and feasible. Such a plan has been developed and is presented in detail in the study report for consideration of all concerned. It was developed with the aid and cooperation of local, State, and Federal interests and will serve the welfare of the Basin as well as the nation. The study further concludes that the installation of measures proposed in the plan will greatly help the Basin develop its potential in the areas of food and fiber production; economic stability and well-being; recreational demands; fish and wildlife production and preservation; and that local and state interests involved are aware of the proposed plan, its attendant benefits, and their responsibilities.

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The proposed plan of development was fully coordinated throughout the study with the International Boundary and Water Commission. Further coordination with the Commission would be required during the detail planning, design, and construction stages for all measures that will affect or be affected by the floodway system of the Rio Grande.

Further Action Required For Implementation

New legislative authority will be required to enable the Secretary of Agriculture to help local organizations install the proposed three-phase program. This cannot be done under Public Law 83-566 because the surface runoff problem requires concurrent installation of structural measures controlling runoff from drainage areas exceeding 250,000 acres.

Prior to the introduction of new authorizing legislation, responsible local interests would be required to give assurances satisfactory to the Secretary of Agriculture that they will:

1. Provide without cost to the United States, all land rights necessary for construction, operation, and maintenance of structural measures.

2. Provide funds sufficient to pay for the local share of construction cost allocated to agricultural water management.

3. Operate and maintain all structural measures after completion in accordance with regulations prescribed by the Secretary of Agriculture.

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The proposed schedule of obligations of funds for the first five years of the installation period is as follows:

Fiscal Year	Measure	Federal Funds (dollars)	Other Funds (dollars)	Total (dollars)
First:	Phase I	4,468,000	4,074,000	8,542,000
	Phase III	1,500,000	1,700,000	3,200,000
Second:	Phase I	6,611,000	1,082,000	7,693,000
	Phase II	525,000	675,000	1,200,000
	Phase III	2,000,000	2,300,000	4,300,000
Third:	Phase I	5,716,000	2,940,000	8,656,000
	Phase II	725,000	1,005,000	1,730,000
	Phase III	3,000,000	3,200,000	6,200,000
Fourth:	Phase II	3,950,000	5,520,000	9,470,000
	Phase III	3,000,000	3,200,000	6,200,000
Fifth:	Phase II	3,900,000	5,500,000	9,400,000
	Phase III	3,200,000	3,400,000	6,600,000
Remaining to be done Prior 1980	Phase II	11,595,000	17,575,000	29,170,000
	Phase III	20,531,000	21,368,000	41,899,000
Total		70,721,000 1/	73,539,000	144,260,000

1/ Includes $420,000 for work plan development under Phase II.

INTRODUCTION

This report by the United States Department of Agriculture in cooperation with the State of Texas results from a study of the control, utilization, and management of the water and related land resources of the Lower Rio Grande Basin in Texas. This study was made by agencies within the Department of Agriculture. The investigations were coordinated with local, State, and other Federal agencies.

In December 1962, the United States Department of Agriculture was requested by the Texas Water Development Board, the Texas Water Rights Commission, and the Texas State Soil and Water Conservation Board to conduct the Type IV Lower Rio Grande comprehensive study. The request was supported by the Willacy-Hidalgo and the Southmost Soil and Water Conservation Districts and the Commissioners Courts of Cameron, Hidalgo, and Willacy Counties. The objectives of the study were to appraise the water and related land resource development needs of the agricultural, rural, and urban areas of the basin, and to formulate a plan for the coordinated and orderly control, regulation, management, and use of these resources.

The need for the study arose from a realization that the problems connected with the control of floodwaters and inadequate surface and subsurface drainage in the basin cannot be solved on a piecemeal basis. The study clarifies the problems and needs and defines a plan which will be both workable and acceptable from the physical, monetary, and aesthetic points of view. Installation of the plan will promote the economic growth and development of the area consistent with overall national objectives.

The United States Department of Agriculture participated in the study under the provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended), which authorizes the Secretary of Agriculture to cooperate with State, local and other Federal agencies in surveys and investigations of the watersheds of rivers and other waterways to develop coordinated programs.

The study was conducted under the general guidance and direction of a steering committee composed of representatives of the Texas Water Development Board, the Texas Water Rights Commission, the Texas State Soil and Water Conservation Board and the U. S. Department of Agriculture. The main functions of the committee were as follows:

1. Define the objectives of the study.
2. Provide guidance for conducting the study and preparing a coordinated report.

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3. Provide a means for full and continuing exchange of views of State and Federal agencies.
4. Assist in the solution of problems as they arise in the study.
5. Make periodic reviews of studies being made.

The United States Department of Agriculture conducted its investigations under the direction of a field advisory committee composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service, with the Soil Conservation Service representative as the chairman. The field advisory committee furnished guidance in scheduling the survey and investigations and coordinated the USDA efforts with other Federal and State agencies. The committee met at intervals to review planning procedures, effect agency coordination, arrange for necessary consultation, and determine progress being made in the investigation.

The study includes an inventory of the water and related land resources, an investigation of the problems and an appraisal of the present and future needs for development. The objectives of the investigation and the study were to:

1. Evaluate the agricultural and nonagricultural damages caused by floodwater, salinity, water erosion, sediment, high-water tables, wind erosion, and pollution.

2. Appraise land use and the land treatment practices as they relate to soils, erosion, and the use of land within its capabilities.

3. Determine the most efficient system of land treatment and structural measures which would alleviate the problems relating to flood prevention, drainage, management of water supplies, salinity control, pollution, fish and wildlife, water quality control, and recreation at a justifiable cost.

4. Identify those elements of the plan that are required to satisfy immediate and long range objectives.

5. Identify those elements of the plan which can be carried out by the United States Department of Agriculture and other Federal, State, and local agencies under existing authorities, and also those activities that should be developed under amended or new authorities.

6. Evaluate the impact of the proposed programs on the physical, economic, and social factors of the area and the State.

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7. Prepare a report which describes the problems and presents solutions, development opportunities, and an analysis of uses of water and land resources.

Prior to and during the course of the study, watershed work plans were developed under the authority of Public Law 566 for the Rancho Viejo, Arroyo Colorado, and Los Fresnos Resaca watersheds in Cameron County. Studies and investigations in Hidalgo and Willacy Counties were limited in detail, but were compatible with the nature and magnitude of the program to which they relate. Field examination-type studies were made on the area involved in the study. These data, along with exising data and information on land conditions, use, and management, were used to determine the potential use and management of water and land resources and needs for development. All known reports, surveys, and plans which had been proposed and/or installed were analyzed in regard to current and long-range flood prevention and water management needs.

Maps were compiled from United States Geological Survey quadrangle maps on which all existing open ditches and pipelines for drainage and irrigation are superimposed. Major drainage ditches and outlets were identified and located on one map of reduced scale for overall viewing. Study areas which warranted investigation and surveying as watershed units were identified. These areas are independent of county lines, drainage and/or irrigation district boundaries. In most cases, the only way to alter these watersheds is by eliminating the existing main drains and starting anew.

Field studies were made to obtain profiles and cross section surveys of existing channels and information on drainage areas, and physical and cultural features in sufficient detail to provide data for hydraulic design and cost estimates.

Information was collected on present land use, yields, production costs, floodwater damages, and losses due to inadequate irrigation distribution systems and inadequate drainage. This information, data from similar nearby areas, and data contained in the Drainage Survey Report, Texas, 1964, prepared by the Soil Conservation Service, were used as a basis for determining damage reduction benefits resulting from flood prevention and improved drainage.

Data pertaining to the agricultural and nonagricultural sectors of the economy, land use, and production were obtained from various secondary sources, local marketing associations and Texas A&M University. From these data basin trends were developed and projected in light of expected changes. The projections are reasoned conclusions about the future direction and magnitude of the agricultural and related nonagricultural economic activity. They are based upon objective analyses of the relevant past and careful estimates of the effects of new forces and developments that are expected to influence trends of future activity.

Geologic investigations made in the basin were principally along three lines--sedimentation, soils, and engineering and ground-water geology. The studies were limited in detail and extent and were made mainly in areas of recognized or suspected problems. Emphasis was placed on the preparation of an up-to-date geologic map, preparation of a general soil map and soil report, determination of drainage problems and needs, a study of soil salinity, a generalized erosion study, and a drilling investigation for engineering and ground-water geology purposes. The geologic map was prepared in collaboration with the University of Texas and the United States Geological Survey.

Semidetail soil loss investigations were made on eight 4-square-mile plots selected at random in Willacy and Hidalgo Counties. Erosion data obtained during the development of PL-566 watershed work plans in Cameron County were combined with the data obtained in Willacy and Hidalgo Counties.

The engineering geology and ground-water investigations utilized existing literature and the results of a drilling program. Borings ranging to 31.5 feet in depth were made to determine subsoil conditions along possible channel locations and the relation of the ground-water table to the La Sal Vieja lakes.

The soil investigations were carried out in cooperation with soil scientists and other personnel experienced with the uses and problems of the soil. A general soil map was prepared which served as a basis for locating salinity and high-water table problem areas. Joint conferences were held with engineers and others to determine the extent of drainage needs. Available literature on soil salinity was used, and conferences on this subject were held with Agricultural Research Service personnel. These investigations resulted in the preparation of the Appendix, Soils of the Lower Rio Grande Valley, Their Characteristics, Uses, and Problems.

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NATURAL RESOURCES OF THE BASIN

Location and Size

The Lower Rio Grande Basin is located in the southern tip of Texas and encompasses all of Cameron, Willacy, and Hidalgo Counties. All of the basin area, except the Rio Grande flood plain, is a portion of Zone 3 of the Nueces-Rio Grande Coastal Basin as designated by the State of Texas.

The basin has an area of 2,209,300 acres, or 3,452 square miles (plate 1). Approximately 88 percent of the basin area is considered land and 12 percent is large water areas. Ninety-eight percent of the land area is privately owned and 2 percent is publicly owned.

Climate

The Valley has a modified marine, or coastal-type, subtropical and semiarid climate. The climate is characterized by long, hot summers and short, mild winters which occasionally are punctuated by severe cold spells.

The average annual rainfall is 20.1 inches at Mission, located in the southwest portion of the basin, 26.5 inches at Raymondville, in the northeast portion, and 26.8 inches at Brownsville, in the southeast portion. The highest average monthly rainfall (4.21 inches) occurs in September, and the lowest (1.09 inches) in March. Figure 1 indicates the wettest months to be May, June, August, September, and October. Figure 1 shows the average monthly rainfall distribution for the basin and at Mission, Raymondville, and Brownsville.

Flood-producing rains may occur in any season, but are most frequent in the fall months. Hurricanes, which strike the area occasionally, are accompanied by heavy rains.

Evaporation averages 58 inches annually from a free water surface.

The mean annual temperature is 74 degrees with extremes of 12 degrees and 107 degrees on record. Extremes are rare, as the climate is tempered by Gulf breezes which tend to stabilize the temperature. Killing frosts have been recorded as early as November 25 and as late as March 30. Occasionally, the Valley will experience weather severe enough to damage or kill citrus trees and tender vegetables. The average length of the growing season is 330 days.

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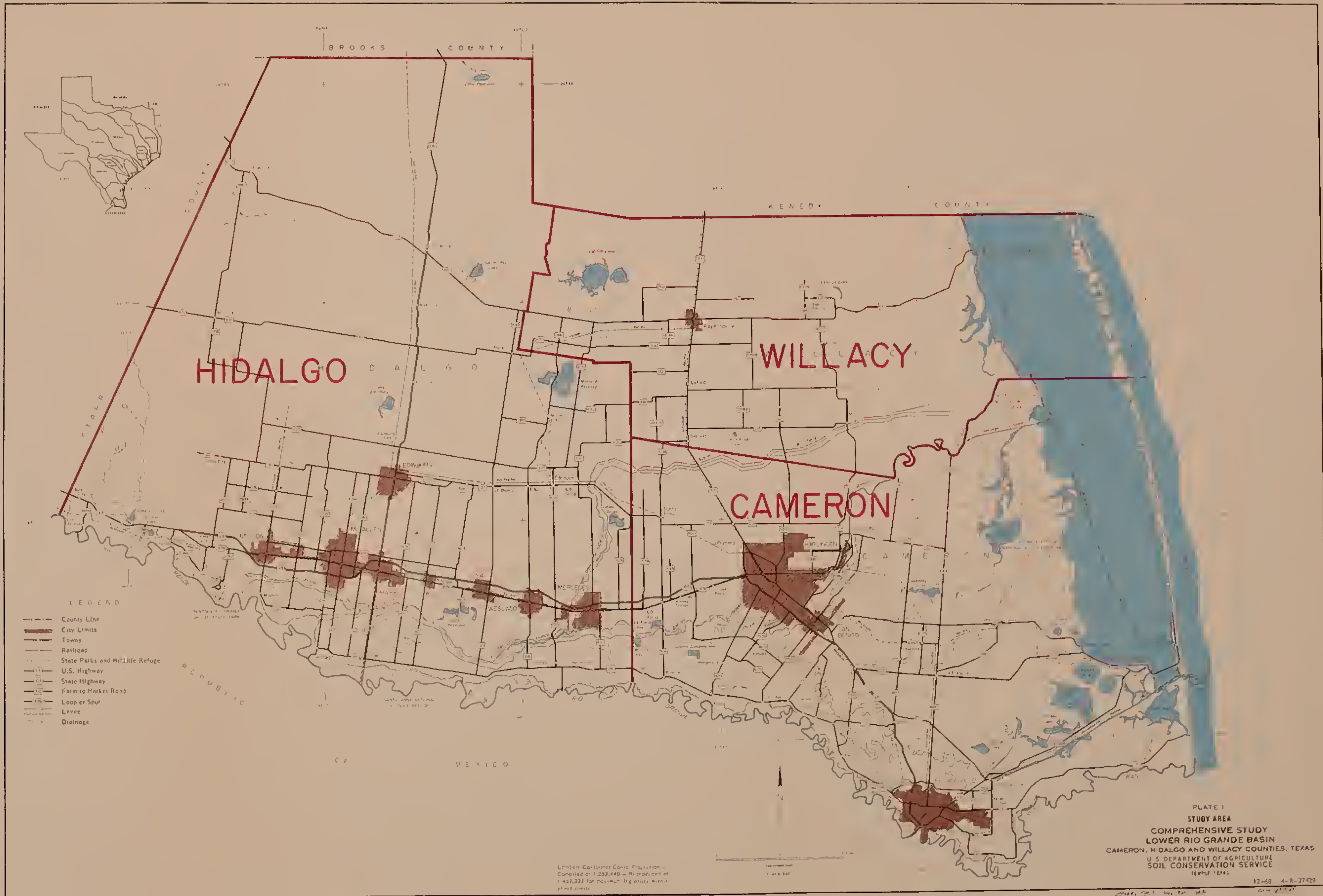
BROOKS COUNTY
KENEDY COUNTY
HIDALGO
WILLACY
CAMERON
HARLINGEN
SAN BENITO
MERCEDES
WESLACO
McALLEN
REPUBLIC
MEXICO
LEGEND
County Line
City Limits
Towns
Railroad
State Parks and Wildlife Refuge
U.S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee
Drainage
PLATE 1
STUDY AREA
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
12-68 4-R-27429

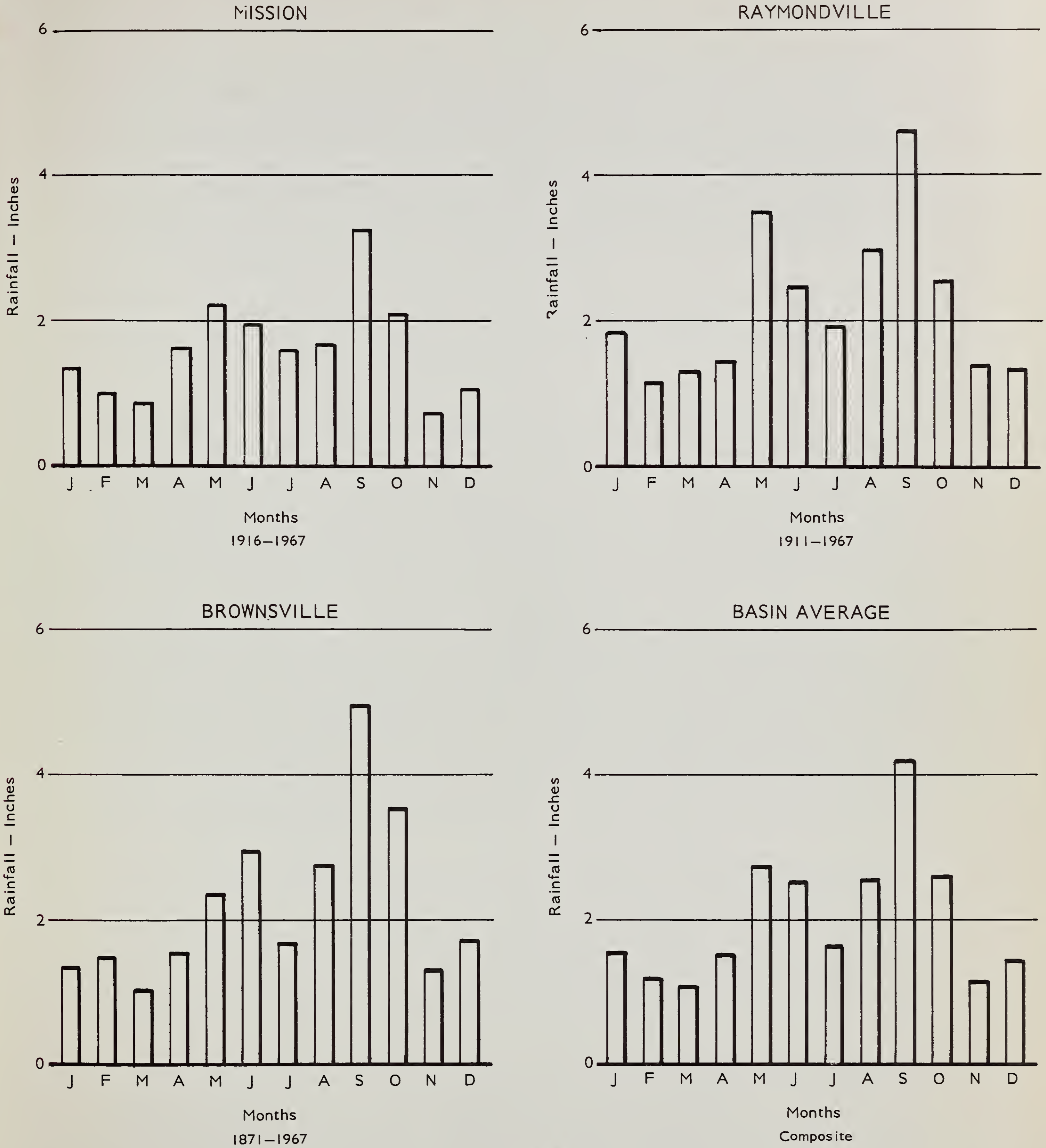

Figure 1

AVERAGE MONTHLY RAINFALL
LOWER RIO GRANDE BASIN, TEXAS

Based on Climatological Data Bulletin, Texas U. S. Department of Commerce, Weather Bureau Annual Summary – 1967

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Physiography, Geology and Mineral Resources

The basin is a comparatively flat plain with a gentle slope to the northeast, away from the Rio Grande and toward the Gulf. Elevations rise to an altitude of about 380 feet in western Hidalgo County. The natural relief is subdued. The only natural drains are the Arroyo Colorado and La Joya Creek. Willacy County is the only county in the State without a natural drainageway.

About 74 percent of the basin is drained by natural or manmade channels. About 3 percent is drained by the Rio Grande, and 23 percent is non-contributing to any drainage system.

Small natural lakes occur in two forms--the cutoff meanders of the Rio Grande, called resacas, and the natural depressions, called pot-holes. The resacas are usually elongated and curved with oxbow-type features. The pothole lakes are usually more or less round, and the larger, deeper ones contain highly saline water. Sal del Rey and La Sal Vieja lakes are of this type and are the principal large, permanent water-filled lakes. The numerous smaller potholes and resacas contain water only after rains.

Topographically, the basin may be divided into three subdivisions--the Hebbronville Plain, the Sand Belt, and the Rio Grande Delta. The Hebbronville Plain occupies about two-thirds of the area north of U. S. Highway 83 in Hidalgo County and a small part of western Willacy County. The Sand Belt occupies most of the area north of Linn in Hidalgo County and a few small areas in Willacy County near the Kenedy County line. The Rio Grande Delta lies between U. S. Highway 83 and the Rio Grande in Hidalgo County, and covers all of Cameron County and most of Willacy County.

A significant topographic feature of the area is the Mission Ridge, which is a low-lying ridge extending from Mission through McAllen, San Juan, Pharr, Donna, and west of Raymondville. This ridge reflects the southern and eastern limits of the Hebbronville Plain. In the Rio Grande Delta the most prominent topographic features are the resacas. In the Sand Belt area and the Western part of the Hebbronville Plain, a distinctive feature is the potholes.

The geologic formations of the basin are shown in plate 2. Geologically the basin may be divided into four major areas. The oldest formations crop out in the midsection of Hidalgo County. They are the Montgomery (or Bentley) and Willis (or Bentley) of the Pleistocene Series and the Goliad Formation of the Pliocene Series. These are marine formations consisting of poorly consolidated clay, sand, silt, caliche, pebbles, and cobbles and are 1 million to 10 million years old.

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The ancient delta deposits of the Rio Grande are considered part of the Beaumont Formation and occupy the center portion of Willacy County, a strip on the eastern edge of Hidalgo County, and most of Cameron County north of the Arroyo Colorado. These deposits consist of poorly consolidated to nonconsolidated channel, point bar, natural levee, and backswamp deposits of the Rio Grande which are 10,000 to 1 million years old.

The Recent deposits of the Rio Grande occur between the Arroyo Colorado and the Rio Grande and are less than 10,000 years old. They consist of nonconsolidated channel, point bar, natural levee, and backswamp depositional sequences and also include marsh, mudflat, clay dune, and offshore barrier island deposits, some of which are connected with the mainland near the mouth of the Rio Grande.

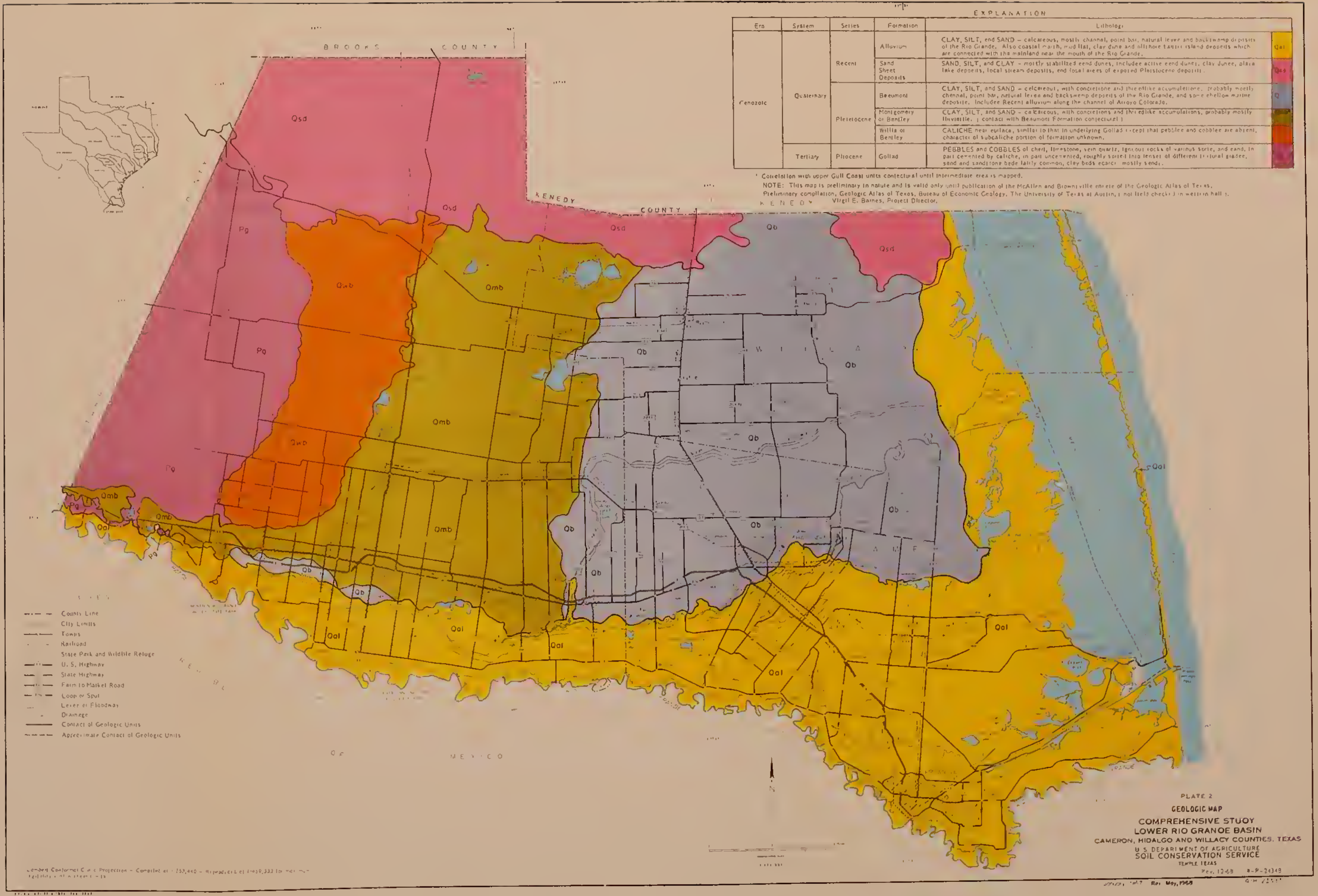
Eolian sand sheet deposits of the Recent Series occur in the northern part of the basin. They consist mainly of stabilized sand dunes but include some active sand dunes, clay dunes, playa lake deposits, local stream deposits, and local areas of exposed Pleistocene Formation. These deposits of sand and detritus are formed along the coast at about latitude 27 degrees north due to the action of two opposing longshore currents which meet at this point. The sand and detritus are picked up by wind and carried inland to form a sand sheet up to 60 feet in thickness.

The area occupied by the delta, both ancient and recent, was once a broad valley up to 400 feet deep which was eroded from the coastal plain by the Rio Grande. It has since been filled with materials brought down by the river from inland areas.

The Valley has no known metallic mineral resources. Nonmetallic mineral resources of importance are the organic minerals--natural gas, natural gas liquids, and petroleum crude. Hidalgo County has inorganic mineral resources in the form of clay, sand, caliche, gravel, and salt. Natural gas, natural gas liquids, and petroleum crude are by far the most important mineral resources in the Valley. Substantial reserves of these resources are known to exist. Natural gas production in the basin has exceeded 200 billion cubic feet per year in recent years. Crude oil production in 1965 was 2,779,000 barrels.

Land Resources

The entire basin lies within the Rio Grande Plain Land Resource Area. This land resource area is characterized by nearly level to gently undulating topography. Valleys are few, widely spaced, and shallow. Local relief ranges from nearly level to undulating.


EXPLANATION
Era | System | Series | Formation | Lithology
Cenozoic
Quaternary
Recent
Alluvium
CLAY, SILT, and SAND – calcareous, mostly channel, point bar, natural levee and backswamp deposits of the Rio Grande. Also coastal marsh, mud flat, clay dune and offshore barrier island deposits which are connected with the mainland near the mouth of the Rio Grande.
Qal
Sand Sheet Deposits
SAND, SILT, and CLAY – mostly stabilized sand dunes, includes active sand dunes, clay dunes, playa lake deposits, local stream deposits, and local areas of exposed Pleistocene deposits.
Qsd
Pleistocene
Beaumont
CLAY, SILT, and SAND – calcareous, with concretions and threadlike accumulations, probably mostly channel, point bar, natural levee and backswamp deposits of the Rio Grande, and some shallow marine deposits. Includes Recent alluvium along the channel of Arroyo Colorado.
Montgomery or Bentley
CLAY, SILT, and SAND – calcareous, with concretions and threadlike accumulations, probably mostly fluviatile. (contact with Beaumont Formation conjectural)
Willis or Bentley
CALICHE near surface, similar to that in underlying Goliad except that pebbles and cobbles are absent, character of subcaliche portion of formation unknown.
Tertiary
Pliocene
Goliad
PEBBLES and COBBLES of chert, limestone, vein quartz, igneous rocks of various sorts, and sand, in part cemented by caliche, in part uncemented, roughly sorted into lenses of different textural grades, sand and sandstone beds fairly common, clay beds scarce, mostly sands.
Correlation with upper Gulf Coast units conjectural until intermediate area is mapped.
NOTE: This map is preliminary in nature and is valid only until publication of the McAllen and Brownsville sheets of the Geologic Atlas of Texas.
Preliminary compilation, Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas at Austin, (not field checked in western half).
Virgil E. Barnes, Project Director.
BROOKS COUNTY
KENEDY COUNTY
KENEDY
Qsd
Pg
Qwb
Qmb
Qb
Qal
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
Contact of Geologic Units
Approximate Contact of Geologic Units
MEXICO
PLATE 2
GEOLOGIC MAP
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 12-69
Rev. May, 1969

The soils are a valuable natural resource of the basin, supporting a highly developed agricultural economy. Most of the soils are level, high in natural fertility, easily cultivated, and suitable for irrigation. They are suitable for the growing of many crops, including cotton, grain sorghum, vegetables, and citrus, provided either natural or artificial drainage is available.

The General Soil Map (plate 3) was developed by condensing mapping units from detailed soil maps into soil associations. The soil associations consist of one or more major soil series grouped together with several minor series for mapping and descriptive purposes. The major series, by which the association is known, occupy from 65 to 90 percent of the area encompassed by the association. This grouping resulted in 35 soil associations. The soil associations have been placed in nine groups based on similar characteristics. Table 1 shows the acreage and estimated land use breakdown for the basin by soil association.

Remnants of native vegetation on the Rio Grande Delta portion of the basin consist of a jungle-like forest of trees such as elm, ebony, hackberry, ash, anaqua, tepeguaje, guayacon, huisache, retama, and palms, interspersed with an occasional mesquite-cactus association. Undergrowth consists of bushes and climbing vines. This type of native vegetation has been largely replaced by introduced species and the remaining is found today mainly in the wildlife refuges. In the remainder of the inland portion of the basin, the native growth consists of fairly good grasses interspersed with scattered mesquites.

At the present time, introduced vegetation covers most of the basin, and may be classified as either agricultural or ornamental. Agricultural types of importance are citrus, vegetables, corn, cotton, grain sorghum, and improved pasture grasses. Important ornamental types are palms, bougainvillaea,poinsettias, and oleander. The rangelands are covered with mesquite, prickly pear, and thorny shrubs. The salty coastal flats which border the eastern edge of the basin support coarse saltgrasses, cordgrass, alkali weeds, cacti, yuccas, and thorn bushes. Willow and saltcedar are found in the river bottoms and along unlined canals.

Water Resources

Water resources within the basin are limited primarily to ground water of mixed and mostly poor quality. Stream gage records are not available, but the average annual runoff is considered to be less than 50 acre-feet per square mile. The flat terrain precludes economical storage of any substantial amounts.

Water for municipal, industrial, irrigation, domestic, and recreational use is dependent on diversions from the Rio Grande. Demands for these purposes will be met from Falcon and Amistad, International Boundary and Water Commission reservoirs on the Rio Grande. Prior to completion of Falcon Reservoir in 1953, Valley water users were dependent on the unregulated flow of the Rio Grande.

Falcon Reservoir, located between Laredo and Rio Grande City, had the following capacities in acre-feet based on a 1956 survey:

Total	3,280,700
Flood Control	
Winter	513,300
Summer	909,500
Conservation	
Winter	2,764,580
Summer	2,368,380
Dead	2,820

Of the 3,280,700 acre-feet of total storage, 300,000 acre-feet is allocated to sedimentation. Of this amount, 258,900 acre-feet distributed throughout the reservoir remained in 1956. The water supply capacity is divided between the United States and Mexico in the proportions of 58.6 percent and 41.4 percent, respectively. When one country's conservation capacity becomes filled, all additional inflow is credited to the other country until its capacity is filled.

Amistad Reservoir is under construction above Del Rio. The damsite is a short distance downstream from the mouth of Devils River. The initial storage capacities of Amistad Reservoir in acre-feet are:

Total	5,325,000
Flood Control	1,775,000
Conservation	3,535,000
Dead	15,000

Sedimentation storage space of 550,000 acre-feet is distributed throughout the reservoir. The water supply capacity will be divided between the United States and Mexico in the proportions of 56.2 percent and 43.8 percent, respectively. Either county can borrow and use available storage space belonging to the other country until accrued inflow of the other country requires use of that space.

The winter conservation capacity of Falcon Reservoir has been increased by 396,200 acre-feet to 2,767,400 acre-feet, including dead storage, since Amistad Dam is nearing completion. The United States share of this increase is 234,000 acre-feet. Studies are being made to determine the feasibility of a further increase in winter storage capacity.

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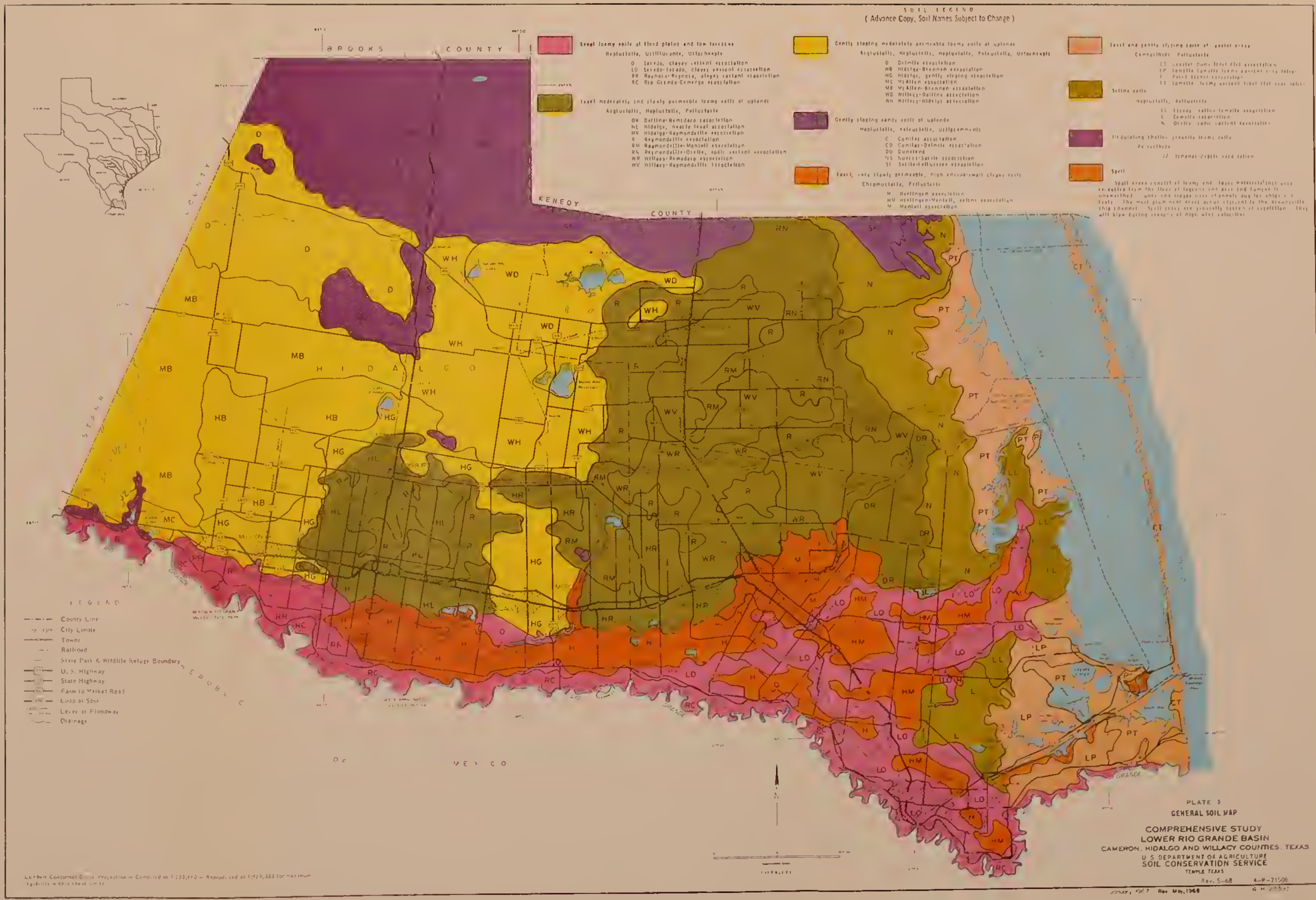
SOIL LEGEND
(Advance Copy, Soil Names Subject to Change)
BROOKS COUNTY
KENEDY COUNTY
HIDALGO
LEGEND
County Line
City Limits
Towns
Railroad
State Park & Wildlife Refuge Boundary
U. S. Highway
State Highway
Farm to Market Road
Levee or Floodway
Drainage
OF MEXICO
PLATE 3
GENERAL SOIL MAP
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 5-68

TABLE 1

ESTIMATED LAND USE BY SOIL ASSOCIATION
LOWER RIO GRANDE BASIN, TEXAS

Soil Association		Cropland		Grassland				
				Pasture				
		Irrigation	Dry	Irrigated	Dry	Range	Misc.	Total
		thousands of acres						
Coastal Dune-Tidal Flat	(CT)	-	-	-	-	14.0	2.0	16.0
Comitas-Delmita	(CD)	0.9	0.9	0.1	-	15.0	1.8	18.7
Comitas	(C)	2.3	-	0.2	-	1.1	0.3	3.9
Delfina-Ramadero	(DR)	19.4	4.4	1.3	-	-	4.1	29.2
Delmita	(D)	-	12.5	-	-	63.1	7.9	83.5
Duneland	(DU)	-	-	-	-	5.9	0.5	6.4
Harlingen-Montell	(HM)	44.9	-	3.3	0.4	-	7.8	56.4
Harlingen	(H)	52.6	17.1	4.9	1.2	-	10.1	85.9
Hidalgo-Brennan	(HB)	54.4	8.6	5.6	-	0.5	7.2	76.3
Hidalgo-Raymondville	(HR)	40.1	-	3.3	0.8	-	6.2	50.4
Hidalgo,gently sloping	(HG)	66.1	-	6.8	0.4	-	7.7	81.0
Hidalgo,nearly level	(HL)	57.8	-	6.0	0.4	-	6.7	70.9
Jimenez-Zapata	(JZ)	-	-	-	-	4.6	0.4	5.0
Laredo-Laredo,clayey variant	(LO)	79.4	-	5.4	15.5	-	17.4	117.7
Laredo,saline-Lomalta	(LL)	-	-	-	-	18.8	3.2	22.0
Lomalta-Lomalta,loamy variant	(LP)	-	-	-	-	11.0	1.9	12.9
Lomalta	(L)	-	-	-	-	21.4	3.7	25.1
McAllen-Brennan	(MB)	6.1	69.1	0.6	12.5	37.0	13.0	138.3
McAllen	(MC)	1.2	0.3	0.1	2.3	1.9	0.6	6.4
Montell	(M)	20.9	9.4	1.4	-	-	5.5	37.2
Orelia, sodic variant	(N)	-	36.5	-	-	45.6	9.0	91.1
Nueces-Sarita	(NS)	-	-	-	-	27.4	2.8	30.2
Laredo,clayey variant	(O)	2.9	-	0.3	-	-	0.4	3.6
Lomalta,loamy variant-Tidal Flat	(PT)	-	-	-	-	71.1	9.8	80.9
Point Isabel	(P)	-	-	-	-	2.6	0.4	3.0
Raymondville-Montell	(RM)	16.7	9.1	1.5	0.1	-	2.9	30.3
Raymondville-Orelia,sodic variant	(RN)	1.2	39.0	0.1	4.0	15.7	5.0	65.0
Raymondville	(R)	49.3	45.9	4.3	-	3.7	10.8	114.0
Reynosa-Reynosa,clayey variant	(RR)	18.3	-	1.9	-	-	2.1	22.3
Rio Grande-Camargo	(RC)	58.9	-	5.1	-	-	8.6	72.6
Sarita-Falfurrias	(SF)	-	-	-	-	165.8	16.5	182.3
Willacy-Delfina	(WD)	28.5	17.9	2.2	2.5	3.6	4.9	59.6
Willacy-Hidalgo	(WH)	35.6	18.6	3.6	1.2	28.0	9.0	96.0
Willacy-Ramadero	(WR)	32.3	5.6	2.2	-	2.0	6.9	49.0
Willacy-Raymondville	(WV)	-	53.3	-	-	29.1	8.6	91.0
Fill		-	-	-	-	4.2	0.7	4.9
TOTAL		689.8	348.2	60.2	41.3	593.1	206.4	1,939.0 1/

1/ Does not include 270,300 acres of large water areas.

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Irrigated cotton is the principal cash row crop with irrigated grain sorghum increasing in importance.

A reservoir operation study for the period 1900-56 was made by the Texas Water Commission. The study was based on yearly demands for a full irrigation supply in accordance with yearly demands for stated acreages and with the balance of available water accrued in storage for future use. After adjustments were made for (1) water allocated to municipal and industrial uses, (2) a reserve supply for domestic uses, and (3) depletion for sediment, it was determined that a full water supply was available to irrigate:

600,000 acres 95 percent of the time,
650,000 acres 89 percent of the time,
700,000 acres 70 percent of the time,
750,000 acres 63 percent of the time,
800,000 acres 47 percent of the time.

Storage was not allowed to exceed the United States' share of the combined conservation storage capacity of Falcon and Amistad Reservoirs. Spills from these reservoirs occurred only when demands to supply 600,000 and 650,000 acres were used. Figure 2 shows the number of years a full water supply could have been furnished. From these reservoir operations studies, it appears that Falcon and Amistad Reservoirs will provide an adequate water supply for only 650,000 to 680,000 acres in the Lower Rio Grande Valley and that periodic shortages will occur. Water for areas along the Rio Grande in Starr County is supplied from Falcon Reservoir.

Two major off-channel reservoirs and one natural lake are used for temporary storage of water diverted from the Rio Grande. Monte Alto Reservoir, also known as Delta Lake in east-central Hidalgo County, has a capacity of 25,000 acre-feet and is owned and operated by Hidalgo and Willacy Counties Water Control and Improvement District No. 1. Valley Acres Reservoir, north of Mercedes in eastern Hidalgo County, has a capacity of 7,800 acre-feet and is owned and operated by the Valley Acres Water District. Loma Alto Lake, a natural lake northeast of Brownsville, is owned and operated by the Brownsville Navigation District. Its capacity is being enlarged to store 26,500 acre-feet.

In Cameron, Willacy and Hidalgo Counties (mostly in Cameron County), there are 24 minor reserovirs with capacities of less than 5,000 acre-feet that are used almost exclusively for off-channel storage of irrigation water. Some are off-channel reservoirs, and the others are on arroyos, resacas, drainage ditches, and floodways.

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Studies indicate that about 30 percent of the inflow into the river below Falcon Dam is available for diversion. Only a part of this is diverted, because the short duration floodflows generally coincide with local rains which reduce the demands.

Poor quality limits the use of return flows for irrigation.

Water released from Falcon Reservoir has an average of 500 ppm dissolved solids, 150 ppm sulfate, and 80 ppm chloride. Return flows to the Rio Grande below Falcon Dam, particularly from the highly saline Morillo Drain in Mexico, increase the mineral loading of the Rio Grande at Anzalduas Dam in Hidalgo County to an average of 750 ppm dissolved solids, 210 ppm sulfate, and 175 ppm chloride. Concentrations of dissolved-solids at times exceed 2,000 ppm. The average concentration of dissolved solids is 0.83 tons per acre-foot of water at Falcon Reservoir.

At Falcon Reservoir, for 1964-65 the biochemical oxygen demand averaged 2.0 ppm; chlorine demand, 1.6 ppm; and dissolved oxygen, 6.4 ppm. Near Hidalgo, the averages for the same period were: biochemical oxygen demand, 3.3 ppm; chlorine demand, 2.8 ppm; and dissolved oxygen, 6.2 ppm.

The alluvial gravel strata of the Recent Series form the primary aquifer which is known as the Lower Rio Grande Ground-Water Reservoir. These gravels occur at depths to 300 feet in an area bound by the river on the south and U. S. Highway 83 on the north in Cameron and Hidalgo Counties. Wells in this area are from 110 to 300 feet deep. The only other significant ground water development is the Linn-Faysville area in northern Hidalgo County. Wells in this area are up to 980 feet deep, but most of them are less than 100 feet deep and tap the Willis (Bentley) Formation of the Pleistocene Series. Wells for miscellaneous uses are scattered throughout the basin area.

Ground water in the basin is characterized by wide variations in chemical composition, often within short lateral distances. Even at best, very little of it can be considered fresh (less than 1,000 ppm total solids), and none of it meets the recommendations of the U. S. Public Health Service for drinking water quality (less than 500 ppm dissolved solids).

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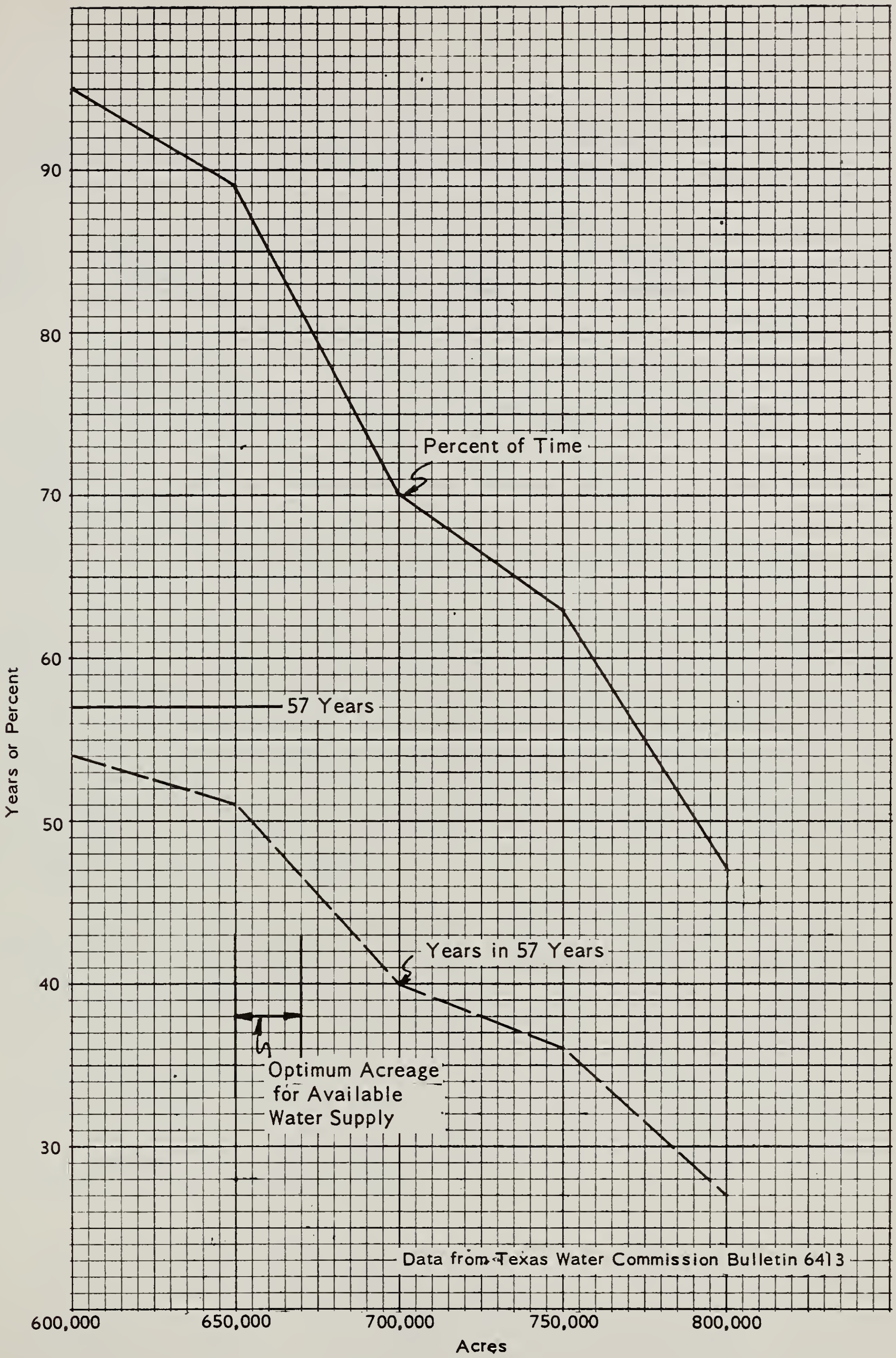

Figure 2

AVAILABILITY OF A FULL WATER SUPPLY FOR IRRIGATION FROM FALCON RESERVOIR
for period 1900–1956
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS

4–25965 5–68
USDA-SCS-FORT WORTH, TEX. 1968

For the purpose of this report, water for irrigation is classified by standards given in USDA Circular 707 as follows:

Class of Water	Dissolved Solids	Boron (ppm)	Percent Sodium
1	Less than 700	Less than 0.5	Less than 60
2	700-2000	0.5 - 2.0	60 - 75
3	More than 2000	More than 2.0	More than 75

Class 1 is excellent to good; suitable for most plants under most conditions.

Class 2 is good to injurious; probably harmful to the more sensitive plants.

Class 3 is injurious to unsatisfactory; probably harmful to most crops and unsatisfactory for all but the most tolerant.

Total dissolved solids in the alluvial ground water range from 600 to 2,500 ppm, averaging about 1,425 ppm. The chloride content ranges from 100 to 600 ppm and averages about 300 ppm. Boron content of these waters averages about 1 ppm and the percent of sodium about 60. These chemical characteristics classify this water as fair for irrigation (class 2). The water is injurious to salinity sensitive crops and should be used only on soils having good drainage that respond to salinity control management. The sodium hazard of this water ranges from low to high.

The ground-water quality of the Willis (Bentley) aquifer in the Linn-Faysville area varies widely and ranges between 500 to 4,000 ppm total solids, averaging about 1,200 ppm. The chloride content ranges from 200 to 800 ppm and averages about 400 ppm. Boron content averages 1.64 ppm and sodium is about 70 percent. The suitability of this water for various uses is about the same as that from the alluvial aquifer, except for the sodium hazard which ranges from medium to high. This water is also classified as fair (class 2). Water quality throughout the remainder of the basin is generally worse than the two areas discussed above.

Over 2,000 wells of various types have been drilled in the basin. About 1,500 of these are irrigation wells, the majority of which have been drilled since 1948. Most of them are used only periodically to supplement seasonally short supplies of surface water. Prior to 1948, the only area in the Valley in which irrigation from wells played an important role was the Linn-Faysville area in northern Hidalgo County where about 100 irrigation wells had been drilled. Several municipalities in the basin utilize ground water for public supply, and most of the others have standby wells.

In years of normal rainfall, ground water supplies only a small fraction of the annual water demand of the Valley. In years of deficient Rio Grande flow such as occurred in 1952 and 1953, it is estimated that ground water supplied approximately 25 percent of the total water used. The 1,500 irrigation wells with yields ranging from 900 to 2,500 gpm, provided 2,200 acre-feet per day. No appreciable declines were recorded in the overall water levels during this period of accelerated pumpage. In 1961, a year of normal riverflow, ground water pumpage for irrigation amounted to only about 3 acre-feet per day from 23 major irrigation wells.

The major use of water for agricultural purposes is irrigation. The principal crops irrigated are vegetables, cotton, grain sorghum, and citrus. Studies show that the supply of water from the Rio Grande would have been sufficient to meet the requirements of the present irrigated area of about 750,000 acres in full during 36 years of the 57-year period from 1900 to 1956. Surface water for irrigation is supplied by about 36 separate water districts and numerous independent irrigators by pumping from the Rio Grande. The status of irrigation in Cameron, Hidalgo and Willacy Counties for 1958 to 1964 is shown in table 2. This inventory shows that about 785,000 acres were irrigated during 1964. Domestic, municipal, and industrial water supplies are furnished by diversions from the Rio Grande supplemented by ground water. In addition, minor quantities of return flows are used to supplement industrial uses. Municipal and industrial use amounted to 40,700 acre-feet in 1958, of which 30,700 acre-feet were supplied from the Rio Grande. In 1963, domestic, municipal, and industrial use had risen to 62,000 acre-feet per year.

Water for recreational purposes has not been provided or assigned specifically for this purpose in any of the existing storage reservoirs. Water-based recreational needs are considered to be incidental to other water uses and of a nonconsumptive nature. Irrigation canals furnish some opportunities for fishing, hunting,and swimming.

Quality of the Natural Environment

The natural and scenic beauty of the Lower Rio Grande Valley relies mainly on its subtropical climate. The abundance of green vegetation, such as the thousands of acres of winter vegetables and citrus fruit, is unique and contrasts vividly with the brushy, scrubby rangelands which stretch for miles north of the area. The vegetables and citrus are accented by rows of stately palm and date trees and by attractive plantings of bougainvillaea, poinsettia, and oleander. Another facet of natural beauty possessed by the Rio Grande Valley is the seashore area of Laguna Madre and Padre Island, which has

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TABLE 2

IRRIGATION SUMMARY 1/
LOWER RIO GRANDE BASIN, TEXAS

County	Total Acres 2/ Irrigated		Total Acres Irrigated by Surface Water		Total Acres Irrigated by Ground Water		Total Acres Irrigated by Combined Surface and Ground Water		Total Acre-Feet Water Used		Previously Irrigated Acres but Not in Year Specified		Number of Irrigation Wells	
	1958	1964	1958	1964	1958	1964	1958	1964	1958	1964	1958	1964	1958	1964
Cameron	280,823	282,800	261,840	274,400	716	400	18,267	8,000	585,132	366,500	17,960	0	80	40
Hidalgo	419,900	466,471	354,000	354,571	5,800	2,500	60,100	109,400	596,599	507,170	4,900	1,000	359	540
Willacy	31,400	36,500	31,100	36,500	0	0	300	0	49,084	58,992	23,000	1,000	6	0
TOTAL	732,123	785,771	646,940	665,471	6,516	2,900	78,667	117,400	1,230,815	932,662	45,860	2,000	445	580

1/ Inventory of Texas Irrigation, 1958 and 1964.

2/ Water in Falcon Reservoir was allocated to about 754,800 acres in the three-county area.

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Scenic beauty of the Lower Rio Grande Valley relies on its subtropical climate.

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miles of sun-drenched sand and surf. Other important areas of natural beauty in the basin are the Arroyo Colorado, and National and State parks and wildlife refuges, and the La Sal Vieja and Sal del Rey Lakes.

Fish and Wildlife Resources

The fish and wildlife resources of the basin are described by the Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service as follows:

> There are both freshwater and marine fish habitats in the Lower Rio Grande Basin. The freshwater habitat is comprised of about 200 miles of the Rio Grande and 8,586 acres of resacas, impoundments, floodways, and irrigation canals. Marine fish occur in approximately 158,000 acres of bays, estuaries, and tidal streams.
>
> The principal species of freshwater fish are white bass, largemouth bass, white crappie, and other sunfishes; freshwater drum, black bullhead, blue catfish, flathead catfish, channel catfish, threadfin shad, gizzard shad, smallmouth buffalo, river carpsucker, carp, gars, Mexican tetra, and Rio Grande perch; and several species of minnows. Most of the fishing is for catfishes, largemouth bass, white crappies, white bass, and other finfishes. Seasonally, there are strong white bass runs in the Rio Grande downstream from Anzalduas Dam. A few smallmouth buffalos and many gars are taken as they are used as food by some local people. Freshwater fish habitat in the basin varies in quality from poor to moderately good. Unfortunately, much of it is of poor quality. Industrial, domestic, and agricultural pollutants have damaged or destroyed a considerable amount of the freshwater habitat. Increasing pollution and diversions of water are steadily degrading the habitat, especially in the Rio Grande and the floodway system. Large populations of black bullheads stir up silt and keep the water perpetually turbid in many of the impoundments and resacas. Fishing is heavy in areas where there is public access as in the Bentson-Rio Grande Valley State Park and various parts of the irrigation systems. There are few places where there is access to the Rio Grande.
>
> There is no significant amount of freshwater commercial fishing in the basin. People sometimes gather minnows for bait and larger fish for food and the commercial market when the canals, resacas, and impoundments in the irrigation system are drained for cleaning. These waters and the

Fishing in the Gulf of Mexico from the north jetty of the Brazos Santiago Pass.

Rio Grande provide considerable potential for freshwater commercial fish production in the basin. It is expected that greater amounts of freshwater commercial fish will be taken for food in the future as human populations expand and the need for food increases.

There is marine fish habitat in the Laguna Madre and the tidal segments of the floodways, streams, and drainage systems. Spotted seatrout, black drum, red drum, flounder, sheepshead, striped mullet, and menhaden are prominent, as are shrimp, blue crabs, and oysters. Estuarine portions of the streams and the Lower Laguna Madre are important spawning and nursery grounds for marine fishes, shrimp, and blue crabs. Spotted seatrout and shrimp are especially dependent upon extensive submerged stands of shoalgrass and widgeon grass. Important forage fish in the basin include pinfish, pigfish, silver perch, mojarra, anchovy, and silversides.

Marine commercial fishing is important to the economy of the basin. Considerable quantities of finfish are taken in the Laguna Madre. A large shrimp fishing fleet based at Port Isabel operates in the Gulf of Mexico.

There also is a small but important commercial fishery for oysters in South Bay. An annual average in excess of seven million pounds of commercial fish are landed in the basin. This amount is expected to increase in the future. Over 6,800,000 pounds of the catch are finfishes and shrimp taken from the Gulf of Mexico. However, marine sport fishing is expected to displace some commercial fishing for finfishes in a few years as a result of increasing sport catches of important game species such as spotted seatrout, red drum, and flounder.

The Lower Rio Grande Basin is in the South Texas Brushland Game Region, a region with a diversity of wildlife habitat. 1/ There are forest and brush associations comprised of plant species of subtropical and temperate origin such as ebony, huisache, granjeno, guayacan, whitebrush, retama, elm, hackberry, mimosa, anaqua, tepeguaje, and horse-bean. Stands of forests and brush are broken up intermittently by mesquite-cactus plant communities. Cordgrass, Bermudagrass, and grama grass occur in openings in the forests and are interspersed throughout the brush.

1/ Abridged from Principal Game Birds and Mammals of Texas, Texas Game, Fish and Oyster Commission, July 1945.

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Toward the coast, brush is restricted to occasional low ridges in the extensive coastal prairie and salt flat areas. The shallow brackish lagoons in the flat areas adjacent to the Laguna Madre have some stands of widgeongrass and shoalgrass. There are large acreages of rangelands in the northern and western portions of the basin. Intensively cultivated croplands, orchards, pastures, and urban areas comprise the remainder of the basin. Some croplands that become salty as a result of irrigation or natural conditions are allowed to grow up in brush or other native vegetation.

The basin is noted for its rich variety of wildlife, which includes several game animals and a number of especially interesting species that attract sportsmen and wildlife observers from many and distant localities. There are several rare, endangered, and peripheral species in the basin.

The terrestrial wildlife includes white-tailed deer, javelinas, wild turkeys, white-winged doves, white-fronted doves, mourning doves, ground doves, bobwhites, scaled quails, chachalacas, cottontails,and jackrabbits.

Species of waterfowl found in the basin include redhead, pintail, mallard, green-winged teal, blue-winged teal, canvasback, lesser scaup, bufflehead, ruddy duck, mottled duck, fulvous tree duck, black-bellied tree duck, coot, white-fronted goose, snow goose, and a number of other kinds of waterfowl.

There are oppossums, raccoons, beavers, minks, skunks, bobcats, ocelots, and jaguarundi in the basin. Roseate spoonbills, American egrets, snowy egrets, reddish egrets, white pelicans, sandhill cranes, and many other birds associated with wetland areas also inhabit the Lower Rio Grande Basin.

Additionally, there are a number of song and insectivorous birds that are considered rare or unique in the United States, a few of which are green jays, buff-bellied hummingbirds, kiskadee flycatchers, and olive sparrows.

There are a few predatory birds that are seldom seen elsewhere in the United States. The Southern bald eagle occasionally is seen in the area. There are a few American alligators in the basin and the Gulfside of the Padre Island National Seashore was historically a nesting habitat

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for the Green turtle. The song and insectivorous birds listed above, as well as a number of others found in the area, have been classed as peripheral and the Southern bald eagle and the American alligator as endangered species in the 1966 list of "Rare and Endangered Wildlife of the United States" compiled by the Bureau of Sport Fisheries and Wildlife.

Populations of white-tailed deer and javelinas are small and there is little hunting for them. Wild turkeys are few and provide little hunting. White-winged doves are moderately abundant, and mourning doves are abundant. Together, these two dove species provide most of the hunting in the basin. Bobwhites and scaled quail provide some hunting, but they are only moderately abundant and landowners do not permit much hunting for them. Chachalacas are restricted to forests and brushy areas. The Texas Parks and Wildlife Department is introducing them to areas where they have become extirpated and their populations are increasing locally. Chachalacas often become extremely abundant in favorable habitat but due to limited access there is only a limited amount of hunting for them.

Large populations of waterfowl, especially ducks, winter in the area. About 90 percent of the continental population of redheads winter in the Laguna Madre and they are one of the favorite ducks of the local hunters. Geese are moderately abundant. Their numbers have been increasing in recent years. Waterfowl sustain only a moderate amount of hunting principally because it is difficult to get to areas where they can be hunted. There is no trapping of fur animals and no significant amount of sport hunting for other wildlife.

The remaining forests and brushy areas generally are excellent wildlife habitat. These areas provide plant cover that is essential for roosting, nesting, and propagation of white-winged doves, mourning doves, other doves, and chachalacas. This is particularly important habitat since there is no significant amount of this kind of nesting habitat on the Mexico side of the Rio Grande adjacent to the basin. Populations of ocelots, jaguarundi, and several species of song and insectivorous birds also are dependent on the habitat. The estuaries and coastal prairies are important wintering grounds for large numbers of waterfowl and many other birds associated with wetlands. The rangelands support most of the white-tailed deer, wild turkeys, bobwhites, and scaled quail.

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The citrus orchards supply a considerable amount of moderately good-quality nesting habitat for white-winged doves. The croplands provide important feeding areas for many kinds of wildlife. Trees and shrubs in urban and industrial areas also are used by doves and many other birds for nesting.

There is excellent wildlife habitat in the Texas Parks and Wildlife Department's owned and leased game management lands. They are primarily brush and timbered areas that provide habitat for white-winged doves and chachalacas. The Bentsen-Rio Grande Valley State Park is composed of similar habitat.

Without the proposed project (contained in this report) populations of white-tailed deer and javelinas are expected to increase slightly. They would support a small increase in hunting. Wild turkey populations and hunting for them would remain at about present levels. Chachalaca populations would increase slightly but hunting would not increase greatly. Under the present conditions the Texas Parks and Wildlife Department intends to maintain white-winged dove populations and hunting at about their present levels. Mourning dove populations would remain about the same as they are now, but there would be more hunting. Bobwhite and scaled quail populations and hunting would not change significantly. Cottontails and jackrabbits would be hunted slightly more. Waterfowl populations would remain at about their present levels, but they would be hunted substantially more than now. Fur-animal populations would not change materially and trapping of fur animals for their pelts would not be significant. Ocelots, jaguarundi, and some other species of rare, endangered, or peripheral species could be expected to disappear from the basin unless adequate habitat and protection is provided for them.

Recreation Resources

The Bureau of Sport Fisheries and Wildlife summarizes the fish and wildlife aspects of recreation resources in the basin as follows:

> The basin is a winter resort area and a major gateway to Mexico. It contains many miles of good beaches and abundant and unique fish and wildlife resources. The tourist industry is expected to continue to expand rapidly in the future.

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The Laguna Atascosa National Wildlife Refuge on the Laguna Madre in eastern Cameron County and the Santa Anna National Wildlife Refuge on the Rio Grande in Hidalgo County are in the project area. The Padre Island National Seashore forms part of the eastern boundary of the Lower Rio Grande Basin.

There are several State or county parks in the basin. Bentsen-Rio Grande Scenic Park on the Rio Grande in Hidalgo County provides public camping, picnicking, fishing, and bird watching. It is used heavily, especially by tourists during the winter. Brazos Island Scenic Park near Boca Chica in Cameron County is an undeveloped Gulf beach that provides public access to the Gulf. The nearby Port Isabel Lighthouse is maintained as a historical site. South Padre Island Park, which extends north from Brazos Santiago Pass on Padre Island, is a county park operated by the Cameron County Parks Board. It provides public access to beaches on the Laguna Madre and the Gulf of Mexico.

There are a number of privately-owned recreation businesses in the basin that provide opportunities for hunting, fishing, and aesthetic appreciation of fish and wildlife. The enterprises include dude ranches, leased or permit hunting and fishing areas, campgrounds, cabins, privately-owned lakes, or other similar facilities.

Camping area in Bentsen-Rio Grande Valley Scenic Park

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ECONOMIC DEVELOPMENT

Historical Development

The Rio Grande Valley has a rather lengthy history of development by Europeans and their descendants. In 1749, Colonel Jose de Escandor established the first of many settlements for the Spanish Crown on the south bank of the Rio Grande. These settlements were used by Spain to secure its claim to the territory which was based upon exploration and partial settlement two centuries earlier. Settlement expanded slowly until land grants were issued. Ranching was the primary economic activity in the area.

Fort Brown was established in 1846, and the town of Brownsville shortly thereafter. Irrigation began in 1876, but very little expansion occurred until a railroad was built into the Lower Valley in 1904. Rail service made large irrigation projects feasible by providing a faster method for moving agricultural commodities. Numerous land companies were formed, and great energy and ingenuity were illustrated by the sales campaigns of these companies. Excursion trains were used by the land promoters to bring larger numbers of prospective land buyers from the north to the Valley. The mild weather, flourishing groves, and profusion of flowers in midwinter proved irresistible to many people.

The first major irrigation systems in the Valley were established around 1905 by large land and irrigation companies. These companies built the irrigation system, cleared and divided the land, and sold it to homeseekers brought to the Valley on excursion trains. The land and water companies did not last long, many were bankrupt by 1915.

Beginning in 1914, farmers organized irrigation districts, issued bonds, bought water rights owned by the development companies, and took over the companies activities. After 1914, increased irrigated acreage came about through expansion of existing districts or creation of new districts. The construction of extensive irrigation projects accelerated in the 1920's and continued through the early 1930's. Much of the development was paid for by the thousands of persons who bought small vegetable and citrus farming tracts.

Before large-scale irrigation was introduced into the Valley, the cattle industry predominated. After irrigation was started, cattle production almost ceased to exist. In recent years, there has been an increase in forage crop acreage. However, few Valley farmers specialize in livestock production.

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In the spring of 1902, rice was planted near Brownsville as an experimental crop. When the crop was harvested, it was of the very highest quality and the yields per acre were amazing. Prospects looked so good that a $25,000 rice mill was constructed in the city of Brownsville. The Valley had everything required to grow rice--rich soil, plenty of fresh water, lots of sunshine, and a long growing season. However, without warning the rice crops withered and died. Due to the abundance of water, salt and alkali in the subsoil floated to the surface killing all plant life. This brought the rice industry to an abrupt conclusion. 1/

Sugarcane had been cultivated in the Valley for many years, but in 1911, the industry began to expand rapidly. New land was brought into production and much northern capital was invested. Production reached a peak about 1914, after which severe competition from foreign countries and water and insect problems caused the industry to gradually disappear.

Don Macedona Vela planted the first citrus in the Valley in the early 1880's. The earliest successful commercial citrus planting was done by Charles Volz in 1908. However, until about 1917, citrus in the Valley was primarily valued for ornamental purposes. In 1920, the industry achieved recognition when about 124,000 trees were reported in the area. Early plantings were mainly white seedy grapefruit and seedy oranges. In 1931, red grapefruit was perfected and widely planted. By 1949, there were 14 million trees; however, the 1949 and 1951 freezes killed 80 percent of them, bringing citrus production to an abrupt halt. Most trees planted after these freezes were red grapefruit. Again in 1962, 30 percent of the trees were destroyed. By 1967, the number of trees in the Valley had been increased to 6,347,900.

Cotton production also began in the early part of this century. However, due to the insect problems it was not widely planted until 1946, when the United States Department of Agriculture began its Pink Bollworm Control program. Also, reduction in citrus acreage, due to the severe freezes in 1949, 1951, and 1962, greatly stimulated cotton production. In fact, it was thought that these freezes would hurt the Valley's economy for many years, but cotton filled the gap. Cotton production in recent years has been around 400,000 bales.

1/ John R. Peavey, Echoes from the Rio Grande (Brownsville, Texas: Springman-King Company, 1963), pp. 50-53.

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A three year old nonbearing orange grove.

Bearing orange trees.

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Since settlement, vegetables have been produced in the Valley in considerable quantities. The short growing period required for vegetables permits a farmer to harvest them and produce a second crop, usually cotton or sorghum. However, development has been restricted historically by freezes, inadequate transportation, and problems of marketing these crops. Sorghums have a rather short history in the Valley. They are of increasing importance, being used for grazing and cover crops as well as cash crops.

Population

Population of the basin more than doubled from 165,043 in 1930 to 352,086 in 1960, an average annual growth rate of 2.56 percent (table 3). The most rapid period of population growth in the basin was during the decade from 1940 to 1950 when the population in the basin experienced an average annual growth rate of 4.23 percent. The population growth in the basin decreased in the decade from 1950 to 1960 to an average annual growth of 1.4 percent.

Migration to the Valley from Mexico has been an important factor in the population increase. In 1960, over two-thirds of the region's population had Spanish surnames, and 44 percent of the total population was of foreign stock (that is, foreign-born or children of foreign-born parents). During the 1955-60 period, more than 15,000 people from other parts of the United States moved to the Valley and nearly 10,000 came to the Valley from Mexico or other foreign countries. This equals a gross in-migration of 5,000 persons per year from outside Texas.

The increase in population before 1930 was due to the rapid development of citrus orchards and vegetable production, which provided employment opportunities. The increase since 1930 has been due to the expansion of industries, particularly those which process agricultural products. Nearly all of the inhabitants live within the irrigated area of the Valley, which is less than one-half of the three county area.

In 1930, slightly more than 50 percent of the population lived in urban areas, compared to approximately 72 percent in 1960. The increase in urban population has been largely a result of machinery replacing farm labor, greater efficiency in farm and ranch operation, increase in sizes of farms, and the development of industries which offer higher pay. Rural farm population decreased from 32 percent in 1940 to 8 percent in 1960 (table 3). Rural nonfarm population as a percent of total population remained fairly constant at approximately 19 percent from 1940 to 1960.

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Population projections developed by the Texas Water Development Board show that the population of the basin is expected to increase from 352,086 in 1960 to 486,600 in 1980, 642,700 in 2000, and 848,900 in 2020 (table 3). This means that resources in the basin will have to feed, clothe and shelter 38 percent more people in 1980, 82 percent more people in 2000, and 141 percent more people in 2020.

Housing, employment, and public services in the urban areas will have to be expanded to absorb a projected urban population of 373,600 in 1980, 502,400 in 2000, and 668,400 in 2020. Rural nonfarm population is expected to increase from 68,977 in 1960 to 97,200 in 1980, 128,500 in 2000, and 169,800 in 2020.

Rural farm population is expected to follow recent trends and decrease from 28,516 in 1960 to 15,800 in 1980, 11,800 in 2000, and 10,700 in 2020.

Major Types of Economic Activity

Agricultural production from crop and grazing land with a normal gross value in excess of $100 million annually is the primary economic activity of the basin. Principal crops include cotton, grain sorghum, vegetables, and citrus. Oil, gas, and building materials production are significant to the basin economy and has increased from $17,380,000 in 1954 to $43,874,000 in 1964. Value added by manufacturing has increased from $25.5 million in 1954 to $56 million in 1963. Food and kindred products accounted for the major portion of this value. Tourism and fish industries also make sizable contributions to the economy.

Trade sale and services receipts have continued to increase with services receipts experiencing the greatest percentage increase as follows:

Item	Year			Percentage Increase	
	1954	1958	1963	1954-1958	1958-1963
	-----thousands of dollars-----				
Retail Sales	220,985	279,210	295,963	26.3	6.0
Wholesale Sales	219,675	277,989	299,338	26.5	7.7
Services Receipts	20,135	25,830	31,051	28.3	20.2

TABLE 3
POPULATION 1930-1960 1/ AND PROJECTED 1980, 2000, and 2020 POPULATION,
LOWER RIO GRANDE BASIN, TEXAS

Year	Total	Urban	Rural			Urban	Rural		
			Total	Farm	Non-Farm		Total	Farm	Non-Farm
	numbers					percent of total			
1930	165,043	82,728	82,315	-	-	50.1	49.9	-	-
1940	202,581	99,520	102,971	64,855	38,116	49.2	50.8	32.0	18.8
1950	306,536	176,627	129,909	56,807	73,102	57.6	42.4	18.5	23.8
1960	352,086	254,593	97,493	28,516	68,977	72.3	27.7	8.1	19.6
1980	486,600 2/	373,600	113,000	15,800	97,200	76.8	23.2	3.2	20.0
2000	642,700 2/	502,400	140,300	11,800	128,500	78.2	21.8	1.8	20.0
2020	848,900 2/	668,400	180,500	10,700	169,800	78.7	21.3	1.3	20.0

1/ U. S. Census of Population: 1940-1960, Texas, U. S. Department of Commerce, Bureau of Census.

2/ Estimates of total population developed by the Texas Water Development Board.

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Employment

Employment has remained at about 32 percent of the total population during the two decades from 1940 to 1960. Table 4 shows employment in 1940, 1950, and 1960. Total 1960 employment was approximately 110,900, an increase of 72 percent from the 1940 employment of approximately 64,400. However, agricultural employment as a percentage of total employment has decreased from 42.2 percent in 1940 to 34.7 percent in 1950, and 23.3 percent in 1960.

In addition to showing employment table 4 also shows the components of employment change in each of the periods 1940-50 and 1950-60. These components of employment change consist of three parts for any single industry. The first of these is the change that would have occurred at the standard region rate (national in this case); the second is change related to industrial mix; and the third is change related to alteration in regional share. The three parts sum to the actual change. Change from 1940 to 1950 in employment in agriculture related to national growth (7,282), represents the agriculture employment increase from 1940 to 1950 that would have occurred in the basin, if the industry had increased at the national rate for all industries for the same period. Industrial mix (-12,183) represents an adjustment for the fact that, nationally in the decade of the 1940's, agriculture was a slow growth industry in terms of employment. The employment expansion rate was less than that for all national industries combined. Regional share (11,084), reflects a further adjustment for the fact that agriculture employment increased more rapidly in the Southwest region than in the Nation as a whole from 1940 to 1950. In summary, the employment change in agriculture from 1940 to 1950 in the basin would have been 7,282 had it grown at the national rate for all industries combined. Because agriculture was one of the Nation's slow growth industries in terms of employment and because the Southwest region's rate of agricultural employment growth was nearly double that for the nation, the actual employment change in agriculture in the basin was 6,183.

The rate of growth in employment in manufacturing has proceeded at a more rapid rate in Texas and in the basin than in the United States as a whole, During the period 1940-1960, employment in manufacturing increased 55.3 percent in the United States, 155.3 percent in Texas and 140.7 percent in the basin.

Employment in agriculture in the basin will continue to decline as reflected in projections of rural farm population. Total employment will continue to increase, supporting the projected population. The present ratio of employment to population is approximately 31.5 percent.

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TABLE 4

EMPLOYMENT AND COMPONENTS OF EMPLOYMENT CHANGE
LOWER RIO GRANDE BASIN, TEXAS

Industry	Employment in			Components of Employment Change: 1940-1950: Changes Related to				1950-1960: Changes Related to			
	1940	1950	1960	National Growth	Industrial Mix	Regional Share	Total Change	National Growth	Industrial Mix	Regional Share	Total Change
Agriculture	27,310	33,493	25,882	7,282	-12,183	11,084	6,183	5,185	-18,068	5,273	-7,610
Forestry and Fisheries	275	469	721	74	-29	151	196	73	-192	372	253
Mining	497	918	1,233	133	-126	415	422	142	-415	587	314
Contract Construction	2,914	6,434	5,715	777	1,179	1,564	3,520	995	-329	-1,386	-720
Manufacturing											
Food and Kindred Products	1,515	3,547	5,459	404	18	1,610	2,032	549	475	887	1,911
Apparel	47	72	767	12	3	9	24	11	-5	689	695
Other	1,304	3,280	3,308	345	181	1,445	1,971	507	387	-866	28
Total	2,866	6,899	9,534	761	202	3,064	4,027	1,067	857	710	2,634
Transportation	2,219	3,488	3,020	610	281	397	1,271	540	-376	-631	-467
Communications	371	961	1,000	99	199	290	588	148	0	-106	42
Utilities and Sanitary Service	538	1,982	2,354	144	94	1,206	1,444	307	-20	86	373
Wholesale Trade	5,355	6,206	7,993	1,427	1,992	-2,569	850	961	-238	1,064	1,787
Retail Trade	8,290	14,569	17,733	2,211	706	3,363	6,280	2,255	-659	1,568	3,164
Finance, Insurance and Real Estate	983	1,956	2,607	261	40	672	973	303	485	-137	651
Services	9,985	15,109	21,712	2,664	-1,595	4,059	5,128	2,340	2,197	2,067	6,604
Public Administration	1,539	2,501	4,403	411	657	-106	962	387	298	1,218	1,903
Armed Forces	603	105	4,269	161	1,260	-1,919	-498	16	56	4,092	4,164
Industry Not Reported	696	1,330	2,716	185	-32	481	634	206	2,582	-1,401	1,387
TOTAL	64,441	96,417	110,892	17,183	-7,355	22,152	31,980	14,925	-13,822	13,376	14,479

Source: Lowell D. Ashby, Growth Patterns in Employment By County, 1940-1950 and 1950-1960, Volume 6 Southwest, U. S. Department of Commerce Office of Business Economics.

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It is expected that this ratio will increase. Assuming a ratio of 33 percent in 1980,34 percent in 2000, and 35 percent in 2020; projected total employment would be 160,600 in 1980, 218,500 in 2000, and 297, 100 in 2020.

Transportation and Communication

The basin's major transportation facilities include three United States highways,rail connections by the Missouri Pacific and the Southern Pacific railroad systems, four ocean ports for water transportation and three major airports. Natural gas pipelines of six major companies connect the basin with other areas of the United States. Four jointly owned International bridges, including a rail crossing, two major highway routes to the interior of Mexico, and the National Railways System of Mexico also serve the area.

There is an extensive network of state highways and farm roads within the basin. A new expressway which is under construction from Brownsville, via Harlingen and McAllen, to west of Mission is expected to be completed by 1969 or 1970. Ten major motor-freight carriers provide service to and from the basin, and three major intercity bus companies serve much of the area. Through truck service from the border to all points in Mexico is also available.

Ports at Brownsville and Port Isabel are served by more than 60 steamship and tanker lines and by eight common-carrier barge lines. Port Brownsville is also the southern terminus of the United States' Intercoastal Canal and Inland Waterways Systems. Ports at Harlingen and Port Mansfield also handle barges.

Two scheduled airlines, Texas International Airlines and Braniff International Airways, provide daily passenger service from the basin to major U. S. cities. Texas International Airlines provides daily flights to Mexico City and other points in Mexico. In addition, Mexican air service provides similar flights to Mexico City and other points in Mexico from airports in Matamoros and Reynosa, Mexico.

Electric power, telephone, and telegraph services are available throughout the basin and radio and television coverage is adequate. Nearly all farms have telephones and electric power.

Agricultural Growth Characteristics and Income

Farms. One of the most significant aspects of the basin's agriculture has been the steady decline in number of farms and the resulting increase in average farm size (table 5). In 1964, there were 5,169 farms,

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Port of Entry and International Bridge at Nuevo Progresso.

TABLE 5

DISTRIBUTION OF FARMS BY SIZE GROUPS AND CAPITAL INVESTMENT, LOWER RIO GRANDE BASIN, TEXAS

Category	Unit	1949	1954	1959	1964
All Farms	Number	9,824	7,773	6,586	5,169
Less Than 49 Acres	Percent	53.5	46.4	48.3	48.2
50-99 Acres	Percent	16.1	15.5	13.1	11.7
100-179 Acres	Percent	13.4	15.0	12.7	10.2
180-259 Acres	Percent	5.4	7.6	7.7	7.0
260-499 Acres	Percent	6.2	8.4	9.0	11.0
500-999 Acres	Percent	3.1	4.5	5.8	7.1
Greater Than 1,000 Acres	Percent	2.2	2.6	3.4	4.7
Average Size	Acres	188	249	254	298
Value of Land And Buildings					
Per Farm	Dollars	40,621	51,199	65,628	83,906
Per Acre	Dollars	216	205	259	282

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, 1964

Shrimp fleet based at Port Isabel, Texas.

Ocean tanker taking on a load of crude oil.

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4,655 less than in 1949. The average farm size in 1964 was 298 acres, 110 acres larger than in 1949. In 1964, 4.7 percent of the farms were larger than 1,000 acres, and an additional 7.1 percent of the farms were between 500 and 1,000 acres.

Another significant aspect is the large group of farms in the less than 49-acre category. This group represents 48.2 percent of the farms in the basin and consists largely of marginal fruit and vegetable farms, retirement farms, and other noncommercial farms.

Investment in Agriculture. The 1964 farm census listed the average value of land and buildings as $83,906 per farm (table 5). The value of land and buildings used for agricultural purposes is about $434 million. There are other sizable investments in agriculture which include machinery, equipment, livestock, and grains on farms.

The average per acre value of farm real estate increased more than 30 percent between 1949 and 1964. This increase is largely a result of continued capital investment in private irrigation development, rehabilitation of existing irrigation and drainage facilities and a large inflow of nonagricultural capital into agricultural land. Similarly capital value per farm more than doubled during the same period, because of the increase in value per acre and the considerable increase in farm size.

Tenure. Tenancy is substanially less than the national and state average. The percent of farms operated by tenants has dropped from 21.5 percent in 1949 to 13.2 percent in 1964 (table 6). Numbers of farmers in all tenure categories have decreased sharply, with the greatest decrease occurring in tenancy.

Farms operated by full owners have also decreased significantly. Two deterrents to full ownership of farms have been the expansion of irrigation and the redevelopment of large acreages of citrus, both of which require a high investment. With larger farms, increasing land values, and an increasing need for costly machinery, farmers will be less likely to own all of the land they operate.

Farm Income. In 1964, cash receipts from crop and livestock sales were $98 million (table 7). Receipts from crop sales represented more than 84 percent of the total sales. Gross farm income averages $18,900 per farm. Income of farm families from nonfarm sources in 1964 exceeded $16.2 million. This included income from sources such as, wages, nonfarm businesses and professions, rents, social security, and welfare. Table 6 shows the significance of employment and income from off-farm sources.

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All family median income in the basin is considerably below the state level, and has increased during the past decade only slightly faster than the state rate in two counties and slower than the state rate in one county (table 8). Farm family median income in the basin in 1959 compared favorably to Texas and the United States medians of $3,014 and $3,228, respectively.

The percentage of all families in Cameron, Hidalgo, and Willacy Counties having incomes under $3,000 in 1959 was 47.2, 53.9, and 51.6 percent, respectively (table 9). This is a significantly higher percentage than the 21.4 and 28.8 percent for the United States and Texas, respectively. The three counties have a low percentage of families with incomes of $10,000 and over, when compared to the United States and Texas.

The Farm Operator Level-of-Living Index, indicates that at the present time the basin's agriculture compares favorably with agriculture in general (table 10). The conclusion from this is that, while the basin may suffer from low agricultural income, it reflects an industry-wide problem. Though there is no indication that the area has special or unique low income problems in agriculture, the past advantage enjoyed by the area is disappearing. From 1959 to 1964, the Level-of-Living Index increased by only nine points for the basin, 28 points for Texas, and 22 points for the nation.

Commercial Farms. Commercial farms are regarded as the backbone of agriculture. They produce most of the agricultural products in terms of volume and value. In 1964, there were 3,324 commercial farms in the basin or 4,614 less than in 1949 (table 11). Farms not classed as commercial farms account for a relatively small volume of the total farm products sold in the basin. However, 35 percent of the farms in the basin fall in this category.

Livestock on Farms and Numbers Sold From Farms. In 1964, 237 farms in the basin received over half of their income from the sale of livestock and livestock products. An additional 80 farms received over half of their income from the sale of dairy products and poultry and poultry products. Only 317, which is less than 10 percent, of the commercial farms in the basin rely on livestock production for their major source of income. This indicates the minor importance of the livestock enterprise to the majority of the commercial farmers in the basin. However, cattle and calves on farms and cattle and calves sold from farms have increased 78.2 and 216.8 percent, respectively, between 1949 and 1964 (table 12). They are expected to continue to increase.

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TABLE 6

OWNERSHIP OF FARMS AND OFF FARM EMPLOYMENT
LOWER RIO GRANDE BASIN, TEXAS

Farms Operated By	Unit	1949	1954	1959	1964
All Farm Operators	Number	9,824	7,773	6,586	5,169
Full Owners	Number	4,666	3,450	3,100	2,470
Part Owners	Number	2,724	2,834	2,364	1,832
Managers	Number	320	86	158	187
All Tenants	Number	2,114	1,403	964	680
Full Owners	Percent	48	44	47	48
Part Owners	Percent	28	37	36	35
Tenancy	Percent	22	18	15	13
Managers	Percent	2	1	2	4
Operators Working Off Their Farms	Percent	35	34	45	49
Operators Working Off Farm 100 days or More	Percent	27	26	36	38
Operators With Other Income Exceeding Value of Farm Products Sold	Percent	25	22	37	n.a.

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, 1949-1964.

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TABLE 7

VALUE OF FARM PRODUCTS SOLD
LOWER RIO GRANDE BASIN, TEXAS

Items	1949	1954	1959	1964
	-----------	thousands	of dollars	----------
<u>All Farm Products</u>	113,746.1	103,450.3	113,654.0	97,687.2
Average Per Farm	11.6	13.3	17.2	18.9
<u>All Crops</u>	107,963.6	97,385.5	100,265.6	82,438.6
Field Crops	82,014.1	81,385.5	77,555.3	64,321.2
Vegetables	11,907.3	11,659.3	11,412.8	12,583.8
Fruits and Nuts	12,800.6	3,148.6	9,679.8	3,732.6
Forest and Horticultural	1,241.7	1,451.8	1,617.7	1,801.0
<u>All Livestock and Livestock Products</u>	5,782.4	6,064.8	13,388.3	15,210.1
Livestock and Livestock Products Other Than Poultry and Dairy	3,628.3	3,749.2	9,756.9	12,173.0
Poultry and Poultry Products	388.4	596.5	1,150.3	1,252.6
Dairy Products	1,765.7	1,719.1	2,481.1	1,784.5

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, 1964.

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TABLE 8

MEDIAN FAMILY INCOMES
UNITED STATES, TEXAS,
AND LOWER RIO GRANDE BASIN COUNTIES

Area	All Family Median Income 1949 1/	All Family Median Income 1959	Percentage Change 1949 to 1959	Farm Family Median Income 1959
	(dollars)	(dollars)	(percent)	(dollars)
United States	3,774	5,660	50	3,228
Texas	3,324	4,884	47	3,014
Lower Rio Grande Basin Counties				
Cameron	2,311	3,216	39	2,838
Hidalgo	1,781	2,780	56	3,147
Willacy	1,869	2,902	55	3,708

1/ Based on 1959 dollars.

Source: U. S. Department of Agriculture, ERS Statistical Bulletin No. 339, Median Family Income and Related Data by Counties Including Rural Farm Income.

TABLE 9

INCOME IN 1959 OF FAMILIES IN UNITED STATES, TEXAS, AND LOWER RIO GRANDE BASIN, 1960

Area	Median Income	Under $3,000	$10,000 and Over
	(dollars)	(percent)	(percent)
United States	5,660	21.4	15.1
Texas	4,884	28.8	11.8
Lower Rio Grande Basin Counties			
Cameron	3,216	47.2	6.9
Hidalgo	2,780	53.9	6.5
Willacy	2,902	51.6	8.4

Source: U. S. Bureau of the Census, County and City Data Book, 1967 (A Statistical Abstract Supplement), U. S. Government Printing Office, Washington, D. C.

TABLE 10

FARM OPERATOR LEVEL-OF-LIVING INDEXES
FOR UNITED STATES,WEST SOUTH CENTRAL REGION,
TEXAS, AND LOWER RIO GRANDE BASIN, TEXAS

Area	Level-of-Living Index 1/			Change in Index		Percentage Increase	
	1950	1959	1964	1950-59	1959-64	1950-59	1959-64
	--------points----------			-------points----------		--------percent --------	
United States	59	100	122	41	22	70	22
West South Central 2/	47	91	120	44	29	94	32
Texas	59	103	131	44	28	75	27
Lower Rio Grande Basin	83	118	127	35	9	70	8

1/ Base: 1959 U. S. Average = 100

Source: Farm Operator Level-of-Living Indexes for Counties of the United States 1950, 1959, and 1964, Statistical Bulletin No. 406, Economic Research Service, U. S. Department of Agriculture.

2/ Includes: Arkansas, Louisiana, Oklahoma, and Texas.

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TABLE 11

DISTRIBUTION OF COMMERCIAL FARMS BY INCOME,
LOWER RIO GRANDE BASIN, TEXAS

Category	Unit	1949	1954	1959	1964
Commercial Farms	Number	7,938	6,286	4,677	3,324
Income					
Less Than $2,499 1/	Percent	24.4	21.7	8.2	19.8
$2,500 to 4,999	Percent	18.9	17.0	21.0	16.6
$5,000 to 9,999	Percent	21.2	20.5	17.9	14.3
$10,000 and Over	Percent	35.5	40.8	52.9	49.3

1/ Excluded farm operators over 65 years of age and farm operators working off the farm 100 or more days.

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, Texas, 1949-1964.

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TABLE 12

LIVESTOCK ON FARMS
AND LIVESTOCK AND LIVESTOCK PRODUCTS SOLD FROM FARMS
LOWER RIO GRANDE BASIN, TEXAS

Items	1949	1954	1959	1964
Numbers on Farms				
All Cattle and Calves	68,685	104,162	90,321	122,409
Milk Cows	12,176	11,097	7,435	5,817
Hogs and Pigs	13,008	10,102	18,011	8,133
Sheep and Lambs	1,002	1,366	3,560	697
Chickens, 4 Months Old and Over	181,443	184,619	321,618	270,723
Turkeys Raised	5,252	4,346	3,580	4,745
Numbers Sold From Farms				
All Cattle and Calves	30,475	46,481	69,848	96,534
Cattle	16,091	20,794	51,383	34,552
Calves	14,384	25,687	18,465	61,982
Hogs and Pigs	8,625	6,438	13,207	10,402
Sheep and Lambs	696	324	1,203	438
All Chickens	98,986	80,270	168,334	44,628
Dozen Eggs	563,569	1,080,660	3,401,680	3,267,696
Pounds Whole Milk (000)	27,393.7	30,582.8	40,692.1	32,274.9
Pounds Cream	50,228	15,383	4,000	1,288
Pounds Wool	2,281	5,006	16,274	2,540

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, Texas, 1949-64.

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Livestock production on farms, although minor is expected to increase.

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Grain Storage. Off-farm grain storage capacity in the basin has increased from 900,000 bushels in 1955 to about 6,400,000 bushels in 1966 or more than 700 percent. The large increase in off-farm grain storage is due to the rapid increase in the production of grain sorghum and other feed grains. Export of feed grains from the basin has also increased which has necessitated additional storage facilities at the basin ports.

Fertilizer. Farmers in the basin fertilized 440,000 acres with approximately 55,000 tons of fertilizing materials in 1964 (table 13). This was an increase of 61 percent in acres fertilized since 1954, and an increase of 52 percent in materials applied. However, pounds of fertilizer applied per acre fertilized decreased from 264 pounds in 1954 to 249 pounds in 1964. Use of fertilizer to replace the natural plant nutrients depleted from the soils by the higher crop yields will continue to increase in the future.

Land Use

The basin contains 2,209,300 acres of land and water (table 14). About 1,792,800 acres or 81 percent of the basin is agricultural land. The remaining 19 percent consists of 146,200 acres of non-agricultural land and 270,300 acres of large water areas.

Nonagricultural land consists of urban and builtup areas, small water areas, and Federal land not used for agricultural purposes. Federal land leased or used for agricultural purposes is included in agricultural land. Urban and builtup areas include cities, villages, and associated industrial sites, railroad yards, cemeteries, airports, golf courses, and institutional and public administrative sites and similar types of areas. Roads and railroads are included in urban and builtup areas. Small water areas include acreages of water less than 40 acres in size and streams less than one-eighth of a mile wide.

The basin contains 270,300 acres of large water areas, which includes approximately 232,000 acres of water area in Laguna Madre and the Gulf of Mexico. Only 38,000 acres of the large water area is actually located inland and above sea level.

Agricultural Land. Use of the agricultural land was developed within the framework used in the 1958 and 1966 USDA Conservation Needs Inventory. Agricultural land, as defined for these reports, includes cropland, both irrigated and nonirrigated, pasture and range. About 1,038,000 acres are classed as cropland in the basin. Of this acreage, approximately 900,400 acres or 87 percent is harvested cropland. About 84,800 acres are double cropped each year.

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Less intensive use is made of 101,600 acres of land in permanent tame pasture. Approximately 593,000 acres of land or 33 percent of the agricultural land is range. About 60,200 acres of other agricultural land is nonproductive uses.

Land Use Projections. Shifts of acreages of land between agricultural and nonagricultural uses expected in the future are only those necessary to accommodate the increase in population. Therefore, the major change in projected land use shown in table 14 is the increase in urban and builtup area. Much of the additional urban and builtup area will occur on land currently irrigated. Some of the irrigated land lost to urban and builtup area will be replaced by new irrigation development. However, a continuous net loss is expected in the future. Therefore, less and less land will be available for agricultural purposes.

This projected decrease in acreage available for agricultural production is readily apparent in table 15. Total land available for agricultural purposes is projected to decrease from 1,792,800 acres at present to 1,733,600 acres in 1980, 1,677,700 acres in 2000, and 1,602,400 acres in 2020. Projected land use in the basin does not include proposed new irrigation development to be supported by the importation of water under the Texas Water Plan.

Crops, Pasture, and Range Production

Agricultural production in the basin has increased rapidly in recent years due in part to development and wide use of insecticides. Because of climatic conditions in the basin, insects were a serious hindrance to agricultural production before the general use of insecticides. Agricultural production will continue to increase in the future, with the rate of increase depending largely on the adoption of on-farm drainage, improved varieties, and other improved farming practices.

Cotton. Acres of cotton planted in the basin are expected to follow recent trends and continue to decrease from the present normal irrigated and dryland acreage of 244,400 acres and 93,800 acres, respectively. 2/ Increasing acreage is being diverted from cotton under the ASCS Crop Diversion program. Most diverted acres are not expected to return to cotton.

2/ Cotton acreages and yields were based on data furnished by the cotton-classing office in Harlingen, Texas.

TABLE 13

ACRES FERTILIZED AND FERTILIZER APPLIED,
LOWER RIO GRANDE BASIN, TEXAS

Item	1954	1959	1964
Land Fertilized		acres	
Total	272,624	369,689	440,238
Cotton	152,588	214,097	199,335
Sorghum	-	9,498	81,931
Hay & Cropland Pasture	19,911	5,829	16,733
Other Pasture	1,807	1,787	4,072
All Other Crops	98,318	138,478	138,167
Fertilizer Applied		tons	
Total	36,043	49,311	54,878
Cotton	18,197	24,897	21,936
Sorghum	-	807	6,222
Hay and Cropland Pasture	1,537	720	2,610
Other Pasture	286	212	253
All Other Crops	16,023	22,675	23,857
Fertilizer Applied Per Acre		pounds	
All Acres	264.4	266.8	249.3
Cotton	238.5	232.6	220.1
Sorghum	-	169.9	151.9
Hay and Cropland Pasture	154.4	247.0	311.9
Other Pasture	316.5	237.3	124.3
All Other Crops	325.9	327.5	345.3

Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, Texas, 1954-1964.

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TABLE 14

PRESENT AND PROJECTED 1980, 2000, and 2020 AGRICULTURAL, NONAGRICULTURAL AND LARGE WATER AREAS LOWER RIO GRANDE BASIN, TEXAS

Year	Agricultural Land	Nonagricultural Land: Federal Land 3/	Nonagricultural Land: Urban and Builtup Area	Nonagricultural Land: Small Water Areas	Nonagricultural Land: Total Non-agricultural Land	Total Land Area	Large Water Area	Total Area
	thousands of acres							
Present	1,792.8 1/	28.9 1/	115.8 1/	1.5 1/	146.2 1/	1,939.0 1/	270.3 2/	2,209.3 2/
1980	1,733.6	28.9	174.9	1.6	205.4	1,939.0	270.3	2,209.3
2000	1,677.7	28.9	230.7	1.7	261.3	1,939.0	270.3	2,209.3
2020	1,602.4	28.9	305.9	1.8	336.6	1,939.0	270.3	2,209.3

1/ U. S. Department of Agriculture, Soil Conservation Service, upublished preliminary Conservation Needs Inventory, 1966.

2/ U. S. Department of Commerce, Bureau of the Census, Area Measurement Reports, GE-20, No. 45, December, 1965.

3/ The unpublished preliminary Conservation Needs Inventory, 1966, included as agricultural land, 11,500 acres of mud flats and 2,100 acres of other miscellaneous land owned by the Federal Government. Also, 6,700 acres of water area in Laguna Madre owned by the Federal Government was included in large water area in the inventory.

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TABLE 15

PRESENT AND PROJECTED 1980, 2000, AND 2020
AGRICULTURAL LAND USE,
LOWER RIO GRANDE BASIN, TEXAS 1/

Land Use	Present	1980	2000	2020
	-------thousands of acres			
Cropland	1,038.0	990.8	958.9	915.8
Irrigated	689.8	659.4	638.2	609.5
Double-cropped 2/	84.8	82.0	79.4	75.8
Dryland	348.2	331.4	320.7	306.3
Tame Pasture	101.6	111.2	107.6	102.8
Irrigated	60.2	65.8	63.7	60.9
Dryland	41.4	45.4	43.9	41.9
Range	593.0	573.4	554.9	530.0
Other Agricultural Land	60.2	58.2	56.3	53.8
Total Agricultural Land	1,792.8	1,733.6	1,677.7	1,602.4

1/ Proposed new irrigation development to be supported by the importation of water under the Texas Water Plan is excluded.

2/ Land on which two or more crops are planted each year.

Present normal yield of cotton for the basin, including irrigated and dryland, is 480 pounds of lint per acre. Based on acres of irrigated and dryland cotton and an estimated yield of dryland cotton of 350 pounds of lint per acre, the yield of irrigated cotton is estimated at 530 pounds of lint per acre.

Grain Sorghum. Production of grain sorghum is becoming increasingly important in the basin. According to the agricultural census, sorghum planted for grain has increased from 34,000 acres in 1949 to 281,000 acres in 1964. The Statistical Reporting Service reported 351,000 acres in 1965. The present normal acreage of grain sorghum shown in table 16 includes acreages of other minor row crops and reflects recent trends. Dryland yield was estimated at 19 CWT per acre and the irrigated yield calculated. Present normal yield of irrigated grain sorghum is estimated at 34 CWT per acre.

Production of grain sorghum and associated cattle feeding are expected to continue to increase in the future.

Citrus. Acreage of citrus bearing age (four years of age and older) in the Valley has varied from 122,500 acres in 1948-49 to 55,200 acres in 1966. Acreage of nonbearing citrus (three years of age and less) currently amounts to 19,800 acres. New plantings of citrus have decreased rapidly in recent years and currently average approximately 800 acres a year. New plantings of citrus for commercial groves are limited with most of the acreage going into groves being developed for sale to nonresidents.

Initial investment and development costs for citrus amount to approximately $1,550 per acre and requires 12 to 15 years to recover. Farmers developing citrus groves must obtain capital from current income or mortgage other assets because many financial institutions in the Valley will not loan money to develop citrus groves. Thus, the high capital requirement limits the development of a citrus grove by an individual farmer to a few acres each year.

The struggle to establish and maintain mature producing groves has been continuously hampered by periodic freezes. Freezes in 1949, 1951, and 1962 destroyed large acreages of citrus. The trees that survived required severe pruning to remove damaged branches. Pruning citrus trees lowers their productive capacity for several years. For example, trees that survived the 1962 freeze and are currenlty 8 to 12 years old are producing yields similar to unpruned 4- and 5-year-old trees.

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Yields from bearing groves are also low because of the relatively low number of trees per acre. Bearing groves averaged 76 to 87 trees per acre in 1965. Texas A&M University research indicates that the most profitable production is obtained from 116 trees per acre in groves less than 25 years of age. Present normal yields for citrus were based on production records for the 20-year period preceding the 1961-62 freeze. Normal yields in tons per bearing acre are: early oranges, 4.3; late oranges, 2.4; and grapefruit, 7.8. Yields in recent years have averaged approximately 3.6, 2.0, and 5.3, respectively.

Low yields from the older trees during the frequent period of recovering from freezes, low numbers of trees per acre, and the necessity of replanting large acreages of citrus trees after each freeze has prevented the potential for profitable citrus production in the Valley from being realized in the past two decades.

> Texas has enough grapefruit groves to become a major factor in the grapefruit market. As marketings increase, a continued testing of volume-price relationships will occur. There is every indication of a need to analyze the probable market position when current grapefruit plantings achieve full production. Indications are that additional plantings would not be profitable in Texas under existing institutional relationships.
>
> Valley orange production is extremely small, occupying less than 2 percent of United States production. Quantities are too small for the development of a major processing industry. Neither quality nor quantity are appropriate for being a major competitive force in the fresh orange industry. It is possible that some potential exists for expansion of orange plantings, if capital is available under the sizable risks involved. 3/

Vegetables. Acres of vegetables harvested for sale in the Lower Rio Grande Basin have decreased from 188,000 in 1949 to 112,000 in 1964. The uncertainty of marketing vegetables at a profitable price and the unwillingness of local credit institutions to extend credit for planting vegetables are largely responsible for this decline in acreage. Vegetables are generally planted in anticipation of high returns per acre should the market price be good. However, speculation on, or anticipation of, a high price usually results in

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3/ John G. McNeely, Fruits and Vegetables--Production and Marketing Trends in the Lower Rio Grande Valley, Texas A&M University, Unpublished manuscript.

TABLE 16

PRESENT AND PROJECTED 1980, 2000, 2020 CROPPING PATTERN, 1/
LOWER RIO GRANDE BASIN, TEXAS

Land Use	Thousands of Acres: Present	1980	2000	2020
Cropland	1,038.0	990.8	958.9	915.8
Irrigated	689.8	659.4	638.2	609.5
Cotton	244.4	236.3	228.7	218.5
Grain Sorghum	252.0	278.9	269.9	257.8
Bearing Early Oranges	14.1	27.5	26.7	25.5
Nonbearing Early Oranges	9.0	0.8	0.8	0.7
Bearing Late Oranges	13.1	19.0	18.5	17.6
Nonbearing Late Oranges	3.7	0.8	0.8	0.7
Bearing Grapefruit	28.0	37.3	36.0	34.4
Nonbearing Grapefruit	7.1	1.6	1.6	1.5
Vegetables	35.2	8.0	7.6	7.3
Double-cropped Vegetables 2/	84.8	82.0	79.4	75.8
Idle Land	83.2	49.2	47.6	45.5
Dryland	348.2	331.4	320.7	306.3
Cotton	93.8	90.7	87.8	83.8
Grain Sorghum	200.0	204.1	197.5	188.7
Idle Land	54.4	36.6	35.4	33.8
Tame Pasture	101.6	111.2	107.6	102.8
Irrigated	60.2	65.8	63.7	60.9
Dryland	41.4	45.4	43.9	41.9
Range	593.0	573.4	554.9	530.0
Other Agricultural Land	60.2	58.2	56.3	53.8
Total Agricultural Land	1,792.8	1,733.6	1,677.7	1,602.4

1/ The change in cropping pattern expected with the proposed new irrigation development to be supported by the importation of water under the Texas Water Plan is excluded.

2/ Vegetables are farmed as a second crop on land primarily used for cotton and grain sorghum.

Acreages of the various vegetable crops being plowed under either partially or completely unharvested. During most years, the market price of the various vegetables declines as the season progresses and often reaches a level where it equals or is below the harvesting costs. At this point the individual growers become indifferent or can minimuze losses by not harvesting.

For the above reasons, the assumption in this study that all acres of vegetables are harvested and sold may be invalid. Thus, the yield (and value) of vegetables may be overstated by production from those acres that go unharvested because of unfavorable market prices. No data is available to suggest the portion of the vegetable acreage that goes partially or completely unharvested. The net effect of this is at least partially offset by using normal prices which somewhat reflect all market conditions over several seasons that permitted harvesting.

Though many different vegetables are grown in the basin, for this study six of the major vegetables were selected to represent all vegetables grown. Actual acreage of these six vegetables were adjusted upward to represent the total vegetable acreage found in the basin. Present normal vegetable yields were derived from production records maintained for the past several years by Texas A&M, the Statistical Reporting Service, and local Vegetable Associations. These yields are as follows:

Crop	CWT Per Acre
All Vegetables	97
Cabbages	113
Carrots	95
Lettuce	96
Onions	123
Peppers	70
Tomatoes	71

In spite of statistics showing declines in acreages of vegetables harvested for fresh market and for processing the potential exists for expanded production. Population of the country is increasing and vegetables have continued to be an accepted part of the diet. However, the Valley share of this total market is not expected to increase because of the severe restraints placed by economic forces.

> Cost of production will continue to be high because of scarce labor and financing, high cost of machinery, equipment and transportation and low yields per acre. Market prices are not expected to improve. These problems might be met to some degree by a different structure of producers and sellers. 4/

Changes or improvements that will increase yields, assist in stabilizing production, and decrease production costs will tend to improve the Valley's economic position in vegetable production.

Tame Pasture. Establishment of tame pasture in the basin has been on the increase in recent years and has reached the present normal level of 101,600 acres. About 60,200 acres of this tame pasture are irrigated. The present normal yield of irrigated tame pasture is estimated to be 13 AUM's per acre per year. Yields of 13 AUM's (animal unit months of grazing) per acre are easily attainable in the Valley when good pasture management is practiced. Present normal yield of nonirrigated pasture is estimated at 3.5 AUM's. Current utilized yields in the Valley are somewhat below 13 AUM's for irrigated pastures and 3.5 AUM's for nonirrigated pastures because of the general lack of intensive pasture management and the relatively minor importance of pasture in the total farm enterprise. Tame pasture is somewhat of a recent enterprise in the Valley and has been planted on relatively small tracts of land, generally too saline or too wet to grow other crops profitably.

Range. Range occupies 593,000 acres or about 33 percent of the agricultural land in the basin. The range is mostly covered with poor stands of native grasses interspersed among stands of mesquite brush and cactus. Increasing the productivity of range represents one of the better opportunities for improving farm income in the basin.

Agricultural Production, Present and Projected

Crop yields per unit of agricultural land have incresed over time. Adoption of improved agricultural production technology will continue to increase yields. Improved production technology includes use of improved crop varieties, increased fertilizer usage, and improved weed and insect control and application of soil and water conservation measures.

4/ McNeely, op. cit., page 67

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Projected yields for crops within each soil group in the Rio Grande Plain resource area are necessary to project future crop production from the basin. Current normal yields were used as the base for projecting future yields. An extrapolation of historical yield trends and time series data from Statistical Reporting Service and U. S. Census of Agriculture reports were used to make first estimates of projected crop yields. Unpublished yield data from research studies by the Texas Agricultural Experiment Station and the Texas A&M University Water Resources Institute were also used. In studies by the Texas Agricultural Experiment Station, plant scientists, soil scientists, and commodity specialists provided estimates of increased crop yields. Their judgments as to the effects of their research and of other research with which they are familiar were considered. The rate that farmers will adopt new technology was taken into account. Average weather and current price relationships of inputs and outputs were among other factors considered.

Table 17 shows the present and projected 1980, 2000, and 2020 yields for crops, pasture, and range. Estimates of yields and carrying capacities for pasture and range were obtained from reports of the U. S. Study Commission - Texas, dated 1960. The projected increases to 1980, 2000, and 2020 were at the same rate for each soil group in the Study Commission reports. These rates reflected the existing problems of land and water management in the basin.

The projected yields may be conservative estimates of what might occur. They are lower than some predictions. Additional emphasis on production in the future, changes in factor-product price relationship, and other conditions offer possibilities for achieving yield levels higher than those used in this study. However, the above projected yields are reasoned estimates and considered appropriate for planning purposes.

The projected cropping pattern and major uses of land in table 16 were used with projected yields to determine projected production. The projected production for crops in the basin in 1980, 2000, and 2020 is shown in table 18. This production is expected without project-type resource development. It is contingent on continuation of the adoption of land treatment measures at about the same rate as in the past.

At present there are about 97,800 acres of diverted cotton land. It was assumed that one-half of this land would continue to be diverted in 1980. Also, there are about 39,800 acres of idle cropland.

TABLE 17

PRESENT AND PROJECTED 1980, 2000, and 2020 CROP YIELDS
PER HARVESTED ACRE, WITHOUT RESOURCE DEVELOPMENT
LOWER RIO GRANDE BASIN, TEXAS

Land Use	Unit	Present Normal Yield	Projected Yield		
			1980	2000	2020
Cropland					
Irrigated					
Cotton	lbs.	530	593	704	826
Grain Sorghum	CWT	34	46	63	70
Early Oranges	Ton	4.3 1/	5.0	5.7	7.2
Late Oranges	Ton	2.4 1/	2.8	3.2	4.0
Grapefruit	Ton	7.8 1/	9.1	10.4	13.0
All Vegetables	CWT	97	136	177	216
Tame Pasture	AUM	13.0	14.2	15.6	17.2
Nonirrigated					
Cotton	Lbs.	350	384	430	491
Grain Sorghum	CWT	19	25	34	38
Tame Pasture	AUM	3.5	3.8	4.2	4.6
Range	AUM	.35	.38	.43	.47

1/ Normal citrus yields are based on 20-year period preceding the 1961-62 freeze. Current yields of citrus are as follows: early oranges, 3.6 tons; late oranges, 2.0 tons; grapefruit, 5.3 tons.

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It is anticipated that this land will be better utilized in the future. Most of the present nonproductive cropland will be shifted to pasture. Some cropland will always be idle, while other land will not be harvested because of unfavorable prices or crop failure.

Value of Production

Current normal prices are used to determine gross value of production. These prices are shown in table 19. The present normal total gross value of production from all crop and grazing land is estimated at $104,013,000. This includes about $5,108,000 of roughages, priced on a pound of beef equivalent. Most of the tame and range pasture is marketed as livestock and livestock products. Assuming no project-type development, the projected acreage of crops grown and land use indicates a more intensive agriculture in the basin in the future. The annual gross value of agricultural production is projected to continue to increase. The gross value of agricultural crop and forage production is estimated at $127,203,000 in 1980, $152,084,700 in 2000, and $169,726,400 in 2020. This does not include the value added by utilization of roughages of livestock. Total value of agricultural production would include the value of livestock sales less the value of roughages utilized. 5/ The increase over present gross value is due to increased yields from the adoption of improved technology.

Institutional Factors Affecting Land and Water Resources in Agriculture

Institutional factors, examined in a study conducted by Texas A&M University and presented in their report "A Study of Institutional Factors Affecting Water Resource Development in the Lower Rio Grande Valley, Texas," are grouped in four classes. These four groups of institutional factors which presently or potentially affect water resource development are: (1) legal, (2) political, (3) cultural, and (4) economic.

5/ The present value of sales of livestock and livestock products in the basin is $15,210,000.
Source: U. S. Department of Commerce, Bureau of Census, Agricultural Census, 1964.

Modern, efficient machinery is used in harvesting late spring potatoes.

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TABLE 18

PRESENT AND PROJECTED 1980, 2000, AND 2020
CROP, PASTURE, AND RANGE PRODUCTION,
LOWER RIO GRANDE BASIN, TEXAS

Land Use	Production Unit	Production			
		Present	1980	2000	2020
		thousands			
Cropland					
Cotton	Lbs.	162,362	174,954	198,758	221,626
Grain Sorghum	CWT	12,368	17,931	23,718	25,216
Citrus	Ton	310	530	585	701
Vegetables	CWT	11,640	12,240	15,399	17,949
Tame Pasture	AUM	927	1,106	1,178	1,234
Range	AUM	207	217	238	249

TABLE 19

CURRENT NORMAL PRICES RECEIVED FOR CROPS,
LOWER RIO GRANDE BASIN, TEXAS

Crop	Unit	Current Normal Price
		---------dollars------------
Cotton Lint 1/	Lbs.	.296
Grain Sorghum 1/	CWT	1.83
Oranges 2/	Ton	42.49
Grapefruit 2/	Ton	27.07
All Vegetables 3/	CWT	1.58
Cabbage 3/	CWT	.96
Carrots 3/	CWT	.74
Lettuce 3/	CWT	3.53
Onions 3/	CWT	2.22
Peppers 3/	CWT	3.26
Tomatoes 3/	CWT	2.64
Pastured Lands 4/	AUM	4.50

1/ Interdepartmental Staff Committee of the Water Resources Council, Interim Price Standards for Planning and Evaluating Water and Land Resources, April, 1966.

2/ Normalized from Texas A&I Colleges', Production, Price and Value of Texas Citrus Fruit, 1935-36 to 1964-65, Weslaco, 1965.

3/ Adjusted from prices reported in Texas A&M University, Texas Agricultural Experiment Station, Production and Production Requirements, Costs and Expected Returns, MP-694, 1964.

4/ USDA, SCS, Unpublished Pasture Values for Use in Watershed Appraisal, E&WP Unit, Fort Worth, 1964.

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Legal institutions relating to water resources are essentially "water rights." The Texas Water Rights Commission states that "a water right is a right to the use of water accorded by law." 6/

A necessary element of the right to use is the right to divert the water--to take possession and reduce it to physical control. A farmer's water right or lack of a water right determines whether or not he can take water for irrigation, the amount, and the time he may take water. Water rights also determine preferences or priorities and afford legal protection to those who divert and use water pursuant to their right.

Water rights in the three-county study area have been significantly affected in recent years by the law suit "The State of Texas, et al vs. Hidalgo County Water Control and Improvement District No. 18, et al" in which all rights to the use of water from the Rio Grande under the Doctrine of Appropriation have been tried. Prior trial of riparian rights claimed under Spanish and Mexican Land Grants for irrigational use of Rio Grande water known as the Valmont Case resulted in a decree that riparian rights to water for irrigation did not apply to Spanish and Mexican Land Grants. This was sustained by the Supreme Court of Texas. The 93rd District Court decision of Special Judge J. H.Starley in the first cited case has been appealed by the State and others. It will be several years before this litigation is resolved and before the extent and priority of respective water rights will be known.

Political institutions at Federal, State, and County levels influence the basin's use and development of water resources. Many Federal, State, and County governmental entities, including 38 special water districts, have various powers and authorities for dealing with water use and resource development problems. However, with so many entities at work in a three-county area, some duplication of effort and overlapping of authority exists and causes conflicts. These conflicts add to the problems of water use and resource development and can only be solved by a unified effort of all governmental entities.

Authorities, policies, and procedures of the various governmental entities for dealing with water use and resource development are described in the Texas A&M report previously mentioned.

6/ State of Texas, Texas Water Rights Commission, Rules, Regulations and Modes of Procedure, 1964 Revision, p. 3.

Cultural institutions often considered to be either customs or traditions, influence water use and resource development equally or greater than legal and governmental institutions. In the basin, according to Texas A&M University report, customary ways of doing things influence water application and use, land ownership, labor use, and crop preference. Many of these customary practices were developed and adopted under conditions that no longer exist and now add to the problems of resource development.

Economic institutions affecting land and water development in the basin are very difficult to adequately describe. Almost all institutions have a degree of economic significance and, thus, a measurable impact upon economic life. Four of the most important economic institutions affecting development and use of water are: (1) water management policies of conservation and improvement districts, (2) markets for agricultural commodities in the basin, (3) land values, and (4) taxes on land and improvements. These institutions have an effect upon resource use and development by the way they affect land use. Improvement in the market system will affect the cropping pattern which in turn will affect water use. Rising land values also affect land uses as they drive the lower value crops out of production. New taxes for flood control, drainage, and irrigation rehabilitation will increase costs and will be resisted. Benefits of land and water development will have to be sufficient to offset these costs.

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WATER AND RELATED LAND RESOURCE PROBLEMS

Floodwater Damage

The floodway system of the International Boundary and Water Commission limits flooding from the Rio Grande to the area between the river and levees along the north side, areas adjacent to the Arroyo Colorado, and the area between the levees of the Main and North Floodways.

Control and disposal of surface runoff is one of the most serious water problems faced by cities and farming communities. Floodwaters interrupt transportation and drown crops, get into houses and stores, back up sewage, and contaminate everything they touch.

Flood-producing storms can occur at any time of the year. However, they occur most frequently during the spring and fall months. Small floods occur in some part of the Valley each year. These usually are caused by local storms of high intensity. Widespread flooding is associated with storms covering a large area and with heavy rainstorms that accompany hurricanes. Some of the more recent major floods occurred in 1955, 1957, 1958, 1961 (Hurricane Carla), and 1967 (Hurricane Beulah).

Flooding and subsequent flood damage is a major problem on agricultural lands. Most of the flood damages are caused by ponding of excess water from rainfall in the area. Water tends to accumulate rather than runoff because of the flat topography, lack of natural channels, and inadequate drainage systems.

Before the advent of irrigation farming, there were few barriers to surface flow, and excess rainfall moved slowly into the Arroyo Colorado and old resacas and lakes or flowed as sheet runoff into Laguna Madre. Irrigation canals, railroads, roads, and highways have been built across the basin in all directions. These manmade obstructions block natural flows and cause inundation of large areas of cropland and improved pasture. In some cases these restrictions cause water to stand for long periods in highly developed urban areas, resulting in extensive damage to property and loss of business. Often schools are forced to close for several days until the water recedes. Flooding of sanitation facilities compounds the health hazard.

Flood problems in Willacy County are interrelated with those in Hidalgo County. Most of the surface runoff from Hidalgo County must flow through Willacy County to Laguna Madre. There are no natural channels in this area. The problem becomes even more acute when local floods coincide with floods on the Rio Grande and floodgates to the floodway system are closed.

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The floodway system of the International Boundary and Water Commission protects the Lower Rio Grande Basin from flooding. However local floodwater cannot enter the system during floods on the river.

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The problem of removal of excess surface water begins with the individual landowner, city or rural, because he has either no outlet or one that is inadequate. Originally, drainage systems came about as a by-product of irrigation distribution systems. Other ditches were built by various irrigation and drainage districts or by a combination of drainage and water districts. Each district designed and built its outlets to serve only the area within its boundaries. Little or no consideration was given to including additional capacity to remove floodwater.

Heavy losses to crop, pasture, and vegetables occur from floods produced by local high-intensity rains. For example, the April 1966 storm east of Lyford produced 13 inches of rain in a 7-day period. It flooded an estimated 60,000 acres in Willacy County alone. In some areas where flow was blocked water stood for three weeks. An estimated 6,000 acres of onions, potatoes, cabbage, and other valuable speciality crops were ruined. This type of flooding and ponding of water on flatlands helps build up a high-water table, which in turn results in soil salinity problems.

Based on interviews with farmers, ranchers, and urban property owners, the total average annual direct floodwater crop and pasture damage in the basin is estimated to be $8,147,000 (table 20). Road and bridge damages amount to $49,000 annually. In urban areas, flood damage to buildings and their contents, streets, sewerlines, lawns, and parks are estimated to be about $62,000 annually. Indirect damages, such as initial losses to local businesses, added expense of rerouting traffic to and from school, and disruption of normal community activities, are extensive. These damages are estimated to be $826,000 annually.

Impaired Drainage

Drainage conditions in the basin generally are fair to poor, despite the numerous drainage ditches and underground drains that have been installed. Overirrigation, seepage water from unlined irrigation canals, outlets of insufficient size, and lack of outlets, together with floods associated with high-intensity rains, contribute to the problem.

Drainage ditches were installed from the beginning, but their adequacy has always failed to keep pace with the needs. The ditch system at present is only partially effective due to lack of depth and capacity, improper maintenance, deterioration of structures, and most important the absence of adequate outlets.

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A street scene in Edinburg, Texas, and flooded highway - <u>three</u> days after Hurricane Beulah in 1967.

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Widespread flooding of dryland farming area around Lyford in Willacy County 14 days after Hurricane Beulah in 1967. Water rose nearly another foot four days later.

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Inadequate drainage structures under roads and railroads cause prolonged flooding. (May 1963)

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Drainage ditches are inadequate for the timely removal of floodwater. The community of Lull and railroad yards 3 miles north of Edinburg are still flooded eight days after Hurricane Beulah.

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Removal of floodwater is delayed because movement is blocked by irrigation canal (thin white line), and because drainage ditch to the right of the canal is inadequate.

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Many soils of the basin have, or could develop, a permanent or intermittent high-water table. Water is held at a high position by some substratum barrier, usually a dense montmorillonitic type of clayey material having little or no permeability.

Since free water is moved by the forces of gravity, it moves along the prevailing slopes riding on top of the barrier. It then accumulates and rises to harmful levels in low, flat, or depressed areas. This effect especially is noticeable around the numerous enclosed depressions of Tiocano clay associated with terrace soils of the Hidalgo, Willacy, and Raymondville series. It also may rise to harmful levels at changes or breaks in the land slope and infrequently where the underlying barrier rides up or outcrops on the land surface. When the water table encroaches on the normal root zone, it saturates the soil and displaces the air. This causes an unfavorable air-moisture relationship which adversely affects production of most crops by restricting the root zone. On the predominantly wet lands, losses of 25 to 50 percent often occur in the form of reduced yields and poor-quality crops harvested. Abnormally wet soil conditions delay planting and cultural operations. The extent of the high-water table problem is shown in table 21.

Also, in the basin where almost all irrigation water contains from 400 to 2,000 ppm of dissolved salts, a further harmful effect is caused by a high-water table. This is brought about by the capillary rise of water through the soil profile above the water table and subsequent buildup of salt on the surface and in the root zone. This occurs because the salt added by irrigation or inherently present in the deltaic or marine terrace soils causes the free soil water to become salty. This saline water rises through the soil and is evaporated from the surface or consumed by crops leaving behind almost all the salts contained in solution. This salt accumulation can reach harmful levels in a very short time. The extent of this problem in the basin is shown in table 21.

It is evident that some of the soils were saline to varying degrees before settlement of the area and that agricultural management practices have raised salinity to critical levels in some areas during the past 50 years. About 34 percent of the basin land area is affected by soil salinity of a magnitude sufficient to hinder or preclude agricultural production. It is estimated that yields presently are being reduced 10 to 15 percent by salinity. In some areas this damage is severe enough to require removal of cropland from production. If no corrective measures are taken, it is reasonable to expect that progressively larger areas will be removed from crop production each year as a result of the salinity problem.

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Existing drainage ditches lack depth and capacity to meet present requirements (top) and are in need of maintenance (bottom).

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TABLE 20

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE, 1/
LOWER RIO GRANDE BASIN, TEXAS

Item	Estimated Average Annual Damage			
	Cameron County	Willacy County	Hidalgo County	Total
	thousands of dollars			
Floodwater				
Crop and Pasture	2,194	1,053	4,900	8,147
Nonagricultural				
Roads and Bridges	16	11	22	49
Urban	45	6	11	62
Subtotal	2,255	1,070	4,933	8,258
Indirect	225	108	493	826
TOTAL	2,480	1,178	5,426	9,084

1/ Price Base: Adjusted normalized prices, April 1966

TABLE 21

AREA HAVING HIGH-WATER TABLE AND SALINITY PROBLEMS
(1967 CONDITIONS)
LOWER RIO GRANDE BASIN, TEXAS

Soil Association 1/	High-Water Table Problem	Salinity Problem
	------thousands of acres-----------	
CT	9.6	9.6
C	0.3	-
DR	22.3	8.7
HM	4.8	56.4
H	5.7	85.9
HB	32.0	-
HR	27.2	6.0
HG	36.9	4.1
HL	39.7	14.2
LO	68.6	17.7
LL	22.0	22.0
LP	12.9	12.9
L	25.1	25.1
MB	3.3	-
MC	0.5	-
M	2.2	37.2
N	91.1	91.1
O	1.3	0.7
PT	80.9	80.9
P	0.8	3.0
RM	11.5	9.1
RN	39.5	39.0
R	53.6	68.4
RR	8.5	4.5
RC	6.4	-
WD	22.6	14.9
WH	27.0	19.2
WR	20.6	10.3
WV	13.7	13.7
TOTAL	690.6	654.6

1/ See Plate 3.

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During the course of geologic investigations with powered drilling equipment, primarily for the purpose of engineering considerations, information relating to drainage problems was gathered. A question arose as to whether or not La Sal Vieja in Willacy County influences static ground-water levels in agricultural lands adjoining to the southeast. It was determined that the extensive sand layer underlying parts of all three counties is hydrostatically connected with the lakes, and a study of water levels in the borings indicated that hydrostatic pressure in the sand layer corresponds roughly with the lake levels. The upper boundary of this sand layer is very undulating and is close to the ground surface in some areas. The sand contains highly saline water and contributes significantly to salinity and high-water table problems.

It was determined that high-water levels in the lake could probably produce a hydrostatic pressure rise in the sand formation. This would create a vertical pressure in the overlying clay and sand soils and cause a harmful rise in the ground-water table in the agricultural lands adjoining the lake.

Erosion

There are no critical sediment source areas, and gully erosion is practically nonexistent. The main source of sediment is sheet erosion from cultivated land. Flood plain scour is not a problem outside the Rio Grande flood plain. Based on limited studies, it was determined that annual sheet erosion from cultivated land averages about 1.0 acre-foot per square mile from cultivated land, 0.25 acre-foot per square mile from orchards and 0.08 acre-foot per square mile from pastures. Because of the low gradients, soil that is removed from the fields is deposited in adjacent drainage ditches. The average annual bank erosion rate is about 0.15 acre-foot per square mile.

Wind erosion is a fairly serious problem on dry cropland in northwestern Hidalgo County and in parts of Willacy County. Soils of this area are especially susceptible to wind damage when freshly tilled or bare. Wind erosion seldom is limited to an individual field or farm since well protected fields may be damaged by soil drift from adjacent fields. Wind erosion is damaging from several standpoints of which removal of fertile topsoil, sandblasting effect of wind-borne particles on protective strips of vegetation and growing crops, and deposition on crops are most important. Cover crops cannot always be established when needed because adequate soil moisture may not be available, particularly during the winter.

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Before (top) and after (bottom) the installation of tile drains to lower the water table and leaching to remove harmful salts.

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A wind erosion problem also exists in the area of the Brownsville ship channel and on Long Island adjacent to the Port Isabel Channel. Windblown saline dust which originates from spoil banks created by the dredging of these channels is of particular concern to the city of Port Isabel. Southwest winds carry dust across the city and create a safety and health problem. Attempts by the city to solve this problem have met with little success. Windblown saline dust which is picked up from dry lakebeds and spoil banks is carried inland where it is deposited on trees and growing crops, causing salt burn. Stabilizing these saline dust source areas by vegetative means is difficult because of the extremely limited number of plant species suited to the range of growing conditions found.

Water Shortages

Water supply problems in the Lower Rio Grande Valley of Texas have been continuous since 1948. The cities, industry, and agriculture depend almost entirely on diversions from the Rio Grande for their water. Periodic water shortages and inefficient use of available supplies during critical periods have a serious affect on the economy of the basin.

The conservation storage capacity of Falcon Reservoir on the Rio Grande is divided 58.6 percent to the United States and 41.4 percent to Mexico on the basis of the historical source and division of the Rio Grande Basin waters of each country by Treaty of 1945, United States and Mexico. The amount of water in storage for either country at any time varies with inflows from all sources during a period divided in accordance with the Treaty plus the carryover storage at the beginning of the period adjusted for withdrawals and proportional losses from the reservoir.

Judge Starley 1/ allotted 2.5 acre-feet of Rio Grande water per acre per year at point of diversion for irrigational use on the lands he found had water rights, and made allotments to specific industrial and research users. Based on a decision of the Civil Appeals Court of Corpus Christi, 135,980 acre-feet of Rio Grande water have been allocated to municipal, industrial and domestic use in the three county area. Agricultural lands were grouped into five classes and assigned priorities for allocation of water. These priorities were weighted in reference to a base of 1.0 for the lowest priority and graduated to 1.7 for the highest priority to receive larger allocations in relation to the priority weighting number. Priorities were based on the appropriations of water perfected under certified filings and permits related to recorded time of filings and issuance of permits and the development of water use.

1/ The State of Texas, et al. v. the Hidalgo County Water Control and Improvement District No. 18, et al. Preliminary decision submitted to Texas Water Rights Commission (Mimeographed), pp.11-17

The United States' share of the Rio Grande's water is insufficient to supply all of the irrigated land with water all of the time. Factors influencing the flow of the Rio Grande are droughts, increased irrigation above Falcon Dam, Mexico's increased use of its share of the Rio Grande water, increase in cultivated acres and distribution system and river channel losses. Inefficient use of existing supplies as a result of inadequate distribution facilities and poor management contributes to depletion of available water supplies for irrigation.

Operations studies show that during severe droughts, such as occurred in the 1950's, conservation storage space in Amistad and Falcon Reservoirs would not meet the demands for irrigation water. Based on the 57-year period studied (1900-1956) with both dams functioning more than 20 percent of the irrigated acreage would not have a full supply in 18 of the 57 years.

Waste of water through seepage and excessive irrigation also aggravates the salinity problem. The problem becomes more pronounced during periods of water shortage because the water supplies have a higher concentration of soluble salts. These salts cannot be removed from the soil because water for leaching is not available. To supplement rural and domestic supplies, some farmers excavate pits or "dugout" ponds to catch precipitation or surface runoff, while others make use of drainage ditches that pass through their farms.

Inadequate water supplies for cities, towns, communities, outdoor recreation, fish and wildlife developments, and enhancement of unique areas of natural beauty are some of the chief problems in the development of those resources.

Domestic, municipal, and industrial water requirements have increased and will continue to increase in the future. Inadequate water resources place a definite limitation on industrial and municipal growth. Any water required for increased municipal and industrial use will result in a reduction in the water available for agricultural uses.

The demand for water-based recreation exceeds the supply. All water-based recreation in water supply reservoirs is incidental to other purposes. During droughts and the summer months, the quality of recreation and fishing is greatly reduced.

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Phreatophytes

Water losses to nonbeneficial plants are relatively small because areas in which they grow are limited. The principal offender is the willow, which grows in abundance along and in the drainage ditches and causes a constant maintenance problem. Saltcedar is an aggressive, fast-spreading, deciduous plant which is found in small areas near the river. The phreatophytes are difficult to control and require constant cutting, plowing, and/or poisoning. They are a major factor in canal and channel maintenance.

Pollution

The Arroyo Colorado, Main Floodway, and North Floodway serve as outlets for treated, partially treated, and unchlorinated sewage effluent from 16 cities in Hidalgo and Cameron Counties. Many of these cities have outdated and inadequate sewage disposal systems. In addition to domestic sewage, untreated cannery and food processing wastes, canal seepage, storm waters, and filter plant backwash contribute to the flow. As a result, the water flowing in the drainageways, particularly during low flows, is of very poor quality both chemically and bacteriologically. Pollutants include phosphates, chlorides, sulphates, organic residue, bacteria, pesticides, silt, and clay. The quality of the water becomes progressively poorer from the Gulf outlet inland and is extremely poor immediately downstream from the city of McAllen. Some contribution to the problem is made by rural residences which are discharging raw sewage directly into drainage ditches which empty into the Arroyo Colorado and floodways.

Pollution occurring in the basin does not appreciably affect basin water supplies. Most urban areas obtain their municipal water supplies from irrigation districts. This water flows by canals from the Rio Grande and does not share this path with waste waters.

Recreation along the Arroyo Colorado is seriously hampered by pollution. Water in the Arroyo and floodways is not suitable for contact water recreation. The average bacteria count in the Arroyo is over 500 times higher than the upper limit set by the American Public Health Association for bathing in natural waters.

Problems Affecting Fish and Wildlife Resources

The principal problems affecting fish and wildlife resources are pollution, shortage of habitat and accessibility to fishing waters and hunting areas. The Laguna Madre is saltier than most other Texas Bays and often is hypersaline for extended periods during droughts. The other extreme is attained when large quantities of flood flows enter the relatively shallow bays and they become comparatively fresh at rare intervals. Access to marine fish habitat is difficult in many parts of the basin. Scarcity of boat launching facilities, shallow water, and the great distances between access points limit the activities of many sport fishermen. Nevertheless, there is heavy sport fishing for spotted seatrout, black drum, red drum, flounder, and sheepshead.

The quality of marine fish habitat in the basin is expected to deteriorate in the future. This condition would be the result of increased pollution and alterations in the habitat brought about by dredging and filling operations associated with mineral developments, navigation projects, and urban and industrial expansion. However, improved marine fish management techniques and pollution abatement methods could be expected to offset to some degree these unfavorable trends.

Before the various dams were built along the Rio Grande and its tributaries, the Arroyo Colorado and floodways were maintained in a relatively fresh state and supported fish life. Studies made by the Bureau of Sport Fisheries and Wildlife indicate that much of the fresh water fish habitat has been damaged or destroyed by industrial, domestic, and agricultural pollutants. Increasing pollution and diversion of water are steadily degrading the habitat, especially in the Rio Grande and the floodway system.

Citrus groves provide good quality nesting habitat for whitewing doves. However severe winters kill large acreages of citrus about once every ten years.

Relationship of Water Problems to Impairment of Natural Beauty

Water problems in the Valley bear directly on the impairment of natural beauty. Natural beauty denotes either well-ordered, attractive human developments which are functional and yet have a pleasing aesthetic value, or natural areas which have aesthetic value because they are unspoiled. Drainage ditches which are not properly maintained are a despoiler of natural beauty in the Valley. The many ditches required may take the form of ugly scars in every direction through the developed and natural areas alike, unless they are properly designed and adequately maintained. The presence of polluted lakes and lagoons impairs natural and scenic beauty.

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This pollution may be accelerated by increasing the efficiency of runoff, especially where the pollutant is a herbicide or pesticide from agricultural land which finds an efficient path into a lake or lagoon. Natural beauty includes wildlife, and pollutants are proven to be adverse to wildlife as well as plant life. The importance of tourism to the Valley's economy is largely the result of favorable natural and scenic beauty.

Institutional Factors

Institutions have exerted considerable influence on the development and use of the Valley's water and land resources. Some of the influence has been constructive and vital to the Valley's welfare; in some instances, it has been passive and has caused misuse of these resources.

Special-purpose districts carry out the development, protection, and administration of land and water resources. Irrigation, drainage, and soil and water conservation districts are concerned with the rural areas. Water and other metropolitan districts are involved in or around cities. Each of these types of districts requires State-enabling legislation, and each involves ad hoc units of government vested with specific administrative, taxation, and other powers. Usually there is a district for each type of activity.

The commissioners court is the branch of government at the county level responsible for any use or development of water resources. The courts have the power to create water districts of various types geographically contained within their county boundaries. The county commissioners courts of Cameron, Hidalgo, and Willacy counties created 25 of 34 active Valley irrigation districts. Of these, fifteen hold title to certified filings, five hold title to both certified filings and permits, six hold title to only permits, and eight districts do not have a written water right.

The most important special districts in the Lower Rio Grande Valley are irrigation and drainage districts. These represent and serve individual farmers and have a great deal of influence with them. Most of the districts operate independently of each other, and give little consideration to other districts and the overall problem of the area. Also, districts make plans and construct drainage and irrigation facilities which are capable of handling the needs of only district lands. Coordination of district activities is essential to further development.

Several plans have been developed during the past 50 years to provide for removal of floodwaters and installation of adequate outlets for surface and subsurface drainage. These did not get past the development stage. The reasons for failure can be attributed to a lack of coordination between local governmental bodies, inability to reach agreement on division of local costs, failure to obtain local acceptance, and inability of local interests to finance their share of the cost.

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PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

The population of the basin is expected to increase from 352,086 in 1960 to 848,900 in 2020. Employment in nonagricultural industries has not been expanding at the national rate; yet more jobs will need to be provided for the expanding population. Median family income is well below the national average and approximately 50% of families in the basin have an income of less than $3,000. The land and water resources of the basin are not being utilized efficiently for production purposes, or for affording optimum environmental conditions for the people. Production capabilities of the natural resources are not being maintained.

Satisfying the land and water resource conservation and development needs discussed in this section will contribute to increased economic development in the area. Job opportunities will be provided and income increased. Environmental conditions will be improved and production capacity of the basins resources maintained.

Watershed Protection and Management

The application and maintenance of land treatment measures are basic requirements for the conservation, utilization, and development of water and related land resources of the basin. The estimate of present land use and land treatment needs for the Rio Grande Basin are tabulated below:

Land Use	Total Acres	Acres Adequately Treated	Acres Remaining to be Treated
Cropland			
Irrigated	689,800	125,000	564,800
Dry	348,200	58,000	290,200
Grassland (Range and Pasture)	694,600	82,000	612,600
Miscellaneous agricultural and nonagricultural land	206,400	146,400	60,000

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Plantings of Bougainvillea provide protection from wind damage, beautify the farm frontage, and provide habitat for songbirds and other wildlife.

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Some of the land treatment measures that are needed include management measures to improve the soil structure and fertility of the cropland and the quality and density of the grassland. Surface and subsurface drainage systems are needed to dispose of surplus water, to lower the water table, and to remove harmful salts from the soil. Control of nonbeneficial water consuming vegetation and improvement of irrigation facilities are needed for more efficient use of the limited water supply. Planting of food bearing plants and vegetative cover around farmsteads, in urban areas, along fencerows, roadsides, and spoil banks are needed to provide food and cover for wildlife and for beautification.

Flood Prevention

The construction of a system of channels to remove floodwaters has been recognized as a prerequisite to the ultimate solution of flood prevention and drainage in the Valley for nearly 50 years. It is also recognized that such a major undertaking could only be accomplished through a united effort by the entire Valley. Floodwater channels are needed to provide for the disposal of storm runoff brought into the system by districts and cities, and early removal of floodwaters which now remain on the lands over long periods, thus adding to the water table and severely damaging crops.

Erosion Control

Control of erosion by water is not a serious need in the basin. Adequate protection can be effected with proper design and application of land treatment measures. There is a need for the control of wind erosion, primarily through land stabilization measures in several areas of the basin. One area in Cameron County consists of approximately 12,000 acres of dry lakebeds along the eastern side of the Rancho Viejo watershed in Cameron County. These lakebeds are the source of highly saline windblown dust.

Another source of windblown sand and dust is from the spoil banks along the Brownsville and Port Isabel ship channels.

About 75,000 acres of cropland in northwestern Hidalgo County are also in need of stabilization measures to control wind erosion.

Drainage Improvement

The primary need for the solution of surface and subsurface drainage problems is a balanced and integrated basinwide system of major drainage outlets. Approximately 1,560 miles of existing ditches

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Floodwater channels are needed for removal of floodwaters from Edinburg and other urban areas.

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need to be improved and about 580 miles of additional ditches are needed to provide adequate outlets for on-farm drainage systems. The problem is so complex that project type action is needed to solve it.

On-farm drainage needs were analyzed from the soils standpoint as related to agricultural use. The soils were examined with particular attention to their surface and subsurface drainage needs. Table 22 summarizes accumulated technical data pertaining to the basin soils and supersedes all previously published or unpublished soils data by the Soil Conservation Service. The definitions and criteria on which these estimates were made are included in the Appendix to this report.

Surface drainage is needed on all of the area which is surface irrigated and on about 44 percent of the dryland. Subsurface drainage is needed on about 48 percent of the irrigated lands and on about 26 percent of the dryland.

Irrigation

The Rio Grande now supplies practically all of the surface water for irrigation in Cameron, Hidalgo, and Willacy Counties. Apportionment of the available supply of water to the allotted acreages during some past water-short seasons by the 93rd District Court has caused drastic curtailment of irrigation. If a dependable supply is to be maintained for the area being irrigated, an additional 385,000 acre-feet of water per year will be required.

About 190,000 acre-feet per year of additional in-basin depletion (additional gross diversions minus respective return flows) may develop along the Rio Grande in Texas between Amistad and Falcon Dams as a result of increased irrigation acreage and water demands. Also, it is conceivable that a gross diversion from the Amistad to Falcon reach of the Rio Grande of 200,000 acre-feet of water per year could be made to the Winter Garden Area in the Nueces River Basin. These potential amounts would have to be matched by replacement of water to Lower Valley users having water rights. Together with the additional water needed to maintain the present acreage irrigated in the Lower Valley a total additional need of 775,000 acre-feet of water per year could develop, not counting potential expansion of irrigated acreage in the Lower Valley. To supply these needs, the State Water Plan provides for possible transmission of the needed amounts of water from areas of water surplus. Together with amounts for possible expansion of irrigated acreage in the Lower Valley, the amounts are shown in table 23.

TABLE 22

LAND USE AND DRAINAGE PROBLEMS BY SOIL ASSOCIATION
LOWER RIO GRANDE BASIN, TEXAS

Soil Assoc.	Crop and Pasture Needing Surface Drainage Only		Crop and Pasture Needing Subsurface Drainage Only		Crop and Pasture Needing Surface and Subsurface Drainage	
	Irrigated	Dry	Irrigated	Dry	Irrigated	Dry
	thousands of acres					
C	-	-	0.3	-	-	-
DR	2.1	0.2	-	0.4	18.6	3.1
HM 1/	43.4	0.4	-	-	4.8	-
H 1/	51.7	16.4	-	-	5.7	-
HB	30.0	0.9	-	-	30.0	-
HR	17.4	-	-	-	26.0	-
HG	36.5	-	-	-	36.5	-
HL	25.5	-	-	-	38.3	-
LO	21.2	-	-	-	63.6	-
MB	3.4	-	-	-	3.3	-
MC	0.8	-	-	-	0.5	-
M 1/	20.1	7.5	-	-	2.2	-
N	-	-	-	3.6	-	32.9
O	1.9	-	-	-	1.3	-
RM	10.9	6.8	-	-	7.3	0.6
RN	-	4.3	-	4.3	1.3	30.1
R	-	27.5	-	4.6	53.6	9.2
RR	12.1	-	-	-	8.1	-
RC	57.6	-	-	-	6.4	-
WD	15.4	2.0	-	-	15.4	-
WH	23.5	1.0	-	-	15.7	-
WR	13.8	1.7	-	-	20.6	-
WV	-	15.9	-	-	-	10.7
TOTAL	387.3	84.6	0.3	12.9	359.2	86.6

1/ Subsurface drainage not feasible.

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TABLE 23

POTENTIAL SUPPLEMENTAL WATER REQUIREMENTS 1/
LOWER RIO GRANDE BASIN, TEXAS

Item	1,000 Acre-Feet				
	1980	1990	2000	2010	2020
Replacement, Additional Depletions, 2/ Amistad to Falcon	0	174	190	190	190
Replacement, Gross Diversion to Upper Nueces (Winter Garden)	0	170	200	200	200
Maintenance of Current Irrigated Acreage With Adequate Water Supply	385	385	385	385	385
Expansion (Deferred) of Irrigation Acreage	0	0	245	315	315
Municipal and Industrial 3/	23	47	76	110	150
TOTAL	408	776	1,096	1,200	1,240

1/ Texas Water Development Board, unpublished data.

2/ Replacement for additional depletions to Falcon inflows caused by gross diversions for potential additional use in the Amistad to Falcon Reach, less return flows to the Rio Grande.

3/ Additional domestic, municipal, and industrial amounts may actually be provided by Rio Grande supplies under amended permits now issued which authorize the use of 135,980 acre-feet. Offsetting additional amounts for irrigation purposes will be provided from supplementary supplies.

The water resource is limited and will support increasing acreages only part-time unless it can be supplemented. Many distribution systems need to be rehabilitated to prevent seepage losses and to decrease the related salinity problems. Practice of better water management would help conserve the limited water supply.

Rural Domestic and Livestock Water Supply

Demands for rural domestic and livestock water are not expected to increase greatly. There is however a need for additional rural community water supply systems to treat the water and distribute it to the users. In the rangelands, more wells and additional stock ponds, where practical, will be needed to provide water for livestock.

Municipal and Industrial Water Supply

Municipal and industrial water supplies are obtained chiefly from the Rio Grande. Minor supplemental supplies are obtained from ground water by several municipalities and small industrial developments. A few industries use salt water from the Gulf of Mexico.

Domestic, municipal, and industrial water requirements will continue to increase in the future. Any water required for increased municipal or industrial use will result in a reduction in the water supplies available for irrigation.

Desalination of brackish water by the electrodialysis process will need to be continued as a source of water. Port Mansfield already obtains all of its water supply from such a source.

Based on an analyses of trends, municipal and industrial water needs will increase from 76,400 acre-feet used in 1960 to 122,000 acre-feet in 1980, as projected by the Texas Water Development Board. This would indicate a need for importing 23,000 acre-feet for these purposes. Figure 3 shows the water needs by purpose and the amounts that will have to be imported to meet these needs.

A relatively small amount of water is used in mining or waterflood operations (1,100 acre-feet in 1960). A need for this amount will continue until 1990, when it will drop to about 200 acre-feet annually.

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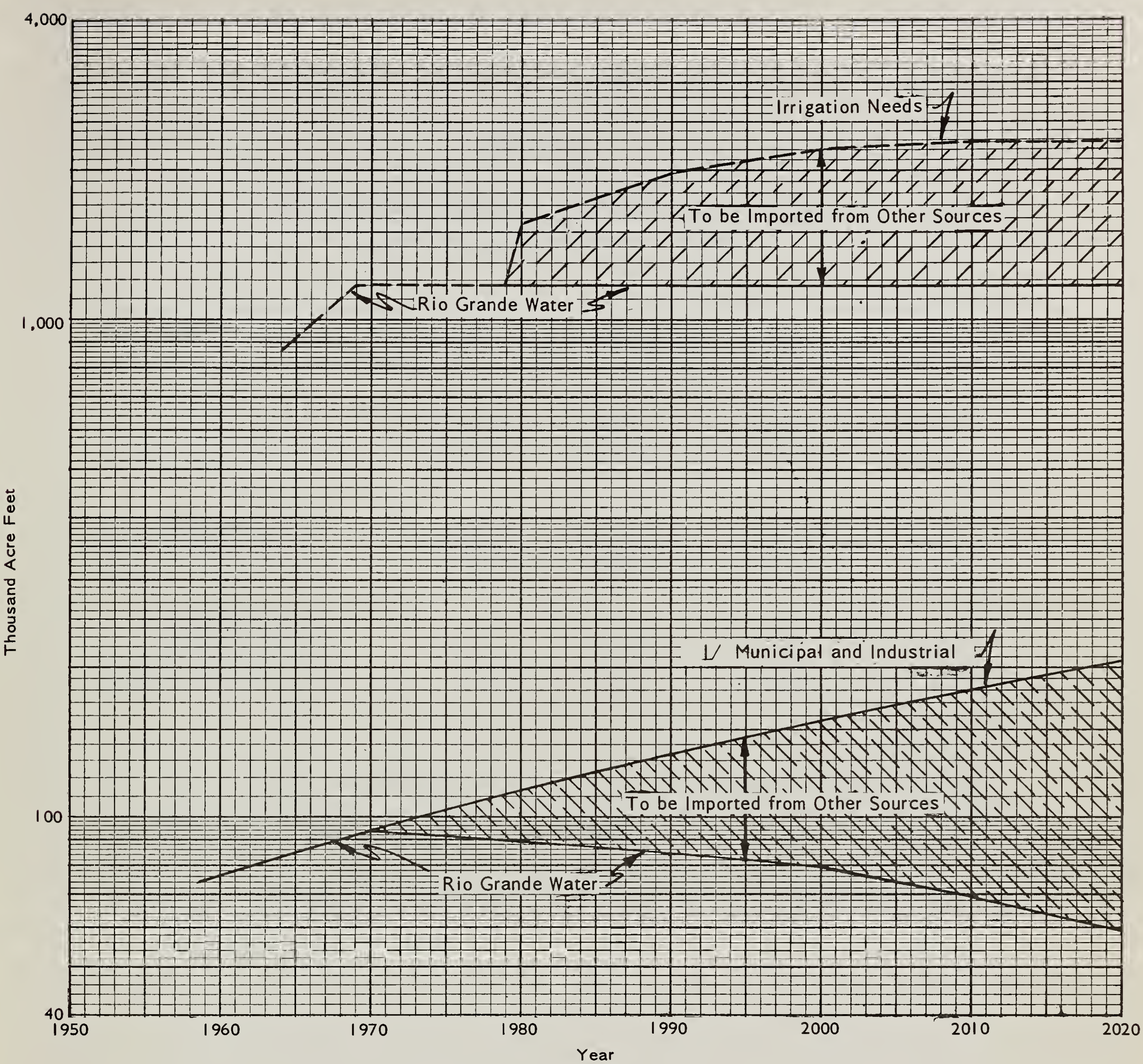

Figure 3

WATER NEEDS
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS

1/ Additional domestic, municipal, and industrial amounts may actually be provided by Rio Grande supplies under amended permits, now issued, which authorize the use of 135,980 acre-feet. Offsetting additional amounts for irrigation purposes will be provided from supplementary supplies.

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USDA-SCS-FORT WORTH, TEX. 1968

TABLE 24

CURRENT AND PROJECTED DEMAND AND SUPPLY FOR
WATER RELATED AND WATER ENHANCED RECREATION 1/
LOWER RIO GRANDE BASIN, TEXAS

Type of Acreage	1968	1980	2000	2020
Demand				
Total Land Acres	5,270	6,360	8,398	11,093
Total Water Acres	8,646	10,431	13,778	18,198
Supply 2/				
Total Land Acres	3,834	4,236	4,236	4,236
Total Water Acres	8,370	8,370	8,370	8,370
Demand-Supply				
Needed Land Acres	1,436	2,124	4,162	6,857
Needed Water Acres	276	2,061	5,408	9,828

1/ Texas Water Development Board, "A Study of Recreational Demand, Supply and Needs of Cameron, Hidalgo and Willacy Counties, Lower Rio Grande Basin, Texas," March 1968.

2/ It is assumed that developable acreage will be developed by 1980, but no other facilities with public access will be planned or constructed by 2020.

Recreation

Considerable land and water has been developed for recreation in the basin and the existing facilities are generally of high quality. However, these developed areas are inadequate to supply the increasing demand for water related and water enhanced recreation. A study by the Texas Water Development Board shows a current need for an additional 1,436 acres of land and 276 acres of water for water oriented recreation (table 24).

One of the most intensive needs is for small picnic areas which low income families in the basin customarily use for weekly gatherings and annual reunions. Other intensive needs include areas developed for camping, swimming, hiking, and walking for pleasure. Areas developed for water skiing, pleasure boating, horseback riding, and playing golf and related activities are also needed. These needs will continue to increase through 2020.

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife lists the following needs and recommendations for improving the fish and wildlife resources in the basin:

> Access to fishable waters is inadequate in the basin. The combination of difficult access and private ownership of access to the waters limits freshwater and marine sport fishing to a considerable degree. Efforts should be made at all levels of government in the basin to increase public access to fishable waters by developing small public parks adjacent to water areas, acquiring public access to water, and construction of boat ramps at public access points.
>
> The indiscriminate introduction of fish species into an area can be harmful to either a new or existing fishery. In the interests of good fish management, only those species of fish recommended by the Texas Parks and Wildlife Department should be stocked.
>
> Many complex fishery management problems such as stunted fish populations and excessive numbers of rough fishes can be expected to occur in the future. The Texas Parks and Wildlife Department should be consulted about fish management problems that arise in the basin.

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There is a wide and interesting variety of fish and wildlife in the basin, including some endangered, rare, and peripheral species. Only a public fully aware of the value of such resources can guarantee their preservation, or continued abundance. A public education program by all concerned should be fostered to increase the appreciation of fish and wildlife.

There are many and varied uses of the basin's water resources, some of which may be conflicting. In order to assure that maximum benefits are attained from the water resources throughout the basin, multiple uses of the waters should be planned and coordinated carefully.

Pollution is becoming more of a problem in the Lower Rio Grande Basin. Fish and wildlife habitat are being steadily degraded or destroyed and it will be only a matter of time until the entire Laguna Madre is affected seriously. Efforts to abate pollution should be accelerated greatly in order to protect the valuable fish and wildlife resources of the basin.

Much of the basin has been placed in intensive agricultural production and little good wildlife cover remains. In order to protect valuable wildlife habitat, brush clearing should be discouraged and if necessary should be kept to a minimum when project measures are installed. Big game, upland game, and some wildlife unique to the area are dependent on the remaining cover.

Wildlife habitat could be improved by planting trees, shrubs, and grasses in appropriate places on or adjacent to fencerows, hedgerows, drainage ditches, irrigation canals, embankments, farm buildings, banks of streams and resacas, odd or eroded areas, and in public parks. Such plantings would provide windbreaks, help control erosion, provide food and cover for many species of wildlife, and beautify the landscape.

The Texas Parks and Wildlife Department has acquired several tracts of brush and timber to preserve valuable and unique wildlife habitat. More selected areas of brush and timber should be preserved as they are a vital part of the habitat for such species as white-winged doves,other doves, chachalacas, and a number of other species.

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Large quantitites of insecticides, herbicides, and fertilizers are used on the intensively cultivated lands of the basin and they are becoming a greater menace to many forms of animal life. This problem could be alleviated significantly by adhering closely to the policy set forth in the Secretary of Agriculture's Memorandum No. 1565, U. S. D. A. Policy on Pesticides. Landowners should be encouraged to use those means of effective pest control which would provide the least potential hazard to animal life. Included would be the use of bio-degradable materials and a reduction in the amounts of insecticide, herbicide, and fertilizer loads discharged from irrigation units.

It is recommended that:

1. Continuing efforts be made by all levels of government in the Lower Rio Grande Basin to increase public access to fishable waters through establishment of small parks, acquisition of public rights-of-way to waters, and construction of public boat ramps.

2. Waters in the basin be stocked only with species of fish recommended by the Texas Parks and Wildlife Department.

3. The Texas Parks and Wildlife Department be consulted about fishery management problems in the basin.

4. That a public education program be fostered in the basin by all concerned with the comprehensive plan to increase appreciation for fish and wildlife resources, especially the endangered, rare, or peripheral species.

5. The multiple uses of water resources in the basin be carefully planned and coordinated in order to obtain the maximum benefits from them.

6. Efforts to abate pollution be greatly accelerated in order to protect the basin's valuable fish and wildlife resources.

7. Brush clearing be restricted to the minimum extent possible when project measures are installed in order to retain habitat valuable for big game, upland game, and wildlife unique to the area.

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8. Plantings of trees, shrubs, and grasses be made in appropriate places on or adjacent to fencerows, hedgerows, drainage ditches, irrigation canals, embankments, farm buildings, banks of streams and resacas, odd or eroded areas, and in public parks to improve wildlife habitat. The Texas Parks and Wildlife Department to be consulted about species best suited for habitat plantings.

9. Selected areas of brush be set aside for wildlife habitat.

10. In accordance with the Secretary of Agriculture's Memorandum No. 1565, U.S.D.A. Policy on Pesticides, landowners be encouraged to use those means of effective pest control which would provide the least potential hazard to animal life including bio-degradable materials and a reduction in the amounts of insecticides, herbicides, and fertilizers discharged from irrigation units.

The above recommendations are in conformance with U.S.D.A. Soil Conservation Service Plant Sciences Memorandum-5, National Standards and Guides to Specification for Conservation Practices in the Plant Sciences. 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.

Water Quality Control

Streams must continue to serve as residual waste carriers in the foreseeable future, simply because there is no other place to dispose of waterborne wastes. But the increasing demands of water for all purposes, including fish, wildlife, and recreation, as well as municipal, industrial, and agricultural water supply, will require that wastes be removed from streams and drains to meet the quality standards established by the State and/or Federal government.

Water for dilution of treated wastes from industries and municipalities is an immediate need. As population increases and industrial expansion takes place, the need to provide water without lowering the water quality in the streams and drainageways will become acute. As water is limited in the basin, complete treatment and disinfection of organic wastes originating in sewage will become an absolute necessity.

Waste and sewage treatment facilities are becoming old and overburdened. Demands on the plants are continually increasing. To meet the needs of future development, a complete coordinated plant should be developed and installed for use by all cities and towns within the basin.

During period of low flows on the Rio Grande, salt-water intrusion from the Gulf of Mexico occurs. With the development of Falcon Dam and controlled flows on the river, the need for preventing this intrusion becomes even more apparent. Studies should be made all along the Laguna Madre coastline to determine detrimental effects of salt-water encroachments. Changes in the balance of fresh water to salt water by changing quantities of water or drainage patterns at bays and estuaries will affect the fish life by changing both habitat and water quality. These changes are usually to the detriment of game fish and often to the benefit of undesirable fishes. Control of pollution caused by chemicals, sediment, and other toxic materials is an apparent need in the basin.

Dredging of canals for purposes of navigation removes large sections of game fish and wildlife habitat from production. The environment is substantially changed and not always conducive to the best in recreation or aesthetics. Without considering these needs, the future development of the basin could be adversely affected.

Rural Power Supply

Electric power for rural areas of the basin is furnished by the Magic Valley Electric Cooperative at Mercedes. This cooperative buys its power from the Central Power and Light Company, which supplies electrical power to all valley cities except Brownsville. The city of Brownsville has a municipal electric system which serves the city and port. The basin power supply is adequate for present and future needs.

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EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

Public Law 566 Projects

The Watershed Protection and Flood Prevention Act, Public Law 566, provides technical and financial assistance to State and local organizations in planning, designing, and installing watershed improvement works. It also provides cost-sharing for flood prevention, irrigation, drainage, sedimentation control, fish and wildlife developments, and public recreation, and extends long-term credit to help local interests with their share of the costs, including costs of developing municipal and industrial water supplies.

Flood prevention measures are eligible for Federal funds covering full cost of construction and engineering. Agricultural water management measures are eligible for Federal technical assistance and cost-sharing. Nonagricultural water management measures such as municipal or industrial water supplies are financed entirely by local interests.

No PL-566 watershed projects have been installed. However, work plans for watershed protection, flood prevention, agricultural water management, and recreation developed under the authority of Public Law 566 for the Rancho Viejo, the Los Fresnos Resaca, and the Arroyo Colorado watersheds cover all of Cameron County. The Public Law 566 projects in Cameron County are sponsored locally by the Southmost Soil and Water Conservation District and the Cameron County Commissioners Court. In addition to these, the local sponsors for the Arroyo Colorado watershed include the Willacy-Hidalgo Soil and Water Conservation District and the La Feria Water Control and Improvement District, Cameron County, No. 3.

The following is a brief summary of these PL-566 watershed work plans:

Rancho Viejo Watershed located north of the Rio Grande in the southeastern part of Cameron County, has a watershed area of 238,445 acres (372.6 square miles). Approximately 50 percent of the watershed is cropland; 7 percent, pasture; 26 percent, rangeland; and 17 percent, miscellaneous use, such as urban areas, roads, railroads, ditch rights-of-way, and farmsteads.

Land treatment measures to be established by landowners and operators during the 10 year project period are estimated to cost \$5,291,231. Critical area planting will be done on 906 acres of denuded rangeland at an estimated cost of \$33,980.

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The structural measures included in this work plan consist of 292 miles of multiple-purpose channels, and three water level control structures. The estimated cost of these measures is $6,305,109.

The average annual cost of structural measures is estimated to be $390,822, including $80,800 for operation and maintenance. These measures are expected to produce average annual project benefits of $1,394,843, of which $733,465 is from reduction of flood damages, $650,115 from increased net returns due to increased efficiency of agricultural operations, and $11,263 from water level control. This produces a benefit-cost ratio of 3.6:1.0.

Los Fresnos Resaca Watershed occupies the central portion of Cameron County and has an area of 220,145 acres (344 square miles). Approximately 59 percent of the watershed is cropland; 6 percent, pasture; 11 percent, rangeland; and 24 percent, miscellaneous use.

The installation cost for the land treatment measures planned for this watershed during the project period is estimated to be $6,685,764.

Structural measures to be installed consist of 242 miles of multiple-purpose channels for flood prevention and drainage. The total cost of the structural measures is estimated to be $6,437,887.

The average annual cost of the structural measures is estimated to be $419,921, of which $103,370 is for operation and maintenance. The average annual benefits expected to accrue to the structural measures are estimated to be $1,206,763, of which $626,030 is from reduction of flood damages and $580,773 from increased net returns from more efficient agricultural operations. The ratio of average annual benefits to the average annual costs of the structural measures is 2.9:1.0.

Arroyo Colorado Watershed occupies the northern portion of Cameron County north of the Arroyo Colorado and has an area of 130,300 acres (203.6 square miles). About 90 percent is cropland; 2 percent, pasture; and 8 percent, miscellaneous use.

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The cost of land treatment measures to be installed during the 10 year project period is estimated to be $4,765,679.

Structural measures to be installed consist of 217 miles of multiple-purpose channels for flood prevention and drainage, one multiple-purpose reservoir for irrigation and recreation, and basic recreation facilities. The cost of the structural measures is estimated to be $7,570,911.

The average annual cost of the structural measures is estimated to be $497,362, of which $125,100 is for operation, maintenance, and replacement costs. The structural measures will produce an estimated average annual benefit of $1,713,137, of which $847,031 is from reduction of flood damages, $785,740 from increased net returns due to increased efficiency of agricultural operations, $57,863 from more timely and efficient applications of irrigation water, and $22,500 from increased recreational benefits. The benefit-cost ratio is 3.4:1.0.

Table 25 shows the estimated cost of structural measures and table 26 shows the cost allocation and cost-sharing summaries for the Public Law 566 watersheds.

Subsequent to the planning under PL-566 of the Cameron County watersheds and as a part of its limited participation in the Lower Rio Grande study, the U. S. Forest Service compiled a list of plant materials as possible complements to the Soil Conservation Service's recommendations for stabilizing sand dunes and salt flats. This list of suggested plant species was developed from a review of literature and research studies and from consultation with a tropical forestry expert of the Florida Forest Service. If the opportunity is presented to test these species in the problem areas, the Florida Forest Service has indicated its willingness to provide seed for test purposes. The list of plant materials suggested is as follows:

<u>Low Ground Cover</u>

Railroad vine	- Ipomoea pes-caprae
Wedelia	- Wedelia trilobata
Coastal panic grass	- Panicum amarulum

TABLE 25

ESTIMATED STRUCTURAL MEASURES INSTALLATION COST SUMMARY
PL-566 WATERSHEDS IN CAMERON COUNTY 1/
LOWER RIO GRANDE BASIN, TEXAS

Installation Cost Items	Unit	Number To Be Applied	Public Law 566 Funds	Other Funds	Total
			dollars		
Construction					
Multiple-Purpose Channel (Mains and Laterals)	Mile	751	7,195,397	2,398,467	9,593,864
Structure for Water Level Control (Single-Purpose)	No.	3	57,721	57,721	115,442
Multiple-Purpose Structure (I & R)	No.	1	215,204	215,204	430,408
Basic Recreational Facilities	No.	1	15,000	15,000	30,000
Subtotal Construction	-	-	7,483,322	2,686,392	10,169,714
Installation Services	-	-	1,881,500	3,000	1,884,500
Land, Easements, and Rights-of-Way	-	-	21,375	8,215,318	8,236,693
Administration of Contracts	-	-	-	23,000	23,000
TOTAL	-	-	9,386,197	10,927,710	20,313,907 2/

1/ Price Base: 1965.
2/ Does not include the cost of Critical Area Planting, $33,980, of which $25,485 are PL-566 funds and $8,495 are non-Federal funds.

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Trees and Shrubs

Australian pine	- Casuarina equistetifolia
Cajaput	- Melaleuca linarufolia, and m. leucadendron
Jerusalem thorn	- Parkinsonia aculeata
India rosewood	- Dalbergia sissoo
Brazilian pepper	- Schinus terebinthifolia
Oleander	- Nerium oleander
Chaste tree	- Vitex agnus - castus
Bottlebrush	- Callistemon rigidus

Soil and Water Conservation Districts

The Texas Legislature passed the Soil Conservation Law in 1939, which authorized the establishment of soil and water conservation districts for the purpose of conserving the soil and water resources of the State. Impetus for the State Law came from the National Soil Conservation Act of 1935, under which technical assistance was made available to farmers, provided they were organized into districts, in applying soil conservation measures.

Each district is governed by an elected five-member board of supervisors and is an independent subdivision of the State. Among other things, the districts are authorized to (1) carry out erosion prevention and control measures within the district; (2) conduct surveys and investigations of flood damage, soil erosion, and control measures needed; (3) conduct demonstration projects; (4) furnish agricultural and engineering machinery and equipment, fertilizer, seeds, and such other material or equipment as will assist farmers and ranchers in carrying on erosion control, flood prevention, and water management operations; and (5) cooperate or enter into agreements with any agency, governmental or otherwise, or any occupier of lands within the district in the carrying on of erosion control and prevention operations within the district.

Soil and water conservation districts in Texas have no taxing or bonding powers. Financing of the soil and water conservation practices undertaken within the district is met, for the most part, by the individual farmers and ranchers. They may be assisted in the planning and construction stages by technicians from the Soil Conservation Service. Soil and water conservation districts serving the basin are the Southmost and the Willacy-Hidalgo Soil and Water Conservation Districts.

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TABLE 26

COST ALLOCATION AND COST-SHARING SUMMARY
FOR PL-566 WATERSHEDS IN CAMERON COUNTY 1/
LOWER RIO GRANDE BASIN, TEXAS

Item	Purpose					Total
	Flood Prevention	Agricultural Water Management				
		Drainage	Irrigation	Water Level: Control	Recreation	
	dollars					
	Cost Allocation					
Multiple-Purpose Channel (Mains, Laterals, and Appurtenances)	9,763,645	9,763,642	-	-	-	19,527,287
Single-Purpose (Mains, Laterals, and Appurtenances)	-	-	-	160,338	-	160,338
Multiple-Purpose Structure	-	-	353,926	-	232,856	586,782
Basic Recreation Facilities	-	-	-	-	39,500	39,500
TOTAL	9,763,645	9,763,642	353,926	160,338	272,356	20,313,907
	Cost Sharing					
Public Law 566	5,684,749	3,286,278	182,925	83,117	149,128	9,386,197
Other	4,078,896	6,477,364	171,001	77,221	123,228	10,927,710
TOTAL	9,763,645	9,763,642	353,926	160,338	272,356	20,313,907 2/

1/ Price Base: 1965.
2/ Does not include the cost of Critical Area Planting, $33,980, of which $25,485 are PL-566 funds and $8,495 are non-Federal funds.

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Public Law 46

The Soil Conservation Act, PL-46, was passed by Congress in April 1935. It formally recognized soil erosion as a "menace to national welfare" and declared as "policy of Congress to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands...."

The soil and water conservation program authorized cooperation with local groups, such as soil and water conservation districts, as well as with other Federal agencies in the development and implementation of soil and water conservation.

Under this Act, the Soil Conservation Service provides technical assistance through soil and water conservation districts programs. These programs assist the farmers and ranchers in the planning and application of measures needed for the protection, use, and improvement of cropland, pastureland, and rangeland.

Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service administers the Agricultural Conservation Program under the Soil Conservation and Domestic Allotment Act of 1936. This program provides cost-share assistance to farmers in implementing soil, water, woodland, and wildlife conservation practices on farmlands now in agricultural production; it does not apply to development of new or additional farmland. The conservation practices must be performed satisfactorily by farmers and in accordance with applicable specifications.

The program provides aerial photos for conservation work; allotments for crop rotations; and planning assistance for land measurement, land sale, residential and industrial development; and emergency measures for natural disasters.

Farmers Home Administration

The agency's programs strengthen family farms and rural communities and reduce rural poverty. The principal types of loans that are available in the Lower Rio Grande Basin are as follows:

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The Agricultural Stabilization and Conservation Service provides cost-sharing assistance to landowners in establishing conservation practices such as planting African stargrass (top). Same field one year after planting (bottom).

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1. Operating Loans - Operating loans are made to eligible operators of not larger than family farms, to assist them in making improved use of their land and labor resources and make adjustments necessary for successful farming.

2. Farm Ownership Loans - Farm ownership loans help family farmers obtain the resources needed to improve their living conditions and farm successfully. These loans are made to buy farms or land to enlarge farms; construct or repair buildings; improve land; develop water, forestry, and fish farming resources; establish recreation enterprises to supplement farm income, and refinance debts.

3. Soil and Water Conservation Loans - Loans are made to eligible individual farm operators and owners to develop, conserve and make better use of their soil and water resources.

4. Watershed Loans - Watershed loans are made to local organizations to help finance projects that protect and develop land and water resources in small watersheds. Loan funds may be used to pay the applicant's share of the cost of flood control dams and reservoirs, water supply reservoirs, rural water supply distribution systems, diversion dams, irrigation canals, drainage facilities, recreation facilities, easements, and similar purposes.

5. Comprehensive Water and Sewer Plans - Grants are available to help communities which currently are without the resources to pay for the development of official comprehensive water and sewer plans in rural areas. Such plans promote efficient and orderly development of rural communities and provide information necessary to avoid overlapping, duplication, underdesign, or overdesign of community water and sewer facilities.

6. Economic Opportunity Loans - Economic opportunity loans are made to low-income families in rural areas to enable them to increase their incomes. Farmers may obtain loans to improve farming or develop and expand a small business or service.

7. Rural Housing Loans - Rural housing loans are made to farmers and other rural residents in open country and small rural communities with populations of not more than 5,500. Loans are made to construct and repair needed homes and essential farm buildings, purchase homes or buy sites on which to build homes.

A rural community water supply system typical of those financed by Farmers Home Administration.

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8. Water and Waste Disposal System Loans and Grants - Loans and grants for the construction of rural community water and waste disposal systems are made to public bodies and nonprofit organizations.

As of August 1967, four water supply systems had been completed in the basin with the aid of FHA loans totaling $280,080, and were serving 228 users. Such a project is the Arroyo Water Supply Corporation of Arroyo City which received a loan of $192,000 for a new water system. The system is serving over 135 members. The distribution system has one 50,000-gallon water storage tank on the ground at the wells, one 50,000-gallon elevated storage tank in Arroyo City and two booster pumps at the well sites to pump water into the elevated tank. A total of 69,140 feet of pipe has been installed.

Loans totaling $1,826,300 and grants totaling $702,000 had been approved for eight systems to serve 1,786 users. One such project will be installed by the Stillman Rural Water Supply Corporation east of Lyford which received a $174,000 loan and a $132,000 development grant for a water distribution system. The distribution system will serve a group of 151 farm and rural families in the Willacy County area. The system will provide a safe, dependable water supply for domestic and livestock use. The system has a storage capacity of 100,650 gallons.

Loan applications for five systems were on record, but not approved.

International Boundary and Water Commission

The International Boundary and Water Commission, a joint agency of the governments of the United States and Mexico, was authorized in 1930 to develop an international plan for flood control. The Commissioners prepared a joint report entitled, Preliminary Report on the Flood Control Plans, Lower Rio Grande, dated September 3, 1932. This report proposed construction of levees along both sides of the river, and construction of two diversion dams to pass floodwaters into the various floodways to limit the flow in the river channel at Brownsville to not more than 30,000 second-feet. Each country was to transport part of the excess floodwater through its interior floodways. Since 1932, both sections of the Commission have engaged in the construction of flood control works along the river and interior floodways.

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Floodway system of the International Boundary and Water Commission in operation during Hurricane Beulah, 1967. The Rio Grande is in the foreground. The Main Floodway (upper left) brings floodwater from the Rio Grande to a point near Mercedes where it is divided between the Arroyo Colorado (to the right) and the North Floodway (toward the top).

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The United States section of the Commission has constructed about 85 miles of river levees and about 130 miles of leveed floodways to afford protection from Rio Grande floods. When not carrying floodwaters, these floodways serve to carry runoff water from adjacent lands. However, when the floodways are carrying floodwaters it is necessary to close the levee gates, thus blocking local runoff. The project was planned to provide for a maximum flood of 140,000 second-feet in the Rio Grande at Penitas, diversion of 75,000 second-feet into the United States Main Floodway below Penitas, the diversion of 45,000 second-feet into floodways south of the Rio Grande, and to continue 20,000 second-feet in the Rio Grande to the Gulf of Mexico. Near Mercedes floodwaters in the Main Floodway are divided between the Arroyo Colorado and the North Floodway, which extend to the Laguna Madre.

Summaries of studies and investigations made by the United States section of the International Boundary and Water Commission to find the best means of storing floodwaters of the Rio Grande and making them available to the Valley for their use are presented in their report entitled, Report on the Investigations of the Valley Gravity Canal and Storage Project for Domestic and Irrigation Water Supply, Lower Rio Grande Valley, Texas, dated January 1940. This report found that the United States' share of the flow of the Rio Grande would provide an adequate supply of water to only a portion of the irrigable lands of the Valley. It proposed construction of diversion works upstream from the present location of Falcon Dam, off-stream reservoirs, and a gravity canal on the American side of the river. The report made no recommendations as to drainage needs, but pointed out the need for more extensive drainage systems in order to permit long-term farming. Construction of this project, known as Federal Project No. 5, was authorized by Congress in June 1941, with the Bureau of Reclamation designated as the construction agency.

Before construction was started on Federal Project No. 5, the treaty between the United States and Mexico relating to utilization of the waters of the Rio Grande below Fort Quitman, Texas, was ratified. The treaty provided for the construction of an international storage dam in the vicinity of the Falcon Dam site, and thereby made a review of the Federal Project Plan No. 5 necessary.

Due to the unprecedented flood on the Lower Rio Grande, resulting from Hurricane Beulah in September 1967, the Commission made studies and recommendations for improvements and new works required to assure protection against such extraordinary floods in the future.

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Bureau of Reclamation

The Small Reclamation Project Act of 1965 authorizes the Bureau of Reclamation to provide loans and grants for the rehabilitation or construction of water supply projects having a total cost not to exceed $10 million. Projects must be primarily for irrigation, but multipurpose projects incorporating municipal water supply, hydro-electric power, flood control, fish and wildlife conservation, and recreation may be included. Irrigation districts or other entities which may contract with the United States Government are eligible. Under this act the Bureau is active in the rehabilitation of water distribution and drainage facilities in 7 basin irrigation districts.

The Donna Irrigation District (Hidalgo County No. 1) has completed rehabilitation of its facilities.

Loan funds have been advanced and construction is in progress for Harlingen District (Cameron County Water Control and Improvement District No. 1).

A repayment contract has been validated and funds are available for El Jardin District (Cameron County Water Control and Improvement District No. 5).

Applications are under consideration by the Bureau of Reclamation for San Benito District (Cameron County Water Improvement District No. 2), Santa Maria Water Control and Improvement District (Cameron County No. 4), and Willacy District (Hidalgo and Willacy Counties Water Control and Improvement District No. 1).

Notice of intent to submit an application for a loan has been received by the Bureau from Adams Gardens District (Cameron County Water Control and Improvement District No. 19).

Rehabilitation of the La Feria District (La Feria Water Control and Improvement District, Cameron County No. 3) and the Mercedes District (Hidalgo and Cameron Counties Water Control and Improvement District No. 9) has been accomplished by the Bureau under specific authorization from the Congress.

The Bureau prepared a report entitled, Plan for the Development of the Valley Gravity Project, Texas, dated December 1948. The report presented a modified plan for a diversion dam near Rio Grande City, an off-stream storage reservoir near Mission, and a gravity canal to deliver water to the distribution system of the

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Valley water users. It also recognized the need of rehabilitation of the existing distribution and drainage systems, and proposed the construction of main drain outlets to permit the achievement of the improved drainage necessary to maintain the productivity of the irrigated lands. This report was presented to the Valley water users for their consideration. Most of the water users approved the report, but concluded there was not sufficient likelihood of obtaining an appropriate contractual agreement, as recognized under the provisions of the Reclamation Laws, to justify submittal of the report to the Congress for authorization of the proposed project plan. Submission of the report to the Congress therefore was deferred to permit resolution of the outstanding problems and the achievement of a fully acceptable plan.

Because of the requests of various Valley interests, and under a jointly-financed program by these interests and the Bureau of Reclamation, the Bureau in 1954 investigated four alternative diversion plans involving dams at the Garza and Anzalduas sites and main canals to deliver flows to existing distribution systems. The report on the investigations, dated May 21, 1954, found all four plans to be feasible and summarized the facts concerning each, but made no recommendations.

The report recognized the need for rehabilitation of the existing distribution systems and for construction of main drain outlets. It was furnished to the concerned local interests as fulfillment of the agreement concerning the investigations.

In May 1957, the Bureau prepared Plans of Drainage Improvement for Precinct 4 of Cameron County and Hidalgo County Drainage District No. 1. No action was taken beyond the planning stage.

In February 1965, the Bureau prepared a plan of development, the Texas Basins Project. The project is designed primarily to provide major new municipal, industrial, and irrigation water supplies to support long-term expansion of the Texas economy.

Corps of Engineers

The Corps of Engineers is responsible for navigation projects in the basin. Federal navigation projects in Cameron and Willacy Counties include the shallow-draft Gulf Intracoastal Waterway, including the channels and small boat basin, and the deep-draft Brazos Island Harbor project at Brownsville.

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The Corps, in accordance with a Congressional directive, undertook a preliminary examination of the major drainage problems of the Valley in 1950. A public hearing was held in the Valley, the findings were reviewed, and a preliminary study of the drainage problems was made. On the basis of these actions, it was concluded that there was a major drainage problem in the Valley and that further investigation was necessary to determine the best solution to the problem. Local interests were divided as to the measures to be taken to safeguard agricultural production within the basin.

The Corps is also conducting studies of the adverse effect of dust storms from Long Island with views toward establishing such remedial and protective measures as may be necessary to prevent damages from wind erosion and salt deposition.

Bureau of Sport Fisheries and Wildlife

The Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior operates two National Wildlife Refuges in the basin, Laguna Atascosa and Santa Anna.

The Santa Anna National Wildlife Refuge is on the Texas-Mexico border in a large bend of the Rio Grande near McAllen, Texas, and Reynosa, Mexico. The 2,000-acre area was established to preserve certain birds found nowhere else in the United States. The refuge is an example of a subtropical lowland forested area that has nearly disappeared from other parts of the basin. The refuge attracts thousands of visitors annually from many parts of the United States and from other countries. Over 435 species of plants and 300 species of birds have been identified. No hunting is permitted on the refuge.

The Laguna Atascosa National Wildlife Refuge is located on the southern portion of the Laguna Madre near San Benito, Texas. It contains about 45,000 acres, of which about 7,000 acres are marsh and open water. The terrain is flat and most of the refuge is less than 5 feet above sea level. The refuge is important as the southernmost link in the chain of national waterfowl refuges along the Central Flyway extending from Canada to the Gulf of Mexico.

A large portion of the continental population of redheads winters on this refuge. About 315 species of birds have been seen there and the annual Christmas bird count always ranks among the highest in the country. Hunting is not permitted on the refuge, but controlled hunting may be permitted in the future.

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Drainage Districts

There are eight drainage districts in the basin (plate 4). These districts are organized under State law to levy and collect taxes to construct, operate,and maintain drainage facilities. However, irrigation districts have provided the majority of the drainage facilities shown on plate 5.

Hidalgo County Drainage District No. 1 has constructed some of the drainage ditches in Hidalgo County with its own equipment.

Hidalgo County Drainage District No. 1 and Willacy County Drainage Districts Nos. 1 and 2 were created by acts of the legislature in 1969.

There are four drainage districts in Cameron County. Drainage District No. 1 maintains drainage facilities and contracts for construction of new facilities. Drainage District No. 2 is inactive. Drainage District No. 3 has provided most of the drainage facilities for Water Improvement District No. 2 by contracting for construction of new facilities and maintaining all existing facilities. Drainage District No. 4 contracts for the construction and maintenance of its facilities, since it owns no equipment.

Irrigation Districts

There are 33 active irrigation districts in the basin (plate 6). These districts are local subdivisions of state government which were organized under state law to divert and distribute irrigation water and for related purposes. These districts have the power to levy and collect taxes; to construct, operate, and maintain works of improvement; to acquire land, easements, and rights-of-way necessary to the accomplishment of these purposes; and to contract with the Federal government. Many of these districts are successors to the land and water companies who were the original developers in the basin.

Plate 7 shows the location of the main distribution canals.

Navigation Districts

There are four navigation projects in the basin under the jurisdiction of the U. S. Army Corps of Engineers for design, construction, and maintenance. Included in these projects are two shallow-draft channels, Arroyo Colorado Navigation District at Harlingen and

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Headquarters of the Donna Irrigation District and the pumping station on the Rio Grande.

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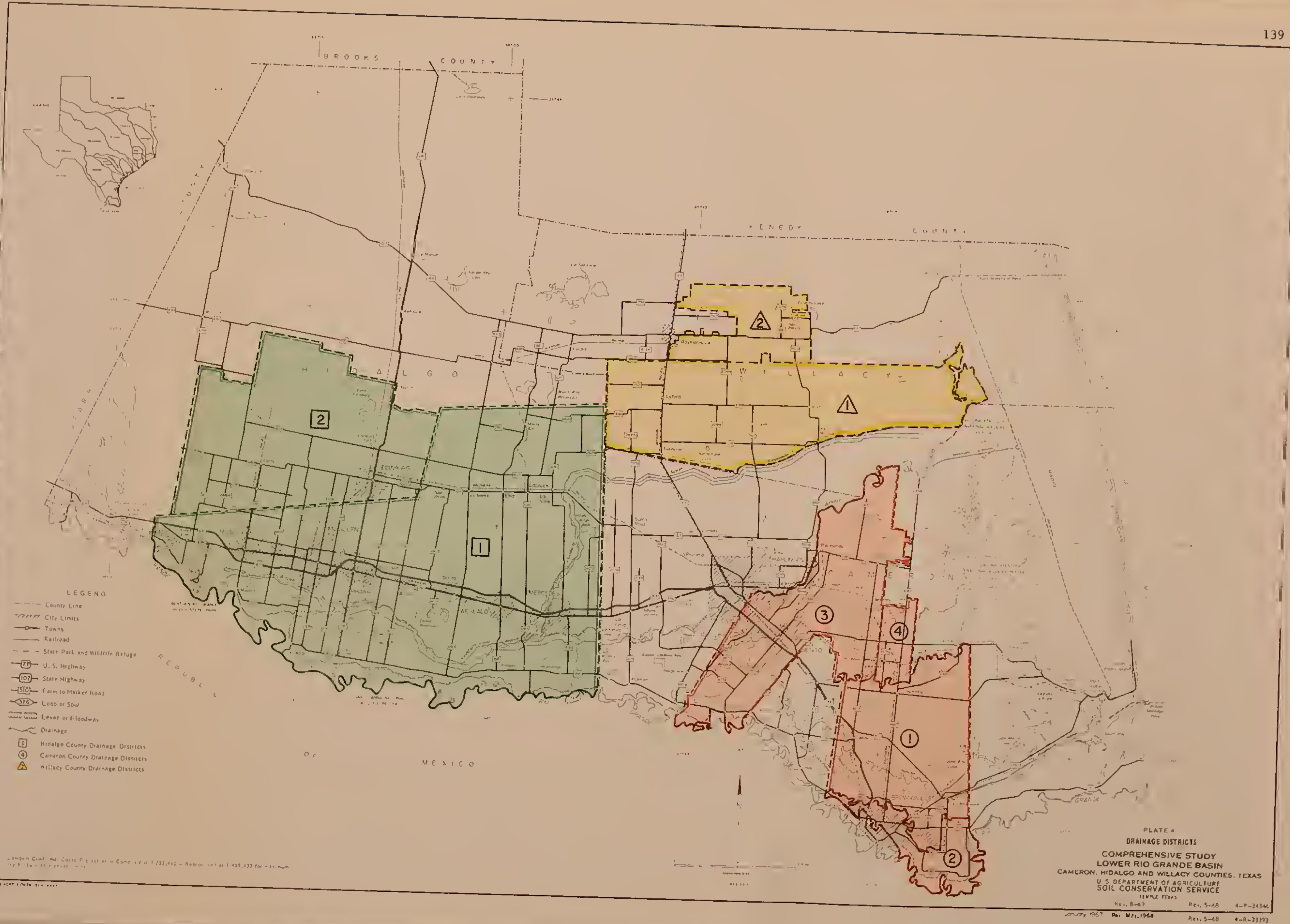
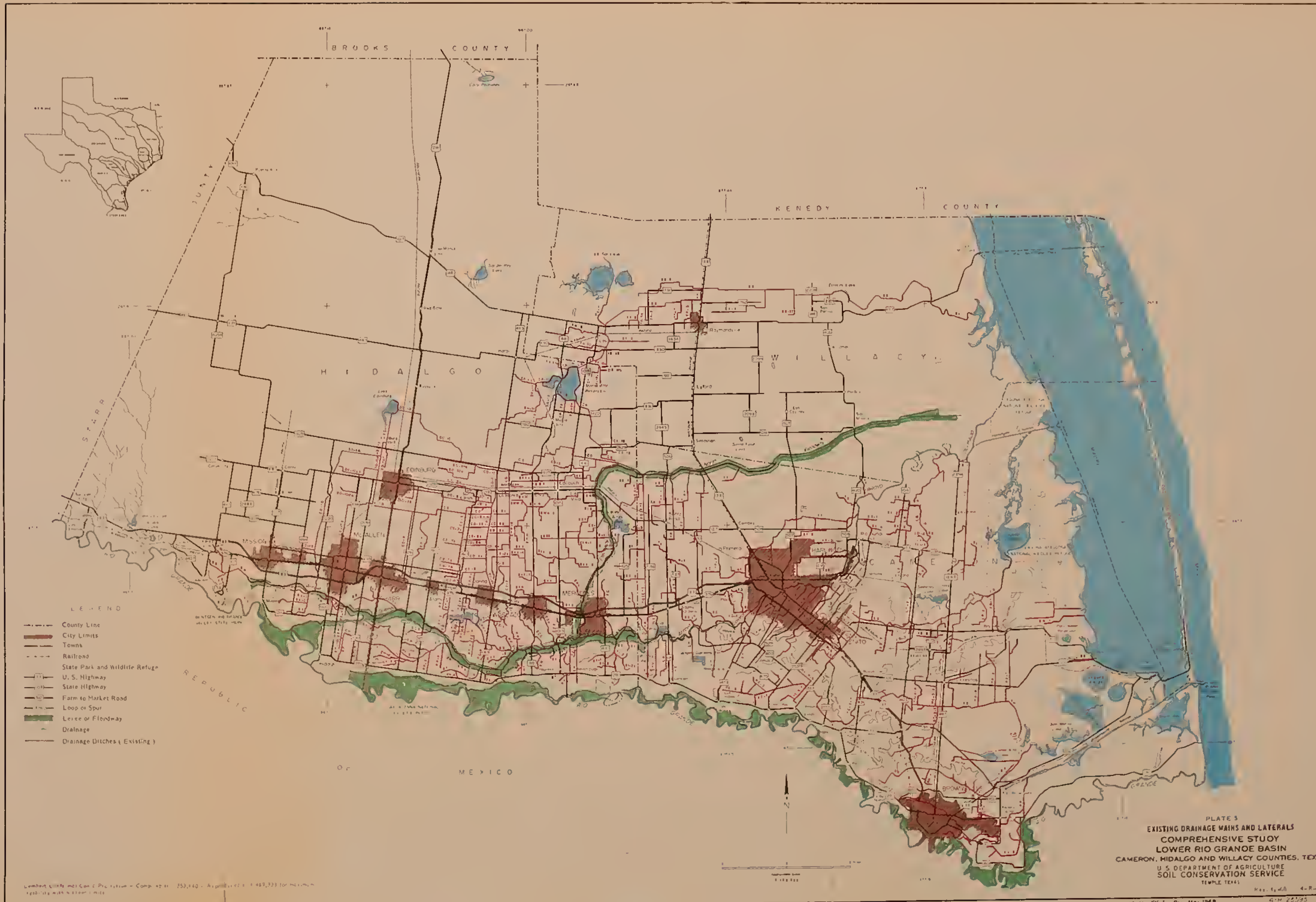

BROOKS COUNTY
KENEDY COUNTY
HIDALGO
WILLACY
CAMERON
REPUBLIC OF MEXICO
LEGEND
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
Hidalgo County Drainage Districts
Cameron County Drainage Districts
Willacy County Drainage Districts
PLATE 4
DRAINAGE DISTRICTS
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 5-68
Rev. 5-68


BROOKS COUNTY
KENEDY COUNTY
HIDALGO
WILLACY
CAMERON
STARR
JUNTY
EDINBURG
McALLEN
MERCEDES
HARLINGEN
REPUBLIC OF MEXICO
LEGEND
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
Drainage Ditches (Existing)
PLATE 3
EXISTING DRAINAGE MAINS AND LATERALS
COMPREHENSIVE STUOY
LOWER RIO GRANOE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
4-R-24254


BROOKS COUNTY
KENEDY COUNTY
HIDALGO
WILLACY
LEGEND
County Line
City Limits
Towns
Irrigation District Boundaries
IRRIGATION DISTRICTS
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE


BROOKS COUNTY
KENEDY COUNTY
STARR COUNTY
HIDALGO
WILLACY
CAMERON
REPUBLIC OF MEXICO
EDINBURG
McALLEN
CITRUS CITY
GOODWIN
EDINBURG
MISSION
HAWKINS
SKIVERS
McALLEN
PHARR-SAN JUAN
DONNA
WESLACO
MERCEDES
PROGRESO
WILLACY
SANTA MARIA
LA FERIA
ADAMS GARDENS
HARLINGEN
IBEMTO
RYCE
SAMS-PORTER
RUSSELL
LOS FRESNOS
EL JARDIN
LEGEND
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
Pump Station
Irrigation Canal
N
PLATE 7
IRRIGATION
MAIN DISTRIBUTION SYSTEM
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 5-68

Willacy County Navigation District at Port Mansfield, and two deep-draft channels, Brownsville Navigation District at Brownsville and Port Isabel-San Benito Navigation District at Port Isabel.

National Park Service

In 1963, Padre Island National Seashore was designated as a national shoreline area by the National Park Service of the Department of the Interior. The island is a typical example of a barrier beach, unusual because of its great size which enhances its primitive character. The wide,clean beach, composed of fine sand and broken shell, extends in an unbroken sweep from horizon to horizon. The slope of the shore is uniformly gentle, providing ideal conditions for swimming, surf fishing, and other beach recreation.

A distinctive feature of Padre Island is the windswept, irregular dunes. Lacking extensive vegetation, much of the sand is shaped and reshaped by the wind. When stable, the dunes bordering the beach are often imposing, up to 40 feet high. Elsewhere, unstable dunes are smaller, often in the shape of small rippling mounds, or else nonexistent, resulting in flats stretching from the Gulf to the Laguna Madre. The general atmosphere of the island is one of undisturbed isolation and seemingly endless expanses of flat, sparsely vegetated beach land. Padre Island stretches from Port Isabel on the south 100 miles northward to Corpus Christi. The Padre Island National Seashore is 80 miles long, beginning about 10 miles from each end of the island. These ends are left available to commercial development. Some development is already underway.

Texas Parks and Wildlife Department

The Texas Parks and Wildlife Department was established for the purpose of protecting, perpetuating, and improving the recreational and wildlife resources. It is concerned with the acquisition, development, maintenance, and operation of parks. It develops and maintains the recreational facilities on land adjoining the several lakes and streams of the State. This Department operates several wildlife management areas in the basin, and the Bentsen-Rio Grande Valley State Park. This park is noted primarily for its wildlife habitat. Vegetation consists of a jungle-like forest of native trees, such as elm, ebony, hackberry, ash, anaqua, huisache, guayacon, and retama. Over 280 different species of birds can be seen in this park. Some of the birds found here are the white-winged dove, chachalaca, red-billed pigeon, white-fronted dove, green jay, tropical kingbird, beardless flycatcher, and others. Mammals present include the raccoon, coyote, skunk, opossum, armadillo, bobcat, and others.

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Dune sands in Padre Island National Seashore

Lakeside cottage on Delta Lake

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There are about 60 picnic tables, 90 campsites including a trailer camp, and one open group shelter.

The Department owns the Las Palomas Wildlife Management Area which includes four units of different tracts of land in Starr, Willacy, and Cameron Counties. That Department also leases six other brushy tracts of land in the Lower Rio Grande Valley. These are the San Juan de Carricitos Tract in Willacy County, the Resaca de la Palma and City of Rio Hondo Tracts in Cameron County, and the Methodist Retreat, La Lomita, and McManus Tracts in Hidalgo County. These areas are managed primarily to provide nesting habitat for white-winged doves and several of the rare or peripheral species.

The Texas Parks and Wildlife Department also operates the Olmito State Fish Hatchery north of Brownsville in Cameron County. The fish produced at this hatchery are intended to supply the needs of this region of Texas.

County Parks, Historic Sites and Miscellaneous Developments

South Padre Island in Cameron County is a recreation area that has been developed by Cameron County and private developers. It is connected to the mainland at Port Isabel by the Queen Isabella Causeway, completed by Cameron County in 1954. The county operates two parks with a bathhouse, cabanas, overnight shelters, a new 1,000-seat pavilion, trailer spaces, and other comforts. Private developers have built hotels, motels, restaurants, grocery stores, beauty parlors, service stations, providing all the conveniences of modern living. Padre Island has miles of beautiful, clean sandy beaches. On the bay side the placid waters of Laguna Madre are ideal for boating, water skiing, or fishing. Anzalduas Park in Hidalgo County is another popular recreational area. The Park is located at Anzalduas Dam south of Mission on the Rio Grande. The visitor will find open camping areas, picnic tables, and comfort facilities. The fresh-water area upstream of the dam is ideal for fishing, water skiing, and boating.

The World Wildlife Fund, a private International wildlife organization, is active in the basin. The organization has been instrumental in saving several valuable wildlife areas consisting primarily of brushy and forested areas. These plots provide indispensable food and cover primarily for doves, quail, and chachalacas, supporting some species in large numbers.

Green Island and the Three Islands, located near the mouth of the Arroyo Colorado in the lower Laguna Madre, are maintained by the National Audubon Society as sanctuaries and nesting areas for several species of birds.

The Palo Alto Battlefield is the location of a battle that occurred May 8, 1846, when General Zachary Taylor's army, on their way to Mexico, encountered and defeated the Mexican army. On May 9, 1846, continuing his march toward Matamoros, Taylor again defeated the Mexican army at Resaca De La Palma, a winding, shallow lake formed when the Rio Grande changed course some centuries ago. This site is known as the Resaca De La Palma Battlefield.

Boca Chica is on the Gulf side of Brazos Island, which in recent years has become a peninsula. It lies south of Padre Island and is on the route used by Zachary Taylor for supplies. The palmetto logs of his causeway may still be seen. Federal troops were stationed here off and on during the War Between the States. Remains of a railroad built by the Federals may still be seen.

The last battle of the Civil War was fought on May 13, 1865 at the Palmetto Hill Battlefield more than a month after Lee's surrender on April 9, 1865. Due to slow communications, the troops had not heard the news. Marching up from their encampment on Brazos Island, Federal troops were routed by Confederate troops coming from Fort Brown.

Port Isabel Lighthouse, which is now a state park, was constructed in 1853 to aid coastal commerce. The lighthouse is near the sites of Palo Alto and Palmetto Hill Battlefields.

William Jennings Bryan, the "Great Commoner", liked the Valley so well on an early visit he bought a home, where he spent a good part of his last years.

The La Lomita Mission is a small chapel built by Oblate Missionaries in 1849. It is still used as a place of worship.

Sal del Rey Lake has been mined for almost pure rock salt for more than two centuries by white men, and for uncounted centuries before that by Indians.

Paso Real was once an important stagecoach crossing on the Arroyo Colorado prior to the coming of the railroad in 1904, and the old inn remains.

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Lower Rio Grande Valley Development Council

The Lower Rio Grande Valley Development Council was formed by the merger of the Texas Southmost Economic Development District and the Lower Rio Grande Valley Council of Governments in August 1967.

The council has three principal areas of activity: (1) the industrial and economic development of the region; (2) the preparation and publication of the Regional Master Plan; and (3) the strengthening of cooperation among local governmental subdivisions, thereby increasing efficiency and economy.

Other Reports

The United States Department of Agriculture prepared a drainage investigation report of the Valley dated June 30, 1914. This report reviewed the progress of drainage work in the Valley and discussed the drainage problems and needs. The report made no project-type proposals. However, problems and needs as expressed in the report are still applicable.

The Reclamation Service prepared a report entitled, Report on Preliminary Investigations for Flood Control in the Lower Rio Grande Valley, Texas, dated 1923. The purpose of this report was to assemble such data as were available concerning flood conditions in the Valley and to consider plans for the protection of the areas subject to overflow. There is no recorded evidence that any action was taken on the report.

In February 1934, the Valley Conservation and Reclamation District "formulated a plan for relieving intolerable drainage conditions in the Lower Rio Grande Valley of Texas and to make an appeal to the Federal government for a money grant for constructing urgently needed drainage works." This plan was developed jointly by the U. S. Department of Agriculture, State of Texas, and Cameron, Hidalgo, and Willacy Counties. There is no evidence that any action was taken on the plan.

In June 1952, the Lower Rio Grande Authority made arrangements with private firms for determination of the feasibility of a plan to divert the Rio Grande flows at the Anzalduas damsite instead of diverting it at the Garza site near Rio Grande City, as proposed by the Bureau of Reclamation in the Valley Gravity Project plan. The advisors to the Authority found such a plan to be feasible from an engineering, economic, and financial standpoint, and presented their findings and recommendations in a report entitled,

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Sun and Salt + Water, dated October 1952. Investigations on which the report were based included a review of the studies and findings of the International Boundary and Water Commission and the Bureau of Reclamation. The report made no recommendations as to drainage improvements, but recognized their need for sustained farming operations.

In July 1966, the Texas Water Development Board developed a preliminary plan for proposed water resource development in the basin. The primary objective of the basin plan is to provide for long-range in-basin water requirements. It suggests means for supplying these requirements. The plan provides for fulfilling all projected in-basin water requirements to the year 2020, and is an integral part of the Texas Water Plan.

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Cannon used in Spanish-American War, Resaca De La Palma Battlefield.

This historical 42-inch gauge railroad locomotive was built in 1870 and used between Port Isabel and Brownsville, Texas.

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WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

Availability of Land for Potential Development

Land available for agriculture in the future will decrease as non-agricultural land needs and water requirements increase. The requirement for nonagricultural land is estimated at 205,400 acres by 1980; 261,300 acres by 2000; and 336,600 acres by 2020. There will be 1,733,600 acres available for agricultural use by 1980; 1,677,700 acres by 2000; and 1,602,400 acres by 2020. Agriculture is and will continue as the major user of the land resource in the basin.

Impoundments

The flat terrains of the Valley limits reservoirs almost exclusively to those of off-channel construction. The earth dams completely encircle the storage areas, and water has to be piped or pumped into the reservoirs. Further limitations on the development of potential sites are the restrictions and priority of use placed on the available water supply by the State of Texas. Recreation or fish and wildlife management can be developed as an incidental feature in all reservoirs. The PL-566 work plan for the Arroyo Colorado Watershed includes development of a multiple-purpose reservoir for irrigation and recreation at the old Tiocana Lake about 4 miles north of La Feria. The Texas Water Plan proposes a regulating reservoir for municipal, industrial, and irrigation water in northeast Hidalgo County adjacent to the Willacy County line.

Cameron County Water Control and Improvement District No. 5 (El Jardin) plans to construct a reservoir for irrigation water storage about one mile east of their river pumping plant. The Brownsville Navigation District has obtained a permit to build a reservoir for industrial storage at the old Loma Alta Lake just north of the Port of Brownsville. Storage potential for the reservoirs by uses is as follows:

Irrigation	6,400 acre-feet
Industrial	26,500 acre-feet
Recreation	3,000 acre-feet
Holding Reservoir (Municipal, Industrial and Irrigation)	33,000 acre-feet
TOTAL	68,900 acre-feet

Ground Water Developments

Ground water of suitable quality is limited in availability in the Valley. It is not, therefore, a dependable and satisfactory permanent source of supply. Municipalities and some irrigators do have wells which, however, are used mostly on a standby basis for emergency use. Ground water use has been intermittent and will likely remain so. Water pumped from shallow wells in alluvium near the river is considered to be a draft on adjacent streamflow, since it is effectively connected hydraulically in most places. Quality of the ground water of the Valley is generally poor. Further deterioration is taking place as mineral-laden irrigation water percolates to the water table. High-water tables, highly mineralized, develop as a result of inadequate drainage. Some improvement could come from ground-water pumping and use only if adequate drainage facilities are installed to conduct mineralized return flows from use areas and thereby lower the water table. Without such improvements, continued ground water use can be locally harmful.

The wells in the Willis (Bentley) and Goliad formations have shown steady declines and would probably fail to meet demands if developed further. Natural recharge to these aquifers is slow and artificial recharge probably is not feasible.

Channel Improvement

The potential for solving the flood problems and problems of inadequate surface and subsurface drainage as well as the salinity problem in Willacy and Hidalgo counties is through the installation of an interdependent system of channel improvements. The solution would require construction of 164 miles of single purpose channel improvement for the removal ot floodwater and 1,394 miles of multiple-purpose channel improvement for the flood prevention and surface and subsurface drainage. Of the 1,394 miles of multiple-purpose channels, 450 miles would be new construction and 944 miles would be improvement of existing facilities. The PL-566 work plans for watersheds in Cameron County provide for improvement of 616 miles of existing and construction of 135 miles of new multiple-purpose channels.

There are three approaches to the treatment of high-water table areas. One is to eliminate the source of the excess water. Another is to intercept and dispose of the excess water before it reaches the affected area. A third is to provide relief drainage and draw down the excess water to the extent that the water table will stay at a level that will not adversely affect agricultural production.

Relative to the first-mentioned treatment method, any seepage preventative measures will improve production on soils adversely affected by poor subsurface drainage. The lining of ditches or canals, replacement of earthen ditches with pipelines, the sealing of reservoirs and the proper management of irrigation water will reduce seepage and conserve water. However, due to the salt content of some of the irrigation water, it is necessary to apply water in excess of that used by the crops. Leaching is the only practical known way to remove the salts added during irrigation. Leaching applications raise the water table unless adequate subsurface drainage is provided.

The possibility of installing interceptor drains in a general north-south direction at several locations in Willacy County was considered. These drains possibly would help to lower the ground-water table on a regional basis, if they could be installed in such a manner as to tap the sand layer and relieve hydrostatic pressure. Adequate outlets for such a series of drains would be available in a system of floodwater channels. This alternative should be given further consideration in the development of Phase II of the proposed plan. A determination should be made as to (1) whether or not such an approach is physically feasible from a geological and engineering standpoint,and (2) whether or not it is economically desirable when weighted against a system of open surface channels installed to achieve basically the same result.

For effective control of high-water table areas on individual farms, a complete system of subsurface drains generally is needed. These drains are recommended for areas where studies and investigations indicated that there is active ground-water flow or movement and where it is possible to locate a drain in the upper part of the wet or affected area. It is desirable to use covered-type drains wherever possible since little maintenance is required and farming operations can be carried on over it without loss of land or time.

Irrigation

If sufficient water were available, about a half million additional areas could be irrigated successfully. The Texas State Water Plan provides for additional water supplies to be transferred from water surplus areas to permit irrigation of a total of about one million acres. This would include acreage presently supplied from the Rio Grande (plate 8). Project-type delivery and distribution systems likely will be required for about 142,000 acres of new irrigated land when this additional water is made available.

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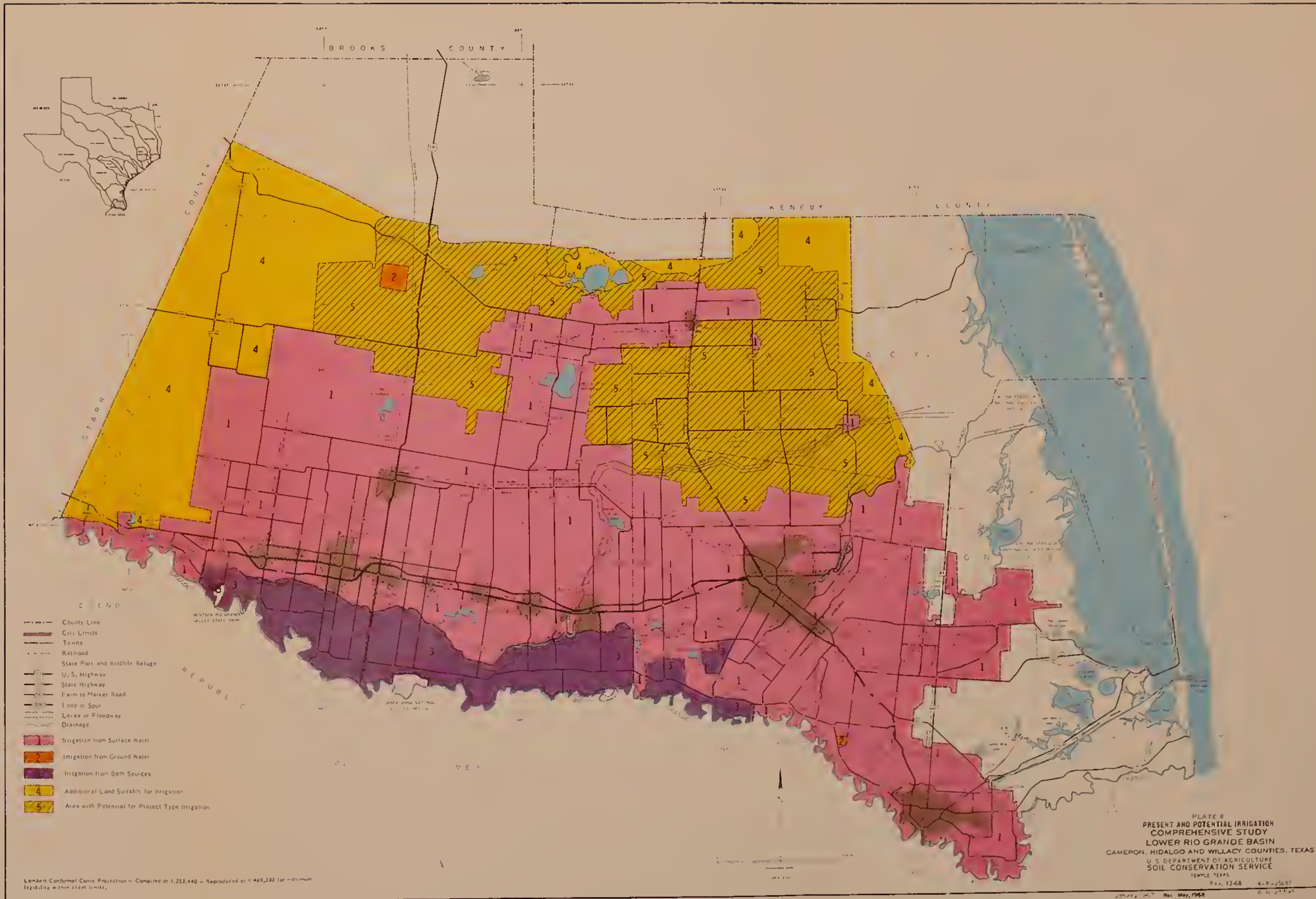
BROOKS COUNTY
KENEDY COUNTY
STARR COUNTY
LEGEND
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
1 Irrigation from Surface Water
2 Irrigation from Ground Water
3 Irrigation from Both Sources
4 Additional Land Suitable for Irrigation
5 Area with Potential for Project Type Irrigation
PLATE 8
PRESENT AND POTENTIAL IRRIGATION
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

The soils most suitable for irrigation in the potential irrigation project area are mostly fine sandy loams which overlie sandy clay loams and clay loams. They are the nearly level and gently sloping, moderately permeable soils of the uplands, which have calcareous substrata. These soils are capable of supporting sustained production under irrigation with the least requirement for artifical drainage. They lie mainly within the WV, WH, HB, MB, D, and WD associations (table 1). The lower-lying, more clayey, slowly permeable soils of the uplands are less desirable for irrigation development, but will produce well with close attention to irrigation management. Most of these soils have high-water tables, or are saline or both. The problems of salinity and high-water tables will increase without artificial drainage. These soils are mostly within the R, RN, RM, and WR associations.

Some water-supply districts already have completed the necessary pipelines, canal lining, and other rehabilitation measures to prevent excessive and unnecessary water loss and to attain a high efficiency in the delivery and application of irrigation water. There are, however, other systems for which rehabilitation is urgently needed.

Development of new project type irrigation and rehabilitation can be carried out under programs administered by the Bureau of Reclamation. Integration of the Texas State Water Plan with existing conditions can be expected to go smoothly, as many of the project facilities already exist. These proposed developments assume an adequate market demand for the resulting increase in production.

Recreation Development

In 1967, the Soil Conservation Service, the Agricultural Stabilization and Conservation Service and the Extension Service of the United States Department of Agriculture and representatives of state and local agencies cooperated in making an appraisal of the potentials for outdoor recreation for Cameron, Willacy, and Hidalgo counties. Table 27 presents a summary showing the results of these appraisals.

The potential for meeting the needs for water based recreation associated with reservoir construction is limited because of lack of suitable natural sites and shortage of water. There are, however, excellent opportunities to develop small parks for picnicking, playgrounds and small gatherings and canal fishing adjacent to the irrigation canals and drainage channels. The network of excellent roads provides ready access to most of these potential sites.

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TABLE 27

OUTDOOR RECREATION POTENTIALS 1/
LOWER RIO GRANDE BASIN, TEXAS

Development Potentials	Cameron County	Hidalgo County	Willacy County
Vacation Cabins, Cottages & Homesites	High	Medium	Medium
Camping Grounds			
Vacation Sites	High	Low	Medium
Pack Trips	Low	Low	Low
Transient	High	Low	Medium
Picnicking & Field Sports Areas			
Game, Play & Target Areas	High	Medium	Medium
Bicycling	High	Medium	Medium
Picnicking	High	High	Medium
Fishing Watershed	High	Medium	High
Golf Courses			
Standard Courses	Medium	High	Low
Miniature Golf & Driving Ranges	High	High	Low
Hunting Areas			
Small Game	High	High	High
Big Game	Low	High	High
Waterfowl	High	Low	High
Scenery Areas			
Natural Areas	High	Medium	Low
Scenic Areas	Medium	Medium	Low
Historic Areas	High	High	Low
Riding Stables	Medium	Low	Medium
Shooting Preserves	Medium	Low	Low
Vacation Farm & Ranches	Low	Low	Low
Water Sports Areas	High	Medium	Medium

1/ Potential based on percent of total score which varies with each activity.
Source: Guide to Making Appraisals of Potentials for Outdoor Recreation Developments, United States Department of Agriculture, Soil Conservation Service.

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The State Comprehensive Outdoor Recreation Plan nearing completion by the Texas Parks and Wildlife Department contains a program for action which can meet many of the needs. The Federal Land and Water Conservation Fund will enable the State to work with the Bureau of Outdoor Recreation in planning and constructing the facilities proposed in the State's Plan. In addition, opportunities exist for local governmental units and private investors to develop some of the recreation needs of their areas.

Technical assistance is available through the soil and water conservation districts for the development of income producing recreation enterprises on rural non-Federal lands.

Fish and Wildlife

Construction of more access roads to potential fishing and hunting areas by the counties or the State would provide more opportunities for the enjoyment of these sports. These agencies also could acquire additional public rights-of-way to waters, construct more public boat ramps and establish additional small parks.

The Texas Parks and Wildlife Department can provide consultive services on fishing management problems and recommendations on proper species of fish for stocking the waters of the basin.

The various State, private, and Federal information agencies, the schools and various civic organizations and sportsmans clubs provide excellent opportunities for fostering a public education program on all phases of fish and wildlife resource conservation.

Comprehensive and coordinated planning provide opportunities for full development and multiple use of the available water resources. Likewise, coordinated planning and appropriate State and Federal legislation will insure an acceptable quality of water for the various uses and will protect the fish and wildlife resources.

Programs adopted by the soil and water conservation districts afford opportunities for landowners and operators of farm and ranch land to establish conservation practices that will improve wildlife habitat and benefit wildlife generally.

There are still some small tracts of brush and timber that could be acquired by the Texas Parks and Wildlife Department, the County or private organizations for the preservation of valuable and unique wildlife habitat.

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A complete system of subsurface drains is needed on individual farms to lower the water table and to permit leaching of harmful salts.

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Water Quality Control

The potential for development in regard to water quality control is large, particularly as related to sewerage treatment, which is one of the principal areas of concern. Many of the municipalities in the basin have been issued permits by the Texas Water Pollution Board which will bring the quality of their effluent discharges within the limits set by the State Water Quality Control Board.

These municipalities have no reasonable alternative but to provide adequate treatment at the source because disposal in the Gulf of Mexico would not only be uneconomical, but would violate the principles of the Texas Water Quality Act through which the State expresses its interest in the quality of all of the waters in the State.

In addition to new standards which must be met by the municipalities, the Water Quality Act will make it mandatory that industrial wastes, including those of the petroleum industry,be treated to a degree sufficient to eliminate danger to fish and wildlife, including birds, mammals, and other terrestrial and aquatic life.

The bays and estuaries must be maintained in a condition favorable to aquatic resources, sport fishing, commercial fishing, and recreation. In order to meet these conditions, particularly along the Arroyo Colorado, a coordinated plan of waste disposal involving most of the major municipalities in the basin could be developed.

Mexico's El Morillo Drain diversion from the Rio Grande to the Gulf of Mexico now under construction will greatly improve the Rio Grande water quality below Anzalduas Dam. Construction of a salt water dam near the mouth of the river would further improve the water quality in the lower reaches of the river.

Associated Land Treatment

An effective soil and water conservation program based on the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs is essential for a sound watershed protection, flood prevention, and agricultural water management program. Such a program is now in operation in this area through the assistance in and cooperation of the Willacy-Hidalgo and Southmost Soil and Water Conservation Districts.

Landowners and operators with assistance from the soil and water conservation districts establish and maintain land treatment measures which help to accomplish development potentials. Basically this consists of measures such as land leveling, agricultural water

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management, on-farm irrigation distribution and drainage systems, conservation cropping systems, crop residue management, and other recurrent-type practices. In many instances the structural type land treatment measures cannot be installed until single and multiple-purpose channels have been constructed.

The more permanent-type practices such as tile drains, open ditch drains, drop structures, and irrigation distribution systems are not effective until drainage outlets for all lands are provided.

Irrigation systems are needed for efficient distribution of irrigation water (bottom) to prevent waste (top).

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PLAN OF DEVELOPMENT

General Description

The plan of development (plate 9) provides a framework for the protection and improvement of the land resources of the Lower Rio Grande Basin that will be consistent with the best interests of the local people, the State, and the Nation. Basic elements of the plan consist of structural measures to be installed through project-type action and land treatment measures to be installed by individual landowners and operators.

The proposed plan of development consists of (1) 164 miles of single-purpose channel improvement for the removal of floodwaters; (2) 1,394 miles of multiple-purpose channel improvement for flood prevention and surface and subsurface drainage; (3) land treatment measures to protect and improve the agricultural lands, permit increased efficiency of land and water management, and insure higher sustained agricultural yields; (4) and works of improvement included in three watershed work plans to be installed under the authority of Public Law 566 in Cameron County.

Elements of the plan for Cameron County will be carried out under the authority of Public Law 566. However, those elements of the plan for Willacy and Hidalgo Counties need to be carried out under new legislative authority because the surface runoff problem requires the concurrent installation of structural measures controlling the runoff from drainage areas exceeding 250,000 acres. The problems in these two counties are so interrelated and the solutions so interdependent that a comprehensive plan for removal of floodwaters and to provide adequate outlets for surface and subsurface drainage must be developed and installed as an integrated system.

It is proposed that those elements of the plan consisting of structural measures to serve Willacy and Hidalgo Counties and land treatment measures in Willacy, Hidalgo, and Cameron Counties be carried out under new legislative authority in three phases.

Phase I. This would consist of 164 miles of single-purpose floodwater channels to be installed with Federal assistance during the first three years after authorization. The proposed channels are

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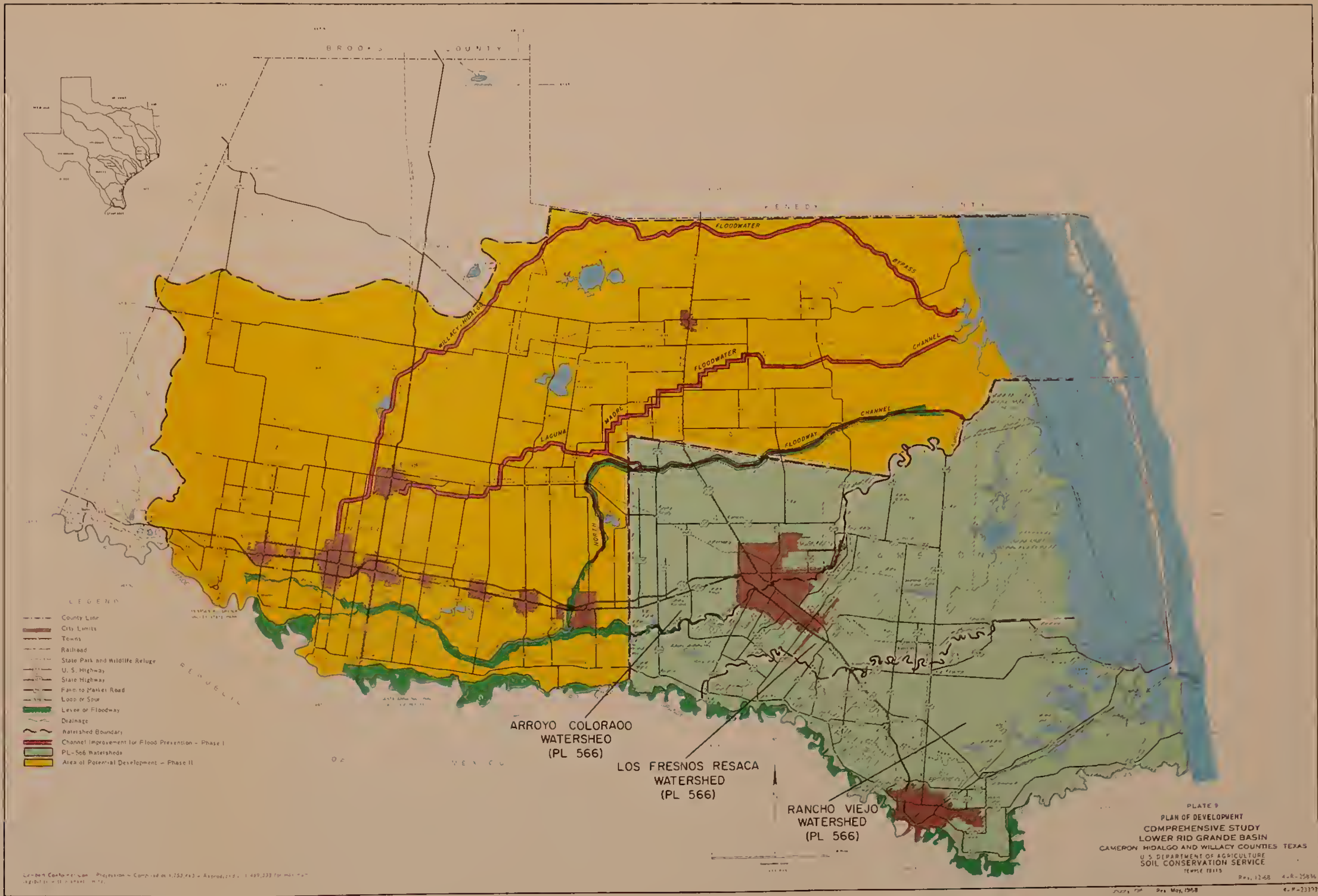
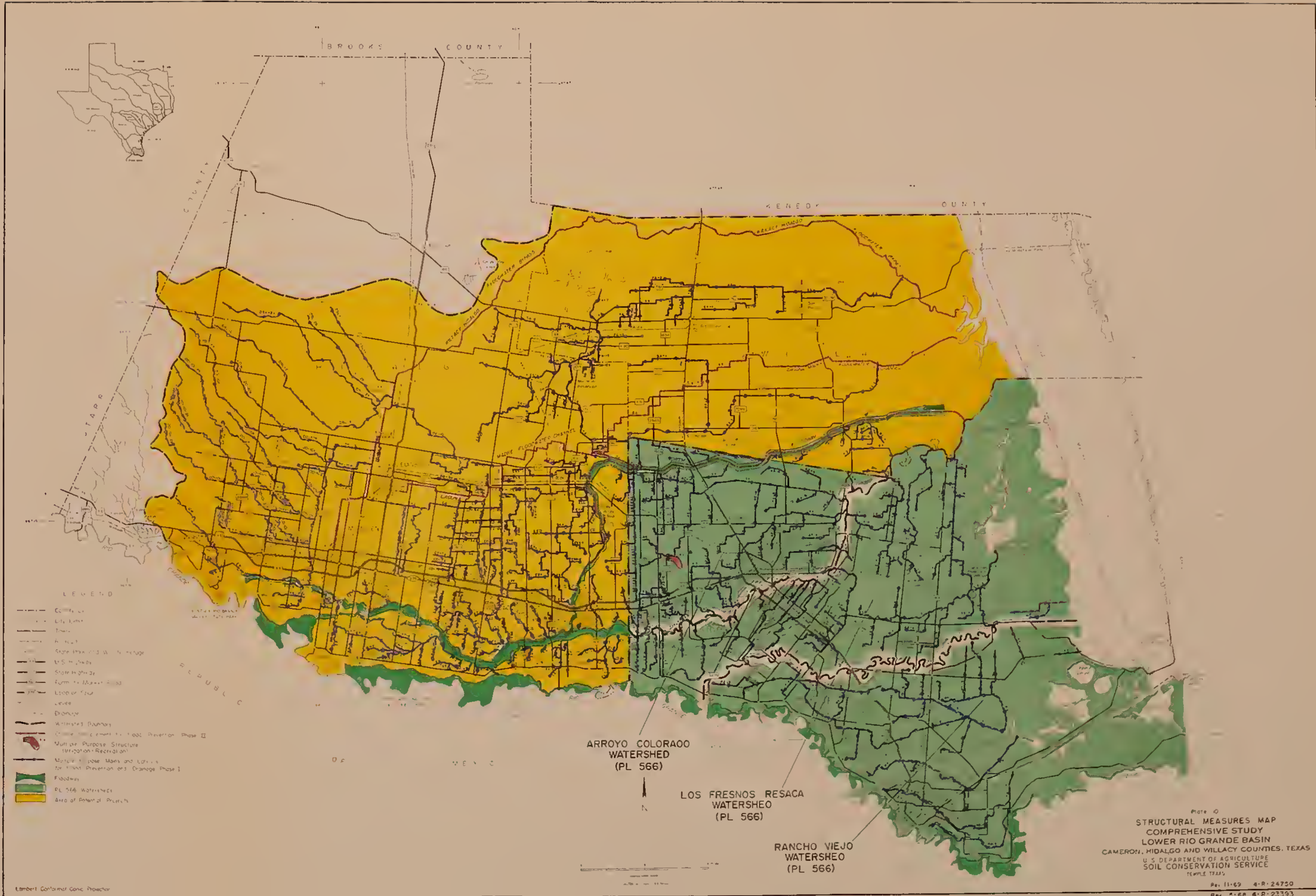

FLOODWATER
BYPASS
CHANNEL
WILLACY-HIDALGO
FLOODWATER
CHANNEL
LAGUNA
MADRE
FLOODWAY
NORTH
ARROYO COLORADO
WATERSHED
(PL 566)
LOS FRESNOS RESACA
WATERSHED
(PL 566)
RANCHO VIEJO
WATERSHED
(PL 566)
LEGEND
County Line
City Limits
Towns
Railroad
State Park and Wildlife Refuge
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
Watershed Boundary
Channel Improvement for Flood Prevention - Phase I
PL-566 Watersheds
Area of Potential Development - Phase II
PLATE 9
PLAN OF DEVELOPMENT
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON HIDALGO AND WILLACY COUNTIES TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE


BROOKS COUNTY
KENEDY COUNTY
LEGEND
Floodway
PL 566 Watershed
Area of Potential Projects
ARROYO COLORADO WATERSHED (PL 566)
LOS FRESNOS RESACA WATERSHED (PL 566)
RANCHO VIEJO WATERSHED (PL 566)
STRUCTURAL MEASURES MAP
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Rev 5-68 4-R-23393

the Willacy-Hidalgo Floodwater Bypass, the Laguna Madre Floodwater Channel, and the North Floodway Channel. These floodwater channels are interrelated with, and essential to, the development of the subwatershed projects and will have to be constructed first.

The Willacy-Hidalgo Floodwater Bypass would divert floodwaters from the west central part of Hidalgo County toward the northeast and away from the highly developed areas in Hidalgo and Willacy Counties. The Laguna Madre Floodwater Channel would convey floodwaters originating in east central Hidalgo County and in southern Willacy County to the Laguna Madre. The North Floodway Channel would provide an outlet for the removal of runoff at an increased rate from the area lying west of Mercedes and between the Rio Grande and U. S. Highway 83. The present maximum flows from this area would continue to outlet through the Arroyo Colorado.

Phase II. This would consist of approximately 1,394 miles of multiple-purpose channels for flood prevention and agricultural water management, 35 structures for water control, and other works of improvement in subwatershed projects in Willacy and Hidalgo Counties. These subwatersheds would be delineated and projects initiated, and carried out by local sponsors with Federal assistance.

Phase III. This would consist of an accelerated land treatment program within the subwatersheds of Willacy and Hidalgo Counties and within the three watersheds in Cameron County to protect and improve the agricultural lands, permit efficient and effective water management, and insure higher sustained agricultural yields. These measures would be installed by landowners and operators with Federal technical and cost-sharing assistance concurrent with or following the installation of appropriate multiple-purpose project channels. Under Phase III, funds for accelerating the land treatment program would be provided to: (1) the Soil Conservation Service for technical assistance in the planning and application of the land treatment measures and (2) the Agricultural Stabilization and Conservation Service for cost-sharing under the ACP program.

The proposed plan of development would require that additional funds be made available to the Farmers Home Administration to make loans or advancements to local organizations to finance the local share of the cost of installing works of improvement proposed in Phase I and Phase II and for making loans under the Soil and Water Conservation Program to eligible individuals to carry out the land treatment program under Phase III.

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Expressions of interest in the proposed plan of development have been favorable. The three-phase approach is widely accepted as the most logical solution to one of the most perplexing problems in the Valley. The installation of the elements of the plan is within the means of the many governmental institutions.

The plan presented herein evolved through numerous meetings and consultations with the many legal entities involved, wherein their views were sought on a number of alternatives. The recommended plan of development most nearly meets the objectives of local interests and is economically feasible and practical to install.

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

No structural measures would be installed for the primary purpose of bringing new land into agricultural production.

Works of Improvement to be Installed

Phase I. The proposed plan of development provides for the construction of three single-purpose floodwater channels to be built first. These are the Willacy-Hidalgo Floodwater Bypass, the Laguna Madre Floodwater Channel and the North Floodway Channel.

The route of the Willacy-Hidalgo Floodwater Bypass would follow existing ditches from McAllen to Lake Edinburg, thence northeast to the Willacy County line and thence through northern Willacy County to the Laguna Madre. An ungated control structure would be required at Lake Edinburg to permit low flows and subsurface drainage to discharge into the DD-10 channel (plate 10). In addition reverse grade would be required in the bottom of the bypass channel from multiple-purpose channel DSL-1 to the control structure. It is estimated that 420 pipe drop structures would be required to convey safely the runoff from the flatlands through the spoil banks at regular intervals. Construction or modification of 25 structures such as siphons, chutes, flumes, and erosion control structures would be required. Two new railroad bridges would have to be constructed and one existing drainage structure would require modification. New drainage structures or modification and relocation of existing structures would be required at about 35 road and highway crossings. Modification of gas and oil transmission lines may be required at approximately 11 locations. The alignment of the Laguna Madre Floodwater Channel would follow existing ditches from the eastern edge of Edinburg to the Willacy County line, thence to the northeast through southern Willacy

County to the Laguna Madre. A siphon would be required in the Willacy Canal to convey water under the Laguna Madre Floodwater Channel. A connecting channel would be required to divert low flows and subsurface drainage into the North Floodway Channel at a point downstream from the existing Willacy Siphon. Concrete lining would be required in the section of channel through Lyford. Construction of the Laguna Madre Floodwater Channel would require modification of existing facilities or construction of new facilities at about 90 road and highway and 17 pipeline crossings. Two new railroad bridges would have to be constructed and 4 existing drainage structures modified. Construction or modification of about 40 siphons, chutes, flumes, and erosion control structures would be required. About 340 pipe drops would have to be installed at regular intervals to safely convey runoff through the spoil banks.

The North Floodway Channel would extend from just below Farm Road 491, north of Mercedes, to the Arroyo Colorado. The plan provides for enlarging the pilot channel of the North Floodway and placing the spoil on top of or behind existing levees. All designs, specifications, and construction would be coordinated with the International Boundary and Water Commission before any work is undertaken. It is estimated that 220 pipe drops would have to be installed at regular intervals to prevent erosion where water from adjacent fields enters the channel. Modification of the Willacy Siphon and two other irrigation system structures would be required. About 15 road and highway crossings, 2 pipeline crossings, and 2 railroad bridges would require modification.

All channels would have a trapezoidal cross section and be earth-lined except where concrete lining is required to prevent erosion or to provide capacity through restricted areas. Spoil banks would be placed and smoothed in accordance with the customary practice for the area. Spoil banks would be vegetated where needed. Clearing of existing brush and trees would be kept to a minimum to preserve wildlife habitat.

The three floodwater channels would have sufficient capacity to remove the runoff from a 24-hour 5-year frequency storm in 24 hours from the agricultural areas. Additional capacity would be provided to remove floodwater from urban areas at a faster rate.

Pertinent data for the floodwater channels is shown in Table 28.

TABLE 28

CHANNEL DATA PHASE I, HIDALGO AND WILLACY COUNTIES
LOWER RIO GRANDE BASIN, TEXAS

Channel Designation	Length	Equivalent Drainage Area	Range Channel Capacity		Range Bottom Width		Range in Depth		Estimated Volume of Excavation
			From	To	From	To	From	To	
	(mile)	(sq.mi.)	-----cfs------		-----------feet----------				(1,000 cu. yds.)
Willacy-Hidalgo Floodwater Bypass	69	422	750	9,450	4	185	11.0	12.5	32,376
Laguna Madre Floodwater Channel	56	304	240	6,350	4	120	8.0	13.5	14,266
North Floodway Channel	39	216	3,500	5,400	105	100	5.5	12.0	7,753

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Phase II. About 1,394 miles of multiple-purpose channels (mains, major laterals, and minor laterals) with appurtenances, and 35 structures for water-control would be required to afford flood prevention and agricultural water management within the subwatershed projects. Flood protection and agricultural water management cannot be provided by land treatment alone, nor can it be provided until Phase I has been completed.

The multiple-purpose channels would consist of new channels into areas without adequate flood protection and drainage, and realignment and enlargement of existing channels. To convey runoff from the flatlands through the spoil banks at regular intervals, about 8,500 pipe drop structures would be required. In addition, an estimated 1,800 other structures and appurtenances such as siphons, chutes, flumes, and erosion control structures would be required. These structures would be located in the field as construction progresses. Project installation would require relocation or modification of about 2,420 bridges and culverts, 10 communications cables, and 470 gas and oil transmission lines. New channels would be located and constructed, insofar as practical, to preserve wildlife habitat.

Minor laterals which are not shown on plate 10 would be located in the field as construction progresses.

Thirty-five water control structures will be required for more rapid removal of local floodwaters into the floodway system of the International Boundary and Water Commission and to confine floodwaters from the Rio Grande to the floodway system. These structures would be constructed as a part of the Phase II program after the North Floodway Channel has been constructed. The proposed plan includes improvements at 17 existing gated structures in the levees of the Main Floodway upstream from FM Highway 1015, at one existing structure just east of FM Highway 1015, and at 6 existing structures in the Arroyo Colorado between FM Highway 1015 and the Cameron County line. A concrete drop structure will be required where the existing ditch enters the Mission Inlet between FM Highway 1926 and FM Highway 494. Additional structures are required in the east levee of the North Floodway between FM Highway 491 and Texas Highway 107. One new gated structures is needed in the north levee of the North Floodway a short distance downstream from the Willacy Siphon. Two new gated structures and improvements to three existing gated structures are required in the levees of the North Floodway in Willacy County. Drop structures will be required at the ends of two ditches emptying into the Arroyo Colorado in Willacy County.

The multiple-purpose channels and structures for water control would provide adequate outlets for on-farm drainage systems, including subsurface drainage where needed. For this report, cost estimates and economic evaluations are based upon channel capacities sufficient to provide protection from the 5-year, 24-hour frequency storm. The actual level of protection would be determined at the time work plans are developed for the particular subwatershed under consideration. The level of protection should be commensurate with the use being made of the land and in accordance with the needs and objectives of local people.

Phase III. The proposed plan of development provides for completing the installation of needed land treatment measures on about 60 percent of the agricultural land by 1980 and about 80 percent by 1990. Land treatment measures associated with the conservation, development, utilization, and disposal of water are necessary to the success of the proposed plan of development. On-farm agricultural water management measures for surface and subsurface drainage and irrigation distribution systems must be established to attain adequate drainage, conserve water and provide maximum effectiveness of other land treatment practices. During the proposed installation period, a combination of measures comprising a conservation cropping system would be applied on about 650,000 acres of cultivated land for improvement of soil-cover conditions and protection from erosion.

Conservation cropping systems include grasses and legumes in rotation, cover and green manure crops, and crop residue use for erosion control, improvement of soil structure, and relation of soil salinity, and surface evaporation.

Pasture management would be practiced for sustained production of high-quality forage on approximately 71,000 acres of pasture.

Land treatment would be applied to approximately 233,000 acres of rangeland to improve the quality and density of forage plants and to control undesirable brush which competes with grass for moisture and plant food. Range management would be practiced through rotation and deferred grazing and the establishment or re-establishment of adapted species of forage plants.

Farmers and ranchers would be encouraged to improve and develop the scenic beauty, ground cover, and wildlife habitat of approximately 60,000 acres of miscellaneous lands, including isolated brushy areas, potholes or depressed areas which are under water part of the time, farmsteads, and feedlots. In addition, farmers and ranchers would be encouraged to establish vegetative cover on spoil banks and drainage channel berms with adapted species of desirable grasses, trees, and shrubs for wildlife habitat.

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Explanation of Installation Costs

General. The project installation cost includes all costs, either in cash or its equivalent, for installing the works of improvement included in the proposed plan of development.

Cash payments or expenditures include all disbursements on behalf of the project by Federal agencies, the State, local organizations, other agencies, groups, and individuals. This includes payments made for land, equipment, whether rented or purchased, labor and other personal services, and materials and supplies. This includes any funds that may be provided under other Federal programs to assist these agencies, groups, or individuals to meet their responsibilities for installing the project.

Donated goods and services include all donations of land, materials and supplies, labor and other personal services contributed by landowners, local organizations, or others in behalf of the project.

Construction costs include the contract or force account cost for constructing structural measures and any or all of the following:

a. Reinforcing, underpinning, or reconstruction of highway and public road bridge piers and abutments necessitated by deepening the channel. These costs are limited to those required to provide a facility of comparable quality and performance capability to the existing bridge or culvert.

b. All necessary construction or alterations of railroad bridges and approaches needed in connection therewith excluding all ballast, rails, ties, telegraph lines, power lines, signal systems, temporary rerouting of traffic, providing flagmen, or other features not directly associated with the structural stability of bridges and approaches.

c. Clearing of sites for project purposes including the cost of removing buildings, bridges, fences, or other improvements which the local organization desires to abandon.

d. Construction of pumping plants and pressure conduits, gates or other structures to carry interior drainage or sewage through dikes or flood walls.

e. Construction of diversion dikes and ditches for conducting surface water to project outlets or pumping plants for interior drainage.

f. Construction of necessary structures to provide controlled inlets for drainage from adjacent fields and lateral ditches into the project channels.

g. Flagman and protective devices such as barriers or lights required to protect workmen or the public during construction.

h. Alteration, modification, or reconstruction of group irrigation facilities made necessary by project works of improvement.

i. Providing needed travelways for maintenance along improved project channels including necessary culverts and fords. Constructing new or changing existing county, State, or farm roads and associated crossings is a land-rights cost. Such roads, however, will be used as travelways for maintenance, whenever possible.

j. Borrow material when actually purchased by the sponsoring local organization at a cost not exceeding the difference in land values before and after borrow removal.

k. Construction of catwalks, handrails, fences, gates, etc. needed for the proper functioning and operator's safety of a structural measure. This also includes any safety features needed for public recreation or fish and wildlife in a project.

l. The disposal of waste spoil in accordance with sound engineering design and construction principles. These include: (1) placing, smoothing, and revegetating excavated material in accordance with the customary practice for the area, and (2) wasting the spoil outside the permanent right-of-way at a location acceptable to the Service when it is determined that highways, buildings, natural obstruction, bank instability, or other factors make it impractical to place and smooth spoil on land contiguous to the ditch or channel.

m. Premiums for construction liability insurance when the construction contractor is made the principal.

The cost of land rights includes all cost for the following items, including elements of work involving construction and engineering services directly associated with land rights:

a. All expenditures made in acquiring land, easements, leases, and rights-of-way or their value as estimated by the local organization with the concurrence of the Service. Included are such items as: the cost of subordination agreements; the cost of complying

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with special provisions in land rights documents not needed for the proper construction, operation or maintenance of works of improvement, etc.

b. Removal of buildings or improvements for salvage or relocation or the construction of dikes or other protective works in lieu thereof.

c. Changes of existing telephone, power, gas, water, and sewer lines or other utilities, but not including group irrigation or drainage facilities.

d. All new and changes of existing public or private road bridges, culverts and other crossings, including approaches, except the reinforcing, underpinning or reconstruction of bridge piers and abutments necessitated by deepening the channel crossing public roads. This does not include the cost for the excavation and installation of a closed conduit crossing a road or street when it is an integral part of an overall closed conduit structural measure.

e. All relocations and changes of highways and roads that are to remain serviceable after project installations.

f. Except for necessary construction or alterations of railroad bridges and approaches needed in connection therewith, all railroad relocations including all ballast, rails, ties, telegraph lines, power lines, signal systems, temporary routing of traffic, providing flagmen, or other features not directly associated with the structural stability of bridges and approaches.

g. Relocation or reconstruction of fences not needed for the proper operation, maintenance, or inspection of the works of improvement. Installation of new fences or guardrails for the protection and safety of the public.

h. Salvaging fences unless the salvaged material is to be used for project purposes.

i. Salvaging timber.

j. Premiums for construction liability insurance when someone other than the construction contractor is made the principal.

k. Engineering or similar services needed in connection with alteration, relocation or modification of facilities or other land rights acquisition.

TABLE 29

SUMMARY OF COSTS, PLAN OF DEVELOPMENT 1/
LOWER RIO GRANDE BASIN, TEXAS

Cost Items	Federal Funds	Other Funds	Total
	dollars		
PL-566 Watersheds	9,412,000	10,936,000	20,348,000
Phase I	16,795,000	8,096,000	24,891,000
Phase II	20,695,000	30,275,000	50,970,000
Phase III	47,315,000	49,524,000	96,839,000
TOTAL	94,217,000	98,831,000	193,048,000

1/ Price Base: 1966

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Engineering costs include the direct costs of engineers and other technicians for surveys, investigations, design, preparation of plans and specifications for structural measures including the vegetative work associated therewith.

Project administration includes all administrative costs associated with the installation of structural measures including the cost of construction surveys, contract administration, review of engineering plans prepared by others, government representatives, and necessary inspection service during construction to insure that structural measures are installed in accordance with the plans and specifications.

The total installation cost of the proposed plan of development for the basin is about $193,048,000, this includes $20,348,000 for structural measures and critical area planting in the three PL-566 watersheds in Cameron County; $24,891,000 for the proposed Phase I program; $50,970,000 for the proposed Phase II program; and $96,839,000 for the proposed Phase III program (Table 29).

PL-566 Watersheds. The cost of structural measures and critical area planting included in the PL-566 projects in Cameron County is about $20,348,000 of which $9,412,000 will be borne by Federal funds and $10,936,000 will be borne by other funds. Structural measures will cost about $20,314,000 of which $9,386,000 will be borne by Federal funds and $10,928,000 by other funds. Critical area planting will cost about $34,000 of which $26,000 will be borne by Federal funds and $8,000 by other funds.

Phase I. The total estimated cost of installing the three proposed floodwater channels is $24,891,000 (Table 30). This amount includes $13,674,000 for construction, $1,144,000 for engineering services, and $2,081,000 for project administration. The remaining $7,982,000 is for land rights, relocations, and modification of structures.

The engineers' estimates of construction costs were based on the cost of constructing channels in similar areas. An allowance was made for special conditions peculiar to each floodwater channel. A contingency of 15 percent was added to the engineers' estimates to provide an allowance for unpredictable construction costs.

The cost of engineering and project administration was based on analyses of previous work in similar areas.

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TABLE 30

INSTALLATION COST OF SINGLE-PURPOSE CHANNELS, PHASE I 1/
LOWER RIO GRANDE BASIN, TEXAS

Installation Cost Item	1970 - 1980		
	Federal Funds	Other Funds	Total
	dollars		
Willacy-Hidalgo Floodwater Bypass			
Channel Construction	7,312,000	-	7,312,000
Engineering Services	589,000	-	589,000
Project Administration	1,149,000	-	1,149,000
Land Rights & Relocation	-	2,667,000	2,667,000
Subtotal	9,050,000	2,667,000	11,717,000
Laguna Madre Floodwater Channel			
Channel Construction	3,611,000	104,000	3,715,000
Engineering Services	290,000	-	290,000
Project Administration	568,000	-	568,000
Land Rights & Relocation	-	3,970,000	3,970,000
Subtotal	4,469,000	4,074,000	8,543,000
North Floodway Channel			
Channel Construction	2,647,000	-	2,647,000
Engineering Services	265,000	-	265,000
Project Administration	364,000	-	364,000
Land Rights & Relocation	-	1,355,000	1,355,000
Subtotal	3,276,000	1,355,000	4,631,000
TOTAL PHASE I	16,795,000	8,096,000	24,891,000

1/ Price Base: 1966

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The estimated value of land required for rights-of-way is based on current market values, as estimated by local organizations and individuals. The cost of relocating or modifying road and railroad structures was based on estimates provided by the Texas Highway Department, the county, and railroad companies in connection with the PL-566 projects in Cameron County.

The entire cost of the Phase I program except the cost of modifying irrigation facilities was allocated to flood prevention. The cost of modifying irrigation facilities, $257,000,was allocated to irrigation.

The proposed Federal share of the cost is $16,795,000 of which $13,570,000 is for construction, including 50 percent of the cost of modifying irrigation facilities; all of the engineering services costs, $1,144,000; and $2,081,000 for project administration.

Proposed costs to be borne by other than Federal funds are $8,096,000. This includes $104,000 of the construction cost for modification of irrigation flumes and siphons, $5,037,000 for land needed for right-of-way, $1,773,000 for construction, modification or relocation of roads, utilities, and bridges, except railroad bridges and $1,182,000 for legal fees and surveys.

Phase II. The total estimated cost of installing proposed structural measures in subwatersheds is $50,550,000 (table 31). Of this amount $19,811,000 is for construction, $1,666,000 for engineering services, $3,441,000 for project administration, and $25,632,000 for land rights. In addition, it is estimated that the cost of developing work plans for subwatershed projects will be $420,000.

The costs of multiple-purpose measures serving both flood prevention and agricultural water management are allocated in accordance with procedures outlined in the first alternative of Section 103.022, Chapter 3, the Watershed Protection Handbook, Soil Conservation Service. Using this procedure, 50 percent of the installation costs are allocated to agricultural water management and 50 percent to flood prevention (table 32). However, cost allocation procedures appropriate for each subwatershed will be determined at the time detailed work plans are developed. In accordance with current criteria, all construction and installation services costs allocated to flood prevention and 50 percent of the construction cost and all of the installation services costs allocated to agricultural water management will be borne by the Federal government.

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TABLE 31

INSTALLATION COST OF MULTIPLE-PURPOSE CHANNELS PHASE II 1/
LOWER RIO GRANDE BASIN, TEXAS

	1970 - 1980		
	Federal Funds	Other Funds	Total
	--dollars--		
Structural Measures (Phase II)			
Construction			
Mains and Laterals	13,635,000	4,643,000	18,278,000
Structures for Water Control	1,533,000	-	1,533,000
Subtotal - Construction	15,168,000	4,643,000	19,811,000
Engineering Services	1,666,000	-	1,666,000
Project Administration	3,441,000	-	3,441,000
Land Rights and Relocations	-	25,632,000	25,632,000
TOTAL STRUCTURAL MEASURES	20,275,000	30,275,000	50,550,000
Work Plan Development (Phase II)	420,000	-	420,000
TOTAL PHASE II	20,695,000	30,275,000	50,970,000

1/ Price Base: 1966

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TABLE 32

COST ALLOCATION AND COST-SHARING SUMMARY PHASE II 1/
HIDALGO AND WILLACY COUNTIES
LOWER RIO GRANDE BASIN, TEXAS

Item	Purpose: Flood Prevention	Purpose: Agricultural Water Management Drainage	Total
	---dollars---		
Cost Allocation			
Single-Purpose Structures for Water Control	1,533,000	-	1,533,000
Multiple-Purpose Channel (Mains, Laterals, and Appurtenances)	24,509,000	24,508,000	49,017,000
TOTAL	26,042,000	24,508,000	50,550,000
Cost Sharing			
Federal	13,226,000	7,049,000	20,275,000
Non-Federal	12,816,000	17,459,000	30,275,000
TOTAL	26,042,000	24,508,000	50,550,000

1/ Price Base: 1966

Under the procedures used in preparing this plan, $26,042,000 of the total estimated installation cost is allocated to flood prevention and $24,508,000 is allocated to agricultural management (table 32). Federal funds would bear $13,226,000 of the costs allocated to flood prevention and $7,049,000 of the costs allocated to agricultural water management. Other than Federal funds would bear $12,816,000 of the costs allocated to flood prevention and $17,459,000 of the cost allocated to agricultural water management. Other than Federal funds could include some funds from other Federal programs for which sponsoring local organizations might be eligible.

The proposed Federal share of the construction cost is $15,168,000. Of this amount $13,635,000 is for multiple-purpose channels, and $1,533,000 for structures for water control. Federal funds would bear the entire cost of engineering services, $1,666,000, and project administration, $3,441,000.

Other than Federal funds would bear $4,643,000 of the cost of constructing the multiple-purpose channels.

The cost of land, easements, and rights-of-way, $25,632,000, would be borne by other than Federal funds. This consists of an estimated $14,758,000 for land easements, $8,099,000 for changes in improvements, bridges, culverts, and road, and utility changes or modifications, and $2,775,000 for legal fees and surveys.

The estimated cost of developing work plans for subwatershed projects is $420,000 and would be borne by Federal funds.

Phase III. The cost of land treatment measures to be installed under the proposed Phase III program is estimated to be $96,839,000. This amount includes $8,183,000 for technical assistance to map soils and plan and apply the measures, $39,132,000 for Federal cost-sharing under the ACP program, and $49,524,000 to be provided by other than Federal funds (table 33). Of these amounts $4,752,000 of Federal funds will be required for technical assistance, and $28,479,000 for ACP cost sharing prior to 1980.

The cost of establishing the land treatment is based on 1966 prices for establishing these measures.

The amount of cost-sharing assistance to be provided under the ACP program was determined in collaboration with the Agricultural Stabilization Service county committees.

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TABLE 33

SUMMARY OF LAND TREATMENT COSTS, PHASE III 1/
LOWER RIO GRANDE BASIN, TEXAS

Land Treatment	1970 - 1980					1980 - 1990					1970 - 1990 Total Land Treatment	
	Acres to be Treated	Federal Funds Accelerated Program	Federal Funds Going Program	Other Funds	Total	Acres to be Treated	Federal Funds Accelerated Program	Federal Funds Going Program	Other Funds	Total	Acres	Dollars
		thousands of dollars					thousands of dollars					(thousands)
Cropland, Irrigated	313,000	20,325	4,063	29,320	53,708	117,000	4,978	3,969	11,620	20,567	430,000	74,275
Cropland, Dry	149,000	1,853	600	3,472	5,925	71,000	412	673	1,743	2,828	220,000	8,753
Grassland	45,000	1,008	208	1,713	2,929	26,000	264	240	808	1,312	71,000	4,241
Rangeland	180,000	321	77	608	1,006	53,000	46	71	185	302	233,000	1,308
Miscellaneous	60,000	19	5	55	79	-	-	-	-	-	60,000	79
Subtotal		23,526 2/	4,953 2/	35,168	63,647		5,700 2/	4,953 2/	14,356	25,009		88,656
Technical Assistance - Soil Conservation Service		1,641	3,111 3/	-	4,752		696	2,735 3/	-	3,431		8,183
TOTAL		25,167	8,064	35,168	68,399		6,396	7,688	14,356	28,440		96,839

1/ Price Base: 1966
2/ ACP Funds
3/ PL 46 Funds, $2,796,000, PL 566 Funds, $315,000

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Project Installation

Phase I. Construction of the Willacy-Hidalgo Floodwater Bypass and the Laguna Madre Floodwater Channel and the North Floodway Channel Improvement would begin at the Laguna Madre and progress upstream. Water control structures and appurtenances would be located and constructed as work progresses. At the same time, inadequate bridges and culverts would be replaced or modified, new bridges and culverts constructed where needed, low-water crossings and water gaps installed, and improvements relocated or modified. This pattern of construction would continue until the project is completed at the upstream limits. Construction could begin on any one of the channels or all of them simultaneously, provided that local sponsoring organizations who have the authority under State law to carry out, operate and maintain the works of improvement have at no cost to the Federal government:

1. Obtained the necessary land rights and permits for the channel improvements.

2. Obtained the necessary flowage easements for the floodwater channel improvement.

3. Provided for the necessary relocation or modification of improvements, including utility lines and systems, pipelines, roads, bridges, and privately-owned improvements.

4. Determined the legal adequacy of the easements and permits required for construction of the project.

5. Provided funds sufficient to pay for the local share of the construction cost.

6. Executed project and operation and maintenance agreements.

The Federal government would contract for the construction of the three flood prevention channels. In addition, technical assistance would be provided for the design, preparation of land rights maps, preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, final inspections, execution of certificate of completion, and related tasks necessary to install the planned works of improvement.

Phase II. Plans would be developed for subwatershed projects as these projects are initiated by local organizations. These plans would specify the details of project installation in accordance with the criteria of the particular agency under which they are being carried out.

Phase III. Farmers and ranchers would establish land treatment measures on 60 percent of the cropland, grassland, rangeland, and miscellaneous lands by 1980 and on additional 20 percent by 1990.

In order to accomplish these objectives an accelerated land treatment program within the subwatersheds would be carried out by landowners and operators within the project area. Federal technical and cost sharing assistance would be made available to landowners and operators concurrent with or following the installation of the multiple-purpose channels. Soil Conservation Service work units would assist landowners and operators cooperating with the Southmost and Willacy-Hidalgo Soil and Water Conservation Districts in accelerating the preparation of soil and water conservation plans, and in the application and maintenance of conservation practices.

The County Agricultural Stabilization and Conservation committee would cooperate with the governing bodies of the soil and water conservation districts by selecting and recommending financial assistance for those Agricultural Conservation Program practices that would accomplish objectives in the shortest possible time.

The Soil and Water Conservation Loan Program of the Farmers Home Administration is available to all eligible farmers and ranchers or organized groups. Educational meetings would be held in cooperation with other agencies to outline the services available and eligibility requirements. Present FHA clients would be encouraged to cooperate in the project.

The Extension Service would assist in the educational phase of the program by conducting general information meetings, preparing press and television releases and other methods of getting information to landowners and operators in the three-county area.

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Financing Project Installation

Phase I. It is proposed that Federal assistance for carrying out Phase I of the plan of development be provided under new legislative authority. The local share of the cost of installing the three floodwater channels would be borne by local sponsoring organizations having authority under State law to install, maintain, and operate the works of improvement in accordance with the terms of an agreement to be executed between the sponsoring organization and the Soil Conservation Service.

It is proposed that $3,000,000 be made available to the Farmers Home Administration for making loans and advancements to the sponsoring organizations to finance the local share of costs for installing works of improvement included in Phase I of the proposed plan of development. The Congress reserves the right to specify the precise terms of local cooperation in any Federally-authorized project or program. Therefore, the requirements for local cooperation in the proposed project may ultimately differ from the information presented in this report.

Phase II. It is proposed that Federal assistance for carrying out the works of improvement in this phase of the plan be provided under new legislative authority.

Plans would be developed for subwatershed projects as they are initiated by local organizations. These plans would specify details of the methods to be used to finance each project installation in accordance with the requirements of the particular agency under which the plans are to be carried out.

In addition, it is proposed that the new legislative authority provide approximately $20,000,000 to the Farmers Home Administration for making loans and advancements to local organizations to finance the local share of costs of carrying out works of improvement to be installed under Phase II of the plan of development.

Phase III. The cost of installing the land treatment measures would be borne by the landowners and operators of the land on which these measures are installed with Federal assistance. The Farmers Home Administration, local banks, and other lending institutions could arrange financing for the landowners and operators' share of the cost. Under the new legislation it is proposed that $7,000,000 be made available to the Farmers Home Administration for loans to individual landowners and operators to finance their share of the cost of applying eligible measures during the period 1970-1980 and $3,000,000 be made available for the period 1980-1990.

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It is proposed that Federal assistance for carrying out the land treatment phase of the plan of development be provided under going programs and under new legislative authority. Funds for technical assistance in the amount of $5,531,000 would be provided under the authority of Public Law 46 for planning and applying the land treatment measures in Willacy, Hidalgo, and Cameron Counties. Of this amount $2,796,000 would be required during the period 1970-1980 and $2,735,000 during the period 1980-1990. Public Law 566 funds would provide $315,000 for technical assistance in the PL-566 watersheds in Cameron County.

It is proposed that the new legislation provide $2,337,000 for accelerated technical assistance in Willacy, Hidalgo,and Cameron Counties, of which $1,641,000 would be required during the period 1970-1980 and $696,000 during the period 1980-1990.

The Agricultural Stabilization and Conservation Service would provide $4,953,000 under its going ACP program for cost-sharing in the installation of land treatment measures in the three-county area, during the period 1970-1980 and a like amount during the period 1980-1990.

It is proposed that new legislation provide an additional $23,526,000 for this purpose during the period 1970-1980 and $5,700,000 during the period 1980-1990 (table 34).

Landowners and operators would provide $35,168,000 for their share of the cost of installing land treatment during the period 1970-1980 and about $14,356,000 during the period 1980-1990.

Provisions for Operation and Maintenance

Phase I. The proposed floodwater channels would be operated and maintained by sponsoring local organizations having the authority under State law to install, operate and maintain the structural measures. Specific operations and maintenance agreements would be executed prior to the construction of each channel. The estimated average annual operation and maintenance cost is about $92,000 based on 1966 adjusted normalized prices. Of this amount $31,000 is for the Laguna Madre Floodwater Channel, $39,000 is for the Willacy-Hidalgo Floodwater Bypass and $22,000 is for the North Floodway Channel. The necessary maintenance work would be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. Funds for this work would be provided by the sponsoring local organizations in accordance with the terms of agreements for sharing operations and maintenance costs.

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Phase II. Works of improvement proposed for construction under this phase would be operated and maintained by the local organizations initiating each subwatershed work plan in accordance with the terms of an operation and maintenance agreement to be executed prior to construction. The estimated average annual operation and maintenance cost is about $783,000 based on 1966 adjusted normalized prices. The necessary maintenance work would be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods.

Phase III. Proposed land treatment measures would be maintained by the owners and operators of farm and ranch lands on which the measures are installed under cooperative agreements with the Willacy-Hidalgo and the Southmost Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage landowners and operators to perform maintenance operations.

TABLE 34

FINANCING INSTALLATION COST OF LAND TREATMENT, PHASE III 1/
LOWER RIO GRANDE BASIN, TEXAS

Installation Cost Item	1970 - 1980				1980 - 1990				1970 - 1990
	Federal Funds				Federal Funds				
	Accelerated Program	Going Program	Other Funds	Total	Accelerated Program	Going Program	Other Funds	Total	Total
	dollars								
Soil Conservation Service Technical Assistance									
New Legislation	1,641,000	-	-	1,641,000	696,000	-	-	696,000	2,337,000
Public Law 566	-	315,000	-	315,000	-	-	-	-	315,000
Public Law 46	-	2,796,000	-	2,796,000	-	2,735,000	-	2,735,000	5,531,000
Subtotal - Soil Conservation Service	1,641,000	3,111,000	-	4,752,000	696,000	2,735,000	-	3,431,000	8,183,000
Agricultural Stabilization and Conservation Service Agricultural Conservation Program	23,526,000	4,953,000	-	28,479,000	5,700,000	4,953,000	-	10,653,000	39,132,000
Non-Federal	-	-	35,168,000	35,168,000	-	-	14,356,000	14,356,000	49,524,000
TOTAL PHASE III	25,167,000	8,064,000	35,168,000	68,399,000	6,396,000	7,688,000	14,356,000	28,440,000	96,839,000

1/ Price Base: 1966

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Installation of the plan to permit more efficient and effective water management will result in higher sustained agricultural yields. Photographs show cotton field before and after tile drains were put in.

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ALTERNATIVE FLOODWATER WORKS CONSIDERED

Three alternative approaches were considered for the removal of floodwater in the Lower Rio Grande Basin. They were: (1) North Floodway Channel Improvement, (2) Edinburg-Raymondville-Laguna Madre Bypass Channel, and (3) South Willacy Floodwater Channel.

(1) Among the early considerations was a study to determine the feasibility of using the North Floodway as a floodwater channel for the removal of floodwater from the east-central part of Hidalgo County. Cost estimates for improvements in the Floodway were approximately the same as the proposed location, which is the Laguna Madre Floodwater Channel.

Falcon Dam has reduced the frequency of the use of the Floodway System, and the frequency will be further reduced by Amistad Dam. But even with Amistad in operation, there will still be a need for use of the floodways. Large floods on the Rio Grande will still occur, particularly from the Mexican tributaries of Alamo and San Juan Rivers below Falcon. During these floodflows in the floodway System local floodwaters are unable to outlet into the Floodway. For this reason it was deemed preferable to outlet the floodwaters from the east-central part of Hidalgo County into the Laguna Madre Floodwater Channel.

(2) Another alternative location for the Willacy-Hidalgo Bypass Channel, via Edinburg-Raymondville-Laguna Madre, was studied. This location angles north and northeasterly from Edinburg to Texas Highway 186, thence eastward to the Raymondville Main Drain and into the Laguna Madre. Although this alternative is shorter in length than the proposed floodwater channel location, it would be approximately 40 percent more expensive because of greater land rights and associated costs. Also, it was felt that this would concentrate too much floodwater in one area.

(3) Consideration, in the planning process, was given to an alternate route through Willacy County for the Laguna Madre Floodwater Channel. This alternative, the South Willacy Floodwater Channel, would have picked up the discharge from the Laguna Madre Floodwater Channel west of the Willacy Canal and conveyed it east along the north side of the Canal to the Hidalgo County line, then north along the county line until it intersects Channel BA-3 and then through Channel BA-3 to the Laguna Madre (plate 10). The route through Lyford was selected as the more desirable because it follows more closely the natural low through Willacy County.

The alternatives were weighed and tested for applicability, effectiveness, relative economy, and total physical impact giving consideration to local views and desires.

Consideration was given to two other alternative apportionments of low flow between the Arroyo Colorado and the North Floodway. Studies of these alternatives were made in cooperation with the International Boundary and Water Commission.

One evaluation concerned the diversion of 5,000 cfs low flow at the divisor down the Arroyo Colorado. This flow, combined with that from the PL-566 Arroyo Colorado and Los Fresnos Resaca watershed projects in Cameron County, would cause significant streambank erosion at Harlingen. This would require measures for streambank protection to prevent damage to residential and business property in Harlingen and to several areas of agricultural land between Harlingen and the Port of Harlingen. Further studies showed the cost of protecting these areas to far exceed their value. Also, it is very probable that erosion would occur in other areas which would have to be protected at an even greater cost.

Another alternative flow apportionment considered was that of carrying the entire 5,000 cfs down the North Floodway below ground level. This would cost almost twice as much as the alternative which was chosen.

EFFECTS OF THE PLAN

Physical and Biological Effects

The proposed plan of development includes the installation of land treatment measures to protect and improve the agricultural lands, permit efficient and effective water management, and insure higher sustained agricultural yields and structural measures for flood prevention, agricultural water management and recreation. Although the basin is well endowed with natural resources it has not begun to achieve its potential. Developments proposed in the plan would contribute to regional development by providing a physical environment conducive to economic growth. In urban areas the flood control features of the plan would allow a more orderly and higher type of development than would otherwise take place.

The planned level of flood protection will make possible more efficient agricultural production in the basin. Farming operations can be carried out more efficiently and complete conservation irrigation systems can be installed for more efficient use of available water.

The structural measures would remove stagnant waters created by excessive rainfall and uncontrolled application of irrigation water, thereby eliminating many health hazards.

A slight increase in sediment rates in the basin may be expected with installation of the single-purpose channels for flood prevention.

These channels will increase the runoff velocities, thus increasing the erosive effect of the water, however, installation of the land treatment measures will reduce the rate of sedimentation to below its present level.

Installation of the proposed channel improvement would result in lowering the water table and decreasing soil salinity. With the planned measures installed, salt-tolerant crops, now grown on highly saline soils and soils with high-water tables, can be replaced with more profitable crops.

The effects of the proposed plan of development on the fish and wildlife resources are described by the Bureau of Sport Fisheries and Wildlife as follows:

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With the proposed projects and programs completed, drainage and flood control would be more effective. Runoff and return flows are expected to continue carrying large loads of agricultural chemicals, salt, and domestic and industrial pollution. Runoff from the Basin would be flushed into the freshwater fish habitat at much faster rates. The freshwater fish habitat would be of poorer quality. However, since much of the habitat is of low quality, the effects of the plan on the amount or quality of freshwater sport fishing would be insignificant. At some locations, heavy loads of pollution would be flushed out of the fresh water more quickly, thus improving it to some degree.

The proposed plan would have no significant effects on freshwater commercial fishing.

Increased pollution of the estuaries and the Laguna Madre would occur with the plan. The drainage and flood control features of the project would deliver the pollutants to the estuaries at a much faster rate and they would not have as much time to break down. Consequently, pollutants such as insecticides and herbicides that are highly toxic to marine animals and plant life would enter the estuaries in a fresher state and could build up to lethal levels more easily. Pollution by fertilizers and sewage effluents could result in unfavorable conditions for plankton growth. Additionally, the grassy nursery areas for spotted seatrout and shrimp would deteriorate in quality.

Marine fish populations are expected to decline as a result of more rapid delivery of pollutants to the bays and estuaries. With the proposed plan, there would be less marine sport fishing due to lower populations of important game fish. This also would be true in the case of marine commercial fishing.

The new and rehabilitated floodwater and multipurpose channels would not affect wildlife resources significantly. Some agricultural lands would be displaced but no brush or other cover vital to wildlife would be involved. Other land would be placed in cultivation to replace that lost to structures.

Range improvement measures such as brush control, controlled and rotation grazing, and establishment of long-term stands of forage plants would have little harmful effect on wildlife habitat or populations. Improved drainage to permit lowering the water table and leaching of salts from the soil would result in the loss of some poor to moderate quality wildlife cover in saline areas that would otherwise be allowed to grow up in native brush.

Conservation-cropping systems such as grasses and legumes in rotation, cover and green-manure crops, and crop residue use generally would benefit big game, upland game, and waterfowl. The proposed irrigation measures such as field ditches, ditch and canal lining, land leveling, pipelines, and water management would not affect wildlife materially. More intensive use of croplands would provide more winter feeding areas for doves and songbirds.

With improved drainage in the basin, pollutants would be flushed into the lower Laguna Madre at a more rapid rate which would increase the potential for damage to waterfowl foods in these areas. Important winter feeding habitat for redheads would be threatened.

Habitat conditions for fur animals would not change significantly with the comprehensive plan.

White-tailed deer and javelina populations and hunting would not be affected significantly. Wild turkey populations would not change greatly and there would be little hunting for them. Populations of white-winged doves and mourning doves and the amount of hunting would not change significantly even though a small amount of brush on saline areas would be cleared. Bobwhite and scaled quail numbers and man-days of hunting for them would not change. Chachalaca populations and hunting would be unaffected. Populations of cottontails and jackrabbits would increase as would the amount of hunting for them. Even though some project measures would benefit waterfowl, damages to estuarine habitat would result in less wintering waterfowl habitat and slightly less hunting. Fur animals and other wildlife would not be affected significantly with the plan.

Plan of Development Benefits

Installation of the structural measures included in the proposed plan of development would result in a substantial reduction in flood damages. Some flooding would still occur, but floodwaters would be removed in less time. It is estimated that the floodwaters created by Hurricane Beulah in September and October 1967 would have been removed in a week had the measures included in the plan of development been in place. Under conditions that existed at the time

The proposed Willacy-Hidalgo Floodwater Bypass and the Laguna Madre Floodwater Channel will provide positive outlets for the removal of floodwater from highly developed agricultural areas and cities in Willacy and Hidalgo Counties.

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TABLE 35

AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
LOWER RIO GRANDE BASIN, TEXAS

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
	thousands of dollars 1/		
PL-566			
Cameron County Watersheds			
Floodwater			
Crop and Pasture	2,194	198	1,996
Nonagricultural			
Roads and Bridges	16	1	15 2/
Urbans	45	6	39
Subtotal	2,255	205	2,050
Indirect	225	20	205
TOTAL	2,480	225	2,255
Phase I and II			
Floodwater			
Crop and Pasture	5,953	551	5,402
Nonagricultural			
Roads and Bridges	33	3	30
Urban	17	2	15
Subtotal	6,003	556	5,447
Indirect	601	56	545
TOTAL	6,604	612	5,992
Basin Summary			
Floodwater			
Crop and Pasture	8,147	749	7,398
Nonagricultural			
Roads and Bridges	49	4	45
Urban	62	8	54
Subtotal	8,258	761	7,497
Indirect	826	76	750
TOTAL	9,084	837	8,247

1/ Price Base: Adjusted normalized price, April 1966.

2/ Not used for project justification in PL-566 watershed work plans for Cameron County of Hurricane Beulah much of the land and many homes, roads, and highways remained flooded for months.

It is estimated that floodwater damages in the basin would be reduced from $9,084,000 annually to $837,000 after the installation of the proposed measures (table 35). Crop and pasture damage would be reduced from $8,147,000 to $749,000 annually. Damage to roads, bridges, and culverts would be reduced from $49,000 annually to $4,000. Damage to residential and commercial properties, streets, lawns, and parks in urban areas would be reduced from $62,000 to $8,000 annually. Indirect damages such as interruption of travel, the inability to move agricultural products to market, the rerouting of school busses and mail routes, losses sustained by businessmen of the area, and other losses would be reduced from $826,000 to $76,000 annually.

The total average annual benefits that would result from the installation of structural measures included in the proposed plan of development, based on 1980 projections are estimated to be $17,457,000 (table 36). Of this amount, $8,084,000 would result from reduction of floodwater damages. Approximately $7,398,000 of project benefits would result from increased net returns from more efficient agricultural operations. These benefits would be derived from increased production, reduced costs of production, and increased prices due to improved quality.

Approximately $11,000 in benefits would accrue annually through reduction of damages from windblown salt-laden dust. These benefits will result from installation of water level control measures and critical area planting on Bahia Grande, Laguna Larga, and portions of Laguna Madre and South Bay lakes.

About $57,000 in benefits would result from more efficient and timely application of irrigation water to 5,000 acres of land from the multiple-purpose reservoir in the Tiocano Lake area. Recreation benefits from this reservoir and basic recreation facilities are expected to be about $22,000 annually.

Area redevelopment benefits amounting to $315,000 would accrue as a result of funds expended on local labor in the construction and operation and maintenance process. This labor would otherwise be unemployed.

Secondary benefits stemming from the plan of development amounting to $1,570,000, would result from increased production of goods and services, increased demand on transporting, processing and marketing of goods, and increased sales of industries associated with agriculture.

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In addition to monetary benefits, substantial intangible benefits would accrue, such as better living conditions, better health conditions, improved environment, and an increased sense of security.

Phase I and Phase II Benefits

Installation of the Willacy-Hidalgo Floodwater Bypass and the Laguna Madre Floodwater Channel would provide positive outlets for the removal of floodwaters from highly developed agricultural and urban areas in Willacy and Hidalgo Counties.

After these channels have been completed, the Willacy and Hidalgo County areas can be divided into smaller, independent subwatershed areas. The local sponsors of each subwatershed then could install a system of channels or improve the existing system for flood prevention and surface and subsurface drainage independent of any other subwatershed.

The North Floodway Channel would remove its proportionate share of the excess waters that will have to be discharged into the main floodway thereby reducing flood, sediment, scour, and salinity problems to the agricultural lands within the North Floodway.

The average annual benefits resulting from the installation of Phase I and Phase II of the proposed plan in Willacy and Hidalgo Counties are estimated to be $12,796,000 of which $12,676,000 is due to structural measures. Of this amount, $5,872,000 would result from reduction of flood damages due to structural measures. An additional $120,000 in benefits would result from reduction of flood damages due to land treatment measures.

Approximately $5,402,000 would be in the form of increased net returns from more efficient agricultural operations. These benefits would result from increased production, reduced production costs, and increased prices due to improved quality. These benefits would result from the installation of subsurface and surface drainage facilities which will lower the water tables, permit the leaching and removal of toxic salts from the more permeable soils, and provide for a more rapid removal of water from depressed areas.

Area redevelopment benefits amounting to $250,000 would accrue as a result of funds expended on local labor for construction and operation and maintenance process of Phases I and II. This labor would otherwise be unemployed.

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TABLE 36

AVERAGE ANNUAL BENEFITS
LOWER RIO GRANDE BASIN, TEXAS

	Flood Prevention	Average Annual Benefits 1/						
		Agricultural Water Management						
	Damage Reduction	Drainage	Irrigation	Water Control	Recreation	Area Redevelopment	Secondary	Total
	thousands of dollars							
PL-566 Watersheds, Cameron Co.								
751 Miles of Main and Lateral Drainage Channels, and three Water Level Control Structures	2,212	1,996	57	11	22	65	418	4,781
Phase I and II								
164 Miles of Channel Improvement for Flood Prevention, and 1,394 Miles of Main and Lateral Drainage Channels	5,872	5,402	-	-	-	250	1,152	12,676
TOTAL	8,084 2/	7,398	57	11	22	315	1,570	17,457 2/

1/ Price Base: Adjusted normalized prices, April 1966.

2/ Land treatment measures will provide additional flood damage reduction benefits of $163,000 annually of which $43,000 is associated with the PL-566 watersheds in Cameron County and $120,000 with Phase I and Phase II.

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Increased volume of agricultural production will generate more activity in industries associated with agriculture.

Top - Cotton Compress
Bottom - Fertilizer and insecticide plant in foreground.
Citrus processing plan in background.

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Secondary benefits stemming from Phases I and II would amount to $1,152,000 and would result from increased production of goods and services, increased transportation, processing, and marketing of goods, and increased sales by industries associated with agriculture.

Agricultural Production and Employment

The physical and biological changes expected to occur with adoption of the program and project proposals will result in increased yields, more intensive use of land, and reduced flood damages. Adoption of technological advances in agricultural production will be facilitated. The efficiency gains in agricultural production will be associated with stabilization of income, increased total volume of production, and lower production costs per unit of product. With the increased volume of production in agriculture, other sectors of the economy in the area will experience increased economic activity. Agri-business will be the major sector of the economy affected; however, the effect of increased agricultural production will pervade the entire economy.

The preceding section presents the estimates of primary, secondary, and redevelopment benefits associated with adoption of the proposed plan. These benefits are compared with costs to determine feasibility and were determined by procedures presently used in the Department of Agriculture for this purpose. The major objective in this section of the report is to analyze the importance of agricultural production to the economy of the area and estimate the effect of the investment of approximately $193 million in the proposed programs and projects of the economy of 1980, 2000, and 2020. This effect, though related to the above benefits, should not be confused with these benefits or considered as additional benefits relating to project justification. However, this effect is of concern to residents of the local area.

Expanded economic activity may be expressed in terms of increased volume of business or employment. It is usually referred to as impact on the local economy. It is difficult to measure precisely this impact; however, several techniques are available for making reliable estimates. Methodology presented here and used in this impact study was adapted from methodology developed by the Texas Water Development Board and presented in their report No. 11, "Importance of Irrigation Water to the Economy of the Texas High Plains," and in an unpublished document "Methodology for Calculating Agricultural Benefits to Irrigation." Assumptions and definitions of terms are essentially the same as used in these documents except that "economic effect" is substituted for the term "benefit".

Economic effect, or impact as used here, is defined as the total additional income (including the project benefits shown in the preceding section) generated by implementing the proposed flood prevention and drainage in the basin. It is divided into four categories in table 38 for examination: agricultural or primary effect, local secondary effect, agricultural inputs tertiary effects, and consumer items tertiary effects.

Primary effects are increases in gross farm income, less harvesting costs 1/, due to increased crop yields and reduced hazards from flooding and improved soil conditions in the root zone from drainage.

Yields without and with development, shown in tables 17 and 37, were multiplied by the normalized field prices shown in table 19. These per-acre crop values were weighted by the percentage each crop is of the total agricultural area and composite per-acre values determined. Composite per-acre crop values were multiplied by the acres of agricultural land in the basin. The difference in gross income for the area with and without development for each time period is considered as the primary effect on the area economy from adoption of the program and project proposals. The estimated primary effects for 1980, 2000, and 2020 are shown in table 38.

Secondary effect is value added by processors to the increase in production from development after farm commodities leave the farm. Local secondary effects refer to the values added in processing before the commodities leave the local area.

Local value added (LVA) is the difference between the value of a partially finished good as it leaves the local area and its farm market value (FMV). The local expansion coefficient (LEC) is one plus the local value added divided by the farm market value (LEC = 1 + (LVA/FMV)). The total secondary impact (per acre) for any given crop is the change in the value of the crop produced as a result of development times its local expansion coefficient.

A composite local expansion coefficient was estimated by weighting the coefficient 2/ for each crop by the percentage that each crop

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1/ See definition of "Agricultural Inputs Tertiary Effect," in the following subsection.

2/ The coefficients used for individual crops were those developed by the Texas Water Development Board for the Lower Rio Grande Valley.

TABLE 37

PROJECTED 1980, 2000, AND 2020 CROP AND PASTURE YIELDS
PER HARVESTED ACRE WITH RESOURCE DEVELOPMENT 1/
LOWER RIO GRANDE BASIN, TEXAS

Land Use	Unit	Projected Yield 1980	2000	2020
Cropland				
Irrigated				
Cotton	lbs.	726	863	1,013
Grain Sorghum	cwt	60	82	90
Early Oranges	ton	6.8	7.7	9.7
Mid-season Oranges	ton	3.7	4.3	5.3
Grapefruit	ton	12.3	14.0	17.5
All Vegetables	cwt	181	235	286
Tame Pasture	AUM	17	19	21
Nonirrigated				
Cotton	lbs.	493	553	632
Grain Sorghum	cwt	32	44	49
Tame Pasture	AUM	4.9	5.4	5.9
Range	AUM	.38	.43	.47

1/ The effect of proposed projects and programs on present normal yields were estimated by the Soil Conservation Service. This effect was applied to projected yields without resource development to determine projected yields with resource development.

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was of the composite per acre value. Estimated total secondary effects were calculated by multiplying the increased gross income attributable to development by the composite local expansion coefficient. Secondary impacts for each of the time periods are shown in table 38.

Agricultural inputs tertiary effects represent increased value added by local suppliers of agricultural inputs. Value added equals the supplier's revenue (or the farmer's cost) for additional inputs used on a composite developed acre minus the wholesale value of the inputs.

Agricultural inputs tertiary effects per acre equal the sum of the value added for all additional inputs (represented only by custom harvesting costs in this analysis) resulting from increased production due to proposed projects and programs. Total agricultural inputs tertiary impact is the effects per acre multiplied by the number of inventory acres as shown in table 38.

Consumer items tertiary effects are the additional values added by the retail consumer section in the local area. The sum of primary effects, local secondary effects, and agricultural inputs tertiary effects is available for successive rounds of consumption spending. Via the multiplier effect, this additional income generates consumption expenditures which are a multiple of the original increase in income.

The local expenditure multiplier (LEM) was calculated by assuming that marketing and merchandising facilities in the area are locally owned and that wholesale purchases represent the only outside leakages.

To offset the above assumption, all wholesale purchases are considered to be made outside the area. Leakages from the area can then be expressed as one minus the wholesale markup (WM), and the local expenditure multiplier is equal to the reciprocal of one minus the wholesale markup (LEM = 1/1-WM). This merely means that a portion of each dollar spent in the local area is respent within the area in successive rounds until its marginal effect is diluted to near zero.

The LEM applied to the sum of primary, local secondary, and agricultural inputs tertiary effects equals the value added in the consumer retail market, or consumer items tertiary effects.

TABLE 38

ESTIMATED ANNUAL ECONOMIC IMPACT
FROM PROPOSED USDA PROGRAMS AND PROJECTS
LOWER RIO GRANDE BASIN, TEXAS

Item	Increase in Economic Activity		
	1980	2000	2020
	------Thousands of Dollars------		
Primary Effects	35,402	42,794	47,180
Local Secondary Effects	9,059	11,036	12,248
Agri. Inputs Tertiary Effects	12,100	14,411	16,344
Consumer Items Tertiary Effects 1/	23,139	27,918	30,998
TOTAL LOCAL IMPACT	79,702	96,160	106,772

1/ Consumer Items Tertiary Coefficient = .4091.

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The Lower Rio Grande Basin's tertiary effects coefficient for all consumer items was calculated by the Texas Water Development Board. This coefficient was used to calculate consumer items tertiary effects shown in table 38.

Based on this analysis, the sum of annual primary and secondary effects or the annual impact on the local volume of business from the investment of approximately $193 million in the proposed projects and programs is estimated at $79.7 million in 1980, $96.2 million in 2000, and $106.8 million in 2020 (table 38).

Associated with the above increase in economic activity will be increased employment. Most of the increase will be in agricultural employment though other sectors of the economy will experience an increase related to their increased economic activity. Only the effect on agricultural employment is discussed here.

Agricultural employment in the United States is related to the agriculture portion of the Gross National Product. Output, in terms of GNP, per agricultural employee is estimated for the United States by dividing the number of agricultural employees into agriculture's contribution to the Gross National Product. Projected trends in increases in output per agricultural worker indicate that agricultural employment in the United States will continue to decrease. 3/ Output in dollars per agricultural employee in the United States is projected to increase from $3,806 in 1959-61 to $8,554 in 1980, $14,648 in 2000, and $21,168 in 2020.

It was assumed that output per agricultural employee in the study area will continue to increase at the same rate as the United States. Thus, output per employee will increase, and total agricultural employment will decrease.

Also, assuming that the value of agricultural production approximates agriculture's contribution to the Gross Product of the study area, present output per agricultural employee is estimated to be $4,018. This output projected at the same rate as the United States gives outputs of $9,000 in 1980, $15,500 in 2000, and $22,300 in 2020.

These outputs, applied to the estimated changes in annual gross value of agricultural production in the basin due to the USDA projects and programs, indicate added agricultural employment of 3,900 in 1980, 2,800 in 2000, and 2,100 in 2020.

3/ Ad Hoc Water Resources Council Staff, National Economic Growth Projections 1980, 2000, 2020, July 1963.

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Because of the projected decline in agricultural employment these increases are not increases in the present level but are increases above what is projected without the projects and programs.

Recreation

Outstanding natural resources are available and are utilized extensively for outdoor recreational purposes. Climate, lush farmlands, ripening citrus, salt-water fishing, hunting, and historical sites are characteristics favorable for use of the area for outdoor recreation. An estimated 3,834 acres of land and 8,370 surface acres of water are currently available for outdoor recreational purposes.

Available outdoor recreation facilities are inadequate to meet present and future demands on the area.

The multiple-purpose reservoir, just north of La Feria in the Arroyo Colorado Watershed, with its associated basic recreation facilities is expected to be used for camping,picnicking, hiking, boating, skiing, and fishing for an estimated 15,000 visitor-days annually, with peak use of 200 per day on weekends during the greater part of the year. Recreation benefits from this reservoir and basic recreation facilities will amount to about $22,000 annually.

Assuming an average multiplier 4/ as developed for counties with similar numbers of employees as Cameron County, the secondary economic effects or income expansion effects of recreation are estimated at $47,740 annually. These secondary economic effects will accrue to the suppliers of goods and services associated with the additional recreation facilities.

Investing $193 million in the proposed projects and programs will aid in improving and stabilizing all sectors of the basin's economy. The increase in economic activity resulting from this investment will increase and sustain both farm and nonfarm employment and income. In turn, the increase in income will allow the basin's most important resource, its people, to improve and stabilize their social environment.

4/ U. S. Department of Agriculture, ERS, NRE, EEB, Recreation Evaluation in River Basin Studies, August 1967.

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COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures proposed for installation under Phase I and Phase II (amortized total installation cost, plus operation and maintenance) is estimated to be $4,584,000 (table 39). These measures are expected to produce average annual primary benefits of $11,524,000 or $2.51 for each dollar of cost. The ratio of total average annual project benefits accruing to structural measures, $12,676,000 to the average annual cost of structural measures, $4,584,000, is 2.8 to 1.0 (table 40).

The total average annual cost of structural measures to be installed under PL-566 is estimated to be $1,308,000. These measures are expected to produce total average annual benefits of $4,781,000 providing a benefit-cost ratio of 3.7:1.0.

The total average annual cost of structural measures included in the plan of development is estimated to be $5,892,000. These measures are expected to produce total average annual benefits of $17,457,000 providing a benefit-cost ratio of 3.0:1.0.

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Output per agricultural employee is expected to increase as a result of more mechanization and higher yields.

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TABLE 39

ANNUAL COST OF STRUCTURAL MEASURES
LOWER RIO GRANDE BASIN, TEXAS

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
	dollars		
PL-566 Watersheds	999,000	309,000	1,308,000
Phase I and II	3,709,000	875,000	4,584,000
TOTAL	4,708,000	1,184,000	5,892,000

1/ Installation costs based on 1966 prices and amortized for 100 years at 4-7/8 percent interest.

2/ Price Base: Adjusted normalized prices, April 1966.

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TABLE 40

COMPARISON OF BENEFITS AND COSTS
FOR STRUCTURAL MEASURES
LOWER RIO GRANDE BASIN, TEXAS

	Average Annual Benefits 1/	Average Annual Cost 2/	Benefit Cost Ratio
	----------dollars--------		
PL-566 Watersheds Cameron Co.			
751 Miles of Main and Lateral Drainage Channels, and three Water Level Control Structures	4,781,000	1,308,000	3.7:1.0
Phase I and Phase II			
164 Miles of Channel Improvement for Flood Prevention, and 1,394 Miles of Main and Lateral Drainage Channels	12,676,000	4,584,000	2.8:1.0
TOTAL	17,457,000	5,892,000	3.0:1.0

1/ Price Base: Adjusted normalized prices, April 1966.

2/ From Table 39

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COORDINATION WITH OTHER AGENCIES

The study and plan of development recommended herein were fully coordinated with all local, State, and Federal agencies concerned. Flood control, water supply, water quality control, recreation, fish and wildlife, power, agricultural water management, including irrigation and drainage, and navigation were all considered in the investigation of the basin. Each State or Federal agency having interests in the Valley was notified that a comprehensive study of the basin was being undertaken. Each was requested to make any contributions that would help in the development of the water and related land resources of the basin.

A Steering Committee, consisting of representatives from the Texas Water Development Board, the Texas Water Rights Commission, the Texas State Soil and Water Conservation Board, and the United States Department of Agriculture, coordinated all studies and investigations so that proposed development would maximize the beneficial use of water and related land resources of the area. The Committee made arrangements for agency coordination, and provided a means for full and continuing exchange of views during the study. Meetings were scheduled with the Bureau of Reclamation and the Corps of Engineers to coordinate planning and design criteria. Both agencies furnished data on their respective projects in the basin.

In addition, meetings were held with local interests and agencies to explain the plan and the criteria used, and to obtain available data from previous surveys and their suggestions for development of a workable overall plan for the basin.

Coordination was maintained throughout the study with the International Boundary and Water Commission. This agency operates and maintains the floodway system of the Lower Rio Grande Valley. The International Boundary and Water Commission has responsibility for determining the apportionment of flows between the Arroyo Colorado and the North Floodway. This includes the runoff that enters the Main Floodway from local areas. Further coordination with the International Boundary and Water Commission will be required throughout the detailed planning, design, and construction of measures included in Phase I and Phase II that might affect or be affected by the operation of the floodway system.

A public hearing was held in Edinburg, Texas, on February 26, 1969, to give all interested Federal, State, local agencies, and individuals concerned an opportunity to express their views on the proposed

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plan of development. A record of the proceedings and of testimony presented is on file in the office of the State Conservationist, Soil Conservation Service, Temple, Texas.

Written and oral statements presented were in support of the plan and urged its implementation. A spokesman for the North Floodway Landowners' Committee requested that a restudy be made of the apportionment of low flows between the Arroyo Colorado and the North Floodway. This request was complied with through a joint study by the International Boundary and Water Commission and the Soil Conservation Service.

Written statements are included as exhibits elsewhere in this report.

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The county judges speak for the proposed plan of development at the public hearing held in Edinburg, Texas, February 26, 1969.

(below)

Oscar C. Dancy
County Judge, Cameron County

(above)

Bill Rapp
County Judge, Willacy County

(left)

Milton D. Richardson
County Judge, Hidalgo County

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TABLE 41

SUMMARY OF INSTALLATION COSTS, USDA PROGRAM 1/
LOWER RIO GRANDE BASIN, TEXAS

	Unit	Number	Federal	Non-Federal	Total
			dollars		
Phase I					
Single-Purpose Channels					
Willacy-Hidalgo Floodwater Bypass	Miles	69	9,050,000	2,667,000	11,717,000
Laguna Madre Floodwater Channel	Miles	56	4,468,000	4,074,000	8,542,000
North Floodway Channel	Miles	39	3,277,000	1,355,000	4,632,000
Subtotal Phase I	Miles	164	16,795,000	8,096,000	24,891,000
Phase II					
Multiple-Purpose Channels	Miles	1,394	18,742,000	30,275,000	49,017,000
Structure for Water Control	No.	37	1,533,000	-	1,533,000
Work Plan Development	-	-	420,000	-	420,000
Subtotal Phase II	-	-	20,695,000	30,275,000	50,970,000
Subtotal Phase I and Phase II	-	-	37,490,000	38,371,000	75,861,000
Phase III					
Land Treatment	Acres	1,014,000	39,132,000	49,524,000	88,656,000
Technical Assistance	-	-	8,183,000	-	8,183,000
Subtotal Phase III	-	-	47,315,000	49,524,000	96,839,000
TOTAL USDA PROGRAM	-	-	84,805,000	87,895,000	172,700,000

1/ Price Base: 1966

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RECOMMENDATIONS

The State Conservationist recommends that the proposed program be carried out in the Lower Rio Grande Basin, with the installation of all elements of the program being initiated prior to 1980;

That in carrying out the proposed program, the Secretary of Agriculture be authorized to assist State and local public organizations, upon their request, to prepare and carry out subwatershed work plans; that such State and local organizations shall include soil and water conservation districts, flood prevention and control districts or combination thereof and or other political subdivisions of the State, or any other public agency having authority under State law to carry out, operate, and maintain works of improvement;

That in carrying out such program, the Secretary of Agriculture be authorized to provide financial and other assistance in the installation of structural works of improvement for flood prevention and for furthering the conservation, development,utilization, and disposal of water and that such assistance shall be provided on a basis comparable to that authorized for similar purposes under other Federal programs, with such modifications as the Secretary deems necessary and appropriate in the public interest;

That the Secretary of Agriculture be authorized to provide financial and other assistance for accelerating the installation of land treatment measures for runoff and waterflow retardation and the control and prevention of erosion, floodwater, and sediment damages, and, in cooperation with farmers and ranchers, and other landowners, operators, and occupiers, the installation of soil and water conservation practices and measures, including changes in cropping systems and land uses, needed to conserve and develop the soil, water, woodland, wildlife, and recreation resources of farm and other lands within the area included in subwatershed plans and as provided in such subwatershed plans; and that such assistance should be comparable to the assistance provided for planning and installing similar practices and measures under PL-83-566, as amended or as may hereafter be amended, and other existing national programs; provided that the portion of the costs of such practices and measures needed to protect structural works of improvement installed with Federal assistance should be that part determined by the Secretary to be necessary and appropriate to effectuate the timely installation of such practices and measures;

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TABLE 42

RECOMMENDED SCHEDULE OF OBLIGATIONS, FEDERAL FUNDS
LOWER RIO GRANDE BASIN, TEXAS

	Federal Funds							
	Year							
	1	2	3	4	5	6-10	11-20	Total
	1,000 dollars							
Phase I								
Structural Measures								
Installation Cost	4,468	6,611	5,716	-	-	-	-	16,795
FHA-Loans (accelerated)	500	1,500	1,000	-	-	-	-	3,000
Phase II								
Structural Measures								
Installation Cost	-	525	725	3,950	3,900	11,595	-	20,695
FHA-Loans (accelerated)	1,000	2,000	2,000	3,000	4,000	8,000	-	20,000
Phase III								
Land Treatment								
ASCS - ACProgram (accelerated)	660	1,029	1,993	1,993	2,192	15,659	5,700	29,226
SCS - Technical Assistance (New authority)	35	164	200	200	200	842	696	2,337
FHA-Loans (accelerated)	500	600	700	800	900	3,500	3,000	10,000
Recapitulation								
Total obligations	5,163	8,329	8,634	6,143	6,292	28,096	6,396	69,053
Total loans	2,000	4,100	3,700	3,800	4,900	11,500	3,000	33,000
Total funding required	7,163	12,429	12,334	9,943	11,192	39,596	9,396	102,053

That prior to participation in the installation of the structural works of improvement on non-Federal lands, cooperating non-Federal entities shall furnish assurances satisfactory to the Secretary of Agriculture that an adequate land treatment program is being installed to provide necessary protection to the watershed lands and planned structural measures; that such entities will acquire all land rights needed in connection with the installation of such works of improvement and in such acquisition there may be used such Federal cost-sharing assistance as may be available under other Federal programs; and that such entities will operate and maintain all upstream structural works of improvement on non-Federal lands, after installation, in accordance with the provisions for non-Federal participation described herein or as may be required under other similar Federal programs.

The first estimate of cost for the proposed Department of Agriculture program is $172,700,000, of which $84,805,000 will be provided by the Federal government and $87,895,000 will be provided by non-Federal interests.

The first estimate of cost for land treatment is $96,839,000, of which $47,315,000 will be provided by the Federal government and $49,524,000 will be provided by non-Federal interests. The Federal share of this includes $15,752,000 which will be available under the going programs and $31,563,000 for the acceleration of this program.

The first estimate of cost for the installation of the structural works of improvement is $75,861,000, of which $37,490,000 will be assumed by the Federal government and $38,371,000 will be assumed by non-Federal interests.

The proposed program which is being recommended for installation is described in detail in the chapter, Plan of Development. Project maps, by reaches, are identified as Plates 9 and 10. Table 41 summarizes the installation costs and cost-sharing from Federal and non-Federal funds. In order that the proposed program can be carried out expeditiously, it is recommended that Federal funds be appropriated according to the schedule shown in table 42. Other summaries are given in the above mentioned report.

Clyde W. Graham

Clyde W. Graham
State Conservationist

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APPENDIX

SOILS OF THE LOWER RIO GRANDE VALLEY
THEIR CHARACTERISTICS, USES, AND PROBLEMS

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USDA-SCS-FORT WORTH, TEX. 1969

COMPREHENSIVE STUDY
AND PLAN OF DEVELOPMENT
OF THE
LOWER RIO GRANDE BASIN, TEXAS

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SOILS OF THE LOWER RIO GRANDE VALLEY
THEIR CHARACTERISTICS, USES, AND PROBLEMS

INTRODUCTION

The Lower Rio Grande Basin Study Area encompasses Cameron, Hidalgo, and Willacy Counties in South Texas and has an area of approximately 2,209,300 acres or 3,452 square miles. This includes 270,300 acres of large water areas. The entire area lies within the Rio Grande Plain Land Resource Area. Approximately half of the basin area is a delta with a gentle slope to the northeast away from the Rio Grande and toward the Gulf of Mexico. The delta covers all of Cameron County, most of Willacy County, and a small portion of eastern Hidalgo County. The deltaic portion of the basin is in the Coastal Prairie Physiographic Area. The remainder of the area is in the South Texas Coastal Plain Physiographic Area.

PURPOSE

The purpose of this report is to provide a comprehensive analysis of the soils of the Lower Rio Grande Valley. The major problems which confront owners and operators of agricultural lands in the Valley are, to a large extent, related to the soils. Information concerning the soils is especially important in this area because of the intensive agricultural development which has taken place during the past 50 years. A major portion of the highest value agricultural land in Texas is located in the Valley. This report on the soils was developed as a basic component of the Type IV River Basin Study undertaken by the U. S. Department of Agriculture. Previous reports on the soils and their associated problems have been made by the Bureau of Reclamation and the U. S. Department of Agriculture.

SCOPE

This report encompasses Willacy, Hidalgo, and Cameron Counties and presents comprehensive information of a general nature concerning the origin, characteristics, uses, and problems of the major soils occurring in this area. A soil map is presented to be used with the text. This map is of a general nature and is not intended for detailed planning. Estimates of drainage needs and estimates on soil salinity and water table conditions are included.

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SOILS AS RELATED TO GEOLOGY

Plate 1 shows the geology of the basin superimposed on the General Soil Map and forms a basis for a discussion of the soils as related to the geologic formations. Plate 1 shows four groupings of the soil associations as they are related to geology.

Group A - The oldestgeologic formations in the basin occur within this group. These are marine and fresh-water deposits of the Pliocene and Pleistocene Series which were deposited in bands parallel to the Texas Gulf Coast and which are 1 to 10 million years old. Formations present, in ascending order of age, are the Montgomery (or Bentley) and Willis (or Bentley) or Pleistocene age and the Goliad of Pliocene age. The Montgomery (or Bentley) and Willis (or Bentley) Formation consists of clay, silt, sand, and caliche. The Goliad formations consist of pebbles and cobbles in a sandstone matrix interbedded with sand and sandstone beds which are in part cemented by caliche. The soils developed on these formations are nearly level to gently sloping, moderately permeable, loamy soils of the uplands, and the undulating, shallow, gravelly, loamy soils. Major soil series included are Delmita, Hidalgo, McAllen, Willacy, Jimenez, and Brennan. The characteristics of these soils reflect, in general the calcareous, sandy, and gravelly nature of the underlying deposits from which they are derived. Most of them are well drained sandy loams with moderate permeabilities and calcareous subsoils. They are not saline and do not have high-water tables under nonagricultural conditions.

Group B - The soils of this group overlie, and are derived from, the ancient delta deposits of the Rio Grande.

These deposits consist of poorly consolidated to nonconsolidated channel, point bar, natural levee, and backswamp deposits of the Rio Grande. They are complicated facies of calcareous clay, sand, and silt which range in age from 10,000 to 1 million years. They are considered to belong to the Beaumont Formation of the Pleistocene Series. The major soil series in this group are: Delfina, Ramadero, Raymondville, Orelia, and Willacy. These soils are the level, moderately, and slowly permeable soils of the uplands.

Saline areas, or hot spots, are common to both the dryland and irrigated agricultural areas in this group. The complicated, deltaic depositional sequences on which these soils are developed are largely responsible for the erratic distribution of the saline areas, and will be discussed further in the section on soil salinity.

An extensive sand deposit is known to exist under most of this area at depths of 10 to 30 feet. This deposit may represent the seaward retreat of marine beaches as the delta was formed which were later covered by channel, point bar, natural levee, and backswamp deposits of the Rio Grande as it migrated back and forth over the area.

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Group C - The soils of this group are derived from Rio Grande delta deposits of Recent geological age. These deposits consist of unconsolidated sand, silt, and clay and are less than 10,000 years old. They are in the form of channel, point bar, natural levee, and backswamp depositional sequences. They also include coastal marsh, mud flat, clay dune, and offshore barrier island deposits which are connected with the mainland near the mouth of the Rio Grande. The soils are weakly developed and are the level, loamy soils of flood plain and low terraces; the level, very slowly permeable, high shrink-swell clayey soils; the saline soils; and the level and gently sloping soils of coastal areas. The major soils series included are: Laredo, Laredo clayey variant, Reynosa, Reynosa-clayey variant, Rio Grande, Camargo, Harlingen, Montell, Lomalta, Lomalta-loamy variant, Point Isabel, Laredo Saline, and Montell Saline. Two land types, Coastal Dunes and Tidal Flats, are also included.

These soils are similar to Group B soils in many respects, such as having salinity and watertable problems. Their principal difference is the weak profile development as a result of being younger in age and the presence of high shrink-swell floodplain clays.

Group D - This group consists of sandy soils developed on the sand sheet deposits of Recent age in the northern portions of the basin. These deposits are eolian in origin and overlie the marine Pleistocene and Pliocene formations. They consist mostly of stabilized sand dunes but include some active sand dunes, clay dunes, playa lake deposits, local stream deposits, and local areas of exposed Pleistocene formations. The sand is initially deposited along the coast at about latitude 27° north due to the action of two opposing longshore currents which meet at this point. The sand and detritus is picked up by the prevailing southeast winds and carried inland to form a sand sheet up to 60 feet in thickness. The soils developed on these deposits are the gently sloping, sandy soils of the uplands. The major soil series included are: Nueces, Sarita, and Falfurrias. A land type, Duneland, is also included.

These soils are generally permeable and relatively low in nutrients due to their origin as windblown sand. They are best suited for use as rangeland.

SOIL ASSOCIATIONS

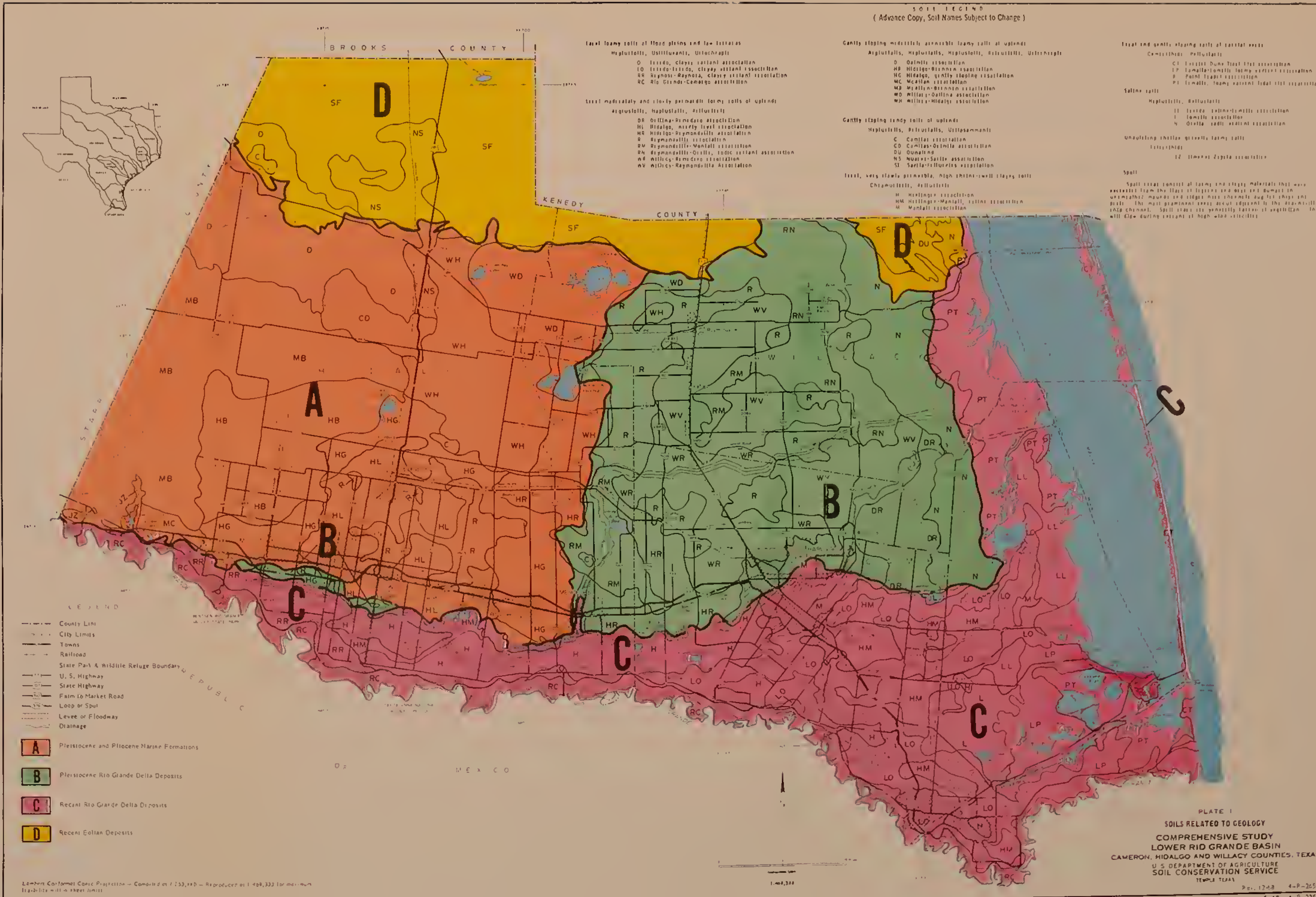
A soil association consists of one or more major soil series, along with several minor series, grouped together for mapping and descriptive purposes. The major series, by which the association is known, occupy from 65 to 90 percent of the area encompassed by the association. The remainder of the area is occupied by the minority series. In the Lower Rio Grande Basin, there are 35 soil associations. The General Soil Map, plate 2, was developed by condensing mapping units from detailed soil maps. Due to its general nature, the map should not be used for detailed planning. For simplification in the map legend, the soil associations have been placed in nine groups based on similar soil characteristics. Under each of the nine groups, the great groups in the Comprehensive System of Soil Classification are listed.

A description of each soil association forms the main body of this report. The description includes the approximate acreage in the association, its general geographic location, its topographic position, a brief physical description of the soil profiles in the major series, the percent of the total area occupied by the major and minor series, the land hazards, problems, and potential. A mapping symbol follows the association title and is utilized for identification on the General Soil Map.

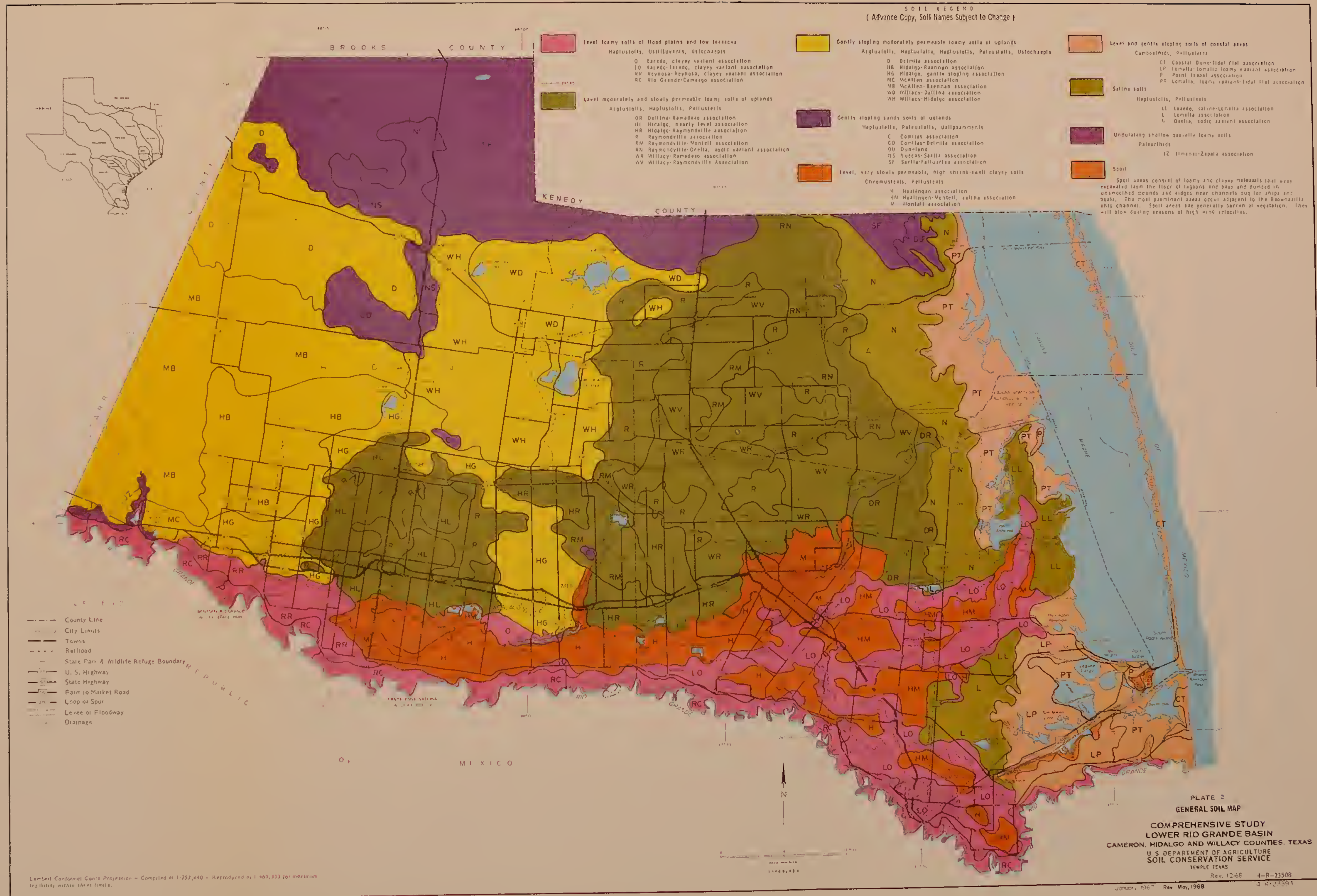
The soil variants, such as Laredo, clayey variant, are soils that are outside the range of the differentiating characteristics for the named series. For example, the clay content in the Laredo, clayey variant is higher than allowed within the range of the Laredo soil series. The soils are, however, more like the Laredo series than any presently established soil series. A new series for such a variant will probably be established sometime in the future. Several variants of different soil series are described in this report.

In the section on soil associations, the drainage classes given are for the major soils of the associations as they occur in their natural conditions and not under irrigation. Factors such as applying more irrigation water than necessary, topographic position, and runoff water from higher areas cause soils to develop problems and needs for surface and subsurface drainage.

The water table and salinity conditions of the soils in their natural state, and under present conditions, as well as their drainage needs, are tabulated in tables in the sections following the soil association and technical descriptions.



SOIL LEGEND
(Advance Copy, Soil Names Subject to Change)
BROOKS COUNTY
KENEDY COUNTY
LEGEND
County Line
City Limits
Towns
Railroad
State Park & Wildlife Refuge Boundary
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
A Pleistocene and Pliocene Marine Formations
B Pleistocene Rio Grande Delta Deposits
C Recent Rio Grande Delta Deposits
D Recent Eolian Deposits
MEXICO
PLATE I
SOILS RELATED TO GEOLOGY
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS


SOIL LEGEND
(Advance Copy, Soil Names Subject to Change)
Level loamy soils of flood plains and low terraces
Haplustolls, Ustifluvents, Ustochrepts
O Laredo, clayey variant association
LO Laredo-Laredo, clayey variant association
RR Reynosa-Reynosa, clayey variant association
RC Rio Grande-Camargo association
Level moderately and slowly permeable loamy soils of uplands
Argiustolls, Haplustolls, Pellusterts
DR Delfina-Ramadero association
HL Hidalgo, nearly level association
HR Hidalgo-Raymondville association
R Raymondville association
RM Raymondville-Montell association
RN Raymondville-Orelia, sodic variant association
WR Willacy-Ramadero association
WV Willacy-Raymondville Association
Gently sloping moderately permeable loamy soils of uplands
Argiustolls, Haplustalfs, Haplustolls, Paleustalfs, Ustochrepts
D Delmita association
HB Hidalgo-Brennan association
HG Hidalgo, gently sloping association
MC McAllen association
MB McAllen-Brennan association
WD Willacy-Delfina association
WH Willacy-Hidalgo association
Gently sloping sandy soils of uplands
Haplustalfs, Paleustalfs, Ustipsamments
C Comitas association
CD Comitas-Delmita association
DU Duneland
NS Nueces-Sarita association
SF Sarita-Falfurrias association
Level, very slowly permeable, high shrink-swell clayey soils
Chromusterts, Pellusterts
H Harlingen association
HM Harlingen-Montell, saline association
M Montell association
Level and gently sloping soils of coastal areas
Camborthids, Pelluderts
CT Coastal Dune-Tidal Flat association
LP Lomalta-Lomalta loamy variant association
P Point Isabel association
PT Lomalta, loamy variant-Tidal Flat association
Saline soils
Haplustolls, Pellusterts
LL Laredo, saline-Lomalta association
L Lomalta association
N Orelia, sodic variant association
Undulating shallow gravelly loamy soils
Paleorthids
IZ Itmanar-Zapata association
Spoil
Spoil areas consist of loamy and clayey materials that were excavated from the floor of lagoons and bays and dumped in unsmoothed mounds and ridges near channels dug for ships and boats. The most prominent areas occur adjacent to the Brownsville ship channel. Spoil areas are generally barren of vegetation. They will blow during seasons of high wind velocities.
BROOKS COUNTY
KENEDY COUNTY
MEXICO
RIO GRANDE
County Line
City Limits
Towns
Railroad
State Park & Wildlife Refuge Boundary
U. S. Highway
State Highway
Farm to Market Road
Loop or Spur
Levee or Floodway
Drainage
N
PLATE 2
GENERAL SOIL MAP
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 12-68 4-R-23506
Rev May, 1968

Level loamy soils of flood plains and low terraces

Haplustolls, Ustifluvents, Ustocrepts

Laredo, clayey variant association	(O)
Laredo-Laredo, clayey variant association	(LO)
Reynosa-Reynosa, clayey variant association	(RR)
Rio Grande-Camargo association	(RC)

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Laredo, clayey variant association (O)

This association consists of 3,600 acres of nearly level areas of dark grayish brown silty clay with a few gently sloping areas of silt loam. The soils of this association are moderately to slowly permeable and are well drained. Surface runoff is slow. Water tables are generally deep.

The Laredo, clayey variant soils have a surface layer of dark grayish brown, calcareous silty clay. The subsoil is a firm, but crumbly, silty clay. Laredo, clayey variant soils occupy about 65 percent of this association.

Other soils within this association are Laredo, 25 percent and Harlingen, 10 percent. Laredo soils have a calcareous silty clay loam surface layer with a friable silt loam subsoil. Harlingen soils are brownish, calcareous clay several feet thick having high shrink-swell properties. The soils of this association are used almost entirely for irrigated cropland. The major crops are cotton, grain sorghum, and winter vegetables. This association has a medium potential for crop production for many of the major crops common to this area.

Laredo-Laredo, clayey variant association (LO)

This association comprises 117,738 acres of gently sloping silty clay loam, nearly level silty clay loam, and nearly level silty clay associated with resacas on recent terrace of the Rio Grande. The soils are moderately to slowly permeable and are well drained. Surface runoff is slow to very slow.

The areas most severely affected by salt occur near the resacas. The Laredo soils have a surface layer of dark grayish brown, calcareous silty clay loam. The subsoil is a friable, light colored silt loam with weak stratification within 50 inches of the surface. Laredo soils occupy about 60 percent of this association.

The Laredo, clayey variant soils have a surface layer of dark grayish brown, calcareous silty clay. The subsoil is a firm, but crumbly, light colored silty clay. Laredo, clayey variant soils occupy about 25 percent of this association.

Other soils within this association are Cameron, 8 percent and Harlingen 7 percent. Cameron soils have a dark colored, calcareous silty clay surface layer with loamy subsoil within 20 to 36 inches of the surface. Harlingen soils are brownish, calcareous clay several feet thick having high shrink-swell properties.

The soils in this association are used almost entirely for irrigated cropland. The major crops are cotton, grain sorghum, and winter vegetables. Citrus is adapted to the Laredo soils. This association has a high potential for crop production for most of the major crops common to this area.

Reynosa-Reynosa, clayey variant association (RR)

This association occurs in southwestern Hidalgo County and comprises 22,300 acres of light colored, gently sloping clay loam and nearly level silty clay in association with resacas on a recent terrace of the Rio Grande. The soils are moderately to slowly permeable and are well drained. Runoff is slow.

The Reynosa soils have a surface layer of calcareous, grayish brown silty clay loam. The subsoil is a friable, light colored silty clay loam or silt loam. Reynosa soils occupy about 45 percent of this association.

The Reynosa, clayey variant soils have a surface layer of calcareous brown silty clay. The subsoil is a firm, but crumbly, light colored silty clay. Reynosa, clayey variant soils occupy about 35 percent of this association.

Other soils within this association are Lagloria, 15 percent and Harlingen, 5 percent. Lagloria soils have a calcareous, light colored silt loam surface layer with a friable very fine sandy loam subsoil. Harlingen soils are brownish, calcareous clay several feet thick having high shrink-swell properties.

The soils of this association are utilized almost entirely for irrigated cropland. The major crops are cotton and winter vegetables. This association has a high potential for crop production for many of the major crops common to this area.

Rio Grande-Camargo association (RC)

This association comprises 72,602 acres of youthful stratified silty sediments occupying the present flood plain of the Rio Grande. The soils of this association are moderately permeable and are well drained. Runoff is slow. Water tables are deep and soil salinity is low.

The Rio Grande soils have a surface layer of calcareous, light brownish gray silt loam. The subsoil consists of stratified, silty sediments averaging a silt loam or very fine sandy loam. Rio Grande soils occupy about 45 percent of this association.

The Camargo soils have a surface layer of calcareous, light brownish gray loam and silty clay loam. The subsoil consists of stratified, silty sediments averaging a silty clay loam. Camargo soils occupy about 35 percent of this association.

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Other soils within this association are Matamoros, 11 percent; Grulla, 4 percent; and Zalla, 5 percent. Matamoros soils are calcareous, silty clay containing stratified, silty sediments, and average a silty clay. Grulla soils are poorly drained, calcareous clay and occupy resacas. Zalla soils are deep, calcareous, sandy sediments.

The soils of this association are used almost entirely for irrigated cropland. Winter vegetables, cotton, and grain sorghum are the major crops grown. This association has a high potential for crop production for most of the major crops common to this area.

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Level moderately and slowly permeable soils of uplands

Argiustolls, Haplustolls, Pellusterts

Delfina-Ramadero association	(DR)
Hidalgo, nearly level association	(HL)
Hidalgo-Raymondville association	(HR)
Raymondville association	(R)
Raymondville-Montell association	(RM)
Raymondville-Orelia, sodic variant association	(RN)
Willacy-Ramadero association	(WR)
Willacy-Raymondville association	(WV)

Delfina-Ramadero association (DR)

This association consists of 29,145 acres of gently sloping fine sandy loam and nearly level loam and clay loam with a few long, narrow depressions or old meanders of wet, saline soils. The soils are slowly to moderately permeable and moderately well to well drained. Surface runoff is slow. Seasonal water tables, 2 to 6 feet below the surface, are common in the soils of this association.

The Delfina soils have a surface layer of grayish brown, noncalcareous fine sandy loam less than 20 inches thick. The subsoil is a firm, distinctly mottled, blocky sandy clay loam. Delfina soils occupy about 35 percent of this association.

The Ramadero soils have a surface layer of dark gray, noncalcareous loam. The subsoil is a firm blocky sandy clay loam. Ramadero soils occupy about 35 percent of this association.

Other soils within this association are Raymondville, 8 percent; Hidalgo, 5 percent; Orelia, sodic variant, 9 percent; and Willacy, 7 percent. Raymondville soils have a dark, gray calcareous clay loam surface with a firm, but crumbly, clay loam or light clay subsoil. Hidalgo soils have a dark grayish brown, calcareous sandy clay loam surface with a friable sandy clay loam subsoil. Orelia, sodic variant soils have a thin surfaced, noncalcareous, saline fine sandy loam surface layer with a compact clay loam subsoil. Willacy soils have a dark grayish brown, noncalcareous fine sandy loam surface with a very friable sandy clay loam subsoil and are leached of carbonates to depths of at least 34 inches.

Practically all of this association is used for irrigated cropland. The major crops are cotton, grain sorghum, and winter vegetables. A small acreage is planted to citrus. About 15 percent is dry cropland. This association has a medium potential for crop production for most of the major crops common to this area.

Hidalgo, nearly level association (HL)

A smooth, broad plain of calcareous, nearly level sandy clay loam make up this association. Ground surfaces mainly are plane. These soils are moderately permeable and are mostly well drained. Surface runoff is slow. This association occurs on 70,900 acres.

The Hidalgo soils have a surface layer of dark grayish brown, calcareous sandy clay loam. The subsoil is a friable, light colored sandy clay loam. Hidalgo soils occupy about 75 percent of this association.

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Other soils within this association are Raymondville soils, 10 percent, and gently sloping Hidalgo fine sandy loam, 15 percent. Raymondville soils have a calcareous clay loam surface layer, and a firm, but crumbly, clay loam or clay subsoil. The gently sloping Hidalgo soils have a calcareous fine sandy loam surface layer, and a friable, sandy clay loam subsoil.

About 90 percent of the soils in this association are used for irrigated cropland. Citrus, winter vegetables, cotton, and grain sorghum are the major crops grown. This association has a high potential for crop production for most of the major crops common to this area.

Hidalgo-Raymondville association (HR)

This association consists of 50,405 acres of nearly level sandy clay loam and level to slightly depressed clay loam. A few areas of gently sloping fine sandy loam occur along the southern edge. The soils are moderately to slowly permeable and surface runoff is medium to slow.

The Hidalgo soils have a surface layer of dark grayish brown, calcareous sandy clay loam and fine sandy loam. The subsoil is a friable, light colored sandy clay loam. Hidalgo soils occupy about 40 percent of this association.

The Raymondville soils have a surface layer of dark gray calcareous clay loam. The subsoil is a firm, but crumbly, clay loam or light clay. Raymondville soils occupy about 40 percent of this association.

Other soils within this association are Willacy, 12 percent; Ramadero, 7 percent; and Tiocano, 1 percent. Willacy soils have a noncalcareous fine sandy loam surface layer with a friable, light sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil. Tiocano soils are deep, dark colored, poorly drained clay occurring in small, enclosed depressions.

The soils in this association are used maily for irrigated cropland. Citrus, cotton, and grain sorghum are the main crops grown. Because of seasonally high-water tables which develop when these soils are irrigated, citrus is not well adapted to the Raymondville soils.

This association has a high potential for crop production for most of the major crops common to this area.

Raymondville association (R)

This association comprises a level or nearly level area of dark gray clay loam. Surfaces generally are plane, but some are slightly concave or convex. The soils are slowly permeable and mostly well drained, and occur on about 113,992 acres. Runoff is slow to very slow.

They lack adequate surface drainage. Seasonal water tables occur 2 to 10 feet below the surface when irrigated.

The Raymondville soils have a surface layer of calcareous, dark gray clay loam. The subsoil is a firm, but crumbly clay loam or clay. Raymondville soils occupy about 70 percent of this association.

Other soils within this association are Hidalgo, 15 percent; Willacy, 10 percent; and Ramadero, 5 percent. Hidalgo soils have a calcareous sandy clay loam surface layer with a friable sandy clay loam subsoil. Willacy soils have a noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil.

The soils in this association are utilized for dry and irrigated cropland. The major crops grown are cotton, grain sorghum, and winter vegetables. Onions are the major vegetable crop. This association has a medium potential for crop production for many of the major crops common to this area.

Raymondville-Montell association (RM)

This association consists of 30,298 acres of nearly level clay loam and slightly depressed clay. The soils of this association are slowly to very slowly permeable and are well drained. Runoff is slow to very slow.

Seasonal water tables, 2 to 6 feet below the surface, occur in some parts of this area.

The Raymondville soils have a surface layer of dark gray, calcareous clay loam. The subsoil is a firm, but crumbly clay loam or clay. Raymondville soils occupy about 50 percent of this association.

The Montell soils have a surface layer of gray, calcareous clay several feet deep and have a high-shrink-swell properties. Montell soils occupy about 30 percent of this association.

Other soils within this association are Hidalgo, 15 percent and Willacy, 5 percent. Hidalgo soils have a calcareous sandy clay loam surface layer with a friable sandy clay loam subsoil. Willacy soils have a noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil.

The soils in this association are utilized for irrigated and dry cropland. The major crops are cotton and grain sorghum. This association lacks adequate surface drainage, and water generally ponds on it for several days following heavy rains. This association has a medium potential for crop production for many of the major crops common to this area.

Raymondville-Orelia, sodic variant association (RN)

This association occurs on 65,000 acres in the eastcentral part of Willacy County and consists of gently sloping fine sandy loam and sandy clay loam with level or slightly depressed clay loam. Numerous small, enclosed depressions occur throughout the association. Seasonally high-water tables and moderate to severe salinity affect a dominant part of this association. The soils are slowly to moderately slowly permeable and are well drained to poorly drained. Runoff is slow to very slow.

The Raymondville soils have a surface layer of dark gray, calcareous clay loam. The subsoil is a firm, but crumbly clay loam or clay. Raymondville soils occupy about 45 percent of this association.

The Orelia, sodic variant soils have a thin surface layer of grayish brown, noncalcareous sandy clay loam and fine sandy loam. The subsoil is a compact sandy clay loam. They are high in exchangeable sodium, and have secondary carbonates at depths of less than 24 inches. Orelia, sodic variant soils occupy about 35 percent of this association.

Other soils within this association are Willacy, 12 percent; Ramadero, 6 percent; and Tiocano, 2 percent. Willacy soils have a noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil. Tiocano soils are dark colored, poorly drained clay occurring in small enclosed depressions.

The soils in this association are used primarily for dry cropland. The major crops are cotton and grain sorghum. A small acreage is irrigated. This association has a low potential for crop production for a few of the major crops common to this area. Low rainfall and soil salinity are the major factors limiting production.

Willacy-Ramadero association (WR)

This association comprises 48,980 acres of gently sloping fine sandy loam and nearly level loam occupying narrow drains. The soils of this association are moderately permeable and well drained. Runoff is slow to very slow.

The Willacy soils have a surface layer of noncalcareous, dark grayish brown fine sandy loam. The subsoil is a friable, light sandy clay loam and is leached of carbonates to depths of at least 34 inches. Willacy soils occupy about 40 percent of this association.

The Ramadero soils have a surface layer of dark gray, non-calcareous loam. The subsoil is a firm, blocky sandy clay loam. Ramadero soils occupy about 30 percent of this association.

Other soils within this association are Hidalgo, 15 percent and Raymondville, 15 percent. Hidalgo soils have a calcareous sandy clay loam surface layer with a friable sandy clay loam subsoil. Raymondville soils have a calcareous clay loam surface layer with a firm, but crumbly clayey subsoil.

The soils in this association are used for irrigated and dry cropland. The principal irrigated crops are citrus, cotton, and winter vegetables. Grain sorghum and cotton are the major dryland crops. This association has a high potential for crop production for most of the major crops common to this area.

Willacy-Raymondville association (WV)

This association consists of 90,970 acres of gently sloping fine sandy loam and nearly level clay loam in the southcentral part of Willacy County. Willacy soils are moderately permeable and well drained. Raymondville soils are slowly permeable and generally lack adequate surface drainage. Surface runoff is slow to very slow.

The Willacy soils have a surface layer of noncalcareous, dark grayish brown fine sandy loam. The subsoil is a friable, light sandy clay and is leached of carbonates to depths of at least 34 inches. Willacy soils occupy about 45 percent of this association.

The Raymondville soils have a surface layer of calcareous, dark gray clay loam. The subsoil is a firm, but crumbly, clay loam or clay. Raymondville soils occupy about 35 percent of this association.

Other soils within this association are Hidalgo, 15 percent and Ramadero, 5 percent. Hidalgo soils have a calcareous sandy clay loam surface layer with a friable sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil.

The soils in this association are used primarily for dry cropland. Cotton, grain sorghum, and onions are the major crops.

This association has a medium potential for crop production for many of the major crops common to this area.

Gently sloping moderately permeable loamy soils of uplands

Argiustolls, Haplustalfs, Haplustolls, Paleustalfs, Ustochrepts

Delmita association	(D)
Hidalgo-Brennan association	(HB)
Hidalgo, gently sloping association	(HG)
McAllen association	(MC)
McAllen-Brennan association	(MB)
Willacy-Delfina association	(WD)
Willacy-Hidalgo association	(WH)

Delmita association (D) 1/

This association consists of 83,500 acres of reddish colored, moderately deep to shallow soils over thick beds of indurated caliche. There are numerous small, enclosed depressions throughout the association. The soils are moderately permeable and well drained. Surface runoff is medium to slow. Soil salinity is low.

The Delmita soils have a surface layer of reddish brown, noncalcareous fine sandy loam and loamy fine sand. The subsoil is a friable sandy clay loam. They have thick beds of indurated caliche beginning 20 to 48 inches below the surface. Delmita soils occupy about 75 percent of the association.

Other soils within this association are Comitas, 13 percent; Nueces, 5 percent; Brennan, 5 percent; and Tiocano, 2 percent. Comitas soils have a deep loamy fine sand surface layer and a slightly more clayey subsoil. Nueces soils have a fine sand surface layer 20 to 40 inches in thickness over a compact, mottled sandy clay loam subsoil. The Brennan soils have a surface layer of grayish brown fine sandy loam with a friable sandy clay loam subsoil and are leached of carbonates to depths of 20 to 28 inches. Tiocano soils are deep, dark colored, poorly drained clays occupying small, enclosed depressions.

The soils in this association are used primarily for rangeland. The native vegetation consists of trichloris, bristlegrass, lovegrass tridens, and tanglehead with a brushy overstory of mesquite, spiney hackberry, and Texas ebony. About 15 percent of the area is dry farmed. This association has a low potential for crop production for a few of the major crops common to this area. Cotton and grain sorghum are the major crops grown. Wind erosion is a moderate hazard.

Hidalgo-Brennan association (HB)

This association consists of 76,300 acres of level to gently sloping fine sandy loam and sandy clay loam having moderately permeable subsoil. A few small, enclosed depressions and minor drains occur in this association. Surface runoff is slow to medium.

The Hidalgo soils have a surface layer of dark grayish brown, calcareous fine sandy loam and sandy clay loam. The subsoil is a friable, light-colored sandy clay loam. Hidalgo soils occupy about 50 percent of this association.

1/ The Delmita series will be reactivated during the correlation process of a county survey.

The Brennan soils have a surface layer of grayish brown, noncalcareous fine sandy loam. The subsoil is a friable sandy clay loam. Free carbonates occur at depths of 20 to 28 inches. Brennan soils occupy about 35 percent of this association.

Other soils within this association are Delmita, 8 percent; Tiocano, 2 percent; Rio, 3 percent; and Comitas, 2 percent. Delmita soils are reddish, noncalcareous, moderately permeable fine sandy loam underlain by indurated caliche. Tiocano soils are dark colored, poorly drained clay occurring in small, enclosed depressions. Rio soils are dark colored, noncalcareous slowly permeable clay loam occurring in minor drains or depressions. Comitas soils are brown, noncalcareous loamy fine sand occurring on low ridges or mounds.

The soils in this association are used mainly for irrigated cropland and comprise one of the main citrus producing areas of the Lower Rio Grande Valley. Other irrigated crops are cotton, grain sorghum, and winter vegetables. About 10 percent of the association is dry farmed to cotton and grain sorghum. A small acreage is utilized as native range.

This association has a high potential for crop production for most of the major crops common to this area.

Hidalgo, gently sloping association (HG)

Eighty-one thousand acres of gently sloping and gently undulating calcareous fine sandy loam make up this association. These soils are moderately permeable and well drained. Surface runoff is slow to medium.

The Hidalgo soils have a surface layer of dark grayish brown, calcareous fine sandy loam. The subsoil is a friable, light colored sandy clay loam. Hidalgo soils occupy about 75 percent of this association.

Other soils within this association are Brennan, 10 percent; Comitas, 5 percent; and the nearly level Hidalgo sandy clay loam, 10 percent. Brennan soils have a noncalcareous, grayish brown fine sandy loam surface layer with a friable sandy clay loam subsoil and is leached of carbonates to depths of 20 to 28 inches. Comitas soils have noncalcareous, loamy fine sandy surface layer with a fine sandy loam subsoil. The nearly level Hidalgo soils have a calcareous, sandy clay loam surface layer with a friable, sandy clay loam subsoil.

The soils in this association are used mainly for irrigated cropland. The major crops grown are citrus, cotton, grain sorghum, and winter vegetables. This association has a high potential for crop production for most of the major crops common to this area.

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McAllen association (MC)

This association occurs in the western part of Hidalgo County and comprises about 6,400 acres of mostly nearly level sandy clay loam. This area represents an old terrace of the Rio Grande. Along the southern boundary, the soils are fine sandy loam and are strongly sloping. The soils of this association are moderately permeable and well drained. Runoff is slow to medium. Water tables are generally deep and salinity is low.

The McAllen soils have a surface layer of light brownish gray, calcareous sandy clay loam and fine sandy loam. The subsoil is a friable sandy clay loam. McAllen soils occupy about 80 percent of this association.

Other soils within this association are Hidalgo, 15 percent and Brennan, 5 percent. Hidalgo soils have a dark colored, calcareous, sandy clay loam surface layer with a friable sandy clay subsoil. Brennan soils have a noncalcareous, fine sandy loam surface layer with a friable sandy clay loam subsoil and are leached of carbonates to depths of 20 to 28 inches.

The soils in this association are used mainly for dry and irrigated cropland and pasture. Cotton, grain sorghum, and winter vegetables are the major crops grown. About 30 percent of the acreage is utilized for native range. This association has a high potential for crop production for most of the major crops common to this area. Low rainfall, in most years, limits production in dryland areas.

McAllen-Brennan association (MB)

This association comprises 138,360 acres of nearly level to gently sloping fine sandy loam with numerous small, enclosed depressions. Many of the depressions are connected by narrow drains. Runoff is slow to medium. Water tables are deep and salinity is low.

The McAllen soils have a surface layer of light brownish gray, calcareous fine sandy loam. The subsoil is a friable, sandy clay loam. McAllen soils occupy about 45 percent of this association.

The Brennan soils have a surface layer of grayish brown, noncalcareous fine sandy loam. The subsoil is a friable sandy clay loam. They are leached of carbonates to depths of 24 to 34 inches. Brennan soils occupy about 40 percent of this association.

Other soils within this association are Delmitas, 10 percent; Tiocano, 3 percent; and Rio,2 percent. Delmita soils are reddish, noncalcareous fine sandy loam underlain with indurated caliche at depths of 20 to 48 inches. Tiocano soils are dark colored, poorly drained clay occurring in small enclosed depressions. Rio soils have a noncalcareous, clay loam surface soil with a firm, more clayey subsoil.

The soils in this association are used primarily for dry cropland. A small acreage is irrigated. About 25 percent of this association is native range which supports a dense cover of mesquite, prickly pear, and mid grasses. This association has a medium potential for crop production for a few of the major crops common to this area. Cotton and grain sorghum are the major crops. The factor limiting production in most years is low rainfall.

Willacy-Delfina association (WD)

This association comprises 59,600 acres of gently sloping to undulating fine sandy loam with numerous small, enclosed depressions and narrow drains. The soils are moderately to slowly permeable and are well drained. Runoff is slow.

The soils in areas near salt lakes differ from the typical by having appreciable sodium in the lower subsoil.

The Willacy soils have a surface layer of noncalcareous, dark grayish brown fine sandy loam. The subsoil is a friable, light sandy clay loam and is leached of carbonates to depths of at least 34 inches. Willacy soils occupy 40 percent of this association.

The Delfina soils have a surface layer of noncalcareous, dark grayish brown fine sandy loam about 15 inches thick. The subsoil is a firm, distinctly mottled, blocky sandy clay loam. Delfina soils occupy about 25 percent of this association.

Other soils within this association are Orelia, sodic variant, 15 percent; Ramadero, 6 percent; Runge, 9 percent; Rio, 2 percent; and Tiocano, 3 percent. Orelia, sodic variant soils have a thin surfaced, noncalcareous, saline sandy clay loam or fine sandy loam surface layer with a compact clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil. Runge soils are noncalcareous fine sandy loam with reddish sandy clay loam subsoils. Rio soils are dark colored, noncalcareous, slowly permeable clay loam occurring in minor drains or depressions. Tiocano soils are dark colored, poorly drained clay occurring in small, enclosed depressions.

The soils in this association are used mainly for irrigated and dry cropland. Citrus, cotton, and grain sorghum are the major irrigated crops. Dryland crops are cotton, grain sorghum, and peas. About 5 percent of this association is native rangeland. Vegetation consists of a dense stand of mesquite, chaparral brush, and prickly pear with mid and short grasses. This association has a high potential for crop production for most of the major crops common to this area.

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Low rainfall limits dryland production in most years. Narrow drains and enclosed depressions form the drainage of this association and contain water for several days or months following heavy rains.

Willacy-Hidalgo association (WH)

This association consists of 96,020 acres of nearly level to gently sloping fine sandy loam in the west central part of Hidalgo County. The soils are moderately permeable and well drained. Runoff is slow.

The Willacy soils have a surface layer of noncalcareous, dark grayish brown fine sandy loam. The subsoil is a friable, sandy clay loam and is leached of carbonates to depths of at least 34 inches. Willacy soils occupy about 40 percent of this association.

The Hidalgo soils have a surface layer of calcareous, dark grayish brown fine sandy loam. The subsoil is a friable, light colored sandy clay loam. Hidalgo soils occupy about 40 percent of this association.

Other soils within this association are Delfina, 6 percent; Ramadero, 4 percent; and Brennan, 10 percent. Delfina soils have a noncalcareous fine sandy loam surface layer with a blocky, mottled sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil. Brennan soils have a noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil and are leached of carbonates to depths of 20 to 34 inches.

The soils in this association are used primarily for irrigated and dry cropland. Cotton, winter vegetables, and grain sorghum are the major crops. A small acreage is planted to citrus. About 30 percent is native rangeland. Vegetation consists of a dense stand of mesquite, prickly pear, and chaparral brush with mid and short grasses. This association has a high potential for crop production for most of the major crops common to this area.

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Gently sloping sandy soils of uplands

Haplustalfs, Paleustalfs, Ustipsamments

Comitas association	(C)
Comitas-Delmita association	(CD)
Duneland association	(DU)
Nueces-Sarita association	(NS)
Sarita-Falfurrias association	(SF)

Comitas association (C)

This association consists of a series of low dunes or hummocks with a northwest-southeast axial alignment and occurs on about 3,920 acres. The surfaces are dune-like with slopes ranging from 1 to 8 percent. The low dunes rise 5 to 15 feet above the surrounding topography. The soils are rapidly permeable and well drained. The sandy textures cause surface runoff to be slow to very slow as most of the water enters the soil. The water tables are generally deep and soil salinity is low.

The Comitas soils have a surface layer of brown, noncalcareous loamy fine sand. The subsoil is slightly less sandy and extends to depths of at least 60 inches. Comitas soils occupy about 75 percent of this association.

Other soils within this association are Delmita, 10 percent and Brennan, 15 percent. Delmita soils have a surface layer of reddish-brown, noncalcareous fine sandy loam and loamy fine sand with friable sandy clay loam subsoil. They are underlain with indurated caliche at 20 to 48 inches below the surface. Brennan soils have a surface layer of grayish-brown, noncalcareous fine sandy loam with friable sandy clay loam subsoil. They are leached of carbonates to depths of 20 to 34 inches.

This association has three distinct land uses. The area occurring north of Mercedes is used primarily for citrus production and comprises about 15 percent of the total acreage of the association. The area northeast of Edinburg is used primarily for irrigated pasture, consisting mainly of coastal bermudagrass, African stargrass, and buffelgrass. The area northeast of McCook is used entirely for rangeland, and comprises about 30 percent of the acreage. This association has a medium potential for crop production when irrigated for a few of the major crops common to this area. Factors limiting production are low water and fertility holding capacities. These soils have a severe wind erosion hazard.

Comitas-Delmita association (CD)

This association consists of 18,700 acres of deep, brownish to reddish colored, moderately sandy soils that are hummocky to nearly level. The low dunes or hummocks occur mostly on an axial alignment of northwest-southeast and rise 5 to 15 feet above the surrounding topography. These soils are moderately to rapidly permeable and are well drained. Surface runoff is medium to slow as most of the water enters the soils. The water table is deep and soil salinity is low.

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The Comitas soils have a surface layer of brown, noncalcareous loamy fine sand. The subsoil is slightly less sandy and extends to depths of at least 60 inches. Comitas soils occupy about 60 percent of this association.

The Delmita soils have a surface layer of reddish brown, noncalcareous fine sandy loam and loamy fine sand. The subsoil is a friable sandy clay loam. They have thick beds of indurated caliche 20 to 48 inches below the surface. Delmita soils occupy about 30 percent of this association.

Other soils within this association are Brennan, 6 percent; McAllen, 3 percent; and Tiocano, 1 percent. Brennan and McAllen soils occur on gently sloping areas within this association. Brennan soils have a surface layer of grayish brown, noncalcareous fine loam with a friable sandy clay loam subsoil. They are leached of carbonates to depths of 20 to 28 inches. McAllen soils have a surface layer of light brownish gray, calcareous fine sandy loam with a friable sandy clay loam subsoil. Tiocano soils occur in small, enclosed depressions and are deep, dark colored poorly drained clay.

This association is used mainly for rangeland. The native vegetation consists of midgrasses with a brushy overstory of mesquite, spiny hackberry and Texas ebony trees. About 5 percent of the association is dry farmed and 5 percent is irrigated. This association has a low potential for crop production for a few of the major crops common to this area. Cotton and grain sorghum are the major crops grown. Low rainfall is the factor which limits production in most years. These soils have a high wind erosion hazard when left bare and unprotected.

Duneland association (DU)

This association consists of 6,400 acres of sand dunes rising 15 to 40 feet above the surrounding area and have a generally northwest-southeast axial alignment. Most of the dunes are stabilized, but about 5 percent are active.

Duneland consists of deep, neutral to slightly acid, pale brown, loose sand. These areas are excessively drained and the permeability is very rapid. Duneland occupies about 80 percent of this association.

Soils within this association are Falfurrias, 10 percent; Sarita, 6 percent; and Nueces, 4 percent. Falfurrias soils are fine sand at least 60 inches in depth. Sarita soils have a fine sand surface layer 40 to 60 inches thick over a compact, mottled sandy clay loam subsoil. Nueces soils have a fine sand surface layer 20 to 40 inches thick over compact, mottled sandy clay loam subsoil.

This association is utilized entirely for range. The control of wind erosion is the major problem. The major stabilizing vegetation is gulfdune Paspalum. These dunes present a serious problem because of the difficulty of establishing vegetation on them. The active dunes require specialized treatment. This association has a very low potential for production of usable forage.

Nueces-Sarita association (NS)

This association consists of 30,200 acres of moderately deep sand on nearly level topography in the northern part of Hidalgo County. The Sarita soils of this association are moderately permeable and are excessively drained. The Nueces soils are slowly permeable and moderately well drained.

The Nueces soils have a surface layer of pale brown, noncalcareous fine sand. The subsoil is a compact, mottled sandy clay loam and begins 20 to 40 inches below the surface. Nueces soils occupy about 40 percent of this association.

The Sarita soils have a surface layer of pale brown, noncalcareous fine sand. The subsoil is a mottled sandy clay loam and begins 40 to 60 inches below the surface. Sarita soils occupy about 40 percent of this association.

Other soils within this association are Falfurrias, 10 percent, and Delmita, 10 percent. Falfurrias soils are fine sands deeper than 60 inches. Delmita soils are reddish loamy fine sands with friable sandy clay loam subsoils and are underlain with indurated caliche beginning at 20 to 48 inches below the surface.

The soils in this association are used almost entirely for rangeland. Vegetation consists of scattered to moderately thick stands of large mesquite trees with mid and tall grasses.

Sarita-Falfurrias association (SF)

This association consists of 182,328 acres of deep sands on nearly level and hummocky topography in the northern part of Hidalgo and Willacy Counties. The soils of this association are moderately to rapidly permeable and are somewhat excessively drained. Runoff is very slow because most of the water enters the soil. Water tables are deep and soil salinity is low.

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The Sarita soils have a surface layer of pale brown, noncalcareous fine sand. The subsoil is a mottled sandy clay loam and begins 40 to 60 inches below the surface. Sarita soils occupy about 50 percent of this association.

The Falfurrias soils have a surface layer of pale brown, noncalcareous fine sand 60 inches or more in depth. Falfurrias soils occupy about 40 percent of this association.

Other soils within this association are Nueces, 7 percent; and the land type, Duneland, 3 percent. The Nueces soils have a fine sand surface layer 20 to 40 inches thick over compact, mottled sandy clay loam subsoil. The Duneland consists of semistable to active sand dunes rising 15 to 40 feet above the surrounding topography.

The soils in this association are used entirely for native rangeland. Vegetation consists of a thin stand of scattered large mesquite trees with mid and tall grasses. This association is extremely susceptible to wind erosion if left unprotected. Total forage production is low.

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Level, very slowly permeable, high shrink-swell clayey soils

Chromusterts, Pellusterts

Harlingen association	(H)
Harlingen-Montell association	(HM)
Montell association	(M)

Harlingen association (H)

This association consists of 85,860 acres of broad, level areas of clay soils broken only by an occasional slight depressional drainageway. The soils are very slowly permeable and surface runoff is very slow. Water tables are generally below 5 feet.

The Harlingen soils have a surface layer of grayish brown, calcareous clay. The subsoils are brown clay extending several feet and have high shrink-swell properties. Harlingen soils occupy about 75 percent of this association.

Other soils within this association are Laredo, clayey variant, 20 percent, and Montell, saline, 5 percent. Laredo, clayey variant soils have firm, but crumbly silty clay subsoil. Montell, saline soils have a surface layer of gray, calcareous clay with gray clay subsoil extending several feet.

The soils in this association are used mainly for irrigated cropland. The major crops are cotton, grain sorghum, and winter vegetables. This association has a slight to moderate salinity hazard. Adequate surface drainage is lacking on this association. This association has a medium potential for crop production for most of the major crops common to this area.

Harlingen-Montell, saline association (HM)

This association consists of 56,376 acres of level and slightly depressed clay that lack adequate surface drainage. These areas are usually flooded for several days following heavy rains. The soils are moderately to severely saline. They are very slowly permeable and surface runoff is very slow to ponded. The water table is generally below 5 feet.

The Harlingen soils have a surface layer of grayish brown, calcareous clay. The subsoils are brown clay extending several feet deep and have high shrink-swell properties. Harlingen soils occupy about 40 percent of the association.

The Montell soils have a surface layer of gray, calcareous clay. The subsoils are gray clay extending several feet and have high shrink-swell properties. Montell soils occupy about 40 percent of the association.

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Other soils within this association are Laredo, clayey variant, 12 percent; Laredo, 4 percent; and Cameron, 4 percent. Laredo, clayey variant soils have a surface layer of dark grayish brown, calcareous silty clay with firm, but crumbly silty clay subsoil. Laredo soils have a surface layer of dark grayish brown, calcareous silty clay loam with friable silt loam subsoil.

Cameron soils have a surface layer of dark grayish brown, calcareous silty clay with loamy subsoil within 20 to 36 inches of the surface.

The soils in this association are used mainly for irrigated cotton and grain sorghum. About 20 percent of the area is utilized as irrigated pasture. Adapted grasses are Angleton grass, African stargrass, and coastal bermudagrass. This association has a low potential for crop production for a few of the major crops common to this area. Crop selection is restricted to medium or high salt-tolerant crops. Yields are generally low in most years.

Montell association (M)

This association is a 37,220 acre level plain of dark gray clay occurring north of the Arroyo Colorado between Harlingen and Rio Hondo. The soils near the Arroyo are gently sloping due to shallow drains extending from the Arroyo into the level plain. The soils are slowly permeable and are mostly moderately well drained to well drained. Runoff is slow to very slow. A high percentage of this association lacks adequate surface drainage. Water tables are deep and salinity is low to moderate.

The Montell soils have a surface layer of gray, calcareous clay. The subsoils are gray clay extending several feet deep and have high shrink-swell properties. Montell soils occupy about 85 percent of this association.

Other soils within this association are Raymondville, 10 percent and Hidalgo, 5 percent. Raymondville soils have a calcareous clay loam surface layer with a firm, but crumbly, more clayey subsoil. Hidalgo soils have a calcareous sandy clay loam surface layer with a friable sandy loam subsoil.

The soils in this association are utilized for both irrigated and dry cropland. The major crop is grain sorghum. A smaller acreage of cotton and winter vegetables is grown on these soils. This association has a medium potential for crop production for many of the major crops common to this area.

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Level and gently sloping soils of coastal areas

Camborthids, Pellusterts

Coastal Dune-Tidal Flat association	(CT)
Lomalta-Lomalta, loamy variant association	(LP)
Point Isabel association	(P)
Lomalta, loamy variant-Tidal Flat association	(PT)

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Coastal Dune-Tidal Flat association (CT)

This association occurs on 15,954 acres of Padre Island and Boca Chica along the eastern Gulf Coast. This area consists of active to semi-stable windblown sand ranging up to about 30 feet above sea level on the gulf side of the islands. Sandy Tidal Flats occur about 2 to 5 feet above mean high tide and extend from the dunes westward to the Laguna Madre.

Coastal Dune consists of very pale brown sand several feet thick. Coastal Dune accounts for about 25 percent of the association.

Tidal Flat consists of recent, light colored, saline sand that are somewhat stratified with darker colored sandy loam. Saline or brackish ground-water tables range from a few inches to about 2 feet below the surface. Tidal Flat accounts for about 60 percent of the area.

Minor parts of this association consist of Mustang fine sand, 7 percent; Galveston fine sand, 4 percent; and Beach, 4 percent.

The soils in this association are not cultivated. It is, however, one of the most important associations of the area from the standpoint of present and potential use for recreation.

Lomalta-Lomalta, loamy variant association (LP)

This association is comprised of 12,913 acres of level to slightly depressed, saline clay and loamy soil having shallow-water tables. Mud flats, with clay dunes rising 20 to 30 feet above sea level along their northwestern edge, occur along the eastern part of the area occupied by the association. The soils are poorly drained.

The Lomalta soils have a surface layer of gray, calcareous clay. The subsoil is plastic, mottled clay. They are saline, sodic and continuously moist below 24 inches. Lomalta soils occupy about 40 percent of this association.

The Lomalta, loamy variant soils have a surface layer of grayish brown, calcareous silty clay loam. The subsoils are mottled, stratified loamy materials. They are saline, sodic, and have water tables at depths of less than 48 inches. Lomalta, loamy variant soils occupy about 40 percent of this association.

Other soils within this association are Point Isabel, 10 percent and Mud Flats, 10 percent. Point Isabel soils are calcareous clay loam with firm, more clayey subsoil containing strata of less clayey material. Mud Flats consist of saline, clayey tidal flats generally a few inches above mean high tide.

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The soils in this association are used entirely for rangeland. Forage yield is very low. Vegetation consists of Gulf cordgrass, bushy sea-ox-eye, seashore saltgrass, and pickleweed. The better drained and less saline clay dunes support the greatest amount of palatable forage.

Point Isabel association (P)

This association comprises 3,038 acres of low ridges and clay dunes. These ridges and dunes rise 10 to 40 feet above sea level along the lower Gulf Coast. The soils of this association are moderately permeable and well drained. Runoff is rapid. They are moderately to severely saline.

The Point Isabel soils have a surface layer of calcareous, light brownish gray clay loam. The subsoil is firm and more clayey, containing thin strata of less clayey, slightly darker material. Point Isabel soils occupy about 75 percent of this association.

Other soils within this association are Lomalta, 15 percent and Lomalta, loamy variant, 10 percent. Lomalta soils have a saline, poorly drained clay surface layer with a plastic, mottled subsoil. Lomalta, loamy variant soils are light colored, loamy soils that are severely saline and have water tables at 1 to 4 feet below the surface.

The soils in this association are used entirely for rangeland. Vegetation consists of chaparral brush, yuccas, sacaton, four-flowered trichloris, and bristlegrass. Total forage production is low.

Lomalta, loamy variant-Tidal Flat association (PT)

This association comprises 80,932 acres of level to depressed loamy soils at or near sea level and Tidal Flats that are subject to inundation by high tides. The level topography is broken by numerous clay dunes rising 10 to 40 feet above the surrounding soils. The areas are poorly to very poorly drained and have water tables 1 to 4 feet below the surface.

The Lomalta, loamy variant soils have a surface layer of grayish brown, calcareous silty clay loam. The subsoils are light colored, mottled, stratified loamy materials. They are saline, sodic and have water tables at less than 48 inches. Lomalta, loamy variant soils occupy about 40 percent of this association.

Tidal Flats are barren, nearly level areas of varying textures. They are subject to inundation by high tides. When dry, these areas form a saline crust which is detached by strong southeast winds, and the salty material blows onto nearby soils and vegetation causing considerable damage. Tidal Flats occupy about 40 percent of this association.

Other soils within this association are Point Isabel, 15 percent and Lomalta, 5 percent. Point Isabel soils have a calcareous clay loam surface layer with a firm, more clayey subsoil containing strata of loamy materials. Lomalta soils have a saline, wet clay surface layer with plastic, mottled subsoil.

The soils in this association are used entirely for native range. Forage yield is very low. Vegetation consists of pickleweed and shoregrass. The clay dunes support the greatest amount of usable forage.

Saline soils

Haplustolls, Pellusterts

Laredo, saline-Lomalta association	(LL)
Lomalta association	(L)
Orelia, sodic variant association	(N)

Laredo, saline-Lomalta association (LL)

This association is comprised of 22,028 acres of gently sloping silty clay loam in association with depressed clay occurring as old meanders along the eastern Gulf Coast of Cameron County. The soils of this association are moderately to severely saline and contain saline water tables 1 to 6 feet below the surface.

The Laredo, saline soils have a surface layer of dark grayish brown calcareous silty clay loam. The subsoil is a friable, light colored silty loam with weak stratification within 50 inches of the surface. These soils are moderately permeable and well drained. Laredo soils occupy about 60 percent of this association.

The Lomalta soils have a surface layer of gray, calcareous clay. The subsoil is plastic, mottled clay. They are saline, sodic, and continuously moist below 24 inches. These soils are very slowly permeable and poorly drained. Lomalta soils occupy about 25 percent of this association.

Other soils within this association are Lomalta, loamy variant, 10 percent and Laredo, clayey variant, 5 percent. Lomalta, loamy variant soils are light colored, calcareous loamy soils that are severely saline and have water tables at 1 to 4 feet below the surface. Laredo, clayey variant soils have a dark colored, calcareous silty clay surface layer with a firm, but crumbly silty clay subsoil.

The soils in this association are used entirely for rangeland. Forage yields are low. The Lomalta soils support Gulf cordgrass and the Laredo soils support stunted mesquite,prickly pear, sacaton, hooded windmill grass, and bufflegrass.

Lomalta association (L)

This association consists of broad, depressed areas of saline clays broken only by low ridges of loamy soils, and occurs on about 25,067 acres. The soils of this association are very slowly permeable and are poorly drained. These areas stand under water for several weeks following heavy rains. Water tables occur 4 to 7 feet below the surface.

The Lomalta soils have a surface layer of gray, calcareous clay. The subsoil is a plastic, mottled clay. They are saline, sodic, and continuously moist below 24 inches. Lomalta soils occupy about 75 percent of this association.

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Other soils within this association are Laredo, saline, 12 percent; Orelia, sodic variant, 7 percent; and Lomalto, loamy variant, 6 percent. Laredo, saline soils have a calcareous silty clay loam surface layer with a friable silt loam subsoil. Orelia, sodic variant soils have a thin noncalcareous saline fine sandy loam surface layer with a compact clay loam subsoil. Lomalta, loamy variant soils are light colored, calcareous, and loamy. They are severely saline and have water tables at 1 to 4 feet below the surface.

The soils in this association are used entirely for rangeland. Forage yields are low. Vegetation consists of Gulf cordgrass, bush-sea-oxeye, seashore saltgrass, and pickleweed. The minor higher lying areas support stunted mesquite and prickly pear with a thin stand of short and mid-grasses.

Orelia, sodic variant association (N)

This association consists of a narrow band of nearly level sandy clay loam and fine sandy loam along the western edge of the saline coastal flat soils of Cameron and Willacy Counties, and occupies about 91,085 acres. Numerous sodic or slick spots and small, enclosed depressions occur throughout the association. The soils have moderately slow permeability and are somewhat poorly drained. Surface runoff is slow to very slow. They are saline, high in sodium, and have water tables 2 to 7 feet below the surface.

The Orelia, sodic variant soils have a thin surface layer of grayish-brown, noncalcareous sandy clay loam and fine sandy loam. The subsoil is a compact sandy clay loam. The soils are high in exchangeable sodium and contain free carbonates at less than 24 inches. Orelia sodic variant soils occupy about 65 percent of this association.

Other soils within this association are Willacy, 15 percent; Ramadero, 12 percent; Delfina, 5 percent; and Tiocano, 3 percent. Willacy soils have a noncalcareous fine sandy loam surface layer with a friable, light sandy clay loam subsoil. Ramadero soils have a noncalcareous loam surface layer with a firm, blocky sandy clay loam subsoil. Delfina soils have a noncalcareous fine sandy loam surface soil with a blocky, mottled sandy clay loam subsoil. Tiocano soils are dark colored, poorly drained clays occurring in small, enclosed depressions.

About 40 percent of the soils in this association are utilized as dry cropland. The major crops are cotton and grain sorghum. Yields are generally low. The remainder of the association is in native range. Vegetation consists of mesquite and prickly pear with mid and short grasses. This association has a low potential for crop production for a few of the major crops common to this area.

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Undulating shallow gravelly loamy soils

Paleorthids

Jimenez-Zapata association (JZ)

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Jimenez-Zapata association (JZ)

Five thousand and forty acres of very shallow, gravelly loamy soils on gently sloping and undulating topography make up this association. The soils are moderately permeable and well drained to excessively drained. Surface runoff is medium. These soils do not have water tables within depths of 20 feet and salinity is low.

The Jimenez soils have a surface layer of dark grayish-brown, calcareous, very gravelly loam less than 15 inches thick over strongly cemented caliche. Jimenez soils occupy about 50 percent of this association.

The Zapata soils have a surface layer of grayish-brown to reddish-brown loam 4 to 16 inches thick over indurated caliche. Zapata soils occupy about 40 percent of this association.

Other soils within this association are McAllen, 6 percent and Delmita, 4 percent. McAllen soils have a light colored, calcareous fine sandy loam surface layer with a friable sandy clay loam subsoil. Delmita soils have a reddish, noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil. Delmita soils have a reddish, noncalcareous fine sandy loam surface layer with a friable sandy clay loam subsoil and are underlain with indurated caliche beginning at 20 to 48 inches.

This association is used entirely for rangeland and has a low carrying capacity. Vegetation consists of black brush, guajillo, cenizo, prickly pear, and leatherstem. Grass species are chiefly Texas bristlegrass, hooded windmillgrass, and fall witchgrass.

TECHNICAL DESCRIPTIONS

Technical descriptions were developed for 26 major soil series. The technical description gives the location of the typical soil, and a detailed soil description.

Brennan fine sandy loam

Location: 4.5 miles northwest of Edinburg; in a cultivated field 200 feet east of county road, which point is 3.0 miles north via county road to F.R. 1925. This junction is 3.4 miles west of the intersection of F.R. 1925 and U. S. 281.

Ap -- 0- 7" -- Dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; very weak subangular blocky structure; slightly hard when dry; friable when moist; noncalcareous, pH 8.0; clear boundary.

A12 -- 7-14" -- Dark grayish brown (10YR 4/2) light sandy clay loam, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky structure; slightly hard when dry; friable when moist; few very fine pores; noncalcareous; pH 8.0; diffuse boundary.

B21t --14-26" -- Brown (10YR 4/2) sandy clay loam, dark brown (10YR 3/3) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; common very fine pores; few discontinuous clay films; noncalcareous, pH 8.0; diffuse boundary.

B22t --26-36" -- Brown (10YR 5/3) sandy clay loam, dark brown(10YR 4/3) when moist; weak subangular blocky structure; slightly hard dry, friable when moist; common fine and very fine pores; few threads of $CaCO_3$; calcareous; diffuse boundary.

B3 --36-46" -- Pale brown (10YR 6/3) clay loam, brown (10YR 4/3) when moist; weak subangular blocky structure; hard dry; friable when moist; common fine and very fine pores; few threads of $CaCO_3$ and few small $CaCO_3$ deposits; calcareous; diffuse boundary.

Cca --46-72" -- Very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) when moist; weak subangular blocky structure; hard dry friable when moist; common soft $CaCO_3$ deposits up to 5mm in size, calcareous; diffuse boundary.

Camargo silt loam

Location: 8.0 miles southeast of San Benito; 100 feet east of field road, which point is 0.4 miles south and 0.3 miles southwest of International Boundary and Water Commission (IBWC) levee; then 1.3 miles northwest on IBWC levee and 0.1 miles north on private road to intersection with U.S. 281. This intersection is 2.0 miles southeast of junction U.S. 281 and F.R. 732, La Paloma, Texas.

Ap -- 0- 8" -- Light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard; friable; calcareous; abrupt boundary.

C1 -- 8-14" -- Light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; structureless, but contains very evident thin bedding planes; few brownish yellow mottles along root channels; slightly hard; friable; common very fine pores; calcareous; abrupt boundary.

C2 --14-39" -- Light gray (10YR 7/2) silty clay loam, dark grayish brown (10YR 4/2) moist; structureless, but contains unaltered bedding planes with thin unaltered silt loam strata; few brownish-yellow mottles along root channels and cleavage plane faces; very fine pores; calcareous; gradual boundary.

C3 --39-51" -- Light brownish gray (10YR 6/2) silt clay loam, dark brown (10YR 4/3) moist; structureless, but contains unaltered bedding planes which have smooth dull faces; few brownish-yellow mottles along root channels; and cleavage plane faces; very hard; firm; few very fine pores; calcareous; clear boundary.

C4 --51-56"+-- Light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; structureless, but contains very thin bedding planes; few faint brownish-yellow mottles; slightly hard;very firm; calcareous.

Comitas loamy fine sand

Location: 6.5 miles northeast of Edinburg; in a cultivated field 100 feet east of county road; which point is 1.5 miles north of the junction of the county road with F.R. 1925 (this intersection is 5.5 miles east of the junction of F. R. 1925 with U.S. 281).

Pedon Description: Comitas loamy fine sand

Ap -- 0- 7" -- Brown (10YR 5/3) loamy fine sand, dark brown (10YR 3/3) when moist; structureless; soft, very friable; many fine roots; neutral; clear boundary.

A1 -- 7-23" -- Brown (10YR 5/3) loamy fine sand, dark brown (10YR 3/3) moist; weak subangular blocky structure; slightly hard; very friable; many fine pores; few fine roots; slightly acid; diffuse boundary.

B21t --23-47" -- Brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak subangular blocky structure; slightly hard, very friable; many fine pores; clay coatings and bridging of sand grains; few fine roots; slightly acid; diffuse boundary.

B22t --47-82" -- Pale brown (10YR 6/3) sandy loam, dark brown (10YR 4/3) moist; very weak subangular blocky structure; slightly hard, very friable; clay coating and bridging of sand grains; slightly acid.

Delfina fine sandy loam

Location: 10.0 miles W 15° S of Raymondville; in a citrus orchard 100 feet east and 350 feet south of county road intersection, which point is 0.7 miles west of intersection with F. R. 1015. This intersection is 2.8 miles south of the intersection of F. R. 1015 and Texas 186.

Ap -- 0- 7" -- Grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; structureless; slightly hard; friable; noncalcareous, pH 6.8; abrupt wavy boundary.

A1 -- 7-15" -- Dark grayish brown (10YR 4/2) fine sandy loam; very dark grayish brown (10YR 3/2) moist, massive; hard, friable; noncalcareous, pH 7.2; abrupt smooth boundary.

B21t --15-20" -- Dark grayish brown(7.5YR 4/2) sandy clay loam, very dark grayish brown (7.5YR 3/2) moist; dark yellowish brown (10YR 4/4) moist when crushed; common, fine distinct yellowish red (5YR 4/6) and strong brown (7.5YR 5/6) mottles; compound moderate coarse prismatic breaking to strong, fine and medium blocky; extremely hard, firm;few citrus tree roots; common very fine pores; continuous clay films and organic coatings are very dark brown (10YR 2/2) moist; few small manganese concretions; noncalcareous, pH 7.1; gradual boundary.

B22t --20-33" -- Brown (7.5YR 5/2) sandy clay loam dark brown (7.5YR 4/2) moist; common, medium distinct yellowish red (5YR 4/6)and strong brown (7.5YR 5/6) mottles; compound moderate coarse prismatic breaking to strong, fine and medium blocky; extremely hard, firm; few fine pores; few fine roots; continuous clay films of very dark brown (10YR 2/2) moist; organic matter coatings on vertical and horizontal ped surfaces; common small manganese concretions; noncalcareous, pH 7.4; gradual boundary.

B3 --33-47" -- Light brown (7.5YR 6/4) sandy clay loam dark brown (7.5YR 4/4) moist, few faint grayish brown mottles; moderate coarse prismatic breaking to weak subangular blocky; hard, friable; few very fine pores; continuous thin clay films of very dark brown (10YR 2/2) moist organic matter coatings on vertical peds; noncalcareous, pH 7.3; clear boundary.

Cca --47-87"+-- Pink (7.5YR 7/4) sandy clay loam, light brown (7.5YR 6/4) moist; weak subangular blocky structure; hard friable; few very fine pores; 3 to 5 percent, by volume, soft and hard $CaCO_3$ concretions; calcareous, pH 8.2.

Delmita fine sandy loam

Location: 20.0 miles northwest of Edinburg; in a native range area 200 feet south of F.R. 1017; which point is 0.5 miles east of intersection of McAllen Ranch headquarters road with F.R. 1017.

A1 -- 0-11" -- Yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak subangular blocky structure; slightly hard; friable noncalcareous; clear boundary.

B2t --11-28" -- Yellowish red (5YR 5/8) sandy clay loam, yellowish red (5YR 4/8) moist; weak subangular blocky structure; hard, friable; few patchy clay films on ped surfaces and clay coating and bridging of sand grains; noncalcareous; abrupt boundary.

Ccam --28-60" -- White (10YR 8/2) caliche,upper part indurated with a hardness of 3, becoming less cemented with depth.

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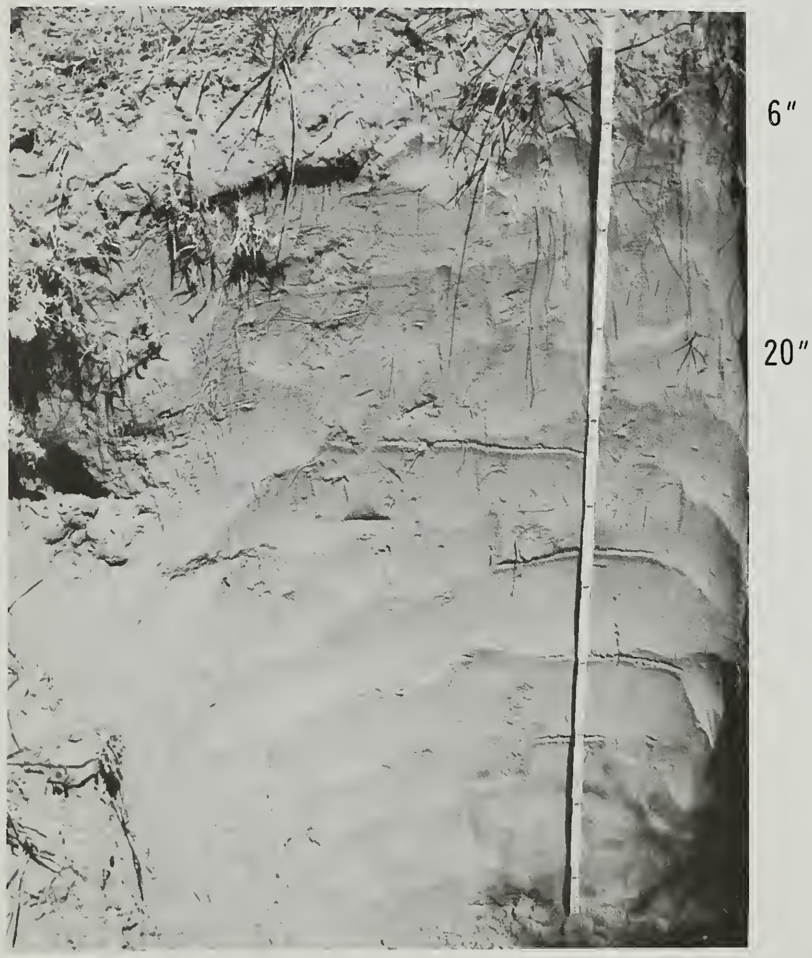
Falfurrias fine sand

Location: 22.0 miles north of San Manuel; in a native range area 200 feet west of U.S. 281; which point is 22.3 miles north (via U.S. 281) of the intersection of U.S. 281 and F.R. 1017 in San Manuel.



Soil profile of Falfurrias fine sand.

A11 -- 0 -6" -- Grayish brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) moist; structureless; loose, very friable; contains organic material in various stages of decomposition; many fine roots; neutral; clear boundary.

A12 -- 6-20" -- Light brown gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; structureless; loose plentiful fine roots; neutral; diffuse boundary.

C1 --20-80"+-- Very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; structureless; loose; few roots in the upper part; neutral.

Harlingen clay

Location: 5.0 miles of S 20° W of San Benito; in a cultivated field 600 feet west of F.R. 509, which point is 3.3 miles south of intersection with U. S. 83 Expressway.

Ap -- 0-11" -- Brown (7.5YR 5/2) clay, dark brown (7.5YR 3.5/2) when moist; weak granular and subangular blocky structure; very hard when dry; firm when moist; plastic when wet; calcareous; abrupt boundary.

A1 --11-23" -- Brown (7.5 YR 5.5 2) clay, dark brown (7.5YR 3.5/2) when moist; moderate medium blocky structure; very hard when dry, extremely firm when moist, plastic when wet; calcareous;diffuse boundary.

AC1 --23-35" -- Brown (7.5YR 5.5/2) clay, dark brown (7.5YR 4/2) when moist; moderate medium blocky structure--mostly wedge shaped; numerous moderately prominent slickensides on about 20 to 35 degrees horizontal; very hard when dry; extremely firm when moist; plastic when wet; few salt threads in lower part; calcareous; diffuse boundary.

AC2sa--35-47" -- Light brown (7.5YR 6/3) clay, dark brown (7.5YR 4/3) when moist; moderate fine angular blocky structure; few prominent slickensides; very hard when dry; extremely firm when moist, plastic when wet; common salt threads; calcareous; diffuse boundary.

AC3 --47-59" -- Light brown (7.5YR 6/3) clay, dark brown (7.5YR 4/3) when moist; moderate fine angular blocky structure; few prominent slickensides; very hard when dry; extremely firm when moist; plastic when wet; few salt threads; calcareous; diffuse boundary.

C --59-71" -- Brown (10YR 5/3) clay, dark brown (10YR 4/3) when moist; weak blocky structure; few prominent slickensides; very hard when dry; extremely firm when moist; very plastic when wet; few salt threads; few soft $CaCO_3$ deposits; calcareous.

Hidalgo sandy clay loam

Location: 1.8 miles northwest of Donna; in a cultivated field, 300 feet west of county road and 1.3 miles north of its intersection with U. S. 83; this intersection is 1.1 miles (via U. S. 83) west of Main Street in Donna.

Ap -- 0- 9" -- Dark grayish brown (10YR 4/2) light sandy clay loam, very dark grayish brown (10YR 3/2) moist; weak subangular blocky and granular structure; hard, friable; few small shell fragments; calcareous; moderately alkaline; clear boundary.

A12 -- 9-17" -- Dark grayish brown (10YR 4/2) light sandy clay loam, very dark grayish brown (10YR 3/2) moist; weak subangular; blocky structure; hard; friable; many fine and very fine pores; few earthworm casts; calcareous, moderately alkaline; diffuse boundary.

B21 --17-28" -- Brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure; hard, friable; many fine and very fine pores; few threads and films or segregated calcium carbonate; few earthworm casts;few small shell fragments, calcareous, moderately alkaline; diffuse boundary.

B22 --28-38" -- Pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak subangular blocky structure; hard, friable; many fine and very fine pores; few snail shell fragments; about 10 percent by volume of soft lumps of calcium carbonate; calcareous, moderately alkaline; diffuse boundary.

Cca --38-85" -- Very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; structureless; hard friable; many fine and very fine pores; few snail shell fragments; about 10 percent by volume of soft lumps of calcium carbonate.

Jimenez very gravelly loam

Location: 13.0 miles west of Mission; in a pasture 50 feet east of county road; which point is 0.7 miles south (via county road) of U.S. 83 (this intersection is 2.0 miles east of junction of F.R.486 and U.S.83).

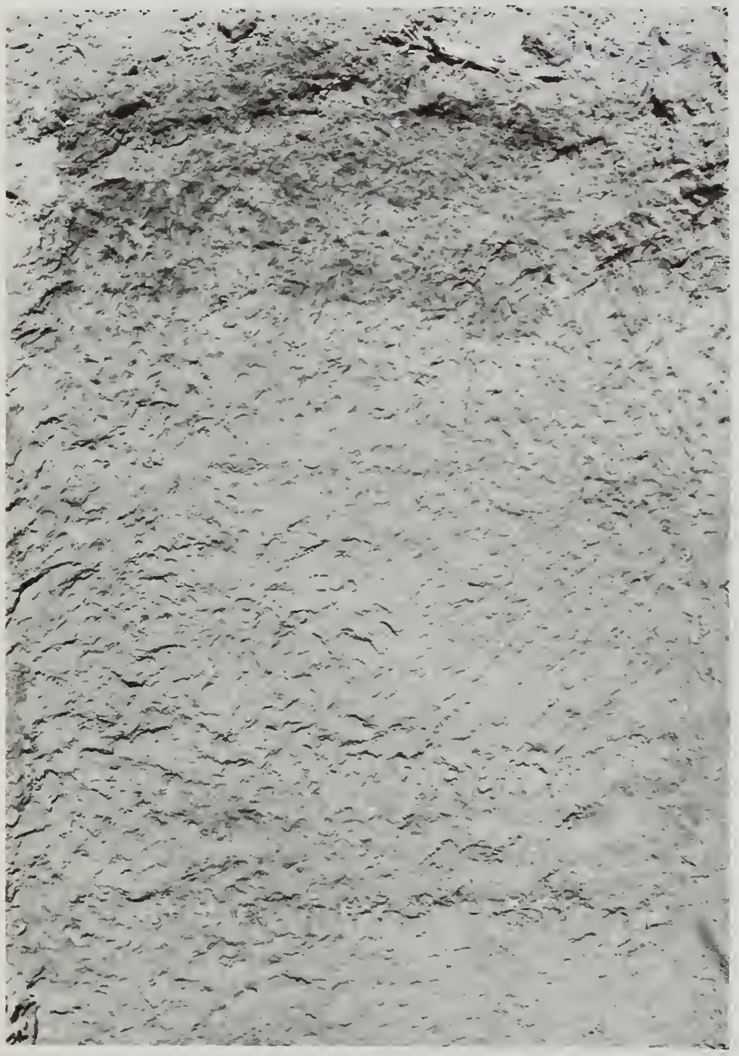
A1 -- 0-11" -- Dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2)moist; weak granular structure; slightly hard, friable; 60 percent by volume of water-worn pebbles; calcareous; abrupt boundary.

C1cam--11-20" -- White (10YR 8/2) strongly cemented caliche with about 30 percent of the mass consisting of embedded gravel , diffuse boundary.

C2ca --20-60"+-- White (10YR 8/2) weakly cemented caliche with about 40 percent by volume being embedded gravel.

Laredo silty clay loam

Location: 8.0 miles southwest of Harlingen; in a cultivated field 200 feet west of F.R. 1479; which point is 0.9 miles south of Rangerville School via F.R. 1479.



Soil profile of Laredo silty clay loam. Note the dark colored mollic epipedon of about 18 inches and the accumulation of soft lumps of calcium carbonate at about 46 inches.

Ap -- 0- 8" -- Dark grayish brown (10YR 4/1.5) light silty clay loam, very dark brown (10YR 1.5/2) when moist; weak subangular blocky and moderate very fine granular structure; hard when dry; friable when moist; calcareous; abrupt boundary.

A11 -- 8-18" -- Dark grayish brown(10YR 4.5/1.5) heavy silt loam, very dark brown (10YR 2/2) when moist; weak subangular blocky and moderate very fine granular structure; slightly hard when dry; friable when moist; many fine pores; numerous earthworm casts; few snail shell fragments; few lime threads in lower half of horizon; calcareous; clear wavy boundary.

B --18-46" -- Light gray (10YR 6.5/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky structure; slightly hard when dry; friable when moist; common fine pores and earthworm casts; few to common streaks and pockets filled with material from a horizon which is slightly more clayey in texture; common films of $CaCO_3$; calcareous; clear boundary.

CIca --46-54" -- Light gray (10YR 6/2) heavy silt loam, dark grayish brown (10YR 3.5/2) when moist; structureless; slightly hard when dry; friable when moist; common fine pores; 5 percent by volume soft lumps and hard $CaCO_3$ concretions; calcareous; clear boundary.

C2 --54-72" -- Light gray (10YR 6/2) silt loam; dark grayish brown (10YR 4/2) when moist; structureless; slightly hard when dry; friable when moist; common fine pores; calcareous.

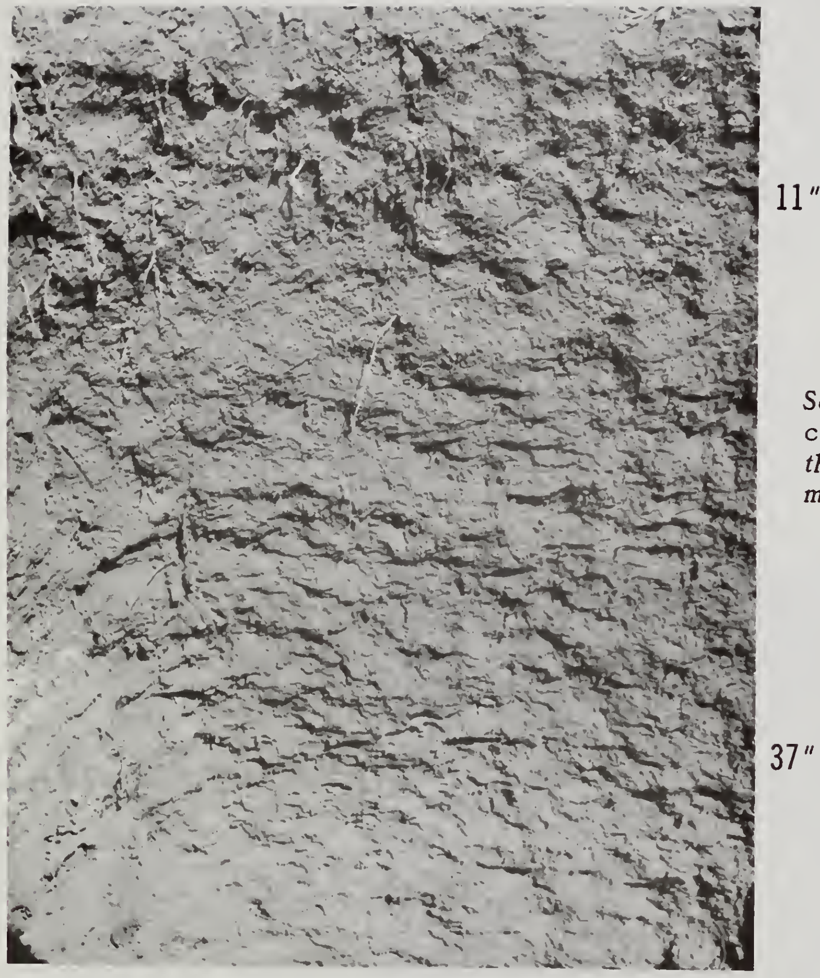
<u>Laredo silty clay, clayey variant</u>

Location: 3.0 miles northwest of Los Fresnos; in a cultivated field 1,200 feet north and 200 feet west of F. R. 2893; which point is 0.5 miles west of junction F.R. 2893 and F.R. 1575 in Laureles.

Ap -- 0- 7" -- Dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist, moderate medium granular structure; hard; friable; many roots and worm casts; calcareous; abrupt boundary.

A1 -- 7-11" -- Dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist, moderate very fine subangular blocky structure; very hard, firm but crumbly; few fine pores; common worm casts; calcareous; clear boundary.

B21 --11-23" -- Grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate fine and medium subangular blocky; very hard; firm but crumbly; few fine pores; calcareous; diffuse boundary.



Soil profile of Laredo silty clay, clayey variant. Note the thick dark colored mollic epipedon.

B22 --23-29" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate fine and medium subangular blocky; very hard, firm but crumbly; few fine pores; calcareous; gradual boundary.

B3 --29-37" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; weak subangular blocky; very hard; firm but crumbly; common fine brownish-yellow mottles along root channels; few hard concretions and soft lumps of $CaCO_3$; calcareous; clear boundary.

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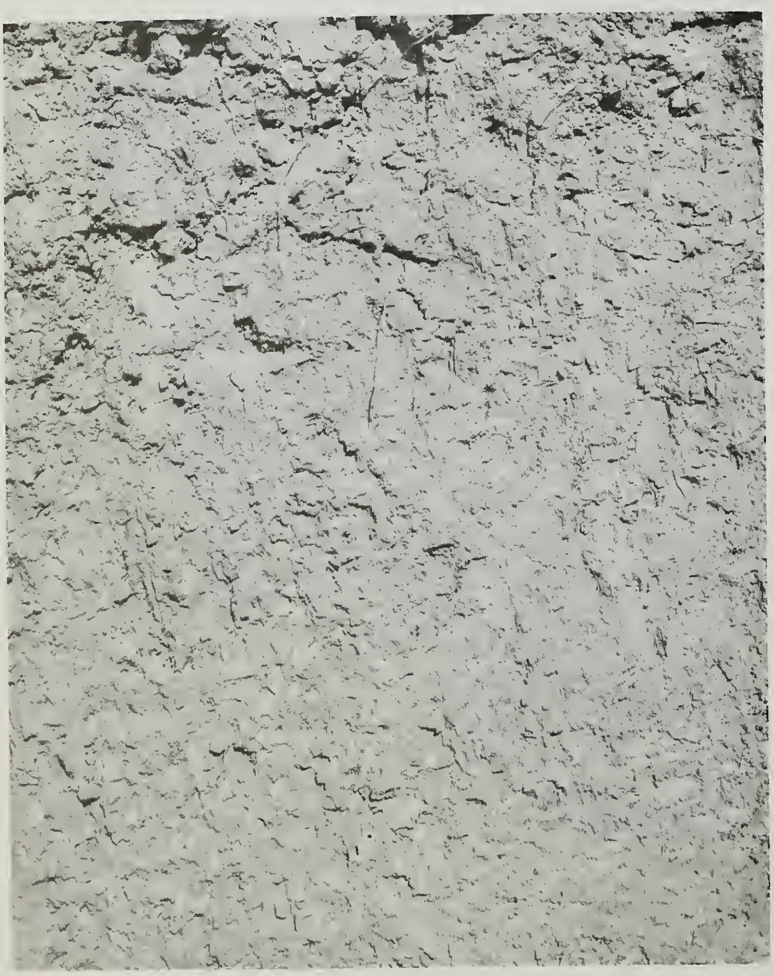
C1ca --37-48" -- Very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; structureless, very hard, firm common fine pores; common fine brownish-yellow mottles; 5 to 8 percent by volume hard concretions and soft lumps of $CaCO_3$; calcareous; diffuse boundary.

C2ca --48-68" -- Very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) moist; structureless; very hard; firm few brownish-yellow mottles; few manganese concretions; 5 to 8 percent by volume soft lumps of $CaCO_3$; calcareous.

Lomalta clay

Location: 2.0 miles south of Los Fresnos; in a level, native pasture of cordgrass, 780 feet east of F.R. 1847; which point is 1.6 miles south of intersection with Texas 100.



Soil profile of Lomalta clay. Note the accumulations of salts in the lower part of the profile.

A11sa-- 0-1/4"-- Gray (N 6/0) clay, dark gray (10YR 4/1) when moist; massive, a surface crust; slightly hard when dry; friable when moist; calcareous; $ECeX10^3$=8.6; abrupt boundary.

A12sa--1/4-7" -- Light gray (5YR 6/1) clay; dark gray (5YR 4/1) when moist; moderate fine blocky and granular structure; very hard when dry; very firm when moist; very sticky and very plastic when wet; numerous roots; calcareous; $ECeX10^3$=22.2; gradual boundary.

A12sa-- 7-13" -- Gray (5YR 5.5/1) clay, dark gray (5YR 4/1) when moist; moderate fine angular blocky structure with wedge-shaped peds, few weak slickensides; extremely hard when dry; extremely firm when moist; very sticky and very plastic when wet; few fine pores; few roots; few slightly darker streaks along old root channels and cracks; few films and threads of salt; calcareous; $ECeX10^3$=34.6; gradual boundary.

AC1sa--13-29" -- Light gray (5YR 6/1) clay, gray (5YR 5/1) when moist; moderate medium angular blocky structure with wedge-shaped peds, moderately large intersecting slickensides; extremely hard when dry;extremely firm when moist; very sticky and very plastic when wet; few fine pores; few roots; few slightly darker streaks along old root channels and cracks; few films and threads of salt; calcareous; $ECeX10^3$=24.6; gradual wavy boundary.

AC2sa--29-39" -- Light gray (5YR 6/1) clay, gray (5YR 4.5/1) when moist; moderate fine and medium angular blocky structure with wedge-shaped peds; few intersecting slickensides; extremely hard when dry; extremely firm when moist; very sticky and very plastic when wet; few roots; 5 percent by volume of soft masses and crystals of salt; calcareous; $ECeX10^3$=27.3; gradual wavy boundary.

Csa --39-60" -- Light brownish gray (10YR 6/2) clay, brown (10YR 5/3) when moist; with few distinct brownish-yellow mottles and 20 percent by volume gray streaks (gray streaks are old land crab burrows); weak blocky structure; extremely hard when dry; extremely firm when moist; very sticky and very plastic when wet; few roots along old crab burrows; 2-3 percent by volume soft masses and crystals of salt; few gypsum crystals; calcareous; $ECeX10^3$=33.0.

Lomalta loam, loamy variant

Location: 10.0 miles northeast of Brownsville; in a native range area 100 feet east of trail; which point is 0.6 miles north of junction with F.R. 1792 (this junction is 4.3 miles northeast of junction of F.R. 1792 and F.R. 511 at Port Brownsville).

Alsa -- 0- 8" -- Light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak subangular blocky structure; slightly hard, friable; common salt threads; calcareous $ECeX10^3$=31.0; diffuse boundary.

Clsa -- 8-27" -- Very pale brown (10YR 7/3) light silty clay loam with common, medium distinct gray streaks, pale brown (10YR 6/3) when moist; massive; hard, friable; few $CaSO_4$ crystals; few small manganese concretions; few to common salt threads; calcareous; $ECeX10^3$=57.5; diffuse boundary.

C2sa --27-63" -- Very pale brown (10YR 7/3) stratified silt loam, silty clay loam and clay loam with common, medium distinct dark gray and strong brown mottles; pale brown (10YR 6/3) when moist; massive structure; hard, friable; few $CaSO_4$ crystals; few small manganese concretions; strongly calcareous; $ECeX10^3$=68.0.

McAllen fine sandy loam

Location: 3.5 miles south of McCook; in a cultivated field 300 feet west of F.R. 2058; which point is 3.5 miles south of the junction of F.R. 2058 and F.R. 490.

Ap -- 0- 6" -- Light brownish gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; structureless; soft, very friable; few snail shell fragments; calcareous; moderately alkaline; clear boundary.

A12 -- 6-14" -- Light brownish gray (10YR 6/2) fine sandy loam, brown (10YR 4/3) moist; weak subangular blocky structure; soft; very friable; many fine pores and root channels; few snail shell fragments; calcareous; moderately alkaline; diffuse boundary.

B2 --14-37" -- Pale brown (10YR 6/3) light sandy clay loam, brown (10YR 4/3) moist; weak subangular blocky structure; slightly hard; friable; many fine pores and root channels; few snail shell fragments; few films and threads of calcium carbonate in the upper part, and increasing in the lower part; calcareous; moderately alkaline; diffuse boundary.

Cca --37-72" -- Light gray (10YR 7/2) light sandy clay loam, brown (10YR 5/3) moist; weak subangular blocky structure; slightly hard; friable; many pores; few snail shell fragments; about 15 percent by volume of soft lumps and concretions of calcium carbonate; calcareous; moderately alkaline.

Montell clay

Location: 5.0 miles east of Harlingen; in a cultivated field 150 feet west of F.R. 1595, which point is 1.6 miles north via F.R. 1595 of the intersection with F.R. 106.

Ap -- 0- 7" -- Gray (10YR 6/1) clay, dark gray (10YR 4/1) when moist; moderate fine angular blocky structure; very hard; the blocks break to very hard, discrete, very fine angular peds when dry; firm; very sticky and very plastic;calcareous; abrupt boundary.

A12 -- 7-27" -- Gray (10YR 5/1) clay, dark gray (10YR 4/1) when moist; moderate medium angular blocky structure; with wedge-shaped peds; very hard; very firm; very sticky and very plastic; slickensides in lower part; calcareous; diffuse boundary.

AC1 --27-48" -- Light brownish gray (10YR 6/2) clay with common faint brownish-yellow mottles, grayish brown (10YR 5/2) when moist; moderate medium angular blocky structure with wedge-shaped peds; very hard; very firm; very sticky and very plastic; distinct intersecting slickensides; few fine, indurated calcium carbonate concretions; calcareous; gradual boundary.

C --48--63"-- Light brownish gray (10YR 5.5/2) clay with common faint brownish-yellow mottles, grayish brown (10YR 5.5/2) when moist; moderate medium blocky structure; very hard when dry; very firm when moist; very sticky and very plastic, few hard concretions, and soft lumps of $CaCO_3$; calcareous.

Nueces fine sand

Location: 16.0 miles north of San Manuel; in a native range area 200 feet east of U.S. 281; which point is 16.3 miles north (via U.S. 281) of the intersection of U.S. 281 and F.R. 1017 in San Manuel.

A1 -- 0- 6" -- Grayish brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) when moist; structureless; loose when dry; very friable when moist; numerous fine roots; pH 6.5; gradual boundary.

A2 -- 6-32" -- Pale brown (10YR 6/3) fine sand; brown (10YR 4/3) when moist; structureless; loose when dry; loose to very friable when moist; few roots; pH 6.0; clear boundary.

B --32-60"+-- Light brownish gray (10YR 5/2) sandy clay, grayish brown when moist (10YR 5/2) with common, medium, distinct red (2.5 YR 4/6) and brownish-yellow (10YR 6/6) mottles; contains a few thin light gray (10YR 7/2) sandy loam strata; weak blocky structure; hard, friable; clay films on ped surfaces; pH 6.3.

Orelia sandy clay loam, sodic variant

Location: 12.0 miles north of Los Fresnos; in a cultivated field 100 feet east of field road; which point is 1.4 miles north of junction General Brandt Road and field road (this junction is 1.8 miles east of intersection of General Brandt Road and F.R. 2358).

Ap -- 0- 8" -- Grayish brown (10YR 5/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; weak granular and subangular blocky structure; slightly hard, friable; noncalcareous; pH 8.0; abrupt boundary.

B2t -- 8-16" -- Dark grayish brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium blocky structure; continuous clay films; very hard, very firm; noncalcareous in upper part and calcareous in lower part; clear wavy boundary.

B3ca --16-26" -- Light brownish gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) moist with few faint and distinct brownish-yellow mottles; moderate fine and medium blocky structure; patchy clay films; hard, firm; 3 percent by volume $CaCO_3$ concretions; calcareous; clear boundary.

Ccasa--26-60" -- Very pale brown (10YR 7/4) light sandy clay loam, light yellowish brown (10YR 6/4) moist with few to common distinct brownish-yellow mottles; weak subangular blocky structure; slightly hard, friable; common films and small pockets of salts; 5 to 8 percent by volume $CaCO_3$ concretions, calcareous.

Point Isabel clay loam

Location: 13.0 miles east of Brownsville; in a native range area 250 feet west of field road; which point is 0.2 miles north of Texas Highway 4 (this junction is 7.6 miles east of the intersection of Texas Highway 4 and F.R. 511).

A11 -- 0- 8" -- Light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak granular to subangular blocky structure; slightly hard, friable; calcareous; clear boundary.

A12 -- 8-12" -- Grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; calcareous; clear boundary.

B --12-19" -- Light brownish gray (10YR 6/2) light clay, grayish brown (10YR 5/2) moist; moderate fine and medium angular blocky structure; hard, firm, common films and threads of carbonates; calcareous; abrupt wavy boundary.

IIAb --19-22" -- Gray (10YR 5/1) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; common and threads of carbonates; calcareous, abrupt wavy boundary.

Bb --22-37" -- Light brownish gray (10YR 6/2) light clay, grayish brown (10YR 5/2) moist; moderate fine and medium angular blocky structure; hard, firm; few films and threads of carbonates; calcareous; abrupt boundary.

IIIAB--37-42" -- Gray (10YR 5/1) light clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; few threads of carbonates; calcareous clear boundary.

IIIB2b--42-65"-- Light gray (10YR 7/2) light clay, grayish brown (10YR 5/2) moist; moderate fine and medium angular blocky structure; hard, firm; common threads and films of carbonates; calcareous.

Ramadero loam

Location: 4.5 miles S 10° E of Santa Rosa; in a citrus orchard 240 feet south and 60 feet west of NE corner, Block 87, Hodges Subdivision.

Ap -- 0- 7" -- Dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak subangular blocky structure; slightly hard when dry; friable when moist; noncalcareous; abrupt boundary.

A1 -- 7-13" -- Dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak subangular blocky structure; slightly hard when dry; friable when moist; noncalcareous; clear boundary.

B1t --13-17" -- Dark grayish brown (10YR 4/2) light sandy clay loam, very dark brown (10YR 2/2) when moist; weak blocky structure; few clay films on ped surfaces; hard when dry; friable when moist; common fine pores; noncalcareous; gradual boundary.

B2t --17-31" -- Grayish brown (10YR 5/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium blocky and prismatic structure; continuous clay films on ped surfaces; very hard when dry; firm when moist; common fine pores; noncalcareous; gradual boundary.

B3 --31-44" -- Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist; weak fine subangular blocky structure; hard when dry; friable when moist; common earthworm casts; common fine pores; few snail shell fragments; common films and threads of $CaCO_3$; calcareous; gradual boundary.

Cca --44-47" -- Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist; few fine distinct strong brown mottles in lower part; structureless; hard when dry; friable when moist; common fine pores; few snail shell fragments; 10 percent by volume soft and hard $CaCO_3$ lumps and concretions; strongly calcareous.

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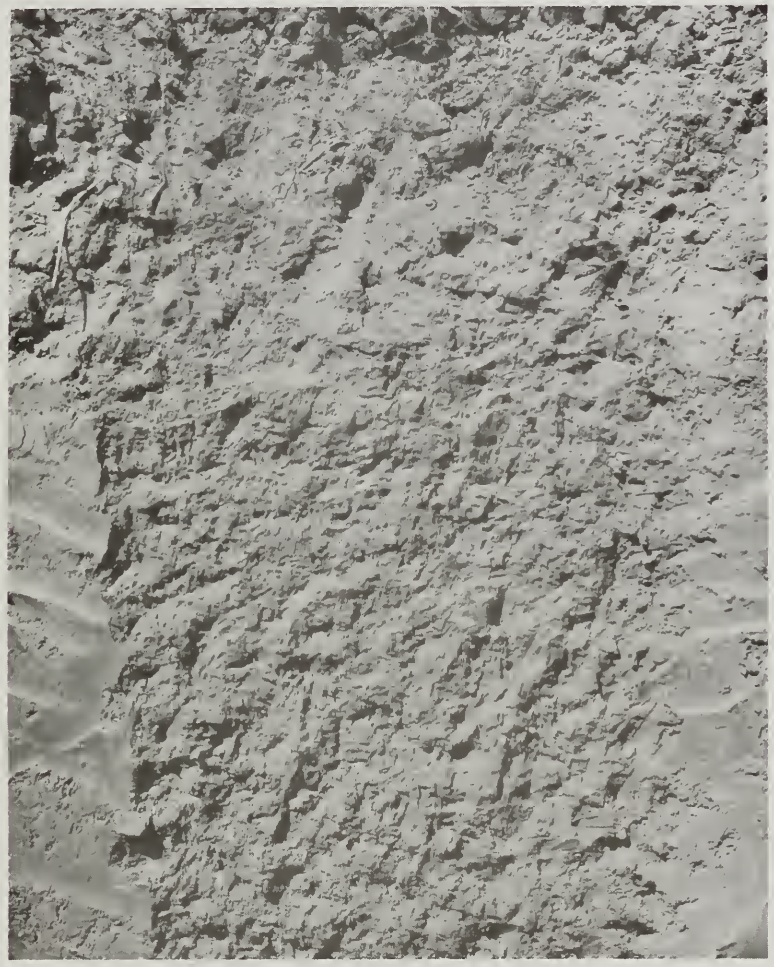
Raymondville clay loam

Location: 6.0 miles N 5°E of Harlingen; in a cultivated field, 260 feet east and 85 feet south of NE corner, block 8, Agua Dulce Farms Subdivision.



Soil profile of Raymondville clay loam.

A1 -- 0-14" -- Dark gray (10YR 4/1) light clay loam, very dark gray (10YR 3/1) moist; weak subangular blocky structure; hard friable; moderately alkaline, calcareous; clear boundary.

B21 --14-25" -- Gray (10YR 5/1) clay loam, dark gray (10YR 4/1) moist; moderate, medium blocky structure; few wedge-shaped peds; very hard, firm; common fine pores; few films and threads of $CaCO_3$; moderately alkaline, strongly calcareous, diffuse boundary.

B22 --25-37" -- Light gray (10YR 6/1) light clay, light brownish gray (10YR 6/2) moist; moderate medium blocky structure, many wedge-shaped peds; few weak slickensides; very hard, very firm; few films and threads of $CaCO_3$; moderately alkaline, calcareous; gradual wavy boundary.

C1ca --37-60" -- Light gray (10YR 7/2) clay; light brownish gray (10YR 6/2) moist; moderate fine and medium blocky structure; very hard, very firm; contains about 3 to 5 percent by volume of hard concretions and soft lumps of $CaCO_3$; moderately alkaline, calcareous; diffuse boundary.

C2 --60-78" -- Light brownish gray (10YR 6/2) clay, brown (10YR 5/3) moist; weak blocky structure; very hard, very firm; contains a few hard $CaCO_3$ concretions; moderately alkaline, calcareous.

<u>Reynosa silty clay loam</u>

Location: 4.0 miles south of McAllen; in a cultivated field 150 feet north of F.R. 1016; which point is 0.5 miles east via F.R. 1016 of junction of F.R. 1926 and 1016.

Ap -- 0- 7" -- Grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; surface crust is 10YR 6/2 when dry; hard; friable; few mica flakes; calcareous; abrupt boundary.

A1 -- 7-14" -- Grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak subangular blocky structure; hard, friable; few worm casts; common fine pores; calcareous; diffuse boundary.

B2 --14-47" -- Light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak subangular blocky structure; hard, friable; common worm casts; spots of brownish colored decaying organic material; common fine pores; common films and threads of $CaCO_3$; calcareous; diffuse boundary.

C --47-73"+-- Pale brown (10YR 6/3) silty clay loam, containing thin lenses of silt loam, brown (10YR 4/3) moist; massive; hard; friable; calcareous.

Reynosa silty clay, clayey variant

Location: 3.0 miles south of McAllen; in a cultivated field 300 feet west of F.R. 1016; which point is 0.2 miles north of intersection of F.R. 1016 and F.R. 336.

Ap -- 0- 9" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; massive; hard; firm; porous; few roots; snail shell fragments; calcareous; moderately alkaline; clear boundary.

A1 -- 9-18" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; weak subangular blocky structure; hard, firm; few fine pores; few wedge-shaped peds; few weak pressure faces on peds; few snail shell fragments; calcareous; moderately alkaline; clear boundary.

B21 --18-28" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; weak subangular blocky structure, stronger than above; hard; firm; few fine and very fine pores and roots; few insect burrows that contain slightly darker materials; few wedge-shaped peds; few slickensides that are intermittent and weakly expressed; threads and films of $CaCO_3$; calcareous, moderately alkaline; gradual boundary.

B22 --28-38" -- Light brownish gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate fine blocky and moderate fine subangular blocky structure; hard; firm; few fine and very fine pores and root channels that contain slightly darker material; few wedge-shaped peds though not as many as above; few non-intersecting weak slickensides; few $CaCO_3$ concretions; calcareous, moderately alkaline; diffused boundary.

C1ca --38-58" -- Pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; with weak angular blocky structure; hard; firm; few fine and very fine pores; contains less than 1 percent by volume of hard concretions and soft lumps of $CaCO_3$; few snail shell fragments; moderately alkaline; calcareous; diffuse boundary.

C2 --58-72" -- Pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; massive; hard; firm; contains weak thin strata of silt loam; moderately alkaline; calcareous.

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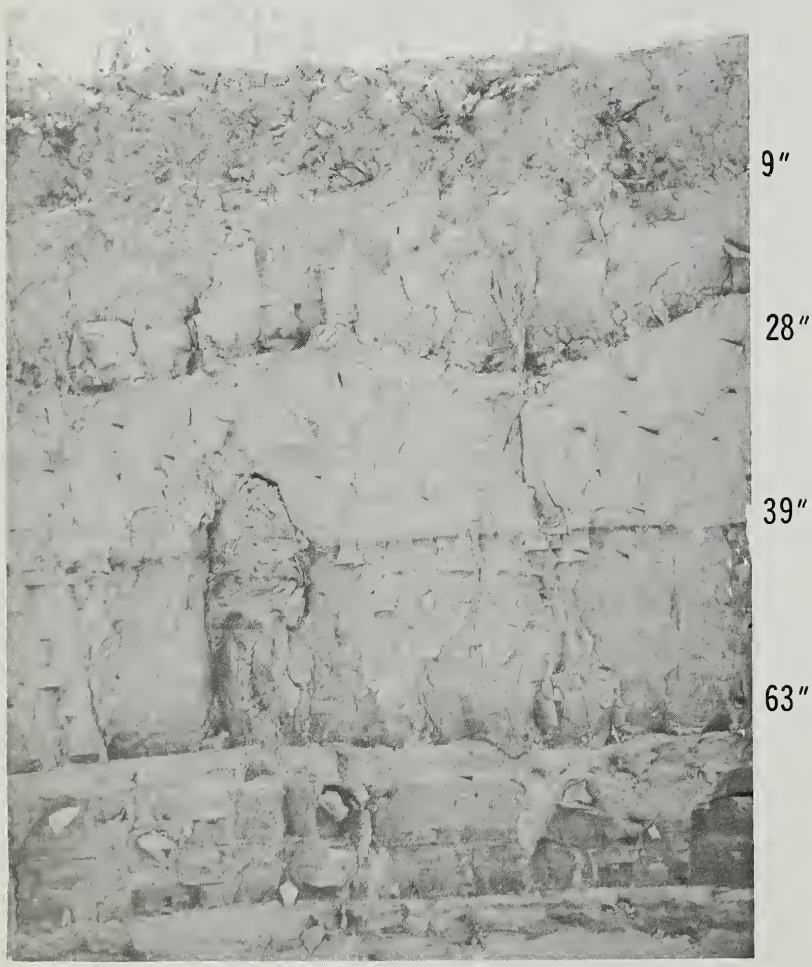
Rio Grande silt loam

Location: 7.0 miles southwest of San Benito; in a cultivated field 100 feet east of field road; which point is 0.2 miles south of junction field road and U.S. 281 (this intersection is 0.2 miles west of junction U.S. 281 and F.R. 2520).



Soil profile of Rio Grande silt loam. Note the stratification and unaltered bedding planes of the C horizon.

Ap -- 0- 9" -- Light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) when moist; structureless; friable; few mica flakes; calcareous; abrupt boundary.

C1 -- 9-16" -- Light gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) moist; structureless with bedding planes evident; friable; common fine pores; few brownish-yellow mottles along root channels and cleavages of bedding planes; calcareous; clear boundary.

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C2 --16-28" -- Very pale brown (10YR 7/3) silt loam with a few pockets of very fine sandy loam, dark grayish brown (10YR 4/2) moist; structureless with bedding planes evident; friable; common fine pores; few brownish-yellow mottles along root channels and cleavages of bedding planes; calcareous; clear boundary.

C3 --28-33" -- Very pale brown (10YR 7/3) light silty clay loam, grayish brown (10YR 5/2) moist; structureless with bedding planes evident; firm, few fine pores common strong along root channels and cleavage planes; calcareous; clear boundary.

C4 --33-39" -- Light gray (10YR 7/2) silt loam, brown (10YR 5/3) moist; structureless with bedding planes evident; friable; common fine pores; few yellowish-brown mottles along root channels; calcareous; diffuse boundary.

C5 --39-63" -- Light gray (10YR 7/2) very fine sandy loam, brown (10YR 5/3) moist; structureless with bedding planes evident; friable; common fine pores; few yellowish-brown mottles along cleavage planes and pores; calcareous.

Sarita fine sand

Location: 6.0 miles north of San Manuel; in a pasture 100 feet south of ranch road; which point is 1.4 miles east of intersection of ranch road and U.S. 281 (this intersection is 6.0 miles north of junction U.S. 281 and Texas 186).

A1 -- 0- 8" -- Light brownish gray (10YR 6/2) fine sand, dark grayish brown (10YR 4/2) moist; structureless; loose; very friable; numerous fine roots; slightly acid; clear boundary.

A2 -- 8-48" -- Very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; few fine and medium faint yellowish-brown mottles; weak blocky structure; extremely hard, friable; porous; slightly acid; clear boundary.

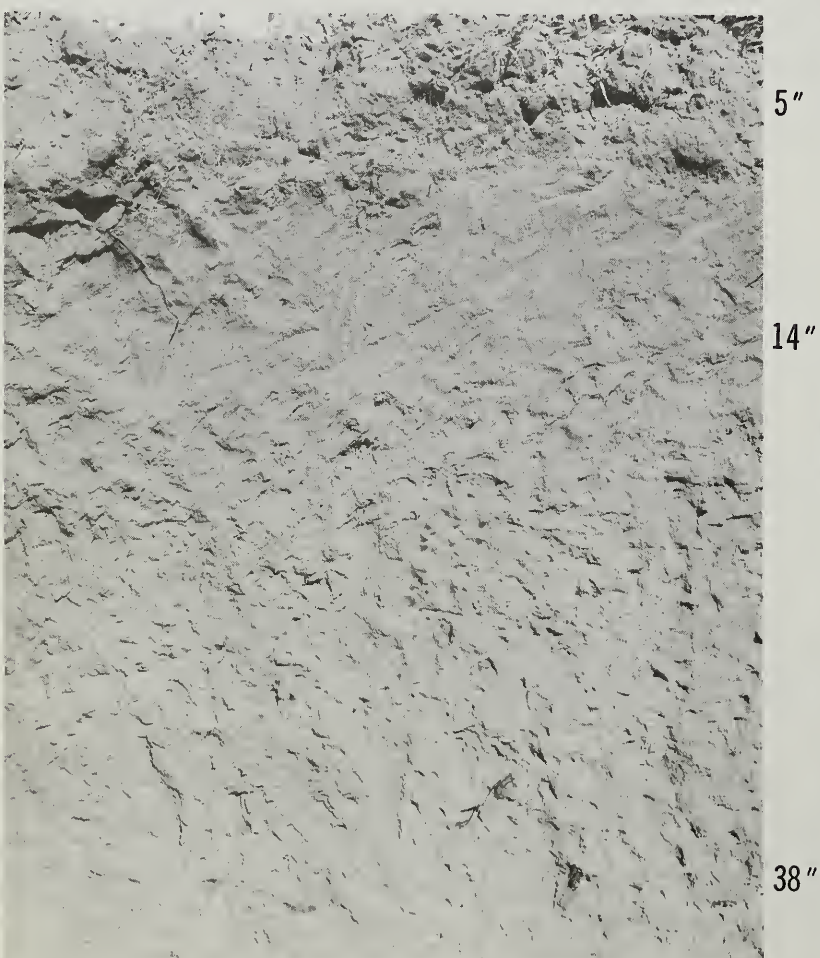
B21t --48-52" -- Pale brown (10YR 6/3)heavy sandy loam, grayish brown (10YR 5/2) moist; few faint fine and medium yellowish-brown mottles; weak blocky structure; extremely hard, friable; porous; clay films on ped surfaces; slightly acid; clear boundary.

B22t --52-58" -- Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist, with many medium distinct yellowish-brown and a few distinct red mottles; moderate, coarse prismatic and weak blocky structure; extremely hard, friable; clay films on ped surfaces; few fine and medium pores; neutral; gradual boundary.

B3 --58-70"+-- Light yellowish-brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; weak blocky structure; very hard, friable; moderately alkaline.

Willacy fine sandy loam

Location: 10.0 miles north of Harlingen; in a cultivated field 135 feet north and 215 feet west of SE corner, Block 16, Combes Subdivision; which point is 1.0 miles (via county road) east of U.S. 77 (intersection of county road and U.S. 77 is 1.0 miles south of the Willacy-Cameron County line).



Soil profile of the Willacy fine sandy loam. Note the dark colored mollic epipedon and the accumulation of soft calcium carbonate at about 38 inches.

Pedon Description: Willacy fine sandy loam

Ap -- 0- 5" -- Very dark grayish brown (10YR 3/1.5) fine sandy loam, very dark brown (10YR 2/2) when moist; weak to moderate fine and very fine granular structure, slightly hard when dry; very friable when moist; noncalcareous; abrupt boundary.

A11 -- 5-14" -- Very dark grayish brown (10YR 3/1.5) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate to weak granular and subangular blocky structure, slightly hard when dry; very friable when moist; many fine and very fine pores and root channels; noncalcareous, pH 7.8; clear boundary.

B21t --14-19" -- Dark grayish brown (10YR 4.5/2) heavy fine sandy loam very dark grayish brown (10YR 3/2) when moist; moderate to coarse medium prismatic breaking to weak subangular blocky structure, slightly hard when dry; friable when moist; clay coatings on prism faces; many insect channels; many fine pores and root channels; noncalcareous; pH 7.8; clear boundary.

B22t --19-33" -- Brown (10YR 5/3) heavy fine sandy loam, dark brown (10YR 4/3) moist; same structure as in B21t; slightly hard, friable; clay coatings on prism faces; many fine pores and root channels; pH 7.8; clear boundary.

B23+ --33-38" -- Brown (10YR 5.5/3) heavy fine sandy loam, dark brown (10YR 4/3) when moist; same structure as B21t horizon; slightly hard when dry; friable when moist; few soft lumps and few threads and films of $CaCO_3$; calcareous; clear wavy boundary.

B3ca --38-52" -- Pale brown (10YR 6/3) light sandy clay loam, brown (10YR 4.5/3) when moist; weak prismatic breaking to weak subangular blocky structure; slightly hard when dry; friable when moist; common fine and very fine pores; 10 to 15 percent by volume of soft lumps and concretions of $CaCO_3$; calcareous; clear boundary.

C --52-74" -- Pale brown (10YR 6/3) fine sandy loam, brown (10YR 4.5/3) when moist; structureless; slightly hard when dry; friable when moist; common fine and very fine pores; 4 to 5 percent by volume of soft lumps and concretions of $CaCO_3$; calcareous.

Zapata loam

Location: 7.0 miles northeast of Mission; in a native range area 100 feet west of Doffing Road; which point is 0.5 miles north of the intersection of Doffing Road and 6 mile line road.

A1 -- 0- 6" -- Dark grayish brown (10YR 4/2) when dry and very dark grayish brown (10YR 3/2) when moist; loam; very weak, subangular blocky structure; contains many gravel and rocks (caliche) from 1/4" to 6" in diameter; calcareous in soil matrix; abrupt boundary.

Ccam -- 6- 8"+-- Strongly indurated white caliche.

Remark: At some exposed places the Ccam horizon appears to be almost a solid layer several feet thick.

LAND USE

Estimated land use for the basin is shown by soil association in table 1.

SOIL SALINITY AND HIGH-WATER TABLES

The descriptive legend gives only a general description of the area affected by soil salinity and high-water tables. This information is expanded in tables 2 and 3. Plate 3 shows the salinity problem area in 1967.

For irrigated lands, the present soil salinity levels have resulted from two conditions;

1. The inherent salinity of the soils. Some of the soils have developed upon sand, clay, and silt deposits which contain seawater entrapped in interstices at the time of deposition. These soils therefore contain some "fossil" salinity. Seawater thus trapped is referred to as connate water.

The extensive sand layer which underlies the soils over much of Willacy County is saturated with highly saline water which is probably largely connate in origin. The extremely high salinity levels in this sand indicate that concentrated brines and perhaps even thin layers of evaporite were incorporated in the depositional sequence as the result of evaporation in shallow basins and lagoons during the formation of the Rio Grande delta on a slowly receding shoreline.

Another possible source of the salt concentrations inherent to the soils is the deposition of salts by precipitation as discussed by Fanning and Lyles. A linear decrease in salt concentration was observed with logarithmic distance inland. The salt content of the shallow saline ground water also decreases with distance inland.

2. The salts contained in irrigation waters. The application of saline irrigation water results in a salt buildup in the soils which reaches harmful proportions unless the salts can be moved through, or out of, the soil.

The relative proportions of salinity from these two sources is extremely difficult to ascertain. Most evidence indicates that the soils were saline to varying degrees before settlement of the area and that the application of irrigation water caused many of them to become critically saline at rates dependent on their natural salinity and physical characteristics. Figure 1 illustrates this process.

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In dryland areas soil salinity is an increasing problem. The critically saline areas are evidently advancing from the east across Willacy County. This advance is believed to be caused by capillary deposition of salts from the highly saline ground water which is present within an extensive sand layer beneath this area. The increased demands placed on soil moisture by crops causes the saline ground water to be drawn towards the surface and permits cyclic deposition of its contained salts within the zone of fluctuation. Soil areas with higher clay contents are subject to higher capillary rise above the water table and lower infiltration rates of fresh rainwater, and therefore are the first areas to become affected by this capillary deposition. Also, the areas lying closer to sea level in elevation would have the highest static ground-water tables and would be affected earliest. There is no evidence which indicates that the ground-water table has risen in the dryland area since the beginning of cultivation. Figure 2 illustrates a probable mechanism for the advancement of the saline areas from east to west. It will be noted from the figure that as new saline areas form to the west, the older ones are undergoing enlargement.

High-water tables have always been present in some of the soils, particularly those near sea level elevation. With settlement and development of the area, the blockage of natural runoff by manmade obstructions and the application of excess irrigation water, have helped to create artificially high-water tables in areas which were not subject to this problem in the natural state. Plate 4 shows the high-water table problem area in 1967.

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TABLE 1

ESTIMATED LAND USE BY SOIL ASSOCIATION
LOWER RIO GRANDE BASIN, TEXAS

Soil Association		Cropland		Grassland				
				Pasture				
		Irrigation	Dry	Irrigated	Dry	Range	Misc.	Total
		thousands of acres						
Coastal Dune-Tidal Flat	(CT)	-	-	-	-	14.0	2.0	16.0
Comitas-Delmita	(CD)	0.9	0.9	0.1	-	15.0	1.8	18.7
Comitas	(C)	2.3	-	0.2	-	1.1	0.3	3.9
Delfina-Ramadero	(DR)	19.4	4.4	1.3	-	-	4.1	29.2
Delmita	(D)	-	12.5	-	-	63.1	7.9	83.5
Duneland	(DU)	-	-	-	-	5.9	0.5	6.4
Harlingen-Montell	(HM)	44.9	-	3.3	0.4	-	7.8	56.4
Harlingen	(H)	52.6	17.1	4.9	1.2	-	10.1	85.9
Hidalgo-Brennan	(HB)	54.4	8.6	5.6	-	0.5	7.2	76.3
Hidalgo-Raymondville	(HR)	40.1	-	3.3	0.8	-	6.2	50.4
Hidalgo, gently sloping	(HG)	66.1	-	6.8	0.4	-	7.7	81.0
Hidalgo, nearly level	(HL)	57.8	-	6.0	0.4	-	6.7	70.9
Jimenez-Zapata	(JZ)	-	-	-	-	4.6	0.4	5.0
Laredo-Laredo,clayey variant	(LO)	79.4	-	5.4	15.5	-	17.4	117.7
Laredo,saline-Lomalta	(LL)	-	-	-	-	18.8	3.2	22.0
Lomalta-Lomalta,Loamy variant	(LP)	-	-	-	-	11.0	1.9	12.9
Lomalta	(L)	-	-	-	-	21.4	3.7	25.1
McAllen-Brennan	(MB)	6.1	69.1	0.6	12.5	37.0	13.0	138.3
McAllen	(MC)	1.2	0.3	0.1	2.3	1.9	0.6	6.4
Montell	(M)	20.9	9.4	1.4	-	-	5.5	37.2
Orelia,sodic variant	(N)	-	36.5	-	-	45.6	9.0	91.1
Nueces-Sarita	(NS)	-	-	-	-	27.4	2.8	30.2
Laredo, clayey variant	(O)	2.9	-	0.3	-	-	0.4	3.6
Lomalta,loamy variant-Tidal Flat	(PT)	-	-	-	-	71.1	9.8	80.9
Point Isabel	(P)	-	-	-	-	2.6	0.4	3.0
Raymondville-Montell	(RM)	16.7	9.1	1.5	0.1	-	2.9	30.3
Raymondville-Orelia,sodic variant	(RN)	1.2	39.0	0.1	4.0	15.7	5.0	65.0
Raymondville	(R)	49.3	45.9	4.3	-	3.7	10.8	114.0
Reynosa-Reynosa,clayey variant	(RR)	18.3	-	1.9	-	-	2.1	22.3
Rio Grande-Camargo	(RC)	58.9	-	5.1	-	-	8.6	72.6
Sarita-Falfurrias	(SF)	-	-	-	-	165.8	16.5	182.3
Willacy-Delfina	(WD)	28.5	17.9	2.2	2.5	3.6	4.0	59.6
Willacy-Hidalgo	(WH)	35.6	18.6	3.6	1.2	28.0	9.0	96.0
Willacy-Ramadero	(WR)	32.3	5.6	2.2	-	2.0	6.9	49.0
Willacy-Raymondville	(WV)	-	53.3	-	-	29.1	8.6	91.0
Fill		-	-	-	-	4.2	0.7	4.9
TOTAL		689.8	348.2	60.2	41.3	593.1	206.4	1,939.0 1/

1/ Does not include 270,300 acres of large water areas.

TABLE 2

AREA HAVING HIGH-WATER TABLE AND
SALINITY PROBLEMS (Prior to Agricultural Development) 1/
LOWER RIO GRANDE BASIN, TEXAS

Soil Association	High-Water Table Problem 2/	Salinity Problem 3/
	thousands of acres	
CT	9.6	9.6
C	-	-
DR	13.1	-
HM	-	56.4
H	-	85.9
HB	9.2	-
HR	8.6	-
HG	4.0	-
HL	14.2	-
LO	17.7	-
LL	22.0	22.0
LP	12.9	12.9
L	25.1	25.1
MB	-	-
MC	-	-
M	-	37.2
N	91.1	91.1
O	-	-
PT	80.9	80.9
P	.8	3.0
RM	10.6	1.8
RN	39.0	37.7
R	-	14.8
RR	4.5	-
RC	-	-
WD	14.9	-
WH	19.2	3.5
WR	-	-
WY	13.6	13.6
TOTAL	411.0	495.5

1/ Factors such as overirrigation through negligence or because it is necessary to leach salts and impairment of natural runoff by man-made structures cause soils to develop abnormal ground-water table and salinity conditions as opposed to their natural state.

2/ Water tables which seasonally occur within 6 feet of the surface.

3/ Salinity sufficient to hinder crop production.

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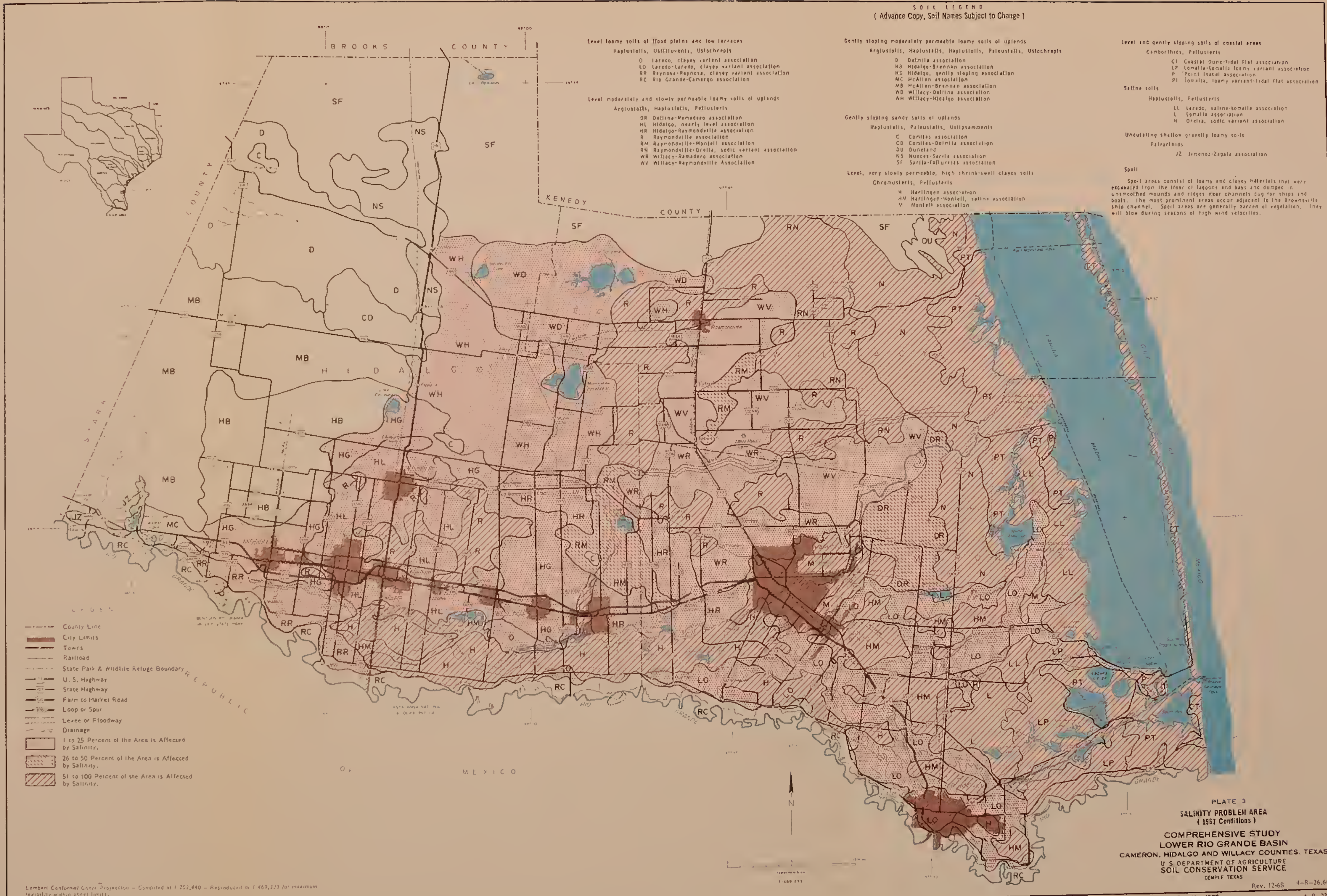

Rev May, 1968 4-R-23508

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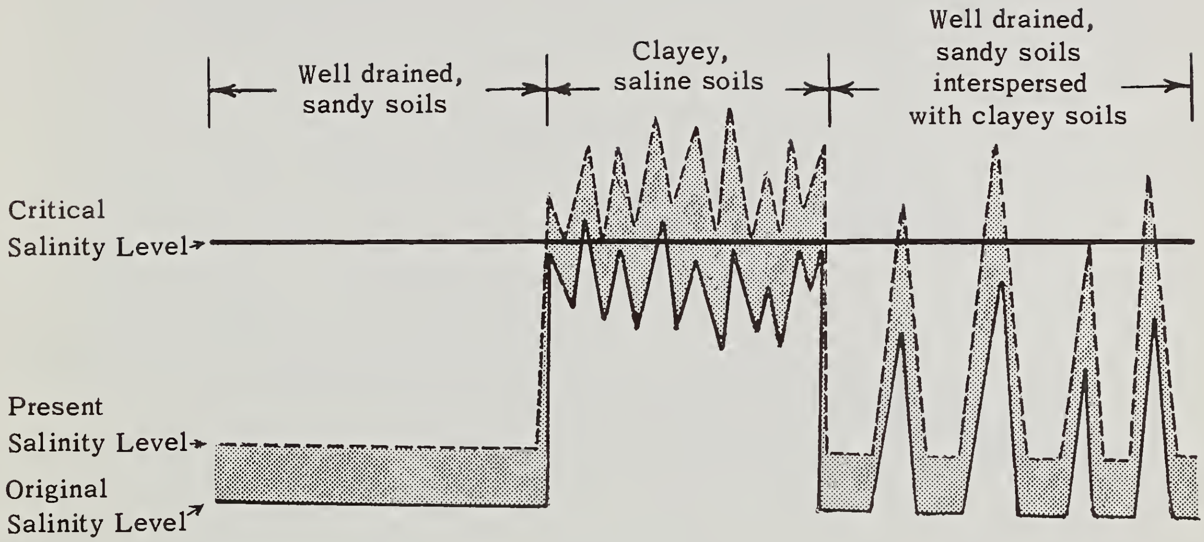

FIGURE 1
PAST AND PRESENT SOIL SALINITY LEVELS
RELATED TO SOIL TEXTURES
LOWER RIO GRANDE BASIN

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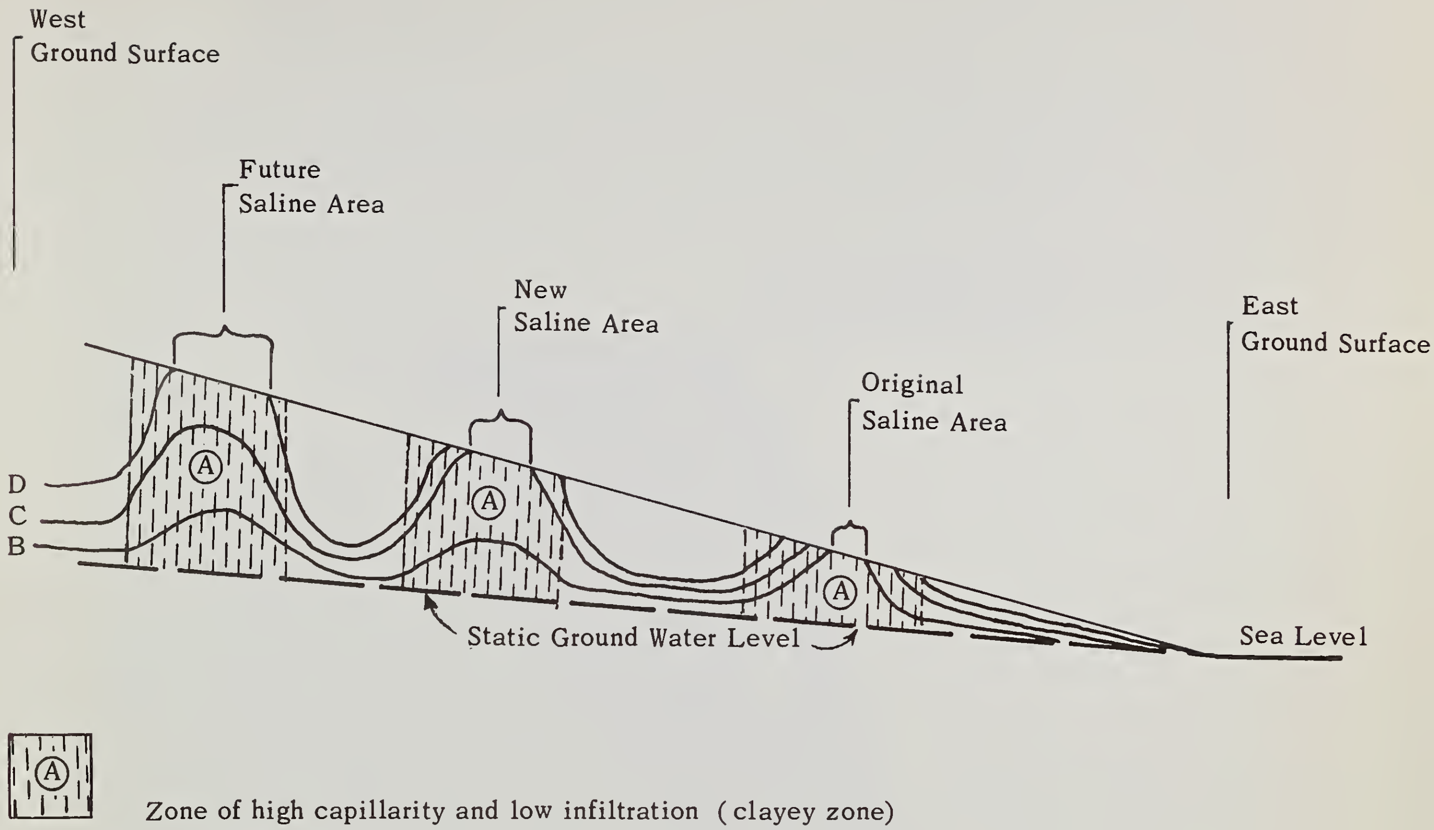

Zone of high capillarity and low infiltration (clayey zone)

B Original upper boundary of critical salinity

C Present upper boundary of critical salinity

D Future upper boundary of critical salinity

FIGURE 2
PROBABLE PROCESS OF HOT SPOT OR SALINE
AREA ADVANCEMENT
LOWER RIO GRANDE BASIN

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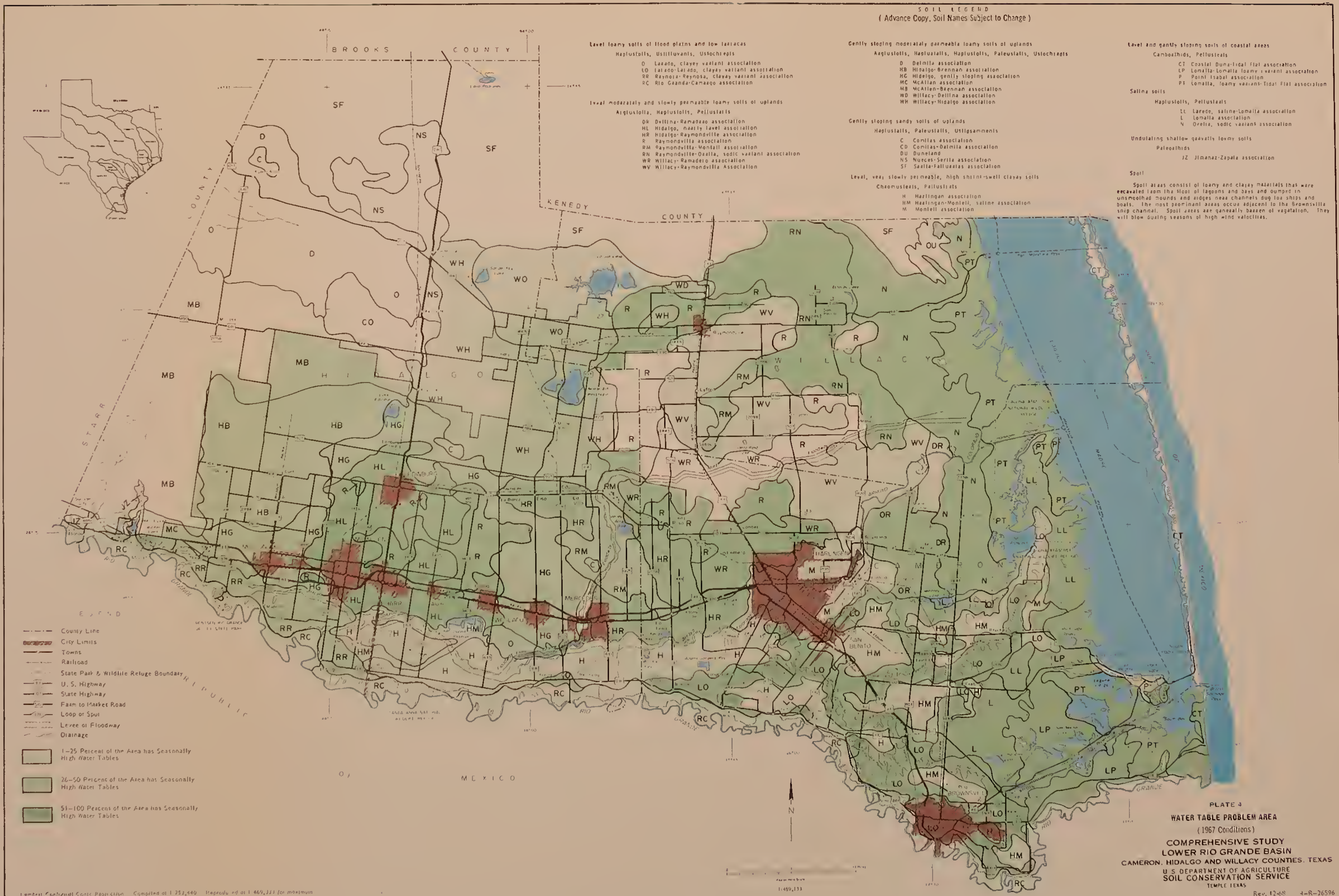

PLATE 4
WATER TABLE PROBLEM AREA
(1967 Conditions)
COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN
CAMERON, HIDALGO AND WILLACY COUNTIES, TEXAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS
Rev. 12-68 4-R-26596

Rev. 5-68 4-R-23508

USDA-SCS-FORT WORTH, TEX. 1969

TABLE 3

AREA HAVING HIGH-WATER TABLE AND SALINITY PROBLEMS
(1967 CONDITIONS)
LOWER RIO GRANDE BASIN, TEXAS

Soil Association 1/	High-Water Table Problem	Salinity Problem
	----------thousands of acres----------	
CT	9.6	9.6
C	0.3	-
DR	22.3	8.7
HM	4.8	56.4
H	5.7	85.9
HB	32.0	-
HR	27.2	6.0
HG	36.9	4.1
HL	39.7	14.2
LO	68.6	17.7
LL	22.0	22.0
LP	12.9	12.9
L	25.1	25.1
MB	3.3	-
MC	0.5	-
M	2.2	37.2
N	91.1	91.1
O	1.3	0.7
PT	80.9	80.9
P	0.8	3.0
RM	11.5	9.1
RN	39.5	39.0
R	53.6	68.4
RR	8.5	4.5
RC	6.4	-
WD	22.6	14.9
WH	27.0	19.2
WR	20.6	10.3
WV	13.7	13.7
TOTAL	690.6	654.6

1/ See Plate 3.

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DRAINAGE NEEDS

Surface and internal soil drainage are serious water management problems in the basin. The mere existence of a high-water table is not conducive to a maximum production of citrus and other agricultural crops. The soils are inherently saline to varying degrees, and this, coupled with use of irrigation water of varying quality and inadequate surface and subsurface drainage, will not permit maximum crop production.

It was determined that a study of the soils should pay particular attention to their surface and subsurface drainage needs. This subject has been treated briefly in the descriptive legend, but is expanded in detail in this section of the report. Plate 5 shows the area needing surface drainage and plate 6, the area needing subsurface drainage. These plates were developed from data shown in Table 4 and from the general soil map considering both dry and irrigated land.

Estimates on the drainage needs for the Lower Rio Grande Valley have been made previously and the results have varied widely. These variances have occurred because previous estimates have been based primarily on opinion or on limited data obtained under different sets of definitions for drainage needs. The data in table 4 is based on a study of accumulated technical data coupled with the results of field experience of USDA personnel, and supersedes all previously published or unpublished data by the SCS on the subject. The definitions and criteria upon which these estimates were made are as follows:

Surface Drainage - Irrigated Land

All surface irrigation systems need surface drainage systems to remove excess rainfall for crop protection. The surface drainage systems may consist of any or all of the following items; (1) row direction, (2) drainage field ditches, (3) drainage mains and laterals and (4) structures for water control. Land leveling is also needed for uniform distribution of irrigation water and rainfall.

Surface Drainage - Dryland

Surface drainage needs on dry cropland and pasture were determined by position in the landscape and soil types.

Subsurface Drainage

Subsurface drainage is defined as the lowering of water tables and removal of excess salts from the root zone of adapted crops by artificial means. Acreages shown are for areas considered as having or developing these problems. Subsurface drainage needs reflect inherent conditions as well as those developed during the past 50 to 60 years of irrigated farming. Needs are also based on an understanding of present technological levels. In this study there has been no attempt to predict drastic changes in technology or conditions that alter needs in the future. Irrigation water quality was considered in the light of $EC\ (rw+iw) = \frac{DrwECrw+DiwECiw}{Drw+Diw}$, where rw represents rainwater, and iw represents irrigation water. D represents the depth of the water entering the soil, and EC represents the electrical conductivity of the water.

Maximum crop production requires the control of salinity within the soils. The maximum permissible salinity contents were based on crop tolerances as listed in Agricultural Handbook 60.

A detailed estimate of drainage needs was developed for each soil association. After estimates were made, the soils were placed in four broad groups for the purpose of showing the range in percentage needing drainage.

Group 1 - 0 to 10 percent needing drainage

This group comprises soils estimated as having little need for subsurface drainage. These soils are mostly fine sandy loam and loamy fine sand with high intake and hydraulic conductivity rates and occur in convex, gently sloping areas. Soil salinity ranges less than 1.0 millimohos/cm at the 5 foot depth. Internal drainage is considered adquate except in areas where these soils occur in close association with other soils having high-water table problems. This group consists of the Comitas and Rio Grande-Camargo associations.

Group 2 - 0 to 10 percent needing drainage

This group consists of soils with a high content of montmorillonitic clay and which have high shrink-swell properties. The dominant salinity level of the root zone ranges between 4 and 6 millimhos/cm. The hydraulic conductivity at the 5 to 6 foot depth is extremely low when the soils are moist. Experience has proven that these soils will not transmit water to drainage conduits. When the soil is dry and cracked, water moves readily through the soil and apparently some leaching is accomplished because of this. These soils are not adapted to low salt tolerant crops such as citrus because of the clayey texture. Cotton, grain sorghum, and vegetables are the dominant crops grown. These soils consist of the Harlingen and Montell series.

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Group 3 - 40 to 60 percent needing drainage

This group of soils consists of fine sandy loam and clay loam with moderate to slowly permeable, crumbly and porous subsoil that ranges from a sandy clay loam to a light clay. These soils are not inherently saline and available data indicates the ECe of the saturation extract under virgin conditions ranges from less than 1 to about 2 millimhos/cm at the 5 foot depth.

The subsurface drainage needs for these soils are based on accumulated data that reflect damaging high-water tables, excessive salinity levels within the root zone for the most sensitive crops (citrus) and topographic positions.

These soils occur on nearly level to gently sloping topography. Hydraulic conductivities range from 0.3 to 3.0 inches per hour. Soils of this group having high hydraulic conductivities and without evidence of high-water tables or salinity levels with the root zone of less than 4 millimhos/cm are considered as having adequate internal drainage. This group consists of the Raymondville; Reynosa; Reynosa, clayey variant; Willacy; Hidalgo; McAllen; Laredo,clayey variant; Brennan; Delfina; and Ramadero Soils.

Group 4 - 60 to 100 percent needing drainage

This group consists of moderately to slowly permeable soils that occur mainly on nearly level areas of eastern Cameron and Willacy Counties. Many of the soils are inherently saline and have seasonally high-water tables. The electrical conductivity of the saturated soil extract is normally greater than 4 millimhos/cm at the 5-foot depth. These are the principal soils which need subsurface drainage under both dryland and irrigated conditions. These soils are not well adapted to salt sensitive crops such as citrus; however, some citrus is grown in these areas. This group consists of the Raymondville; Delfina; Ramadero; Orelia, sodic variant; Laredo; and Laredo, clayey variant soils.

TABLE 4

LAND USE AND SOILS PROBLEMS BY SOIL ASSOCIATION, LOWER RIO GRANDE BASIN, TEXAS

Soil Assoc.	Crop and Pasture Needing Surface Drainage Only		Crop and Pasture Needing Subsurface Drainage Only		Crop and Pasture Needing Surface and Subsurface Drainage	
	Irrigated	Dry	Irrigated	Dry	Irrigated	Dry
	thousands of acres					
C	-	-	0.3	-	-	-
DR	2.1	0.2	-	0.4	18.6	3.1
HM 1/	43.4	0.4	-	-	4.8	-
H 1/	51.7	16.4	-	-	5.7	-
HB	30.0	0.9	-	-	30.0	-
HR	17.4	-	-	-	26.0	-
HG	36.5	-	-	-	36.5	-
HL	25.5	-	-	-	38.3	-
LO	21.2	-	-	-	63.6	-
MB	3.4	-	-	-	3.3	-
MC	0.8	-	-	-	0.5	-
M 1/	20.1	7.5	-	-	2.2	-
N	-	-	-	3.6	-	32.9
O	1.9	-	-	-	1.3	-
RM	10.9	6.8	-	-	7.3	0.6
RN	-	4.3	-	4.3	1.3	30.1
R	-	27.5	-	4.6	53.6	9.2
RR	12.1	-	-	-	8.1	-
RC	57.6	-	-	-	6.4	-
WD	15.4	2.0	-	-	15.4	-
WH	23.5	1.0	-	-	15.7	-
WR	13.8	1.7	-	-	20.6	-
WV	-	15.9	-	-	-	10.7
TOTAL	387.3	84.6	0.3	12.9	359.2	86.6

1/ Subsurface drainage not feasible.

CONCLUSIONS

1. A definite correlation exists between the geologic setting and the soils derived therefrom. A study of soils, as related to geology, may be made from this correlation.

2. The soils were grouped into 35 soil associations for the purposes of study and analysis, and mapped and described on this basis.

3. The natural fertility of the soils is high in all of the area with the exception of the saline coastal portions and the sand sheet area in the northern part of the basin.

4. Realistic estimates of the drainage needs for the basin may be made by applying accumulated data and field experience to the soil associations. These are the most valid estimates available that are based on the present state of technology. They are suitable for planning purposes.

Surface drainage, as defined herein, is needed on all of the area which is flood irrigated and on about 44 percent of the dry crop and pasture land. Subsurface drainage is needed on about 48 percent of the irrigated lands and on about 26 percent of the dryland.

5. The problem of soil salinity is a result of several interrelated factors involving connate soil water, irrigation water, physical soil properties and natural precipitation. It is evident that certain of the soils were saline to varying degrees before settlement of the area, and that agricultural management practices have raised the salinity levels to critical values in some areas during the past 50 years. The practical method of removing this salinity is by leaching, either by the ponding of natural precipitation or the application of excess irrigation water. Either method requires adequate internal or subsurface drainage, either natural or artificial. If drainage is not adequate, water tables will rise and damage crops by drowning and salt deposition.

6. About 36 percent of the land area in the basin is affected by seasonally high-water tables which are detrimental to crop growth. About 34 percent of the land area in the basin is affected by soil salinity of a magnitude sufficient to hinder or preclude agricultural production.

7. A logical explanation for the appearance of saline areas or hot spots in areas which have been put under cultivation lies in the relation of these areas to neighboring areas in regard to their capillary rise and infiltration rates.

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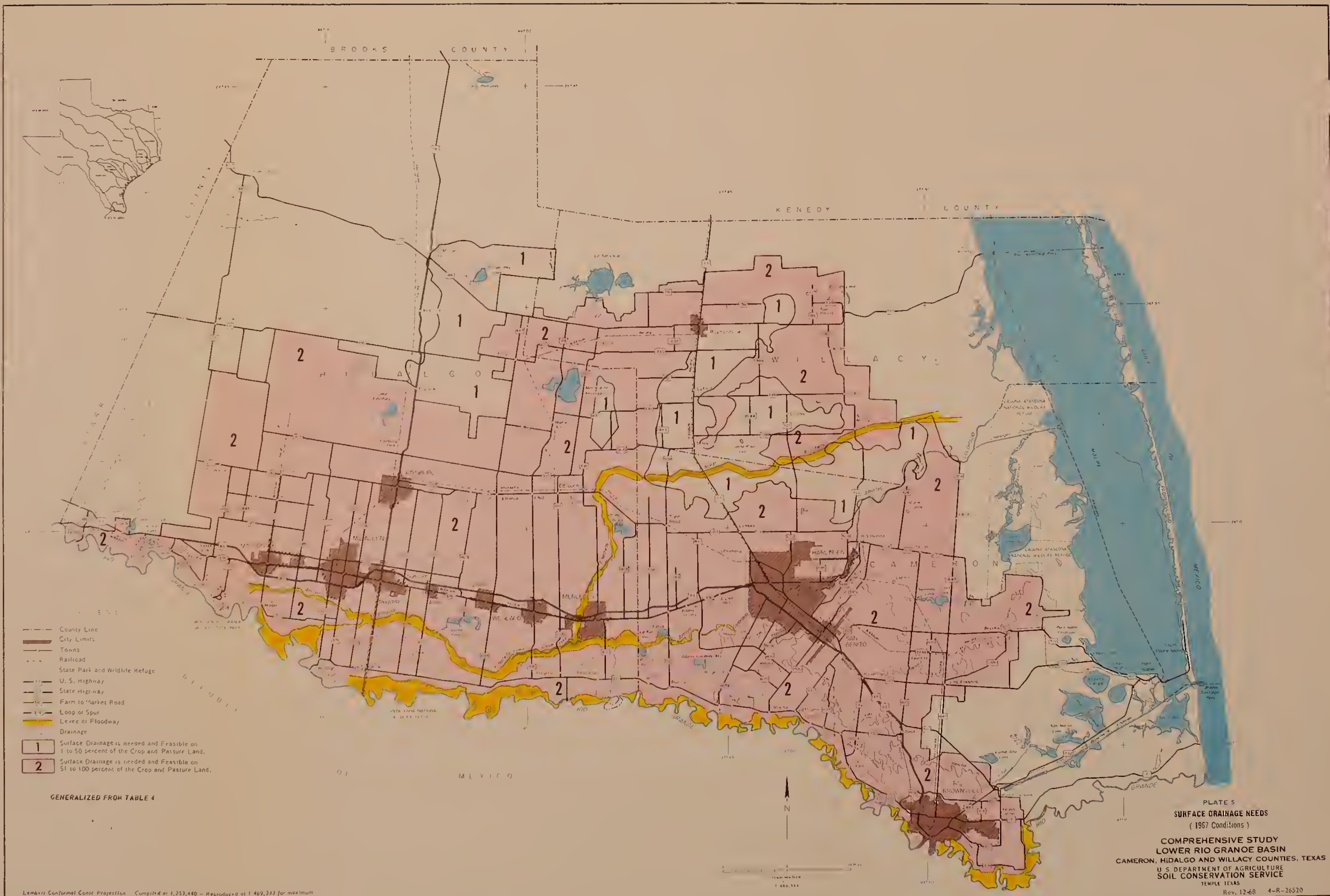
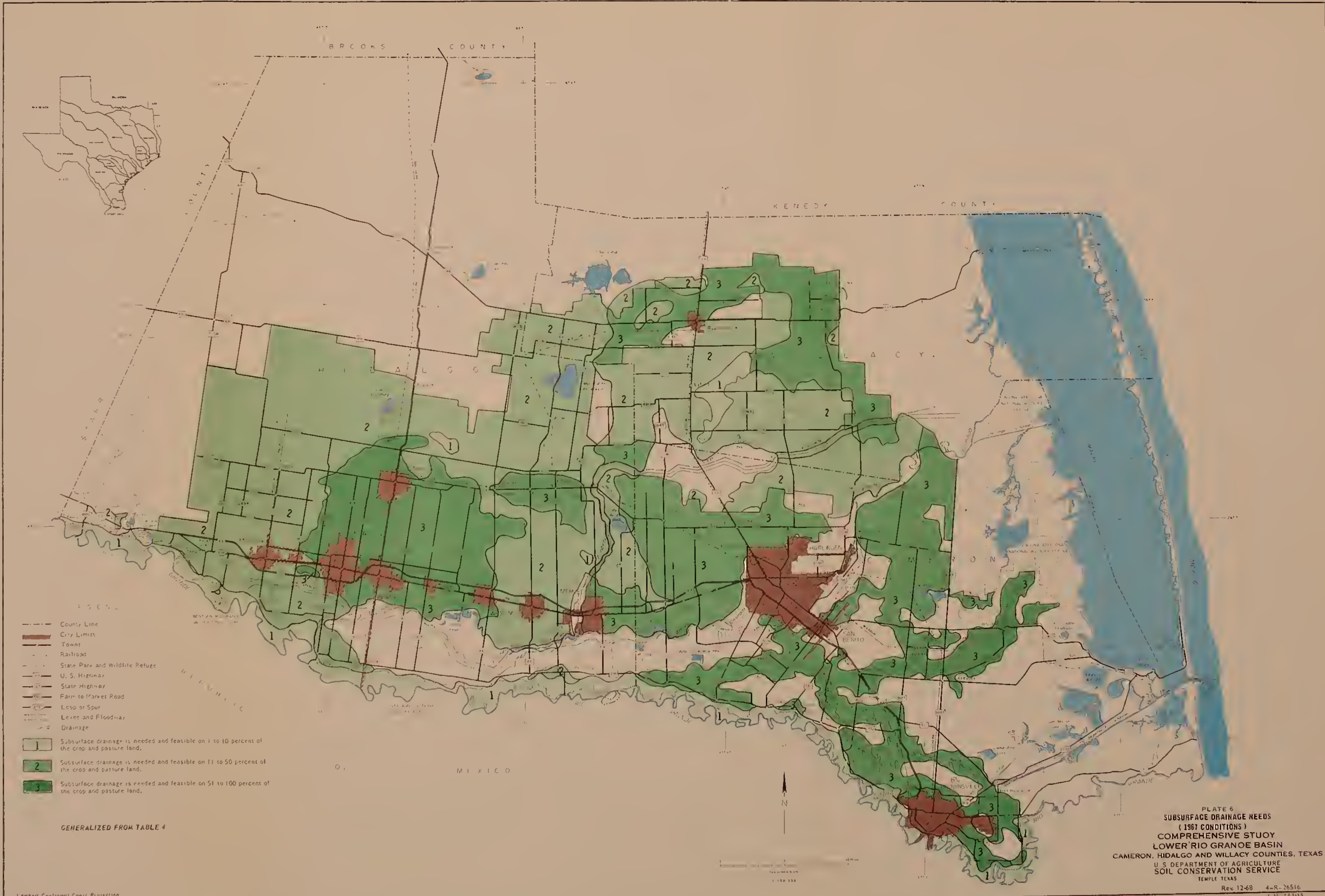


January 1967 Rev May, 1968 4-R-23303

USDA SCS-FORT WORTH, TEX 1969



USDA-SCS-FORT WORTH, TEX. 1969

REFERENCES

1. Agricultural Research Service, USDA, "Chemical, Physical and Mineralogical Characteristics of Eight Irrigated Soils of the Lower Rio Grande Valley of Texas." Weslaco, Texas, 1966.

2. Agricultural Research Service, USDA, "Water Table Depth and Ground Water Salinity in the Non-Irrigated Area of the Lower Rio Grande Valley of Texas," Weslaco, Texas, 1966.

3. Bureau of Reclamation, U. S. Department of Interior, "Report on Infiltration Studies, Valley Gravity Project, Texas," 1948.

4. Fanning,Carl D. and Leon Lyles, "Salt Concentration of Rainfall and Shallow Ground Water Across the Lower Rio Grande Valley," 1964.

5. Myers, V. I., L. N. Langan, and R. D. Lloyd, "Interpretative Soil Groupings for Analysis of Drainage Problems in Western Irrigated Areas."

6. Salinity Laboratory Staff,USDA, "Diagnosis and Improvement of Saline and Alkali Soils, " Riverside, California, 1954.

7. Soil Conservation Service, USDA, "Drainage Guides for Area 25."

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9. Soil Conservation Service, USDA, revised 1967, "Soil Classification, A Comprehensive System," 7th Approximation, Soil Survey Staff, 1960.

10. Soil Conservation Service, USDA, "Watershed Protection Handbook."

11. "Drainage Study Report - Hidalgo County," 1960.

EXHIBITS

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EXHIBITS

VIEWS AND COMMENTS OF INTERESTED AGENCIES

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Statement of Steering Committee

COMPREHENSIVE STUDY
LOWER RIO GRANDE BASIN, TEXAS
February 19, 1969

The final review draft of the report of this study as prepared by the U. S. Department of Agriculture has been reviewed by the Steering Committee, composed of representatives of the United States Department of Agriculture, the Texas State Soil and Water Conservation Board, the Texas Water Development Board, and the Texas Water Rights Commission who provided assistance and guidance throughout the course of the study.

The Committee concludes that the report:

1. Provides for control and management of floodwaters and subsurface waters as needed for the best use or combination of uses of the water and related land resources to meet short-term and long-term needs of the area.

2. Provides a facility that would be compatible with and complement the irrigation developments projected in the Texas Water Plan.

3. Provides a flexible procedure for continuing participation of Federal, State and local entities.

The Committee recommends this report for consideration of the participating agencies and the public.

Harvey D. Davis
Texas State Soil and Water
Conservation Board

Howard B. Boswell
Texas Water Development Board

F. R. Booth
Texas Water Rights Commission

H. N. Smith
Soil Conservation Service
U. S. Department of Agriculture
Chairman

4-28157 11-69

TEXAS STATE SOIL AND WATER CONSERVATION BOARD
1018 First National Building
Temple, Texas 76501
AREA CODE 817, 773-2250

February 20, 1969

Mr. H.N. Smith, State Conservationist
Soil Conservation Service
P.O. Box 648
Temple, Texas

Dear Mr. Smith:

The Texas State Soil and Water Conservation Board has reviewed the Final Review Draft of Volumes I and II of the Comprehensive Study of the Lower Rio Grande Basin as requested in your letter of January 8, 1969.

We believe the report is well prepared and provides a flexible plan for the installation of measures needed to control and manage excess floodwaters and subsurface waters in the study area.

It appears to us that the installation of Phase I of the plan must be accomplished before Phase II and III can be started. Phase II and III provide measures needed for removal of excess surface and subsurface waters on all agricultural lands and will provide a means for installation of on-farm conservation measures.

The State Board feels that this is a much needed project and recommends it to the local people for consideration in conserving, protecting and developing their vital soil and water resources.

Sincerely yours,

Harvey Davis

Harvey Davis
Executive Director

HD:ej

4-28157 11-69

TEXAS WATER DEVELOPMENT BOARD

MEMBERS
MILLS COX, CHAIRMAN
GAY HILL
MARVIN SHURBET, VICE CHAIRMAN
PETERSBURG
ROBERT B. GILMORE
DALLAS
GRONER A. PITTS
BROWNWOOD
MILTON T. POTTS
LIVINGSTON
W. E. TINSLEY
AUSTIN

P. O. BOX 12386
CAPITOL STATION
AUSTIN, TEXAS 78711

HOWARD B. BOSWELL
EXECUTIVE DIRECTOR

AREA CODE 512
475-2201

301 WEST 2ND STREET

February 24, 1969

IN REPLY REFER TO:

TWDBE

Mr. H. N. Smith
State Conservationist
United States Department
of Soil Conservation Service
Post Office Box 648
Temple, Texas 76501

Dear Mr. Smith:

A review has been made of the Department of Agriculture report, "Comprehensive Study of Rio Grande Basin, Texas." We have had continuing participation in the preparation of this report, as it was originally requested by the Texas Water Commission. When the Water Development Board and the Water Rights Commission were assigned the duties of the Texas Water Commission, each of the new organizations was assigned a place on the Steering Committee of the Rio Grande Basin Study. We have, therefore, been involved in the Lower Rio Grande Study.

We believe that the plan can best be implemented by following the schedule of development outlined in the report; that of dividing the work into three projects to:

(a) provide the main canals of the drainage system,
(b) provide the lateral drainage network, and
(c) provide land treatment practices.

Through the above approach, work can be initiated as the need arises and as the economic situation justifies it. As an early action program, no doubt a system of drainage canals or arteries to remove major flooding from the three-county area constitutes an emergency need. This review does

Mr. H. N. Smith
February 24, 1969
Page 2

not address itself to the feasibility of routings that have been selected. It is our understanding, however, that the routing of the most northerly drainage canal will be integrated with plans to develop additional lands, as proposed in the Texas Water Plan. Also, the placing of lateral drainage systems and land treatment methods are matters of local concern, and are not touched on in this review. We believe these developments will follow in natural sequence the construction of arterial drainways.

Primarily the Board is charged with the responsibility of planning for an adequate supply of water to meet all needs of the entire state. Achieving this goal brings into focus such peripheral benefits as navigation, flood control, drainage, waste disposal and many others. We are, to that extent, concerned with drainage being provided to the very important Lower Rio Grande Valley; a fact that is discussed in the Texas Water Plan. The Comprehensive Study as presented is a significant step toward a totally integrated water plan.

Sincerely,

Howard B. Boswell

Howard B. Boswell

4-28157 11-69

Exhibit - 4

TEXAS WATER RIGHTS COMMISSION

COMMISSIONERS

JOE D. CARTER, CHAIRMAN
GREENWOOD 5-2453

WILLIAM E. BERGER
GREENWOOD 5-2452

O. F. DENT
GREENWOOD 5-2451

SAM HOUSTON
STATE OFFICE BUILDING
P. O. BOX 12396
CAPITOL STATION
AUSTIN, TEXAS 78711

F. R. BOOTH
EXECUTIVE DIRECTOR

AUDREY STRANDTMAN
SECRETARY

AREA CODE 512
GREENWOOD 5-4514

February 26, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
U.S. Department of Agriculture
P. O. Box 648
Temple, Texas 76501

Dear Mr. Smith:

In response to your request by letter of January 8, 1969, we have reviewed the Final Review Draft of Volumes I and II of the Report on the Comprehensive Study of the Lower Rio Grande Basin, Texas.

The report is evidence of the comprehensiveness of the study made by the Department of Agriculture and has value as a presentation of a mass of historical information in addition to the plan evolved and the engineering and economic analyses made.

The proposed work of improvement to be installed in the plan of development appears to provide a flexible procedure for the continuing participation of local entities with Federal and State agencies. Floodwater conveyance facilities in Hidalgo and Willacy Counties as described under Phase I are in proper perspective for priority as essential to alleviate critical conditions of flooding following heavy rain.

We are pleased to have served on the Steering Committee for this Study and thank you for the opportunity to comment on the Final Review Draft of the Report.

Sincerely yours,

F. R. Booth

F. R. Booth

LLM/mw

4-28157 11-69

6

Texas State Department of Health

JAMES E. PEAVY, M.D., M.P.H.
COMMISSIONER OF HEALTH

J. B. COPELAND, M.D.
DEPUTY COMMISSIONER

AUSTIN, TEXAS

February 19, 1969

Mr. H. N. Smith
State Conservationist
United States Department
of Agriculture
Soil Conservation Service
P. O. Box 648
Temple, Texas 76501

Subject: Comprehensive Basin Study
Lower Rio Grande Basin, Texas

Dear Mr. Smith:

Volumes I and II of the Comprehensive Basin Study of the Lower Rio Grande Basin, Texas, transmitted in your correspondence of January 22, 1969, have been reviewed. These reports contain a wealth of information and will be useful in many facets of comprehensive planning. It is our feeling that the projects proposed will generally benefit the public health programs in the area. We trust that the activities outlined in the plan have been coordinated with the water and sewer plan for Hidalgo County prepared under a grant from the Farmers Home Administration.

We will be unable to have a representative present at the hearing to be held on February 26, 1969; however, if we can be of any assistance, please call on us.

Very truly yours,

G. R. Herzik, Jr., P. E.
Deputy Commissioner for
Environmental Engineering

DMC:fjt

CAMERON HIDALGO WILLACY

Exhibit - 6

LOWER RIO GRANDE VALLEY DEVELOPMENT COUNCIL
FIRST NATIONAL BANK BLDG. • SUITE 411
PHONE AREA CODE 512 682-3481
McAllen, Texas 78501

PAUL G. VEALE
PRESIDENT
TED R. HUNT
VICE-PRESIDENT
LLOYD HAWKINS
SECRETARY-TREASURER

ROBERT A. CHANDLER
EXECUTIVE DIRECTOR
RICHARD L. McVAY
ECONOMIC PLANNER
JOHNNY W. JANAK
COMMUNITY SERVICES OFFICER

March 7, 1969

Mr. H. M. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas 76502

Dear Mr. Smith:

This is to advise you that the Lower Rio Grande Valley Development Council in an official meeting Thursday, February 27, 1969, passed a motion approving the Soil Conservation Service Proposed Plan of Development of the Water and Related Land Resources of the Lower Rio Grande Basin. That motion read to approve the proposed plan in concept and as presented at the public hearing held in Edinburg, February 26, 1969.

If needed for your purposes, a copy of the minutes of that meeting will be forwarded to you upon request or if you need a resolution, please advise.

Sincerely yours,

Robert A Chandler

Robert A. Chandler
Executive Director

RAC:at
cc: Hal Storey
Area Conservationist
U. S. Dept. of Agriculture
Soil Conservation Service
221 E. Van Buren
Harlingen, Texas 78550

4-28157 11-69

COUNTY *of* HIDALGO

SANTOS SALDANA
COUNTY CLERK

EDINBURG, TEXAS

March 5, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
Box 648
Temple, Texas

Dear Mr. Smith:

Enclosed please find a certified copy of a Resolution which was adopted by the Commissioners' Court of Hidalgo County, Texas, following a public hearing held on the proposed Master Drainage Plan.

A certified copy of the Resolution is also being mailed to Senator John G. Tower and Senator Ralph W. Yarborough and to Congressman E. (Kika) de la Garza.

We have also furnished a copy of the Resolution to Bob Williams of your Edinburg office.

Very truly yours,

Santos Saldana

SANTOS SALDANA, County Clerk

SS:LDB
Encl.

4-28157 11-69

RESOLUTION

WHEREAS, The Commissioners' Court of Hidalgo County, Texas, is aware that the lands located within the boundaries of Hidalgo County, Texas, are being and have been damaged for many years due to high water tables, inadequate surface drainage and the unfavorable soil conditions resulting from poor drainage; and

WHEREAS, this condition of inadequate drainage within this County is one of the most important problems facing this Commissioners' Court and all of the residents and tax payers of Hidalgo County, Texas; and

WHEREAS, the Commissioners' Court of Hidalgo County has heretofore employed engineering firms to make a study and survey of a Master Drainage Plan for Hidalgo County; and

WHEREAS, the United States Soil Conservation Service has made a comprehensive study of the Lower Rio Grande Basin of Texas and has developed a proposed plan of development of water and related land resources of the Lower Rio Grande Valley and Hidalgo and Willacy Counties in particular; and

WHEREAS, the engineers employed by Hidalgo County have worked closely with the United States Soil Conservation Service with regard to the development of the Master Drainage Phase of this plan and are in accord with the Master Drainage Plan developed by the United States Soil Conservation Service and presented at its public hearing on February 26, 1969, at the Hidalgo County Courthouse in Edinburg, Texas.

NOW, THEREFORE, BE IT RESOLVED that the Commissioners' Court of Hidalgo County approves the Master Drainage Plan prepared by the United States Soil Conservation Service and urges that all necessary steps be taken to obtain legislative authority required for the implementation of said plan.

BE IT FURTHER RESOLVED that a certified copy of this Resolution be introduced into the records of the public hearing held on February 26, 1969 by the United States Soil Conservation Service at the Hidalgo County Courthouse and that other copies of this Resolution be mailed to our United States Representative and Senators and to all other interested parties.

Upon said Motion being put to a vote, same was adopted by all present voting "Aye", a quorum being present.

4-28157 11-69

CERTIFICATE

THE STATE OF TEXAS X

COUNTY OF HIDALGO X

I, SANTOS SALDANA, County Clerk of Hidalgo County, Texas, and Ex-Officio Clerk of the Commissioners' Court of said County, do hereby certify that the above and foregoing is a true and correct copy of a RESOLUTION adopted by the Commissioners' Court of Hidalgo County, Texas, on the 4th day of March, 1969, at a Special Meeting of the Court, and which Resolution appears in the Minutes of Commissioners' Court in Volume 32, Pages 774-775, of Record in my office.

WITNESS my Hand and the Seal of said Court at Edinburg, Texas, this 5th day of March, 1969.

SANTOS SALDANA, County Clerk and Ex-Officio
Clerk of the Commissioners' Court

RESOLUTION

We, the members of the Willacy County Commissioners Court hereby commend the Soil Conservation Service of the United States Department of Agriculture for developing a comprehensive Flood water drainage program for Cameron, Hidalgo and Willacy Counties.

We, the Commissioners Court of Willacy County are fully aware of the need for drainage in Willacy and Hidalgo Counties with facilities to provide for the watersheds which start in Hidalgo and continue their course through Willacy County.

We especially commend the Phase III part of the Soil Conservation Service report providing drainage to alleviate the soil salinity problem in the Willacy County area.

We, the Commissioners Court of Willacy County have been cooperating with Willacy residents to provide the local component elements necessary to implement the overall drainage project recommended by the Soil Conservation Service. The Willacy Commissioners Court recently testified before the Reclamation and Conservation Committee of the Texas House of Representatives in favor of creating two drainage districts in Willacy County which will assist to implement an overall Hidalgo and Willacy County drainage and Flood Control project. These two bills have now passed the House of Representatives.

Willacy County citizens have held many meetings to discuss drainage and flood control projects. A majority of Willacy citizens now seem agreed there must be a project for solving the flood water and drainage problem.

We, the Commissioners Court of Willacy County pledge our cooperation with the Commissioners Court of Hidalgo County and the personnel of the Soil Conservation Service in seeking a solution to the Flood water drainage program in Hidalgo and Willacy Counties.

4-28157 11-69

Exhibit - 9

Southmost Soil & Water Conservation District

NO. 319

P.O. Box 1292 - Harlingen, Texas, 78550

SUPERVISORS
H. J. GARRETT
Harlingen
C. H. THOMPSON
Mission
BILL GOLDSBERRY
Edinburg
DEAN ALEXANDER
La Feria
NOLAN WILLIS
Brownsville

June 5, 1968

TO: Members of Congress and U.S. Senate; Commissioners Court of Cameron, Hidalgo, and Willacy County; and H.N. Smith, State Conservationist Soil Conservation Serviee, U.S.D.A.

Gentlemen:

The Supervisors of the Southmost Soil & Water Conservation District proposed the following resolution at their regular meeting held on May 16, 1968.

A true extract from the Minutes of this Meeting is as follows:

"Motion by H.J. Garrett, seconded by Nolan Willis, that the Southmost Soil & Water Conservation District go on record as accepting the River Basin Survey as submitted by the Soil Conservation Service-U.S.D.A., in their joint meeting with the Willacy-Hidalgo Soil and Water Conservation District and that the Commissioners Court of Hidalgo and Willacy County push this to completion, especially Phase I which sets up the three main outlets for these Counties. Motion carried."

Very truly yours,

C H Thompson

C.H. Thompson
Chairman of the Board

SOIL CONSERVATION DISTRICTS OF AMERICA
CONSERVATION · DEVELOPMENT · SELF-GOVERNMENT

Willacy - Hidalgo
Soil Conservation District

P.O. Box ~~432~~ 1296 • Raymondville, Texas 13

February 11, 1969

Exhibit - 10

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
Post Office Box 648
Temple, Texas 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development for the Lower Rio Grande Basin, Texas was adopted by the supervisors of the Willacy-Hidalgo Soil and Water Conservation District in its regular meeting on February 12, 1969, and it is requested that this statement be incorporated as a part of the report.

"The Willacy-Hidalgo Soil and Water Conservation District is composed of Willacy County and the northern two thirds and southwest part of Hidalgo County. We believe the three phase program for flood control, drainage and land treatment as outlined in the report is essential to the future development of the agricultural resources of our area.

"The lack of adequate surface outlets in our District and adjoining Districts has caused water tables to rise. This coupled with lack of suitable outlets for subsurface drainage prevents the lowering of the high water table and the capability for leaching accumulated salts from our soils. Part of the dryland area in our District is in serious trouble due to rising water tables and salt accumulations in the plant root zone.

"We are particularly interested in Phase II and Phase III of the proposed plan of development because these phases will enable groups of landowners and operators to organize and install the much needed multiple-purpose channels for the removal of floodwaters and for outlets for surface and subsurface drainage. However, we realize that these phases cannot be carried out until Phase I is underway.

"The Willacy-Hidalgo Soil and Water Conservation District will join other organized groups in seeking new legislation to carry out the proposed program. The District will promote the formation of local legal entities necessary to assume reponsibilities for local participation in the proposed program."

This action was authorized by a resolution of the governing body of the Willacy-Hidalgo Soil and Water Conservation District adopted at a meeting held on February 12, 1969.

Sincerely,

Lloyd B. Ridling

Lloyd B. Ridling, Chairman

4-28157 11-69

Exhibit - 11

THE STATE OF TEXAS)(
RESOLUTION - MASTER DRAINAGE PLAN
CITY OF EDINBURG)(

WHEREAS, the Soil Conservation Service of the United States Department of Agriculture has heretofore presented to the Board of Commissioners of the City of Edinburg, Texas, its Master Drainage Plan for Hidalgo County and adjoining counties; and

WHEREAS, the said Master Drainage Plan, sometimes referred to as Phase I of a proposed plan for the development of water and related land resources in the Lower Rio Grande Basin, would be of tremendous benefit to the City of Edinburg, Texas, in the solution of its drainage problems; and

WHEREAS, the said Board of Commissioners of the City of Edinburg, Texas, unanimously approves and endorses the said Master Drainage Plan;

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF COMMISSIONERS OF THE CITY OF EDINBURG, TEXAS:

1. That it approves and endorses the Master Drainage Plan prepared and submitted by the Soil Conservation Service of the United States Department of Agriculture.

2. That this Resolution be presented at the Public Hearing to be held on said Master Drainage Plan on the 26th day of February, 1969, at the County Courthouse in Edinburg, Texas, as the official approval and endorsement of the governing body of the said City of Edinburg.

PASSED, ADOPTED AND APPROVED on the 18th day of February, 1969

/s/ Lloyd Hawkins
Mayor, City of Edinburg, Texas

ATTEST:

/s/ P. Trevino Jr.
City Clerk

Seal

4-28157 11-69

RESOLUTION

WHEREAS, the CITY COMMISSION OF McALLEN, Hidalgo County, Texas, is aware that the lands located within the boundaries of Hidalgo County, Texas are being and have been damaged for many years due to high water tables, inadequate surface drainage and the unfavorable soil conditions resulting from poor drainage; and

WHEREAS, this condition of inadequate drainage within this County and in the area of McAllen is one of the most important problems facing the CITY COMMISSION of McALLEN and all of the other residents and taxpayers of Hidalgo County, Texas; and

WHEREAS, the Commissioners' Court of Hidalgo County has heretofore employed engineering firms to make a study and survey of a Master Drainage Plan for Hidalgo County, with which the CITY concurs; and

WHEREAS, the United States Soil Conservation Service has made a comprehensive study of the Lower Rio Grande Basin of Texas and has developed a proposed plan of development of water and related land resources of the Lower Rio Grande Valley and Hidalgo and Willacy Counties in particular; and

WHEREAS, the engineers employed by Hidalgo County have worked closely with the United States Soil Conservation Service and have conferred with the CITY OF McALLEN with regard to the development of the Master Drainage Phase of this plan and are in accord with the Master Drainage Plan developed by the United States Soil Conservation Service and presented at its public hearing on February 26, 1969, at the Hidalgo County Courthouse in Edinburg, Texas.

NOW, THEREFORE, BE IT RESOLVED that the CITY COMMISSION of McALLEN in the County of Hidalgo, Texas approves the Master Drainage Plan prepared by the United States Soil Conservation Service and urges that all necessary steps be taken to obtain legislative authority required for the implementation of said plan.

BE IT FURTHER RESOLVED that a certified copy of this RESOLUTION be introduced into the records of the public hearing held on February 26, 1969 by the United States Soil Conservation Service at the Hidalgo County Courthouse and that other copies of this Resolution be mailed to our United States Representative and Senators and to all other interested parties.

Upon said Motion being put to a vote, same was adopted by all present voting "Aye", a quorum being present.

4-28157 11-69

I, NATIVIDAD SANCHEZ, City Clerk of the City of McAllen hereby certify that the above and foregoing is a true and correct copy of a Resolution passed by the Board of Commissioners of the City of McAllen, Texas, at a meeting held on the 6th day of March, 1969, as reflected by the Official Minutes thereof, to certify which witness my hand and seal of office.

/s/ Natividad Sanchez
NATIVIDAD SANCHEZ, City Clerk

CITY OF MISSION

900 DOHERTY
MISSION, TEXAS
78572

February 14, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas 76501

Dear Mr. Smith:

The City Council of the City of Mission has reviewed the proposed plan of development of the related land resources of the Lower Rio Grande Basin and find the plan acceptable.

As there is an urgent need, within the basin comprising Cameron, Hidalgo and Willacy Counties for a plan concerning the present water problems, we feel this study meets the needs.

The City of Mission stands ready to assist the United States Department of Agriculture Soil Conservation Service in supporting the local cooperation required by law.

Sincerely,

Charles D. Eyeington

Charles D. Eyeington
City Manager

cde:ds

4-28157 11-69

DIRECTORS
RICHARD WIESEHAN
President
P. S. BROWN
Vice-President
W. W. CURL
Secretary
WILLIAM E. ROGERS
J. L. ANTHONY

Hidalgo County Water Control and Improvement District Number One

Paul R. Hetrick, Manager
BOX 870
Edinburg, Texas 78539

P. I. WILLIAMS
Assistant Manager
B. R. STEWART
Attorney
L. RENFROE
Tax Assessor-Collector

RESOLUTION ADOPTED BY THE BOARD OF DIRECTORS OF HIDALGO COUNTY WATER CONTROL & IMPROVEMENT DISTRICT NO. 1.

WHEREAS, the United States Soil Conservation Service has made a comprehensive study of the Lower Rio Grande Basin of Texas; and

WHEREAS, the said Soil Conservation Service has developed a proposed plan of development of water and related land resources of the Lower Rio Grande Valley; and

WHEREAS, the Board of Directors of Hidalgo County Water Control and Improvement District Number One is of the opinion that said proposed plan offers a practical solution to the problems of flood water removal and inadequate surface and subsurface drainage for the District and Hidalgo County:

NOW, THEREFORE, BE IT RESOLVED that Hidalgo County Water Control and Improvement District Number One approves said proposed plan and urges all necessary steps be taken to obtain legislative authority required for the implementation of said plan; and

BE IT FURTHER RESOLVED that a copy of this Resolution be presented at the Public Hearing on the proposed plan to be held on February 26, 1969 at the Hidalgo County Courthouse and a copy forwarded to the Hidalgo County Commissioners Court.

I hereby certify that upon motion made by Director BROWN and seconded by Director ANTHONY, the above Resolution was duly adopted in the minutes of the Board of Directors of Hidalgo County Water Control and Improvement District No. 1 held on February 20, 1969.

Wm W. Curl
Secretary

4-28157 11-69

Exhibit - 15

DONNA IRRIGATION DISTRICT, HIDALGO COUNTY NUMBER ONE

BOARD OF DIRECTORS
J. N. VERTREES, PRESIDENT V. N. WOODMAN, JR., SECRETARY
B. B. DILLON - G. C. VINEYARD - W. M. WASHER
DONNA, TEXAS 78537

March 6, 1969

Mr. H. N. Smith, State Conservationist
P. O. Box 648
Temple, Texas 76502

Dear Sir:

At the regular meeting of the Directors of the Donna Irrigation District Hidalgo County Number One held February 21, 1969, upon motion by Director Woodman, seconded by Director Washer, the following resolution was unanimously adopted:

"WHEREAS since areas of the Donna Irrigation District have been repeatedly subjected to flooding by overflow of local drainage facilities during and after rains in these and neighboring areas, said flooding resulting from lack of adequate outlets for these local facilities, several "Master Plans" for drainage have been studied.

It is the opinion of the members of this Board that the plan presented by Mr. Charles Melden to the Commissioners of Hidalgo County on February 18, 1969, is generally the best to serve the needs of the Hidalgo County area, the degree of drainage provided being adequate and the cost to local interests being quite reasonable.

It is the expressed desire of this Board that further study be given to the division of water between the North Floodway and the Arroya, and plans modified, if necessary, to get maximum use from existing facilities; thus keeping flood losses to a minimum without endangering lives or homes during certain conditions of storm and flood flow;

THEREFORE, BE IT RESOLVED that the Directors of the Donna Irrigation District endorse the "Master Plan for Storm Water Disposal for Hidalgo County, Texas", as presented by Mr. Melden, which plan includes Phase I of the Soil Conservation Service Plan, as being physically adequate and economically feasible to serve the needs for providing drainage outlets for the area considered, and hereby urges the Commissioners of Hidalgo County to take action

WM. A. GREEN, GENERAL MANAGER

MISS TEXIE H. VAUGHAN, ASSESSOR AND COLLECTOR

DONNA IRRIGATION DISTRICT, HIDALGO COUNTY NUMBER ONE

BOARD OF DIRECTORS

J. N. VERTREES, PRESIDENT — V. N. WOODMAN, JR., SECRETARY

B. B. DILLON - G. C. VINEYARD - W. M. WASHER

DONNA, TEXAS 78537

March 6, 1969

Mr. H. N. Smith, State Conservationist
Page 2

necessary to secure funds for this project as soon as it is possible to do so."

Yours very truly

DONNA IRRIGATION DISTRICT

BY Wm A Green
Wm. A. Green, Manager

WAG TV

CC Hon. Milton D. Richardson
County Judge, Hidalgo County
Edinburg, Texas

4-28157 11-69

HIDALGO AND WILLACY COUNTIES
WATER CONTROL AND IMPROVEMENT DISTRICT No. 1

OTHA HOLLAND, President
B. C. HESTER, Vice President
HOKE McKIM, Secretary
L. F. NITTLER, Director
TED PARHAM, Director

68,000 ACRES UNDER IRRIGATION
PHONE
AM 2-1311
EDCOUCH

EDCOUCH, TEXAS

L. C. BRENNER, General Manager
CLIFFORD E. CROSS, Engineer
JOHN M. GUPTON, Tax Assessor-Collector
HILL & KING, Attorneys
TRUETT HUBBARD, Tax Attorney
WINSTON & GREENWOOD, Consulting Engineers

March 1, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas

Dear Mr. Smith:

We are pleased to mail you a certified copy of the resolution adopted by the Board of Directors of this District on the 27th day of February, 1969.

A letter including the following paragraph has been mailed to all interested parties.

"We urge you to give this project "Soil Conservation Service Plan of Development, Lower Rio Grande Basin, Texas" your careful consideration and to lend your best efforts to effect the plan at the earliest possible date."

Yours sincerely,

L. C. Brenner, General Manager

HIDALGO & WILLACY COUNTIES WATER
CONTROL AND IMPROVEMENT DISTRICT #1

LCB/gsk

4-28157 11-69

RESOLUTION
OF
HIDALGO AND WILLACY COUNTIES WATER CONTROL AND IMPROVEMENT DISTRICT NO. 1

WHEREAS, this board finds the following facts to be true:

1. Lands in this district and surrounding lands are being irreparably damaged and have for some years been damaged by high water tables, inadequate surface drainage and the unfavorable soil conditions attendant upon poor drainage;

2. The productive potential of lands in this district and surrounding lands have been curtailed and in some cases destroyed by poor drainage;

3. Hurricane Beulah and the heavy rainfalls following it accentuated these problems, and

4. Property damage to facilities of the district and its landowners and neighbors due to inadequate drainage has become a major problem,

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF HIDALGO AND WILLACY COUNTIES WATER CONTROL AND IMPROVEMENT DISTRICT NO. 1:

1. This district approves the master drainage plan prepared and recently promulgated by the United States Soil Conservation Service, and this district urges the Commissioners Court of Hidalgo County, its congressman, the Honorable Eligio de la Garza, its Senators, Honorable Ralph Yarborough and Honorable John Tower, and all other responsible officials to lend their best effort to affect said plan as early as possible.

2. The Manager of this District is directed to mail certified copies hereof to the Commissioners Courts of Hidalgo and Willacy Counties and to our United States Congressman and Senators and to other interested parties.

/s/ Otha Holland
President

ATTEST:

/s/ Hoke McKim
Secretary

4-28157 11-69

STATE OF TEXAS

HIDALGO AND WILLACY COUNTIES WATER CONTROL AND IMPROVEMENT DISTRICT NO.1

I, Hoke McKim, Secretary of the Board of Directors of Hidalgo and Willacy Counties Water Control and Improvement District No. 1 hereby certify that the above and foregoing is a true and correct copy of a resolution adopted by said Board on February 27, 1969.

Witness my hand and the seal of said District this 27 day of February, 1969.

/s/ Hoke McKim
Secretary

Exhibit - 17

RESOLUTION

WHEREAS, the Board of Directors of Hidalgo County Water Control and Improvement District No. 6 at its regular meeting held on March 4 1969, reviewed and discussed the proposed plan of development of water and related land resources of the Lower Rio Grande Valley as submitted by the Soil Conservation Service and master plan for storm water disposal for Hidalgo County as submitted by the Hidalgo County Commissioners' Court and

WHEREAS the Board of Directors of Hidalgo County Water Control and Improvement District No. 6 desires to approve and endorse such plans as submitted

NOW THEREFORE, BE IT RESOLVED by the Board of Directors of Hidalgo County Water Control and Improvement District No. 6 that it place this resolution in its minutes endorsing and approving Phases 1, 2 and 3 of the plan as submitted by the Soil Conservation Service and also the master plan submitted by the Hidalgo County Commissioners Court for storm water disposal

BE IT FURTHER RESOLVED that a copy of this resolution be furnished to the County Judge and Commissioners Court of Hidalgo County, Texas and to the State Conservationist, Soil Conservation Service, Temple, Texas.

ATTEST:

/s/ Ray Barnick	/s/ Harry Thompson
Secretary	President

4-28157 11-69

RESOLUTION
OF
HIDALGO COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT NO. 7.

WHEREAS, this board finds the following facts to be true:

1. Lands in this district and surrounding lands are being irreparably damaged and have for some years been damaged by high water tables, inadequate surface drainage and the unfavorable soil conditions attendant upon poor drainage;

2. The productive potential of lands in this district and surrounding lands have been curtailed and in some cases destroyed by poor drainage;

3. Hurricane Beulah and the heavy rainfalls following it accentuated these problems, and

4. Property damage to facilities of the district and its landowners and neighbors due to inadequate drainage has become a major problem,

THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF HIDALGO COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT NO. 7:

1. This district approves the master drainage plan prepared and recently promulgated by the United States Soil Conservation Service, and this district urges the Commissioners Court of Hidalgo County, its Congressman the Honorable Eligio de la Garza, its Senators Honorable Ralph Yarborough and Honorable John Tower, and all other responsible officials to lend their best effort to effect said plan as early as possible.

2. The manager of this district is directed to attend the public hearing to be held February 26, 1969, at the Hidalgo County Courthouse Auditorium for the purpose of presenting this resolution and urging the adoption of said plan.

3. Certified copies hereof shall be mailed to the Commissioners Court, to our United States Congressman and Senators and to other interested parties.

/s/ C. H. Thompson
President

ATTEST:

/s/ Elton L. Key, Secretary

STATE OF TEXAS

HIDALGO COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT NO. 7

I, Elton Key, Secretary of the Board of Directors of Hidalgo County Water Control and Improvement District No. 7 hereby certify that the above and foregoing is a true and copy of a resolution adopted by said board on February 14, 1969.

Witness my hand and the seal of said district this 14 day of February, 1969.

/s/ Elton L. Key
Secretary

Hidalgo County Water Control and Improvement District No. 16

P. O. BOX 709
MISSION, TEXAS 78572

March 10, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
Post.Office Box 648
Temple, TX 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development of the Lower Rio Grande Basin, Texas was adopted by the Board of Directors of the Hidalgo County Water Control & Improvement District No. 16 at its regular meeting on February 27, 1969.

"The Hidalgo County Water Control and Improvement District is composed of 12,641 acres of irrigable land in the west part of Hidalgo County, Texas. We believe the three phase program for flood control, drainage and land treatment as outlined in the report is essential to the future development of the agricultural resources of our area.

"The lack of adequate surface outlets in our District and adjoining Water Districts has caused water tables to rise. This coupled with lack of suitable outlets for subsurface drainage prevents the lowering of the high water table and the capability for leaching accumulated salts from our soils.

"We are particularly interested in Phase II and Phase III of the proposed plan of development because these phases will enable groups of landowners and operators to organize and install the much needed multiple-purpose channels for the removal of floodwaters and for outlets for surface and subsurface drainage.

"The Hidalgo County Water Control and Improvement District No. 16 will join other organized groups in seeking new legislation to carry out the proposed program."

Hidalgo County Water Control and Improvement District No. 16 authorized this action by a resolution of the Board of Directors at a meeting held on February 27, 1969.

Very truly yours,

Hid. Co. WC&I Dist. No. 16

By--Jack Brady--
Manager

Edinburg, Texas
February 5, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development for the Lower Rio Grande Basin, Texas, was adopted by members of the Hidalgo County Technical Action Panel in its regular meeting on February 3, 1969.

The Technical Action Panel is cognizant of the fact that without adequate floodwater channels and a complimenting system of laterals the Rio Grande Valley cannot remain as a thriving agricultural community.

As the Technical Action Panel for Hidalgo County we will do everything possible within the authority granted to us in bringing about the implementation Phase I, II and III of the Basin Plan.

Sincerely,

Jim O. Hill

Jim O. Hill, Chairman
Hidalgo County TAP

4-28157 11-69

UNITED STATES DEPARTMENT OF AGRICULTURE
FARMERS HOME ADMINISTRATION
Box 1328
Raymondville, Texas 78580

February 18, 1969

Mr. H. N. Smith, State Conservationest
Soil Conservation Service
Box 648
Temple, Texas 76502

Dear Mr. Smith:

SUBJECT: PLAN OF DEVELOPMENT FOR LOWER RIO GRANDE RIVER BASIN OF TEXAS

The Willacy County Technical Action Panel has reviewed the Plan of Development for the Lower Rio Grande River Basin of Texas.

The plan outlines a three step approach to meet the needs of our area which includes flood control, drainage, and accelerated land treatment. We believe that this concept is practical, feasable, and needed for the future development of agriculture in Willacy County.

The Willacy County Technical Action Panel endorses this proposed flood control and drainage plan and will make it a TAP project.

Sincerely yours,

Charles G. Bridges

Charles G. Bridges
County Supervisor, FHA
Chairman, RAD, Technical Action Panel

4-28157 11-69

AGRICULTURAL EXTENSION SERVICE
of
TEXAS A&M UNIVERSITY

P.O. Box 600
Edinburg, Texas 78539
February 20, 1969

Mr. H.N. Smith
State Conservationist
Soil Conservation Service
P.O. Box 648
Temple, Texas 76501

Dear Mr. Smith:

The Hidalgo County Program Building Committee met on Tuesday, February 18, at the Courthouse in Edinburg, Texas and voted to support the plan of development of the Lower Rio Grande Basin.

Total membership of the committee is 87 representing all areas of Hidalgo County in family living, youth, citrus, beef cattle, cotton, vegetables, grain and forage crops and dairying.

Very truly yours,

Earl Barnes

Earl Barnes, Chairman
Rt. 1, Box 213, Weslaco, Texas
Hidalgo County Program Building Committee

EBjw

4-28157 11-69

TEXAS Farm BUREAU
100,926 MEMBER FAMILIES

HIDALGO COUNTY FARM BUREAU

P. O. Drawer KK • Pharr, Texas 78577 • 512 STerling 7-3229

February 13, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
Post Office Box 648
Temple, Texas 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development for the Lower Rio Grande Basin, Texas, was adopted by the board of directors of Hidalgo County Farm Bureau at its regular meeting on February 12, 1969, and it is requested that this statement be incorporated as a part of the report.

"We believe the three phase program for flood control, drainage and land treatment as outlined in the report is essential to the future development of the agricultural resources of our area.

"The lack of suitable outlets for subsurface drainage prevents the lowering of our high water table and makes it difficult to remove the accumulated salts from our soils.

"We are particularly interested in Phase II and Phase III of the proposed plan because these phases will enable groups of landowners and operators to organize and install the much needed multi-purpose channels for the removal of floodwaters and for outlets for surface and subsurface drainage. However, we realize that these phases cannot be carried out until Phase I is underway.

"The Hidalgo County Farm Bureau will join other groups in securing new legislation to carry out the proposed program".

This action was authorized by a resolution by the Board of Directors of Hidalgo County Farm Bureau and adopted at our regular meeting held on February 12, 1969.

Sincerely,

HIDALGO COUNTY FARM BUREAU

Herman Henry

Herman A. Henry
President

HH/JB

"SERVING THE AGRICULTURAL NEEDS OF HIDALGO COUNTY FARMERS & RANCHERS"

4-28157 11-69

Rt. 1 Box 370
Edinburg, Texas 78539
February 14, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
Post Office Box 648
Temple, Texas 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development for the Lower Rio Grande Basin, Texas was adopted by the members of the Edinburg Farm Bureau at its regular meeting on February 13, 1969, and it is requested that this statement be incorporated as a part of the report.

"We the Edinburg Unit of the Farm Bureau, are aware of the need for surface and subsurface drainage if our area is to continue to grow and prosper as a leading agricultural area. We therefore submit this written statement in support of the three phase plan recommended by the Lower Rio Grande River Basin Survey."

This action was authorized by a resolution of the members of the Edinburg Unit of Texas Farm Bureau and adopted at a meeting held on February 13, 1969.

Sincerely,

EDINBURG FARM BUREAU

Louie Kieffer

Louie Kieffer
President

LK/JB

Rt. 1 Box 241
Pharr, Texas 78577
February 21, 1969

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas 76501

Dear Mr. Smith:

This statement in support of the proposed plan of development for the Lower Rio Grande Basin, Texas was adopted by the members of the Tri City Farm Bureau at its regular meeting on February 20, 1969, and it is requested that this statement be incorporated as a part of the report.

"We the Tri City Farm Bureau hereby endorse the master drainage plan as presented by the Soil Conservation Service and urge that it be started as soon as possible."

This action was authorized by a resolution of the members of the Tri City unit of Texas Farm Bureau and adopted at a meeting held on February 20, 1969.

Sincerely,

TRI CITY FARM BUREAU

Allen Arnold

Allen A. Arnold
President

AAA/JB

4-28157 11-69

Mr. H N Smith, State Conservationest
Soil Conservation Service
Box 648
Temple, Texas 76502

Dear Mr Smith:

SUBJECT: PLAN OF DEVELOPMENT FOR LOWER RIO GRANDE RIVER BASIN OF TEXAS

The Willacy County Farm Bureau Steering Committee for proposed Drainage District No. 2 feels that a complete coordinated system of drainage and flood channels is most vital for the maintanence of our present and future agricultural economy.

Some parts of this district have experienced severe loses due to flood waters and are experiencing further continual loses due to salinity brought about by the high water table and some of these are of such proportions that total loss of production is experienced plus reduced land values.

We support the program as presented and pledge our assistance in implementing the plan.

We plan to urge our senators Yarborough and Tower and our representative De la Garza to lend their efforts toward obtaining authorization by congress and we further encourage other organizations and individuals in this area to give their support to this vital project.

Sincerely yours,

Willacy County Farm Bureau Steering Committee

Chas Hoot Charles Hoot

Kenneth McNeil Kenneth McNeil

THomas Rains Thomas O. Rains

J T Mayo J T Mayo

Alvin Land Alvin Land

Judson Savage J Savage

F W Lewer F. W. Lewer

Mission, Texas
February 3, 1969

Mr. H. N. Smith
State Conservationist
Post Office Box 648
Temple Texas 76501

Dear Mr. Smith:

This statement is in support of the Proposed Plan of development for the Lower Rio Grande River Basin of Texas. This was adopted by the members present at a meeting on February 3rd 1969, and it is requested that this Statment be Incorporated as a part of the report.

We of the Mission Farm Bureau unit of Hidalgo County realize that our drainage problems are very acute, and we feel that this plan will when installed improve our Future development of the agricultural resourses of our area.

Respecrfully submitted
Mission Farm Bureau

L. B. Ridling
L. B. Ridling (Pres.)

4-28157 11-69