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COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSAS--ETC(U)
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COMPREHENSIVE BASIN STUDY



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RED RIVER BELOW DENISON DAM

ORIGINAL CONTAINS COLOR PLATES: ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE.

VOL. 3 APP. V

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RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

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and Programs
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② Comprehensive Basin Study.

RED RIVER BELOW DENISON DAM,
 ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
 COMPREHENSIVE BASIN STUDY

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APPENDIX V

UPSTREAM WATERSHED PROTECTION, USE,
 MANAGEMENT, AND DEVELOPMENT

ORIGINAL CONTAINS COLOR PLATES: ALL DDG
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ERRATA SHEET

The USDA recommended and alternative project plans for lower Bois d'Arc Creek Watershed (3-25) and upper Bois d'Arc Creek Watershed (3-25a) are tabulated incorrectly in the final section of Appendix V. The alternative plan, which includes Bonham Reservoir, 22 upstream reservoirs, and 30.3 miles of channel improvements, should be the plan recommended by USDA for the early-action program. The USDA plan, which includes 41 upstream reservoirs and 30 miles of channel improvements for these watersheds, should be the alternative plan. Accordingly, data shown for these watersheds in tables 72, 73, 75, and 76 should be interchanged with similar data in tables 80, 81, 82, and 83.

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Arkansas, Louisiana, Oklahoma, and Texas

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| III | Hydrology, Surface and Ground Water, and Geology | USAE & USGS |
| IV | Flood Control and Major Drainage | USAE |
| V | Upstream Watershed Protection, Use, Management, and Development | USDA |
| VI | Irrigation | USDA & BR |
| VII | Drainage and Flood Prevention on Flatlands | USDA |
| VIII | Mineral Resources and Mineral Industry | BM |
| IX | Archeological, Historical, and Natural Resources | NPS |
| X | Hydroelectric Power | FPC, SPA & USAE |
| XI | Water Supply and Water Quality Control | FWPCA |
| XII | Outdoor Recreation | BOR |
| XIII | Fish and Wildlife | BSF&W |
| XIV | State Water Laws, Policies, and Programs | States of Arkansas, Louisiana, Oklahoma, and Texas |
| XV | Plan Formulation | Plan Formulation Task Force |

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SUMMARY

Upstream watershed protection, use, management, and development investigations in the Red River Basin Study Area were made by the Soil Conservation Service, Forest Service, and Economic Research Service of the U. S. Department of Agriculture. The purposes of ~~the investigations~~ ^{this document} ~~were~~ to: (1) identify water and related land resource problems; (2) prepare a potential plan for water and related land resource development that could be accomplished under USDA programs; (3) prepare agricultural and forestry data for use of cooperating agencies in planning water and related land resource projects under their programs; and (4) compile engineering, economic, and related data that local organizations could use for developing water and related land resources. All investigations were coordinated with investigations of other cooperating agencies. December 31, 1962, was selected by USDA as the planning base.

The Study Area extends from Denison Dam in Oklahoma and Texas to a point near the mouth of the Red River in Louisiana. It includes all of the drainage area between these points except for the drainage area of the Ouachita River and Black River and Concordia Parish in Louisiana. The Study Area includes approximately 29,610 square miles (18,950,272 acres) in all or parts of 60 counties and parishes in parts of Arkansas, Louisiana, Oklahoma, and Texas. Geology and relief vary substantially and mean sea level elevations range from 40 feet to 2,600 feet. The dendritic drainage pattern consists of 193 Conservation Needs Inventory (CNI) watersheds within 24 tributary basins. About 289,300 acres, or 1.5 percent of the total area, are permanent water surfaces such as larger lakes, streams, sloughs, and canals. The land area of 18,661,000 acres is about 55 percent forest and woodland, three percent miscellaneous land, 35 percent cropland, pasture, and rangeland, and the remaining seven percent is land not inventoried as to land use.

The 1962 population was about 1,757,400 or about 59 persons per square mile. About 49 percent of the population live in urban areas, 40 percent in rural towns, and 11 percent on farms. Farm population decline began in 1930 and is continuing. The Study Area included about 77,150 farms in 1962 with an average size of 190 acres. Farm numbers are decreasing and farm sizes are increasing. The 1962 value of farm products sold was about \$297,669,500, or about \$3,860 per farm. Livestock and livestock products provided about 56 percent of all farm income.

Population projections and projections of economic activity were made to provide a basis for determining needs for additional water and related land resource development. Projections indicate that deficits in agricultural production needs allocated to the Study Area can be expected by 1980. Deficits will increase by 2010. Additional water and related land resource development would provide opportunities to meet production needs. Watershed project developments also are needed to meet projected needs for flood prevention, municipal and industrial water supplies, pollution abatement, rural and domestic water supplies, recreation, and rural area redevelopment by 1980 and in subsequent periods.

Water and related land resource problems were identified in each of the 193 CNI watersheds. Principal problems include flooding, inadequate drainage, water pollution, inadequate recreation development, drought, and inadequate municipal and industrial water supplies. Problems and needs vary in each of the CNI watersheds. The nature and severity of the problems provided a basis for selecting watersheds for initial and long-range development. Sixty-five CNI watersheds were selected for initial development (within the next 10-15 years), six CNI watersheds were selected for long-range development (beyond the next 10-15 years), and 122 CNI watersheds were considered not feasible for development. Thirteen of the 65 watersheds in the initial development category had been approved for watershed project operations under P. L. 566 prior to 1963. A total of 25 watershed projects had been approved for P. L. 566 operation in 27 CNI watersheds through 1966, and construction was completed on seven projects.

Soil erosion, soil limitation, and excess water problems adversely affect agricultural and forestry production on 16,559,800 acres, or nearly all of the productive base area. The nature and severity of the problems vary by major resource areas and land uses. Conservation treatment consisting of land user conversions and the common soil and water conservation practices has been applied to about one-fourth of the Study Area.

Existing water and related land resource development includes 13 CNI watershed projects authorized for P. L. 566 operations, 20 U. S. Army Engineers reservoir projects, six Forest Service reservoir projects on public land, and 12 State, municipal, and private reservoir projects. These projects were authorized for operations prior to December 31, 1962, and include water storage for flood prevention, irrigation, municipal water supply, and recreation purposes. Drainage improvement is a corollary purpose in one project.

Water and related land resource potential for development under USDA programs was appraised. Potential projects were identified in 52 CNI watersheds for initial development. Projects would include land treatment and structural measures for watershed protection, drainage, flood prevention, water quality control, recreation, municipal and industrial water supply, and irrigation purposes. Single-purpose reservoir storage could be added in four of the CNI watersheds to meet water quality control, recreation, and municipal and industrial water supply needs. Additional storage would be available in most reservoir sites.

Seven single-purpose recreation reservoirs, including aggregate storage of 2,870 acre-feet and 507 surface acres, are proposed for initial development in National Forests.

Potential multiple-purpose projects were identified for long-range development in six CNI watersheds. Projects would include land treatment and structural measures for watershed protection, drainage, flood prevention, recreation, and municipal and industrial water supply needs. Ten additional single-purpose reservoir projects to meet long-range recreation and irrigation water needs were identified in five CNI watersheds that were

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identified for initial and long-range development. Structural measures would include 30.3 miles of channel improvement and 38 reservoirs with 161,469 acre-feet of useful storage.

Reservoir site development opportunities to meet water quality control, recreation, municipal water supply, and irrigation projected needs for initial and long-range development were identified in 39 non-feasible CNI watersheds. Reservoir useful storage capacity of 768,665 acre-feet could be developed. An additional 803,975 acre-feet of storage is available in these sites.

Project plans for CNI watershed development were prepared to integrate U. S. Army Engineers reservoir site development proposals for Parker, Bonham, Durant, and Kisatchie Reservoirs. The first three reservoirs would reduce the upstream watershed project size, and the Kisatchie Reservoir would eliminate the potential for early-action upstream watershed development in three CNI watersheds. Some of the combined project plans would include water storage for interbasin transfer.

Alternate water supplies for irrigation needs are also available to meet 2030 needs. Surface water supplies would provide better quality water than Red River supplies and should be given a higher development priority for irrigation development.

Land resource development potential can be realized by adoption of improved production practices and adjustments in land use. Establishment and maintenance of conservation practices is needed to maintain and improve agricultural and forestry productivity. Existing agricultural programs are being used for land resource development.

The most obvious impacts of potential project development are conversions of land to water areas. Existing, authorized, and potential projects would increase permanent water surfaces from 289,300 acres in 1962 to 745,400 acres in 1980. The productive base for agriculture and forestry would decrease from 17,333,300 acres in 1962 to 16,782,000 acres in 1980. Part of the decrease would result from increases in area devoted to urban, built-up, and small water uses. These changes and projected major land use changes would decrease total land treatment requirements, but would require increased use of cropland conservation practices.

Potential projects will contribute to meeting increased agricultural production requirements in 1980 by allowing formerly flooded and poorly drained land to be farmed more intensively. Irrigation projects will increase agricultural production. Projected 1980 agricultural production with potential projects and programs will provide about 96 percent of projected feed unit needs.

Potential projects would result in favorable overall agricultural economic impacts such as increased rural employment and income. Reduction of woodland acreage would affect forest industry and related employment adversely. Expected reductions in bottomland hardwood acreages will have detrimental effects on the hardwood industry.

USDA potential projects and programs will have only minor effects on water yields in most years. Benefits from further reduction of remaining flood damages in the Red River alluvial area upstream from Fulton, Arkansas, may be expected.

USDA is recommending early action in the development of improvements urgently needed to solve watershed problems and to meet estimated needs through 1980. Upstream watershed improvements include structural and land treatment measures. About 24 percent of the Study Area is included in early-action development. About 501,600 acres will require acceleration of installation of land treatment measures in upstream watershed projects.

Installation costs of structural measures would amount to \$116,277,900 including \$108,643,510 for multiple-purpose projects, and \$7,634,390 for single-purpose projects. Total annual costs are \$5,308,470 and annual benefits are \$13,309,635.

INTRODUCTION

This Appendix by the U. S. Department of Agriculture (USDA) is one of 15 appendices to the Red River Basin Comprehensive Study (RRBCS) interagency report. The Field Coordinating Committee (FCC) assigned to USDA primary responsibility for Appendix VI (Irrigation), Appendix VII (Drainage and Flood Prevention on Flatlands), and Appendix V (Upstream Watershed Protection, Use, Management, and Development). This Appendix is concerned with upstream watershed problems, water and land development needs, potential for development of water, and related land resources, and with identification and descriptions of watershed projects that need to be initiated within the next 10-15 years. Other appendices to the interagency report are listed on page i.

Recommendations contained in this Appendix for upstream watershed projects are USDA recommendations to the FCC for basin plan formulation. Recommended upstream watershed projects were formulated to meet future needs for water and related land resource development insofar as USDA programs could be adapted to meeting the needs. Needs for resource development are described in this Appendix and other Appendices. Combined project plans were prepared cooperatively with the U. S. Army Engineers to integrate major reservoir site development proposals with upstream watershed projects in several upstream watersheds. Data for combined projects also are included in this Appendix for consideration by the FCC in basin plan formulation. Data for upstream watershed projects and for combined projects are presented in sufficient detail in this Appendix to enable the FCC to select appropriate projects for inclusion in the basin plan. The basin plan will be discussed in the Plan Formulation Appendix and the Summary Report.

AUTHORITY

The USDA participated in the Red River Basin Comprehensive Study under authority provided by Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). The Act is administered by the Soil Conservation Service (SCS) of the USDA. It authorizes the USDA to cooperate with other Federal, State, and local groups or agencies in surveys and investigations of river basins as a basis for development of coordinated programs.

OBJECTIVES

The USDA study was designed to develop agricultural and forestry data for the use of cooperating agencies and to prepare a potential plan of development for water and related land resources that could be accomplished under USDA programs. Agricultural data is needed by State and other Federal agencies as a basis for planning water and related land resource projects under their programs. A potential plan of development under USDA programs is needed for preparation and selection of an overall plan for water and related land resources development in the Study Area.

The primary objective of the USDA Study is to facilitate the coordination and orderly investigation, development, utilization, and management of water and related land resources of the Study Area. Achievement of this aim necessitated a general appraisal of the upstream water and land resource problems and an appraisal of the potential for resource development. This included:

(1) An inventory and description of water and related land resource problems and the general approaches that appear appropriate for their solution.

(2) Studies and projections of economic development.

(3) Translations of such projections into needs for water and related land resource uses.

(4) Appraisals of the availability of water supplies both as to quantity and quality.

(5) Appraisals of the availability of the related land resources.

(6) Studies and identification of projects which need to be initiated during the next 10-15 years.

(7) Studies to determine the extent to which recreation, fish and wildlife habitat improvement, flood control, drainage, irrigation, water quality control, and water supplies for rural, municipal and industrial uses can be provided by water and related land resource developments and programs in upstream areas to satisfy needs.

(8) A compilation of economic, engineering, and related data that local organizations could use for developing water and related land resources.

NATURE, SCOPE, AND INTENSITY OF INVESTIGATIONS

The Red River Basin below Denison Dam Study is defined as a Type II comprehensive detailed survey. A study of this type includes the major elements of a Type I Study (Objectives 1 thru 5) plus intensive studies of specific projects, the installation of which will need to be initiated within the next 10-15 years.

Basin conditions that existed on December 31, 1962, were selected by the USDA to represent the planning base. All potential improvements and evaluations of impacts of the potential improvements were referenced to the 1962 base year. A project evaluation maximum period extending from 1980 to 2080 was selected for use by all cooperating agencies. An agricultural projection period extending from 1962 to 2010 was used for major crops and other agricultural commodities. Agricultural census data, through 1959, were primary guides for establishing the agricultural planning base, and these were adjusted on the basis of later information.

The SCS, Economic Research Service (ERS), and Forest Service (USFS) participated in the USDA study. Participation of each agency was coordinated through the Washington Advisory Committee (WAC) and the Field Advisory Committee (FAC). The latter met on the call of the Chairman to effect coordination of USDA studies and to assure that studies were adequately coordinated with studies of other cooperating agencies.

Field examination scope studies, preliminary investigation scope studies, and reimbursable studies for the U. S. Army Engineers were conducted. All studies were oriented toward the individual tributary watershed. Field examination scope studies were developed early in the study to produce a preliminary appraisal of potential project feasibility. Results of the studies were summarized for all watersheds within a tributary basin in preliminary reports, which were provided to cooperating agencies. Preliminary investigation scope studies were made in selected watersheds. These consisted of more intensive studies of

specific projects, the installation of which will need to be initiated within the next 10-15 years. Watershed problems were defined, the nature of the project described, and the cost and benefits of the proposed project were developed, based on data for specific watersheds. Allocation of project costs to project purposes was included. Potential projects were coordinated with projects of other agencies insofar as coordination could be effected.

Investigational efforts were largely confined to the physical and economic relationships within the Study Area. The availability of land for development purposes was indicated by its projected use in the absence of development. The land-taking impact of development was indicated by the changes in the pattern of land use induced by resource development. An intensive study and evaluation was made of the satisfaction of demands for outdoor recreation opportunities in the rural sector, and of levels and efficiency of crops and pasture production. Evaluations were based in part on materials developed and provided by cooperating agencies.

Preliminary examinations were made of the forest resource in selected watersheds and forest cover conditions in selected problem areas were sampled. These studies were combined with a general reconnaissance of all forest lands in the Study Area. Woodland and plant managers, key State and Federal personnel, and officials of private organizations having a primary interest in the forest resources collaborated in the studies. Background information for this study, and other specific information used to correlate published data, were obtained in cooperation with other agencies.

COOPERATING AGENCIES

Cooperating agencies included the U. S. Army Engineers (USAE); the U. S. Geological Survey (USGS), Bureau of Reclamation (BR), Bureau of Mines (BM), Bureau of Outdoor Recreation (BOR), the Federal Water Pollution Control Administration (FWPCA), and the Bureau of Sport Fisheries and Wildlife (BSF&W) of the U. S. Department of Interior (USDI); the Weather Bureau (USWB) of the U. S. Department of Commerce (USDC); the Public Health Service (PHS) of the U. S. Department of Health, Education, and Welfare (USHEW); and the Federal Power Commission (FPC). State agencies included the Arkansas Soil and Water Conservation Commission, Louisiana Department of Public Works, Oklahoma Water Resources Board, and Texas Water Development Board.

The Study was made under the overall direction of the FCC comprised of a representative from each of the Federal departments and each of the State cooperating agencies. The FCC established subcommittees comprised of representatives designated by cooperating agencies for the purpose of effecting planning coordination. Other agencies represented on subcommittees included the Texas Water Rights Commission, Texas State Health Department, Arkansas State Health Department, Arkansas Game and Fish Commission, Texas Department of Parks and Wildlife, Arkansas Geological Commission, and the Texas Bureau of Economic Geology.

ACKNOWLEDGEMENTS

Several Federal and State agencies furnished valuable data for developing this Appendix. The field offices of the Soil Conservation Service, Forest Service, and Statistical Reporting Service furnished information relating to soils, land use, agricultural production, land treatment, and land use problems. The Forest Service also furnished information and data on management of National Forests. The basin needs for navigation, flood control, recreation, fish and wildlife, water supply, water quality control, and irrigation that were developed by the U. S. Army Engineers, Bureau of Outdoor Recreation, Bureau of Sport Fisheries and Wildlife, Federal Water Pollution Control Administration, and the Bureau of Reclamation provided essential information for developing a potential plan of water and related land resource development under USDA programs.

The Texas Water Development Board and the Louisiana Department of Public Works facilitated preparation of the USDA potential development plan by providing planning and project data within their states. Federal and State cooperating agency comments on USDA preliminary reports for tributary basins and on USDA upstream watersheds investigation reports were useful for coordination of USDA studies with investigations of cooperating agencies.

DESCRIPTION OF THE STUDY AREA

LOCATION AND SIZE

The total land and water area included in the USDA Comprehensive Study is approximately 29,610 square miles (18,950,272 acres) in parts of Arkansas, Louisiana, Oklahoma, and Texas (figure 1). The Study Area extends from Denison Dam, forming Lake Texoma, to a point near the mouth of Red River in Louisiana. It includes all of the drainage area between these points except for the drainage area of the Ouachita River and Black River and the drainage area of Concordia Parish, Louisiana. Also included in the Study Area are Lower Mississippi River drainage areas that are naturally interrelated with Red River drainage areas.

The Study Area includes all or parts of 60 counties and parishes. Nine counties are in Arkansas, 13 in Oklahoma, 19 in Texas, and 19 parishes are in Louisiana. Twenty-two parishes and counties are entirely within and 38 are partly within the Study Area.

GEOLOGY

A relatively small area in the extreme northwestern part of the Study Area lies within the Arbuckle uplift region. Hard limestones, sandstones, shales, and crystalline igneous rocks of Paleozoic and Precambrian ages are represented. The granitic soils in this area are light colored and medium to coarse textured.

Formations in the Ouachita Province represent rocks ranging in age from the lower Paleozoic Era to the Mesozoic Era. Deformation with accompanying induration has added to their resistance to weathering. Metamorphism was not of a significant magnitude to change the nature of all rocks, but there are some quartzites and slates. Rocks of the Ouachita Province, in order of their abundance are shale and slate, sandstone and quartzite, chert, novaculite, tuff, limestone, and conglomerate. Soils developed from the varied types of parent material range from sandy loams to silty clays and clay.

From the Trinity sandstone of Cretaceous age, which is exposed near Denison Dam, the Red River Valley traverses younger formations ranging upward through the Tertiary and Quaternary Periods to Recent age in the West Gulf Coastal Plain. Much of the material in these formations was derived from older sedimentary rocks, and is therefore regarded as reworked material. All the common varieties of sedimentary rocks are contained in Cretaceous and Tertiary formations of the region and impart certain prominent characteristics to the Red River sediments. The usually bright red color is very noticeable. The coloring matter is obtained partly from the Pennsylvanian and Permian rocks farther west, but the amount of ferruginous sediment is increased considerably in Louisiana by the addition of iron oxides from Tertiary formations which contain iron bearing minerals such as glauconite, limonite, hematite, magnetite, and ilmenite. The high mica content of the Midway silts, sands, and clays is

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notable, and their color is typically higher than that of later Tertiary groups. Above the Tertiary System, Pleistocene Terraces and Recent alluvium are composed of gravels, sands, clays, and silts and are in contact with present river alluvium. The gravels of the region are mostly chert, quartz, and iron oxides.

TOPOGRAPHY

The terrain in the tributary basins draining into Red River ranges from rugged mountains to low, rolling hills. Elevations range from approximately 40 feet above sea level in Avoyelles Parish, Louisiana, to more than 2,600 feet in southwestern Arkansas. The Ouachita Mountains in Arkansas and Oklahoma have steep slopes, sometimes towering 1,000 feet above narrow valleys. Local areas may have narrow floodplains and one or two stream terraces ranging from 40 to 80 feet above the large channels.

Lands adjoining the Ouachita Mountains on the west are characterized by wide valleys bounded by abrupt escarpments. Generally, the streams flow in broad, shallow channels.

In the tributary basins below the Ouachita Mountains, low relief and gentle southeastward slopes predominate. Irregular, rolling, and hilly uplands associated with relatively flat terraces and floodplains are common topographic expressions. Generally, relief is low, averaging from 100 to 200 feet, except in the Ouachita Mountains.

The elevation of the alluvial land along the main stem of Red River ranges from less than 40 feet above sea level near the mouth of Red River to more than 500 feet near Denison Dam. The valley gradient is steeper above southwestern Arkansas with accompanying slight changes in local relief. Low terraces, or second bottoms, become more common upstream, attaining a relief of 10 to 15 feet in comparison with first bottom alluvium near Denison Dam. In the Arkansas-Louisiana portion of the floodplain, local relief is small; a few isolated low ridges or hills constitute the sharpest breaks in the relatively flat terrain. Depressions resulting from abandoned stream channels are common. Generally, the land slopes gently away from the natural levee adjacent to the river channel.

STREAMS AND LAKES

The Red River, which is the main stem of the drainage system, enters the Study Area at Denison Dam and flows generally southeasterly 470 miles to its confluence with Old River. The river channel is from 700 to 1,200 feet wide, between high banks ranging from 15 to 35 or 40 feet above low water, except for occasional short reaches where the channel lies against the high escarpments that border the alluvial plain in local areas. The floodplain, eight to ten miles wide in general, narrows to about two miles near Denison Dam. Below Alexandria the floodplain becomes integral with the alluvial valley of the Mississippi River. Numerous tributaries enter the Red River below Denison Dam.

Major tributary streams in the Study Area are Boggy Creek, Kiamichi River, Little River, Sulphur River, Twelve Mile Bayou, Loggy Bayou

LEGEND

County Boundary

State Boundary

Existing Lakes December 31, 1962

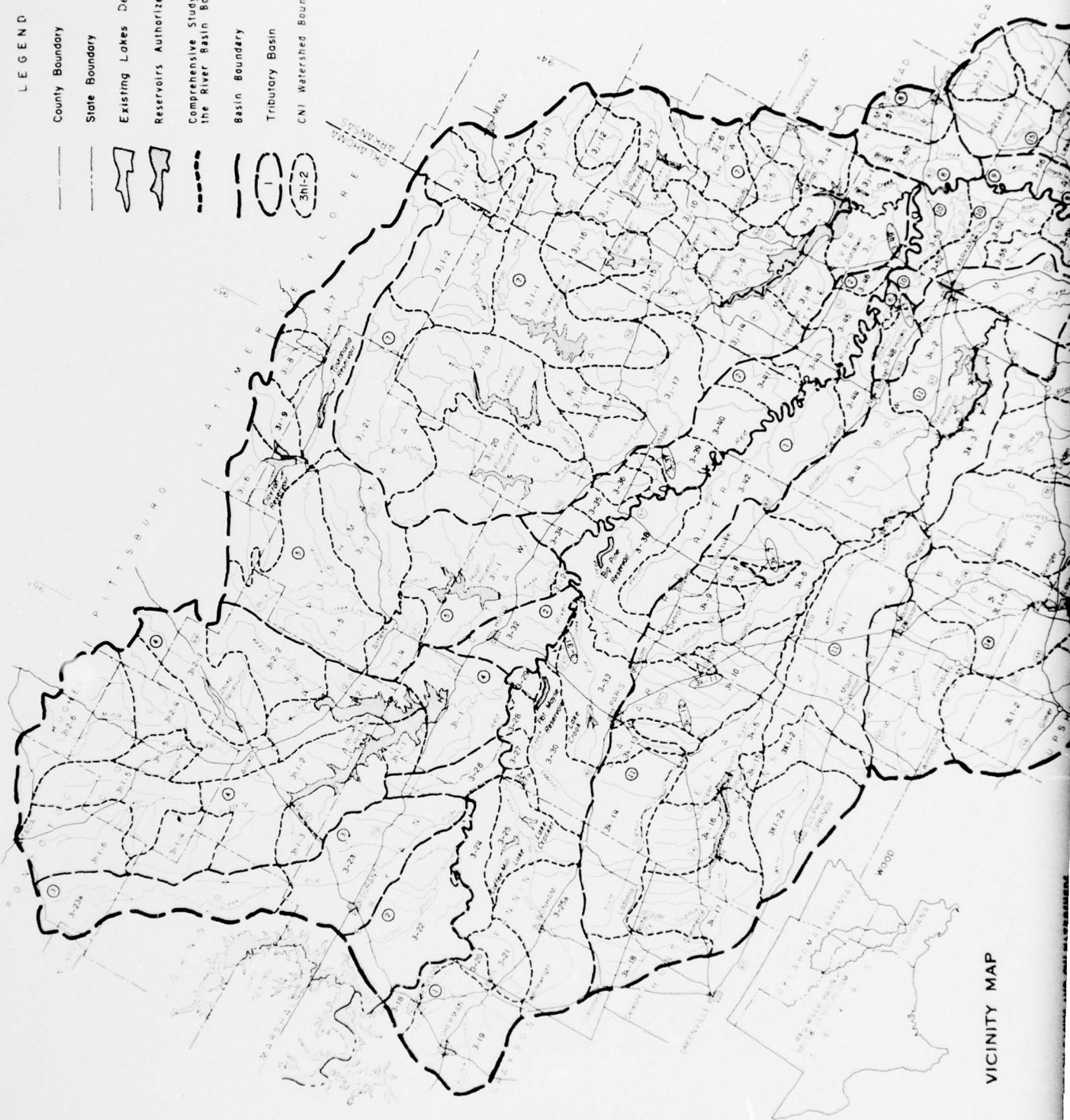
Reservoirs Authorized December 31, 1962

Comprehensive Study Area Outside the River Basin Boundary

Basin Boundary

Tributary Basin

CNI Watershed Boundaries



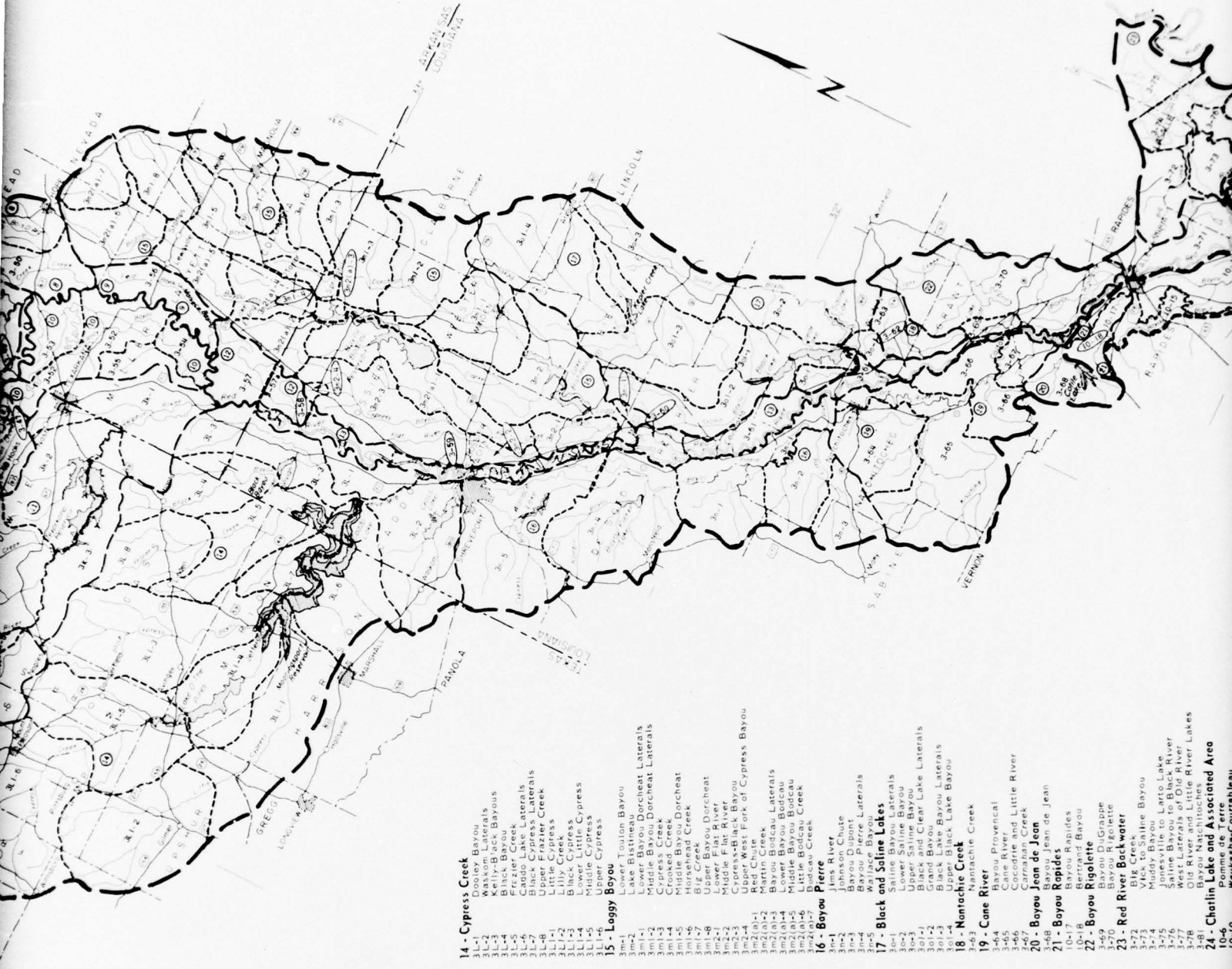
VICINITY MAP

VICINITY MAP

TRIBUTARY BASINS AND CNI WATERSHEDS

- 1 - Intervening Areas-Texas
 - 3-18 Grayson Lateral
 - 3-19 Choctaw Creek
 - 3-20 Grayson-Fannin Lateral
 - 3-21 Fannin Lateral
 - 3-22 Fannin Lateral
 - 3-23 Lower Bois d'Arc Creek
 - 3-24 Upper Bois d'Arc Creek
 - 3-25 Upper Sulphur Creek
 - 3-26 West Sanders Lateral
 - 3-27 Chicota Creek
 - 3-28 Sanders Creek Lateral
 - 3-29 Pine Creek
 - 3-30 Big Pine Creek
 - 3-31 Pecan Bayou
 - 3-32 Island Bayou
- 2 - Intervening Areas-Arkansas and Oklahoma
 - 3-26 Whitegrass Creek
 - 3-27 Choctaw Lateral
 - 3-28 McKinney-Buzzard
 - 3-29 Whitegrass Waterhole
 - 3-30 Perry Creek
 - 3-31 Northwood Creek
 - 3-32 Walnut Bayou
 - 3-33 Lower Walnut Bayou
 - 3-34 Hine Creek
 - 3-35 Cutoff Lakes
- 3 - Blue River
 - 3-23a Upper Blue River
 - 3-23b Lower Blue River
- 4 - Boggy Creek and Laterals
 - 3n1-1 Boxwell-Boggy
 - 3n1-2 Lower Clear Boggy
 - 3n1-3 Caney Creek
 - 3n1-4 Leazer-Middle Clear Boggy
 - 3n1-5 Upper Clear Boggy
 - 3n2-1 Lower Muddy Boggy
 - 3n2-2 Middle Muddy Boggy Creek
 - 3n2-3 Caney-Coon Creek
 - 3n2-4 Muddy Boggy Creek
- 5 - Kiamichi River
 - 3n1-1 Lower Kiamichi
 - 3n1-2 Frogville
 - 3n1-3 Cedar Creek
 - 3n1-4 Buck Creek
 - 3n1-5 Jack Fork
 - 3n1-6 Upper Kiamichi River
 - 3n1-7 Buffalo Creek
- 6 - Barkman Creek
 - 3-47 Ash Slough
 - 3-48 Barkman Creek
- 7 - Little River Creek
 - 3n1-2 Lower Little River Lateral
 - 3n1-3 Lower Saline River
 - 3n1-4 Mine Creek
 - 3n1-5 Middle Saline River
 - 3n1-6 Upper Saline River
 - 3n1-7 Lick Creek Lateral of Little River
 - 3n1-8 Lower Cossatot River
 - 3n1-9 Middle Cossatot River
 - 3n1-10 Harris Creek
 - 3n1-11 Upper Little River
 - 3n1-12 Lower Rolling Fork
 - 3n1-13 Upper Little River
 - 3n1-14 Glover Creek
 - 3n1-15 Middle Little River
 - 3n1-16 Upper Little River
 - 3n1-17 Middle Mountain Fork
 - 3n1-18 Cove-Hatfield
 - 3n1-19 Upper Mountain Fork
- 8 - Bois d'Arc Creek
 - 3-50 Britage Creek
 - 3-51 Bois d'Arc Creek
- 9 - Montrece Bayou
 - 3-56 Maniece Bayou
- 10 - McKinney Bayou
 - 3-52 Upper McKinney Bayou
 - 3-53 McKinnis Bayou
 - 3-54 Bench Creek
 - 3-55
- 11 - Sulphur River
 - 3-4-1 Lower Sulphur River
 - 3-4-2 Big Creek
 - 3-4-3 Anderson Creek
 - 3-4-4 South Sulphur Lateral

- 14 - Cypress Creek
 - 3L-1 Dooley Bayou
 - 3L-2 Maskom Lateral
 - 3L-3 Upper Cypress Bayou
 - 3L-4 Black Bayou
 - 3L-5 Frizier Creek
 - 3L-6 Gaddo Lake Lateral
 - 3L-7 Black Cypress Lateral
 - 3L-8 Little Cypress
 - 3L-9 Lilly Creek
 - 3L-10 Black Cypress
 - 3L-11 Middle Cypress
 - 3L-12 Upper Cypress
- 15 - Loggy Bayou
 - 3m-1 Lower Toulon Bayou
 - 3m-2 Lake Bistreau
 - 3m-3 Middle Bayou Dorcheat Lateral
 - 3m-4 Cypress Creek
 - 3m-5 Crooked Creek
 - 3m-6 Horshead Creek
 - 3m-7 Big Creek
 - 3m-8 Upper Bayou Dorcheat
 - 3m-9 Upper Flat River
 - 3m-10 Middle Flat River
 - 3m-11 Cypress-Black Bayou
 - 3m-12 Upper West Fork of Cypress Bayou
 - 3m-13 Med. C. Creek
 - 3m-14 Bayou Bodcau Lateral
 - 3m-15 Lower Bayou Bodcau
 - 3m-16 Middle Bayou Bodcau
 - 3m-17 Bodcau Creek
- 16 - Bayou Pierre
 - 3n-1 Jims River
 - 3n-2 Johnson Chute
 - 3n-3 Bayou Pierre Lateral
 - 3n-4 Bayou Pierre Lateral
 - 3n-5 Wallace Bayou
- 17 - Black and Saline Lakes
 - 3o-1 Saline Bayou Lateral
 - 3o-2 Lower Saline Bayou
 - 3o-3 Black and Clear Lake Lateral
 - 3o-4 Grand Bayou
 - 3o-5 Black Lake Bayou Lateral
 - 3o-6 Black Lake Bayou
 - 3o-7 Nantachie Creek
- 18 - Nantachie Creek
 - 3-63 Nantachie Creek
- 19 - Cane River
 - 3-64 Bayou Provencal
 - 3-65 Cane River
 - 3-66 Concorde and Little River
 - 3-67 Carmichael Creek
 - 3-68 Bayou Jean de Jean
 - 3-69 Bayou Jean de Jean
- 20 - Bayou Rapides
 - 10-17 Bayou Rapides
- 21 - Bayou Rigolette
 - 10-18 Berrand Bayou
 - 3-69 Bayou DuGrape
 - 3-70 Bayou Yalette
 - 3-71 Vicks to Saline Bayou
 - 3-72 Muddy Bayou
 - 3-73 Jonesville to Black River
 - 3-74 West Lateral of Old River
 - 3-75 Old River and Little River Lakes
 - 3-76 Bayou Nachitoches
- 22 - Chatin Lake and Associated Area
 - 10-46 Pomme de terre
 - 10-46 Redoubte-Capraiblaeu



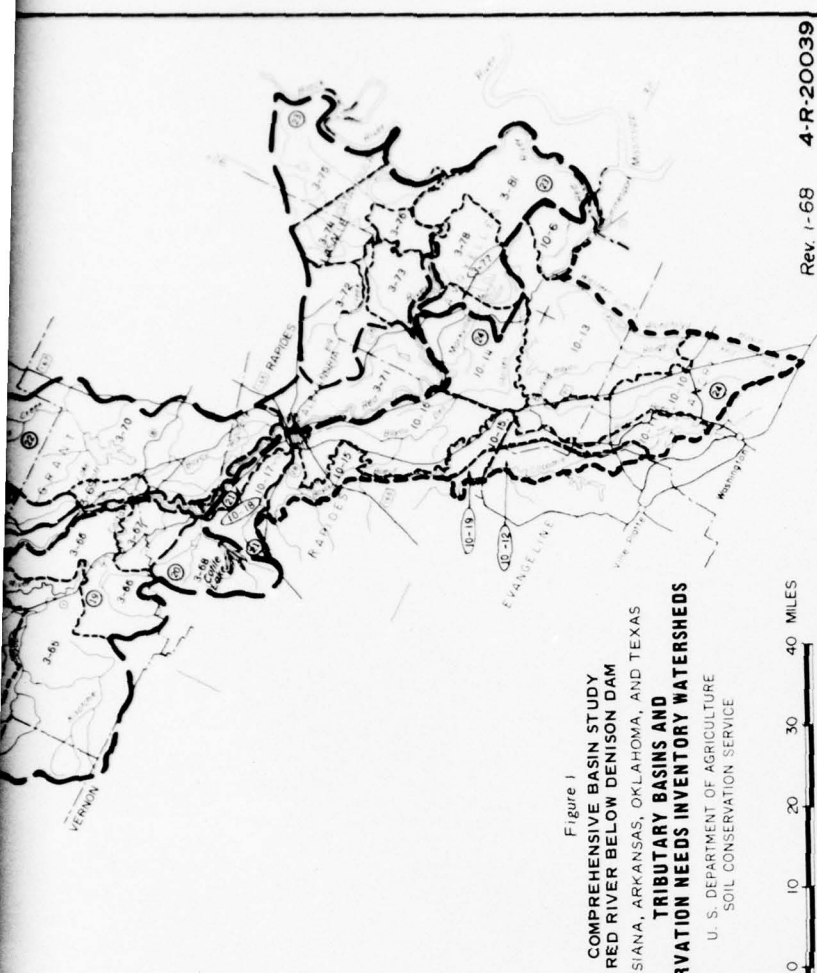


Figure 1
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
CONSERVATION NEEDS INVENTORY WATERSHEDS
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

10 0 10 20 30 40 MILES

4-R-20039

3-64

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS
 EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS.
 USDA SOI 7047 20474 TX 1948

- 301-1 Upper Saline Bayou
- 301-2 Black and Clear Lake Laterals
- 301-3 Grand Bayou
- 301-4 Upper Black Lake Bayou
- 18 - Nontachite Creek
- 19 - Cane River
- 20 - Bayou Jean de Jean
- 21 - Bayou Rapides
- 22 - Bayou Rigollette
- 23 - Red River Backwater
- 24 - Chatlin Lake and Associated Area
- 301-1 Middle Cassatot River
- 301-2 Harris Creek
- 301-3 Upper Cassatot River
- 301-4 Lower Cassatot River
- 301-5 Upper Rolling Fork
- 301-6 Lower Little River
- 301-7 Glover Creek
- 301-8 Middle Little River
- 301-9 Upper Little River
- 301-10 Upper Little River
- 301-11 Middle Mountain Fork
- 301-12 Cave-Hatfield
- 301-13 Upper Mountain Fork
- 8 - Bois d'Arc Creek
- 9 - Monteece Bayou
- 10 - McKinney Bayou
- 11 - Sulphur River
- 12 - Pesten Bayou
- 13 - Red River Main Stem
- 340 Sunny Point and Half Moon Lake
- 341 East Point
- 342 Bull Lake and Shinn Bayou
- 343 Smiths Bayou
- 344 Wiggins Bayou
- 10-6 Pomme de Terre
- 10-7 Muddy Bayou
- 10-8 Jonesville to Larto Lake
- 10-9 Saline Bayou to Old River
- 10-10 Old River and Little River Lakes
- 10-11 Bayou Natchitoches
- 10-12 Muddy Bayou
- 10-13 Muddy Bayou
- 10-14 Bayou Cocodrie
- 10-15 Bayou Des Glaises
- 10-16 Chatlin Lake
- 10-17 Upper Bayou Cocodrie
- 345 Lower Sulphur River
- 346 Big Creek
- 347 Anderson Creek
- 348 South Sulphur Laterals
- 349 Cuthbert Creek
- 350 Langford Creek
- 351 Bratton Creek
- 352 Sand-Mustang Laterals
- 353 Upper North Sulphur River
- 354 Forge Creek
- 355 South Sulphur River, Middle Sulphur River & Pecan Creek
- 356 Upper Sulphur River
- 357 White Oak Laterals
- 358 Posten Bayou
- 359 Lower Sulphur River
- 360 Holly Lake
- 361 Sunny Point and Half Moon Lake
- 362 East Point
- 363 Bull Lake and Shinn Bayou
- 364 Smiths Bayou
- 365 Wiggins Bayou

Bayou Pierre, and Saline Bayou. These tributary streams flow directly into the main stem of Red River and have drainage areas ranging from 1,138 square miles to 4,231 square miles.

Minor tributaries, too numerous to identify, enter Red River at points scattered throughout its length. Generally, tributaries in the upper reaches of Red River are fast, freely flowing streams; tributaries in the lower reaches are slow, congested streams.

Numerous natural lakes, such as river cutoffs and tributary streams with silt plugs in their drainage outlets, exist in and adjacent to the Red River floodplain. Federal and State agencies have increased the storage in some of the natural tributary lakes to provide water for recreation and navigation. For example, Caddo Lake was improved by the USAE in 1914 to provide for a navigation pool at an elevation of 168.5 feet mean sea level. The lake covers an area of 20,900 acres. This area also provides varied recreation facilities. Bistineau, Black, and Clear Lakes are other natural lakes improved by the Louisiana Department of Public Works to provide increased recreation opportunities.

Several major reservoirs providing flood control, water supply, and other beneficial uses are either completed or under construction by the USAE. Millwood Reservoir on Little River and Lake Texarkana on Sulphur River are the largest of these reservoirs with storage capacities of 1,858,000 and 2,654,300 acre-feet, respectively.

Other smaller lakes have been built by Federal, State, or private groups for multiple uses. The SCS, under the authority of Public Law 566, has built many floodwater retarding structures on tributary streams.

TRIBUTARY BASINS AND CONSERVATION NEEDS INVENTORY WATERSHEDS

The Study Area was subdivided into 24 tributary basins ranging in size from 73 to 4,231 square miles. Tributary basin names, numbers, and locations are shown in Figure 1 and areal data are tabulated in Table 1.

Each of the tributary basins is essentially an independent hydrologic unit consisting of one or more smaller hydrologic units. The hydrologic units within the tributary basin are referred to as Conservation Needs Inventory (CNI) watersheds. Each watershed is identified by name and code designation (figure 1).

LAND AND WATER AREAS

Land and water areas were based on data developed for the 1958 National Inventory of Soil and Water Conservation Needs and adjusted to reflect conditions existing in 1962. The 1958 Inventory was prepared by the Conservation Needs Committee in each of the four states. Basic areal data were developed for parishes and counties for the National inventory. These data were used for parishes and counties lying wholly within the Study Area. For parishes and counties that are not wholly in the Study Area, acreages were planimetered and coordinated with acreages of

Table 1 - Tributary Basin Areas, Red River Basin Study Area

| Tributary Basin | : Total Land and Water Area | |
|---------------------------------------|-----------------------------|---------------|
| | acres | square miles |
| Intervening Areas - Texas | 1,352,773 | 2,114 |
| Barkman Creek | 46,700 | 73 |
| McKinney Bayou | 246,088 | 385 |
| Sulphur River | 2,377,736 | 3,715 |
| Cypress Creek | 2,308,043 | 3,606 |
| Blue River | 433,751 | 678 |
| Intervening Areas - Ark. and Oklahoma | 759,371 | 1,187 |
| Boggy Creek | 1,546,617 | 2,417 |
| Kiamichi River | 1,176,923 | 1,839 |
| Little River | 2,707,621 | 4,231 |
| Bois d'Arc Creek | 154,108 | 241 |
| Maniece Bayou | 73,818 | 115 |
| Posten Bayou | 89,050 | 139 |
| Loggy Bayou | 1,716,675 | 2,682 |
| Bayou Pierre | 762,820 | 1,192 |
| Cane River | 484,439 | 757 |
| Bayou Jean de Jean | 58,494 | 91 |
| Bayou Rapides | 52,979 | 83 |
| Black & Saline Lakes | 888,609 | 1,388 |
| Nantachie Creek | 54,071 | 84 |
| Bayou Rigolette | 267,370 | 418 |
| Red River Backwater Area | 486,954 | 760 |
| Chatlin Lake and Associated Area | 598,543 | 936 |
| Red River Main Stem <u>1/</u> | 306,719 | 479 |
| Total | 18,950,272 | 29,610 |

1/ Main Stem Tributary Basin is confined to Louisiana

adjacent river basins. Distribution of land and water resources, rounded to the nearest 100 acres, is shown by states in Table 2.

About 29.3 percent of the Study Area is in Texas, 28.2 percent is in Louisiana, 27.2 percent is in Oklahoma, and the remaining 15.3 percent is in Arkansas. The large water area includes permanent water surfaces such as lakes, reservoirs, and ponds having 40 acres or more of surface area

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Table 2 - Land and Water Areas by States, Red River Basin Study Area, 1962

| State | Land Area | Large Water Area | Total Land and Water Area |
|----------------------------|-----------------|------------------|---------------------------|
| ----- thousand acres ----- | | | |
| Arkansas | 2,853.2 | 41.7 | 2,894.9 |
| Louisiana | 5,208.9 | 132.1 | 5,341.0 |
| Oklahoma | 5,111.0 | 51.0 | 5,162.0 |
| Texas | 5,487.9 | 64.5 | 5,552.4 |
| Total | 18,661.0 | 289.3 | 18,950.3 |

and streams, sloughs, and canals one-eighth of a statute mile or more in width, and islands within large water areas that are less than 40 acres in size. Large water areas comprise approximately 1.5 percent of the total area. About 45.7 percent of the large water area is in Louisiana, 22.3 percent is in Texas, 17.6 percent is in Oklahoma, and 14.4 percent is in Arkansas.

The land area was subdivided into Inventory and Noninventory areas for purposes of the USDA investigations. The Noninventory acreage includes urban and built-up areas, land owned by the Federal Government other than agricultural land operated under lease or permit, and small water areas consisting of bodies of water less than 40 acres in size (mostly farm ponds) and streams less than one-eighth of a mile wide. The Inventory acreage includes the remaining land area. Distribution of Inventory and Noninventory land areas by states is shown in Table 3.

Table 3 - Inventory and Noninventory Areas by States, Red River Basin Study Area, 1962

| State | Inventory Area | Noninventory Area | Total Land Area |
|----------------------------|-----------------|-------------------|-----------------|
| ----- thousand acres ----- | | | |
| Arkansas | 2,660.7 | 192.5 | 2,853.2 |
| Louisiana | 4,627.7 | 581.2 | 5,208.9 |
| Oklahoma | 4,879.8 | 231.2 | 5,111.0 |
| Texas | 5,165.1 | 322.8 | 5,487.9 |
| Total | 17,333.3 | 1,327.7 | 18,661.0 |

Of the 1,327,700 acres in the Noninventory Area, about 52 percent is Federal land. Federal land consists principally of National Forests and Defense Department lands. About 80 percent of all the Federal land produces timber products for regional markets. All National Forests and

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about 50 percent of the Defense Department land (USAE reservoir areas) are managed for a wide variety of recreational use by the general public.

Urban and built-up areas constitute about 42 percent of the Noninventory acreage. These include cities, villages, and other built-up areas of more than 10 acres, industrial sites, roads, railroads and railroad yards, cemeteries, airports, golf courses, shooting ranges, and similar developments.

Small water areas include about six percent of the Noninventory acreage. Noninventory area composition is shown in Table 4.

Table 4 - Noninventory Area Land Use Distribution by States, Red River Basin Study Area, 1962

| Land Use | Arkansas | Louisiana | Oklahoma | Texas | Total |
|----------------------------|--------------|--------------|--------------|--------------|----------------|
| ----- thousand acres ----- | | | | | |
| Federal land | 107.0 | 332.7 | 139.9 | 114.5 | 694.1 |
| Forest land | 107.0 | 316.6 | 136.9 | 99.8 | 660.2 |
| Other | - | 16.1 | 3.0 | 14.7 | 33.9 |
| Urban & built-up | 71.4 | 213.3 | 78.7 | 189.2 | 552.6 |
| Small water areas | 14.1 | 35.2 | 12.6 | 19.1 | 81.0 |
| Total | 192.5 | 581.2 | 231.2 | 322.8 | 1,327.7 |

LAND RESOURCES

Farming Regions

More than 500 type-of-farming areas and 400 subtypes have been outlined in the United States. There are, however, 10 major farming regions. They differ in soils, slope of land, climate, distance to market, and in storage and marketing facilities. Over the years, the general types of farming best suited to each region have developed, although traditional crops may be less important now.

The four states in the Red River Basin Comprehensive Study (below Denison Dam) are located in two of the 10 regions. Arkansas and Louisiana are a part of the Delta Region and Texas and Oklahoma are part of the Southern Plains Region.

Trends for these two regions as they relate to their production as a percent of United States production, 1939-63, and projected to 1980, are presented in Exhibit 1. These statistical trends served as guidelines for more detailed analyses of the agricultural sector in the Study Area. This exhibit material shows that it is within primarily agricultural regions

that functional changes are occurring in agriculture. 1/

Land Capability Classes

All soils in the Inventory acreage were classified according to their potentialities and limitations for sustained agricultural and forestry production. All soils of the Study Area are included in seven land capability classes. The risk of soil damage or limitations in use becomes progressively greater from Class I to Class VII. Soils in the first four classes are capable of producing, under good management, adapted plants such as trees or range plants, and the common cultivated field crops and pasture plants. Soils in the last three classes are best suited to the production of native vegetation. Some soils in Classes V and VI also are capable of producing specialized crops, such as certain fruits, ornamentals, field crops, and vegetable crops, under highly intensive management involving elaborate soil and water conservation practices.

- Class I - Soils in this class have few limitations that restrict their use.
- Class II - Soils in this class have some limitations that reduce the choice of plants or require moderate conservation practices.
- Class III - Soils in this class have severe limitations that reduce the choice of plants or require special conservation practices, or both.
- Class IV - Soils in this class have very severe limitations that restrict the choice of plants and require very careful management.
- Class V - Soils in this class have little or no erosion hazard, but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland and forest, or wildlife habitat.
- Class VI - Soils in this class have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland and forest, or wildlife habitat.

1/ Talk by W. B. Sundquist, FPED, at the 44th Annual Agricultural Outlook Conference, Washington, D. C., November 15, 1966

Class VII - Soils in this class have very severe limitations that make them unsuited for cultivation and that restrict their use largely to grazing, woodland and forest, or wildlife habitat.

All the Inventory acreage was classified except minor areas of some miscellaneous uses, such as farmsteads, roads, and cemeteries. Land capability class distribution is shown in Table 5 by major land resource areas. Table 5 also shows distribution of inventory and noninventory areas by major land resource areas. Approximately 62 percent of the inventory acreage is capable of producing the common cultivated field crops.

Table 5 - Major Land Resource Area Distribution and Land Capability Classes by Major Land Resource Areas, Red River Basin Study Area, 1962

| Major Land Resource Area and Numerical Designation | Inventory Area | | | | | | | Unclassified | Total Inventory | Non-Inventory Area | Total Land Area |
|--|------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------|-----------------|--------------------|-----------------|
| | Land Capability Class | | | | | | | | | | |
| | I | II | III | IV | V | VI | VII | | | | |
| | - - - - - thousand acres - - - - - | | | | | | | | | | |
| Southern Mississippi Valley Silty Uplands 134 | 1.1 | 72.9 | 24.5 | - | 3.4 | - | 8.2 | - | 110.1 | 3.9 | 114.0 |
| Southern Mississippi Valley Alluvium 131 | 391.8 | 562.8 | 721.5 | 1.0 | 723.0 | 0.1 | - | 1.7 | 2,401.9 | 122.4 | 2,524.3 |
| Southern Coastal Plain 133 | 180.6 | 1,731.4 | 3,067.8 | 1,489.2 | 1,139.7 | 686.5 | 613.2 | 30.4 | 8,938.8 | 834.7 | 9,773.5 |
| Texas Blackland Prairie 86 | 29.1 | 573.6 | 617.8 | 132.7 | 298.9 | 16.4 | 113.4 | 3.9 | 1,785.8 | 83.1 | 1,868.9 |
| Grand Prairie 85 | 47.5 | 146.6 | 137.8 | 34.6 | 42.9 | 93.5 | 196.4 | - | 699.3 | 20.1 | 719.4 |
| Cross Timbers 84 & 84a | 5.9 | 27.9 | 45.7 | 12.5 | 6.6 | 40.5 | 69.3 | 1.3 | 209.7 | 14.2 | 223.9 |
| Cherokee Prairies 112 | 5.4 | 82.0 | 114.4 | 46.2 | 79.2 | 45.3 | 73.5 | - | 446.0 | 22.5 | 468.5 |
| Ouachita Mountains 119 | 14.2 | 72.7 | 209.2 | 153.4 | 177.6 | 243.3 | 1,851.5 | 2.2 | 2,724.1 | 226.3 | 2,950.4 |
| Central Rolling Red Prairies 80 | 9.7 | 1.7 | - | 2.1 | - | 4.1 | - | - | 17.6 | 0.5 | 18.1 |
| Total | 685.3 | 3,271.6 | 4,938.7 | 1,871.7 | 2,471.3 | 1,129.7 | 2,925.5 | 39.5 | 17,333.3 | 1,327.7 | 18,661.0 |

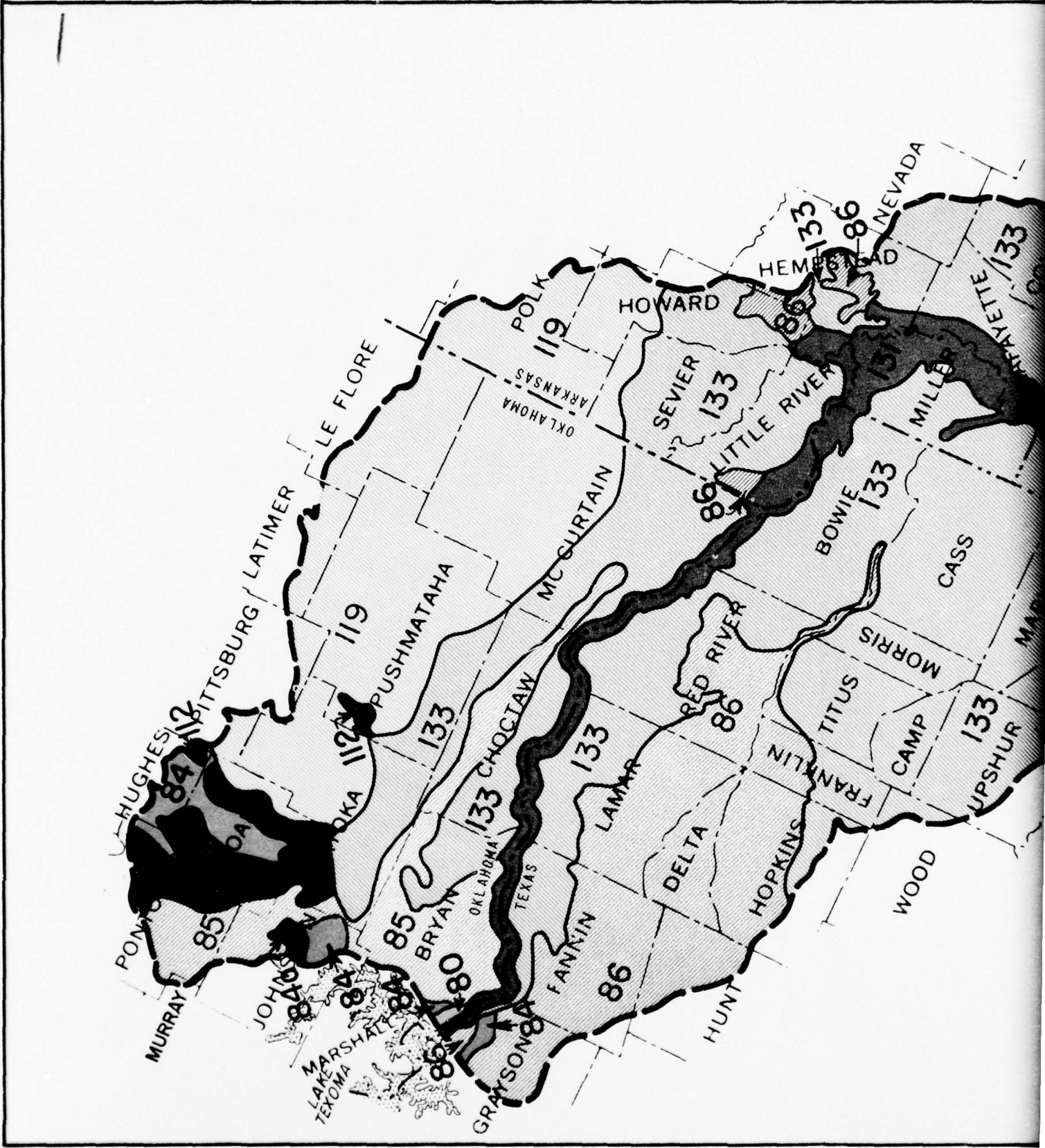
Source: 1958 National Inventory of Soil and Water Conservation Needs adjusted to 1962 conditions

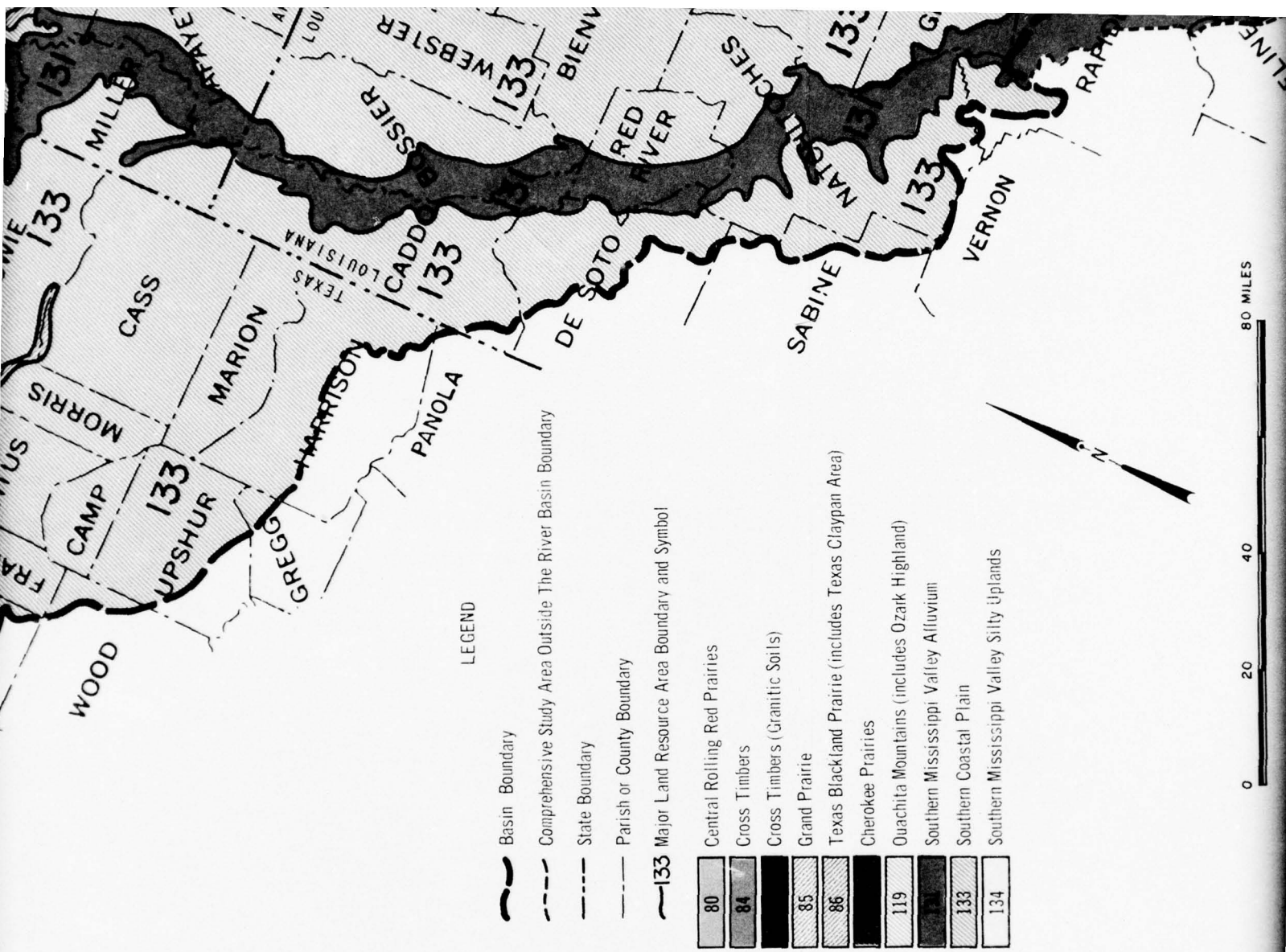
Land Resource Areas

The range in climatic and soil conditions within the Study Area has resulted in distinctive patterns of agriculture and land use. Geographical areas of land, at least several thousand acres in extent, characterized by a particular combination of pattern of soils, including slope and erosion, climate, water resources, land use, and types of farming called land resource areas, have been delineated as shown on Figure 2. A land resource area may occur in one continuous area, or in discontinuous segments. Figure 2 shows locational distribution of land resource areas. Table 6 shows for each land resource area the acreages within the Study Area by the four states and the percent of the total land area occupied by each land resource area.

Southern Mississippi Valley Silty Uplands (134)

This LRA includes 114,000 acres in Louisiana. This is a gently rolling, generally well-drained area. Soils are developed from loessial materials. The vegetation is mainly pine with an understory of hardwood trees. A high proportion of this forested area has been cleared and used for cropland and pasture.



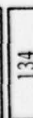




LEGEND

- Basin Boundary
- Comprehensive Study Area Outside The River Basin Boundary
- State Boundary
- Parish or County Boundary
- Major Land Resource Area Boundary and Symbol

| | |
|-----|---|
| 80 | Central Rolling Red Prairies |
| 84 | Cross Timbers |
| 85 | Cross Timbers (Granitic Soils) |
| 86 | Grand Prairie |
| 119 | Texas Blackland Prairie (includes Texas Claypan Area) |
| 133 | Southern Coastal Plain |
| 134 | Southern Mississippi Valley Silty Uplands |

-  Southern Mississippi Valley Alluvium
-  133 Southern Coastal Plain
-  134 Southern Mississippi Valley Silty Uplands

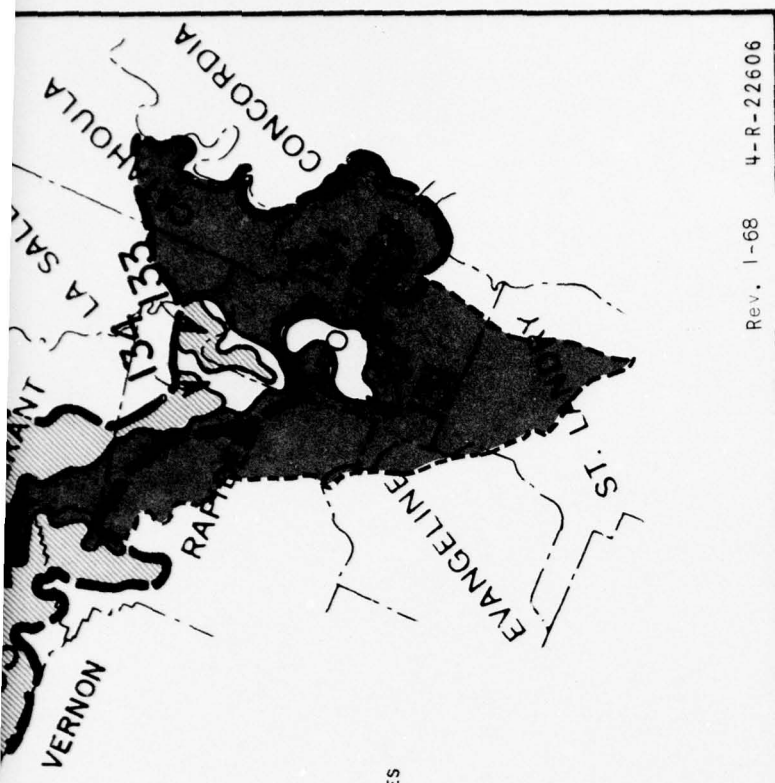


Figure 2

COMPREHENSIVE BASIN STUDY
RED RIVER BASIN BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
MAJOR LAND RESOURCE AREAS
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

Rev. 1-68 4-R-22606

USDA SCS-FORT WORTH, TEX. 1968

Table 6 - Major Land Resource Areas by States, Red River Basin Study Area, 1962

| Major Land Resource Area and Numerical Designation | Arkansas | Louisiana | Oklahoma | Texas | Land Area | Percent of Total Land Area |
|--|----------------|----------------|----------------|----------------|-----------------|----------------------------|
| ----- thousand acres ----- | | | | | | |
| Southern Mississippi Valley Uplands 134 | - | 114.0 | - | - | 114.0 | 0.6 |
| Southern Mississippi Valley Alluvium 131 | 370.5 | 1,821.5 | 155.6 | 176.7 | 2,524.3 | 13.6 |
| Southern Coastal Plain 133 | 1,842.2 | 3,273.4 | 1,160.6 | 3,497.3 | 9,773.5 | 52.4 |
| Texas Blackland Prairie 86 | 110.6 | - | - | 1,758.3 | 1,868.9 | 10.0 |
| Grand Prairie 85 | - | - | 719.4 | - | 719.4 | 3.8 |
| Cross Timbers 84 and 84a | - | - | 168.3 | 55.6 | 223.9 | 1.2 |
| Cherokee Prairies 112 | - | - | 468.5 | - | 468.5 | 2.5 |
| Ouachita Mountains 119 | 529.9 | - | 2,420.5 | - | 2,950.4 | 15.8 |
| Central Rolling Red Prairies 80 | - | - | 18.1 | - | 18.1 | 0.1 |
| Total | 2,853.2 | 5,208.9 | 5,111.0 | 5,487.9 | 18,661.0 | 100.0 |

Southern Mississippi Valley Alluvium (131)

Red River and intermingled Lower Mississippi River Alluvial soils are included in this LRA. This includes 2,524,300 acres in the four states from the mouth of Red River to Denison Dam. The surface relief is subdued and slopes generally to the south and east. Areas of undulating or dissected topography occur where overflows are frequent. The LRA is sometimes divided into first bottoms which may overflow frequently and the higher elevation terraces which seldom overflow. The native vegetation is mainly hardwood trees. However, because of the high inherent fertility and favorable topography, most of the hardwoods have been cleared where flood hazards and drainage problems have been surmounted.



Cropland in the Southern Mississippi Valley Silty Uplands



Southern Mississippi Valley Alluvium - Avoyelles Parish, Louisiana

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Southern Coastal Plain (133)

The Southern Coastal Plain is the largest LRA in the Study Area. It occupies 9,773,500 acres and occurs in each of the four states. This is a gently rolling to hilly, well-dissected, mostly well-drained area, although some flat areas on stream divides and in stream floodplain areas have poor drainage. The vegetation in the eastern part is mainly pine trees with an understory of hardwood trees; mainly oak, gum, elm, and some hickory. In the western part, locally called the Post Oak Belt, the vegetation is mainly hardwood trees; mostly post oak, blackjack, and elm, with some pine.



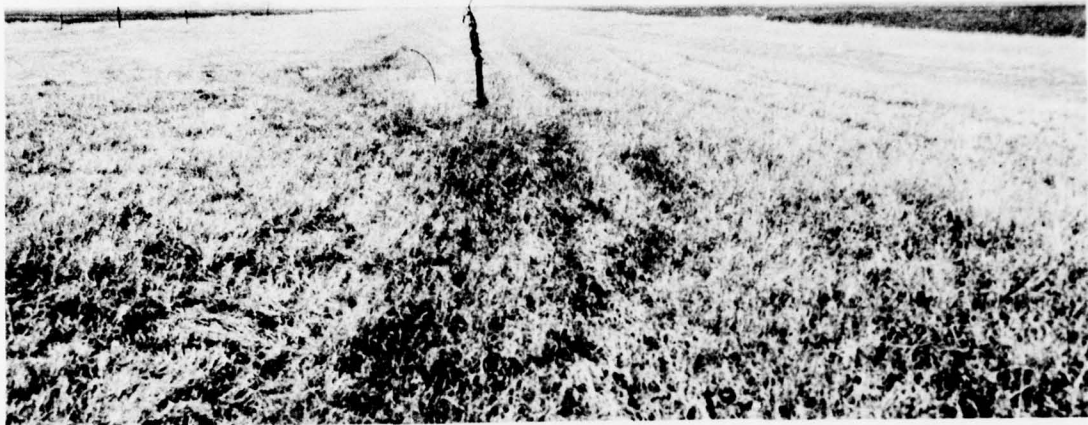
Southern Coastal Plain - Webster Parish, Louisiana

A high proportion of this forested area has been cleared and used for cropland at one time or another over a long period of years. Because of depleted fertility and soil loss by erosion, much of this once-cultivated land has been reforested, either by natural reseeding or by planting. Some is now used for pasture. The soils, if well-managed, are suited for growing a wide variety of field crops, special and truck crops, and vine and tree fruit.

Texas Blackland Prairie (86)

Surface relief of LRA 86 is generally undulating to gently rolling, although it ranges from nearly level on some watershed divides to strongly

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Texas Blackland Prairie - Fannin County, Texas

sloping in areas bordering stream valleys. It includes 1,868,900 acres in Texas and Arkansas. The native vegetation consists primarily of bunch and short grasses. A subarea of the Texas Blackland Prairie LRA known as the "Graylands" occurs in Texas as a transition zone between the Southern Coastal Plain and this LRA.

The soils of the Texas Blackland Prairie LRA, as a whole, are among the most productive upland soils of the Study Area. However, because of the clay texture and sloping surfaces, they are very susceptible to erosion. Many areas have been severely eroded, and some of the steeper slopes are so gullied that they are no longer suited for cultivation.

Grand Prairie (85)

This LRA includes 719,400 acres in Oklahoma. It includes rocky rangeland on steep slopes, as well as deep, agriculturally productive land on undulating to gently sloping topography. The climax vegetation is primarily mid and tall grasses. In many areas, scrubby, woody vegetation is an invader.

Cross Timbers and Granitic Soils (84 and 84a)

This LRA comprises 223,900 acres of land in Texas and Oklahoma. Native vegetation and soils are similar to the Post Oak Belt of the



Grand Prairie Rangeland



Grand Prairie Crop and Pasture Land



Cross Timbers - Bryan County, Oklahoma

Southern Coastal Plain LRA, except for the small area of Granitic soils in Johnston County, Oklahoma. The Granitic soils are developed from pre-Cambrian granites and occur on bouldery, tree-covered slopes with prairie grasses on some of the ridges. Inherent soil fertility is low and relatively small areas have been cleared for cultivation.

Cherokee Prairies (112)

The LRA includes 468,500 acres of land area in Oklahoma. The climax vegetation consists primarily of mid and tall grasses. Climax vegetation in most of the area succumbed to the plow. Soils are developed from sandstones and shales and are agriculturally productive. Topography is generally undulating to gently sloping.

Ouachita Mountains (119)

LRA 119 includes an area of 2,950,400 acres in Arkansas and Oklahoma. It is a forested area of great natural beauty. Topography is rolling to steep. Soils are developed from sandstones, shale, and chert, and are generally too shallow for cultivation. Agriculture is important to the area only in the relatively narrow valleys and in local areas of deeper soil development. The climax vegetation is mainly pine trees with an understory of hardwood trees; mainly oak, elm, and hickory. A relatively small amount of Ozark Highland, which is an area of rough hills formed by the dissection of a cherty plateau, is interspersed with this land resource area.

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Cherokee Prairies - Pontotoc County, Oklahoma



Ouachita Mountains - McCurtain County, Oklahoma

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Central Rolling Red Prairies (80)

The LRA extends into the Study Area in Oklahoma. It occupies only 18,100 acres and occurs as a high terrace of the Red River. Slopes are gently sloping and soils are deep. Native vegetation consists of hardwood trees.

Major Land Use

Major land use distributions were developed for the Inventory Area of the land resource base. This area of 17,333,300 acres (table 3) is the primary agricultural and forestry land resource base. Major land use distribution by the nine land resource areas is shown in Table 7. The proportion that each major land use occupies of the total land area also is shown in this table.

Table 7 - Distribution of Inventory and Noninventory Areas by Major Land Resource Areas and Major Land Uses of the Inventory Area, Red River Basin Study Area, 1962

| Major Land Resource Area and Numerical Designation | Inventory Area | | | | | Non- Inventory: Area | Total Land Area |
|--|----------------|------------------|--------------------|-----------------------------|-----------------|----------------------------|--------------------|
| | Cropland | Pasture Range | Forest Woodland | Miscel- laneous: Land | Total Area | | |
| ----- thousand acres ----- | | | | | | | |
| Southern Mississippi Valley Silty Uplands 134 | 19.8 | 38.7 | 50.0 | 1.6 | 110.1 | 3.9 | 114.0 |
| Southern Mississippi Valley Alluvium 131 | 718.0 | 531.0 | 1,104.3 | 48.6 | 2,401.9 | 122.4 | 2,524.3 |
| Southern Coastal Plain 133 | 1,350.1 | 1,383.8 | 6,003.3 | 201.6 | 8,938.8 | 834.7 | 9,773.5 |
| Texas Blackland Prairie 86 | 965.8 | 491.4 | 301.4 | 27.2 | 1,785.8 | 83.1 | 1,868.9 |
| Grand Prairie 85 | 164.5 | 337.0 | 157.8 | 40.0 | 699.3 | 20.1 | 719.4 |
| Cross Timbers 84 and 84a | 26.5 | 38.1 | 112.9 | 32.2 | 209.7 | 14.2 | 223.9 |
| Cherokee Prairies 112 | 71.8 | 193.5 | 119.5 | 61.2 | 446.0 | 22.5 | 468.5 |
| Ouachita Mountains 119 | 56.5 | 147.4 | 2,436.9 | 83.3 | 2,724.1 | 226.3 | 2,950.4 |
| Central Rolling Red Prairies 80 | 16.1 | - | 0.3 | 1.2 | 17.6 | 0.5 | 18.1 |
| Total | 3,389.1 | 3,160.9 | 10,286.4 | 496.9 | 17,333.3 | 1,327.7 | 18,661.0 |
| Percent of total land area | 18.2 | 16.9 | 55.1 | 2.6 | 92.8 | 7.2 | 100.0 |

About 35 percent of the land is used for cropland and pasture and/or range. Slightly over 55 percent is in forest woodland. Miscellaneous land which includes farmsteads, farm roads, levees, and other miscellaneous rural uses involves less than three percent. Noninventoried areas, or urban land, public roads, and other public land ownership, also are shown in Table 7. These lands amount to approximately seven percent of the total land area.

Significant characteristics pertaining to land use, crop distribution, and land capability subclasses are summarized in subsequent tables. Areal data as it relates to major agricultural land uses, the four basin states, and land resource areas are presented in Exhibits 2 and 3.

FOREST RESOURCES

General Description

Of the 18,661,600 acres of land in the Red River Basin Study Area, 10,946,600 acres ^{1/}, or 58.6 percent, were forest land in 1962. This forest cover varies from lush oak-gum-cypress stands on the floodplain of the lower Red River to the relatively thin stands of upland oaks and hickories in the uppermost reaches of the Study Area in Oklahoma and Texas. Pines, red oaks, white oaks, red gums, and hickories are predominant on the extensive upland forest areas of intervening tributary basins, with relatively small areas of a variety of bottomland species found along the floodplains and low terraces of the tributary streams.

The Forest Timber Types Map, Figure 3, shows the distribution and extent of forest cover types. The development of natural forest cover is dependent on overall climate, the physical and chemical character of the soil, topography and other natural features, and cultural factors induced by man's occupancy and increasing heavy use of the land. The amount and distribution of rainfall and inherent fertility of the soil are the most important influences, with precipitation (as soil moisture available to plants) being the ultimate limiting factor. Generally, species that occupy a forest site are those that grow most vigorously under the combination of the above factors that exist on the site.

In 1962, the different lands in the Grand Prairie, Central Rolling Red Prairies, Cross Timbers, and Granitic Soils land resource areas were not producing commercial timber in saleable quantities. These areas lie in the uppermost reaches of the basin and the normal rainfall will not usually support good growth in commercial species. In 1962, the bulk of the commercial forest lands were found in the Southern Mississippi Valley Alluvium and Silty Uplands, Southern Coastal Plain, and Ouachita Mountains LRAs.

^{1/} Includes inventoried and noninventoried forest land

Commercial Forest Land

For 1962, Forest Surveys 1/ in Arkansas, Louisiana, Oklahoma, and Texas show 10,180,600 acres of commercial 2/ forest land in the Red River Basin Study Area. According to these studies, 93 percent of the total forest land area in the basin is commercial forest land. Table 8 gives the commercial forest acreage in the different timber types and their prevalence in the basin. Figure 3 shows the geographical distribution of timber types and the extent of commercial forest land.

Seventy-eight percent of the commercial forest area supports essentially upland forest types. Pine and hardwood-pine types occupy almost two-thirds of the upland area. The remaining upland forest area, generally located along the northern and western perimeter of the basin, supports the oak-hickory type.

The elm-ash-cottonwood and oak-gum-cypress types are bottomland forest types and comprise 22 percent of the total commercial forest area.

Forty percent of the commercial forest area bears sawtimber stands, 27 percent bears poletimber stands, 31 percent bears seedlings and saplings, and the remaining two percent is nonstocked. Table 9 shows the commercial forest area by forest types and stands sizes.

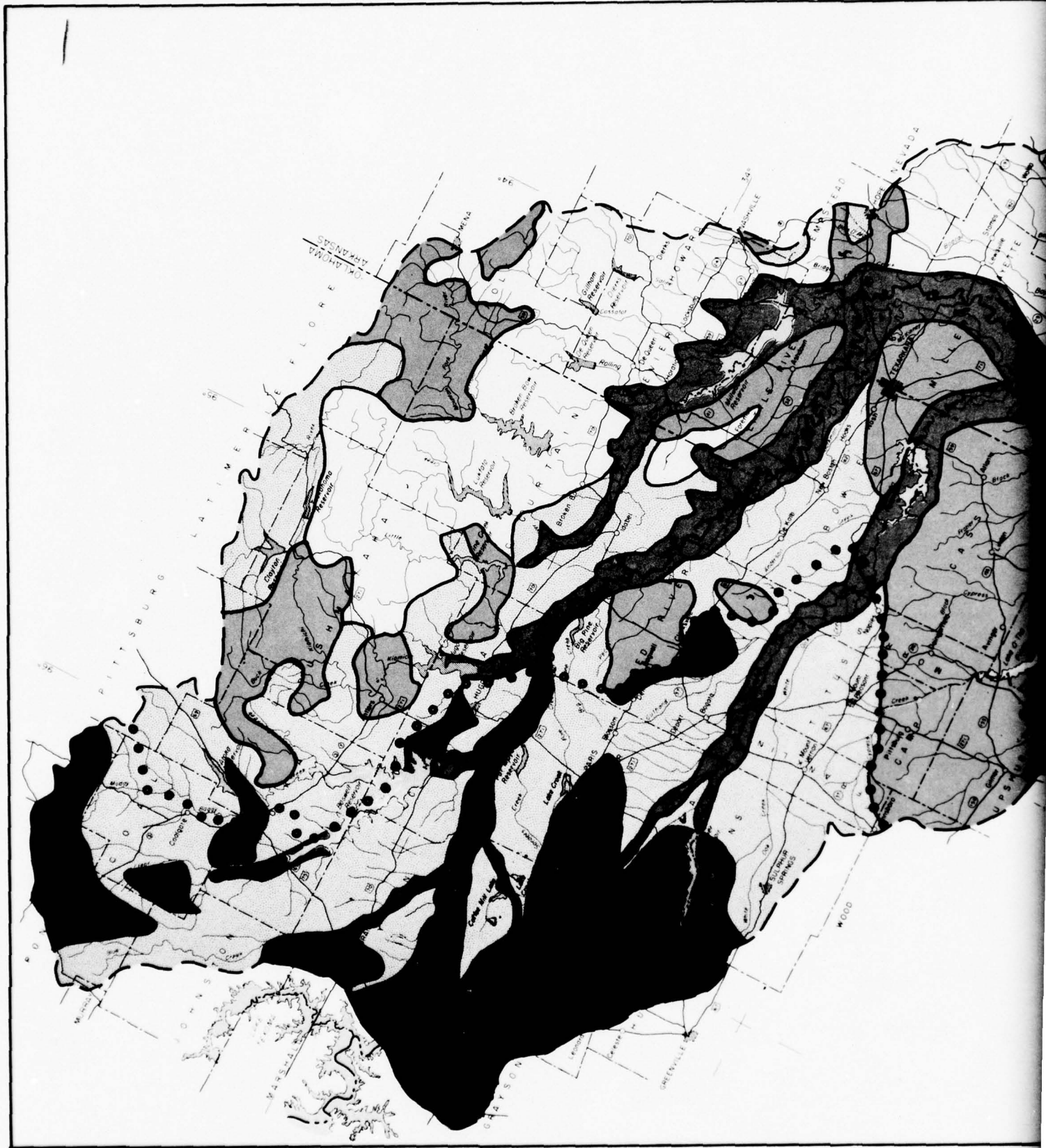
Forest Land Ownership

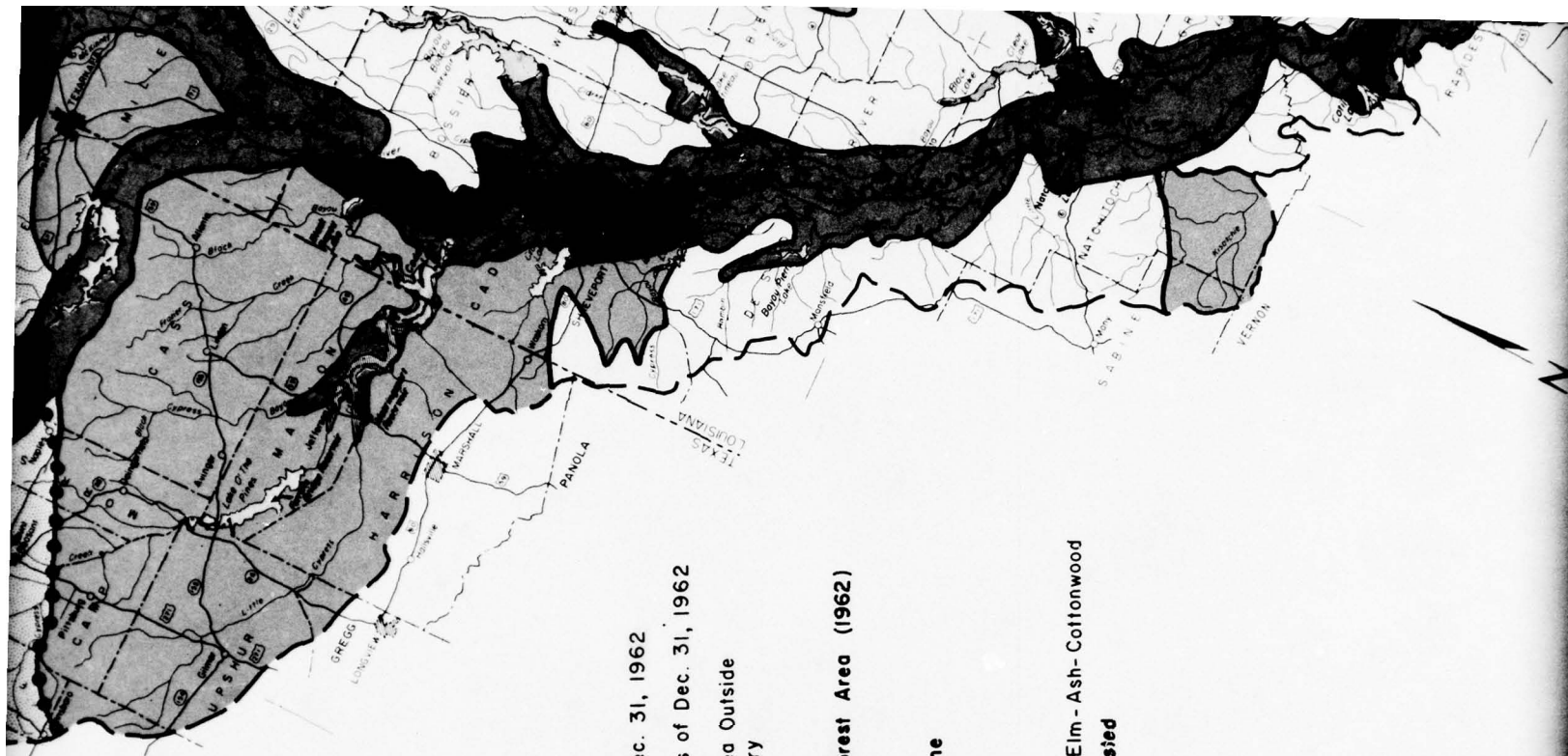
In 1962, about 93 percent of the Study Area's commercial forest land was privately owned and seven percent was publicly owned. Distribution by ownership classes was as follows: farm ownership, 20 percent; forest industry, 23 percent; other private ownership, 50 percent; National Forest, four percent; other Federal ownership, two percent; and State, county, or municipal ownership, one percent. Table 10 shows commercial forest land area by ownership class, by States. Table 11 shows, by ownership class, the 1962 volume of growing stock and sawtimber on commercial forest lands.

Since 1962, the National Forests have acquired an additional 11,000 acres within the Study Area. This additional acreage was acquired for present and future recreation needs. The 55-mile Talimena Scenic Drive and recreation complex in LeFlore County, Oklahoma, and Polk County, Arkansas, is under construction (1966) on some 3,000 acres acquired since 1962. As of 1966, only minor changes in National Forest acreage can be foreseen. These minor changes will occur through planned acquisition of key tracts needed for future recreation needs and tracts within critical












1/ Arkansas Forest Survey of 1959, Louisiana Forest Survey of 1954 and 1964, Oklahoma Forest Survey of 1956, and Texas Forest Survey of 1955 and 1965 by Southern Forest Experiment Station, USFS. Data used was adjusted to 1962 levels by field sampling in 1964-1966.

2/ Commercial forest land, as used in this report, is forest land that is producing or is capable of producing crops of industrial wood and has not been withdrawn from timber production.





LEGEND

-  Existing Lakes as of Dec. 31, 1962
-  Reservoirs Authorized as of Dec. 31, 1962
-  Comprehensive Study Area Outside The River Basin Boundary
-  Basin Boundary
-  Limit of Commercial Forest Area (1962)
-  Longleaf - Slash Pine
-  Loblolly - Short Leaf Pine
-  Oak - Pine
-  Oak - Hickory
-  Oak - Gum - Cypress and Elm - Ash - Cottonwood
-  Less Than 10% Forested



VICINITY MAP

Figure 3

**COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS
DISTRIBUTION OF FOREST
TIMBER TYPES**
U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE



Rev. 1-68 4-R-23082

Rev. 1-68 4-R-18030

BASE MAP COMPILED BY U.S.D.A., SOIL CONSERVATION SERVICE, FORT WORTH, TEXAS, FROM U.S.G.S. 1:250,000 BASE AND AMS 1:250,000 MAPS.

USDA/CS FORT WORTH, TEX 1968

Table 8 - Distribution of Commercial Forest Area by Forest Types ^{1/}, Red River Basin Study Area, 1962

| Forest Type | Area | |
|-------------------------|----------------|---------|
| | thousand acres | percent |
| Softwood types | | |
| Longleaf-slash pine | 128.9 | 1 |
| Loblolly-shortleaf pine | 3,502.4 | 34 |
| Oak - pine | 1,504.3 | 15 |
| Total | 5,135.6 | 50 |
| Hardwood types | | |
| Oak - hickory | 2,858.7 | 28 |
| Elm - ash - cottonwood | 203.8 | 2 |
| Oak - gum - cypress | 1,982.5 | 20 |
| Total | 5,045.0 | 50 |
| All Types | 10,180.6 | 100 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, U. S. Forest Service

^{1/} Definitions of forest types as used in this report are as follows: Longleaf-slash pine. These species, singly or in combination, make up 50 percent or more of the forest stand. Other southern pines, oak, and gum are common associates.

Loblolly-shortleaf pine. These species, singly or in combination, or other southern yellow pines except longleaf or slash pine, compose 50 percent or more of the forest stand. Oak, hickory, and gum are common associates.

Oak-pine. Fifty percent or more of the stand is hardwood, usually upland oaks and 25-49 percent is southern pine. Gum, hickory, and yellow-poplar are common associates.

Oak-hickory. Upland oak and hickories, singly or in combination, make up 50 percent or more of the forest stand except where pines are present and compose 25 to 49 percent of the stand. Under the latter conditions, the stand is classified as oak-pine. Yellow poplar, elm, maple, and black walnut are common associates.

Elm-ash-cottonwood. These species, singly or in combination, make up 50 percent or more of the forest stand. Willow, sycamore, beech, and maple are common associates.

Oak-gum-cypress. Bottomland forests where tupelo, black gum, sweetgum, oaks, or southern cypress, singly or in combination, make up 50 percent or more of the stand. Where pines are present and compose 25-49 percent, the stand is classified as oak-pine types. Cottonwood, willow, ash-elm, hackberry, and maple are common associates.



A virgin loblolly pine stand, reserved for a scenic area on National Forest lands near Saline Lake in Winn, Parish, Louisiana. This stand contains an average of 30,000 board feet per acre. (U. S. Forest Service Photo)

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Table 9 - Area of Commercial Forest Land by Forest Type and Stand Size Classes, Red River Basin Study Area, 1962

| Forest Type | ∴ All ∴ | ∴ Saw- ∴ | ∴ Pole- ∴ | ∴ Seedlings: Nonstock ∴ | ∴ and ∴ | ∴ and Other ∴ |
|------------------------------------|-----------|-----------|------------|-------------------------|-----------|---------------|
| | ∴ Stand ∴ | ∴ Sizes ∴ | ∴ timber ∴ | ∴ Saplings ∴ | ∴ Areas ∴ | |
| - - - - - thousand acres - - - - - | | | | | | |
| Softwood types | | | | | | |
| Longleaf-slash pine | 128.9 | 58.7 | 23.0 | 47.0 | 0.2 | |
| Loblolly-shortleaf pine | 3,502.4 | 1,791.7 | 835.7 | 851.6 | 23.4 | |
| Oak-pine | 1,504.3 | 474.3 | 412.2 | 611.9 | 5.9 | |
| Total | 5,135.6 | 2,324.7 | 1,270.9 | 1,510.5 | 29.5 | |
| Hardwood types | | | | | | |
| Oak-hickory | 2,858.7 | 487.3 | 1,028.9 | 1,274.1 | 68.4 | |
| Elm-ash-cottonwood | 203.8 | 88.0 | 42.7 | 65.8 | 7.3 | |
| Oak-gum-cypress | 1,982.5 | 1,200.3 | 449.6 | 276.1 | 56.5 | |
| Total | 5,045.0 | 1,775.6 | 1,521.2 | 1,616.0 | 132.2 | |
| Total all types | 10,180.6 | 4,100.3 | 2,792.1 | 3,126.5 | 161.7 | |

Source: State Forest Survey Reports, Southern Forest Experiment Station, U. S. Forest Service

watersheds that will consolidate National Forest lands. Additional consolidation of National Forest lands for improved efficiency in management is planned through land exchanges with private landowners.

Table 10 - Area of Commercial Forest Land by States and Ownership Classes, Red River Basin Study Area

| State | All | Public Ownership | | | | Private Ownership | | | |
|------------------------------------|----------|------------------|-----------------|---------------|--------------|-------------------|---------|----------|---------------|
| | | Total | National Forest | Other Federal | Other Public | Total | Farm | Industry | Other Private |
| - - - - - thousand acres - - - - - | | | | | | | | | |
| Arkansas | 2,022.2 | 120.2 | 105.8 | 1.2 | 13.2 | 1,902.0 | 513.9 | 581.6 | 806.5 |
| Louisiana | 3,513.9 | 329.9 | 242.4 | 74.2 | 13.3 | 3,184.0 | 344.7 | 631.5 | 2,207.8 |
| Oklahoma | 2,828.2 | 170.4 | 120.4 | 16.5 | 33.5 | 2,657.8 | 628.6 | 936.5 | 1,092.7 |
| Texas | 1,816.3 | 105.7 | 0.0 | 99.7 | 6.0 | 1,710.6 | 528.2 | 151.6 | 1,030.8 |
| Total | 10,180.6 | 726.2 | 468.6 | 191.6 | 66.0 | 9,454.4 | 2,015.4 | 2,301.2 | 5,137.8 |

Source: See Table 9

Table 11 - Volume of Growing Stock and Sawtimber on Commercial Forest Land by Ownership and Species Group, Red River Basin Study Area, 1962

| Ownership | Volume of Growing Stock | | | Volume of Sawtimber | | |
|------------------|--------------------------------|-----------|---------|--------------------------------|-----------|----------|
| | Softwoods | Hardwoods | Total | Softwoods | Hardwoods | Total |
| | - - - million cubic feet - - - | | | - - - million board feet - - - | | |
| Public | | | | | | |
| National forest | 318.8 | 91.2 | 410.0 | 1,477.7 | 214.8 | 1,692.5 |
| Other Federal | 64.5 | 63.0 | 127.5 | 294.3 | 175.4 | 469.7 |
| Other public | 18.2 | 7.3 | 25.5 | 34.6 | 54.3 | 88.9 |
| Subtotal public | 401.5 | 161.5 | 563.0 | 1,806.6 | 444.5 | 2,251.1 |
| Private | | | | | | |
| Farm | 295.1 | 532.1 | 827.2 | 1,098.0 | 1,245.1 | 2,343.1 |
| Forest industry | 1,226.6 | 506.4 | 1,733.0 | 5,546.7 | 1,427.4 | 6,974.1 |
| Other private | 1,166.8 | 1,376.7 | 2,543.5 | 4,657.4 | 4,048.9 | 8,706.3 |
| Subtotal private | 2,688.5 | 2,415.2 | 5,103.7 | 11,302.1 | 6,721.4 | 18,023.5 |
| All Ownership | 3,090.0 | 2,576.7 | 5,666.7 | 13,108.7 | 7,165.9 | 20,274.6 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, U. S. Forest Service

Forest Land, Timber Inventories, and Volumes, By States

In 1962, the distribution of commercial forests by States was as follows: Arkansas, 19.9 percent, Louisiana, 34.5 percent; Oklahoma, 27.8 percent; and Texas, 17.8 percent. Table 12 shows the 1962 distribution of growing stock and sawtimber volumes in the Study Area by States. The inventory represented in the table is far too little to utilize the full growth potential of the commercial forest lands available in each state. This condition in the overall timber inventory is caused by accumulation of cull trees and competing vegetation on many acres of poorly managed forest lands.

Many timber stands on commercially productive forest land have become submarginal in merchantability due to the build-up of low-quality trees and low-value species. This condition is most apparent in mixed and pure hardwood stands.

Table 12 - Volume of Growing Stock and Sawtimber on Commercial Forest Lands by Species Groups in States, Red River Basin Study Area, 1962

| States | Volume | | | | | |
|-----------|-----------------------------|-----------|---------|-------------------------------|-----------|----------|
| | Growing Stock | | | Sawtimber | | |
| | Softwoods | Hardwoods | Total | Softwoods | Hardwoods | Total |
| | - - million cubic feet- - - | | | - - - million board feet- - - | | |
| Arkansas | 769.1 | 516.3 | 1,285.4 | 3,473.7 | 1,216.6 | 4,690.3 |
| Louisiana | 1,517.4 | 1,086.7 | 2,604.1 | 6,699.8 | 3,530.2 | 10,230.0 |
| Oklahoma | 423.0 | 455.3 | 878.3 | 1,723.5 | 1,102.1 | 2,825.6 |
| Texas | 380.5 | 518.4 | 898.9 | 1,211.7 | 1,317.0 | 2,528.7 |
| Basin | 3,090.0 | 2,576.7 | 5,666.7 | 13,108.7 | 7,165.9 | 20,274.6 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, U. S. Forest Service

The 1962 inventory of timber volumes by states, on an average per acre basis is shown in Table 13. The difference in magnitude of this average data is not a direct indication of the average management levels in the different state areas. Considerable variation is attributable to the inherent productivity of the forest soils and climate of the areas involved. The level and viability of local and regional timber markets have a direct effect on average management levels and prevailing stand conditions.

Table 13- Average Volume Per Acre of Growing Stock and Sawtimber on Commercial Forest Land by States and Species Groups, Red River Basin Study Area, 1962

| States | Volume per acre | | | | | |
|---------------|-------------------------------|-----------|-------|-------------------------------|-----------|-------|
| | Growing Stock | | | Sawtimber ^{1/} | | |
| | Softwoods | Hardwoods | Total | Softwoods | Hardwoods | Total |
| | - - - - - cubic feet- - - - - | | | - - - - - board feet- - - - - | | |
| Arkansas | 380 | 256 | 636 | 1,718 | 602 | 2,320 |
| Louisiana | 414 | 296 | 710 | 1,906 | 1,004 | 2,910 |
| Oklahoma | 143 | 168 | 311 | 611 | 390 | 1,000 |
| Texas | 209 | 286 | 495 | 612 | 778 | 1,390 |
| Basin Average | 304 | 253 | 557 | 1,287 | 704 | 1,991 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, U. S. Forest Service

^{1/} Board foot volume is included in cubic foot growing stock volume

WATER RESOURCES

Appendix Report III describes in detail the quantities and qualities of both surface water and ground water in the Study Area. Only a cursory treatment of this subject is given in this report.

Surface Water Supply

The average annual runoff of tributary basins ranges from eight inches in Bryan County, Oklahoma, to 20 inches in Polk County, Arkansas. Near Alexandria, Louisiana, the average annual runoff is approximately 15 inches.

Total annual streamflow in the tributary basins varies greatly from year to year. In the Blue River Basin of the Bryan County area, the highest flow was equivalent to about 28 inches; and the lowest flow was equivalent to about one inch. In the Nantachie Creek Basin near Alexandria, Louisiana, the highest flow was equivalent to about 36 inches; and the lowest annual flow was equivalent to about two inches.

The diagrams in Figures 4 and 5 show variations in streamflow for drainage areas selected as representative of variations to be expected in upper and lower parts of the Study Area. Figure 4 shows the year-to-year variations in annual flow and Figure 5 shows average variations in monthly flow.

Existing and authorized Federal water projects through 1962 contain approximately 2.9 million acre-feet of storage for all purposes. An additional 0.6 million acre-feet is available from state, municipal, and private reservoirs. Of the total 3.5 million acre-feet available, approximately 1.6 million acre-feet are for municipal and industrial uses.

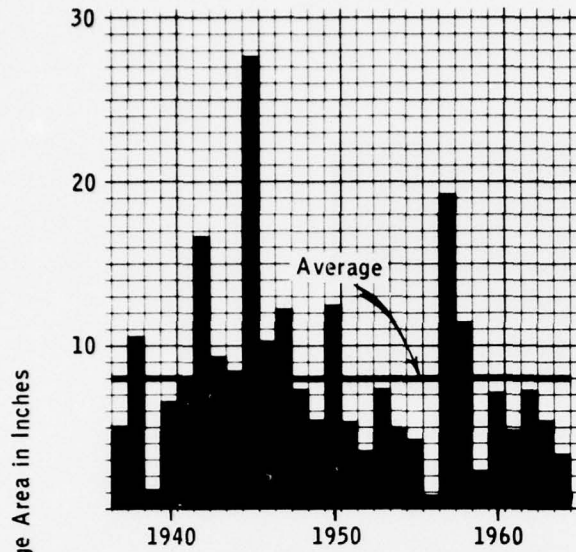
Water in Red River is poor quality for all uses because of the high natural salt content. Generally speaking, water in tributary streams is better quality than Red River water and is suitable for municipal and many industrial uses with little treatment.

Ground Water Supply

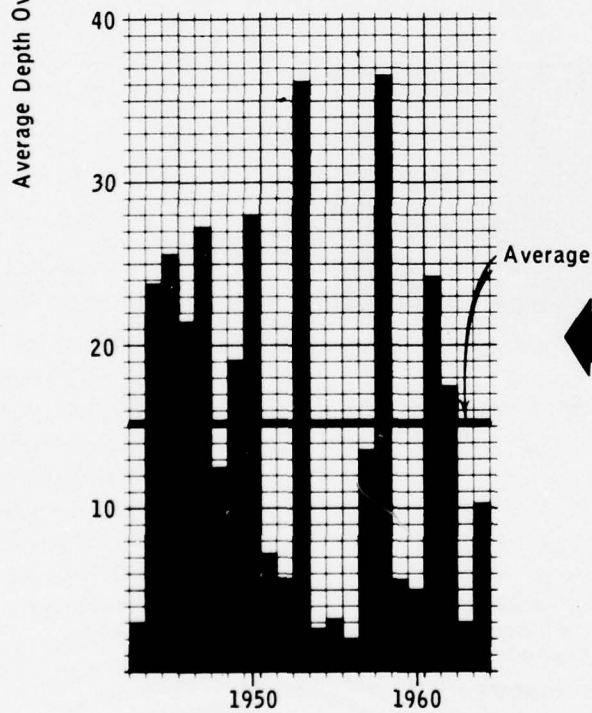
Large supplies of ground water are available in parts of the Sulphur River and Cypress Creek basins and along the main stem of Red River in Texas. The greatest potential for ground water development is in the southeastern part of the area, which is underlain by thick sections of water-bearing sands. These strata may yield as much as 500 g.p.m. (gallons per minute) to individual wells that range in depth from about 100 to 800 feet.

Supplies of ground water are also available in the northwestern part of this area. However, because the depth to most of the aquifers is more than 1,200 feet, development has been slow.

Alluvial deposits along the Red River in Arkansas, Louisiana, and Texas and in the lower reaches of Sulphur River and Cypress Creek are

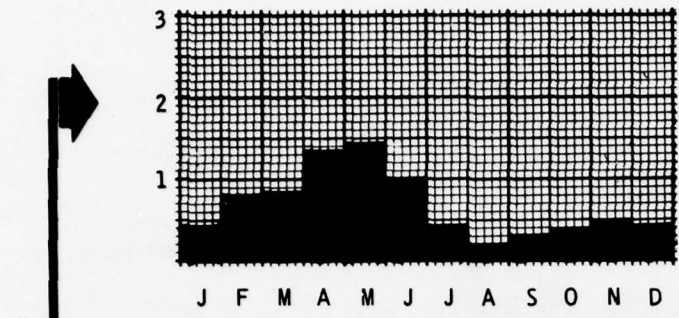


Water Year
Blue River, Oklahoma



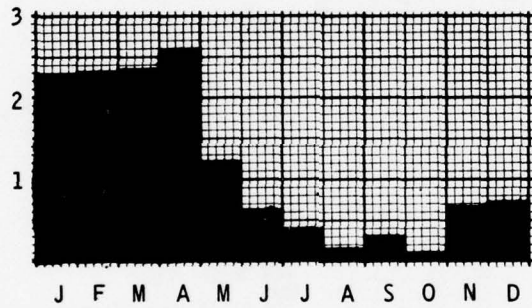
Water Year
Natchie Creek, Louisiana

Figure 4
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
ANNUAL RUNOFF
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



Blue River, Oklahoma

Inches Per Month



Nantachie Creek, Louisiana

Figure 5
 COMPREHENSIVE BASIN STUDY
 RED RIVER BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
AVERAGE RUNOFF
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

capable of yielding large supplies of ground water. The depth of wells in the alluvium generally is less than 125 feet and yields range from 500 g.p.m. in Texas to 1,700 g.p.m. in Louisiana.

The principal sources of ground water, in estimated decreasing order of potential, are as follows:

1. Terrace and alluvial deposits in the Red River Valley in Louisiana, Arkansas, and Texas.
2. Sand belts of the Wilcox Group and the Carrizo Sand which underlie the area south of a line through Sulphur Springs and Texarkana.
3. The Trinity Group, Woodbine Formation, Blossom Sand, and Nacatoch Sand which underlie the area north and west of a line through Sulphur Springs and Texarkana.
4. Near surface formations in the upper Sulphur River basin along White Oak Creek from Cooper to Bogota, Texas, and northeastward in the vicinity of New Boston, Texas; and in the Cypress Creek Basin in Caddo Parish, Louisiana.

Abundant supplies of ground water are available for development in only a few parts of Blue River, Boggy Creek, Kiamichi River, and Little River Tributary Basins. The greatest potential lies in the lower reaches of the basins which are underlain by sediments of the Southern Coastal Plain, and in the limestone formations of the Arbuckle Mountains in the upper Blue River Basin. The sandstone and shales, which underlie nearly all of the upper river basins, are capable of producing only limited quantities of variable-quality water. Therefore, there appears to be little potential for extensive development of ground water in a large portion of the upper river basins.

The principal sources of ground water, by aquifers in decreasing order of potential development, are as follows:

1. The outcrop of the Paluxy Sand, which extends east to west across the lower basins and southward where it dips under younger rocks. Wells yield from 50 to 500 g.p.m. from depths less than 150 feet.
2. Terrace and alluvial deposits along the lower reaches of all the rivers, especially Little River and along the Red River. Well depths in the alluvium range from 25 to 80 feet and yield up to 500 g.p.m. Well depths in terrace deposits range from 100 to 800 feet and yield 50 to more than 500 g.p.m.
3. Limestone formations in the Arbuckle Mountains. These formations yield water to springs and wells from fractures and solution channels. Wells yield as much as 500 g.p.m. locally from shallow depths, but the strata may be barren

of water at other locations because of the lack of openings.

4. Sandstone and shale strata of the upper river basins in the Arbuckle and Ouachita Mountains. Wells less than 25 feet deep will yield from 10 to 50 g.p.m. intermittently.

In Louisiana, the Red River alluvium ranges in thickness from 75 feet near the Arkansas line to more than 150 feet in Avoyelles Parish. The lower sections are composed of sands and gravels which form an aquifer capable of yielding large quantities of water suitable for irrigation. Wells tapping the alluvial aquifers range in yields from 200 to 1,700 g.p.m. and in depth from 45 to 130 feet.

Older formations are sources of ground water beneath and adjacent to the alluvium along Red River in Louisiana. Pleistocene Terrace deposits yield water from wells ranging from 15 to 130 feet deep. In thick deposits, several hundred thousand gallons per day possibly can be obtained. Yields vary from 100 to 600 g.p.m. Eocene and Miocene deposits produce water from depths ranging from 100 to 1,000 feet. These older sands are typical continental deposits and may pinch out abruptly or grade laterally into clay. Consequently, hydraulic characteristics are reliable for only local areas. Yields range from 250 to 1,200 g.p.m. in these older formations.

Data are insufficient to permit an evaluation of the annual dependable maximum withdrawals available from aquifers. Reconnaissance investigations have been performed by the USGS in Texas, Oklahoma, and Arkansas, and numerous publications are available from state and other agencies which evaluate ground water depths and the yields to wells in gallons per minute; however, little information is available on the amount of water that can be withdrawn annually. Data are available on annual dependable maximum withdrawals available from some formations in the Sulphur River and Cypress Creek Basins. A dependable annual yield of 4,800 acre-feet is available from the Trinity Group, 11,700 acre-feet from the Woodbine Formation, and 18,000 acre-feet from the Carrizo Sand and Wilcox Group, Undifferentiated. The utilization of large amounts of the ground water from these formations is preempted by present municipal and industrial consumers, particularly in Grayson County.

The quality of water is suitable for most uses from practically all of the principal aquifers in the Red River Basin in Texas in the upper zones; however, the chloride content increases with depth. In general, good quality water is available in Oklahoma and Arkansas except in southern McCurtain County, Oklahoma, and southern Little River County, Arkansas, where the water is highly saline.

Generally, water quality is suitable for most uses in Louisiana. A few isolated areas are excepted because of contamination with salt water from underlying formations. One of the larger areas of salt water contamination is at Clarence, in Natchitoches Parish, where the chloride concentration reaches 8,000 parts per million. More detailed information is needed before evaluation of the potential for future development of ground water can be attempted.

ECONOMIC DEVELOPMENT AND ACTIVITY, PRESENT AND PROJECTED

POPULATION

In 1962, the Study Area population was about 1,757,400 or approximately 59 persons per square mile (Exhibit 4). About 49 percent of the people lived in the urban areas of Shreveport, Alexandria, Bossier City, Texarkana, Sherman, and Paris; 40 percent lived in rural towns with populations of 2,500 or less; and 11 percent lived on farms (table 14).

Table 14 - Population Distribution: Urban and Rural, 1930, 1940, 1950, 1960, and 1962; Projection ^{1/} for 1980 and 2010, extrapolated to 2080, Red River Basin Study Area ^{2/}

| Classification | Year | | | | | | | |
|--------------------|-----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | 1930 | 1940 | 1950 | 1960 | 1962 | 1980 | 2010 | 2080 |
| | - - - - - numbers - - - - - | | | | | | | |
| Urban | 359,517 | 471,849 | 636,787 | 808,923 | 865,950 | 1,379,500 | 2,565,400 | 8,330,300 |
| Rural | 1,348,243 | 1,413,170 | 1,102,179 | 895,254 | 891,450 | 857,200 | 857,700 | 857,800 |
| Rural, Non-farm | NA | 442,954 | 534,525 | 687,465 | 698,570 | 733,500 | 772,400 | - |
| Rural, Farm | NA | 970,216 | 567,654 | 207,789 | 192,880 | 123,700 | 85,300 | - |
| Total | 1,707,760 | 1,885,019 | 1,738,966 | 1,704,177 | 1,757,400 | 2,236,700 | 3,423,100 | 9,188,100 |

^{1/} Based on projection of Series B Census of Population, U. S. Department of Commerce

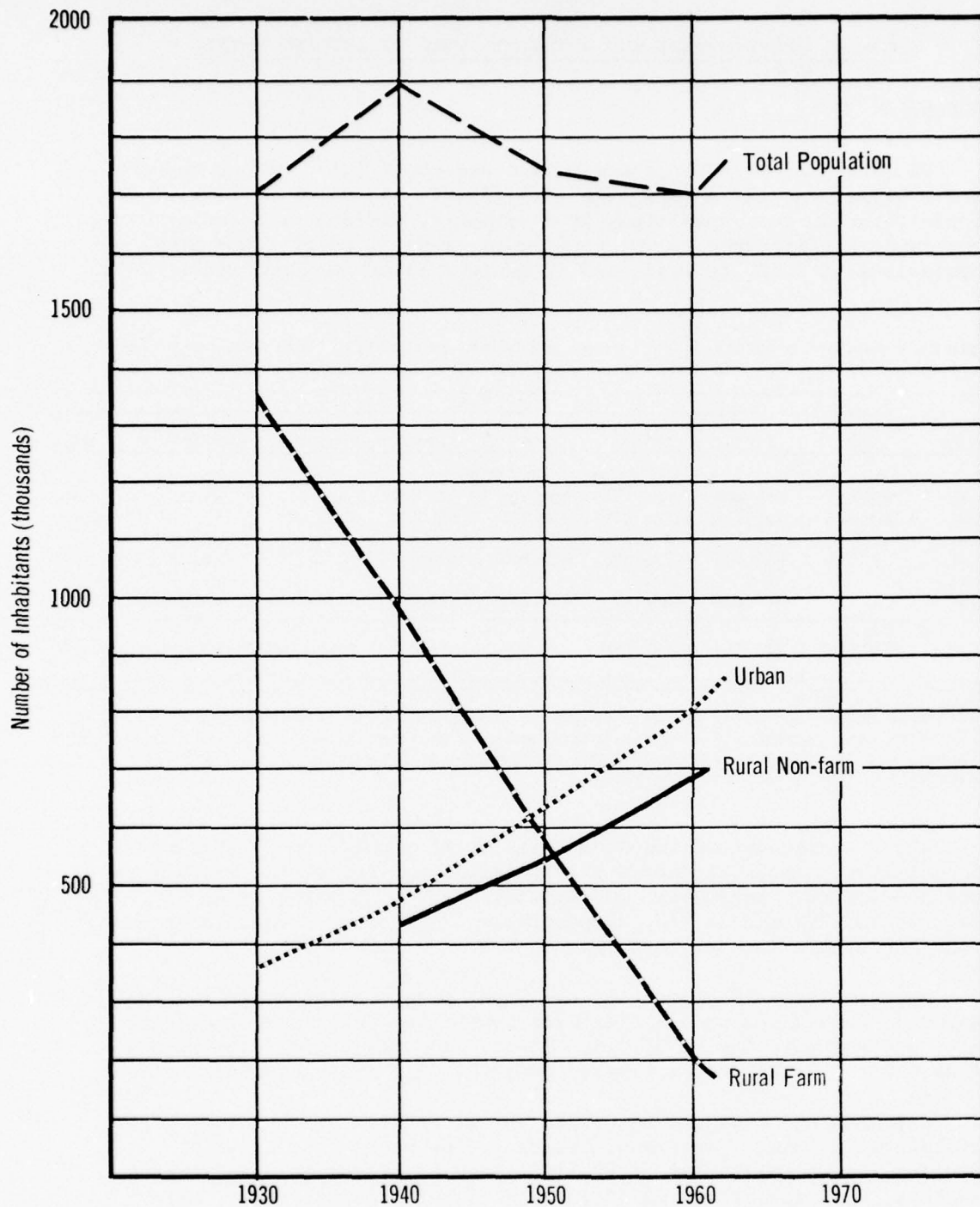
^{2/} These data represent 9 counties in Arkansas, 19 parishes in Louisiana, 13 counties in Oklahoma, and 19 counties in Texas. Whole county data are presented in this analysis. Census of Population definitions apply.

About 48 percent of the Study Area total population in 1960 was in Louisiana. Major cities in the Louisiana portion of the Study Area were Shreveport, Alexandria, and Bossier City, with populations of 164,372; 40,279; and 32,776, respectively. All other urban places and towns had populations of less than 32,000.

Approximately 30 percent of the Study Area population in the 1960 Census of Population was in the Texas counties. Texarkana, the major city, had a population of 30,218. Sherman and Paris with populations of 24,988 and 20,977 respectively, were the only other sizeable cities.

Oklahoma and Arkansas accounted for 22 percent of the Study Area population in 1960. Texarkana, Arkansas, the major city in this grouping, had a population of 19,788. Magnolia, Arkansas, and Durant, Oklahoma, had populations of 10,651 and 10,467, respectively. All other towns and communities had populations of less than 10,000 each.

The total population of the Study Area increased slightly more than 10 percent from 1930 to 1940. Since 1940, the population of the basin decreased at each Census reporting period (figure 6).



SOURCE: U. S. Census of Population

Figure 6
 POPULATION: URBAN, RURAL NON-FARM, RURAL FARM
 AND TOTAL POPULATION
 RED RIVER BASIN STUDY AREA, 1930-1962

Rural farm population has continually declined since 1930. Expanded farm size resulting from improved technology and mechanization has been the major factor contributing to the decline in rural farm population.

The decline in rural farm population has been offset by an increase in rural non-farm and urban population. The expansion of wood processing (plywood, pulp mills, etc.) and other industries was a major factor contributing to the population relocation.

Changes in the numbers and composition of the Study Area population are indicators of a changing economy. The historic decline in total population may suggest a faltering economy. However, the decline in the past can be related mainly to the rural segment of the economy. The urban and rural non-farm sectors of the economy have been increasing. An internal shift of this type suggests that reorganization of the economy is occurring, and the expected results would be a more prosperous and stable economy. The readjustment, however, is expected to take many years and the decline of the rural farm sector is projected to continue through the year 2010 (table 14).

The projected urban population increase is expected to be concentrated in the presently established metropolitan areas, Shreveport-Bossier City, Alexandria, and Texarkana. By 2010, less than 10 percent of the total rural population will be classified as rural farm. The remaining 90 percent of the rural population will be classified as rural non-farm, or those persons "living outside the cities or other incorporated places having 2,500 inhabitants or more who do not live on farms". The larger proportion of rural farm decline will be in the less productive areas of the basin. After 1980, the total rural population will remain fairly constant at approximately 857,700.

Persons per farm are expected to remain fairly constant after 1962, at about 2.5 persons per farm. The farm population projections can be determined by projected farm numbers and person per farm.

EMPLOYMENT

Labor Force

In 1962, about 724,900 people, or 41 percent of the population in the Study Area, were employed. About 39 percent of the working force were employed in services and government, and 17 percent were employed in wholesale and retail trades. Manufacturing, agriculture, and mining employed 14 percent; 7 percent; and 3 percent, respectively. Seasonal agricultural workers are not included in this figure. Utilities, communications, and transportation and contract construction each employed about 6 percent of the labor force. The remaining 8 percent worked in finance, insurance and real estate, and other industries.

Trends in employment are shown in Table 15. Employment in agriculture has declined since 1940, while employment in manufacturing, services, finance and government services has increased. Percentage increases in employment between 1950 and 1960 were the greatest in other industries, government and armed forces, and finance. Industrial employment increased over 40 percent during the last decade; government and armed forces, and finance employments were up 26 percent and 23 percent, respectively.

Table 15 - Labor Force and Employment Estimates, 1940, 1950, 1960, and 1962, Projected 1980 and 2010, Red River Basin Study Area ^{1/}

| Industry | : 1940 | : 1950 | : 1960 | : 1962 | : 1980 | : 2010 |
|--|---------------------|----------------|----------------|----------------|----------------|------------------|
| | - - - | - - - | - - - | - - - | - - - | - - - |
| | - - - numbers - - - | | | | | |
| Agriculture | 212,902 | 115,069 | 54,764 | 52,200 | 55,000 | 50,000 |
| Mining | 18,820 | 25,015 | 20,361 | 20,300 | 22,000 | 34,000 |
| Manufacturing | 49,990 | 78,619 | 93,379 | 98,600 | 128,000 | 219,000 |
| Utilities, communications, and transportations | 32,935 | 49,315 | 42,828 | 44,900 | 51,000 | 75,000 |
| Trade | 97,629 | 133,652 | 122,165 | 126,800 | 142,000 | 235,000 |
| Services | 100,570 | 134,366 | 161,483 | 168,200 | 188,000 | 308,000 |
| Construction | NA | 52,174 | 44,934 | 44,900 | 56,000 | 87,000 |
| Finance, insurance and real estate | NA | 20,012 | 24,574 | 26,100 | 22,000 | 39,000 |
| Other industries | 75,280 | 20,727 | 29,488 | 31,200 | 18,000 | 29,000 |
| Government | NA | 69,327 | 82,848 | 86,300 | 41,000 | 48,000 |
| Armed forces | NA | 16,439 | 25,276 | 25,400 | 18,000 | 18,000 |
| Total labor force | 588,126 | 714,715 | 702,100 | 724,900 | 741,000 | 1,142,000 |

^{1/} A refinement of these data is found in the Economic Appendix

With increasing urbanization and a stabilization of agricultural employment opportunities, the labor force participation rates in the Study Area are expected to gradually approach the National level ^{1/}. Agriculture employment is projected to decrease through 1980 and remain fairly constant through 2010. The armed forces projection reflects a basic assumption of no major wars. All other industries are expected to increase in the number employed (table 15).

These estimates of population and employment are based on the current rates of resource development. The anticipated effect of proposed projects and other types of accelerated resource development are not included in these projections.

^{1/} USAE, New Orleans District. Economic Appendix, Appendix I, New Orleans: 1967

Farm Employment

The total farm labor force in the Study Area decreased between 1939 and 1949; increased 26 percent from 1949 to 1954; and then decreased more than 50 percent from 1954 to 1959 (table 16). In the 1959 Census of Agriculture, 114,000 people were reported in the total farm labor force. The number of farms reporting farm labor varies widely between "family workers, including the farm operator" and "all hired workers" employed in the farm labor force. It is estimated that approximately 134,400 people were classified in these two categories in 1962.

In 1939, 86 percent of the total farm number was reported as having over 235,500 persons listed as family farm labor. This amounted to 1.5 persons per farm reporting. Since 1939, the number of persons listed as family farm labor has decreased about 60 percent, while the persons per farm reporting remain fairly stable at 1.4.

Hired farm workers include those employed more than 150 days and seasonal workers. In 1939, only 11 percent of the total farms reported hired workers, for a total hired labor force of 43,974. The percentage of farms reporting hired workers has remained fairly stable at 10 percent through 1959. The number of hired workers per farm reporting varies from 1939 to 1962 as indicated in Table 16.

Table 16 - Farm Labor: Family including Operator, and All Hired Workers on Farms Reporting, 1939-1959 Census Periods, and 1962 and Projected to 1980 and 2010, Red River Basin Study Area 1/

| Year | Farms | | Family incl. operator | | All hired workers | | Total | |
|------|--------------|-------------------------|-----------------------|-------------------------|-------------------|-------------------------|--------------|-------------------------|
| | :Total farms | :Total persons per farm | :Total farms | :Total persons per farm | :Total farms | :Total persons per farm | :Total farms | :Total persons per farm |
| 1939 | 177,264 | 86.3 | 1.5 | 235,503 | 11.3 | 2.2 | 43,974 | 279,477 |
| 1944 | 152,385 | 87.2 | 1.5 | 197,314 | 2.4 | 1.9 | 6,939 | 204,251 |
| 1949 | 136,093 | 80.4 | 1.5 | 163,452 | 7.9 | 2.2 | 24,169 | 187,621 |
| 1954 | 112,857 | 85.8 | 1.6 | 155,395 | 12.4 | 5.8 | 81,975 | 235,370 |
| 1959 | 78,293 | 79.1 | 1.4 | 84,484 | 10.1 | 3.7 | 29,524 | 114,008 |
| 1962 | 77,150 | 79.7 | 1.5 | 92,232 | 10.8 | 5.0 | 41,660 | 133,892 |
| 1980 | 53,770 | 74.0 | 1.4 | 55,706 | 13.5 | 7.4 | 53,717 | 109,423 |
| 2010 | 32,800 | 64.5 | 1.4 | 29,618 | 18.1 | 11.6 | 68,869 | 98,487 |

1/ Whole counties are represented in the four basin states of Arkansas, Louisiana, Oklahoma, and Texas

2/ Farm labor was defined to include any work, chores, or planning necessary to the agricultural operations of the farm; and to exclude housework, contract construction work, custom machine work, and repair installation, or construction work done by persons employed specifically for such work. An operator was considered as working if he worked one or more hours; unpaid members of the operator's family, if they worked 15 or more hours; and hired persons, if they worked at all during the week.

Hired workers include "regular workers" (employed more than 150 days) and "seasonal workers" (employed less than 150 days).
Source: Census of Agriculture

Trends in total farm labor, family farm labor, and all hired farm labor are shown in Table 16. With the total farm number rapidly decreasing, and the average size of farms increasing, the family farm labor force has continued to decline since 1939. Expanded farm size and industrialization are becoming more prevalent where rural farm population and low labor productivity were once common. The presence of employment opportunities is conducive to off-farm work. Therefore, it appears that industrialization provides an outlet for concentrated areas of subsistence units, under-sized farms, and under employment of labor on farms. Continued improvement in technology and mechanization will continue to be contributive factors in the decline of family farm labor. At the same time employment in agribusiness firms, such as farm supply, will respond to the increased need for off-farm services. However, farm employment data in this report does not include employment in the agribusiness firms.

The number of hired farm workers will remain fairly constant in the shortrun; however, there will be an increase in hired workers per farm. Measures directed towards production adjustment and improved resource use in the agricultural industry will be major factors in an increasing hired farm labor force.

The total family labor force is projected to continue decreasing through the year 2010 (table 16). This part of the total farm labor has historically decreased at a faster rate than farm numbers. This trend is projected to continue; however, family workers per farm are expected to decrease only slightly from 1.5 in 1962 to 1.4 in 2010.

The number of hired farm workers is influenced partly by the economic atmosphere in which the farmer operates. Inputs including hired labor are varied in response to expected returns. The number of hired workers in the basin is expected to increase in future time periods. However, the increase will not be as great as the decrease in family labor. The number of farm workers per farm is expected to increase from 7 in 1980 to about 12 by 2010.

The Census of Population has historically used a more restrictive definition of agricultural employment than the Census of Agriculture. This accounts for the apparent discrepancy between Tables 15 and 16, since the former is based on Census of Population data and the latter is based on Census of Agriculture data.

Forest Industry Employment

Employment in 1962 in the states of Arkansas, Louisiana, Oklahoma, and Texas had approximately 115,000 workers in primary and secondary forest industry. Outside of Houston and New Orleans, forest connected payrolls included about one-third of the four states' workers. In addition, a substantial share of the employment in construction, transportation, and marketing was directly attributable to wood products originating in the four-state area.

Table 17 shows employment in forest industry on the base area and an estimate of workers attributable to roundwood from the Study Area. Generally, employment in transportation and wholesale and retail marketing attributable to wood products is not included. This table includes only the transportation required to move raw wood products to the point of initial manufacture and the limited marketing facilities integrated with primary or secondary manufacturing plants.

Table 17 - Employment in Forest Industry, Red River Basin Study Area, 1962

| | : Basin Study Area 1/ | : Base Area 2/ |
|-------------------------------------|-------------------------|----------------|
| | - - - - numbers - - - - | |
| Management and harvesting <u>3/</u> | 3,436 | 4,913 |
| Primary manufacturing <u>4/</u> | 8,056 | 12,278 |
| Secondary manufacturing <u>5/</u> | 2,436 | 3,231 |
| State forest agencies | 188 | 245 |
| Other <u>6/</u> | 27 | 36 |
| | 14,143 | 20,703 |

1/ Estimates of employment attributable to roundwood produced on the Study Area

2/ Whole counties and parishes touched by the Study Area, except Panola County, Texas

3/ Includes personnel for management of Federal Forest lands

4/ The initial process when harvested roundwood is changed in form and/or utility

5/ Manufacturing process, or processes, after primary manufacture, that finish the product for marketing and/or consumption. Not required for use of all forest products.

6/ Includes other personnel employed in promoting the use, sale and production of forest products. Does not include personnel in academic and research fields.

Interim Trends and Projected Employment

The 1965 level of employment in forest industry on the Study Area and base area totaled 13,739 and 20,356, respectively. This data is comparable with that for 1962 in Table 17. The 1965 figures show employment at about 97 percent of 1962 levels. Information from the employment security divisions of Arkansas, Louisiana, and Oklahoma show more full-time jobs on the base area in 1965, than in 1962. The actual decrease in total employment between 1962 and 1965 took place mostly in the part-time and family-type logging and sawmill operations. Employment information on this segment of forest industry has been largely unreported.

Since 1965, ten major plants have been added to forest industry on the base area. These are under construction or operating (1967). On

the basis of forest land acquisition programs, selection of mill sites, affirmative engineering studies, and applications for manufacturing water needs, at least two additional major plants will be established before 1980. Estimates of initial labor requirements for these plants are as follows:

New Forest Industry, Base Area

| Type | Operating or | | Employment Needs 1/ | |
|----------------|-----------------------|----------------------|---------------------|---|
| | Building (1966-68) | Planned (1968-80) | Mill and Yard | : Forest Management : and Harvesting |
| Pulp and Paper | 2 | 2 | 1,665 | 3,200 |
| Pine Plywood | 8 | 1 | 1,145 | 1,725 |
| Total | | | 2,810 | 4,925 |

1/ Based on information from company officials and/or needs of mills of minimum size for efficient operation

There are several factors that will influence future levels of employment in forest industry on the base area. Manufacturing facilities are being provided by new investments to utilize the full productivity of the Base Study Area, at the current level of management. A considerable number of new job opportunities are being provided during this period (1966-1980). The pressure for increased efficiency and higher employee productivity in established industry is causing a low rate of job loss, or increasing production with the same employee force. Improved mechanization and increasing automation will cause a general, steady attrition of jobs for a period of 20 to 30 years, in most sectors of forest industry.

Estimates of future employment attributable directly to roundwood produced on the Basin Study Area follows, with total employment in forest industry on the base area are as follows:

| Year | Total Employees | |
|------|------------------|-------------|
| | Basin Study Area | : Base Area |
| 1980 | 17,000 | 24,400 |
| 2010 | 12,900 | 19,800 |

This employment data does not include the share of employees attributable to Study Area timber in transport of the finished products of secondary manufacture, in the marketing field, in construction, or in the many industries where wood makes-up a minor share of the raw materials used.

TRANSPORTATION

The Study Area is served by the Texas & Pacific, Kansas City Southern, Frisco, Missouri Pacific, and St. Louis & Southwestern Railroads. Two interstate highways transverse the basin; Interstate 30

in the northeastern-southwestern direction; and Interstate 20 in an east-west direction intersecting at Dallas, Texas. U. S. Highway 71 parallels the Red River from Alexandria, Louisiana, to Texarkana, Arkansas. Several state highways and numerous well-maintained county roads link the population centers.

Transcontinental bus service is available on all major highways. The motor truck industry handles a considerable amount of intercity traffic.

Shreveport and Alexandria have the only airports that are used by a transcontinental carrier (Delta Airlines) for major flights. Alexandria and Texarkana are served by Trans-Texas Airlines, which provided feeder service to larger terminals in the Mid-South. There are other smaller airports in the Study Area which provide public and private air facilities. It was assumed that in the future the Study Area will continue to have adequate transportation facilities; therefore, no projections regarding transportation were made.

NON-AGRICULTURAL USES OF LAND

Preemptive nonagricultural use of land is expected to increase in the future. Urban areas are expected to expand to provide homesites, service, and industrial development areas. In rural areas, highways and communities are expected to use more land.

Given the expected increases in population, the amount of land needed to accommodate the larger number of people will depend on the population density. Population density has a direct relationship to homesite, service, and industrial development land use.

Decreases in population occurred in 12 instances, or 25 percent of the incorporated places having 2,500 inhabitants. Losses in population of individual incorporated places varied from nine to more than 1,600. In Arkansas and Oklahoma there are 14 incorporated places of 2,500 or more in the Study Area. Half of them decreased in population between 1950 and 1960. Increases in population occurred in 35 of the urban places in the Study Area. Increases ranged from as few as 31 persons in Nashville, Arkansas, to more than 37,000 in Shreveport, Louisiana.

The average relationship between urban population and urban land area for the entire Study Area was approximately .125 acres per person. This estimate includes only land inside the corporate limits of urban places. Highways or recreational land outside the corporate limits were not considered. Between 1960 and 1980, highways are estimated to require 23 acres per 1,000 increase in population. By 1980, the interstate system is assumed complete, and the highway requirement from 1980 to 2010 is estimated at 20 acres per 1,000 increase in population. Highway land use estimates were based on research conducted by ERS.

The total nonagricultural land use requirement for urban and built-up, including highway construction to account for the urban population increases expected between 1960 and 1980, is about 148 acres per 1,000.

Between 1980 and 2010, the figure is expected to drop to 145 acres. About 76,000 acres more land would be required for urban and built-up uses in 1980 than in 1962, and almost 172,000 acres additional by 2010. Thus, the amount of urban and built-up land in 2010 would be 247,900 acres more than in 1962. The latter represents 4.3 percent of the 1962 total land area versus 3.0 percent in 1962.

Some of the urban development projected will have impact on rural lands such as cropland, forests and woodlands, and areas not in farms. The proposed project developments by communities in the Study Area will influence urban and built-up expansion. An assessment of the economic impacts will be considered in a latter section of the Appendix.

AGRICULTURAL DEVELOPMENT

Farm Numbers and Size

About 78,300 farms were reported in the Study Area in 1959 by the Census of Agriculture (table 18). These data indicate that approximately 40 percent were commercial farms; 42 percent were part-time farms; and 18 percent were part-retirement farms. ^{1/} There were 8,355 farms in Arkansas, 28,964 in Louisiana, 15,077 in Oklahoma, and 25,987 in Texas. By 1962, it was estimated that the total number of farms had decreased to 77,150.

Table 18 - Trends in Farm Numbers, Size, and Land in Farms, 1934 Through 1959 and 1962 Projected to 1980 and 2010, Red River Basin Study Area ^{1/}

| Year | Farms | Average Size | Land in Farms | Proportion of Total Land Area in Farms |
|------|---------|--------------|----------------|--|
| | number | acres | thousand acres | percent |
| 1934 | 219,086 | 73.8 | 16,180 | NA |
| 1939 | 177,264 | 88.7 | 15,719 | 53.2 |
| 1944 | 152,385 | 98.8 | 15,063 | 51.1 |
| 1949 | 136,093 | 118.1 | 16,070 | 54.6 |
| 1954 | 112,857 | 138.7 | 15,657 | 53.2 |
| 1959 | 78,293 | 187.5 | 14,683 | 50.1 |
| 1962 | 77,150 | 190.0 | 14,660 | 51.4 |
| 1980 | 53,770 | 270 | 14,520 | 49.9 |
| 2010 | 32,800 | 416 | 13,640 | 47.4 |

^{1/} Whole counties are represented in the four basin states of Arkansas, Louisiana, Oklahoma, and Texas. Compiled from U. S. Census of Agriculture Bureau of Census, Department of Commerce.

^{1/} Commercial farms include all farms with a value of sales amounting to \$2,500 or more. Part-time farms include farms with a value of sales of farm products of \$50 to \$2,499 and operators under 65 years of age that either worked off the farm 100 days or more or had other income from non-farm sources that was greater than the total value of farm products sold. Farms with a value of sales of farm products of \$50 to \$2,499 were classified as part-retirement if the farm operator was 65 years old or over.

Farms are rapidly increasing in size. While the number of farms has decreased by 65 percent since 1934, the average size has more than doubled. Land in farms also decreased. However, the proportion of land area in farms has only decreased 3 percent since 1939.

There are a number of reasons for the increase in farm and ranch size. Cost-price problems of recent years have encouraged a constant search for economies in operation. The extensive grain and livestock operations are particularly conducive to economies of scale. Technological advancement, a major factor in a number of agricultural changes, has influenced expansion in ranch and farm size in at least two ways. First, the use of more efficient equipment and methods make possible additional output with the same number of manhours; and second, the cost of new innovations, a fixed expense, must often be spread over land to be economically justified.

There will be a continued decrease in the number of farms. Those remaining will be larger and better managed as a result of improved farming techniques, market news distribution, and more highly trained farm management. Also, mechanization of farm operations will allow a higher percentage of planted acreages to be harvested with minimum loss.

Trends in farm numbers, size, land in farms, and the proportion of total land area in farms for 1980 and 2010 are presented in Table 18. The projected rate of change for the number of farms is more between 1962 and 2010 than the historical rate of change between 1949 and 1959 (table 20). However, the average size farm unit is projected to increase about 120 percent by 2010 over the 1962. The larger size units will be offset by the increased number of farms being divided into smaller units in the area surrounding Shreveport, Bossier City, Alexandria, and Texarkana. These smaller units may still be classified as rural nonfarms by Census criteria, but will become suburban homes with acreages. This is substantiated by the increase in "rural non-farm" population projections presented in Table 14. This will, of course, affect the distribution of the size of farms throughout the Study Area. The farms in the outer regions will continue to increase in size and decrease in numbers.

The proportion of total land area in farms has historically decreased since 1939 (table 18). The same trend has been extended to 2010. Total land area in farms is projected to decrease approximately 8 percent by 2010 from the 1962 farm land area.

Tenure

Census data indicate that in 1959, 62 percent of the farmers were full owners; 19 percent were tenants; 18 percent were part-owners; and one percent were professional managers. No projections were made of tenure situations.

Type of Farm

Farms are classified by type on the basis of their major source of income. This classification indicates the major characteristics of the agriculture in the Study Area. These characteristics are influenced by such physical factors as soil, rainfall, temperature, and topography.

Economic factors influencing type of farming include population, population distribution, transportation, production cost, and commodity prices. Fundamentally, agriculture in the basin is oriented to production of commodities which can be readily shipped to population centers (table 19). Production of perishable commodities, vegetables and milk, are limited to supplying the local demand.

Table 19 - Farms by Type: Percentage Distribution of Farm Numbers, 1949, 1954 and 1959, Red River Basin Study Area

| Farms by type | : 1949 | : 1954 | : 1959 |
|------------------------------|---------------------|--------------|--------------|
| | - - - percent - - - | | |
| Cash - grain | 1.0 | 1.1 | 1.5 |
| Cotton | 30.3 | 24.2 | 14.1 |
| Other field - crop <u>1/</u> | 3.4 | 1.8 | 1.9 |
| Vegetable | 0.4 | 0.3 | 0.3 |
| Fruit - and - nut | 0.3 | 0.2 | 0.2 |
| Poultry | 0.9 | 1.5 | 2.0 |
| Dairy | 2.4 | 2.6 | 3.1 |
| Livestock <u>2/</u> | 9.2 | 10.6 | 16.8 |
| General | 5.5 | 3.5 | 2.6 |
| Miscellaneous | 46.6 | 54.2 | 57.5 |
| Total | 100.0 | 100.0 | 100.0 |

1/ Other than vegetable, fruit-and-nut farms

2/ Other than poultry and dairy

Source: Census of Agriculture

The second most common type of farm was livestock (other than dairy and poultry). Livestock farms have practically doubled in number during the past decade. Cotton farms have decreased from 30 percent of all farms in 1949, to 14 percent in 1959.

In 1959, livestock, dairy, and poultry farms accounted for 22 percent of all farms, while field crop farms accounted for 18 percent. By contrast, in 1949, these same farm type classification groupings were 12 percent and 35 percent, respectively.

Nearly 58 percent of the farms were classified as miscellaneous farms, or farms which have no single segment of income representing more than 50 percent of the total value of all farm products sold

during the year (table 19). This type of farm classification includes sources of cash income from nursery and greenhouse products, forest products, mules, horses, colts, and ponies.

Value of Agricultural Production

Agricultural income in the Study Area was about \$298 million in 1962 (table 20). Crops accounted for 42 percent of the agricultural income, and livestock accounted for 57 percent. Forest products sold by farmers accounted for the other one percent. This does not include value of products sold from commercial forest land.

Table 20 - Estimated Value of Farm Products Sold, 1962 and Projected to 1980 and 2010, Red River Basin Study Area

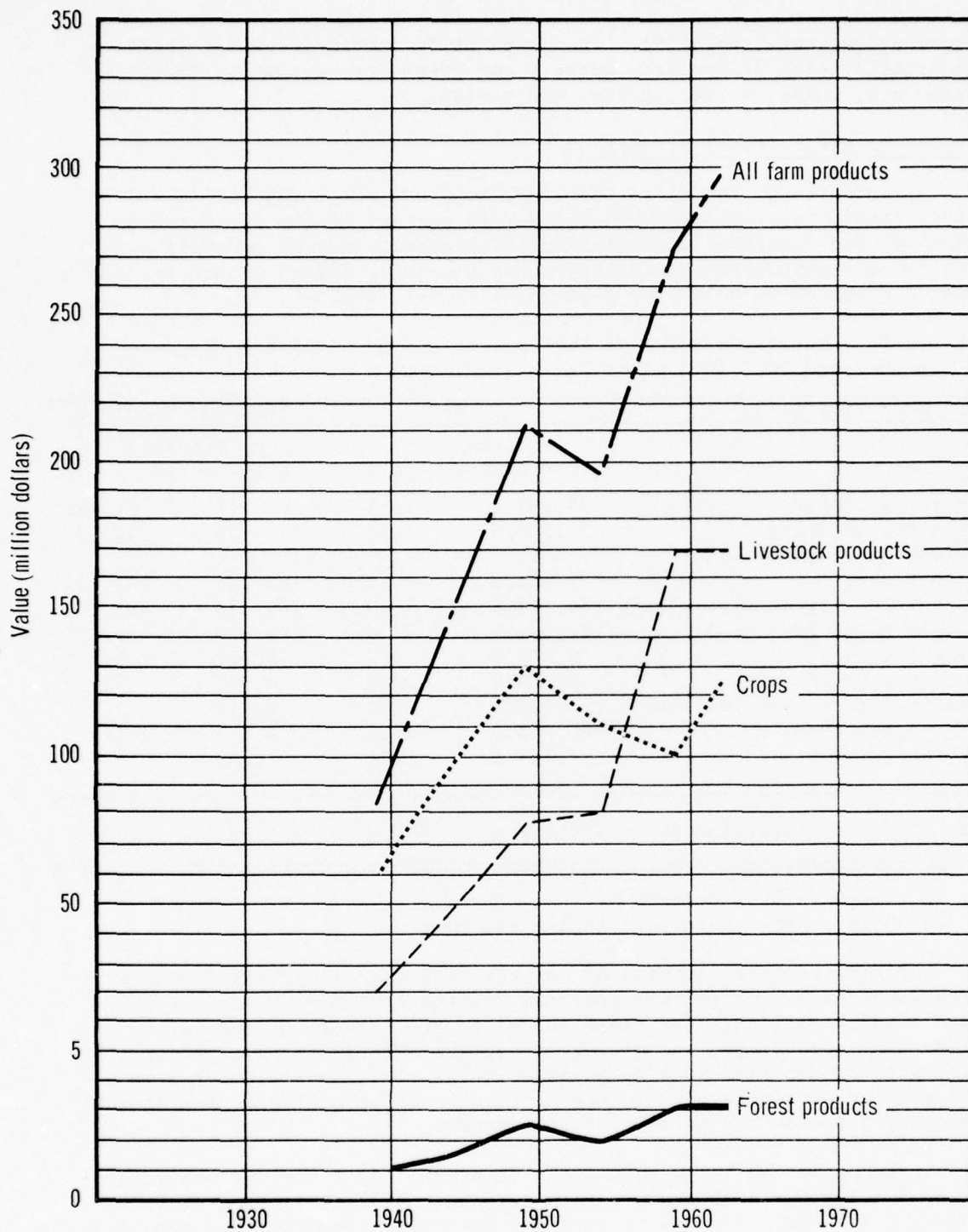
| Commodity Sold | 1962 | | : 1980 1/ : 2010 1/ | |
|-----------------------------------|------------------------|--------------|--------------------------------|----------------|
| | thousand - dollar - | percent | thousand - - - dollar - - - | |
| Dairy products | 29,985.5 | 10.1 | 49,176 | 71,665 |
| Poultry products | 31,500.0 | 10.6 | 48,195 | 60,480 |
| Livestock & livestock products | 107,826.3 | 36.2 | 183,305 | 271,722 |
| Total livestock products | 169,311.8 | 56.9 | 280,676 | 403,867 |
| Field crops 2/ | 117,864.5 | 39.6 | 200,370 | 298,197 |
| Vegetables | 1,871.8 | 0.6 | 2,770 | 3,968 |
| Fruits and nuts | 2,709.3 | 0.9 | 4,037 | 5,852 |
| Horticultural specialties | 2,628.1 | 0.9 | 3,916 | 5,677 |
| Total crops | 125,073.7 | 42.0 | 211,093 | 313,694 |
| Forest products | 3,284.0 | 1.1 | 7,192 | 12,347 |
| Total agricultural income | 297,669.5 | 100.0 | 498,961 | 729,908 |

1/ Based on 1962 dollars

2/ Other than vegetables, fruits and nuts

Field crops represented 40 percent of the agricultural income in the Study Area. Cotton was the most important crop with receipts of about \$36.4 million. Hay crops and corn were the second and third most important cash crops, accounting for another \$22.7 million. These crops account for approximately 20 percent of the total agricultural income. Vegetables, fruits and nuts, and horticultural specialty crops together account for only 2.4 percent of the income.

Trends in the value of crops, livestock, and forest products in actual dollars are shown in Figure 7. Since 1939, the value of livestock and livestock products sold has increased approximately sevenfold. The value of crops only doubled between 1939 and 1962. The increase in value of livestock and livestock products is primarily a result of higher production and prices for cattle which has more than offset the decline in hog production. Cattle and calves are rapidly becoming a major



SOURCE: U. S. Census of Agriculture and Statistical Reporting Service

Figure 7
 VALUE OF FARM PRODUCTS SOLD
 RED RIVER BASIN STUDY AREA, 1939-1962

segment of the agricultural industry. The increase in value of crops is due to high production of cotton, hay, and corn and favorable prices received, which have offset the decline in acreage of some crops, notably cotton and corn.

Projected values of farm products sold are based on a 1962 price level. The total value of farm products sold is projected to be approximately \$499 million in 1980, and \$730 million in 2010 (table 20). All of the major components of income to agriculture, livestock, crops, and forest products, are projected to increase.

The cash value of on-farm domestic consumption of farm products is negligible and was not considered. It was assumed that the value of on-farm consumption is directly related to rural-farm population. This form of consumption is expected to decline in relative importance because rural-farm population is expected to decline while total farm production is expected to increase.

Land Use

Eighteen percent of the total land area is used as cropland. Approximately 17 percent is grassland pasture and range. Over one-half is in forest-woodland. If grassland is included, about 35 percent of all land is in crop and livestock production (excluding grazing on forest lands). If the forest-woodland is included, the area in agricultural use is about 90 percent. In Table 21, total land use is presented for the inventoried area only.

Table 21 - Land Utilization: Trends in Major Agricultural Land Uses, 1939-1959, Red River Basin Study Area

| Major agricultural uses: | 1939 | 1944 | 1949 | 1954 | 1959 |
|--------------------------------------|------------------------------------|----------|----------|----------|----------|
| | - | - | - | - | - |
| | - - - - - thousand acres - - - - - | | | | |
| Total cropland | 9,323.3 | 6,572.3 | 6,688.9 | 5,572.3 | 4,880.9 |
| Crops and related uses ^{1/} | 6,910.1 | 5,357.0 | 4,721.4 | 3,496.6 | 2,869.8 |
| Cropland used only for pasture | 2,413.2 | 1,215.3 | 1,967.5 | 2,075.7 | 2,011.1 |
| Pasture ^{2/} | NA | 3,805.1 | 3,413.9 | 4,448.7 | 4,613.3 |
| Woodland | 3,986.7 | 3,976.6 | 5,345.8 | 5,149.5 | 4,706.1 |
| Other land ^{3/} | NA | 547.4 | 622.6 | 459.2 | 480.6 |
| Total land in farms | - | 14,901.4 | 16,071.2 | 15,629.7 | 14,680.9 |

Census of Agriculture

Acres rounded to nearest hundred

- ^{1/} Cropland harvested, crop failure, fallow, and idle cropland
- ^{2/} Grassland pasture and other non-forest rangeland, excluding cropland used only for pasture
- ^{3/} Farmsteads, farm roads, idle land, wildlife areas, etc.

Cropland acreage was high in 1939 with 9,323,300 acres (table 21). There has been a decline in cropland since the 1939 census of 4.4 million acres.

Grasslands pasture and other nonforest rangeland, excluding cropland used for pasture, were 808 thousand acres more in 1959 than in 1944. Much of this land use change was from lower quality cropland. Interchange between cropland and pasture has occurred in the better quality land areas of the Study Area. When demand is low, cropland tends to decrease, with part of the excess going into grassland pasture. Total acreages used for pasture purposes have increased from 5,020,400 in 1944 to over 6,624,000 acres in 1959. ^{1/}

Substantial shifts have been made between land uses in some sectors of the Study Area. Cropland is being concentrated on fertile and more nearly level areas. Hilly and eroded land is being put in grass and trees. This shift of field crops to the more productive land has increased average yields.

A shift in the use of the land resource base is taking place along with the reduction of the resource base itself. The withdrawal from cultivation of lands of poor quality is affecting the land use pattern.

CNI data were used to determine major land use categories by soil groups by resource areas for each of the four states and the Study Area. These data were for 1958. Inventory acreages, or total land in farms, and non-inventory acreages were adjusted to 1962 conditions to reflect changes in large water areas by counties and LRA.

Cropping patterns for each LRA grouping were determined from 1962 crop reports. The cropping pattern for sample county data was tabulated for each LRA grouping, and the distribution of each crop was aligned to the 1962 adjusted CNI "total cropland acreage".

Similarly, cropland harvested, pastured, and idle, or fallow, historic trends were used to determine the percentage change for each use. The percentage distribution for each use was applied to the 1962 adjusted CNI "total cropland acreage".

The projected increases in fresh water and nonagricultural areas indicate a reduction of approximately 281,600 acres in the area devoted to agriculture between 1962 and 2010. This loss of agricultural lands to other uses plus the projected increase in demand for agricultural and forestry products will cause substantial changes in land use within the agricultural area. The increased demand will be supplied in part by improved technology and more efficient operations. In addition, a greater portion of the agricultural area will be utilized for production of the more intensive crops and improved pasture. This will cause a shift to the more productive, less hazardous soils, at the expense of rangeland and woodland.

^{1/} "Cropland" used only for pasture and "pasture"

Projected 1980 acreages of the major agricultural uses are: feed grains including wheat 299,600; cotton 232,200; hay crops and silage 658,800; improved pasture 1,209,200; other crops 465,000; pasture and rangelands 3,268,100; forest and woodland 10,703,900; and other uses 413,000. Corresponding acreages for 2010 are: feed grains including wheat 309,500; cotton 112,200; hay crops and silage 670,200; improved pasture 1,190,900; other crops 451,700; pasture and rangeland 3,411,500; forest and woodland 10,245,800; and other uses 659,900.

The projected 1980 and 2010 land utilization as it pertains to land in farms and major crop distribution without project development is summarized in Table 22.

Table 22 - Projected Land Utilization: Land in Farms, Major Agricultural Use with Crop Distribution, Without Project Development, Red River Basin Study Area, 1980 and 2010.

| Land Use | : | 1980 | : | 2010 |
|-----------------------------|---|--------------------|---|----------|
| | - | - | - | - |
| | | - thousand acres - | | |
| Total cropland: | | 2,864.8 | | 2,734.5 |
| Cotton | | 232.2 | | 112.2 |
| Corn silage | | 12.1 | | 5.6 |
| Corn grain | | 45.9 | | 26.2 |
| Oats | | 58.1 | | 63.0 |
| Barley | | 19.5 | | 21.0 |
| Sorghum, silage | | 19.3 | | 10.2 |
| Sorghum, grain | | 73.7 | | 85.4 |
| Wheat | | 102.4 | | 113.9 |
| Rice | | 5.5 | | 5.0 |
| Soybeans, forage | | 46.4 | | 16.0 |
| Soybeans, beans | | 51.7 | | 86.0 |
| Peanuts | | 28.0 | | 19.5 |
| Sweet potatoes | | 20.0 | | 16.9 |
| Vegetables | | 21.6 | | 21.4 |
| Cowpeas | | 2.8 | | - |
| Sugarcane/sugar | | 1.0 | | 1.0 |
| Field seed crops (other) | | 35.0 | | 35.8 |
| Alfalfa | | 45.6 | | 50.2 |
| Other hay | | 535.4 | | 588.2 |
| Fruit, noncitrus | | 14.8 | | 15.0 |
| Other | | 5.1 | | 5.3 |
| Nonharvested: | | | | |
| idle, fallow, etc. | | 279.5 | | 245.8 |
| Pastured | | 1,209.2 | | 1,190.9 |
| Pasture-Range | | 3,268.1 | | 3,411.5 |
| Forest-Woodland: | | 10,703.9 | | 10,245.8 |
| Grazed | | 6,974.4 | | 6,677.4 |
| Not grazed | | 3,729.5 | | 3,568.4 |
| Other land: | | 413.0 | | 659.9 |
| Total land in farms | | 17,249.8 | | 17,051.7 |

A more detailed delineation of land use data is presented in Exhibits 5, 6, and 7. These exhibits display projected land use data by the five land resource area groupings, land in farms, and major crop distribution.

Cropping Pattern

Cropland in the Study Area is utilized for the production of a number of crops (table 23). Over 59 percent of the cropland was in pasture and forage crops during the base year of 1962. Cotton, feed grains, wheat, and soybeans harvested for beans utilized approximately 23 percent of the cropland. Minor crops, fallow, and idle acreage accounted for the remainder of the total cropland acreage, or 18 percent. The 3,389,100 acres of cropland, together with the 3,160,900 acres of pasture and 6,717,500 acres of woodland grazed, represented 76 percent of the total land in farms utilized for the production of crops and cattle industry.

Over 54 percent of the total land in farms in LRA 86 is utilized as cropland. Cotton is the major single crop harvested, but pasture and forage crops represent 18 percent of the acreage. Small grains, grain sorghum, and corn, occupy a large total acreage.

Approximately 52 percent of LRA 131, 134 grouping is in cropland, and pasture and range; the remainder of the total land in farms is in forest-woodlands and other land uses. This is an important cash crop area. Cotton, soybeans, and corn grown by highly mechanized methods are major cash crops in this grouping. However, pastured cropland and hay crops account for over 16 percent of the total farm land use.

Over 20 percent of the land in farms is cropland throughout the LRA 85, 112, grouping. Hay, small grains, grain sorghums, peanuts, cotton, and corn are the principal crops. About half of the total land in farms is in pasture-range which supports beef cattle and other livestock grazing.

Less than one-fifth of the land in farms in the LRA 80, 84, 133 grouping is in cropland. The proportion of forest-woodland acreages is greatest in this grouping. Corn, cotton, vegetables, and grain sorghum were important crops in 1962. Hay crops and pastured cropland utilize the major portion of all cropland. The trend is to more pasture and woodland and less cropland.

Approximately 90 percent of the agricultural land use of LRA 119 is forest-woodland. Pastures and mixtures of tame hay are the main crops.

Following determination of the projected acreage of cropland and pasture-range available for agricultural use by 1980 and 2010, the production of major crops that could be obtained without an acceleration in the rate of resource development was then computed (table 24). Projected harvested acreages for crops are displayed

Table 23 - Land Utilization: Land in Farms, Major Agricultural Use With Crop Distribution, By Major Land Resource Area Groupings, 1962, Red River Basin Study Area

| Land Use | LRA : 86 | LRA : 131, 134 | LRA : 85, 112 | LRA 80, 84, 133 | LRA : 119 | Basin Total |
|------------------------|----------------------------|-------------------|------------------|--------------------|--------------|----------------|
| | - - - thousand acres - - - | | | | | |
| Total cropland: | 965.8 | 737.8 | 236.3 | 1,392.7 | 56.5 | 3,389.1 |
| Cotton | 235.8 | 114.4 | 8.6 | 34.4 | Z | 393.2 |
| Corn, silage | 1.4 | 6.8 | 0.2 | 4.3 | 0.1 | 12.8 |
| Corn, grain | 51.7 | 40.6 | 5.9 | 52.7 | 1.0 | 151.9 |
| Oats | 35.9 | 4.6 | 3.3 | 2.2 | - | 46.0 |
| Barley | 13.5 | Z | 0.7 | 0.3 | - | 14.5 |
| Sorghum, silage | 10.1 | 0.5 | 3.4 | 13.1 | 0.2 | 27.3 |
| Sorghum, grain | 27.9 | 0.5 | 10.6 | 9.4 | 0.2 | 48.6 |
| Wheat | 78.4 | 1.7 | 2.0 | 0.4 | - | 82.5 |
| Rice | - | 7.9 | - | - | - | 7.9 |
| Soybeans, forage | 2.9 | 35.9 | 0.3 | 0.9 | - | 40.0 |
| Soybeans, beans | 2.4 | 26.9 | 1.7 | 0.3 | - | 31.3 |
| Peanuts | 11.3 | - | 16.0 | 6.8 | - | 34.1 |
| Sweet potatoes | Z | 14.7 | Z | 8.4 | - | 23.1 |
| Vegetables | 0.9 | 2.0 | 0.4 | 15.5 | - | 18.8 |
| Cowpeas | 2.2 | 0.8 | 0.7 | 6.2 | - | 9.9 |
| Sugar/sugar | - | 1.0 | - | - | - | 1.0 |
| Field seed crops | | | | | | |
| (other) | 31.0 | 1.5 | 0.7 | 1.4 | - | 34.6 |
| Alfalfa | 17.8 | 9.8 | 8.9 | 4.2 | - | 40.7 |
| Other hay | 100.8 | 76.9 | 35.2 | 156.0 | 11.3 | 380.2 |
| Fruit, non-citrus | 1.9 | 6.8 | 0.8 | 5.3 | 0.2 | 15.0 |
| Other | 0.1 | Z | 0.1 | 0.6 | Z | 0.8 |
| Not harvested: | | | | | | |
| idle, fallow, etc. | 151.2 | 51.3 | 31.9 | 225.1 | 2.6 | 462.1 |
| Pastured | 188.6 | 333.2 | 104.9 | 845.2 | 40.9 | 1,512.8 |
| Pasture-Range: | 491.4 | 569.7 | 530.5 | 1,421.9 | 147.4 | 3,160.9 |
| Forest-Woodland: | 301.4 | 1,154.3 | 277.3 | 6,116.5 | 2,436.9 | 10,286.4 |
| Grazed | 244.1 | 600.2 | 252.3 | 4,036.9 | 1,584.0 | 6,717.5 |
| Not grazed | 57.3 | 554.1 | 25.0 | 2,079.6 | 852.9 | 3,568.9 |
| Other land: | 27.2 | 50.2 | 101.2 | 235.0 | 83.3 | 496.9 |
| Total land in farms | 1,785.8 | 2,512.0 | 1,145.3 | 9,166.1 | 2,724.1 | 17,333.3 |

Source: USDA National Inventory of Soil and Water Conservation Needs 1958, adjusted to 1962 conditions

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in Exhibits 5, 6, and 7 by each land resource area grouping. The projected crop yields together with the harvested acreages were used to determine the potential agricultural production for the economic evaluation period 1962 to 2010.

Table 24 - Selected Crops: Production by Land Resource Areas Without Project Development, Projected 1980 and 2010, Red River Basin Study Area

| Crops | Units | Study Area | | LRA 86 | | LRA 131, 134 | | |
|---------------------|-------|-------------------------------|--------|--------|--------|--------------|--------|--|
| | | 1980 | 2010 | 1980 | 2010 | 1980 | 2010 | |
| | | - - - - - thousands - - - - - | | | | | | |
| Cotton | lbs. | 140,550 | 97,392 | 87,025 | 64,242 | 45,472 | 30,804 | |
| Feed grains: | | | | | | | | |
| Corn | bu. | 2,243 | 1,639 | 1,004 | 368 | 870 | 1,088 | |
| Oats | bu. | 1,722 | 2,223 | 1,305 | 1,635 | 218 | 328 | |
| Barley | bu. | 468 | 567 | 468 | 567 | - | - | |
| Sorghum | bu. | 2,848 | 4,100 | 1,790 | 2,989 | 51 | 160 | |
| Wheat | bu. | 2,575 | 3,127 | 2,405 | 2,876 | 84 | 152 | |
| Rice | lbs. | 25,520 | 30,600 | - | - | 25,520 | 30,600 | |
| Soybeans | bu. | 1,403 | 3,548 | 105 | 129 | 1,212 | 3,284 | |
| Peanuts | lbs. | 23,970 | 22,747 | 8,910 | 5,605 | - | - | |
| Sweet potatoes | bu. | 2,382 | 2,210 | - | - | 1,338 | 1,430 | |
| Vegetables | cwt. | 1,897 | 2,111 | 41 | 43 | 192 | 229 | |
| Alfalfa & mixture | ton | 117 | 163 | 45 | 59 | 28 | 53 | |
| Other hay | ton | 867 | 1,264 | 142 | 177 | 231 | 342 | |
| Sugarcane for sugar | ton | 27 | 33 | - | - | 27 | 33 | |
| Fruit, noncitrus | ton | 15 | 17 | 2 | 2 | 5 | 6 | |
| Pasture & range | AUM | 18,830 | 19,635 | 3,724 | 4,184 | 4,292 | 4,774 | |
| Cropland pastured | AUM | 7,440 | 8,910 | 1,744 | 2,405 | 1,629 | 1,727 | |
| Woodland pastured | AUM | 2,037 | 1,948 | 127 | 121 | 183 | 124 | |

Table 24 - Continued

| Crops | Units | LRA 85, 112 | | LRA 80, 84, 113 | | LRA 119 | | |
|---------------------|-------|-------------------------------|--------|-----------------|-------|---------|------|--|
| | | 1980 | 2010 | 1980 | 2010 | 1980 | 2010 | |
| | | - - - - - thousands - - - - - | | | | | | |
| Cotton | lbs. | 2,485 | 2,346 | 5,568 | - | - | - | |
| Feed grains: | | | | | | | | |
| Corn | bu. | 104 | 43 | 265 | 140 | - | - | |
| Oats | bu. | 140 | 209 | 59 | 51 | - | - | |
| Barley | bu. | - | - | - | - | - | - | |
| Sorghum | bu. | 455 | 554 | 548 | 392 | 4 | 5 | |
| Wheat | bu. | 78 | 99 | 8 | - | - | - | |
| Rice | lbs. | - | - | - | - | - | - | |
| Soybeans | bu. | 69 | 105 | 17 | 30 | - | - | |
| Peanuts | lbs. | 11,656 | 13,992 | 3,404 | 3,150 | - | - | |
| Sweet potatoes | bu. | - | - | 1,044 | 780 | - | - | |
| Vegetables | cwt. | 29 | 34 | 1,575 | 1,805 | - | - | |
| Alfalfa & mixture | ton | 29 | 32 | 15 | 19 | - | - | |
| Other hay | ton | 69 | 101 | 402 | 613 | 23 | 31 | |
| Sugarcane for sugar | ton | - | - | - | - | - | - | |
| Fruit, noncitrus | ton | 1 | 1 | 7 | 8 | - | - | |
| Pasture & range | AUM | 4,786 | 3,424 | 5,522 | 6,618 | 506 | 635 | |
| Cropland pastured | AUM | 394 | 434 | 3,565 | 4,230 | 108 | 114 | |
| Woodland pastured | AUM | 109 | 105 | 1,293 | 1,231 | 325 | 317 | |

The total projected agricultural production in the Study Area for each crop is the sum total of production by LRA grouping and time frame.

Feed units produced without an acceleration in the rate of resource development amounted to 11,722 million in 1962. In 1980 and 2010, the projected feed unit production using this same assumption, amounts to 13,824 million and 15,163 million, respectively.

Yields

The cropping pattern and yield of each crop, including the yields of pasture and range and woodland pastured, were determined for the major land resource area groupings and the Study Area (exhibit 8). Estimated yields were obtained from State Offices of SCS for all major crops by soil groupings in the land resource areas. These estimates were used as guides in determining yields under current conditions. Also, a current yield was calculated from 1934-62 record of acreage and production of each crop in the sample counties for each LRA grouping. These two sources were adjusted to agree to determine yields for each major crop.

Current yields reflect a high level of management using present technology. It was assumed that the yields presented in Exhibit 8 represent the average yields in 1962. Using this data on cropping patterns and yields by LRA groupings, the production of crops in the base year was estimated.

Crop yield projections for individual crops for 1980 and 2010 were based on historical trends and future expected improvement in production technology. Production technology was considered to encompass all factors that result in increased agricultural production other than resource development and major land use change.

Yield data for major crops by land resource area groupings are presented in Exhibit 8. Weighted yield data were computed for the entire Study Area based upon crop acreage harvested and yields within the LRA groupings.

Livestock

The land and water resources of the Study Area supported in 1962 a livestock population of about 2,110,000 cattle and calves, 305,000 hogs and pigs, 58,000 sheep and lambs, and 58,000 horses and mules (table 25). In addition, 3,460,000 chickens (4-months or older) and 228,000 turkeys are raised annually.

Poultry production is an important agricultural industry. It is estimated that over 70,000,000 broilers were raised during 1962.

Table 25 - Livestock Numbers, 1962, Projected 1980 and 2010, Red River Basin Study Area ^{1/}

| Livestock | Livestock Numbers | | |
|------------------------------------|---------------------------|---------|---------|
| | 1962 | 1980 | 2010 |
| | - - - - thousands - - - - | | |
| Cattle & calves | 2,110 | 2,808 | 3,970 |
| Horses & mules | 58 | 38 | 23 |
| Hogs & pigs | 305 | 252 | 230 |
| Sheep & lambs | 58 | 68 | 85 |
| Broilers ^{2/} | 70,159 | 107,450 | 225,645 |
| Chicken, ⁴ mos. & older | 3,460 | 7,907 | 9,884 |
| Turkeys | 228 | 248 | 281 |

^{1/} Whole counties are represented in the four Basin States of Arkansas, Louisiana, Oklahoma, and Texas

^{2/} Assumed 12 weeks for total broiler production

Additionally, 3.5 million other chickens (over 4-months of age) and 228,000 turkeys were raised.

The 173,000 milk cows are raised predominately in the Texas and Louisiana portion of the area. Over 75 percent of the milk cows are in these two states where the largest population centers are located. Also, forage and pasture is available in the prairies and bottomland land resource areas.

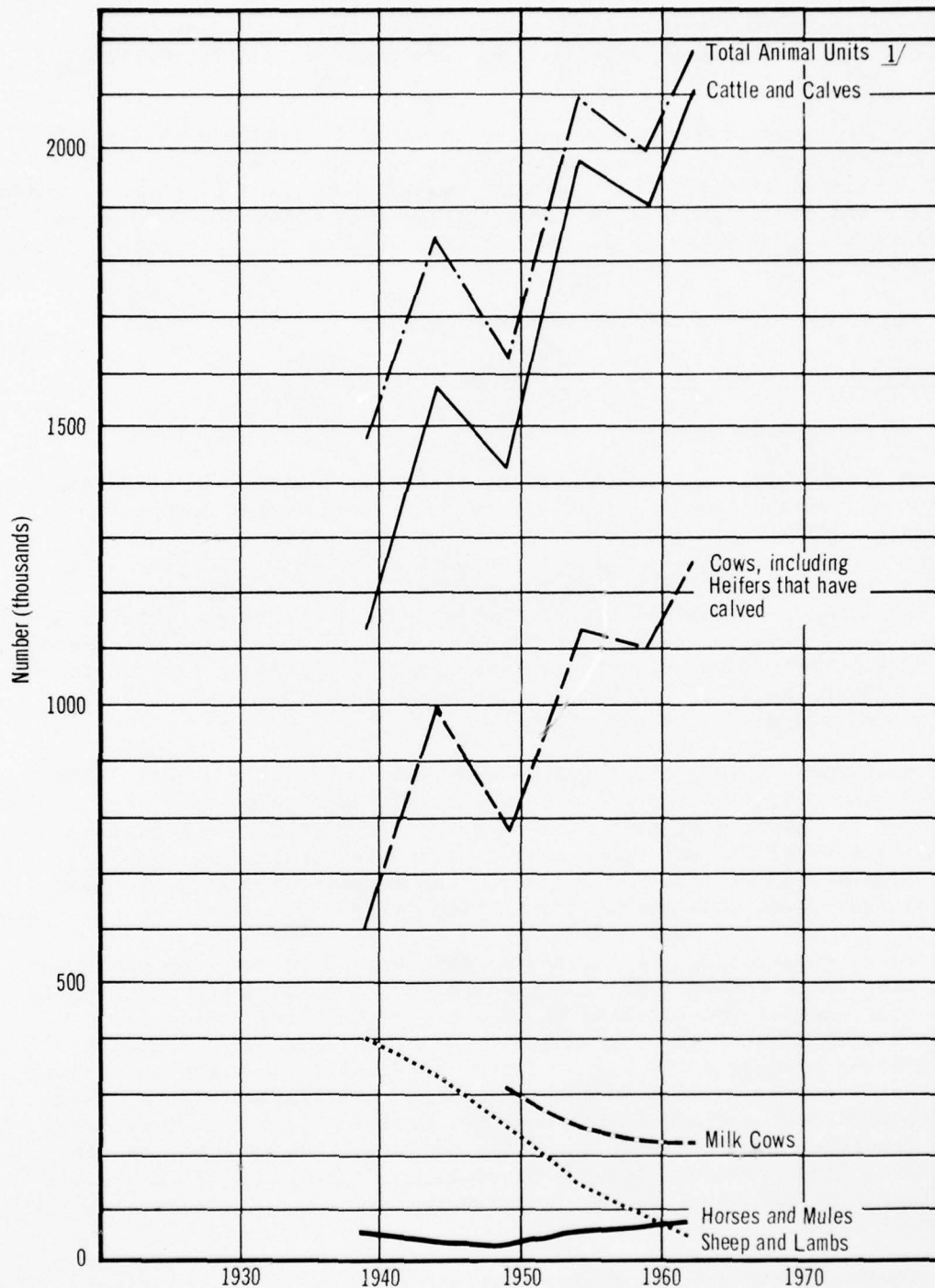
Milk cow numbers have declined since 1949 from a reported 314,200 head. This decline is consistent with the national trend and is associated with the decline in consumption of dairy products per capita and the rapid rise in milk production per cow.

Although beef cattle are raised throughout the Study Area, they are most numerous in the Texas counties where extensive grazing land is available. Livestock farm numbers increased in Texas, Oklahoma, and Louisiana since 1954, giving an indication of the increased importance of livestock feeding operations in the Study Area.

Sheep are more prevalent in the Texas and Oklahoma portion of the Study Area where rangeland is available for grazing. Sheep numbered about 58,000 head, approximately the same as 23 years earlier. The lowest level was reached in 1949.

There are 58,000 horses and mules in the Study Area. With the advent of mechanized power on the farm, horses and mules were no longer needed and have continually decreased in numbers since 1939.

The net results of the changes in animal numbers is shown in Figure 8 in terms of animal units. Cattle and calves numbers have



1/ Factors used to convert livestock into animal units are: 1 cow = 1 AU,
1 sheep = 2 AU, 1 horse = 8 AU

SOURCE: U. S. Census of Agriculture and Statistical Reporting Service

Figure 8

LIVESTOCK NUMBERS FOR WHOLE COUNTIES
IN RED RIVER BASIN STUDY AREA, 1939-1962

been increasing while horses and mules, sheep and lambs have been decreasing. Thus, total animal units have remained fairly constant since 1954.

Projections of livestock numbers in Table 25 indicate that cattle, calves, and poultry are expected to increase considerably over their 1962 levels in 1980 and 2010. Horses, mules, hogs, and pigs are expected to decrease rather rapidly in number during this time. These changes are a result of the continuance of factors leading to the present situation.

FOREST PRODUCTION AND RELATED ECONOMIC ACTIVITY

1962 Development and Production Levels

Pine Production and Sawmill Industry

Historically the largest segment of forest industry in Arkansas, Louisiana, Oklahoma, and Texas, has been involved in the production of pine lumber. This sector of forest industry participated in the strong lumber market generated by the home building boom in the late 1940's and early 1950's, but in the middle 50's, rising operating costs began to increasingly affect forest-based enterprise. Steadily rising labor costs placed a particular strain on poorly mechanized and relatively inefficient operations. Increased competition from Western and Canadian lumber (see exhibit 9) and from substitute materials compounded the difficult situation.

When the general building boom subsided in the late 1950's, (see exhibit 10) pine lumber producers were caught in a price-cost squeeze and many of the smaller mills and yards were forced out of business. Small producers of other products such as posts, crossties, and fuel wood were seriously affected by rising labor costs, and many of their operations closed down during this period (1958-62)

Many companies had to reorganize and reequip to meet the challenge of rising costs and increasing competition. Mill machinery and layouts were modernized. The handling of logs and lumber were more fully mechanized. Some of the more competitive firms expanded operations, integrating processes for new products and raising the grade and finish of other products by additional processing. Utilization was improved by new machinery and additional employee training. More mill residues were reclaimed for wood pulp and other products. Management was intensified on land dedicated to wood production. Table 26 lists mills and manufacturing plants of forest industry that were doing business at the close of 1962.

These efforts and expenditures were justified by the relatively large tracts of forest land with unbroken ownership, integrated in many cases with mill operation, and the rapid increase in growth and inventory on well-managed forest lands. Table 27 shows net annual growth for 1962 by states and species groups. Table 28 shows the 1962 percentage distribution of stands by size classes.

Table 26 - Primary and Secondary Manufacturers in Forest Industry, Red River Basin Study Area, 1962

| | Number of mills | |
|------------------------|-----------------|--------------|
| | Study Area | Base Area 1/ |
| Sawmills, large 2/ | 38 | 63 |
| Sawmills, small | 120 | 126 |
| Wood preserving plants | 17 | 24 |
| Veneer mills | 5 | 6 |
| Wood pulp mills | 2 | 6 |
| Miscellaneous 3/ | 26 | 31 |
| Total | 208 | 256 |

Source: State directories of forest industries

1/ Includes facilities in Study Area

2/ Output of more than 3 million board feet/day

3/ Cooperage, handles, charcoal, etc.

Table 27 - Net Annual Growth of Growing Stock and Sawtimber by Species Groups by States, Red River Basin Study Area, 1962

| State | Growing Stock | | | Sawtimber | | |
|---------------------|--------------------|--------------|--------------|--------------------|----------------|--------------|
| | All Species | Soft-wood | Hard-wood | All Species | Soft-wood | Hard-wood |
| | million cubic feet | | | million board feet | | |
| Arkansas | 74.7 | 49.7 | 25.0 | 287.4 | 236.4 | 51.0 |
| Louisiana | 152.1 | 126.5 | 25.6 | 669.0 | 582.1 | 86.9 |
| Oklahoma | 71.9 | 34.9 | 37.0 | 182.4 | 132.5 | 49.9 |
| Texas | 46.6 | 30.5 | 16.1 | 136.4 | 101.0 | 35.4 |
| Entire Basin | 345.3 | 241.6 | 103.7 | 1,275.2 | 1,052.0 | 223.2 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, USFS

The production of pine sawtimber and total industrial roundwood was up in 1962 on the Basin Study Area, above the lows of 1954, 1958, and 1960-61. Table 29 shows the volume of industrial roundwood products for 1962.

Hardwood Production and Manufacture

Thirty percent of the 1962 production of industrial roundwood for the Basin Study Area was hardwood. A little more than half of this hardwood was sawlog material and about one-quarter was pulpwood.

Table 28 - Area and Distribution of Forest Land by Stand Size Classes and Species Groups, Red River Basin Study Area, 1962

| Stand Size Class | Softwoods | | Hardwoods | | All Types | |
|--------------------------------|-------------|-----------------|-------------|-----------------|-------------|-----------------|
| | Thou. Acres | Percent of Area | Thou. Acres | Percent of Area | Thou. Acres | Percent of Area |
| | | | | | | |
| Sawtimber <u>1/</u> | 2,324.7 | 45 | 1,775.6 | 35 | 4,100.3 | 40 |
| Poletimber <u>2/</u> | 1,270.9 | 25 | 1,521.2 | 30 | 2,792.1 | 27 |
| Seedlings & Saplings <u>3/</u> | 1,510.5 | 29 | 1,616.0 | 32 | 3,126.5 | 31 |
| Non-stocked or Other <u>4/</u> | 29.5 | 1 | 132.0 | 3 | 161.7 | 2 |
| All Stand Sizes | 5,135.6 | 100 | 5,044.8 | 100 | 10,180.6 | 100 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, USFS

1/ At least 10 percent stocked with growing stock trees, mostly sawtimber

2/ At least 10 percent stocked with growing stock trees, mostly poletimber

3/ At least 10 percent stocked with growing stock trees, mostly seedlings and/or saplings

4/ Commercial forest land less than 10 percent stocked with growing stock trees

Table 29 - Industrial Roundwood Production, 1962, Red River Basin Study Area

| Product | Volume | | |
|----------------------------------|---------------------|----------|---------|
| | Thousand Cubic Feet | | |
| | Pine | Hardwood | Total |
| Sawtimber | 58,934 | 25,090 | 84,024 |
| Veneer | 0 | 1,891 | 1,891 |
| Pulpwood | 48,844 | 13,406 | 62,250 |
| Piling | 678 | 0 | 678 |
| Poles | 4,302 | - | 4,302 |
| Posts | 3,208 | 605 | 3,813 |
| Cooperage | - | 47 | 47 |
| Hewn ties | 84 | 1,427 | 1,511 |
| Fuelwood <u>1/</u> | 357 | 2,248 | 2,605 |
| Miscellaneous Products <u>2/</u> | 304 | 3,614 | 3,918 |
| Total Industrial Roundwood | 116,711 | 48,328 | 165,039 |

Source: State Forest Survey Reports, special reports by Southern Forest Experiment Station, severance tax and other published reports

1/ Includes some material used for charcoal production

2/ Includes roundwood used in manufacture of handles, boxes and crates, some sawn ties, hickory chips, and other specialty items

Table 29 shows the volume of these and other hardwood products for 1962.

Flooring and dimension stock are the principal items manufactured from factory grade hardwood logs. The smaller mills cutting hardwood logs habitually produce rough lumber and crossties. The lumber from these mills is usually graded, finished, and merchandized by concentration yards. These smaller operations were reduced in numbers by the rising operating costs in the late 1950's, and early 1960's.

In 1961, the production of hardwood sawlog and veneer logs on the Study Area reached the lowest point since 1950. This trend was in step with other producing areas of the entire Southeast (see exhibit 11). Demand started to rise in 1962.

Most of the higher quality hardwood sawlogs are produced on the floodplain of the lower Red River and that part of the Mississippi alluvium lying within the Study Area. All floodplains of the commercial forest area, except possibly those of the prairie sections, will produce factory grade logs under high-level forest management. In 1962, the level of management of bottomland hardwoods was generally poor. The average volume of all merchantable sawlogs was 1,800-2,000 board feet per acre. The average volume of factory grade logs was considerably less. In the average stand, the best growing stock consisted of saplings and polesize trees, and about thirty percent of the growing space was occupied by cull trees, or competing vegetation.

Wood Pulp and Paper Industry

The pulp and paper industry has been a very important addition to the forest industry of the Study Area. The introduction and expansion of this segment of the industry has opened another door in National markets. A market for small material made more intensive forest management feasible for other forest industry and non-industrial forest landowners. The small forest landowner has been given the opportunity for more immediate returns from his forest land and management activities. The market provided by the pulp industry was the primary factor in the large pine planning program that took place on the Red River Basin and adjacent areas. The sale of chipped residues has improved utilization and chances for profits for sawmills and other wood manufacturing plants.

The first successful Kraft papermaking operation in the states of Arkansas, Louisiana, Oklahoma, and Texas started at Bogalusa, Louisiana, in 1918. The Springhill, Louisiana, mill established in 1938, was the first in the Study Area. A large mill was established at Hodge, Louisiana, adjacent to the Study Area, in 1927. Several small mills, utilizing mostly hardwoods to produce roofing felt and wall board materials, were established between 1949 and 1960.

The production of pine pulpwood on the Study Area has followed a generally steady rise between 1950-62. The volume of hardwood pulpwood produced doubled during this period. Table 29 shows the 1962 production

of pulpwood. An additional 9,739,000 cubic feet of pine mill residues were chipped for wood pulp. Pulpwood was 36.8 percent of all industrial roundwood production.

The 1962 average daily production of mills in the Study area was 1,660 tons of pulp. Almost all this pulp was processed into Kraft paper and container board. Approximately 60,000 tons of the annual production were converted into containers and other finished products by secondary manufacturing facilities.

On-farm Use

Integrated wood lots have always been a convenient and economical source of wood products for use in overall farm management. This source of supply is especially important to the small, family type operation. The 1962 production of material used on-the-farm in the Study Area was as follows:

| State | Volume 1/ -1,000 Cubic Feet | | |
|-----------|-----------------------------|-----------|-------|
| | Pine | Hardwoods | Total |
| Arkansas | 70 | 318 | 388 |
| Louisiana | 100 | 577 | 677 |
| Oklahoma | 47 | 555 | 602 |
| Texas | 53 | 208 | 261 |
| Total | 270 | 1,658 | 1,928 |

1/ Not included in Table 28

Forest Based Economic Activity

In 1962 industrial roundwood (table 29) produced on the Study Area had a total stumpage value of \$12,447,389. The value of these raw products delivered at mills and processing plants on the base area was \$33,494,271.

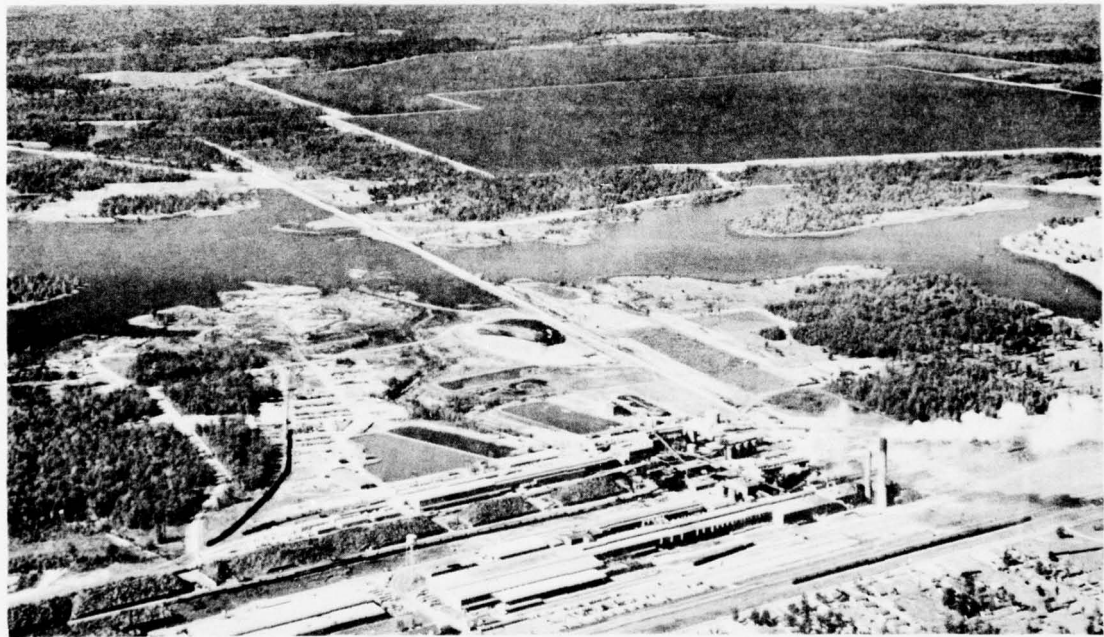
Of the value added in primary manufacturing \$57,507,997 was attributable to 1962 wood production from the Study Area. An additional \$31,473,542, attributable to Study Area timber, was added in secondary manufacturing processes on the base 1/ area. Data on values attributable to timber in transportation and marketing of finished products, and in the construction field are not available.

In 1962, 14,143 full-time workers in forest management and forest-based industry whose employment was directly attributable to timber resources of the Study Area, earned a total of \$52,540,880 in wages and salaries. The bulk of these earnings are costs of harvesting

1/ Whole counties and parishes of the Basin Study Area, except Panola County, Texas



A professional forester advises the owner of well-managed private forest lands, on an upland site managed essentially for pine species. (U. S. Forest Service Photo)



A partial view of the pulp and paper mill at Springhill, Louisiana. Impounding basins and fresh water lakes in the background are used in effluent disposal. (Photo Courtesy International Paper Company)

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and processing stumpage, and appears as value added in data given in the preceding paragraphs. This economic activity was confined to the base area.

Total employment in forest management and forest industry on the base area was 20,703 full-time jobs for 1962. Wages and salaries earned by this work force totaled \$73,861,808.

Forest Productivity and Technology

Projected National Consumption

A comprehensive study ^{1/} by the USFS of trends in consumption of industrial wood in the United States, shows an actual consumption of lumber in 1962 of 35 billion board feet and a projected consumption of 55 billion in 2010. The bulk of the lumber used in 2010 is shown to be domestic softwood.

The same report shows plywood and veneer consumption in 2010 as over 25 times the 1962 production. Softwood plywood is expected to supply about 79 percent of the 2010 consumption.

"Timber Trends" ^{1/} shows a 2010 consumption of pulpwood more than triple that of 1962. Imports are expected to furnish a relatively minor part of the total supplies during the 1970-2010 period. Domestic hardwoods are expected to furnish about 45 percent of the total roundwood for pulping.

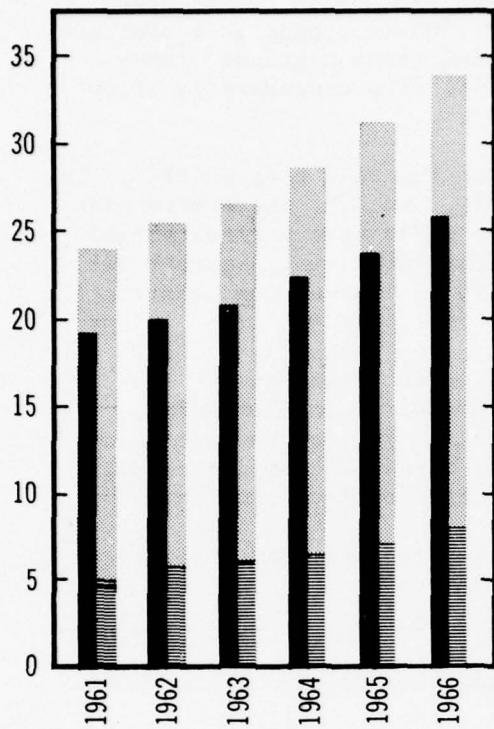
Study Area Interim Development and Productivity

Figure 9 shows the actual production of lumber, roundwood pulpwood, and chipped wood residues for the South in the 1961-66 period. Similar data is shown for softwood plywood production in the U. S.

Softwood lumber production in the South increased 13-1/3 percent from 1962 to 1966. The increase in production on the Study Area was about 20 percent for the same period. The transition of forest industry on the Study Area from small mills to medium and large modern mills has increased efficiency in manufacturing and resulted in higher quality products. The increasingly diversified forest industry is producing (1967) more and more of the building materials (paperboard, particle board, softwood plywood) that are displacing lumber in some sectors of the market.

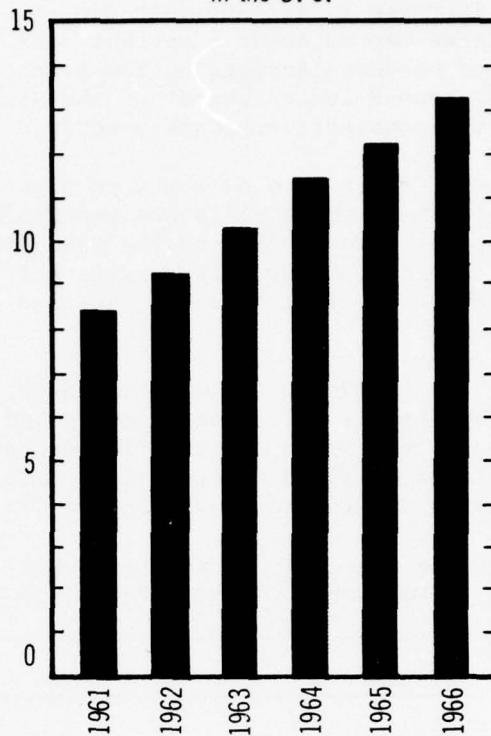
^{1/} "Timber Trends in the U. S.", Forest Resource Report No. 17, U. S. Forest Service, 1963.

Pulpwood Roundwood Production
in the South

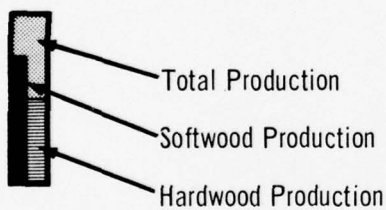


Million cords

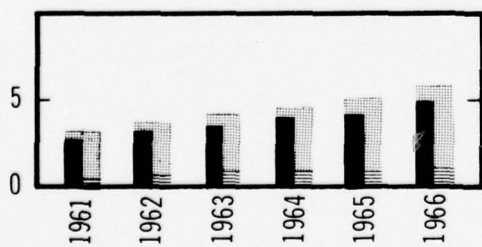
Softwood Plywood Production
in the U. S.



Billion square feet (3/8 inch)

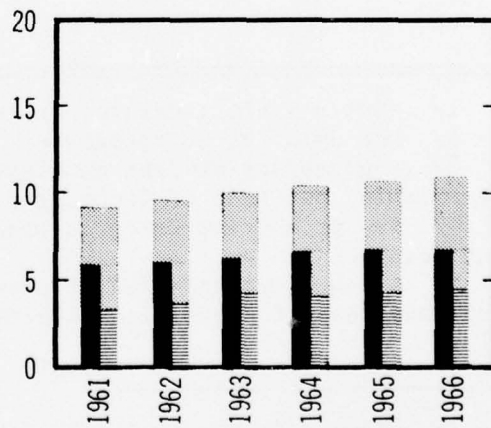


Chip Production in the South



Million cords

Lumber Production in the South



Billion board feet

Figure 9

CURRENT WOOD PRODUCTS PRODUCTION

Hardwood lumber production in the South showed considerably less increase in 1961-66 than did pine. The 1966 production on the Study Area was up about 5 percent over 1962. If 1963-66 trends in conversion of hardwood acreage on the principal alluvial lands continue, future hardwood lumber output on the Study Area will drop considerably below the consumption trends predicted in 1962 1/.

There were no softwood plywood mills on the base area in 1962. The first of these mills was established in 1964. In 1967 there were nine pine plywood mills on the base area. These mills have a total annual capacity of 640 million square feet (3/8 inch material). Another mill of 50-60 million square feet annual capacity is planned for construction by 1970.

In 1962 there was one large pulp mill on the Study Area. Two additional mills were under construction in 1966. Final planning, preliminary to construction is taking place in 1967 for two additional large pulp and paper mills. Table 30 shows actual and estimated pulp mill development and increases in pulping capacity from 1962 to 1980.

Table 30 - Pulp 1/ and Paper Mill Development to 1968, and Expected Development to 1980, Red River Basin Study Area

| Year | : Number : of Mills | : Daily Production <u>2/</u> : (tons of dry pulp) |
|------|-----------------------------|--|
| 1962 | 3 | 1,750 |
| 1963 | 3 | 1,750 |
| 1964 | 3 | 1,770 |
| 1965 | 3 | 2,045 |
| 1966 | 3 | 2,075 |
| 1967 | (Two under construction) | 2,100+ |
| 1968 | 5 | 3,300 |
| 1975 | 8 <u>3/</u> | 4,600 <u>4/</u> |
| 1980 | 9 <u>-</u> | 5,900 <u>5/</u> |

- 1/ Mostly Kraft (sulfate) process, some mechanical and semi-chemical
2/ Per 24 hours of operation
3/ Engineering studies completed, mill sites purchased, water supply available, purchase of timber supply lands continuing in 1968, 3 mills
4/ New production based on preliminary information from company officials
5/ Allows for expansion of previously established mills up to a minimum level for efficient operation

1/ "Timber Trends in the U. S.", Forest Resource Report No. 17, U. S. Forest Service, 1963.

Projected Growth, Cut, and Inventory

Table 31 shows the projected cut, growth, and inventory of growing stock for 1980 and 2010, as well as that for the base year.

Table 31 - Timber Cut, Growth, and Inventory of Growing Stock in 1962, and Projections to 1980 and 2010, Red River Basin Study Area

| Year | Cut | | | Growth | | | Inventory | | |
|---------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | :All :Species | :Soft- :woods | :Hard- :woods | :All :Species | :Soft- :woods | :Hard- :woods | :All :Species | :Soft- :woods | :Hard- :woods |
| | - | - | - | - | - | - | - | - | - |
| | million cubic feet | | | | | | | | |
| 1962 1/ | 169 | 116 | 53 | 346 | 242 | 104 | 5,667 | 3,090 | 2,577 |
| 1980 2/ | 311 | 218 | 93 | 469 | 332 | 137 | 9,733 | 6,027 | 3,706 |
| 2010 2/ | 616 | 456 | 160 | 396 | 262 | 134 | 7,562 | 4,194 | 3,368 |

1/ Volume based on Forest Survey Reports: Arkansas 1959, Louisiana 1954 and 1965, Oklahoma 1956, and Texas 1955 and 1965. Data was adjusted to 1962 level. County data was prorated to basin portion by commercial forest land area.

2/ Projections based on regional trends of supply and demand presented in Timber Trends in The United States, Forest Resource Report No. 17, and modified by historical trends and other local factors on the basin area.

Table 32 shows 1980 and 2010 projections for sawtimber cut, growth, and inventory. Figure 10 illustrates, and compares, cut and growth for 1962, 1980, and 2010. According to these projections 1/ the expected cut of growing stock begins to exceed growth sometime in the 1980 and 2010 period. These projections are based on the 1962 level of management.

Table 32 - Timber Cut, Growth, and Inventory of Sawtimber in 1962, and Projections to 1980 and 2010, Red River Basin Study Area

| Year | Cut | | | Growth | | | Inventory | | |
|---------|--------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| | :All :Species | :Soft- :woods | :Hard- :woods | :All :Species | :Soft- :woods | :Hard- :woods | :All :Species | :Soft- :woods | :Hard- :woods |
| | - | - | - | - | - | - | - | - | - |
| | million board feet | | | | | | | | |
| 1962 1/ | 657 | 431 | 226 | 1,275 | 1,052 | 223 | 20,275 | 13,109 | 7,166 |
| 1980 2/ | 1,064 | 840 | 224 | 1,623 | 1,371 | 252 | 31,074 | 23,858 | 7,216 |
| 2010 2/ | 1,932 | 1,624 | 308 | 1,440 | 1,213 | 227 | 25,000 | 19,313 | 5,687 |

1/ Volume based on Forest Survey Reports: Arkansas 1959, Louisiana 1954 and 1965, Oklahoma 1956, and Texas 1955 and 1965. Data was adjusted to 1962 level. County data was prorated to basin portion by commercial forest land area.

2/ Projections based on regional trends of supply and demand presented in Timber Trends in The United States, Forest Resource Report No. 17, and modified by historical trends and other local factors on the basin area.

1/ "Timber Trends", U. S. Forest Service

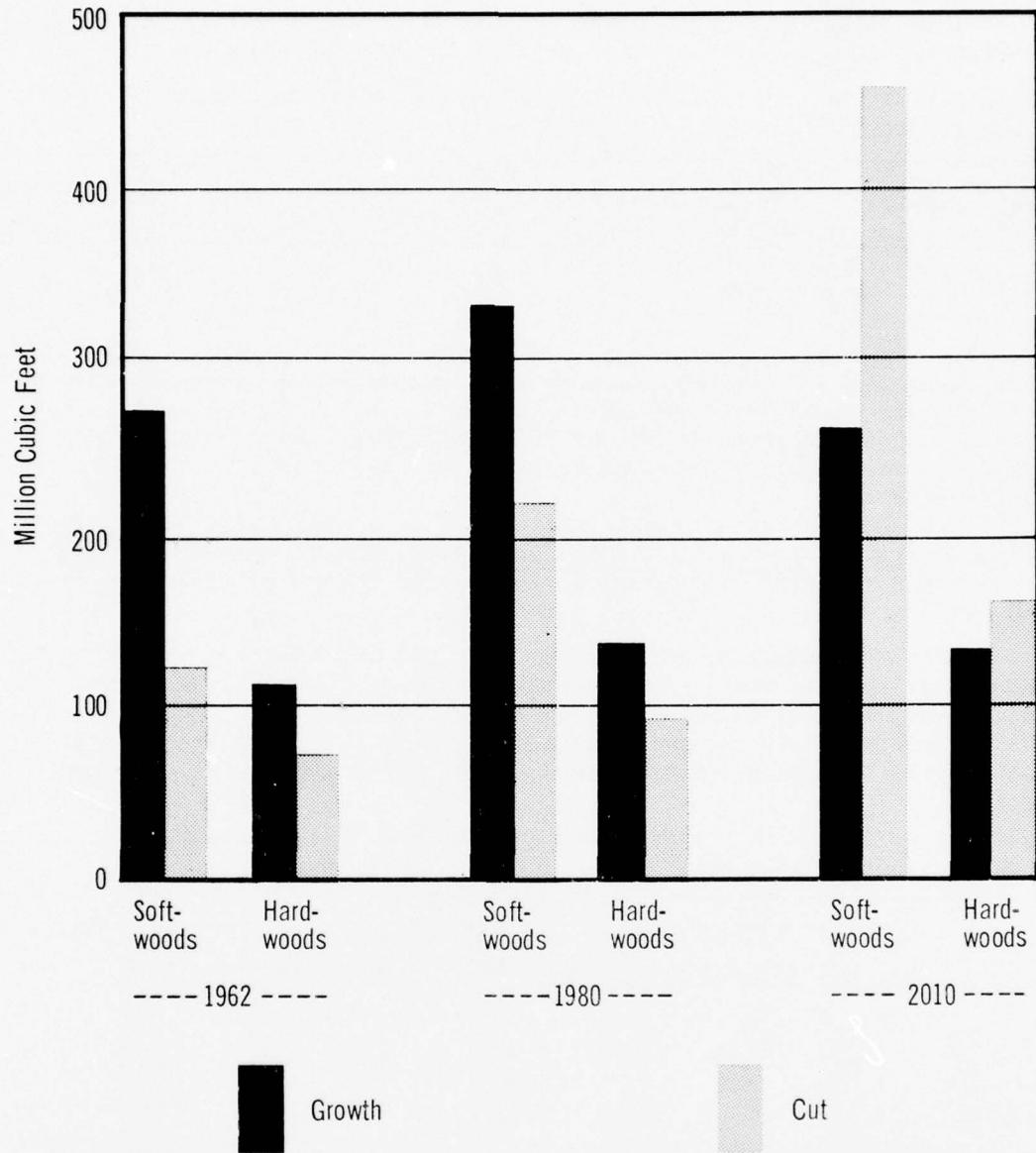


Figure 10

COMPARISON OF 1962 AND EXPECTED CUT AND GROWTH
 BY SPECIES GROUPS, AT THE 1962 LEVEL OF MANAGEMENT,
 RED RIVER BASIN STUDY AREA

Recent (1966) reports indicate that the actual cut is significantly exceeding that established and projected 1/ from 1962 information 2/. The origin in 1964 of the southern pine plywood industry, and its subsequent rapid expansion in the Study Area in 1965-1966, has made unforeseen inroads on inventories and is affecting the cut-growth relationship. The cut and growth relationship for hardwoods, as projected from 1962 information, has been affected by large scale land clearing that has occurred on major alluvial areas of the Study Area since 1962. A considerable acreage of hardwood timber has been taken out of production.

Since 1962, established forest industry has been acquiring non-industry forest lands (particularly pinelands) in the Study Area. These lands have been effectively acquired by extended cutting contracts, long-term leases, and outright purchase. This will result in improved forest management and increased production, and will tend to alleviate the unexpected (in 1962) drain on inventories. Further improvements in utilization would also extend future supplies somewhat, with the current level of forest management. Evidence at present (1967), however, indicates that forest industry on the Study Area will further expand its manufacturing capacity in response to future rises in National demand and improved market conditions. The growth and inventory made available by the 1967 level of management is not expected to sustain industry on the area through the period of this Study.

Forest Technology

The manufacturing plants in the Study Area have been modernized and are capable of competing with those of other supply areas. Improved forest management is necessary on much of the nonindustry private forest lands, if the timber resource is to adequately sustain forest-based industrial expansion in response to increased National demands.

Stumpage prices on the Study Area have responded to increased demand generated by new manufacturing plants. Augmentation of demand by mills under construction in areas of previously weak demand will substantially reinforce markets in these areas. Sound forest management, keyed to the inherent productivity of the lands concerned, should repay initial costs within a reasonable period, increase land values, generate additional sustained revenue, and offer expanded economic opportunities for the future.

Where small forest landowners are concerned, cooperative management ventures seem to offer the best chance for continuous professional-level advice and supervision at acceptable costs. For the landowners

1/ Guided by "Timber Trends in the U. S.", Forest Resource Report No. 17, U. S. Forest Service

2/ State Forest Survey reports

AD-A036 750

RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSAS--ETC(U)
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with highly productive forest land, though of limited acreage, this arrangement offers worthwhile economic returns.

The logging industry is a sector where improvement is imperative for the economic health of forest industry as a whole. If operators and employees in the logging field are to get their share of the future wood dollar, production costs must be lowered substantially. Improved planning and organization, increased mechanization, improved equipment and increased employee skills are needed for most of these operations. The distribution and volume of available supplies of timber is an important consideration in the methods and equipment to be used.

The use of satellite processing stations to supply large pulp-mills is an innovation that reduces transportation costs and simplifies wood storage problems and preliminary processing at the parent mill. Material can be debarked, chipped, screened, and then loaded pneumatically or by mechanical conveyer into rail cars. The material is ready for the pulp digester when it arrives at the mill.

Stumpsides chippers may be used to eliminate skidding. Roadside chippers could prove feasible where large volumes are harvested with a minimum of shifting of equipment and would improve utilization.

Tree-length logging for sawlogs, with roadside sorting, offers advantages in utilization and increased return from stumpsides. Careful planning and imagination will be needed to develop methods of more productive wood harvesting.

Oak and similar "hard" hardwood species are being used (1967) extensively in papermaking in some sections of the southeastern United States. The increased pulping of such species for particle board and paper would permit the utilization of large areas of upland hardwoods, now bearing stands poorly merchantable for sawlogs. This would produce needed income for landowners and materially extend industrial wood supplies. Pulpwood sales could be used to remove low-quality portions of bottomland hardwood stands, while retaining ample growing stock of desirable species and quality for a sawlog stand.

On productive sites, plantations of cottonwood and sycamore, worked on short rotations, appear feasible. Pole-size sycamore can be chipped and processed for paper without debarking. If chipping at stumpsides is added to such an operation, pulp material could be harvested in very short rotations and would provide a rapid return of capital.

Marketing

Rising National demand for wood products and the rapid establishment of large, modern softwood plywood plants on the Study Area and base area since 1962 have strengthened the pine sawlog stumpsides market (see exhibits 12 and 13). Pulp and paper mills now under construction and committed to construction will substantially augment pulp stumpsides

markets throughout the Study Area. The increasing scarcity of high-grade hardwood logs is a definite factor in rising stumpage and log prices (exhibits 12 and 13).

For best results, forest landowners should sell stumpage at, or after, financial maturity. Intermediate cuts should yield the highest value in a combination of immediate returns and improvement of the remaining stands. Saleable trees should be offered to all producers. Combination sales to improve the return on high-demand material such as piling and veneer logs should be considered. Small owners of adjacent lands should consider combined sales in order to demand top market prices. Ownerships combined in one plan and managed cooperatively in sustained yield could readily adopt this method. As logging operations become more mechanized, value of low-volume stumpage will be discounted to cover higher equipment operating cost and depreciation.

Most of the lumber manufactured by mills in the Study Area is now finished, trimmed, and packaged before shipment. Most finished material is protected from the weather during shipment. Such merchandizing is attractive to wholesalers and consumers (see exhibits 14 and 15 for 1961-66 lumber prices). Well-finished dimension material has a special utility in the construction field in raising the productivity of high-cost labor. The paper industry can be expected to add more variety to its products as market opportunities occur and mill capacity becomes available. With the processes and techniques now available, almost any paper product can be manufactured from available wood-fiber materials. To remain competitive in the future, forest industry must give merchandizing and customer service the same careful attention given forest management and plant operation.

WATER AND RELATED LAND RESOURCE PROBLEMS

WATER RESOURCE PROBLEMS

The diversity of soils, topography, land use, annual rainfall, types of agriculture, and distribution of population in the Study Area are some of the factors related to various problems that were considered in this comprehensive study. Problems were investigated in each of the 193 CNI watersheds in the 24 tributary basins.

Flood Problems

Flooding is a major problem on the alluvial soils of the Red River and its tributaries. Average annual precipitation in the Red River ranges from about 39 inches at Durant, Oklahoma, to approximately 60 inches at Alexandria, Louisiana. The average annual amounts of moisture are adequate to produce satisfactory agricultural yields, but the problem concerns rainfall distribution for efficient use.

Flooding in the Red River Alluvium was investigated only where flood problems occur in association with other problems such as inadequate drainage or drought. Flooding in the Red River Alluvium is caused by headwater runoff and also backwater from the Red River during high stages. Damages in the Red River Alluvium from flooding by Red River were evaluated by the USAE and are not included in these damage estimates.

The major flood damage on agricultural land is to crops and pastures. The flood problem is most severe on floodplains of high productivity and intensive use. Such soils may be found in the Southern Mississippi Valley Alluvium and the Texas Blackland Prairie.

Floodplains in the Southern Coastal Plain LRA are generally used for a less intensive type of agriculture with a major portion in woodland and flood problems are only moderate. The Ouachita Mountains LRA includes a small percentage of floodplain and problems from flooding are of a minor nature. There is a small amount of open land and scarcely any cropland along the narrow valleys. There are few problems from flooding in the other land resource areas, which comprise a minor portion of the Study Area.

Other problems to agriculture from flooding include livestock losses, damages to fences, levees, and farm equipment. Nonagricultural flood problems are primarily from damage to roads and bridges. Damages occur most frequently to county or secondary roads. Highways with asphalt surface pavements are also damaged by inundation for extended periods, although all of the damage often does not become apparent for several months after the flood.

Problems are encountered where flooding occurs within the corporate limits of a town, or city, and this is classed as urban damage. The problems may affect either residential areas or business establishments



Cropland and Pastureland Flooding
Southern Mississippi Valley Alluvium, Caddo Parish, Louisiana



Red River Bank Caving Encroachment on Cotton Field--Caddo Parish, Louisiana

4-24879

V-81

or both. Examples of such problems are found in a number of towns scattered throughout the Study Area. Normal growth and development is retarded in areas with this problem.

Floodplain erosion problems occur frequently. These are always associated with other floodwater problems. The greatest of these concerns the *forming of scour channels in the floodplain*. Severity of scour damage is correlated with depth of water flowing over the land.

Erosion of streambanks is of minor importance except along the main stem of Red River and in isolated cases elsewhere. Bank stabilization studies for the Red River have been made by the USAE. The most extensive other area of channel enlargement is along Upper North Sulphur River in the Sulphur River Tributary Basin.

The most prevalent sediment problem is deposition on floodplain land. It results in decreased production yields of crops and pasture from existing yield potential in the absence of sediment damage. Sediment problems also occur from deposition in reservoirs. This necessitates inclusion of additional capacity for sediment storage in design of reservoirs.



Sediment Deposits up to 16 inches in Depth from one Flood--Bossier Parish, Louisiana

Other problems are encountered and include certain indirect losses which result from flooding even though the property involved was not flooded. Some examples include loss of business due to interruption and rerouting of traffic, value of extra feed required for livestock, and food spoilage as a result of flooding.

Land use and flood damages were estimated to determine the magnitude of the flood problem in each CNI watershed. In watershed investigations, the floodplain was defined as the maximum area which would be inundated by floodwater, without project conditions, by a storm of approximately 25-year expected frequency. Floodplain area estimates were prepared for all CNI watersheds. An estimated floodplain area of 77,746 acres occurs in watershed projects authorized for construction prior to December 31, 1962. Floodplain major land use for each of these CNI watersheds is summarized in Exhibit 16.

Flooding is a problem on about 1,132,136 acres of floodplain in watersheds considered feasible for development and initiation of construction within 10-15 years. Floodplain major land use by tributary basins and CNI watersheds in this category are summarized in Exhibit 17.

Flooding is a problem on approximately 78,150 acres of floodplain in six watersheds that are considered feasible for development after 10-15 years. Floodplain major land use is summarized for each of these watersheds in Exhibit 18.

The remaining floodplain consisting of 1,761,858 acres is in watersheds considered not feasible for development at this time. This area is primarily woods and pasture with flood problems of minor nature. Floodplain major land use for each of these watersheds is summarized in Exhibit 19.

Average annual flood damages were compiled from Public Law 566 Watershed Work Plans, data developed during selected watershed detailed investigations, and data developed during field examination scope studies in the remaining watersheds. Floodwater, sediment, erosion (floodplain scour), and indirect damages are estimated at \$9,639,600 annually, exclusive of damages on major floodplains investigated by the USAE. These annual damages will be reduced to \$8,513,665 by upstream watershed projects authorized prior to 1963.

Flood damage problems are greatest in CNI watershed groups in which planning and construction have already been initiated and those which are feasible for project development and initiation of construction within 10-15 years. About \$7,619,420 or approximately 78 percent of all flood damages occur in these watershed groups. Flood damages for each watershed of each group are included in Exhibits 20 and 21. These damages are summarized for each group of watersheds in Table 33.

Flood damages in the group of six watersheds considered feasible for project development after 1980 average \$211,580 annually. The group of watersheds that is not considered to be feasible for development also contribute to total flood damages. Average annual flood damages are estimated at \$1,808,600 for the latter group.

Table 33 - Estimated Average Annual Flood Damages, Red River Basin Study Area

| Watershed Group | Floodwater | | Sediment | Erosion | Indirect | Total |
|---|------------------|-----------------|----------------|----------------|----------------|------------------|
| | Agricultural | Nonagricultural | | | | |
| - - - - - dollars - - - - - | | | | | | |
| Watersheds authorized for operations | 914,090 | 146,270 | 73,560 | 116,460 | 127,260 | 1,377,640 |
| Watersheds feasible for development by 1980 | 5,291,345 | 380,410 | 114,625 | 139,440 | 315,960 | 6,241,780 |
| Total | 6,205,435 | 526,680 | 188,185 | 255,900 | 443,220 | 7,619,420 |

Inadequate Drainage Problems

Drainage includes works of improvement installed for the purpose of lowering the water level in areas that under natural conditions are swamps, marshes or lakes, or in areas where normal precipitation, seepage, or excess irrigation water keeps soil too wet for sustained agricultural use. A large portion of the area with flood problems is also considered to have drainage problems. These are incidental to problems of flooding and occur only so long as flood problems persist.



Cotton Crop Damaged by Inadequate Drainage near Natchitoches, Louisiana

4-24879

In flatlands, the problems of inadequate drainage are considered inseparable from problems of flooding due to their interrelationship. Thus, the acreage with drainage problems is considered to have a combined problem of inadequate drainage and flooding.

A tabulation of acreages with a combined drainage and flood problem reveals approximately 4,822,400 acres in this category. An inventory of the acreage with a drainage and flood problem by land use and tributary basins is shown in Table 34.

Table 34 - Drainage and Flood Problem Areas by Tributary Basins and Major Land Uses, Red River Basin Study Area

| Tributary Basin | Drainage and Flood Problem Area | | | |
|---|----------------------------------|--------------|----------------|----------------|
| | Cropland | Pasture | Woodland | Total |
| | - - - - - thousand acres - - - - | | | |
| Barkman Creek | 4.9 | 2.5 | 14.2 | 21.6 |
| Bayou Jean de Jean | 0.2 | 0.5 | 16.6 | 17.3 |
| Bayou Pierre | 41.8 | 77.1 | 165.3 | 284.2 |
| Bayou Rapides | 8.1 | 16.1 | 8.8 | 33.0 |
| Bayou Rigolette | 7.8 | 15.8 | 47.6 | 71.2 |
| Black and Saline Lakes | 1.8 | 16.0 | 172.6 | 190.4 |
| Blue River | 1.3 | 3.4 | 10.7 | 15.4 |
| Boggy Creek | 16.3 | 22.7 | 105.7 | 144.7 |
| Bois d'Arc Creek | 3.1 | 5.5 | 33.2 | 41.8 |
| Cane River | 7.3 | 40.7 | 110.6 | 158.6 |
| Chatlin Lake and Associated Area | 80.6 | 87.1 | 231.2 | 398.9 |
| Cypress Creek | 69.9 | 93.0 | 337.1 | 500.0 |
| Kiamichi River | 5.0 | 24.9 | 75.1 | 105.0 |
| Little River | 13.3 | 39.9 | 298.4 | 351.6 |
| Loggy Bayou | 41.4 | 41.1 | 516.4 | 598.9 |
| Maniece Bayou | 3.2 | 9.7 | 20.7 | 33.6 |
| McKinney Bayou | 17.8 | 10.8 | 73.9 | 102.5 |
| Intervening Areas - Arkansas and Oklahoma | 28.9 | 51.7 | 85.7 | 166.3 |
| Intervening Areas - Texas | 109.4 | 39.6 | 227.1 | 376.1 |
| Nantachie Creek | 0 | 0.3 | 10.1 | 10.4 |
| Posten Bayou | 20.1 | 6.6 | 15.9 | 42.6 |
| Red River Backwater Area | 17.8 | 23.6 | 363.3 | 404.7 |
| Red River Main Stem | 9.1 | 26.5 | 72.1 | 107.7 |
| Sulphur River | 136.7 | 131.0 | 378.2 | 645.9 |
| Total | 645.8 | 786.1 | 3,390.5 | 4,822.4 |

Drainage and flood problem areas exist in all land resource areas. The Southern Mississippi Valley Alluvium and Southern Coastal Plain LRA contain 85 percent of the drainage and flood problem area with the Southern Mississippi Valley Alluvium LRA containing the greater amount.

Drought and Irrigation Problems

Drought problems vary from year to year. Although there has been some supplemental irrigation in the basin by individuals for many years, the practice was intensified during the drought of 1956.

Although the average annual precipitation is adequate for satisfactory yields of crops and pasture throughout the Study Area, its untimely distribution greatly increases the risks involved in agricultural production, thereby bringing about the desirability for supplemental irrigation. All irrigation, except for rice, is classed as supplemental.

Data on current irrigation development, totaling approximately 42,000 acres in the Study Area, are summarized in the Irrigation Appendix. About 34,000 additional acres have been irrigated previously. Rice, the predominant irrigated crop, comprises over 60 percent of the irrigated area in Louisiana. Other major crops on land with drought problems are cotton, alfalfa, corn, and pasture. In Oklahoma and Texas, supplemental irrigation has been extended to peanut acreages.

Water Quality Control Problems

Extensive water pollution stems from natural, municipal, industrial, and agricultural sources. With the population increase and industrial growth predicted for the area, pollution problems will become more acute unless corrective action is taken.

Salt from natural sources above Lake Texoma creates pollution problems in Red River below Denison Dam. Ten significant natural brine emission areas have been located by the Public Health Service ^{1/}. Five source areas are located on the Prairie Dog Town Fork tributary, three are on the Wichita River tributary, one is on the Pease River tributary, and one is on the Elm Fork tributary.

Turbidity, caused by sediment, is objectionable for esthetic and other reasons. It is detrimental because it inhibits the growth of plants important to fishfood, and it renders the water unsuitable for many municipal and industrial uses.

^{1/} Figure IV-6, Arkansas-Red River Basins, Water Quality Conservation, Appendix Volume I; U. S. Department of Health, Education, and Welfare, June 1964.

Municipalities pollute streams primarily through sewage waste disposals. The available oxygen in water is used for decomposition of organic wastes. Where large quantities of wastes are dumped into streams, the oxygen content of the water can fall below a critical point needed for survival of fish. When this happens, even for a short period of time, a fish kill will result.

Paper mill, poultry processing plant, and oil field effluents are the principal causes of both local and far-reaching pollution problems. In the manufacturing process, woodpulp mills take in large quantities of good quality water and cast off similar quantities of polluted water. Effluent from processing plants intensifies the presence of disease-causing organisms. Brine from oil field operations kills all vegetation and renders water unfit for nearly all uses.

Agricultural practices cause several pollution problems. The erosion of tilled land increases turbidity. Insecticides, herbicides, and chemical fertilizers from treated fields sometimes contaminate natural streams. In some areas, irrigation return water with high concentrations of soluble salts impairs water quality in receiving streams.

The FWPCA evaluated all water quality problems. Their studies are covered in detail in Appendix XI.

Recreation Problems.

Inadequate water areas and associated recreation facilities are recreation problems. The Study Area has large areas of surface water, but the distribution is inadequate to meet water-orientated recreation needs. For example: Lake Texoma is adjacent to Denison and Sherman, Texas, and Durant, Oklahoma. However, the needs for water and associated recreational facilities are evident in the CNI watersheds in which these cities are located. The increasing population and greater individual participation compounds the recreation problem. BOR studies indicate that problems will be intensified in future years.

The increasing use made of areas open to public hunting shows clearly the great need for additional such areas. National Forest lands, state-owned hunting areas, and those privately-owned areas open to public hunting, cannot meet the demand. There is a clear and increasing need for the development of hunting opportunities on private lands, now closed to public use.

As the population increases and urban living becomes more organized, the demand for forest-oriented recreation will grow. Areas of National Forests and state parks and forests will continue to be developed for such recreational use; however, the demand within the period of this study report may well exceed the expected capacities of these areas. Table 35 shows the 1958 to 1965 trends in use of developed recreational areas on National Forests and National Grasslands in the Study Area. Too-heavy use or overcrowding on such areas detracts from the recreational experience for many users. The

development of forest areas for recreational use offers an economic opportunity to private landowners.

Table 35 - Use of Recreational Facilities on National Forests System Lands on Base Area

| | National Forests | | | National Grasslands | | |
|-------------------------|--|----------------|----------------|---------------------|--------------|--------------|
| | 1958 | 1962 | 1965 | 1958 | 1962 | 1965 |
| | - | - | - | - | - | - |
| | - - - - visitor-days ^{1/} of actual use - - - - | | | | | |
| Camping | 26,400 | 47,350 | 245,043 | - | 550 | 900 |
| Picnicking | 53,075 | 102,702 | 217,981 | 1,800 | 2,500 | 2,500 |
| Swimming | 20,450 | 40,070 | 52,424 | 2,500 | - | - |
| Boating | 4,500 | 12,274 | 15,815 | 3,000 | 600 | 550 |
| Hiking and Scenic Areas | 27,837 | 52,867 | 55,885 | - | - | - |
| Total | 132,262 | 255,263 | 587,148 | 7,300 | 3,650 | 3,950 |

^{1/} Equivalent to 12 hours use by one individual (different individuals may be involved in any one visitor-day's use)

Water Supply Problems

Municipal and Rural Community

During field examination scope studies, inquiries were made regarding existing or potential shortages of water supply for municipal or industrial use, in an effort to identify water supply problems. Water supply problems are also described in the PHS Publication 775 (latest revision) "Inventory Water Facilities". The FWPCA developed projected municipal and industrial water supply needs. These are covered in detail in Appendix XI.

Almost all of the cities and larger towns in the Study Area obtain their water supply from surface storage in reservoirs. A few towns obtain their water directly from streamflow. Bossier City, Louisiana, and Durant, Oklahoma, pump water from Red River and Blue River, respectively. Wells are the source of water for rural residents and smaller towns and communities. Lack of water supplies dependable for sustained use may cause industry to hesitate to locate in some towns. These problems were recognized in developing several P. L. 566 watershed work plans.

Forest Industry

Water supplies for potential development of forest industry are recognized as a problem. The heavy users of consequence are the pulp and paper mills. Other forest industry is usually supplied by local or municipal systems without excessive drain on the source.

The USFS inventoried present and foreseeable needs by established pulp and paper mills in the Study Area. These data were developed from estimates by plant managers and studies of pulp and paper making by the USGS and others. In developing possible future water needs, pulp and paper mills for full utilization of the wood raw material were considered as built. These establishments have been suggested or recommended by recent engineering studies and by studies made by public agencies interested in forest utilization. (These studies assume that per capita paper consumption will continue at the level necessary to absorb all products supplied by the basin area.) Construction of all proposed mills was considered to be feasible by the year 2000. In setting water needs by future installations of heavy forest industry, allowances were made for subsequent expansion and increased production as a result of improved efficiency. Water supply problems represented by these present and apparent future needs were brought to the attention of the FWPCA for developing data for the Appendix XI and are shown in Exhibit 22.

LAND RESOURCE PROBLEMS

Erosion, Soil Limitation, and Excess Water Problems

Land resource problems were classified into three general categories. The major problem is soil erosion. Excess water and soil limitations in the root zone are two lesser problems. Extent of problems was estimated by major land uses and land capability subclasses.



Unprotected Cropland Sheet and Gully Erosion

Subclasses were not recognized in land capability Class I. All other land capability classes were divided into appropriate subclasses to identify the land resource problems. Subclass (e) includes soils that have limitations in use because erosion is the dominant problem or hazard. Soil erosion susceptibility and past erosion damage are the principal factors for placing soils into this subclass.

Subclass (w) includes soils that have limitations in use because excess water is the dominant problem or hazard. Soil wetness, high water table, overflow, and poor drainage are factors for placing soils into this subclass.

Soils with root zone limitations as the dominant hazard or limitation in use were included in subclass (s). Factors such as shallow soils, stoniness, low-moisture-holding capacity, low fertility that is difficult to correct, and salinity or alkalinity limit root zones in this subclass.

The dominant kind of soil problem or hazard that affects limitation in land use determined the subclass into which soils were placed. Where two kinds of soil problems or hazards that can be modified or corrected are essentially equal, soils were included in subclasses according to the priority (e), (w), and (s). For example, in parts of the Study Area, land use may be limited equally by erosion and excess water problems or hazards. In such cases, soils would be included in subclass (e) and would not be included in subclass (w).

Major land use distribution by land capability subclasses is a primary factor in determining the scope and magnitude of land resource problems. An inventory of land capability subclasses by major land uses is shown in Table 36.

Of the 17,333,300 acres in the inventory area, about 16,559,800 acres are included in land capability subclasses that have either erosion, soil, or excess water problems. Soil erosion is the major problem. It affects almost 51 percent of the entire acreage of the land resource problem area. Excess water and soil condition problems affect about 31 and 18 percent, respectively, of the entire problem area.

Soil erosion problems are concentrated in land capability classes that are capable of producing cultivated field crops. About 79 percent of the erosion problems occur on soils in Land Capability Classes I to IV and only 21 percent occur on the land area that is best suited to native vegetation. Soil condition problems exist predominantly on land that is best suited to native vegetation. The excess water problems exist entirely on land resources that are capable of producing field crops and pasture plants if the hazard were removed.

Land resource problems vary considerably by states. Tabulations showing land capability classes by states and land resource problems by subclasses are included in Exhibit 23.

Table 36 - Land Capability Subclass Distribution by Major Land Uses,
Red River Basin Study Area, 1962 Conditions

| Land Capability: | : | : | : | Miscell- | : |
|------------------------------------|----------------|----------------|-----------------|--------------|-----------------|
| Class and | : | Grazing | : | aneous | : |
| Subclass | Cropland | Land | Woodland | Land | Total |
| - - - - - thousand acres - - - - - | | | | | |
| Subclass IIe | 765.7 | 435.7 | 754.0 | 85.5 | 2,040.9 |
| Subclass IIIe | 1,048.9 | 855.3 | 1,388.5 | 127.6 | 3,420.3 |
| Subclass IVe | 157.4 | 267.8 | 675.5 | 45.1 | 1,145.8 |
| Subclass VIe | 28.7 | 154.7 | 807.8 | 63.8 | 1,055.0 |
| Subclass VIIe | 64.5 | 138.3 | 533.5 | 5.0 | 741.3 |
| Subtotal | 2,065.2 | 1,851.8 | 4,159.3 | 327.0 | 8,403.3 |
| Subclass IIs | 343.7 | 111.4 | 126.8 | 8.2 | 590.1 |
| Subclass IIIs | 57.0 | 29.9 | 138.8 | 7.8 | 233.5 |
| Subclass IVs | 4.4 | 5.4 | 21.7 | 3.9 | 35.4 |
| Subclass VIs | 0.9 | 2.8 | 16.0 | - | 19.7 |
| Subclass VIIs | 0.1 | 204.8 | 1,949.7 | 5.7 | 2,160.3 |
| Subtotal | 406.1 | 354.3 | 2,253.0 | 25.6 | 3,039.0 |
| Subclass IIw | 190.6 | 162.2 | 319.6 | 21.7 | 694.1 |
| Subclass IIIw | 218.5 | 261.7 | 772.4 | 14.3 | 1,266.9 |
| Subclass IVw | 26.9 | 60.3 | 575.3 | 1.6 | 664.1 |
| Subclass Vw | 105.1 | 323.2 | 2,044.1 | 20.0 | 2,492.4 |
| Subtotal | 541.1 | 807.4 | 3,711.4 | 57.6 | 5,117.5 |
| Total | 3,012.4 | 3,013.5 | 10,123.7 | 410.2 | 16,559.8 |

Sedimentation

Sediment production rates per unit of area are related to the size of the drainage area contributing the sediment. A distinct trend toward lower rates of production per unit of area is evident as the drainage area increases in size. Table 37 shows average rates of sediment production per square mile by LRA and the variations in the rates as related to the size of the drainage areas.

Sediment produces detrimental effects other than those associated with flooding and reservoir sedimentation. Water pollution caused by sediment in stream transport is a significant problem in water quality control. Municipal and industrial water users generally must process stream water prior to consumption; costs for these purification processes are affected depending upon the amount of suspended and colloidal sediment load.

Sediment concentrated in stream water sometimes results in reductions in the fish population because of strangulation of some species.

Aside from the unattractiveness of muddy water, costs are incurred in maintaining the cleanliness of recreational use facilities.

Table 37 - Relation of Average Annual Rate of Sediment Production to Land Resource Area and Drainage Area Size - Red River Basin Study Area

| Land Resource Area | : Drainage : Area | : Sediment : Production Rate |
|---|----------------------|---------------------------------|
| | square miles | acre-feet/square- mile/year |
| Central Rolling Red Prairies | 1 | 0.94 |
| | 10 | 0.75 |
| | 20 | 0.70 |
| Cross Timbers | 1 | 3.50 |
| | 10 | 1.77 |
| | 20 | 1.45 |
| Cross Timbers (Granitic Soils) | 1 | 2.80 |
| | 10 | 1.35 |
| | 20 | 1.10 |
| Grand Prairies | 1 | 0.90 |
| | 10 | 0.67 |
| | 20 | 0.61 |
| Texas Blackland Prairie | 1 | 2.52 |
| | 10 | 1.60 |
| | 20 | 1.35 |
| Cherokee Prairies | 1 | 0.90 |
| | 10 | 0.59 |
| | 20 | 0.47 |
| Ouachita Mountains (Includes Ozark Highland) | 1 | 0.70 |
| | 10 | 0.41 |
| | 20 | 0.30 |
| Southern Mississippi Valley Alluvium | 1 | 0.55 |
| | 10 | 0.39 |
| | 20 | 0.35 |
| Southern Coastal Plain | 1 | 0.77 |
| | 10 | 0.49 |
| | 20 | 0.43 |
| Southern Mississippi Valley Uplands | 1 | 0.66 |
| | 10 | 0.40 |
| | 20 | 0.35 |

Forest Land Problems

The loss of feasible growth and quality of merchantable production and the lack of forest conditions that generate needed benefits in soil and water management are the basic problems that affect the forest resource. Many forest landowners lack sufficient inventory and developed growth-potential for best returns in the strengthening stumpage markets of the Study Area. Poor condition of forest cover and inadequate development of forest soils on much of this acreage reduce considerably the beneficial influence of forest areas on ground water recharge and sediment reduction.

Table 38 shows commercial forest land by area-condition class. In deriving this data, desirable growing stock on the upland area was considered to be vigorous southern pines, or well-formed hardwoods of a readily merchantable species, growing on a site capable of producing a merchantable tree. Desirable growing stock on bottomland areas is well-formed, vigorous hardwoods of a species readily acceptable, or preferred, for factory use. The acreage breakdown in Table 38 indicates a general lack of desirable growing stock, and occupation of much stand space by worthless or low-value trees and competing vegetation.

Table 38 - Area of Commercial Forest Land by Area - Condition Class, Red River Basin Study Area

| Area-Condition Class 1/ | : | Thousand Acres | : | Percent |
|-------------------------|---|----------------|---|---------|
| 1 | | 857.3 | | 8 |
| 2 | | 935.2 | | 9 |
| 3 | | 2,131.6 | | 21 |
| 4 | | 1,534.7 | | 15 |
| 5 | | 3,538.9 | | 35 |
| 6 | | 1,182.9 | | 12 |
| All Classes | | 10,180.6 | | 100 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, USFS

1/ Definitions:

Class 1 - Areas 70 percent or more stocked with desirable trees

Class 2 - Areas 40 to 70 percent stocked with desirable trees and with 30 percent or less of the area controlled by acceptable growing-stock trees, cull trees, inhibiting vegetation, slash or nonstockable conditions

Class 3 - Areas 40 to 70 percent stocked with desirable trees and with more than 30 percent of the area controlled by other trees/or conditions that, ordinarily, prevent occupancy by desirable trees

Class 4 - Areas less than 40 percent stocked with desirable trees, but 70 percent or more stocked with growing-stock trees

Class 5 - Areas less than 40 percent stocked with desirable trees, but 40 to 70 percent stocked with growing-stock trees

Class 6 - Areas less than 40 percent stocked with desirable trees and less than 40 percent stocked with growing-stock trees

On the Study Area there is a general correlation between total forest productivity and class of ownership. (See table 39.) Management levels and the prevalence of persistent problems in forest management can be likewise correlated with ownership class. There are many exceptions, but, basinwide, this approach is justified.

Table 39 - 1962 Average Volume of Growing Stock and Sawtimber Per Acre by Ownership Class, Red River Basin Study Area

| Ownership Class | Volume | |
|-----------------|-----------------|-----------------|
| | Growing Stock | Sawtimber |
| | Cubic Feet/Acre | Board Feet/Acre |
| National Forest | 874 | 3,611 |
| Other Federal | 665 | 2,451 |
| Other Public | 386 | 1,346 |
| Farm | 405 | 1,162 |
| Forest Industry | 753 | 3,030 |
| Other Private | 495 | 1,694 |

Source: State Forest Survey Reports, Southern Forest Experiment Station, USFS

Generally, National Forest System Lands, other Federal forest lands, and state-owned land receive high-level management for all applicable forest uses (see exhibit 24). Watershed values are well-protected. Forest conditions and productivity on these lands are being brought up to the requirements of the various management plans. A 14,500-acre weapon range area of the Army Training Command in Louisiana is an exception.

Game management takes precedence on much of the state forest lands, designated game refuges, and public hunting areas. The continued use of some of these areas by free-ranging livestock, particularly hogs, is a problem in management. This problem also occurs on the Bodcau Reservoir area, a USAE holding. Use of these areas by livestock damages forest soils and desirable young growing stock, and reduces the game-carrying capacity of the areas.

Forest industry in 1962 held approximately one-quarter of commercial forest land on the Study Area. Generally, forest management is being intensified. Optimum wood production is planned for most of this area. Implementation of management plans is well-advanced.

Short rotations, as in operations restricted to pulpwood production, expose the humus in the forest soils to oxidation at relatively short intervals and limit the development of forest soils. The increasing reliance in forest industry on planting for rapid stand regeneration promises to

minimize the effects of such site exposure. The establishment of the pine plywood industry in the Study Area and the increasing integration of manufacturing operations will probably lead to sawlog rotations on much of the pine land.

The forest land ownerships in primarily agricultural operations are the most numerous, and, as an ownership class, practice the poorest forest management. The forest land acreage involved in a single farm ownership is often too little for economic operation in sustained commercial production, or the operator feels that he cannot afford the initial costs involved in reaching a high level of productivity, or the available markets hold too little promise.

Frequently, poor forest management is the result of poor management in other phases of farm operation. Insufficient forage due to poor pasture maintenance, or overstocking, leads to overgrazing of forested areas, or attempts to convert areas of commercial forest land to rangeland. The practice of burning field crop residues often brings about the frequent burning of adjacent forest areas. The pressure of operating costs in other areas of farm operation leads to sales that remove all merchantable inventory regardless of size, age, and current rate of growth. In many such operations, merchantable material of little value as growing stock is left to accumulate in the timber stands.

There are many farm operators who maintain their forest land in good condition for timber production. Most of these owners also are aware of the value of well-stocked, adequately protected forest land in game production and in soil and water management. However, most of the farm forest land acreage needs intensive land treatment, improved protection, and additional technical supervision to produce its highest return.

Data from the State Forest Surveys show the average condition of farm forest lands and other privately-owned nonforest industry lands to be very similar. There is, however, considerable difference in the acreage involved in the two classes of ownership, and in the potential contribution of each to the total forest-based goods and services available in the Study Area. Nonfarm private forest lands, not integrated with forest industry, were 50 percent of the commercial forest area in 1962.

Professional forestry assistance is not regularly employed on much of this ownership area. Management decisions are made by nonprofessional personnel in many cases. Average stocking is much less than that desirable for good forest management. Cutting and harvesting operations are largely unregulated. Average inventories are much too low to realize the growth-interest potential of these forest lands. A substantial part of this land ownership is too heavily grazed for best forest management.

The protection of forest lands from wildfire, and insects and disease that attack valuable timber species, is of basic and continuing



An active gulley area on old agricultural lands. (U. S. Forest Service Photo)



Damage from wildfire in a slash pine plantation. (U. S. Forest Service Photo)

4-24879

importance to the forest resource. Protection from such insects and diseases is especially important in that such threats may readily endanger any and all forest operations.

On forest areas whose owners desire development for recreation or hunting, the lack of suitable forest or habitat quality is a problem. Such conditions are being corrected on most public-owned areas designated for these uses. The problem remains for most private owners interested in economic returns in recreation development or game management.

Progress in Treating Problems

Cropland and Pastureland

Conservation practices have been designed to prevent further deterioration of the land resource and to reduce limitations in use. The scope and intensity of the practices increase as the use limitations of the land resource increase. Common conservation practices for cropland and pastureland include terracing, contour farming, strip cropping, water diversions, proper use of crop residues, definite cropping systems, addition of plant nutrients, grass waterways or outlets, farm drainage and water disposal, land grading, leveling or smoothing, chiseling or subsoiling, proper cultivated row direction, land bedding, liming, pasture and hayland establishment and management, provisions for livestock water, and pasture and hayland renovation. Major land use conversion sometimes is required.

The combined efforts of Federal, State, and local agricultural organizations and of landowners and operators have played a major role in treating land resource problems. It is estimated that conservation treatment, consisting of land use conversions and the common soil and water conservation practices, has been applied to about one-fourth of the Study Area.

Forest Land

A variety of programs that offer some assistance in forest land management are in effect on the Study Area. These programs are essentially aimed at improving management on private lands. The cooperative forest fire control provided by the states of Arkansas, Louisiana, Oklahoma, and Texas protects State and private lands. The 1962 status of this program on the Study Area is shown in Table 40.

Table 40- Status of Forest Fire Protection by States, Red River Basin Study Area, 1962

| State | Protection Status | | | | | Average Annual Loss | |
|--------------|--|-------------------|-------------------------|----------------------------|--------------------------|------------------------------|----------|
| | :Needing :Protection | : : :Protected | :Without :Protection | :Federal 1/ :Protection | :State 2/ :Protection | :Protection:1958-62 :Goal | :Results |
| | - - - - - thousands of acres - - - - - | | | | | Percent of Protected area | |
| Arkansas | 2,022.2 | 2,022.2 | - | 105.8 | 1,916.4 3/ | 0.5 | 0.37 |
| Louisiana | 3,513.9 | 3,513.9 | - | 280.7 | 3,233.2 4/ | 0.25 | 0.31 |
| Oklahoma | | | | | | | |
| Intensive | 2,828.2 | 2,132.6 | 695.6 | 135.6 | 1,997.0 | 0.5 | 1.7 |
| Extensive 5/ | 367.1 | - | 367.1 | - | - | - | - |
| Texas | | | | | | | |
| Intensive | 1,816.3 | 1,816.3 | - | 99.7 | 1,716.6 | 0.5 | 0.4 |
| Extensive 6/ | 423.2 | 423.2 | - | - | 423.2 | 1.0 | 1.0 |

- 1/ Federal lands
- 2/ Protection by state under state-Federal cooperative program
- 3/ Includes 1.1 M acres of Federal land in Bodcau Reservoir
- 4/ Includes 35.9 M acres of Federal land in Bodcau Reservoir
- 5/ In post oak-blackjack oak forest type
- 6/ In post oak forest type

Other programs regularly provided by the States, in cooperation with the Forest Service, accomplish the following: (1) Provide planting stock at moderate prices for private and non-Federal public lands. (2) Provide tree planting service with cost-sharing on some private lands with technical assistance at no cost to private landowners. Tree planting costs are shared on non-Federal public lands. (3) Provide management assistance on private lands. (4) Develops and conducts cooperative programs for the control of forest pests, with cost-sharing on State and private lands.

Forestry programs administered by the USFS and regularly available to landowners offer the following services: (1) specialized technical assistance in management on private and public lands, (2) advice in processing forest products, (3) special information and assistance in such programs as Rural Area Development, and (4) assistance in the management of naval stores, through the Agricultural Stabilization and Conservation Service.

Other Federally-sponsored provisions for assistance in forest management are the ACP practices, tree planting, and timber stand improvement administered by Agricultural Stabilization and Conservation Service, the FHA and Federal Land Bank's long-term loans for forestry purposes, and assistance by the Soil Conservation Service in developing conservation plans and providing other assistance on forest land acreage.

Additional forest management assistance is available through the state forestry agencies, the Agricultural Extension Service and through the guidance and facilities of Soil Conservation Districts. Assistance in forest management is also available through representatives of the larger forest industries. Educational programs by state forestry associations also have been helpful in advancing good forest management.

All the foregoing programs and available assistance have been utilized by private forest landowners in the Study Area. (See exhibits 25 and 26 for summaries of measures installed on private and National Forest System lands.)

Some progress has been made in meeting the existing demand for forest-oriented recreation. (See exhibits 27 and 28 for development on National Forest System lands.) State planning bodies, SCD's, and responsible Federal agencies have inventoried available facilities and studied forest recreation demand (with other recreation demand). Private forest land ownership has shown increased interest in supplying public recreation demand related to forest areas to add income from forest lands.

EXISTING DEVELOPMENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCES

Existing development and future needs for water and related land resources development were analyzed by time periods. Development is proceeding throughout the Study Area and the status of development is changing continuously. For purpose of this study, existing development describes the status of water and related land resources development December 31, 1962. Future needs for development were analyzed for the next 10-15 year period, ending in 1980, and for the period from 1980 to 2080.

EXISTING DEVELOPMENT

Existing and Authorized Watershed Projects

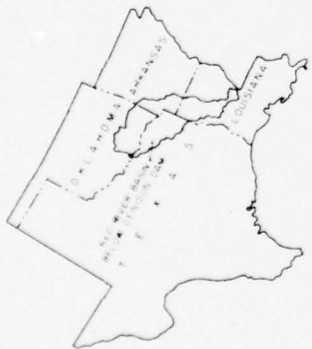
As of December 31, 1962, twelve Public Law 566 watershed projects, including 13 CNI Watersheds in eight tributary basins, were completed or approved for operations. Figure 11 shows locations and status of these watershed developments.

Approximately 1,316 square miles are included in these watersheds. Structural measures in the watersheds consist of 264 floodwater retarding and multiple-purpose reservoirs, about 42 miles of channel improvement and irrigation delivery systems, and recreation basic facilities in connection with a multiple-purpose reservoir. Pertinent structural data are shown in Table 41.



Multiple-Purpose Reservoir - Combining Recreation and Irrigation Water Storage

2



VICINITY MAP

LEGEND

- County Boundary
- - - State Boundary
- Existing Lakes as of Dec. 31, 1962
- Reservoirs Authorized as of Dec. 31, 1962
- - - Comprehensive Study Area Outside The River Basin Boundary
- Basin Boundary
- Watershed Boundary and CNI Number
- P.L. 566 Watershed Projects Completed or Under Construction
- P.L. 566 Watershed Projects Approved for Operations
- Navigation Projects Under Construction or Completed
- Navigation Projects Authorized
- Levee Under Construction or Completed
- Levee Authorized
- Channel Improvement Under Construction or Completed
- Channel Improvement Authorized



- Navigation Projects Under Construction or Completed
- Navigation Projects Authorized
- Levee Under Construction or Completed
- Levee Authorized
- Channel Improvement Under Construction or Completed
- Channel Improvement Authorized

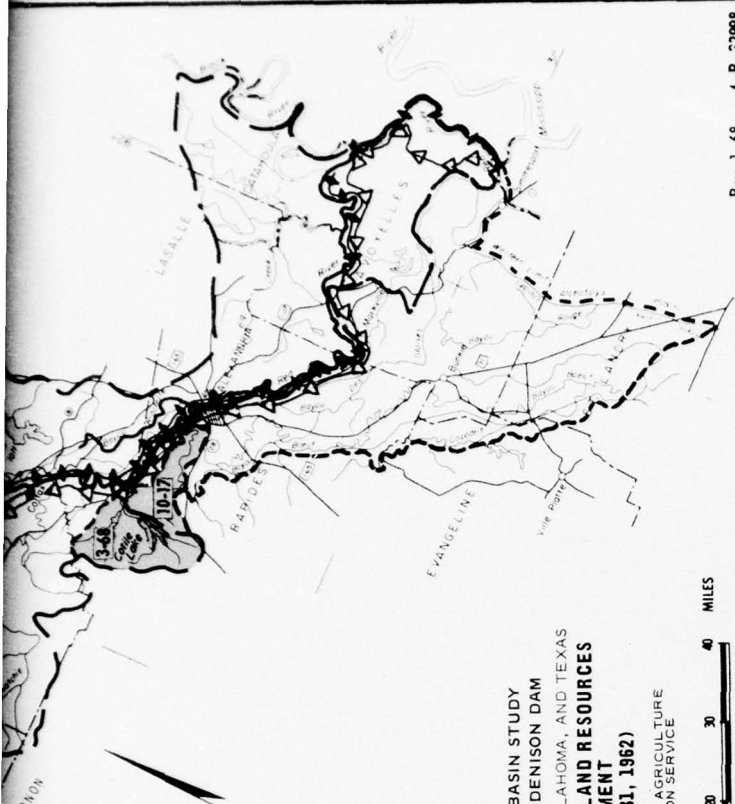


Figure 11
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
WATER AND RELATED LAND RESOURCES
DEVELOPMENT
(DECEMBER 31, 1962)
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

10-17
 3-68
 Rev. 1-68 4-R-22998
 Rev. 1-68 Base 4-R-18830

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS.
 EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS
 USDA SCS FORT WORTH, TEX. 1968

Table 41 - Pertinent Structural Data - P. L. 566 Watershed Projects Authorized for Construction Prior to December 31, 1962, Red River Basin Study Area

| Tributary | Basin and | CNI Watershed | Area | Drainage Area | Floodwater Retarding | Channel Improvement | Storage | Surface Area |
|--|----------------|---------------|------------|-------------------|----------------------|---------------------|-------------------|--------------|
| Watershed | Area | Controlled | Area | Area | Structures | ments | 1/ | 2/ |
| | (sq. mi.) | (sq. mi.) | number | miles | - | - | (ac. ft.) | - |
| Intervening Areas - Texas | | | | | | | | |
| 3-21 | 73.1 | 40.7 | 15 | - | 14,324 | 2,863 | - | 482 |
| Total | 73.1 | 40.7 | 15 | - | 14,324 | 2,863 | - | 482 |
| Intervening Areas - Arkansas & Oklahoma | | | | | | | | |
| 3-36 | 46.2 | 23.6 | 9 | 4.5FP& 15.0 MP | 8,474 | 790 | - | 191 |
| Total | 46.2 | 23.6 | 9 | 19.5 | 8,474 | 790 | - | 191 |
| Blue River | | | | | | | | |
| 3-23a | 317.3 | 219.3 | 74 | - | 57,929 | 7,236 | - | 1,517 |
| Total | 317.3 | 219.3 | 74 | - | 57,929 | 7,236 | - | 1,517 |
| Boggy Creek | | | | | | | | |
| 3h1-4 | 78.2 | 51.9 | 14 | - | 13,907 | 1,996 | - | 14 |
| 3h1-5 | 168.7 | 117.0 | 43 | - | 34,726 | 3,905 | - | 891 |
| 3h1-6 | 253.8 | 178.2 | 54 | - | 54,328 | 5,611 | - | 1,065 |
| 3h2-5 | 36.9 | 29.7 | 3 | - | 10,441 | 1,061 | 3,000M | 535 |
| Total | 537.6 | 376.8 | 114 | - | 113,402 | 12,573 | 3,000M | 2,505 |
| Sulphur River | | | | | | | | |
| 3k-8 | 39.1 | 16.9 | 12 | - | 5,214 | 662 | 1,118M | 340 |
| 3k-13 | 49.5 | 19.0 | 14 | - | 6,233 | 1,119 | - | 290 |
| Total | 88.6 | 35.9 | 26 | - | 11,447 | 1,781 | 1,118M | 630 |
| Loggy Bayou | | | | | | | | |
| 3m2-4 | 8.7 | 4.5 | 3 | - | 1,779 | 1,534 | 710M 595FW | 249 |
| Total | 8.7 | 4.5 | 3 | - | 1,779 | 1,534 | 1,305 | 249 |
| Bayou Pierre | | | | | | | | |
| 3n-3 | 90.0 | 44.3 | 22 | 2.9FP | 14,406 | 2,153 | - | 547 |
| Total | 90.0 | 44.3 | 22 | 2.9 | 14,406 | 2,153 | - | 547 |
| Bayou Rapides | | | | | | | | |
| 3-68 & 10-17 | 154.5 | - | 1 | 20.0ID | - | 652 | 18,573I 5,775R | 1,775 4/ |
| Total | 154.5 | - | 1 | 20.0 | - | 652 | 24,348 | 1,775 |
| Grand Total | 1,316.0 | 745.1 | 264 | 42.4 | 221,761 | 29,582 | 29,771 | 7,896 |

1/ Abbreviations: FP-Flood Prevention; MP-Multiple-purpose; ID-Irrigation delivery system

2/ Abbreviations: M-Municipal; FW-Fish & Wildlife; I-Irrigation; R-Recreation

3/ Total surface area at principal spillway elevation

4/ Supplemental workplan data included

Average annual benefits from these structural measures amount to \$1,817,250 annually. Reduction of damages amounting to \$1,043,120 comprises the major benefit item. The installation of floodwater retarding and multiple-purpose structures with capacity for sediment storage reduces the amount of sediment delivered to downstream reservoirs. In the four watershed projects in Boggy Creek Tributary Basin, annual benefits of

\$7,725 will result from downstream reservoir sediment damage reduction. Additional damage reduction benefits from land treatment are estimated at \$90,540. Benefits of \$221,770 annually are expected from more intensive use of the floodplain. Benefits, including \$20,800 from drainage, \$259,630 from irrigation, \$45,590 from municipal water supply, \$119,810 from recreation, and \$106,530 from secondary sources are summarized by CNI watersheds in Table 42.

Table 42 - Summary of Annual Benefits - P. L. 566 Watershed Projects Authorized for Construction Prior to December 31, 1962, Red River Basin Study Area 1/

| Tributary: Basin and: CNI Watershed: | Flood Prevention | | | | Agricultural | Nonagricultural: | Total | | | |
|---|---------------------|-------------------------|-----------|-----------|---------------------|---------------------------------|--------------------------------|------------|-----------|----------------------|
| | Damage Reduction | More | Reservoir | Sediment | Water Management | Water Management: Municipal: | Benefits From Structural | | | |
| | Land | Structural | Intensive | Reservoir | Drainage | Irrigation | Supply | Recreation | Secondary | Measures |
| - - - - - dollars - - - - - | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-21 | 3,240 | 49,120* | 1,130 | - | - | - | - | - | - | 50,250 |
| Total | 3,240 | 49,120 | 1,130 | - | - | - | - | - | - | 50,250 |
| Intervening Areas - Arkansas & Oklahoma | | | | | | | | | | |
| 3-36 | 8,660 | 148,240* | 55,730 | - | 20,800 | - | - | 27,970 | - | 252,740 |
| Total | 8,660 | 148,240 | 55,730 | - | 20,800 | - | - | 27,970 | - | 252,740 |
| Blue River | | | | | | | | | | |
| 3-23a | 16,580 | 225,140* | 27,210 | - | - | - | - | 25,650 | - | 278,000 |
| Total | 16,580 | 225,140 | 27,210 | - | - | - | - | 25,650 | - | 278,000 |
| Boggy Creek | | | | | | | | | | |
| 3h1-4 | 2,180 | 40,490* | 17,090 | 1,350 | - | - | 26,460 | - | - | 85,390 |
| 3h1-5 | 8,690 | 185,130* | 56,260 | 2,340 | - | - | - | - | - | 243,730 |
| 3h1-6 | 24,410 | 233,510* | 36,220 | 3,000 | - | - | - | - | - | 272,730 |
| 3h2-5 | 610 | 10,215* | - | 1,035 | - | - | 14,360 | 8,080 | 3,780 | 37,470 ^{3/} |
| Total | 35,890 | 469,345 | 109,570 | 7,725 | - | - | 40,820 | 8,080 | 3,780 | 639,320 |
| Sulphur River | | | | | | | | | | |
| 3k-8 | 4,250 | 34,660 | - | - | - | - | 1,770 | - | 3,180 | 39,610 |
| 3k-12 | 8,580 | 35,390 | 830 | - | - | - | - | - | 2,950 | 39,170 |
| Total | 12,830 | 70,050 | 830 | - | - | - | 1,770 | - | 6,130 | 78,780 |
| Loggy Bayou | | | | | | | | | | |
| 3m2-4 | 6,300 | 24,150 | - | - | - | - | 3,000 | - | - | 27,150 |
| Total | 6,300 | 24,150 | - | - | - | - | 3,000 | - | - | 27,150 |
| Bayou Pierre | | | | | | | | | | |
| 3n-3 | 7,040 | 49,350 | 27,300 | - | - | - | - | 7,000 | - | 83,650 |
| Total | 7,040 | 49,350 | 27,300 | - | - | - | - | 7,000 | - | 83,650 |
| Bayou Jean de Jean & Bayou Rapides | | | | | | | | | | |
| 10-17 & 3-68 | - | - | - | - | 259,630 | - | 111,730 | 36,000 | - | 407,360 |
| Total | - | - | - | - | 259,630 | - | 111,730 | 36,000 | - | 407,360 |
| Grand Total ^{1/} | 90,540 | 1,035,395 ^{2/} | 221,770 | 7,725 | 20,800 | 259,630 | 45,590 | 119,810 | 106,530 | 1,817,250 |

1/ Adjusted normalized prices, Water Resources Council, April 1966
2/ Red River Main Stem benefits aggregating approximately \$13,600 annually from watersheds with asterisks
(*) not included
3/ Supplemental work plan data included

Red River main stem benefits above Fulton, Arkansas, estimated at \$13,600 also will accrue from structural measures.

Construction costs of floodwater retarding, multiple-purpose structures, and channel improvement are estimated at \$11,361,170. Costs of recreation basic facilities, installation services, administration of contracts, land, easements, and rights-of-way bring the total installation cost of structural measures to \$17,347,785. These are summarized in Table 43.

Table 43 - Estimated Structural Installation Costs - P. L. 566 Watershed Projects Authorized for Construction Prior to December 31, 1962, Red River Basin Study Area

| Tributary Basin and CNI Watershed | Construction | | | Subtotal | Recreation Basic Facilities | Installation Services | Land Easements and Rights of Way | Administration of Contracts | Total | Price Base |
|---|---------------------------------|-----------------------------|---------------------|------------|-----------------------------|-----------------------|----------------------------------|-----------------------------|------------|------------|
| | Floodwater Retarding Structures | Multiple Purpose Structures | Channel Improvement | | | | | | | |
| dollars | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-21 | 685,630 | - | - | 685,630 | - | 217,235 | 147,065 | 7,500 | 1,057,430 | 1958 |
| Total | 685,630 | - | - | 685,630 | - | 217,235 | 147,065 | 7,500 | 1,057,430 | |
| Intervening Areas - Arkansas & Oklahoma | | | | | | | | | | |
| 3-36 | 264,760 | - | 144,670 | 409,430 | - | 131,020 | 112,560 | 4,370 | 657,380 | 1961 |
| Total | 264,760 | - | 144,670 | 409,430 | - | 131,020 | 112,560 | 4,370 | 657,380 | |
| Blue River | | | | | | | | | | |
| 3-23a | 2,753,455 | - | - | 2,753,455 | - | 718,195 | 440,890 | 22,200 | 3,934,740 | 1961 |
| Total | 2,753,455 | - | - | 2,753,455 | - | 718,195 | 440,890 | 22,200 | 3,934,740 | |
| Boggy Creek | | | | | | | | | | |
| 3h1-4 | 871,245 | - | - | 871,245 | - | 222,100 | 81,270 | 4,200 | 1,178,815 | 1961 |
| 3h1-5 | 913,750 | - | - | 913,750 | - | 242,600 | 244,335 | 12,900 | 1,413,585 | 1959 |
| 3h1-6 | 1,688,635 | - | - | 1,688,635 | - | 527,605 | 205,360 | 16,200 | 2,437,800 | 1958 |
| 3h2-5 | 64,600 | 385,100 | - | 449,700 | - | 116,000 | 104,500 | 4,000 | 674,200 | 1964 1/ |
| Total | 3,538,230 | 385,100 | - | 3,923,330 | - | 1,108,305 | 635,465 | 37,300 | 5,704,400 | |
| Sulphur River | | | | | | | | | | |
| 3k-8 | 289,680 | - | - | 289,680 | - | 96,175 | 71,530 | 6,000 | 463,385 | 1957 |
| 3k-13 | 326,955 | - | - | 326,955 | - | 104,625 | 49,990 | 7,000 | 488,570 | 1957 |
| Total | 616,635 | - | - | 616,635 | - | 200,800 | 121,520 | 13,000 | 951,955 | |
| Loggy Bayou | | | | | | | | | | |
| 3m2-4 | 53,040 | 266,735 | - | 319,775 | - | 100,255 | 41,825 | 1,500 | 463,355 | 1957 |
| Total | 53,040 | 266,735 | - | 319,775 | - | 100,255 | 41,825 | 1,500 | 463,355 | |
| Bayou Pierre | | | | | | | | | | |
| 3n-3 | 872,040 | - | 72,875 | 944,915 | - | 171,780 | 157,560 | 133,060 | 1,407,315 | 1954 |
| Total | 872,040 | - | 72,875 | 944,915 | - | 171,780 | 157,560 | 133,060 | 1,407,315 | |
| Bayou Jean de Jean & Bayou Rapides | | | | | | | | | | |
| 10-17 & 3-68 | - | 1,549,600 | 158,400 | 1,708,000 | 284,480 | 651,880 | 494,850 | 32,000 | 3,171,210 | 1964 1/ |
| Total | - | 1,549,600 | 158,400 | 1,708,000 | 284,480 | 651,880 | 494,850 | 32,000 | 3,171,210 | |
| Grand Total | 8,783,790 | 2,201,435 | 375,945 | 11,361,170 | 284,480 | 3,299,470 | 2,151,735 | 250,930 | 17,347,785 | |

1/ Supplemental Work Plan data included

The amortized annual equivalent of structural measures amounts to \$635,000. With inclusion of \$69,075 for operation and maintenance, the total annual cost of these measures is estimated at \$704,075. In comparison of these costs to average annual benefits of \$1,817,250, approximately \$2.60 in benefits is returned for each dollar spent on improvements. The comparison of average annual benefits and costs for structural measures is summarized in Table 44.

Land Treatment

Soil and water conservation districts have been assisting landowners in the application of basic conservation programs on farms within the watersheds for many years. Emphasis is placed on establishment of land treatment measures that will have a measurable effect on reduction of floodwater and sediment damages and costs of providing sediment storage in floodwater retarding structures. These include measures that are required primarily for establishment of good vegetative cover and improvement of hydrologic soil conditions. Cropland treatment measures include rotation hay and pasture, cover cropping in conservation crop rotations, and improved tillage to attain crop residue utilization for soil protection and conditioning. Pasture and rangeland treatment measures include planting and range seeding to establish good cover, proper use of pasture and range to maintain good cover, and construction of farm ponds to provide strategically located watering places as an aid in pasture and range management.

Approximately 100,000 farm ponds have been constructed through 1962, an average of 3.4 ponds per square mile. These ponds represent a total surface area of approximately 50,000 acres assuming a surface area of one-half acre per pond. They will hold approximately 200,000 acre-feet of water based on an average capacity of two acre-feet per pond.

Table 44 - Average Annual Benefits and Costs for Structural Measures -
P. L. 566 Watershed Projects Authorized for Construction Prior to
December 31, 1962, Red River Basin Study Area

| Tributary : | Amortized : | Operation and Maintenance : | Total Annual Costs : | Benefits : | Benefit Cost Ratio : |
|---|------------------------|-----------------------------|----------------------|------------------|----------------------|
| Basin and CNI Watershed : | Installation Cost 1/ : | Costs 2/ : | Costs : | Benefits 3/ : | Cost Ratio : |
| - - - - - dollars - - - | | | | | |
| Intervening Areas - Texas | | | | | |
| 3-21 | 37,283 | 4,003 | 41,286 | 50,250 | 1.2:1 |
| Total | 37,283 | 4,003 | 41,286 | 50,250 | 1.2:1 |
| Intervening Areas - Arkansas & Oklahoma | | | | | |
| 3-36 | 23,978 | 7,867 | 31,845 | 252,740 | 7.9:1 |
| Total | 23,978 | 7,867 | 31,845 | 252,740 | 7.9:1 |
| Blue River | | | | | |
| 3-23a | 142,197 | 6,923 | 149,120 | 278,000 | 1.9:1 |
| Total | 142,197 | 6,923 | 149,120 | 278,000 | 1.9:1 |
| Boggy Creek | | | | | |
| 3h1-4 | 42,601 | 1,290 | 43,891 | 85,390 | 1.9:1 |
| 3h1-5 | 49,843 | 4,220 | 54,063 | 243,730 | 4.5:1 |
| 3h1-6 | 85,957 | 5,580 | 91,537 | 272,730 | 3.0:1 |
| 3h2-5 | 26,826 | 475 | 27,301 | 37,470 | 1.4:1 4/ |
| Total | 205,227 | 11,565 | 216,792 | 639,320 | 2.9:1 |
| Sulphur River | | | | | |
| 3k-8 | 16,338 | 1,96 | 18,305 | 39,610 | 2.2:1 |
| 3k-13 | 17,226 | 1,497 | 18,723 | 39,170 | 2.1:1 |
| Total | 33,564 | 3,464 | 37,028 | 78,780 | 2.1:1 |
| Loggy Bayou | | | | | |
| 3m2-4 | 14,878 | 750 | 15,628 | 27,150 | 1.7:1 |
| Total | 14,878 | 750 | 15,628 | 27,150 | 1.7:1 |
| Bayou Pierre | | | | | |
| 3n-3 | 51,673 | 2,503 | 54,176 | 83,650 | 1.5:1 |
| Total | 51,673 | 2,503 | 54,176 | 83,650 | 1.5:1 |
| Bayou Jean de Jean & Bayou Rapides | | | | | |
| 10-17 & 3-68 | 126,200 | 32,000 | 158,200 | 407,360 | 2.6:1 4/ |
| Total | 126,200 | 32,000 | 158,200 | 407,360 | 2.6:1 |
| Grand Total | 635,000 | 69,075 | 704,075 | 1,817,250 | 2.6:1 |

- 1/ Amortized for 50 years at 2.5 percent (except for CNI Watershed 3h2-5 which was amortized for 50 years at 3-1/8 percent)
 2/ Long-term prices projected by ARS, 1957 (except CNI Watershed 3k-13 which used long-term prices as projected by ARS, 1956)
 3/ Adjusted normalized prices, Water Resources Council, April 1966
 4/ Supplemental Work Plan data included

Table 45 shows the accomplishments from 1962 to June 30, 1966, in forest land treatment with going programs, on private lands. Recommendations for accelerated treatment of forest land were included in nine P. L. 566 watershed projects authorized (by June 30, 1966) in the Study Area.

4-24879

Table 45 - Land Treatment Accomplished on Private Forest Lands With Going Programs, Since 1962, Red River Basin Study Area

| Measures | Total Installed | |
|------------------------------|-----------------------|------------|
| | 6/30/63 ^{1/} | to 6/30/66 |
| | acres | |
| Field Planting | 22,300 | |
| Interplanting | 4,600 | |
| Underplanting (with release) | 1,400 | |
| Timber Stand Improvement | 62,000 | |
| Total | 90,300 | |

^{1/} Data period starts after closure of records for fall-winter tree planting season of 1962-63

Land treatment accomplishments from 1962 to June 30, 1966 are shown in Table 46.

Table 46 - 1962 to June 30, 1966, Accomplishments in Forest Land Treatment on P. L. 566 Watershed Projects, Red River Basin Study Area

| Purpose and Measures | Unit | Total Installed |
|--|-------|-------------------|
| WATERSHED PROTECTION | | |
| Openland Tree Planting | Acres | 1,130 |
| Interplanting | Acres | 2,410 |
| Underplanting | Acres | 522 |
| Hydrologic Stand Improvement ^{1/} | | |
| Release of Desirable Species ^{2/} | Acres | 6,563 |
| Grazing Control | Acres | 5,710 |
| Selective Harvest | | |
| Thinning | Acres | 4,810 |
| Regeneration | Acres | 100 |
| FLOOD PREVENTION | | |
| Critical Area Stabilization | | |
| Site Preparation | Acres | 99 |
| Tree Planting | Acres | 17 |
| Roadside Erosion Control | Acres | 960 ^{3/} |
| Intensified Fire Protection | | |
| Equipment | No. | 2 ^{4/} |
| Tool Caches | No. | 2 |
| Firebreaks | Miles | 24 |

^{1/} To improve the hydrologic performance of forest soils and cover

^{2/} That build soil humus at a relatively rapid rate

^{3/} Applied to National Forest lands

^{4/} Small truck - pumper units

Watershed management is integrated with all other phases of land management on National Forest System Lands. These lands are administratively divided into natural watershed units and these units are treated, unit by unit, to meet the outstanding watershed protection and flood prevention needs. The protection needs of watershed management units are considered in all planned use of these areas. National Forest System Lands are shown in Figure 12.

As of June 30, 1966, treatment of 1962 problem areas on all watershed management units of National Forest System Lands on the Study Area have been essentially completed. Some additional channel stabilization is needed for better water management, and completion of these measures is scheduled before 1980. Table 47 shows the land treatment accomplished on National Forest System Lands, from 1962 to June 30, 1966. Most of these measures are keyed directly to the maintenance of watershed values

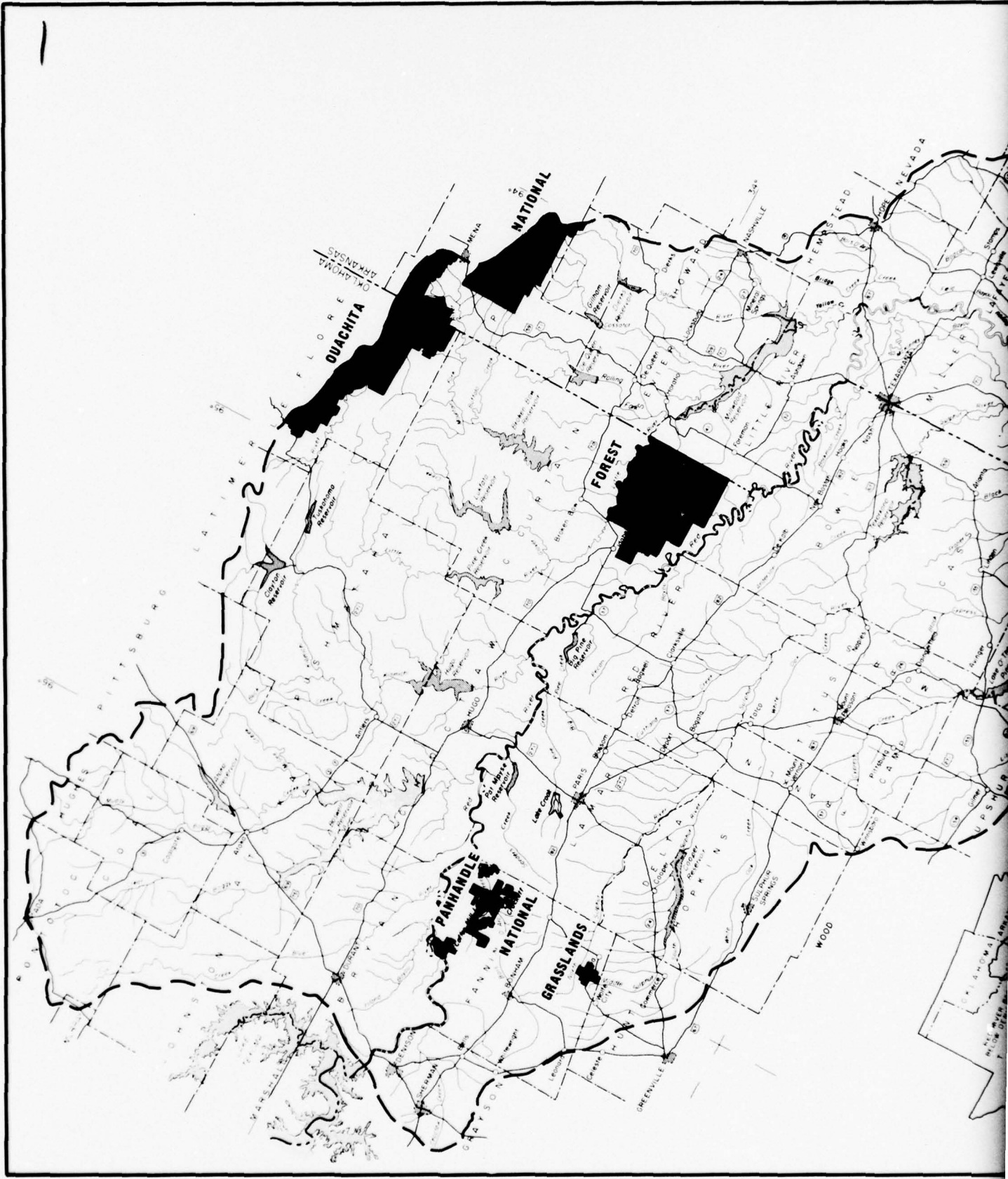
Table 47 - 1962 to June 30, 1966, Accomplishments in Land Treatment on National Forest System Lands, Red River Basin Study Area

| Measures | Unit | Total Installed |
|---------------------------------|-------|-----------------|
| Tree planting | Acres | 9,466 |
| Timber stand improvement | Acres | 50,236 |
| Erosion control | Acres | 1,828 |
| Range improvement (reseeding) | Acres | 170 |
| Channel stabilization <u>1/</u> | Miles | 7 |
| Total | Acres | 61,700 |
| Total (Channel Stabilization) | Miles | 7 |

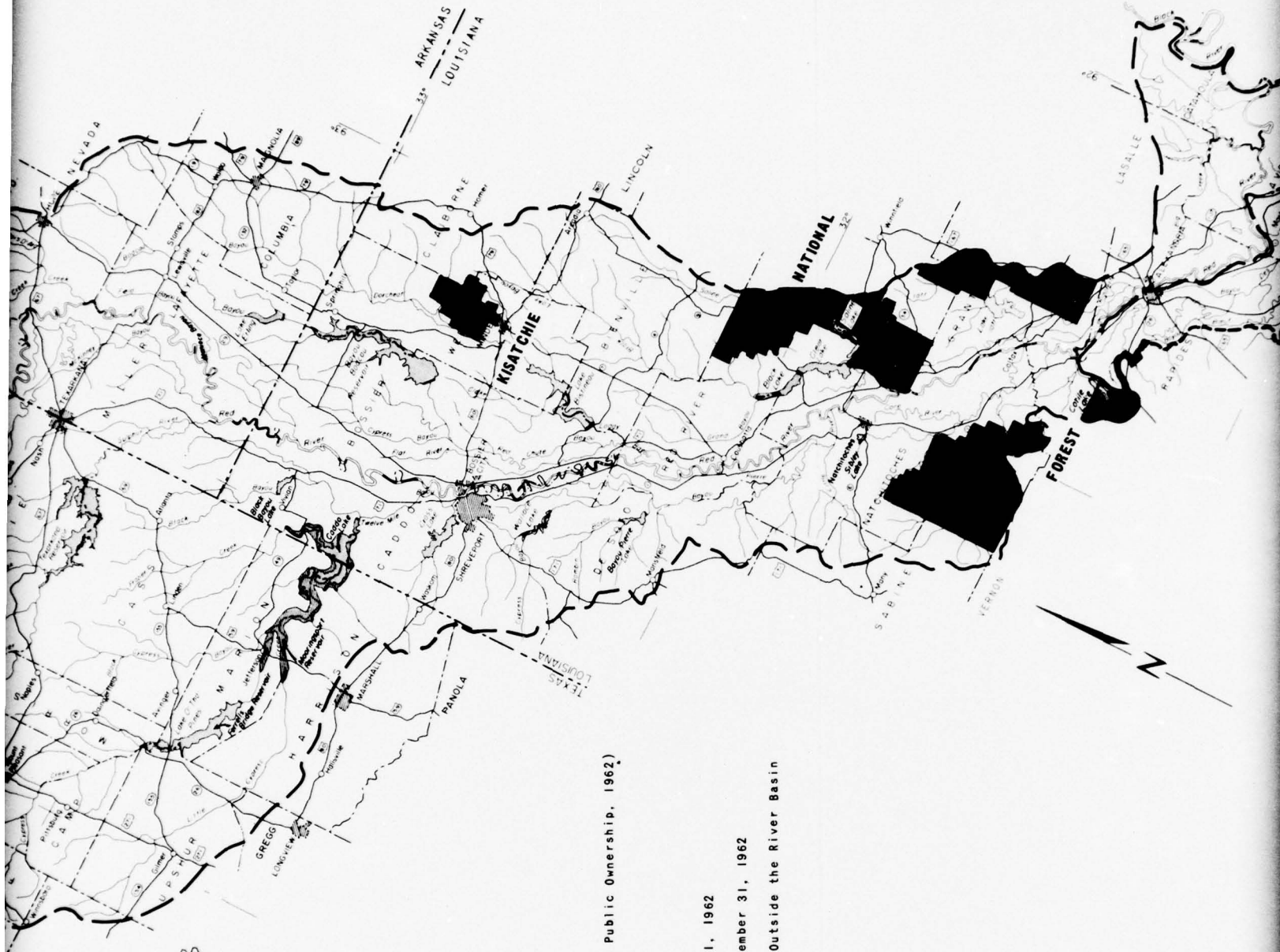
1/ Desnagging, revetment, and current control structures

Multiple-use management on National Forest System Lands has resulted in additional development of land and water areas for recreation in the Study Area. Exhibit 28 shows the 1963-67 development.

The acquisition of areas by the states for game management and public hunting has gained impetus since the study began. In the 1963-67 period, Arkansas acquired some 67,000 acres in several blocks in the Study Area. Louisiana has purchased some 71,500 acres of bottom-land hardwood forest, in two blocks.










2.



VICINITY MAP

LEGEND

-  Gross Area (486,560 Acres Public Ownership, 1962)
-  County Boundary
-  State Boundary
-  Existing Lakes December 31, 1962
-  Reservoirs Authorized December 31, 1962
-  Comprehensive Study Area Outside the River Basin Boundary
-  Basin Boundary

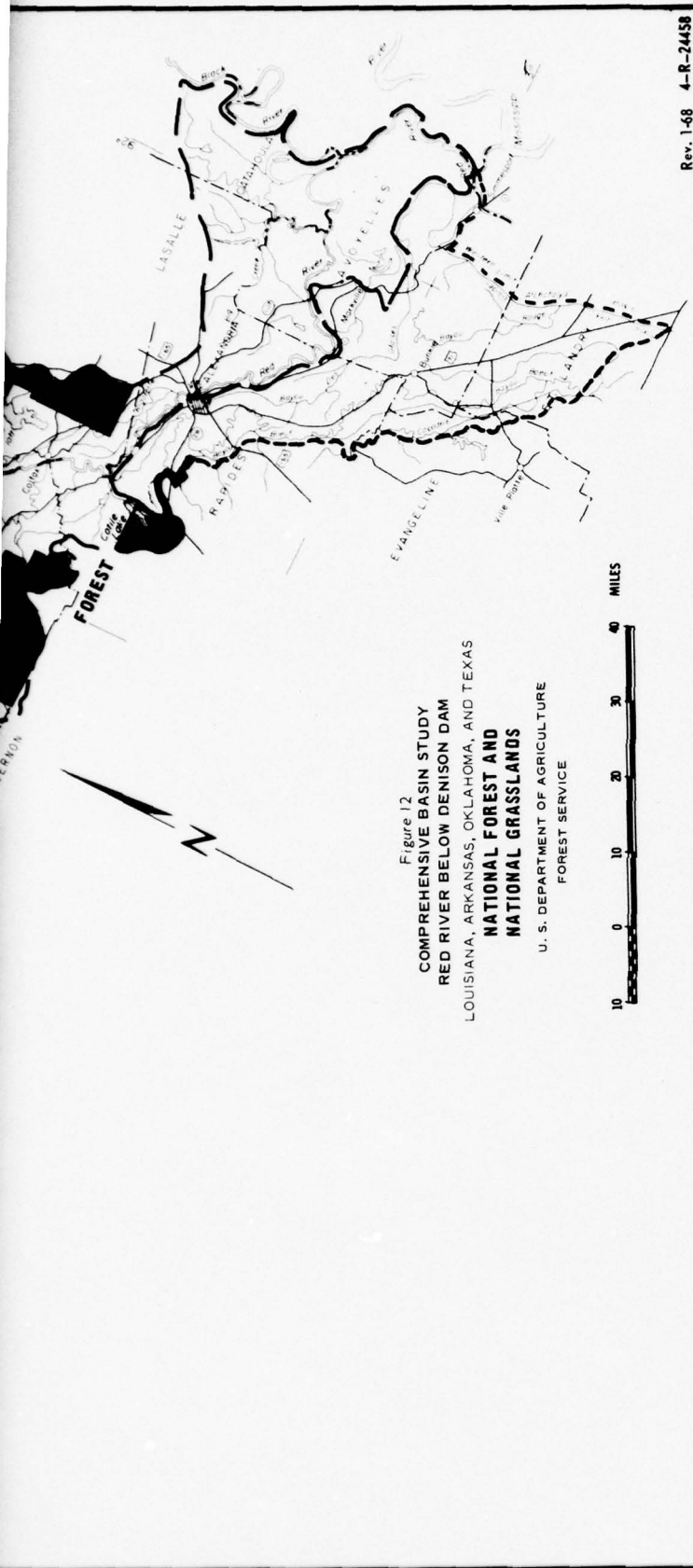


Figure 12
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
NATIONAL FOREST AND
NATIONAL GRASSLANDS
 U. S. DEPARTMENT OF AGRICULTURE
 FOREST SERVICE



Rev. 1-68 4-R-24458

Rev. 1-68 Base 4-R-18830

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS.
 EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS.

USDA-ECF-FORT WORTH, TEX. 1968

3



The tractor and plow of a forest fire suppression unit at work. State protection programs cover most private forest lands. (U. S. Forest Service Photo)

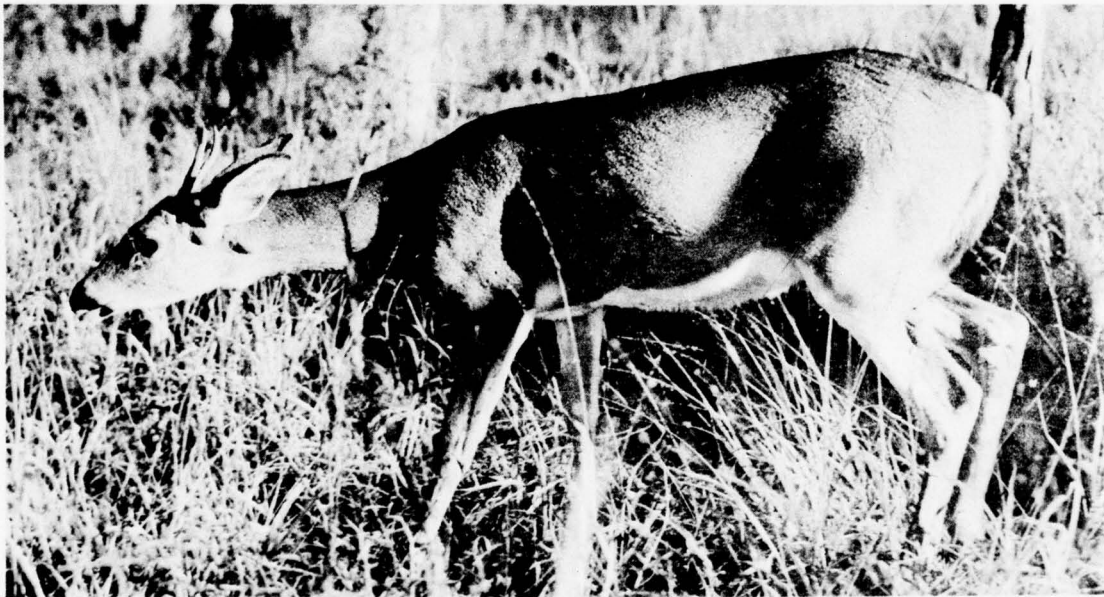


Erosion control on a critical sediment source on National Forest lands. (U. S. Forest Service Photo)

4-24879



Gum Springs, Winn Parish, Louisiana. A family group makes use of a recreation area on National Forestlands. (U. S. Forest Service Photo)



A Spike buck on a game management area. The deer herd on the Study Area is increasing and hunting is popular. (U. S. Forest Service Photo)

4-24879

Other Federal Water Projects

Flood control improvements often include multiple-purpose reservoirs for flood control and water conservation. Benefits from these reservoirs include the prevention of flood damages and the conservation of water for various purposes, such as municipal and industrial uses, navigation, generation of hydro-electric power, recreation, and the preservation and enhancement of fish and wildlife resources.

Under authority of the Flood Control Act of 1946 and subsequent modifications, the USAE have constructed two multiple-purpose flood control reservoirs and two single-purpose flood control reservoirs. Fifteen other multiple-purpose flood control reservoirs have been authorized for construction as of December 31, 1962 (figure 11). Since this date, construction has begun on nine of the authorized reservoirs; Hugo, Pine Creek, Lukfata, Broken Bow, DeQueen, Gillham, Dierks, Millwood, and Pat Mayse.

Complete installation of the flood control and multiple-purpose reservoirs will provide storage for 9,410,900 acre-feet of water for flood prevention and 3,055,000 acre-feet for other purposes. Rainfall runoff from approximately 19,639 square miles of drainage area will be controlled to provide reduced flood stages along Red River and pertinent tributaries. Pertinent structural data on the individual reservoirs are summarized in Table 48.

Table 48 - Existing and Authorized Reservoirs-- U. S. Army Engineers, December 31, 1962, Red River Basin Study Area

| Reservoir | | Drainage Area | Storage Capacities | | | | | Surface Area |
|-------------------|------------|---------------|--------------------|--------------------------|-----------------------|----------------|--------------|----------------|
| Name | Status | | Flood Control | Municipal and Industrial | Water Quality Control | Conservation | Other | |
| | | square miles | thousand acre-feet | | | | | thousand acres |
| Lake Texarkana | Existing | 3,400 | 2,509.0 | 0 | 0 | 145.3 | 0 | 20.3 |
| Lake O' the Pines | Existing | 850 | 587.2 | 251.1 | 0 | 3.8 | 0 | 18.7 |
| Bayou Bodcau Lake | Existing | 656 | 337.3 | 0 | 0 | 0 | 0 | 0 |
| Wallace Lake | Existing | 260 | 88.3 | 0 | 0 | 7.8 | 0 | 2.3 |
| Caddo Lake | Existing | 2,740 4/ | 0 | 0 | 0 | 0 | 175.0 | 32.7 |
| Millwood | Authorized | 4,144 | 1,651.4 | 154.6 | 0 | 52.0 | 0 | 29.2 |
| Dierks | Authorized | 113 | 66.0 | 14.0 | 0 | 0 | 0 | 1.1 |
| Gillham | Authorized | 277 | 164.6 | 0 | 0 | 33.4 | 0 | 1.4 |
| DeQueen | Authorized | 169 | 101.2 | 18.0 | 0 | 2.0 | 0 | 1.7 |
| Broken Bow | Authorized | 754 | 450.0 | 470.1 | 0 | 0 | 448.7 | 14.2 |
| Lukfata | Authorized | 291 | 172.0 | 31.0 | 0 | 4.0 | 0 | 1.0 |
| Pine Creek | Authorized | 635 | 378.0 | 70.0 | 0 | 7.0 | 0 | 16.3 |
| Clayton | Authorized | 275 | 104.0 | 0 | 0 | 186.5 | 0 | 8.9 |
| Hugo | Authorized | 1,709 | 809.5 | 0 | 0 | 40.0 | 0 | 5.5 |
| Tuskahoma | Authorized | 347 | 138.6 | 0 | 0 | 235.4 | 0 | 11.6 |
| Boswell | Authorized | 2,273 | 1,094.2 | 0 | 0 | 35.8 | 0 | 5.5 |
| Big Pine | Authorized | 95 | 53.6 | 0 | 0 | 85.0 | 0 | 4.6 |
| Cooper | Authorized | 476 | 131.4 | 240.9 | 0 | 37.0 | 0 | 9.5 |
| Pat Mayse | Authorized | 175 | 64.6 | 124.5 | 0 | 0 | 0 | 6.0 |
| Mooringsport | Authorized | 2,740 | 510.0 | 0 | 0 | 150.0 | 0 | 31.0 |
| Totals | | 19,639 | 9,410.9 | 1,374.2 | 0 | 1,025.0 | 623.7 | 221.7 |

1/ Includes storage for sediment accumulation
 2/ Caddo Lake storage is for navigation; other storage in Broken Bow Reservoir is for hydro-electric power
 3/ Water surface area exclusive of flood storage pool
 4/ This area not included in total; Caddo Lake will be incorporated into Mooringsport Reservoir

The Flood Control Act of 1946 also provided the USAE authority to raise and strengthen the existing levees below Denison Dam to provide protection against a flood equivalent to that of 1945 confined by levees, and for bank protection and channel stabilization works in highly developed areas where levee relocations are impracticable. The levee system under this project consists of approximately 400 miles of levees. The bank protection works to be constructed amount to approximately 30 miles. Construction is in progress on levee and bank improvements.

Approximately 456 miles of Red River and 240 miles of tributary channel improvements have been authorized for construction by the USAE under several authorizing acts. The majority of these channels have been improved and subsequently modified.

The levee and channel improvement provides flood protection to portions of Arkansas, Louisiana, and Texas. Alleviation of flood damages to floodplain lands along Red River, and some tributaries in Arkansas, Texas, and Louisiana is provided by the projects.

The Overton-Red River Waterway was authorized in 1946 as a modification of the navigation project on Red River below Fulton, Arkansas, authorized in 1892. It provided for the construction of a navigation channel nine feet deep by 100 feet wide from the Mississippi River via Old and Red Rivers for about 31 miles, and then a new land cut generally following existing streams along the right floodplain of the Red River to a turning basin on Bayou Pierre at Shreveport, Louisiana. All work has been suspended because local interests have not agreed to provide the required local cooperation.

Cypress Bayou and Waterway between Jefferson, Texas, and Shreveport, Louisiana, was authorized in 1872 and modified in 1910. The project, completed in 1914, provided for channel improvement and construction of Caddo Lake Dam for navigational use.

In the late 1930's, the SCS constructed two reservoirs in the Land Utilization project in Fannin County, Texas. These reservoirs, Coffee Mill Lake (650 acres), and Lake Crockett (450 acres), were put under the administration of the FS in 1953.

Impoundments on National Forest System Lands serve primarily for public use in recreation and fish and game management. Floodwater storage is not usually a feature of these projects. Table 49 shows the 1962 level of development. These impoundments are maintained by the FS units involved.

Table 49 - Level of Water Development on National Forest System Lands, 1962, Red River Basin Study Area

| Administrative Unit - Name | :Location :State and :County | :Drainage :Area, :Sq. miles | :Storage :Capacity :Acre-feet | :Surface :Area, :Acres | :Principal : Use |
|--------------------------------------|------------------------------|-----------------------------|-------------------------------|------------------------|------------------|
| <u>Kisatchie National Forest</u> | | | | | |
| Caney Lake | Louisiana Webster | 8.0 | 4,100 | 391 | Recreation |
| <u>Ouachita National Forest</u> | | | | | |
| Shady Lake | Arkansas Polk | 10.0 | 270 | 35 | Recreation |
| Kullifond Lake | Oklahoma McCurtain | .2 | 13 | 2 | Recreation |
| <u>Panhandle National Grasslands</u> | | | | | |
| Coffee Mill Lake | Texas Fannin | 39.32 | 8,000 | 650 | Recreation |
| Lake Crockett | Fannin | 10.92 | 3,800 | 450 | Recreation |
| Fannin Lake | Fannin | .60 | 344 | 50 | Recreation |

State, Municipal, and Private Water Projects

Surface water has long been recognized as a valuable source of water supply and water-based recreation. By 1962, four municipalities and one industrial firm had developed and were using approximately 309,700 acre-feet of water from surface reservoir storage.

Oklahoma City, Oklahoma, constructed Lake Atoka in Atoka County, Oklahoma, to supplement municipal water supplies. The water is delivered to the city through 125 miles of pipeline. The City of Paris, Texas, constructed Lake Crook for municipal water storage. Sibley Lake was constructed by Natchitoches, Louisiana, to supplement ground water supplies that were inadequate to serve municipal expansion in recent years. Cross Lake was constructed by the City of Shreveport, Louisiana, to replace Red River as a source of municipal water. Industrial water requirements prompted the International Paper Company to construct Lake Erling on Bayou Bodcau in southern Arkansas. Although recreation was not a primary purpose in many of these reservoirs, facilities have been added for swimming, boating, and camping. Facilities for fishing, skiing, and other water sports generally are provided. Figure 11 shows the location of these reservoirs.

Black-Clear Lake, Saline Lake, Lake Bistineau, Bayou Pierre, Kepler, Iatt, and Black Bayou Lakes were developed by the Louisiana Department of Public Works for recreation use. Approximately 84 square miles of water surface are available on these lakes. The primary purpose for construction of these reservoirs was for fishing and hunting; however, other facilities such as boating, camping, and swimming have been added in some areas. Lake Bistineau State Park is one of the areas that provides facilities for most water-based recreational uses.

These projects include 650,650 acre-feet of storage. Table 50 summarizes pertinent reservoir data and purposes.

Table 50 - Existing State, Municipal, and Private Reservoirs, December 31, 1962, Red River Basin Study Area

| Reservoir | State | Storage Volume | Surface Area | Purpose ^{1/} |
|------------------|-------|-------------------|-----------------|-----------------------|
| | | acre-feet | square miles | |
| Cross Lake | La. | 76,700 | 14.0 | M |
| Sibley Lake | La. | 19,500 | 3.4 | M |
| Lake Erling | La. | 77,000 | 10.9 | I |
| Black-Clear Lake | La. | 109,000 | 21.6 | R |
| Saline Lake | La. | 52,000 | 13.0 | R |
| Lake Bistineau | La. | 120,400 | 26.9 | R |
| Bayou Pierre | La. | 11,500 | 4.6 | R |
| Kepler Lake | La. | 16,800 | 3.0 | R |
| Iatt Lake | La. | 13,500 | 8.4 | R |
| Black Bayou Lake | La. | 17,750 | 6.2 | R |
| Atoka Lake | Okla. | 125,000 | 9.2 | M |
| Lake Crook | Texas | 11,500 | 2.0 | M |
| Total | -- | 650,650 | 123.2 | - |

^{1/} Abbreviations: M--municipal water supply; I--industrial water supply; R--recreational uses

FUTURE DEVELOPMENT NEEDS

Area Redevelopment

Overall Economic Development Programs have been developed for counties or parishes in each of the four states included in the Study Area. The primary purpose of the programs for various counties was to analyze economic conditions, especially in the rural sector, and to devise ways to help meet the needs of the areas. The following counties are eligible for assistance under the Area Redevelopment Act: Columbia, Hempstead, Lafayette, Little River, Nevada, Polk, and Sevier Counties in Arkansas; Avoyelles, Catahoula, Evangeline, Natchitoches, Red River, Sabine, and Vernon Parishes in Louisiana; Atoka, Choctaw, Coal, Hughes, Latimer, LeFlore, McCurtain, Pittsburg, Pontotoc, and Pushmataha Counties in Oklahoma; and Delta, Fannin, Marion, and Red River Counties in Texas.

The primary objective of the Economic Development Program is to insure employment opportunities, sustain purchasing power, and maintain an adequate tax structure in an area. To attract new industries into an area, adequate water is required to supply municipal and industrial needs. Sources of credit for adequate financing of new developments are needed. In order to maintain the rural population, income levels, and

economic standards of living must be improved. Resources must be used more nearly to their full potential in order to achieve these goals.

Crop and Pasture Land Resources

Projections of future requirements were made without consideration of productive capacity, but rather the production which must be achieved for the Study Area to maintain its relative position in the Nation's agriculture (exhibits 29 and 30). This assumed the projected share of National requirements and represents an allocation of production requirements among all areas of the United States. It also assumed that there will be no further acceleration in the rate of resource development.

This allocation provides a benchmark to which the productive capacity of the Study Area can be compared. If the productive capacity required to produce this volume exists, then it indicates the probable future level of production. It is assumed that the future competitive position of the Study Area will be relatively the same as at the present.

A summary of feed units required for feed crop requirements and projected production without project development is shown in Table 51. Although a surplus existed in the base year, deficits of 1,661 and 17,002 million feed units are projected for 1980 and 2010, respectively.

Table 51 - Feed Units Required and Feed Units Produced Without Project Development, 1962, 1980, and 2010, Red River Basin Study Area

| Item | : 1962 | : 1980 | : 2010 |
|--|------------------------------|----------|-----------|
| | - - million feed units - - - | | |
| Feed units required to produce Study Area livestock products | 8,121.6 | 15,494.6 | 32,166.0 |
| Total feed units produced without project development | 11,722.0 | 13,833.6 | 15,163.3 |
| Balance | +3,600.4 | -1,661.0 | -17,002.7 |

Adjustments of Crop and Pasture Land Utilization

Production requirements for feed-crops, including range and pasture, were expressed as a composite, measured in terms of feed units. The projected feed units that could be produced without further acceleration of the rate of resource development were compared with the projected requirements. Nonfeed crops projected requirements were expressed as an allocation of National requirements among all areas of the United States.

The maximum productive capacity of the Study Area has not been measured. Conversion of land to a more intensive use, drainage, flood

control, and irrigation are all means of increasing production from land and water resources. Resource development may be accomplished by project-type action or by individuals. Production increases may also occur as a primary effect from flood control projects.

Three alternative ways to achieve feed-unit requirements are: (1) additional feed-crop production without project development, (2) additional feed-grain production without project development, and (3) additional feed-grain production with project development.

Additional Feed-crop Production Without Project Development

In 1980 and 2010, projected feed-unit production based on historical data falls short of the projected needs. Historical data reflect internal shifts between all feed crops, and these changes are likewise reflected in the extension of trends to 1980 and 2010.

Historical distribution of feed units would suggest that the 1980 deficit of about 1.7 billion feed units be allocated among the three major feed-crop components according to their share of total production (table 52). Therefore, in 1980, 2.5 percent of the deficit would be allocated to feed-grain crops, 6.0 percent to hay crops, and 91.5 percent to grazing and pasture. Deficits for 2010 would be handled in the same manner. The allocated feed units for each major feed-crop component is divided by its weighted feed unit per acre to determine the acreage requirement.

Table 52 - Percentage Distribution and Feed Units Per Acre by Three Major Feed Components, Without Accelerated Development, 1962, 1980, and 2010, Red River Basin Study Area

| | 1962 | | 1980 | | 2010 | |
|---------------------|--------------------|----------------------------|--------------------|----------------------------|--------------------|----------------------------|
| | :Percent :distrib- | :Weighted :units :per acre | :Percent :distrib- | :Weighted :units :per acre | :Percent :distrib- | :Weighted :units :per acre |
| Feed grains | 3.3 | 1,472 | 2.5 | 1,781 | 2.6 | 2,037 |
| Hay crops | 4.3 | 1,196 | 6.0 | 1,422 | 9.6 | 2,271 |
| Grazing and pasture | 92.4 | 951 | 91.5 | 1,105 | 87.8 | 1,180 |
| Total | 100.0 | 971 | 100.0 | 1,131 | 100.0 | 1,252 |

Following this procedure, an additional 1,469,000 acres must be converted to feed-crop production in 1980. By 2010, over 12,651,000 acres will be required to meet the Study Area's requirements of the National production of feed crops.

Additional Feed Grain Production Without Project Development

The projected feed units per acre for feed grains in 1980 and 2010 are 1,781 units and 2,037 units, respectively. A balance between projected production without project development and the Study Area's requirements may be achieved wholly by feed grains. Approximately 933,000 acres of additional land would need to be converted to feed grain production by 1980 to meet requirements, and an additional 8,347,000 acres in 2010. Since feed grains have greater capacity for feed unit production per acre, this alternative method is also suggested.

Additional Feed Grain Production With Project Development

Assuming drainage and flood control improvement projects in place by 1980 and 2010, another alternative is presented to meet a balance between land conversion and feed unit requirements. With project development in place, increased yields, and high levels of management, additional output will be realized in feed grains alone. For example, it is estimated that under these conditions, feed units per acre will increase from 1,781 units to about 2,400 units in 1980. Therefore, an additional 366,400 acres of feed grains would be required in 1980 to meet the feed unit deficit, and over 6.5 million acres in 2010.

Forest Land Resources

There was a net increase in commercial forest land of the Study Area between 1952 and 1962, but the rate of increase declined during the latter part of the decade. The principal areas of accretion were on the uplands with some increase along the floodplain areas of the smaller streams. Attrition by reservoir and highway construction and increased urbanization has blunted the trends toward increasing forest acreage on the uplands, but no rapid decrease in forest acreage can be foreseen. Apparently the acreage available for development of the forest resource will remain largely intact through 2010.

Since 1962, forest acreage along the major floodplain has sharply decreased. The future availability of any considerable acreage of forest land along the main stream and larger tributaries is questionable at present (1967).

Analysis of forest cover conditions for 1962 showed that the Study Area was producing only 40-50 percent of its potential due to inadequate stocking and competition from worthless vegetation.

The 1962 condition of forest soils on much of the Study Area is less than that desirable for good soil and water management. Improvements in fire protection are needed. Some 875,400 acres of forest land now unprotected should be placed under organized fire protection. Grazing control is needed on seven percent of the commercial forest land area. Approximately nine percent of the commercial forest area needs interplanting to improve stocking and some 26 percent of the forest stands need thinning to improve stand vigor and composition.

An estimated additional growth of 110 to 135 million cubic feet per year will be required to meet the manufacturing capacity of forest industry in and near the Study Area by the year 2010, above that which can be expected with the present level of management. With the 1962 level of management, cut is expected to exceed growth near the year 1990. To forestall undue losses in established inventory and growth potential that would begin to occur around 1990, additional new inventory would have to be built up prior to that time. This new production potential should begin to make some contribution in available wood supplies by 1985 to 1990. The maximum production should be required during the 2000 to 2010 period.

The area of private (nonforest industry) forest lands, with average volume of growing stock, were as follows:

| | Volume of Growing Stock, Cubic Feet/Acre | Total Forest Land 1,000 Acres |
|-----------------|---|----------------------------------|
| Farm ownership | 405 | 2,015.4 |
| Other ownership | 495 | 5,137.8 |

The average annual growth of desirable merchantable material is less than 1/2 cord, or 200 board feet, per acre. The annual growth on most of these lands could be increased two to four times with reasonably good management.

Sustained yield management, comparable to that now employed by well-established forest industry, on about 2,250,000 acres of the most productive private forest lands would meet the expected shortages for the Study Area.

There is a looming National and Regional shortage in hardwood face veneer logs and high-quality hardwood sawlogs for factory use. Projections from 1962 data, as used in this report, do not fully illustrate the supply problem that is developing in the Study Area. The lack of well-managed hardwood acres, coupled with the accelerated clearing since 1962 of the most productive remaining sites, is resulting in unexpected supply problems for manufacturers in or near the Study Area.

If this future hardwood supply shortage is to be alleviated, high-level sustained yield management will be required on all remaining bottomland hardwood areas, and all suitable upland sites must be managed for quality hardwood production.

Water Resources

Municipal and Industrial Water Supply Needs

Water supply problems, as projected through the time periods 1980, 2000, 2030, and 2080, will be ever increasing. Table 53 summarizes the municipal and industrial needs for these periods by states. From the

1980 needs of 200 mgd, requirements will practically double in each succeeding period.

Table 53 - Municipal and Industrial Water Supply Needs ^{1/}, Red River Basin Study Area

| State | 1980 | 2000 | 2030 | 2080 |
|---|--------------|--------------|--------------|----------------|
| - - - - million gallons per day - - - - | | | | |
| Oklahoma | 1.1 | 3.7 | 13.5 | 155.5 |
| Arkansas | 14.3 | 21.0 | 41.9 | 120.6 |
| Texas | 60.3 | 91.9 | 157.3 | 334.7 |
| Louisiana | 124.3 | 263.1 | 364.3 | 804.6 |
| Total | 200.0 | 379.7 | 577.0 | 1,415.4 |

Source: FWPCA data

^{1/} Net requirements

Municipal expansion, resulting from population increases, will be the major factor contributing to these increases in water supply needs.

Water Quality Control Needs

As determined by FWPCA, stream pollution will increase with continued population and industrial growth. Detailed water quality control requirements to the year 2080 will be presented in Appendix XI.

Rural Household and Livestock Water Requirements

Rural households and livestock water requirements were projected for the economic evaluation period (1962 to 2010), and are summarized in Table 54. These projections are based on average daily water consumption per person, or per animal unit. Data for the 2080 time frame were computed following the assumption that water use ratios for rural households and livestock will remain constant after 2020.

Table 54 - Total Annual Water Requirements for Rural Households and Livestock Uses, 1962. Projected 1980, 2010, 2020, 2080, Red River Basin Study Area ^{1/}

| Year | Annual rural household water requirements ^{2/} | Annual livestock water requirements | Total annual water requirements |
|---------------------------------|---|-------------------------------------|---------------------------------|
| - - - - million gallons - - - - | | | |
| 1962 | 22,776 | 12,432 | 35,208 |
| 1980 | 31,288 | 16,321 | 47,609 |
| 2010 | 37,254 | 23,044 | 60,298 |
| 2020 | 38,506 | 25,308 | 63,814 |
| 2080 | 38,506 | 25,308 | 63,814 |

^{1/} Whole counties are represented in the four Basin States of Arkansas, Louisiana, Oklahoma, and Texas

^{2/} Annual household water requirements include rural farm and rural nonfarm households

Rural farm and rural nonfarm household water requirements are shown in Exhibit 31. Estimates were derived by multiplying the projected rural population by the average daily water consumption per person by 365 days to determine annual requirements. This resulted in a declining total annual demand for domestic water by rural farm families, and an increasing total annual demand for domestic water by rural nonfarm families. Demand is estimated to be about 31.3 billion gallons annually in 1980, and 37.3 billion gallons by the year 2010.

Livestock water requirements are projected to increase to more than 23 billion gallons on basin farms by 2010 (exhibit 32). This amount is about twice the present livestock water requirements.

Cattle and calves required over 11.5 million gallons of water in 1962. This amount represents 93 percent of the total livestock water requirements. This figure does not change significantly in its relationship to total water requirements. However, the increasing production of broilers will require a larger share of water requirements, while hogs and pigs decline in numbers and water consumption. Annual livestock water requirements represent 35 percent of the total in 1962, 34 percent in 1980, and 38 percent by 2010.

Recreation Resources

Total outdoor recreation demands were estimated for 1960, 1980, and 2020. Existing public and private outdoor recreation opportunities were inventoried.

This study includes an inventory of recreation opportunities enhanced by water which appears to be physically feasible in potential upstream watershed projects. Also, consideration is given to the active recreational use of developed resources as supplied by BOR.

The study evaluates the present types of water oriented recreation activities and the present demand and supply. Unsatisfied demand and the needs for land, water, and facilities to accommodate these anticipated demands were estimated. Activities have been grouped by subareas that indicate a general geographical distribution of these water-enhanced activities.

Demand

The total annual demand for outdoor recreation in the Study Area is increasing at a faster rate than population. Population is estimated to increase 94 percent between 1960 and 2020, while total annual demand for recreation is estimated to increase over 725 percent. Table 55 summarizes the existing and projected population and total annual recreation demand.

Recreation demand is defined "as the types and quantity of outdoor recreational activities that people desire. True demand is assumed to be that which people will accept in view of their expressed desires and wants". Closely correlated with recreation demand is per capita personal

income and activity occasions per capita. BOR criteria conclude that, for most activities, a person's rate of participation in outdoor recreation is proportional to his income. However, this is not to imply alternative criteria do not exist in recreation planning.

Table 55 - Existing and Projected Resident Population and Total Annual Recreation Demand, 1960, 1980, and 2010, Red River Basin Study Area

| Year | : Resident population : in drainage area <u>1/</u> | : Total annual : demand <u>2/</u> |
|---------------------|---|--------------------------------------|
| | number | activity occasions |
| 1960 | 1,670,048 | 25,043,500 |
| 1980 | 2,187,000 | 54,127,200 |
| 2020 | 3,235,800 | 207,535,000 |
| Projected increase: | | |
| 1960-1980: | | |
| Net | 516,952 | 29,083,700 |
| Percent | 31 | 116 |
| 1980-2020: | | |
| Net | 1,048,800 | 153,407,800 |
| Percent | 48 | 283 |
| 1960-2020: | | |
| Net | 1,565,752 | 182,491,500 |
| Percent | 94 | 727 |

1/ Whole county population data are presented

2/ See Table 57

The approach followed by BOR in computing demand is an acceptable method. Their demand function or input-output relationship denotes consistent or linear returns in activity occasions based on income per capita and participation in the Census South Region. The participation function (exhibit 33) reflects a constant increase in relation to population, income per capita, and recreation participation activity. These are based on 1960 data. Data developed by BOR for 1965 show only minor changes in participation rates.

Existing and projected population and per capita personal income for the four ERS subareas are presented in Table 56. Per capita personal income data for 1960 were obtained from a USDC publication. The per capita personal income for each subarea are weighted averages based on population and county income. Projected per capita personal income was obtained from BOR's "Interim Report", and population projected data were obtained from the USAE. These projected personal income data were derived by projecting historical trends into the future and adjusting to 1960 dollars. Exhibit 34 presents the counties in each subarea with population and per capita personal income for 1960.

Table 56 - Population and Per Capita Personal Income, by Subareas, 1960, 1980, and 2020, Red River Basin Study Area

| Subareas: | Population | | | Per capita personal income 1/ | | |
|-----------|--------------------|-----------|-----------|-------------------------------|-------|-------|
| | 1960 | 1980 | 2020 | 1960 | 1980 | 2020 |
| | - - - number - - - | | | - - dollars - - - | | |
| 1 | 152,519 | 172,700 | 221,500 | 1,141 | 1,932 | 5,195 |
| 2 | 133,670 | 162,600 | 244,700 | 905 | 1,532 | 4,117 |
| 3 | 341,888 | 438,500 | 725,300 | 1,360 | 2,122 | 5,413 |
| 4 | 1,041,971 | 1,413,200 | 2,044,300 | 1,232 | 2,026 | 5,232 |
| Basin | | | | | | |
| Total | 1,670,048 | 2,187,000 | 3,235,800 | 1,224 | 2,001 | 5,185 |

1/ 1960 dollars

Recreation facilities are subject to seasonal and daily variations in demand. Outdoor activities maintain a level during the winter hunting season and spring. The peak season starts with the close of schools, reaches its high through the summer, and drops off again in September. Table 57 presents a summary of the peak-day, or average Summer Sunday demand 1/. Also, this table shows the total annual demands for 1960, 1980, and 2020. A refinement of these data by subarea is presented in Exhibit 33.

Table 57 - Recreation Demand: Summary of Existing and Projected Total Annual, Summer and Average Sunday Demand in Activity Occasions, Red River Basin Study Area, 1960, 1980, and 2020

| Activity or Activity Group | Average Summer Sunday | | | Total Summer (1,000) | | | Total Annual (1,000) | | |
|---------------------------------|-------------------------------|---------|-----------|----------------------|----------|----------|----------------------|----------|-----------|
| | 1960 | 1980 | 2020 | 1960 | 1980 | 2020 | 1960 | 1980 | 2020 |
| | - - - activity occasion - - - | | | | | | | | |
| Canoeing | 2,220 | 4,844 | 18,500 | 68.8 | 148.8 | 570.5 | 113.4 | 245.0 | 939.7 |
| Boating, Sailing, & Waterskiing | 42,930 | 92,810 | 355,740 | 1,395.2 | 3,015.3 | 11,561.3 | 2,768.0 | 5,982.5 | 22,938.2 |
| Swimming | 138,500 | 299,330 | 1,147,740 | 4,503.3 | 9,733.0 | 37,318.5 | 6,285.1 | 13,584.4 | 52,085.3 |
| Subtotal | 183,650 | 396,984 | 1,521,980 | 5,967.3 | 12,897.1 | 49,450.3 | 9,166.5 | 19,811.9 | 75,963.2 |
| Camping | 23,280 | 50,290 | 192,930 | 431.4 | 932.2 | 3,189.4 | 897.1 | 1,938.8 | 7,433.5 |
| Picnicking | 44,760 | 98,870 | 379,220 | 1,486.3 | 3,212.2 | 12,316.4 | 3,142.6 | 6,792.1 | 26,042.6 |
| Subtotal | 68,040 | 149,160 | 572,150 | 1,917.7 | 4,144.4 | 15,505.8 | 4,039.7 | 8,730.9 | 33,476.1 |
| Playing Games | 10,330 | 22,320 | 85,610 | 334.1 | 722.1 | 2,768.7 | 1,459.9 | 3,155.4 | 12,098.4 |
| Fishing (Incidental) | 15,390 | 33,220 | 127,490 | 498.1 | 1,076.6 | 4,127.9 | 1,200.8 | 2,595.2 | 9,950.5 |
| Sightseeing | 55,880 | 120,780 | 463,160 | 1,814.3 | 3,921.3 | 15,034.7 | 5,772.8 | 12,477.0 | 47,839.7 |
| Hiking | 5,860 | 12,720 | 48,600 | 192.4 | 415.8 | 1,594.1 | 396.8 | 857.8 | 3,285.7 |
| Nature Walks | 19,240 | 41,810 | 159,380 | 623.7 | 1,347.9 | 5,168.2 | 3,007.0 | 6,499.0 | 24,918.2 |
| Subtotal | 106,700 | 230,650 | 884,240 | 3,462.6 | 7,483.7 | 28,693.8 | 11,837.3 | 25,584.4 | 98,095.7 |
| Total | 358,390 | 776,794 | 2,978,370 | 11,347.6 | 24,525.2 | 93,849.7 | 25,063.5 | 54,127.2 | 207,535.0 |

Supply

Supply, as it relates to recreation, is the inventory of existing facilities which are available to satisfy demand. The known water-oriented public supply in the Study Area was inventoried by the BOR.

1/ Peak-day, as it is referred to, means the average Summer Sunday. This is the day when the greatest demand, outside of peak holiday use (July 4 or Labor Day), is put upon the facilities

This inventory points up that the present supply of outdoor recreation land and water facilities is poorly developed, particularly the latter. The proposed reservoir construction and bank stabilization programs by USDA and other action agencies will greatly increase the water-dependent recreation supply.

In 1960, P. L. 566 projects did not supply or provide for any appreciable recreation facilities for the general public. However, State and locally constructed water-oriented facilities are widely used because of the variety of recreation they provide. In addition to fishing, many other activities, such as swimming, boating, and waterskiing are also important. Recreation facilities are not necessarily limited to water sports but may include hunting, picnicking, camping, children's playground activities, and competitive sports.

Man-day fishing allocations to the proposed multiple-purpose USDA reservoirs were computed by the BSF&W in Atlanta (exhibit 35) ^{1/}. The data depict weighted averages depending on fishing needs for the individual states along the Red River. These allocations may change as planning by other agencies progresses and other impoundments are considered.

The recreation facilities' supply is translated to an annual supply of recreation-days. This provided a means to obtain "total recreation days" by adding the supply of recreation facilities using BOR's criteria and fishing supply developed by BSF&W.

Unsatisfied Demand and Needs

Future outdoor recreation facilities should reflect the needs of the Study Area's population and ability of the Federal, State, County, and local officials and citizens to recognize and provide for the needs. Recreation facilities in 1980 and 2020 will include the present facilities, expansion and development of these facilities during the ensuing years, and the acquisition and development of these facilities resulting from planning.

Future needs are based upon increases in both population and per capita personal income. Leisure time resulting from a shorter work week, an increase in the days of paid vacation per worker, and earlier retirement are also complementary forces.

Table 58 sets forth the criteria used to determine the unit need for recreation facilities. Studies by BOR and others in the growing field of recreation planning have determined the type of facilities needed. These needs may change with changes in the interests of people such as the increase in skin-diving and related forms of water recreation. However, to provide sufficient outdoor recreation areas at this time would not appear to be in error. Rather, it would appear preferable to have

¹ A "man-day" and "recreation-day" are assumed to be the same measurement, or a visit by one individual for recreation or fishing purposes during any portion or all of a 24-hour day.

too much rather than to fall short, since land areas available for recreation may continue to diminish.

Table 58 - Tentative Use Standards for Selected Outdoor Recreation Activities ^{1/}

Camping:

Prepared site camping, 3 five-person sites per acre

Wilderness camping, 1 camp site per acre

Picnicking:

Prepared site picnicking, 7 five-person tables per acre with a turnover of two per table. One acre will accommodate 70 persons per day.

Wilderness picnicking, 2 five-person tables per acre with a turnover of two per table.

Boating:

6 acres of water surface per boat and 3 persons per boat with a turnover of 2

1 boat ramp per 40 boats

Swimming:

1 acre of beach and water for each 200 swimmers with a turnover of three per day. (Ratio of 2/3 acre of beach, 1/3 acre of water)

Hiking:

One-eighth mile of trail per hiker

23 acres per mile of trail

Waterskiing:

15 acres of water area per towing boat

Fishing:

10 linear feet of shore per person

Historical sites:

200 square feet per person

Nature study:

10 acres per person

Pleasure driving:

0.25 miles of scenic roadway per car

^{1/} U. S. Department of Interior, "Interim Report on the Demand, Supply and Needs, Red River Basin." Bureau of Outdoor Recreation, Atlanta, February 1, 1967; and Florida Board of Conservation, "Florida Land and Water Resources, Southwest Florida, 1963, 1980, and 2015". Division of Water Resources, Tallahassee, 1966.

Table 59 presents a summary of demand, supply, and unsatisfied demand for selected water-oriented recreation activities to meet total peak-day demand in 1960, 1980, and 2020. Unsatisfied demand was translated into needs expressed in types of facilities. These data represent the total need for a resident population indicated in Table 57.

Data in Table 59 substantiate the need for recreation facilities, especially when needs are expressed in activity occasions and then reduced to needed facilities. However, projected needs do not consider

substitute activities, nor do these preliminary data represent a real, or net unsatisfied demand.

Table 59 - Existing and Projected "Average Summer Sunday" Demand and Needs for Water-Orientated Recreation Facilities, with Needs Expressed in Facilities, Red River Basin Study Area

| Supply and demand by time period | Boating | Swimming | Camping | Picnicking |
|----------------------------------|--------------------------------|-------------|--------------|---------------|
| | - - - activity occasions - - - | | | |
| 1960 | | | | |
| Average Summer Sunday demand | 42,930 | 138,500 | 23,280 | 45,760 |
| Supply: | | | | |
| Public & private | 64,850 | 15,782 | 10,064 | 34,062 |
| SCS 1/ | - | - | - | - |
| Unsatisfied demand | +21,920 | 122,718 | 13,216 | 11,698 |
| Needs expressed in facilities | - | 205 acres | 2,643 units | 1,170 tables |
| 1980 | | | | |
| Average Summer Sunday demand | 92,810 | 299,330 | 50,290 | 98,870 |
| Supply: | | | | |
| Public & private 2/ | 64,850 | 23,846 | 18,713 | 51,423 |
| 1980 SCS | 3,797 | 25,080 | 2,231 | 17,925 |
| Unsatisfied demand | 24,163 | 250,404 | 29,346 | 29,522 |
| Needs expressed in facilities | 48,326 acres | 418 acres | 5,868 units | 2,952 tables |
| 2020 | | | | |
| Average Summer Sunday demand | 355,740 | 1,147,740 | 192,930 | 379,220 |
| Supply: | | | | |
| Public & private 2/ | 64,850 | 23,846 | 18,713 | 51,423 |
| 2020 SCS | 3,918 | 78,360 | 7,635 | 45,990 |
| Unsatisfied demand | 286,972 | 1,045,534 | 166,582 | 281,807 |
| Needs expressed in facilities | 573,944 acres | 1,743 acres | 33,316 units | 28,181 tables |

1/ No Soil Conservation Service projects prior to December 31, 1962 with recreation facilities.

2/ Projected data for 1980 and 2020 are an enlargement of existing facilities that were reported on December 31, 1962 (Table 66). These data do not include SCS facilities.

NOTE: Projected 1980 and 2020 public supply data were not available at the time this report was prepared. Public supply is delineated by Federal, State, and local agency, including SCS projects in Appendix XII (Outdoor Recreation).

The projected supply to 1970 was computed by BOR from a nationwide inventory of programmed supply. The 1970 public supply represents an enlargement of existing facilities that were reported on December 31, 1962, or the supply that has been definitely programmed. The SCS supply for 1980 and 2020 represents the capacity that the proposed multi-purpose projects can provide. Therefore, unsatisfied demand as shown in Table 59 does not include project proposals being planned by Federal, State, or local agencies other than the SCS. However, based on available data, there will be a shortage of supply facilities in the Study Area for 1980 and 2020 for these selected activities.

By 1980, 48,300 surface acres of water will be necessary to meet the demand for boating; 418 acres of beach and water area for swimming; over 5,800 units of camp sites; and approximately 3,000 additional picnic tables.

Projected needs to 2020 point up a vast shortage of supply facilities in the Study Area for boating, or an additional 573,944 surface acres of water. Swimming needs will require approximately 1,750 acres of beach and water; camping and picnicking will need 33,320 units and 28,200

tables, respectively. A delineation of these data for the four subareas is presented in Exhibit 36.

Multi-use

The land and water areas cited as needed in Table 59 are the areas to take care of a particular type of recreation. Much of the land and water area required can be used to satisfy several needs either concurrently or at different seasons of the year. Thus, camping and picnicking areas may serve the same need. Fall and winter hunting areas specified by the BSF&W may serve as summer nature, hiking, and camping areas. As yet, recreation resource planners have not developed sufficiently refined techniques to say how much of an area can serve dual purposes. This depends upon the nature of the particular area.

Multi-purpose is a term used frequently where water resource areas are concerned. Its connotation in these instances is the multiple use of a water area for other than recreation. Considering the use of water areas for just recreation, there are some compatible uses. For example, there can be fishing and esthetic enjoyment together with some types of boating, but not necessarily waterskiing and fishing in the same immediate area.

With regard to other uses, water areas may serve several needs; e.g., municipal water use, flood control, and electric power generation. It may not be possible for each multi-use project to be operated at maximum capacity and still allow the project to be used for the greatest number of purposes. The shortage of available water areas makes this a manifest necessity.

POTENTIAL FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

WATER RESOURCES DEVELOPMENT POTENTIAL

Physical Potential

The topography of the Study Area is well-suited for reservoir impoundments. Occasionally, ample storage was not available in tentative site locations in the Texas Blackland Prairie LRA. Practically unlimited possibilities exist in other land resource areas. Optimum storage development for reservoirs was considered to be about twice the average annual runoff above the site, or physical or cultural limitations of the individual site.

In the upper part of the Study Area in Bryan County, Oklahoma, the average annual runoff is about eight inches. Required flood detention storage is about 5.6 inches and required sediment storage is about 1.5 inches. This leaves approximately the average annual runoff available for other uses.

In the lower part of the Study Area in Rapides Parish, Louisiana, the average annual runoff is about 15 inches. Required flood detention storage is about 8.4 inches and required sediment storage is about 0.6 of an inch. This leaves about 1-1/2 times the annual runoff available for other uses.

Additional ground water development may be undertaken anywhere in the Study Area. The aquifers that underlie the Southern Coastal Plain LRA can provide the largest yields. The combined aquifers can provide an estimated 800 m.g.d. yield of fresh water which is substantially more than is presently used. Of course, optimum withdrawals would depend upon the proper distribution and pumpage from wells throughout the aquifer. Large areas of unexplored or underdeveloped ground water are available to meet future needs.

Channel improvement and associated reservoirs can contribute greatly to flood prevention in upstream watersheds. Channel improvement for drainage in flatlands can contribute greatly to drainage needs. The need for levees is confined largely to Red River alluvial land or along major tributary streams. In some areas, levees or floodwalls in combination with channel improvement will be needed for urban area flood protection.

The potential for supplemental irrigation development is distributed throughout the four states. More than half the total potential is in Louisiana. Only 40 percent of the total potential could be project-type development, which is confined to the alluvial land along Red River. Only 18 percent of the project-type development can be irrigated safely with present quality Red River water. Individual-type development, which represents about 60 percent of the potential, can be done safely with ground water or small surface impoundments.

The potential for recreation and fish and wildlife development involves more than an appraisal of natural resources alone. The potential

depends upon a combination of physical, social, economic, and other factors. Studies point up a vast shortage of recreational facilities in almost every category. The physical potential to meet these shortages will not be a limiting factor in meeting these needs.

Projects Needed for Initial Development

The land and water resource programs urgently needed by 1980 consist of land treatment measures, multiple-purpose watershed projects, and single-purpose reservoir development. These programs are recommended for early action and the data for these programs are summarized in a later section of this Appendix.

Land treatment practices will be applied through the going Public Law 46 program and the Public Law 566 program. Emphasis will be placed on practices that reduce erosion, improve tilth, and contribute to increased farming efficiency.

Fifty multiple-purpose watershed projects in 52 CNI watersheds are feasible and needed to alleviate watershed problems and meet estimated needs. Thirteen of these projects in 14 CNI watersheds have been approved for operations since 1962. The projects would provide measures to reduce damage from erosion, sediment, and flooding, to improve drainage, and to provide water for municipal, industrial, recreation, water quality control, and irrigation purposes. Watershed locations are shown in Figure 13.

Single-purpose reservoirs to meet estimated shortages are needed on National Forest System Lands and on private lands. Seven recreational reservoirs are needed in the Ouachita National Forest in Arkansas and Oklahoma. Nine additional reservoirs on private lands are needed; four for municipal and industrial purposes and five for recreational purposes. Reservoir locations are shown in Figure 14.

Multiple-Purpose Projects for Long-Range Development (to 2080)

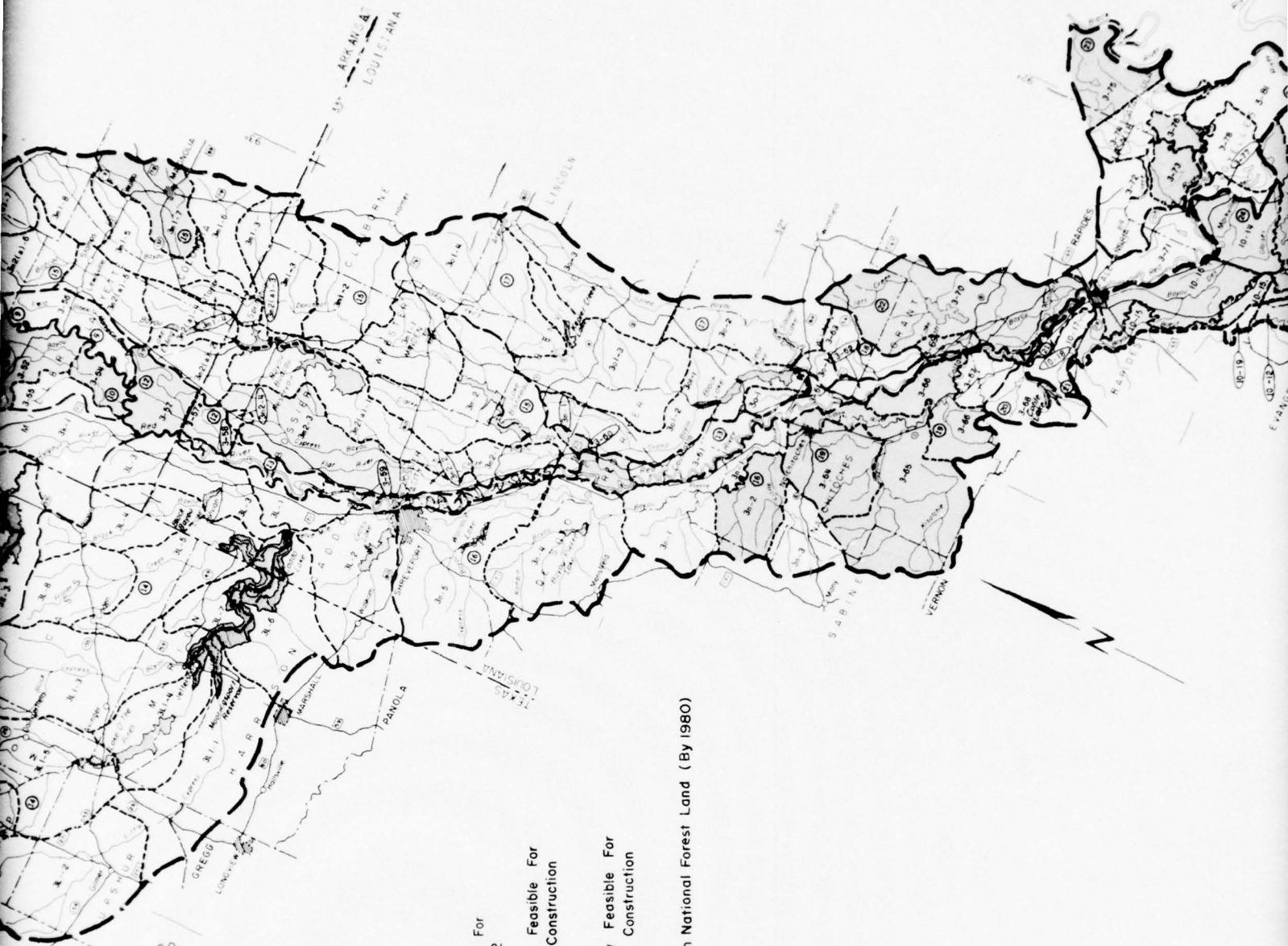
CNI Watersheds 3-22 and 3-26 in the Intervening Areas, Oklahoma, 3j-2 in Little River Tributary Basin, Arkansas, 3-30 in the Intervening Areas, Texas, 3k-15 in the Sulphur River Tributary Basin, Texas, and 3-57a in Posten Bayou Tributary Basin, Louisiana, are considered potentially feasible for project development after 10-15 years. An aggregate area of approximately 805 square miles is included in these potential projects. Project locations are shown in Figure 13.

Flooding, erosion, and sedimentation are occurring in these watersheds; however, damages attributable to these sources are relatively low in comparison to areas of more intensive use. Needs for agricultural and nonagricultural water management are apparent and are expected to increase.

Generally, local interest in these areas is insufficient for project development, but it is expected to increase as watershed conditions change and greater needs develop. Pertinent structural data are summarized in Table 60. Benefits would exceed costs of structural works of improvement.



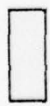











21



VICINITY MAP

LEGEND

-  Watershed Improvements Approved For Operations After December 31, 1962
 -  Watersheds Considered Potentially Feasible For Development And Initiation Of Construction Within 10 - 15 Years
 -  Watersheds Considered Potentially Feasible For Development And Initiation Of Construction After 10 - 15 Years
 -  Water Development For Recreation On National Forest Land (By 1980)
 -  County Boundary
 -  State Boundary
 -  Existing Lakes December 31, 1962
 -  Reservoirs Authorized December 31, 1962
 -  Comprehensive Study Area Outside the River Basin Boundary
 -  Basin Boundary
 -  Tributary Basin
 -  CNI Watershed Boundaries
- TRIBUTARY BASINS
- 1 Intervening Areas - Texas
 - 2 Intervening Areas - Ark. & Okla.
 - 3 Blue River
 - 4 Boggy Creek
 - 5 Kiamichi River
 - 6 Barkman Creek
 - 7 Little River
 - 8 Bois d'Arc Creek
 - 9 Maniace Bayou
 - 10 McKinney Bayou
 - 11 Sulphur River
 - 12 Pasten Bayou
 - 13 Red River Main Stem
 - 14 Cypress Creek

3h1-2

CNI Watershed Boundaries

- 1 TRIBUTARY BASINS
- 2 Intervening Areas - Texas
- 3 Intervening Areas - Ark & Okla
- 4 Blue River
- 5 Boggy Creek
- 6 Kiamichi River
- 7 Barkman Creek
- 8 Little River
- 9 Bois d'Arc Creek
- 10 Maniece Bayou
- 11 McKinney Bayou
- 12 Sulphur River
- 13 Pasten Bayou
- 14 Red River Main Stem
- 15 Cypress Creek
- 16 Loggy Bayou
- 17 Bayou Pierre
- 18 Black and Saline Lakes
- 19 Nantachie Creek
- 20 Cane River
- 21 Bayou Jean de Jean
- 22 Bayou Rapides
- 23 Bayou Rigollette
- 24 Red River Backwater Area
- Chatlin Lake and Associated Area



Figure 13
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
 LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS
POTENTIAL DEVELOPMENT
WATER AND RELATED LAND RESOURCES

U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE



Rev. 1-68 4-R-23022
 Rev. 1-68 4-R-20039

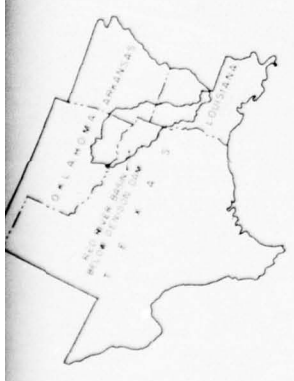
OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS.
 EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS
 USDA SCS-FORT WORTH, TEX. 1968
















21



VICINITY MAP



LEGEND

-  County Boundary
-  State Boundary
-  Existing Lakes December 31, 1962
-  Reservoirs Authorized December 31, 1962
-  Comprehensive Study Area Outside the River Basin Boundary
-  Basin Boundary
-  CMI Watershed Boundaries
-  Water Quality Dam Site Potentially Feasible Beyond 10-15 Years
-  Municipal and Industrial Dam Site Potentially Feasible Within 10-15 Years
-  Municipal and Industrial Dam Site Potentially Feasible Beyond 10-15 Years
-  Recreation Dam Sites Potentially Feasible Within 10-15 Years
-  Recreation Dam Sites Potentially Feasible Beyond 10-15 Years
-  Irrigation Dam Sites Potentially Feasible Beyond 10-15 Years

▲ Recreation Dam Sites Potentially Feasible
Beyond 10-15 Years

△ Irrigation Dam Sites Potentially Feasible
Beyond 10-15 Years

V-133

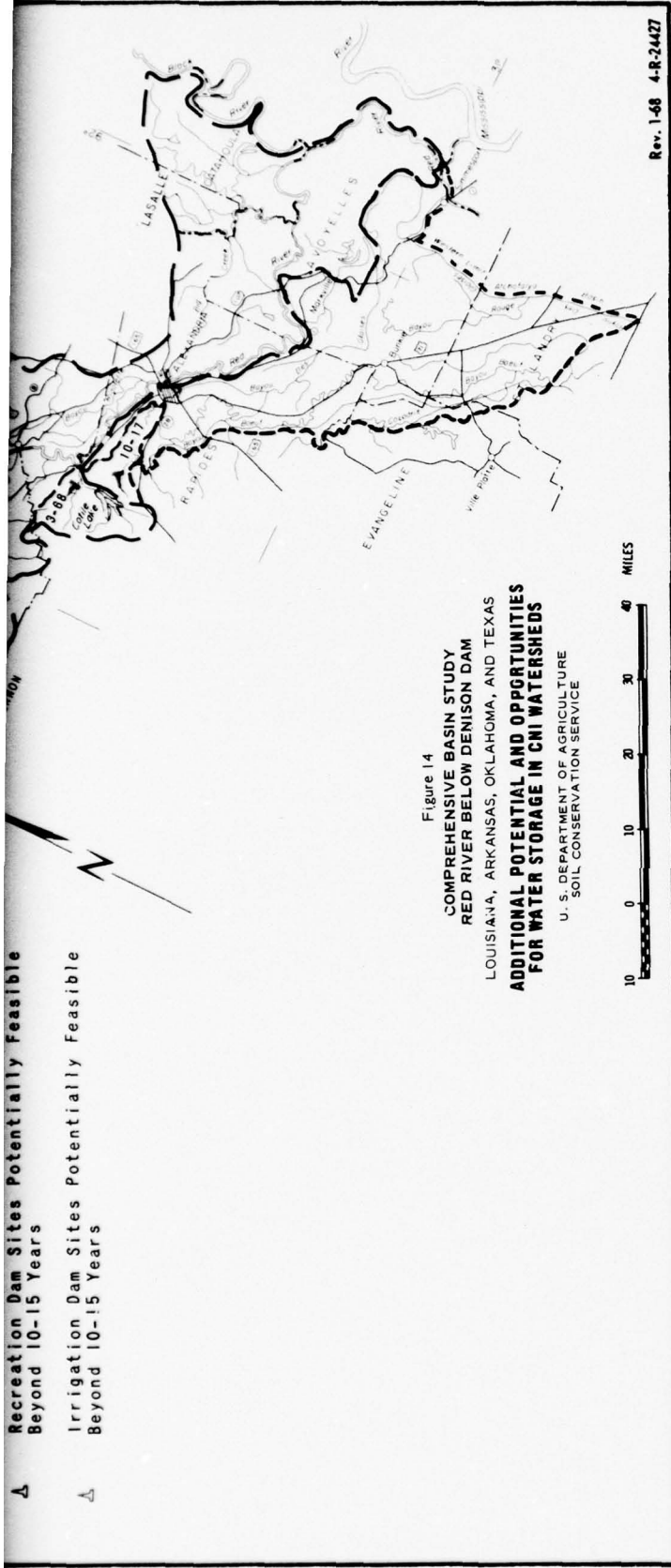


Figure 14
**COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM**
LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS
**ADDITIONAL POTENTIAL AND OPPORTUNITIES
FOR WATER STORAGE IN CBI WATERSHEDS**
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



Rev. 1-66 4-R-24427

3-64 Base 4-R-10830

OKLAHOMA PORTION COMPILED FROM USGS 1:500,000 BASE - REMAINDER FROM AMS 1:250,000 SHEETS.
EXISTING LAKES FROM ABOVE SOURCES SUPPLEMENTED WITH USGS QUADRANGLES AND COUNTY HIGHWAY MAPS
USDA-SEC FORT WORTH, TEX. 1968

Table 60 - Pertinent Structural Data - Potential Multiple-Purpose Projects for Long-Range Development, Red River Basin Study Area

| Tributary : | : Drainage : | | : Structural Measures : | | : Pool Capacity : | | | : Surface Area of |
|---|---------------|--------------|-------------------------|--------------|-------------------|--------------|-------------------------|--------------------------------|
| Basin and : | : Watershed : | : Area : | : Reservoirs : | : Channel : | : Detention : | : Sediment : | : Other ^{1/} : | : Permanent Pool ^{2/} |
| Watershed : | Area : | Controlled : | Improvement : | Reservoirs : | Detention : | Sediment : | Other ^{1/} : | Permanent Pool ^{2/} |
| | (sq.mi.) | (sq.mi.) | number | miles | (ac.ft.) | (ac.ft.) | (ac.ft.) | acres |
| Intervening Areas - Texas | | | | | | | | |
| 3-30 | 184 | 53 | 11 | 6.3 | 18,120 | 9,878 | 0 | 760 |
| Total | 184 | 53 | 11 | 6.3 | 18,120 | 9,878 | 0 | 760 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | |
| 3-22 | 334 | 74 | 7 | 0 | 22,400 | 3,360 | 0 | 265 |
| 3-26 | 113 | 34 | 5 | 0 | 11,385 | 1,855 | 0 | 220 |
| Total | 447 | 108 | 12 | 0 | 33,785 | 5,215 | 0 | 485 |
| Little River | | | | | | | | |
| 3j-2 | 116 | 0 | 0 | 8.0 | 0 | 0 | 0 | --- |
| Total | 116 | 0 | 0 | 8.0 | 0 | 0 | 0 | --- |
| Sulphur River | | | | | | | | |
| 3k-15 | 15 | 11 | 4 | - | 3,806 | 2,282 | 0 | 220 |
| Total | 15 | 11 | 4 | - | 3,806 | 2,282 | 0 | 220 |
| Posten Bayou | | | | | | | | |
| 3-57a | 43 | 4 | 1 | 16.0 | 1,948 | 249 | 276 R | 60 |
| Total | 43 | 4 | 1 | 16.0 | 1,948 | 249 | 276 | 60 |
| Grand Total | 805 | 176 | 28 | 30.3 | 57,659 | 17,624 | 276 | 1,525 |

^{1/} Abbreviations: R- Recreation

^{2/} Total surface area at principal spillway elevation

Coordination with Plans of Other Agencies

Other agencies prepared plans for water and related land resource development. The USAE and the TWDB plans include recommendations for projects to be initiated within the next 10-15 years. Projects include reservoir storage for municipal and industrial water supply, water quality control, power, irrigation, recreation, flood control, and unassigned conservation storage. Durant Reservoir was recommended for early-action development by the USAE. The USDA recommended an early-action plan for CNI Watershed 3-23 (Lower Blue River) that does not include Durant Reservoir; however, the USDA does not object to inclusion of Durant Reservoir in the long-range plan. Channel improvement projects serve flood control and drainage purposes. The USAE has submitted an interim report for the navigation project.

Projects identified by the USAE and the TWDB for long-range development are predominantly reservoir projects for flood control and conservation storage. Red River navigation from Shreveport, Louisiana, to Denison Dam and the Loggy Bayou Ring Levee also are included in the long-range development plan.

USDA potential development was based on data developed by USDA and on needs data developed by other agencies and submitted by them to the FCC. Needs for irrigation development were prepared jointly by the BR and USDA and are described in Appendix VI; needs for drainage improvements are described in Appendix VII.

Other Potential and Opportunities for Long-Range Development

Storage opportunities for water quality, municipal and industrial

water supply, recreation, and irrigation needs beyond the next 10-15 years were investigated. Two water quality reservoirs, five municipal and industrial water supply reservoirs, thirty-four recreation reservoirs, and nineteen irrigation reservoirs were identified. Locations of these reservoir sites are shown in Figure 14. The total estimated storage capacity of the reservoirs is 1,590,490 acre-feet. Of this amount, approximately 5,900 acre-feet would be for water quality, 27,130 acre-feet for municipal and industrial water storage, 436,770 acre-feet for recreation, 287,220 acre-feet for irrigation, 56,825 acre-feet for sediment accumulation, and 776,645 acre-feet would be available for additional potential storage. The total surface area of the permanent pools would be approximately 58,040 acres of which 32,870 acres would be for recreational use. Approximately 776,645 acre-feet of additional storage that would not be needed for water quality, municipal and industrial, recreation and irrigation could be developed. Reservoir storage data are shown in Table 61.

Recreation and irrigation water supply needs identified for development beyond 10-15 years exist in watersheds considered potentially feasible for initial development. Recreation facilities and storage opportunities in the vicinity of Paris, Texas, could be provided in one site in CNI Watershed 3-30 and one site in CNI Watershed 3-33. Recreation storage opportunities for Lewisville, Arkansas, could be provided in one site in CNI Watershed 3-56. One site located in CNI 3k-16 could supply recreation storage for the Cooper, Texas, area. Recreation needs in the vicinity of Commerce, Texas, could be met with one site identified in CNI Watershed 3k-17.

The Town of Lewisville, Arkansas, has municipal and industrial water supply needs for 2080 which could be satisfied in one reservoir located in CNI Watershed 3m2(a)-5. The 2030 municipal and industrial water supply needs for Bossier City, Louisiana, could be satisfied in one reservoir located in CNI Watershed 3m2(a)-2. The 2080 municipal and industrial water supply needs for the Town of Mansfield, Louisiana, could be met in one reservoir located in CNI Watershed 3n-4. The Towns of Coushatta and Montgomery, Louisiana, have 2080 municipal and industrial water supply needs that could be supplied with one reservoir in CNI Watershed 3ol-2 and one reservoir in CNI Watershed 3-63, respectively.

Irrigation needs appraisals indicate that water supply requirements for project-type irrigation development would have to be provided from surface sources. Nineteen reservoir sites were identified which would provide opportunities for irrigation storage development beyond 10-15 years. Eight sites were located in Oklahoma, four in Texas, two in Arkansas, and five in Louisiana.

The BR in their Goodland Project and Liberty Bottoms Project shows flows of Red River and ground water as a water supply source for irrigation. Since the quality and quantity of water from these sources are marginal, potential reservoir sites were located which could supplement these sources. All sites were located on minor tributaries to Red River; however, as future needs increase, it may be necessary to use storage potentials which are available upstream in most of the major tributaries. Two areas with

Table 61 - Pertinent Structural Data- Additional Storage Potential for Long-Range Development, Red River Basin Study Area

| Tributary Basin and CN1 | Number of Watershed Structures | Drainage Area (sq. mi.) | Water Quality | Pool Capacity (ac. ft.) | | | | | Surface Area of Pool (acres) | Additional Storage Capacity (ac. ft.) |
|---|--------------------------------|-------------------------|---------------|-------------------------|---------------|----------------|---------------|---------------|------------------------------|---------------------------------------|
| | | | | Water | Recreation | Industrial | Irrigation | Sediment | | |
| Potentially Feasible Watersheds for Development | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-30 | 1 | 16.9 | --- | 18,000 | --- | --- | --- | 900 | 1,330 | 0 |
| 3-33 | 1 | 5.6 | --- | 5,970 | --- | --- | --- | 300 | 500 | 0 |
| Subtotal | 2 | 22.5 | --- | 23,970 | --- | --- | --- | 1,200 | 1,830 | 0 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | |
| 3-22 | 6 | 64.5 | --- | --- | --- | --- | 41,400 | 5,200 | 2,850 | 0 |
| Subtotal | 6 | 64.5 | --- | --- | --- | --- | 41,400 | 5,200 | 2,850 | 0 |
| Sulphur River | | | | | | | | | | |
| 3k-17 | 1 | 9.5 | --- | 3,450 | --- | --- | --- | 510 | 320 | 4,140 |
| Subtotal | 1 | 9.5 | --- | 3,450 | --- | --- | --- | 510 | 320 | 4,140 |
| Posten Bayou | | | | | | | | | | |
| 3-57a | 1 | 6.4 | --- | --- | --- | --- | 10,020 | 160 | 800 | 0 |
| Subtotal | 1 | 6.4 | --- | --- | --- | --- | 10,020 | 160 | 800 | 0 |
| Total | 10 | 102.9 | --- | 27,420 | --- | --- | 51,420 | 7,070 | 5,800 | 4,140 |
| Watersheds Considered Not Potentially Feasible for Development | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-24 | 1 | 6.0 | --- | 3,450 | --- | --- | --- | 320 | 320 | 1,350 |
| 3-27a | 1 | 14.6 | --- | --- | --- | --- | 11,380 | 790 | 760 | 0 |
| 3-42 | 3 | 102.9 | --- | --- | --- | --- | 67,900 | 3,540 | 5,040 | 34,400 |
| 3-42 | 1 | 12.4 | --- | 9,600 | --- | --- | --- | 660 | 740 | 17,840 |
| Subtotal | 6 | 135.9 | --- | 13,050 | --- | --- | 79,280 | 5,310 | 6,860 | 53,590 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | |
| 3-32 | 1 | 11.2 | --- | --- | --- | --- | 8,700 | 910 | 650 | 0 |
| 3-37 | 1 | 21.0 | --- | --- | --- | --- | 23,100 | 730 | 1,680 | 10,840 |
| Subtotal | 2 | 32.2 | --- | --- | --- | --- | 31,800 | 1,640 | 2,330 | 10,840 |
| Kiamichi River | | | | | | | | | | |
| 3i-1 | 1 | 7.1 | --- | 2,570 | --- | --- | --- | 380 | 250 | 4,620 |
| Subtotal | 1 | 7.1 | --- | 2,570 | --- | --- | --- | 380 | 250 | 4,620 |
| Little River | | | | | | | | | | |
| 3j-15 | 1 | 10.6 | --- | 12,100 | --- | --- | --- | 450 | 900 | 7,250 |
| 3j1-4 | 1 | 16.5 | --- | 4,800 | --- | --- | --- | 700 | 410 | 29,700 |
| Subtotal | 2 | 27.1 | --- | 16,900 | --- | --- | --- | 1,150 | 1,310 | 36,950 |
| McKinney Bayou | | | | | | | | | | |
| 3-55 | 1 | 35.3 | --- | --- | --- | --- | 21,870 | 1,940 | 1,680 | 33,400 |
| Subtotal | 1 | 35.3 | --- | --- | --- | --- | 21,870 | 1,940 | 1,680 | 33,400 |
| Sulphur River | | | | | | | | | | |
| 3k-16 | 1 | 11.8 | --- | 4,010 | --- | --- | --- | 630 | 375 | 7,960 |
| 3k-1 | 1 | 33.5 | --- | 23,000 | --- | --- | --- | 1,430 | 1,550 | 32,770 |
| 3k-4 | 1 | 4.6 | --- | 4,000 | --- | --- | --- | 250 | 370 | 3,110 |
| 3k1-1 | 1 | 6.0 | --- | 5,800 | --- | --- | --- | 320 | 480 | 4,080 |
| 3k1-2a | 2 | 56.5 | --- | 20,130 | --- | --- | --- | 3,020 | 1,520 | 37,150 |
| 3k1-2a | 1 | 6.5 | 1,900 | --- | --- | --- | --- | 450 | 220 | 6,700 |
| Subtotal | 7 | 120.9 | 1,900 | 56,940 | --- | --- | --- | 6,100 | 4,515 | 91,770 |
| Cypress Creek | | | | | | | | | | |
| 3L-4 | 1 | 28.5 | --- | 23,480 | --- | --- | --- | 1,520 | 1,680 | 17,600 |
| 3L-8 | 1 | 44.8 | --- | 22,610 | --- | --- | --- | 2,390 | 1,680 | 41,900 |
| 3L1-3 | 1 | 9.1 | --- | 9,300 | --- | --- | --- | 490 | 720 | 2,810 |
| 3L1-5 | 1 | 21.6 | --- | 8,600 | --- | --- | --- | 1,150 | 670 | 27,150 |
| 3L1-1 | 2 | 29.5 | --- | 18,800 | --- | --- | --- | 2,100 | 1,445 | 33,100 |
| 3L1-2 | 2 | 38.8 | --- | 23,200 | --- | --- | --- | 2,065 | 1,740 | 24,335 |
| 3L1-6 | 1 | 33.2 | --- | 13,500 | --- | --- | --- | 1,770 | 990 | 41,330 |
| 3L1-2 | 1 | 5.3 | 4,000 | --- | --- | --- | --- | 230 | 340 | 5,000 |
| 3L-3 | 1 | 26.6 | --- | --- | --- | --- | 22,350 | 1,460 | 1,680 | 19,000 |
| Subtotal | 11 | 237.4 | 4,000 | 119,490 | --- | --- | 22,350 | 13,175 | 10,945 | 212,225 |
| Logy Bayou | | | | | | | | | | |
| 3m2(a)-2 | 1 | 80.6 | --- | --- | 15,500 | --- | --- | 4,300 | 2,310 | 24,380 |
| 3m1-3 | 1 | 31.1 | --- | 23,670 | --- | --- | --- | 1,330 | 1,680 | 28,100 |
| 3m2(a)-5 | 1 | 2.8 | --- | --- | 500 | --- | --- | 150 | 70 | 4,150 |
| 3m2(a)-7 | 2 | 25.6 | --- | 30,800 | --- | --- | --- | 1,100 | 2,280 | 20,400 |
| 3m1-2 | 1 | 37.3 | --- | 23,410 | --- | --- | --- | 1,590 | 1,680 | 40,600 |
| Subtotal | 6 | 177.4 | --- | 77,880 | 16,000 | --- | --- | 8,470 | 6,020 | 117,630 |
| Maniece Bayou | | | | | | | | | | |
| 3-56 | 1 | 5.8 | --- | 5,250 | --- | --- | --- | 250 | 440 | 4,400 |
| Subtotal | 1 | 5.8 | --- | 5,250 | --- | --- | --- | 250 | 440 | 4,400 |
| Bayou Pierre | | | | | | | | | | |
| 3n-1 | 4 | 87.5 | --- | --- | --- | 80,500 | --- | 3,700 | 5,860 | 58,700 |
| 3n-4 | 2 | 42.0 | --- | 13,000 | 8,440 | --- | --- | 1,810 | 2,330 | 39,240 |
| 3n-5 | 2 | 54.0 | --- | 39,700 | --- | --- | --- | 2,300 | 2,830 | 44,400 |
| Subtotal | 8 | 183.5 | --- | 52,700 | 8,440 | 80,500 | --- | 7,810 | 11,020 | 142,340 |
| Black and Saline | | | | | | | | | | |
| 3o1-2 | 2 | 42.0 | --- | 23,470 | 1,700 | --- | --- | 1,810 | 1,850 | 41,920 |
| 3o1-4 | 1 | 25.7 | --- | 23,900 | --- | --- | --- | 1,100 | 1,680 | 18,800 |
| 3o-3 | 1 | 10.4 | --- | 17,200 | --- | --- | --- | 300 | 1,210 | 120 |
| Subtotal | 4 | 78.1 | --- | 64,570 | 1,700 | --- | --- | 3,210 | 4,740 | 60,840 |
| Nantachie Creek | | | | | | | | | | |
| 3-63 | 1 | 7.3 | --- | --- | --- | 990 | --- | 320 | 130 | 3,900 |
| Subtotal | 1 | 7.3 | --- | --- | --- | 990 | --- | 320 | 130 | 3,900 |
| Total | 50 | 1,048.0 | 5,900 | 409,350 | 27,130 | 235,800 | 49,755 | 52,240 | 772,505 | |
| Grand Total | 60 | 1,150.9 | 5,900 | 436,770 | 27,130 | 287,220 | 56,825 | 58,040 | 776,645 | |

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the most favorable storage potential are Cypress Creek and Little River Tributary Basins. Other good storage possibilities exist in the Loggy Bayou and Black and Saline Lake Tributary Basins. Most of these storage possibilities would necessitate long delivery systems.

Watershed Development Alternatives

The SCS participated with the USAE in the development of several potential project plans that are alternates to the potential upstream watershed projects. Alternate potential project plans were developed for several potential watershed multiple-purpose projects proposed for initial development. One alternate plan was prepared for a potential project for long-range development. Alternates for developing irrigation water supplies also were investigated.

Multiple-Purpose Projects for Initial Development

The SCS formulated with the USAE alternate multiple-purpose plans on a project by project basis. Alternate plans were developed for two potential watershed projects in Texas, three watershed projects in Oklahoma, and one project in Louisiana.

Benefits were allocated equitably to elements of the combined projects by mutual agreement of the two planning agencies. Details for these projects are given in the section describing projects recommended for early action.

Multiple-Purpose Projects for Long-Range Development

CNI Watershed 3-22 (Island Bayou) was placed in the category for long-range development by USDA. The USAE, in their investigation of this watershed, proposed improvements for initial development. If, however, the USAE project (Albany Reservoir) is not installed, the potential upstream watershed project would become an alternate plan of development. Data for this project are included in Table 60.

Alternatives for Irrigation Water Supply

Initial Development

The USAE have identified a potential reservoir for initial development for utilizing storage for irrigation purposes. The Kisatchie Reservoir, Louisiana, has about 47,000 acre-feet of storage allocated for irrigation. This storage is an alternate to the irrigation storage described for potential upstream watershed early-action projects in Cane River Tributary Basin Watersheds.

Long-Range Development

Irrigation would be confined primarily to the Southern Mississippi Valley Alluvium LRA. Soils in this LRA are located adjacent to Red River and have the greatest potential for future irrigation development. The

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estimated maximum gross water requirement to meet the 1980-2080 needs is 1,814,100 acre-feet. About 1,108,900 acre-feet would be needed for individual-type development and 705,200 acre-feet would be needed for project-type development between 1980 and 2080.

Alternates for developing irrigation water supplies are available to meet 2030 and 2080 needs. A summary of irrigation water supply project-type needs by States for 2030 and 2080 follows:

| State | 2030 | 2080 |
|-----------|-----------------------------|---------|
| | - - - - acre-feet - - - - - | |
| Arkansas | 118,300 | 236,500 |
| Louisiana | 129,300 | 258,700 |
| Oklahoma | 75,000 | 150,000 |
| Texas | 30,000 | 60,000 |
| Total | 352,600 | 705,200 |

Irrigation investigations made by the BR indicate that Red River flows will satisfy all future irrigation water requirements provided that both suitable drainage outlets and ample surface water for leaching are available. Water quality records show that Red River water during low flow periods, the periods irrigation water would be needed, is high-salinity water. This water would be restricted to use on coarse textured soils. However, projects are being installed that would reduce the salt content of Red River water and would make it more suitable for irrigation use. Also, Red River water quality could be improved by releases from planned tributary reservoirs. Even so, the limitations involved in using Red River water for irrigation purposes indicate a need for alternate irrigation water supplies.

The USDA identified 19 potential reservoir sites that could be used as an alternate water supply to Red River. The sites are located on laterals to Red River and they could be used either to supplement water taken from Red River or to furnish the entire supply for several of the small, noncontiguous areas suitable for irrigation. Generally, the quality of water from these reservoirs would have no limitations for irrigation use. Reservoir site locations are shown in Figure 14.

Approximately 287,200 acre-feet of irrigation storage could be developed in CNI watersheds in the 19 potential reservoir sites. Eight reservoirs with a total storage of approximately 73,200 acre-feet could be located in Oklahoma. Four reservoirs with approximately 79,300 acre-feet could be located in Texas. Two reservoirs with approximately 44,200 acre-feet could be located in Arkansas. Five reservoirs with approximately 90,500 acre-feet could be located in Louisiana. The 287,200 acre-feet of storage in potential reservoirs would not supply all of the 2030 project-type irrigation needs.

The two reservoirs located in Arkansas would provide approximately 37 percent of the 2030 water requirements needed for project-type irrigation. Approximately 70 percent of the 2030 project-type water

requirements in Louisiana could be stored in five reservoirs. Eight reservoirs in Oklahoma could supply approximately 98 percent of the 2030 project-type irrigation water requirements for that State. The potential irrigation storage identified in Texas is greater than that needed to satisfy the 2080 needs. This storage is not available for use on all lands because of reservoir location.

The locations of the laterals into Red River, in relation to potentially irrigable land, limit reservoir irrigation storage potential. Reservoir sites for supplemental irrigation water storage are not available in CNI Watershed 3-29, Texas. The Pat Mayse Reservoir, Texas, which is located adjacent to this watershed, has 124,500 acre-feet of water supply storage which has been allocated to other purposes. This reservoir is ideally located to furnish irrigation to CNI Watershed 3-29, Texas. In the future, if water needs for other purposes change, water from Pat Mayse Reservoir should be considered for irrigation.

The intervening areas between potential reservoir sites would have to use water from Red River as a supplement to surface water storage in order that the remaining 2030 needs could be satisfied. Remaining 2080 water requirements for Arkansas, Oklahoma, and Louisiana would have to be supplied from Red River.

LAND RESOURCE DEVELOPMENT POTENTIAL

Agriculture

Land resource development is concerned with land and water uses that will yield continuing returns to the people of the Study Area and of the Nation. A development program places emphasis on accelerating the land treatment measures that have a significant effect on reducing runoff, erosion, and sediment production. The measures are designed to protect and improve the agriculture and woodlands and increase overall farming efficiency. Thus, to meet the Study Area's share of the expanding National market demands, farmers will need to capitalize on the potential of land resource development. This can be accomplished by the adoption of improved crop and livestock production and, insofar as practical, use of land according to its capabilities.

In addition, farmers will need to make some adjustments in land use such as (1) clearing and draining wet land capable of profitable crop and pasture production and (2) shifting idle land to crop or pasture uses. On the other hand, some land now idle, in crops, or in pasture should be reforested. Improved technology and its rate of acceptance and adaptation by farmers represents another potential for land resource development. Better communications, larger farms, and greater managerial ability will accelerate the physical development of underdeveloped lands being used below their capabilities. As a result, a greater portion of the agricultural area will be utilized for production of the more intensive crops and improved pasture, the location of which will tend to shift to the more productive, less hazardous soils.

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A major objective in the physical resource development program will be to control erosion on 1,972,000 acres of sloping cropland. The major land treatment practices to be applied include terraces, contour farming, grassed waterways, and special residue management. A cropping system designed to reduce erosion to a minimum is necessary to prevent resource deterioration.

About 95,500 acres, now classified as cropland, are too steep and eroded for cultivated crops. This land should be seeded to permanent grass and used for meadow or pasture. Some of it may be converted to woodland, wildlife land, or recreational areas.

About 1,810,700 acres of Southern Mississippi Valley Alluvium and Southern Mississippi Valley Silty Uplands have a wetness problem. Most of this surface ponding or wetness, which originates from high land runoff, is aggravated by stream overflow. Diversion terraces placed to intercept runoff from the high areas and convey the water to natural outlets through surface field ditches will help alleviate the on-farm drainage problem. Control structures may be needed where the field ditches empty into the stream. Land grading and smoothing, combined with a cropping system designed to prevent deterioration of soil structure, are some practices needed on lands with wetness problems.

Approximately 765,600 acres, distributed throughout the four states in the Study Area, have a potential for irrigation development. More than half of this acreage is in Louisiana. Of the total area, approximately 317,000 acres are suitable for project-type development, and 448,600 acres could be developed individually by landowners and operators. Approximately 57,500 acres of the land suitable for project-type development would be feasible by 1980. Land shaping and other practices for water management would be needed on these lands.

The CNI indicates that nearly 41 percent, or 1,851,800 acres, of the grazing and pastureland has adequate cover to prevent soil erosion. However, for grazing and pasturelands to produce sufficient grazing to yield an economic return, at least 1,558,800 acres should be treated. High-level management of pastureland is accomplished by liming, fertilizing, reseeding improved pasture mixtures, and by fencing and developing additional water supplies for proper grazing control.

About 33 percent of the 10,286,400 inventoried acreage of forest and woodland in the Study Area is on land-capability Classes VI and VII. Lands in these capabilities are suited only to grass, tree production, and wildlife and recreational areas. Forty-eight percent is in capability Classes I to IV. Capability Class V accounts for the remaining 19 percent of the woodland area and is so classified because of a wetness problem. With land treatment measures applied, this land in capability Classes I through V, or about 6,900,000 acres, could be used for cultivation, if needed to meet the future crop production needs.

Forestry

Table 62 shows estimates at the 1962 level of treatment measures

recommended for forest lands of the Study Area. These measures are needed if full benefits in watershed management and wood productivity are to be realized. Installation of the recommended measures would require that all private, non-forest industry lands be put under good forest management and sustained yield.

Table 62- 1962 Quantity and Costs of Recommended Forest Land Treatment, Red River Basin Study Area

| Measure | Quantity | | | Costs ^{1/} Installation |
|---------------------------------|---------------------|---------------------|------------------------|-------------------------------------|
| | Total Needs | Going Program | Recommended Program | |
| | thousand acres | | | thousand dollars |
| Openland tree planting | 213.0 ^{2/} | 136.0 ^{3/} | 77.0 | 1,256.5 |
| Forest interplanting | 880.0 | 290.5 ^{4/} | 589.5 | 10,432.0 |
| Hydrologic stand improvement | 2,693.3 | 538.7 ^{4/} | 2,154.6 | 11,421.5 |
| Forest grazing control | 644.0 ^{5/} | - | 644.0 | 2,414.7 ^{6/} |
| Total | 4,430.3 | 965.2 | 3,465.1 | 25,524.7 |

^{1/} 1962 level

^{2/} Idle, depleted, poorly protected agricultural lands

^{3/} Total for 1962-80 at current rate

^{4/} On Federal and forest industry lands

^{5/} Unprotected forest land with moderate or heavy damage

^{6/} Does not include annual maintenance costs of \$128,800

Since 1962, a portion of the recommended measures have been installed under going programs and accelerated programs of small watershed (P.L. 566) projects. There is evidence that some of the forest land recommended for treatment in Table 62 has recently come under control of forest industry with a higher level of management, but the great bulk of the 1962 acreage needing treatment is still without a good management program.

Table 63 shows the estimated quantity and costs of the technical assistance needed to install the forest land treatment measures recommended in Table 62.

Table 64 shows the quantity and costs of improvements in fire protection recommended for forest lands of the Study Area. No broad improvement in forest land management would be feasible without added assurance against untoward losses from wildfire. Protection of the capital invested in accelerated land treatment and water management values added by improved fire protection would justify the intensified program for the Study Area.

Table 63 - 1962 Quantity and Costs of Technical Assistance for Installation of Recommended Forest Resource Improvement Measures, Red River Basin Study Area

| State | Quantity | | | Cost 1/ | |
|----------------|----------------|------------------|---------------------|--------------|-----------|
| | Total Needs 2/ | Going Program 3/ | Recommended Program | Installation | Annual 4/ |
| thousand acres | | | thousand dollars | | |
| Arkansas | 546.8 | - | 546.8 | 12 | 34.0 |
| Louisiana | 1,080.4 | 300.0 | 780.4 | 18 | 51.0 |
| Oklahoma | 1,265.7 | 120.0 | 1,145.7 | 24 | 68.0 |
| Texas | 1,103.5 | 180.0 | 923.5 | 21 | 59.5 |
| Total | 3,996.4 | 600.0 | 3,396.4 | 75 | 212.5 |

- 1/ 1962 Cost level
- 2/ Based on 1962 conditions and 1962 level of accomplishment
- 3/ Does not include programs on Federal, State, and forest industry lands
- 4/ For estimated 15-20 year program

Table 64 - Quantity and Added Costs of Recommended Fire Protection 1/ Measures, Red River Basin Study Area

| State | Total Needs | Federal Lands | Private Lands | Total State and Program 2/ | Going State 2/ | Recommended Protection Area | Additional Costs 6/ | Added Annual Costs | | Total Added Annual Costs |
|----------------|-------------|---------------|---------------|----------------------------|----------------|-----------------------------|---------------------|--------------------|---------------------|--------------------------|
| | | | | | | | | On New Area | On Established Area | |
| thousand acres | | | | thousand dollars | | | | | | |
| Arkansas | 2,022.2 | 106.9 | 1,915.3 | 1,916.4 3/ | - | - | - | - | 76.7 | 76.7 |
| Louisiana | 3,513.9 | 316.6 | 3,197.3 | 3,332.2 4/ | - | - | - | - | 129.3 | 129.3 |
| Oklahoma | 3,195.3 | 135.6 | 2,990.2 | 1,997.0 | 875.4 5/ | 48.5 6/ | 101.5 | 143.4 | 244.9 7/ | 244.9 7/ |
| Texas | 2,239.5 | 99.7 | 2,139.8 | 2,139.8 | - | - | - | 73.6 | 73.6 | 73.6 |
| Total | 10,970.9 | 658.7 | 10,242.6 | 9,866.4 | 875.4 | 48.5 | 101.5 | 423.0 | 524.5 | 524.5 |

- 1/ Based on 1962 acreages in Study Area. Cost estimates based on 1963 costs of protection.
- 2/ 1962
- 3/ Includes 1,100 acres of Federal land
- 4/ Includes 35,900 acres of Federal land
- 5/ Includes 385,200 acres for nonintensive protection
- 6/ At 3-1/8 percent, amortized for 15 years: Annual Costs = \$0.0014/acre on 2,844,600 acres
- 7/ Does not include installation costs for added acreage

Table 65 shows land treatment measures planned for National Forest System Lands on the Study Area, for the period July 1, 1966, through 2010. Except for channel stabilization, the measures listed are regular and continuing programs under management of National Forest System Lands.

Regular USFS funds and share of timber sale and grazing revenues established by Federal law are expected to cover the costs of installation for the land treatment measures listed in Table 65.

Table 65 - Future Land Treatment ^{1/} Needs for National Forest System Lands, Red River Basin Study Area

| | Unit | 7/1/66 Thru 1980 | 1981 Thru 2010 | Total |
|-------------------------------|------|------------------|----------------|---------|
| Tree planting | Acre | 37,843 | 124,379 | 162,222 |
| Timber stand improvement | Acre | 200,943 | 218,679 | 419,622 |
| Erosion control | Acre | 3,474 | 6,817 | 10,291 |
| Range improvement | Acre | 680 | 800 | 1,480 |
| Channel stabilization | Mile | 29 | 36 | 65 |
| Total | Acre | 242,940 | 350,675 | 593,615 |
| Total (channel stabilization) | Mile | 29 | 36 | 65 |

^{1/} Mostly recurring

Programs for Potential Development

USDA water and related land resource programs also are being developed under authorities other than P. L. 566. The FHA provides financial assistance to rural communities for water supply improvements, as well as watershed development. The FHA also is authorized to make loans for recreation enterprises to farmers and ranchers who personally manage and operate units that are not larger than family farms. These loans are designed for helping borrowers develop recreation enterprises that will supplement farming income. Loans also may be made to nonprofit organizations for development of recreation enterprises.

The Agricultural Stabilization and Conservation Service (ASCS) administers several USDA programs. The Cropland Adjustment Program (CAP) authorized by the Food and Agricultural Act of 1965 provides for long-term diversion of land currently being used for production of surplus crops to conservation and other beneficial uses such as expansion of recreation, wildlife habitat, and reforested areas. A special section of the CAP helps State and local agencies to purchase cropland and establish on it practices and uses for preservation of open spaces and natural beauty, development of wildlife or recreational facilities, and prevention of air and water pollution. The Cropland Conversion Program assists farmers in converting cropland that is now surplus crop production to wildlife and recreational uses. The contracts to divert land being used for production of commodities into conservation uses, under the Conservation Reserve Program, can be modified to change the land use from vegetative cover to wildlife and recreational uses. The Agricultural Conservation Program, also administered by the ASCS, provides cost-sharing assistance to farmers who are interested and willing to establish soil and water conservation practices on their farms.

The SCS provides technical assistance to landowners and operators, through Soil and Water Conservation Districts, with planning, installation, and maintenance of soil and water conservation practices. Technical

assistance is also available for the planning and installation of income-producing recreation enterprises as a phase of soil and water conservation and proper land use. Income-producing recreation enterprises on private land, as differentiated from those on public land, are defined as recreation enterprises which are planned and developed as a use of land and water resources to provide service to the public through private economic enterprise. This program is administered by the SCS under authority of P. L. 46.

The Resource Conservation and Development Projects (RC&D) Program is administered by the SCS with participation by other USDA agencies. Agencies outside the USDA who may have interests in program activities also are invited to participate. The program provides for development of locally initiated and sponsored projects designed to provide additional economic opportunities to rural areas.

A Resource Conservation and Development Project Plan has been developed for Bossier and Webster Parishes, Louisiana, under the authority of Public Law 87-703 (Food and Agriculture Act of 1962). The primary objective of the plan, and ultimately the project, is to develop and use wisely natural resources for economic growth and to provide for the needs of people in and outside the project area. The project includes three multiple-purpose reservoirs and 9.4 miles of channel improvement in addition to those previously listed for CNI watersheds. Annual benefits of \$141,200 are expected from the improvements. Total installation cost is estimated to be \$2,785,000. Annual costs, including operation and maintenance, are estimated to be \$95,800.

The plan also incorporates CNI Watershed 3m2-4 (Upper West Fork of Cypress Bayou), which was authorized prior to December 31, 1962, CNI Watershed 3m2-3 (Cypress-Black Bayou), authorized for operations after 1962, and CNI Watershed 3-57 (Posten Bayou), which is considered potentially feasible for development after 10-15 years. These three watersheds have been included in previous discussion of watershed projects for potential development.

There are 15 other potential reservoir sites located throughout the two parishes that can be developed to conserve soil and water and bring about improved land utilization. Other uses could be for irrigation, municipal, industrial, and recreation purposes. Structures on these 15 potential sites could be installed with technical and financial assistance from RC&D funds. The total estimated cost for installing these structures is about \$16,000,000.

Other similar opportunities may develop for planning and installing resource conservation and development projects. Project starts are dependent upon local initiative.

IMPACTS OF PROPOSED PROGRAMS AND PROJECTS

IMPACTS ON AGRICULTURAL PRODUCTION

Physical

The influence of programs and projects proposed to help satisfy the food and fiber requirements in the Study Area is expected to bring about major land use changes. Table 66 presents 1980 land utilization and large water area with no further acceleration in the rate of resource development (without project), and the land use changes with an acceleration in the rate of resource development under proposed programs and projects to satisfy agricultural requirements and increases in urban and built-up area (with project).

Table 66 - Inventory, Non-Inventory, and Water Area: Without and With Project Development, Red River Basin Study Area, 1980 ^{1/}

| Major Uses | : Without : Project | : With : Project ^{2/} |
|------------------------------------|------------------------|-----------------------------------|
| | - - - - - | thousand acres - - - - - |
| Inventory: | | |
| Cropland | 2,864.8 | 3,762.7 |
| Crops & related uses ^{3/} | 1,655.6 | 2,090.0 |
| Used only for pasture | 1,209.2 | 1,672.7 |
| Pasture-range | 3,268.1 | 2,726.7 |
| Forest-woodland | 10,703.9 | 9,794.9 |
| Other lands ^{4/} | 413.0 | 497.7 |
| Total inventory | 17,249.8 | 16,782.0 |
| Non-inventory: | | |
| Federal land | 694.1 | 694.1 |
| Urban & built-up | 586.7 | 628.7 |
| Small water areas | 86.1 | 100.1 |
| Total non-inventory | 1,366.9 | 1,422.9 |
| Total land area | 18,616.7 | 18,204.9 |
| Large water area | 333.6 | 745.4 |
| Total land and water area | 18,950.3 | 18,950.3 |

^{1/} See Exhibits 5 and 37

^{2/} These data are compiled from information furnished by the SCS and USAE

^{3/} Cropland harvested, crop failures, and cultivated summer fallow, soil improvement crops, and idle cropland

^{4/} Farmsteads, farm roads, idle land, wildlife, and recreation areas

By 1980, 897,900 acres of pasture-range and woodland will shift into cropland use. An additional 41,900 acres will shift into urban and built-up areas. Within the farm land area, there are anticipated variations in the pattern of land distribution between the major land uses. Extensive clearing of hardwoods and other timber in the bottomlands of the Southern Mississippi Valley Alluvium land resource area is

changing the pattern of crop acreages and crop distribution. Exhibit 37 shows for 1980 a detailed inventoried land use with crop distribution by land resource area groupings with the proposed programs and projects. This land utilization of cropland would satisfy food and fiber requirements allocated to the Study Area.

The 1980 production requirements for nonfeed crops require a 42 percent increase in the projected trends of nonfeed crop acreages (table 67). This acreage increase is due largely to the soybean requirement, which requires a 280 percent increase from the present trend. However, cotton acreages can be reduced approximately 95,000 acres and still satisfy production requirements. Other nonfeed crops can be expected to be met with minor variations in the normal pattern of crop production at yields attainable through technological improvement and water resources development.

Table 67 - Feed and Non-feed Crop Acreages: Without Further Resource Development, and With an Acceleration in the Rate of Resource Development, to Satisfy Food and Fiber Requirements, Red River Basin Study Area, 1980

| | Without project development | Project development to satisfy needs |
|--|-----------------------------------|--|
| | | |
| | - - - - | - - - - |
| | thousand acres | |
| <u>Non-feed crops</u> | | |
| Wheat | 102.4 | 222.3 |
| Cotton | 232.2 | 137.6 |
| Sweet potatoes | 20.0 | 43.0 |
| Non-citrus fruit | 14.8 | 11.3 |
| Vegetables | 21.6 | 22.8 |
| Peanuts | 28.0 | 56.1 |
| Miscellaneous | 49.4 | 49.4 |
| Soybeans | 51.7 | 196.4 |
| Total | 520.1 | 738.9 |
| <u>Feed crops, hay, and pasture</u> | | |
| Corn, grain | 45.9 | 41.1 |
| Sorghum, grain | 73.7 | 117.4 |
| Oats | 58.1 | 38.4 |
| Barley | 19.5 | 36.3 |
| All hay and forage | 658.8 | 923.8 |
| Cropland pastures | 1,209.2 | 1,672.7 |
| Permanent pasture & range | 3,268.1 | 2,726.7 |
| Woodland grazed | 6,974.4 | 5,265.6 |
| Total | 12,307.7 | 10,822.0 |
| <u>Not harvested: idle, fallow, etc.</u> | 279.5 | 194.2 |
| Grand Total | 13,107.3 | 11,755.1 |

Feed crops, including hay and pasture, will undergo major variations from the projected trends of feed crop production to satisfy 1980 requirements (table 67). An additional 36,000 acres of feed grains, largely grain sorghums and barley, are necessary. Also, the production of hay and forage crops will require an additional 265,000 acres at yields attainable through technological improvement and resource development.

Capability Classes II and III lands presently in grass and pasture may be converted to more intensive farming with the application of complete water management systems. Floodplain land that is presently being used below capacity, because of the high flood risk, will be farmed more intensively. With flood control structures operating in conjunction with applied land treatment and water management practices, yields are expected to increase and total production will be greater.

In addition to cropland, approximately 10,032,100 acres of permanent pasture and range, including cropland pastured and woodland grazed, should be available for producing 14,806.4 million feed units. It is estimated that 1980 production with proposed programs to satisfy food and fiber requirements will provide about 96 percent of projected feed unit needs. Additional feed units from pasture and grazing may be available in this 10- to 15-year period, if timber clearing in the Southern Mississippi Valley Alluvium and Texas Blackland Prairie continues until maximum clearing operations are achieved. However, to make up the deficit, additional feed units will be realized from grains and hay crops imported from other regions as they meet their share of National Requirements.

By 1980, it is estimated that about 92 percent of the total land area will be classified as inventory land. Within commuting distance of Shreveport, Alexandria, and Texarkana, some cropland and pasture will be intermingled with small farms used as suburban residences. The crop and livestock production will mostly come from commercial family farms. The size of farm units will increase where necessary to maintain an efficient unit under intensive farming operations.

Economic

The installation of the proposed plan for development of land and water resources will result in an increase in crop production and of livestock and livestock products. The increased demands for food by the population, along with improved technology, flood protection for the floodplains, land treatment and water management for soils subject to erosion, and water available for irrigation as needed, will cause rapid changes in the agricultural economy in future years. Operation and maintenance of the 453 potentially feasible upstream reservoirs in the 10- to 15-year category will provide employment for an estimated 130 people annually. Upstream watershed projects also include 1,484 miles of channel improvement. Twenty-three multiple-purpose reservoirs with recreation storage as a purpose will provide 834,200 estimated days of recreation use.

Improved use of the agriculture resource base should occur with proposed programs. The accelerated development of land and water resources will bring about a change in the volume of goods and services produced. With growing demand, farm value of agricultural production rises. Values are added, usually off of the farm, through the handling, packing, shipping, and processing of raw materials. Increases in net agricultural income are reflected in producers' consumption expenditures or capital accumulation. Expenditures for farm inputs such as hired labor, fertilizer, machinery, gasoline, oil, insecticides, etc., create jobs, payrolls, business profits, and add to the level of economic activity.

The gross value of major crop production during the base year was estimated at \$86.3 million. Values fluctuate considerably from year to year as yields and prices of some crops, especially vegetables, are sensitive to supply. Therefore, all prices were converted to current normalized prices.

Assuming an acceleration in the rate of resource development during the projected period, the gross value of crop production by 1980 is expected to increase nearly one-fourth, to an estimated \$115.7 million (table 68). Gross value of crop production is projected to be \$1,709 per farm in 1980 without project development. With project development, a value of \$2,151 is expected. The growth of agriculture during this period results largely from expanding production of soybeans, wheat, grain sorghum, alfalfa and other hay crops, and vegetables. Among the cultivated crops, soybean production is expected to increase 300 percent over the normal trend. Cotton production has been declining in the Study Area, and it can decrease about 38 percent from the projected 1980 trend and still satisfy requirements.

Table 68 - Current Normalized Value of Production of Major Crops, Red River Basin Study Area, 1962 and 1980

| Crop or crop group | : 1962 | : 1980 ^{1/} |
|--------------------------------|---------------|----------------------|
| - - - - thousand dollars - - - | | |
| <u>Non-Feed Crops</u> | | |
| Wheat | 2,448 | 7,179 |
| Cotton (seed & lint) | 45,609 | 24,622 |
| Sweet potatoes | 6,082 | 11,725 |
| Non-citrus fruits | 915 | 1,118 |
| Vegetables | 3,605 | 5,767 |
| Peanuts | 2,311 | 4,324 |
| Soybeans | 1,598 | 13,052 |
| Miscellaneous | 1,369 | 1,422 |
| Total | 63,937 | 69,209 |
| <u>Feed crops and hay</u> | | |
| Feed grains | 8,091 | 8,609 |
| Alfalfa | 2,525 | 7,635 |
| Other hay | 11,737 | 30,199 |
| Total | 22,353 | 46,443 |
| <u>Grand Total</u> | <u>86,290</u> | <u>115,652</u> |

^{1/} With an acceleration in the rate of resources development, or "with project", as proposed by the SCS and USAE

The rapidly increasing population with rising incomes demands an ever increasing amount of livestock products. From the increased production of grains, pasture, and hay, farmers can increase their production of livestock. The total income by 1980 from livestock and livestock products with an acceleration in the rate of resource development is estimated to be \$341.2 million (current normalized prices), or an increase of approximately \$176.5 million over 1962.

The net effect of resource development will be an increased orientation of agriculture towards requirements of population for foods and fiber, including milk, eggs, poultry, beef, and feed to satisfy feed unit requirements. Production of most of these agricultural products is responsive to rising National population and demand.

Major cash inputs in agricultural production are projected to increase 44 percent above 1962 levels by 1980. Changes in labor inputs can be related closely to local employment opportunities. For example, there is a decreasing trend in farm labor costs of 30 percent, or \$7.8 million between 1962 and 1980. This would be equivalent to nearly 2,170 jobs at \$3,600 annual earnings. It is impossible to determine the net effect that proposed projects will have on farm labor as a result of projects and proposed programs. However, the trend substantiates the decline in farm labor resulting from larger and more efficient farm units.

As has been indicated, the composition of agricultural production is expected to change with greater expansion in soybeans, feed crops and hay, and livestock industries than in cotton and some field crops. These changes in the production mix result in some shift in the character of inputs. Feed costs remain the largest items, and increase greatly in absolute and relative importance. The purchase of livestock and poultry decreases in relative importance, thus emphasizing the expanding cattle feeding industry developing in the Mid-South. To the extent that agriculture can provide feed and livestock for purchase within the industry, it has an opportunity to become less dependent upon nonfarm segments of the economy for required inputs.

As population continues to increase, so will the number of people employed. The trend of decreasing employment in agriculture and increasing employment in nonagriculture will continue. This will be especially significant in the areas around the three largest cities.

The increase in the total number of people employed raises the total income for the Study Area. Much of the increase in employment will occur as a result of project implementation, of increased economic activity, and of people visiting the area to participate in water-oriented outdoor recreation.

Continuing changes in the agricultural economy after the 10- to 15-year project period can be expected. Improvements resulting from long-range project implementation will continue to increase farm income and reduce costs of production while recreational use of lands will continue to contribute additional income for many farm owners and operators.

IMPACTS ON FORESTRY PRODUCTION

Conversion Since 1962

Considerable reservoir construction had been authorized for the USAE by 1962, but no installation had been completed. Completion of these projects will remove directly from production some 155,300 acres of commercial forest lands. The flood protection below these authorized reservoirs is expected to remove from production an additional 53,100 acres of forest land. These lands would be converted to pasture and croplands, according to project estimates.

Reservoir projects proposed by USAE and TWDB for the Study Area will remove an estimated 97,100 acres of commercial forest land from production. Fifteen to 20 percent of this loss is expected from conversion to open land, as a result of flood protection below reservoirs. These changes in land use are attributable to early-action proposals. Additional such developments are proposed before 2010.

Studies of the Red River Navigation and Bank Stabilization project proposed for the Study Area by the USAE, show the project would result in the conversion of some 61,000 acres of bottomland hardwood forest to pasture or cropland.

USDA projects authorized at the time of this report (1967) will remove approximately 15,000 acres of commercial forest land as a result of clearing and conversion to water storage.

USDA projects proposed in the Study Report will remove from production an additional 40 to 45 thousand acres of commercial forest land. Some 32 to 33 thousand acres of this area will be bottomland hardwood forest on the principal alluvial areas.

Multiple-Use Public Forest Lands

Public forest lands are involved on three P. L. 566 watersheds already authorized (by June 30, 1967), with construction after December 31, 1962. Table 69 gives the project name, location by state, and the size and ownership of the public lands.

Table 69 - Public Forest Lands Involved on Authorized 1/ P. L. 566 Projects, Red River Basin Study Area

| State and Watershed | CNI Number | Total Area | Public Ownership | Responsible Agency |
|---------------------|--------------|------------------|------------------|--------------------|
| | | acres | acres | |
| <u>Louisiana</u> | | | | |
| Bayou Rapides | 3-68 & 10-17 | 96,970 | 5,000 | National Forest |
| Bayou Bouef | 10-15 | 64,406 <u>2/</u> | 2,165 <u>2/</u> | National Forest |
| <u>Oklahoma</u> | | | | |
| Waterfall-Gilford | 3-40 | 43,410 | 960 | National Forest |

1/ As of June 30, 1967

2/ Acreage in the Study Area

Some upstream watershed projects proposed in this Study involve public forest lands. Table 70 lists the pertinent data for these projects.

Table 70 - Public Forest Lands Involved on Proposed 1/ Upstream Watershed Projects, Red River Basin Study Area

| State and Watershed | CNI Number | Total Area | Public Ownership | Responsible Agency |
|---|------------|------------|------------------|-----------------------|
| | | acres | acres | |
| <u>Louisiana</u> | | | | |
| Bayou Rigolette | 3-70 | 247,200 | 50,900* | National Forest |
| Bayou Pierre-Cane River | 3-66 | 101,240 | 16,500* | National Forest |
| Kisatchie Bayou-Cane River | 3-65 | 247,908 | 80,000 | National Forest |
| Provencal Creek, Youngs Bayou, & Cane River | 3-64 | 107,070 | 14,800 | Army Training Command |
| | | | 100 | National Forest |
| <u>Oklahoma</u> | | | | |
| Norwood Creek | 3-40 | 55,290 | 1,170 | National Forest |
| Walnut Bayou | 3-41 | 46,210 | 12,370* | National Forest |
| <u>Texas</u> | | | | |
| Barkman Creek | 3-48 | 44,030 | 2,000 | Army Material Command |
| Lower Bois d'Arc Creek | 3-25 | 133,350 | 13,000* | National Grasslands |
| Upper North Sulphur River | 3k-14 | 204,600 | 1,980 | National Grasslands |
| Middle Sulphur River | 3k-17 | 135,040 | 700* | National Grasslands |

1/ Not authorized by June 30, 1967. Proposed for 10-15 year development

* Structural measures proposed on public lands

The Kisatchie Bayou reservoir project proposed by the USAE in Louisiana will inundate some 4,000 acres of public forest lands. This project is proposed for development within 15 years. National Forest lands in the permanent pool, as well as additional National Forests lands occupied intermittently by flood storage, include hardwood areas that provide superior habitat for several game species and other wild-life. Hardwood stands managed for timber production occupy some of the area.

Public lands such as those of the National Forest system practice multiple-use management to produce a wide range of products and services for many different private users. These products and services are utilized on an area, State, and regional basis. Watershed and water management proposals that impact on these lands must be examined for compatibility with the multiple-use plans that are formulated to provide these products and services. Project proposals in all cases should be acceptable to the overall plan for National Forest use and development.

Summary

On the Study Area and base area, forest industry wood supply needs by 1980 are expected to approximate the available growth on the 1962 acreage, at 1962 levels of management. A substantial share of the excess growth available at the 1962 level of utilization has been appropriated (1967) by new industry and substantial demands will be added by large plants to be completed in 1968-70.

Some 221,600 acres of commercial forest land will be removed from production by authorized USAE and USDA projects. Loss of another 203,100 acres is expected as a result of proposed projects. All project conversion since 1962 will reduce commercial forest acreage by four to five percent. Some curtailment of present manufacturing activity and employment may occur as a result, or plans for future expansion in some forest industry may be affected.

Losses of hardwood supplies from the expected conversion with project cannot be alleviated on the Study Area, or adjacent supply areas. Employment loss has occurred in hardwood industry of the Study Area. Additional losses can be expected as a result of conversion with project. Expected losses of softwood supplies as a result of authorized and proposed projects can be recovered by reasonable advances in high-level forest management, on lands now in low production.

EFFECTS ON WATER YIELDS

The SCS made estimates of the effects of the potential agricultural program on tributary annual water yield. Calculations were made at stream gage locations near the mouths of several tributary streams. At each gage location, potential upstream watershed development for the tributary basin was assumed in place. The method employed considered the effects of land treatment, stock ponds, and permanent pools of upstream reservoirs. Also, it considered net accretion to base flow at the gage.

Results of the studies show that the aggregate effect of these programs reduce the annual yield at the gage locations approximately four to five percent during years of normal precipitation. The reductions are slightly higher during drouth years--approximately six to seven percent; and slightly lower during wet years--approximately two to three percent. These results should be regarded as approximations only. The net effect could be within the error of measuring water yield from the gaged areas.

Experimental research data from small watershed plots show that a sound program of conservation farming increases infiltration rates. The same is true for large watersheds. However, in very large areas, compensating changes in land treatment practices are likely to occur. Also, in some cases, it is apparent that water which enters the soil as infiltration will appear later as surface runoff at some downstream point.

Gross annual lake surface evaporation losses range from 56 inches in the upper part of the Study Area to 49 inches in the lower part; reservoir net evaporation losses range from about 30 inches to about 6 inches. Losses would come mainly from floodwater detention reservoir permanent pools and from farm pond pools.

Reservoir seepage is not expected to produce any significant changes in tributary water yield. Usually, the construction procedures used to build reservoirs are designed to minimize seepage losses.

RED RIVER MAIN STEM DOWNSTREAM EFFECTS

Upstream watershed reservoir control of the Red River drainage area below Denison Dam ranges from near 40 percent at the mouth of Bois d'Arc Creek, Texas, to near 25 percent near Index, Arkansas. Below Index, reservoir control diminishes rapidly to near 12 percent at Shreveport, Louisiana. It remains about 12 percent at Alexandria, Louisiana. Because of the high percent control above Index, Arkansas, the program could be expected to modify stages along Red River for some storms.

The net effect of the upstream watershed program considers the USAE authorized system of reservoirs in place. At present, the USAE authorized system consists of Denison, Hugo, Boswell, Pat Mayse, and Big Pine reservoirs. Excluding the drainage area above Denison Dam, the system of four reservoirs controls 51 percent of the remaining drainage area above the Index gage. For the storms studied, the USAE authorized system reduced peak flows to approximate bankfull stages at several evaluation points. The completeness of the USAE authorized system of control tends to minimize the beneficial effects of the upstream watershed program.

The Tulsa District Corps of Engineers office cooperated with the SCS in determining the upstream watershed program net effects on Red River stages above Index, Arkansas. Time limitations did not permit an intensive, detailed evaluation of all storms.

The storms of 1938, 1945, and 1957 produced major flooding along Red River. The USAE has used these storms in other studies within the Lower Red River Basin and has developed data related to these events. For these reasons, hydrographs for storms of 1938, 1945, and 1957 were used in making an analysis.

The SCS prepared for these storms, hold-out hydrographs at the mouths of Blue River, Oklahoma, and Bois d'Arc Creek, Texas. The hold-out hydrographs represented the effect of the SCS tributary programs. The USAE routed these storm hydrographs down Red River to determine stage effects at key gage locations. The results of the routings were used for estimating the stage effect of the total upstream watershed program.

Results of the routings show a beneficial stage reduction for the 1938 storm only. The timing and distribution of storm rainfall in 1945

and 1957, coupled with the USAE system of reservoir control, preclude any beneficial stage changes for these events. Probably, the total upstream watershed program would not effect significant stage changes for these events.

For the 1938 flood, the routings indicated three-tenths of a foot net stage reduction at the Arthur City gage; one-tenth of a foot at the Index gage; and one-tenth of a foot at the Fulton gage. With the total upstream watershed program in place, reduction estimates are three-tenths of a foot at the Arthur City gage; two-tenths of a foot at the Index gage; and two-tenths of a foot at the Fulton gage. At the Arthur City gage, note that additional reductions are not attainable because the flow is within bankfull capacity. It is apparent from the hold-out routings that the aggregate upstream watershed program will have beneficial effects on some, but not all, future storms.

The Tulsa District, USAE, furnished information that the SCS used to evaluate the stage effects in monetary terms. The evaluations are considered preliminary since many of the procedures used in arriving at the results are lacking in detail. However, the evaluation results should suffice for basin planning purposes.

Considering the USAE authorized system in place, the average annual flood losses above the Fulton gage are approximately \$203,000. Residual losses occur mainly along that part of the river from the mouth of Blue River to the Index gage. In developing an estimate of total annual benefits expected to accrue to the upstream watershed program, a net stage reduction of two-tenths of a foot was assumed for the range of storm frequencies that produced over-bank flow. Correspondingly, average annual losses prevented above the Fulton gage amount to approximately \$15,000. Allowing approximately \$29,000 for land enhancement and future development, the total annual benefits amount to approximately \$44,000. These benefits amount to about seven cents per acre-foot of detention storage assuming 660,000 acre-feet of detention storage in the potential upstream reservoir system.

According to data presented in the USAE survey report "Boswell Reservoir, Boggy Creek, Oklahoma", the flood losses prevented above the Fulton gage for the 1938 storm amount to approximately \$25,000 per tenth of a foot net stage reduction at the Fulton gage. Using this relationship as a basis for estimate, the flood losses prevented by the aggregate upstream watershed program for this storm are approximately \$50,000.

Information furnished by these investigations provides a basis for assuming that, for most storms, the upstream watershed program will not produce significant stage changes on Red River below the Fulton gage.

IMPACT ON SOIL CONSERVATION AND LAND TREATMENT REQUIREMENTS

Projected land use trends and water and related land resources development will affect land treatment requirements. Amounts and types of conservation practices will be affected. Changes after the 1962 base

period will result from decreases in total land area and Inventory acreage and from major land use changes on the projected Inventory acreage.

Parts of the agricultural land resource base will be converted to water area and to urban and built-up area. A tabulation of these changes (from tables 2, 3, and 66) for the base period and 1980 projections without project development follows:

| Item | 1962 | 1980 | Projected Changes to 1980 |
|------------------|----------------------------------|----------|---------------------------------|
| | - - - - - thousand acres - - - - | | |
| Large water area | 289.3 | 333.6 | + 44.3 |
| Land area | 18,661.0 | 18,616.7 | - 44.3 |
| Inventory area | 17,333.3 | 17,249.8 | - 83.5 |
| Non-Inventory | 1,327.7 | 1,366.9 | + 39.2 |
| Total Study Area | 18,950.3 | 18,950.3 | 0 |

These data show that the land treatment requirements will decrease by 44,300 acres. Another 39,200 acres shift into urban and built-up area and will no longer require application of agricultural and forestry conservation practices.

Major land use changes will be produced with project development. These are summarized in Table 71 by land resource areas.

Project development will increase cropland acreage in each land resource area. Pasture and range acreages will decrease in all land resource areas except in the Southern Mississippi Valley Alluvium and Silty Uplands Land Resource Areas, which increase about 14 percent. Forest and woodland acreages decrease in all resource areas.

The data indicate the direction of changes that will be required in total amounts of conservation practices for the major land uses. On-farm drainage can be expected to increase substantially in the Southern Mississippi Valley Alluvium to stay in pace with project development. Irrigation conservation practices in Louisiana will need to be developed concurrently with structural features of watershed projects.

Watershed protection is a major purpose of all potential upstream watershed projects. An effective conservation program, based upon the use of each acre of land within its capabilities and upon its treatment in accordance with its needs for protection and improvement, is necessary for sound watershed protection and structural programs in potential watershed projects. Establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use are basic to watershed project development.

Table 71 - Major Land Use Changes with Project Development by Land Resource Areas, Red River Basin Study Area

| Land Resource Area and Major Land Use | 1980 | 1980 | Changes |
|--|-----------------------|-----------------------|-------------|
| | Without | With | With |
| | Project | Project | Project |
| | Development <u>1/</u> | Development <u>2/</u> | Development |
| - - - - - thousand acres - - - - - | | | |
| Texas Blackland Prairie (86) | | | |
| Cropland | 831.2 | 1,174.5 | + 343.3 |
| Pasture-Range | 653.4 | 305.5 | - 347.9 |
| Forest-Woodland | 261.7 | 201.9 | - 59.8 |
| Other Land | 30.9 | 32.4 | + 1.5 |
| Subtotal | 1,777.2 | 1,714.3 | - 62.9 |
| Southern Mississippi Valley Alluvium and Silty Uplands (131,134) | | | |
| Cropland | 622.6 | 892.4 | + 269.8 |
| Pasture-Range | 640.6 | 685.2 | + 44.6 |
| Forest-Woodland | 1,173.6 | 815.0 | - 358.6 |
| Other Land | 63.3 | 76.0 | + 12.7 |
| Subtotal | 2,500.1 | 2,468.6 | - 31.5 |
| Grand Prairie and Cherokee Prairies (85,112) | | | |
| Cropland | 201.7 | 271.7 | + 70.0 |
| Pasture-Range | 598.2 | 558.3 | - 39.9 |
| Forest-Woodland | 239.3 | 200.0 | - 39.3 |
| Other Land | 100.4 | 105.4 | + 5.0 |
| Subtotal | 1,139.6 | 1,135.4 | - 4.2 |
| Central Rolling Red Prairies, Cross Timbers, and Southern Coastal Plain (80, 84, 84a, 133) | | | |
| Cropland | 1,162.1 | 1,367.8 | + 205.7 |
| Pasture-Range | 1,227.0 | 1,024.5 | - 202.5 |
| Forest-Woodland | 6,529.3 | 6,096.6 | - 432.7 |
| Other Land | 203.8 | 264.9 | + 61.1 |
| Subtotal | 9,122.2 | 8,753.8 | - 368.4 |
| Ouachita Mountains (119) | | | |
| Cropland | 47.2 | 56.3 | + 9.1 |
| Pasture-Range | 148.9 | 153.2 | + 4.3 |
| Forest-Woodland | 2,500.0 | 2,481.4 | - 18.6 |
| Other Land | 14.6 | 19.0 | + 4.4 |
| Subtotal | 2,710.7 | 2,709.9 | - 0.8 |
| Entire Study Area | | | |
| Cropland | 2,864.8 | 3,762.7 | + 897.9 |
| Pasture-Range | 3,268.1 | 2,726.7 | - 541.4 |
| Forest-Woodland | 10,703.9 | 9,788.9 | - 915.0 |
| Other Land | 413.0 | 497.7 | + 84.7 |
| Total | 17,249.8 | 16,776.0 | - 473.8 |

1/ From Exhibit 5

2/ From Exhibit 37

Treatment on drainage areas above structural improvements is necessary to reduce the rate of deterioration in the uplands and to prevent excessive sediment accumulation in reservoirs and channels. Land treatment measures will reduce soil erosion, sediment production, and storm runoff by improving the soil-water relationship. Land treatment measures on drainage areas that do not discharge runoff

through structural improvements will serve to reduce floodwater and sediment damage to floodplain lands.

Potential project development would require special emphasis on the establishment of those land treatment practices that have a measurable effect on reduction of floodwater and sediment damages and on costs of providing sediment storage capacity in reservoirs. Acceleration of land treatment establishment would be required in potential project areas.

USDA WATER AND RELATED LAND RESOURCE PROJECTS AND MEASURES
RECOMMENDED FOR EARLY ACTION

EARLY-ACTION PROGRAM

USDA investigations show that projects and measures included for early action are feasible and are urgently needed to solve watershed problems and meet estimated needs through 1980. All projects have been coordinated with interested agencies and some projects are interrelated with project development proposed by other agencies.

Watersheds listed for early action have acute problems that can be solved under the USDA upstream watershed program. Problems include floodwater, sediment, erosion, inadequate drainage, pollution, drought, water supply, and recreation. In addition to solving problems within the watershed, the early-action watershed program can help alleviate related problems that occur outside the watershed areas and contribute to meeting estimated needs within the basin. Single-purpose projects also are needed to meet acute shortages. These would include reservoirs for recreational development and municipal and industrial water supplies.

The USAE proposed reservoir projects in some watersheds in which USDA projects have been proposed. These include Bonham, Durant, Parker, and Kisatchie Reservoirs in CNI Watersheds 3-25a, 3-23, 3h2-4, and 3-64. USDA developed alternate plans for these watersheds to accommodate USAE proposals. All of the projects will be considered by the Plan Formulation Task Force in basin plan development. Projects selected for the basin plan will be shown in the Plan Formulation Appendix.

Multiple-Purpose Projects

Watershed Improvements

Multiple-purpose watershed project plans were formulated for all CNI watersheds that urgently need development within the next 10-15 years. The installation of reservoirs, channel improvement, sediment control structures, erosion control, and water control structures would provide direct flood prevention, erosion control, and drainage improvements benefits along the floodplains of the watersheds. These structural improvements would provide protection that cannot be attained by land treatment measures alone. Selected reservoir sites could be developed for multiple-purpose use by including storage for water supply, recreation, water quality control, and irrigation purposes.

Approximately 6,967 square miles, or about 24 percent of the Study Area, are included in the CNI watersheds recommended for early action. Watershed locations are shown in Figure 13. Structural measures that could be installed include 459 floodwater retarding and multiple-purpose reservoirs, 15 water control structures, seven erosion control structures, one sediment control structure, and 1,479 miles of flood prevention, drainage, and irrigation channels. Pertinent structural data are summarized in Table 72.

Table 72 - Pertinent Structural Data - Multiple-Purpose Projects for Early Action, Red River Basin Study Area

| Tributary: | : | : | : | : | : | : | : | : | : | Surface | Additional | | |
|--|----------|----------|------------|-------------|---------|-------------|----------|-----------|-----------|----------|------------|---------|---------|
| Basin and: | Water-- | Drainage | Structural | Measures | Channel | Pool | Capacity | Area of | Reservoir | | | | |
| CNI | Planning | shed | Area | Reservoirs | Other | Improve | ment | Detention | Sediment | Other | Pool | Storage | |
| Watershed: | Status | 1/ | Area | Controlled: | 2/ | Reservoirs: | Other | 3/ | 4/ | 5/ | 6/ | 7/ | |
| | | | (sq.mi.) | (sq.mi.) | number | number | miles | (ac.ft.) | acres | (ac.ft.) | | | |
| Intervening Areas - Texas | | | | | | | | | | | | | |
| 3-19 | A | | 262.5 | 112.6 | 41 | 7 | EC | 25.0 | 43,106 | 11,699 | 2,990 R | 2,508 | 0 |
| | | | | | | | | | | | 24,127 M | | |
| | | | | | | | | | | | 101 I | | |
| 3-25 | C | | 208.4 | 102.0 | 20 | 0 | | 22.0 | 34,420 | 9,760 | 0 | 1,505 | 58,180 |
| 3-25a | C | | 222.6 | 94.8 | 21 | 0 | | 8.0 | 35,710 | 8,620 | 1,580 R | 2,280 | 43,700 |
| | | | | | | | | | | | 5,750 W | | |
| | | | | | | | | | | | 10,400 M | | |
| 3-27 | A | | 11.5 | 4.0 | 3 | 0 | | 12.1 | 1,336 | 303 | 0 | 61 | 0 |
| 3-29 | C | | 22.8 | 1.5 | 2 | 1 | SC | 28.6 | 490 | 140 | 480 R | 98 | 0 |
| 3-33 | A | | 186.0 | 84.0 | 19 | 0 | | 19.5 | 31,793 | 4,380 | 0 | 670 | 0 |
| Total | | | 913.8 | 398.9 | 106 | 8 | | 115.2 | 146,855 | 34,902 | 45,428 | 7,122 | 101,880 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | | | | |
| 3-35 | D | | 26.0 | 12.0 | 1 | 0 | | 8.5 | 4,925 | 576 | 394 R | 65 | 5,770 |
| 3-39 | A | | 67.8 | 18.4 | 12 | 0 | | 68.0 | 4,537 | 702 | 0 | 167 | 0 |
| 3-40 | D | | 86.4 | 28.0 | 3 | 0 | | 21.2 | 8,634 | 1,350 | 0 | 164 | 10,460 |
| 3-41 | C | | 89.8 | 32.0 | 11 | 0 | | 27.0 | 10,940 | 1,950 | 450 R | 463 | 30,140 |
| 3-46 | A | | 24.0 | 8.4 | 2 | 0 | | 16.6 | 3,080 | 293 | 0 | 71 | NA |
| Total | | | 294.0 | 98.8 | 29 | 0 | | 141.3 | 32,116 | 4,871 | 844 | 930 | 46,370 |
| Blue River | | | | | | | | | | | | | |
| 3-23 | C | | 160.4 | 167.3 | 30 | 0 | | 0 | 66,510 | 13,570 | 1,000 F | 2,520 | 48,680 |
| | | | | | | | | | | | 2,000 R | | |
| | | | | | | | | | | | 8,060 M | | |
| | | | | | | | | | | | 2,050 W | | |
| Total | | | 360.4 | 167.3 | 30 | 0 | | 0 | 66,510 | 13,570 | 13,110 | 2,520 | 48,680 |
| Boggy Creek | | | | | | | | | | | | | |
| 3h1-2 | A | | 375.5 | 161.8 | 37 | 0 | | 2.0 | 43,811 | 6,957 | 0 | 1,302 | NA |
| 3h1-3 | A | | 47.7 | 32.2 | 14 | 0 | | 0 | 8,865 | 1,423 | 0 | 286 | NA |
| 3h2-4 | D | | 225.4 | 155.0 | 25 | 0 | | 0 | 49,250 | 8,250 | 2,000 M | NA | NA |
| 3h2-6 | B, D | | 322.2 | 199.0 | 55 | 0 | | 0 | 63,500 | 10,600 | 2,000 M | NA | NA |
| Total | | | 970.8 | 548.0 | 131 | 0 | | 2.0 | 165,426 | 27,230 | 5,000 | 1,588 | NA |
| Kiamichi River | | | | | | | | | | | | | |
| 3i-2 | A | | 14.3 | 2.0 | 2 | 0 | | 12.0 | 609 | 103 | 0 | 24 | 0 |
| 3i-4 | B | | 62.0 | 37.8 | 10 | 0 | | 8.5 | 12,288 | 2,142 | 1,350 R | 873 | 0 |
| | | | | | | | | | | | 3,000 M | 0 | |
| 3i-8 | A | | 59.4 | 24.9 | 4 | 0 | | 0 | 9,285 | 1,083 | 2,600 M | 70 | NA |
| Total | | | 135.7 | 64.7 | 16 | 0 | | 20.5 | 22,182 | 3,328 | 6,950 | 967 | NA |
| Barkman Creek | | | | | | | | | | | | | |
| 3-47 | C | | 4.0 | - | - | - | | 4.0 | - | - | - | - | - |
| 3-48 | C | | 69.0 | - | - | - | | 19.0 | - | - | - | - | - |
| Total | | | 73.0 | - | - | - | | 23.0 | - | - | - | - | - |
| Little River | | | | | | | | | | | | | |
| 3j-4 | C | | 147.0 | 47.4 | 14 | 0 | | 0 | 21,120 | 3,390 | 320 R | 580 | 30,790 |
| Total | | | 147.0 | 47.4 | 14 | 0 | | 0 | 21,120 | 3,390 | 320 | 580 | 30,790 |
| McKinney Bayou | | | | | | | | | | | | | |
| 3-52 | C | | 195.8 | 31.0 | 4 | 0 | | 78.0 | 14,870 | 800 | 1,410 R | 408 | 13,740 |
| 3-53 | C | | 86.3 | - | - | - | | 71.0 | - | - | - | - | - |
| 3-54 | C | | 45.1 | - | - | - | | 33.0 | - | - | - | - | - |
| Total | | | 327.2 | 31.0 | 4 | 0 | | 182.0 | 14,870 | 800 | 1,410 | 408 | 13,740 |
| Sulphur River | | | | | | | | | | | | | |
| 3k-9 | D | | 98.0 | 46.0 | 7 | 0 | | 0 | 18,320 | 7,624 | 0 | 610 | 0 |
| 3k-11 | D | | 6.0 | 5.0 | 1 | 0 | | 0 | 3,065 | 540 | 324 R | 240 | 0 |
| | | | | | | | | | | | 354 M | | |
| 3k-12 | C | | 30.0 | 11.3 | 3 | 0 | | 0 | 4,870 | 970 | 0 | 154 | 3,480 |
| 3k-14 | C | | 319.7 | 12.7 | 1 | 0 | | 0 | 5,690 | 1,860 | 1,250 R | 306 | 0 |
| 3k-17 | C | | 211.0 | 49.2 | 21 | 0 | | 16.0 | 17,280 | 4,090 | 0 | 880 | 5,710 |
| 3k-18 | C | | 121.0 | 61.0 | 23 | 0 | | 0 | 21,140 | 5,950 | 700 W | 1,190 | 10,010 |
| Total | | | 785.7 | 185.2 | 56 | 0 | | 16.0 | 70,365 | 21,034 | 2,628 | 3,380 | 19,200 |

Table 72 - Pertinent Structural Data - Multiple-Purpose Projects for Early Action, Red River Basin Study Area -- Continued

| Tributary: | : | : | : | : | : | : | : | : | : | Surface | Additional |
|--------------------------------|------------------------|----------|-------------|-------------|-----------------------|---------|---------------|-----------|-----------------------|----------------------|------------|
| Basin and: | Water-- | Drainage | Structural | Measures: | Channel | : | Pool Capacity | : | Area of | Reservoir | : |
| CNI | Planning: | shed | Area | : | Improve-- | : | : | : | Permanent | Storage | : |
| Watershed: | Status ^{1/} : | Area | Controlled: | Reservoirs: | Other ^{2/} : | ment | Detention: | Sediment: | Other ^{3/} : | Pool ^{4/} : | Available |
| | (sq.mi.) | (sq.mi.) | number | number | miles | - - - | (ac.ft.) | - - - | acres | (ac.ft.) | |
| Posten Bayou | | | | | | | | | | | |
| 3-57 C | 95.8 | 0 | 1 | 0 | 39.2 | 0 | 130 | 500 R | 120 | 0 | |
| Total | 95.8 | 0 | 1 | 0 | 39.2 | 0 | 130 | 500 R | 120 | 0 | |
| Red River Main Stem | | | | | | | | | | | |
| 3-60 D | 37.6 | - | - | - | 9.0 | - | - | - | - | - | |
| Total | 37.6 | - | - | - | 9.0 | - | - | - | - | - | |
| Loggy Bayou | | | | | | | | | | | |
| 3m-1 A | 13.4 | 3.8 | 1 | 0 | 3.0 | 1,175 | 98 | 0 | 20 | NA | |
| 3m1-7 C | 140.2 | 54.4 | 9 | 0 | 21.8 | 25,010 | 1,090 | 820 R | 2,813 | 5,300 | |
| | | | | | | | | 20,300 M | | | |
| | | | | | | | | 6,000 W | | | |
| 3m2-3 A | 232.0 | - | 2 | 11 WC | 55.0 ^{5/} | 0 | 1,590 | 6,010 R | 3,850 | NA | |
| | | | | | | | | 19,650 I | | | |
| | | | | | | | | 4,350 M | | | |
| Total | 385.6 | 58.2 | 12 | 11 WC | 79.8 | 26,185 | 2,778 | 57,130 | 6,683 | 5,300 | |
| Bayou Pierre | | | | | | | | | | | |
| 3n-2 C | 144.1 | 63.9 | 9 | 0 | 12.0 ^{5/} | 27,450 | 2,080 | 5,100 I | 2,659 | 52,810 | |
| | | | | | | | | 7,540 R | | | |
| Total | 144.1 | 63.9 | 9 | 0 | 12.0 | 27,450 | 2,080 | 12,640 | 2,659 | 52,810 | |
| Cane River | | | | | | | | | | | |
| 3-64 D | 162.8 | 89.9 | 10 | 0 | 10.0 | 32,471 | 4,372 | 52,560 M | 4,070 | NA | |
| 3-65 D | 378.3 | 257.0 | 23 | 0 | 5.0 ^{5/} | 103,933 | 12,244 | 807 R | 4,691 | NA | |
| | | | | | | | | 49,278 I | | | |
| 3-66 D | 161.7 | 63.9 | 5 | 0 | 45.0 | 23,461 | 2,820 | 902 R | 291 | NA | |
| Total | 702.8 | 410.8 | 38 | 0 | 60.0 | 159,865 | 19,436 | 103,547 | 9,052 | NA | |
| Bayou Rigolette | | | | | | | | | | | |
| 3-69 C | 31.5 | - | - | - | 18.0 | - | - | - | - | - | |
| 3-70 C | 386.2 | 116.8 | 11 | 0 | 63.0 | 54,940 | 3,440 | 3,200 R | 986 | 105,950 | |
| Total | 417.7 | 116.8 | 11 | 0 | 81.0 | 54,940 | 3,440 | 3,200 | 986 | 105,950 | |
| Red River Backwater | | | | | | | | | | | |
| 3-73 D | 60.8 | - | - | - | 29.0 | - | - | - | - | - | |
| 3-75 D | 173.5 | - | - | - | 70.0 | - | - | - | - | - | |
| 3-76 D | 37.0 | - | - | - | 28.0 | - | - | - | - | - | |
| Total | 271.3 | - | - | - | 127.0 | - | - | - | - | - | |
| Chatlin Lake & Associated Area | | | | | | | | | | | |
| 10-10 A, D | 169.3 | - | - | - | 80.0 | - | - | - | - | - | |
| 10-11 & 10-12 A | 103.4 | - | - | - | 83.0 | - | - | - | - | - | |
| 10-13 & 10-14 B, D | 375.8 | - | - | - | 249.0 | - | - | - | - | - | |
| 10-15 A | 180.0 | - | 2 | 4 WC | 24.4 ^{5/} | - | 1,450 | 10,860 R | 4,170 | - | |
| | | | | | | | | 37,690 I | | | |
| 10-16 B, D | 71.6 | - | - | - | 135.0 | - | - | - | - | - | |
| Total | 904.6 | - | 2 | 4 WC | 571.4 | - | 1,450 | 48,550 | 4,170 | - | |
| Grand Total | 6,967.1 | 2,191.0 | 459 | 23 | 1,479.4 | 807,884 | 138,439 | 301,257 | 41,165 | 424,720 | |

1/ Abbreviations: A - Watershed approved for operation; B - Workplan investigations underway; C - River Basin watershed investigation report completed; D - Field examination scope study completed
 2/ Abbreviations for other structures: EC - Erosion Control; SC - Sediment Control; WC - Water Control
 3/ Abbreviations for other pool capacities: R - Recreation; M - Municipal; I - Irrigation; W - Water Quality Control; F - Fish and Wildlife
 4/ Total surface area at principal spillway elevation
 5/ Multiple-Purpose channel - Irrigation and drainage

Tabulated structural data were derived from watershed work plans, river basin investigation reports, and field examination scope studies. Data included in watershed work plans were developed from detail field

survey and design by the respective states. Investigation report data were developed using field survey data, quadrangle data, and other available data. Field examination scope studies data were developed from quadrangle maps and curves of structural measures in similar land resource areas. The intensity of studies for each watershed is shown under planning status in Table 72.

Potential storage of the floodwater retarding and multiple-purpose reservoirs is approximately 1,247,580 acre-feet divided as follows: 138,439 acre-feet for sediment accumulation, 44,187 acre-feet for recreation, 129,751 acre-feet for municipal and industrial water supply, 111,819 acre-feet for irrigation, 14,500 acre-feet for water quality control, 1,000 acre-feet for fish and wildlife, and 807,884 acre-feet for flood detention. Multiple-purpose reservoir storage was allocated to purposes based on water resource development needs in each watershed.

Channel improvement provides adequate outlets for floodwater retarding structure releases and on-farm drainage systems. Approximately 96 miles of multiple-purpose channel could provide a delivery system and drainage outlets for irrigation water.

The upstream watershed program offers excellent opportunities for developing recreation resources by including recreation water storage in favorably located multiple-purpose reservoirs. Recreation facilities for picnicking, boating, fishing, camping, and swimming could be included in conjunction with reservoir site development.

Based on physical characteristics of the sites and water yield, an additional 424,720 acre-feet of storage is available in some of the 459 reservoir sites. Additional potential storage was computed only for watersheds where basin investigation reports were made. Data were not available for determining the additional storage potential in areas with watershed work plans and field examination scope studies. A dependable runoff yield and physical limitation of the sites related to topography and cultural development were the criteria used in determining additional storage possibilities. Sediment and flood detention requirements were not considered a part of the additional storage.

Installation Costs

The structural installation costs data were tabulated from watershed work plans and from watershed investigation reports. Field examination scope study data were used for some watersheds.

Structural costs included in investigation reports were based on unit costs of structural measures in similar areas. Ten percent was added as a contingency to provide funds for unpredictable construction costs. Unit costs were modified to reflect special conditions for establishing protective vegetation and size of principal spillway. Estimated values of land required for rights-of-way were based on appraisals made by local landowners and SCS personnel. Costs of legal fees, administration of contracts, and installation services that

include engineering and administrative costs are based on SCS experience for similar works.

Structural costs included in field examination scope studies were estimated based on data developed for structural measures in similar areas.

Prices current at the time of project planning were used for estimating installation costs. These range from 1961 to 1967.

The estimated installation cost of the potential projects is \$108,643,510. Of this amount, \$70,491,280 would be expended for construction, \$19,910,620 for installation services; \$17,239,470 for land, easements, and rights-of-way, and \$502,140 for administration of contracts. The estimated structural installation costs are summarized for individual watershed projects in Table 73.

Allocation of Cost and Cost Sharing

Structural installation costs were allocated to purposes proportionately to the use of facilities. In all multiple-purpose reservoirs that include floodwater retardation storage, costs for sediment storage were allocated to the flood prevention purpose. Total installation costs are \$108,643,510. Of these costs, about \$74,323,567 would be borne by Federal funds and the remaining \$34,319,943 would be provided by non-Federal funds. Cost allocation and cost sharing for watershed projects is shown in Table 74.

Project Benefits

Benefits from structural measures total \$12,216,205 annually. Reduction of damages amounting to \$4,494,275 comprises the major item of benefits. Benefits of \$1,430,460 annually are expected from more intensive and changed land use. Additional Red River main stem benefits above Fulton, Arkansas, estimated at \$29,150 annually, will accrue from structural measures in watersheds above Fulton. There are also damage reduction benefits estimated at \$178,710 annually from land treatment measures in these watersheds. Agricultural water management benefits are estimated at \$2,247,895 from improved drainage and \$797,620 from irrigation. Benefits from nonagricultural water management are estimated at \$427,770 for municipal and industrial water supply, \$56,000 for water quality control, and \$1,247,030 for recreation. Benefits from potential watershed projects are summarized in Table 75.

The amount of municipal and industrial water supply storage, annual benefits, and benefited communities are summarized by CNI watersheds in Exhibit 38. Water quality storage, pollution source, and annual benefits are summarized by watersheds in Exhibit 39. Recreation benefits from multiple-purpose reservoirs and incidental recreation from sediment pools of flood prevention reservoirs are valued at \$1,247,090 annually from an estimated 885,900 visitor-days of recreation use. These are summarized by CNI watersheds in Exhibit 40.

Table 73 - Estimated Structural Installation Cost - Multiple-Purpose Projects for Early Action, Red River Basin Study Area

| Watershed | Basin and CNL | Planning Status | Construction | | | | | Installation Services | Land, Easements, and Right-of-Way | Administration | Total | Price Base | Year |
|--|---------------|-------------------|---------------------------------|-----------------------------|---------------------|---------------------|------------------|-----------------------|-----------------------------------|-------------------|----------------|--------------------|-------------|
| | | | Floodwater Retarding Structures | Multiple Purpose Structures | Other Z/ Structures | Channel Improvement | Basin Facilities | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | | | | |
| 3-19 | A | 2,081,200 | 2,263,800 | 165,950 | EC | 399,300 | 425,810 | 5,336,060 | 1,137,600 | 2,204,240 | 39,500 | 8,717,400 | 1965 |
| 3-25 | C | 1,277,100 | 0 | 0 | | 1,390,400 | 0 | 2,667,500 | 692,000 | 729,630 | 12,670 | 4,101,800 | 1966 |
| 3-25a | C | 826,870 | 729,630 | 0 | | 356,400 | 165,000 | 2,077,900 | 460,230 | 848,790 | 10,380 | 3,397,300 | 1966 |
| 3-27 | A | 133,430 | 0 | 0 | | 143,440 | 0 | 276,870 | 76,460 | 63,170 | 3,500 | 420,000 | 1962 |
| 3-29 | C | 24,710 | 47,950 | 9,380 | SC | 123,150 | 5,000 | 210,190 | 54,530 | 40,880 | 3,600 | 309,200 | 1967 |
| 3-33 | A | 1,269,180 | 0 | 0 | | 737,770 | 0 | 2,006,950 | 484,130 | 558,820 | 10,000 | 3,059,900 | 1962 |
| Total | | 5,612,490 | 3,041,380 | 175,330 | | 3,150,460 | 595,810 | 12,575,470 | 2,904,950 | 4,445,530 | 79,650 | 20,005,600 | ---- |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | | | | |
| 3-35 | D | 0 | 264,300 | 0 | | 44,570 | 165,000 | 473,870 | 129,240 | 77,050 | 2,150 | 682,310 | 1965 |
| 3-39 | A | 205,530 | 0 | 0 | | 774,180 | 0 | 979,710 | 263,090 | 474,190 | 13,420 | 1,730,410 | 1961 |
| 3-40 | B | 265,560 | 0 | 0 | | 161,150 | 0 | 426,710 | 116,380 | 64,130 | 1,940 | 609,160 | 1965 |
| 3-41 | C | 393,360 | 110,660 | 0 | | 279,300 | 165,000 | 1,148,300 | 310,010 | 145,300 | 5,230 | 1,608,840 | 1966 |
| 3-46 | A | 202,510 | 0 | 0 | | 257,180 | 0 | 459,690 | 124,100 | 73,830 | 2,090 | 659,710 | 1964 |
| Total | | 1,266,940 | 374,960 | 0 | | 1,516,380 | 330,000 | 3,488,280 | 942,820 | 834,500 | 24,830 | 5,290,430 | ---- |
| Blue River | | | | | | | | | | | | | |
| 3-23 | C | 1,964,270 | 1,121,220 | 0 | | 0 | 165,000 | 3,250,490 | 871,790 | 1,486,380 | 14,670 | 5,623,330 | 1966 |
| Total | | 1,964,270 | 1,121,220 | 0 | | 0 | 165,000 | 3,250,490 | 871,790 | 1,486,380 | 14,670 | 5,623,330 | ---- |
| Boggy Creek | | | | | | | | | | | | | |
| 3n1-2 | A | 1,844,850 | 0 | 0 | | 35,380 | 0 | 1,885,230 | 488,280 | 347,960 | 11,100 | 2,732,570 | 1961 |
| 3n1-3 | A | 453,460 | 0 | 0 | | 0 | 0 | 453,460 | 118,610 | 60,000 | 4,200 | 636,270 | 1961 |
| 3n2-4 | D | 1,475,000 | 196,000 | 0 | | 0 | 0 | 2,171,000 | 507,000 | 203,000 | 7,500 | 2,888,500 | 1966 |
| 3n2-6 | B,D | 2,870,000 | 414,630 | 0 | | 0 | 165,000 | 3,449,630 | 836,150 | 473,100 | 17,780 | 4,776,660 | 1966 |
| Total | | 7,148,310 | 610,630 | 0 | | 35,380 | 165,000 | 7,959,320 | 1,950,040 | 1,084,060 | 40,580 | 11,034,000 | ---- |
| Kiamichi River | | | | | | | | | | | | | |
| 3i-2 | A | 73,700 | 0 | 0 | | 216,950 | 0 | 290,650 | 78,040 | 110,260 | 3,050 | 482,000 | 1963 |
| 3i-4 | B | 430,500 | 259,030 | 0 | | 221,060 | 142,060 | 1,052,650 | 240,230 | 239,610 | 8,280 | 1,540,770 | 1963 |
| 3i-8 | A | 882,540 | 126,050 | 0 | | 0 | 0 | 1,008,590 | 200,950 | 20,980 | 1,600 | 1,232,120 | 1962 |
| Total | | 1,386,740 | 385,080 | 0 | | 438,010 | 142,060 | 2,351,890 | 519,220 | 370,850 | 12,930 | 3,254,890 | ---- |
| Barkman Creek | | | | | | | | | | | | | |
| 3-47 | C | 0 | 0 | 0 | | 34,100 | 0 | 34,100 | 9,210 | 19,430 | 160 | 62,900 | 1967 |
| 3-48 | C | 0 | 0 | 0 | | 224,510 | 0 | 224,510 | 60,590 | 118,060 | 1,020 | 404,180 | 1967 |
| Total | | 0 | 0 | 0 | | 258,610 | 0 | 258,610 | 69,800 | 137,490 | 1,180 | 467,080 | ---- |
| Little River | | | | | | | | | | | | | |
| 3i-4 | C | 1,688,060 | 314,930 | 0 | | 0 | 165,000 | 2,167,990 | 585,310 | 298,760 | 9,870 | 3,061,930 | 1967 |
| Total | | 1,688,060 | 314,930 | 0 | | 0 | 165,000 | 2,167,990 | 585,310 | 298,760 | 9,870 | 3,061,930 | ---- |
| McKinney Bayou^{1/} | | | | | | | | | | | | | |
| 3-52 | C | 245,960 | 173,690 | 0 | | 545,820 | 165,000 | 1,130,470 | 305,180 | 316,550 | 5,140 | 1,757,340 | 1967 |
| 3-53 | C | 0 | 0 | 0 | | 626,120 | 0 | 626,120 | 169,030 | 201,360 | 2,850 | 999,360 | 1967 |
| 3-54 | C | 0 | 0 | 0 | | 182,310 | 0 | 182,310 | 49,220 | 107,360 | 830 | 339,720 | 1967 |
| Total | | 245,960 | 173,690 | 0 | | 1,354,250 | 165,000 | 1,938,900 | 523,430 | 625,270 | 8,820 | 3,096,420 | ---- |
| Sulphur River | | | | | | | | | | | | | |
| 3k-9 | D | 561,690 | 0 | 0 | | 0 | 0 | 561,690 | 199,140 | 97,020 | 2,550 | 860,400 | 1965 |
| 3k-11 | D | 0 | 82,140 | 0 | | 0 | 110,000 | 192,140 | 31,630 | 73,500 | 870 | 298,140 | 1965 |
| 3k-12 | C | 196,680 | 0 | 0 | | 0 | 0 | 196,680 | 49,260 | 125,400 | 980 | 372,320 | 1967 |
| 3k-14 | C | 0 | 309,650 | 16,720 | EC | 0 | 165,000 | 491,370 | 96,090 | 152,300 | 2,460 | 742,220 | 1967 |
| 3k-17 | C | 888,470 | 0 | 0 | | 127,160 | 0 | 1,015,630 | 277,760 | 445,970 | 5,070 | 1,744,430 | 1967 |
| 3k-18 | C | 899,690 | 90,530 | 0 | | 0 | 0 | 990,220 | 277,660 | 546,330 | 4,970 | 1,819,180 | 1967 |
| Total | | 2,546,530 | 482,320 | 16,720 | | 127,160 | 275,000 | 3,447,730 | 931,540 | 1,440,520 | 16,900 | 5,836,690 | ---- |
| Posten Bayou^{2/} | | | | | | | | | | | | | |
| 3-57 | C | 0 | 0 | 115,000 | | 617,300 | 172,000 | 904,300 | 242,800 | 187,200 | 3,900 | 1,338,200 | 1965 |
| Total | | 0 | 0 | 115,000 | | 617,300 | 172,000 | 904,300 | 242,800 | 187,200 | 3,900 | 1,338,200 | ---- |
| Red River Main Stem | | | | | | | | | | | | | |
| 3-60 | D | 0 | 0 | 0 | | 53,460 | 0 | 53,460 | 16,520 | 9,480 | 240 | 79,700 | 1966 |
| Total | | 0 | 0 | 0 | | 53,460 | 0 | 53,460 | 16,520 | 9,480 | 240 | 79,700 | ---- |
| Loggy Bayou | | | | | | | | | | | | | |
| 3n-1 | A | 68,520 | 0 | 0 | | 11,950 | 0 | 80,470 | 27,530 | 28,400 | 1,600 | 138,000 | 1964 |
| 3n1-7 | C | 748,150 | 1,735,640 | 0 | | 398,970 | 191,810 | 3,074,570 | 830,050 | 690,110 | 13,970 | 4,608,700 | 1967 |
| 3n2-3 | A | 0 | 3,748,440 | 320,320 | WC | 413,190 | 748,550 | 5,230,500 | 1,711,260 | 1,342,640 | 100,500 | 8,384,900 | 1965 |
| Total | | 816,670 | 5,484,080 | 320,320 | | 824,110 | 940,360 | 8,385,540 | 2,568,840 | 2,061,150 | 116,070 | 13,131,600 | ---- |
| Bayou Pierre | | | | | | | | | | | | | |
| 3n-2 | C | 810,700 | 740,300 | 0 | | 112,200 | 165,000 | 1,828,200 | 640,680 | 411,340 | 8,300 | 2,888,520 | 1966 |
| Total | | 810,700 | 740,300 | 0 | | 112,200 | 165,000 | 1,828,200 | 640,680 | 411,340 | 8,300 | 2,888,520 | ---- |
| Cane River | | | | | | | | | | | | | |
| 3-64 | D | 303,980 | 1,819,470 | 0 | | 110,000 | 0 | 2,233,450 | 791,840 | 513,600 | 10,160 | 3,549,050 | 1965 |
| 3-65 | D | 1,520,880 | 3,107,940 | 0 | | 376,750 | 330,000 | 5,335,570 | 1,876,710 | 1,104,250 | 24,250 | 8,340,780 | 1965 |
| 3-66 | D | 475,830 | 286,990 | 0 | | 321,750 | 330,000 | 1,414,570 | 486,530 | 278,430 | 6,430 | 2,185,960 | 1965 |
| Total | | 2,300,690 | 5,214,400 | 0 | | 808,500 | 660,000 | 8,983,590 | 3,155,080 | 1,896,280 | 40,840 | 14,075,790 | ---- |
| Bayou Rigolette^{2/} | | | | | | | | | | | | | |
| 3-69 | C | 0 | 0 | 0 | | 116,820 | 0 | 116,820 | 36,210 | 59,200 | 530 | 212,760 | 1966 |
| 3-70 | C | 1,660,010 | 514,910 | 0 | | 1,408,330 | 165,000 | 3,748,250 | 1,242,260 | 744,750 | 17,020 | 5,752,280 | 1966 |
| Total | | 1,660,010 | 514,910 | 0 | | 1,525,150 | 165,000 | 3,865,070 | 1,278,470 | 803,950 | 17,550 | 5,965,040 | ---- |
| Red River Backwater | | | | | | | | | | | | | |
| 3-73 | D | 0 | 0 | 0 | | 142,660 | 0 | 142,660 | 44,100 | 25,290 | 650 | 212,700 | 1966 |
| 3-75 | D | 0 | 0 | 0 | | 345,400 | 0 | 345,400 | 106,760 | 61,230 | 1,570 | 514,960 | 1966 |
| 3-76 | D | 0 | 0 | 1,207,200 | Pump | 138,340 | 0 | 1,345,540 | 384,800 | 24,520 | 5,660 | 1,760,520 | 1966 |
| Total | | 0 | 0 | 1,207,200 | | 626,400 | 0 | 1,833,600 | 535,660 | 111,040 | 7,880 | 2,488,180 | ---- |
| Chatin Lake and Associated Areas | | | | | | | | | | | | | |
| 10-10 | B,D | 0 | 0 | 0 | | 200,000 | 0 | 200,000 | 70,910 | 35,180 | 910 | 307,000 | 1965 |
| 10-11 & 10-12 | A | 0 | 0 | 0 | | 766,240 | 0 | 766,240 | 267,030 | 239,450 | 20,000 | 1,292,720 | 1965 |
| 10-13 & 10-14 | B,D | 0 | 0 | 0 | | 1,944,480 | 0 | 1,944,480 | 260,740 | 176,870 | 8,840 | 2,390,930 | 1966 |
| 10-15 | A | 0 | 3,138,300 | 229,090 | WC | 211,240 | 290,690 | 3,869,320 | 1,265,930 | 417,210 | 64,000 | 5,616,460 | 1964 |
| 10-16 | B,D | 0 | 0 | 0 | | 918,800 | 0 | 918,800 | 309,060 | 166,960 | 4,180 | 1,399,000 | 1966 |
| Total | | 0 | 3,138,300 | 229,090 | | 4,040,760 | 290,690 | 7,698,840 | 2,173,670 | 1,035,670 | 97,930 | 11,006,110 | ---- |
| Grand Total | | 27,447,370 | 21,596,200 | 2,063,660 | | 15,488,130 | 4,395,920 | 70,991,280 | 19,910,620 | 17,239,470 | 502,140 | 108,643,510 | ---- |

^{1/} Abbreviations for Planning Status: A - Authorized for operation; B - Workplan investigations underway; C - River Basin watershed investigation report complete; D - Field examination scope studies complete

^{2/} Abbreviations for Other Structures: EC - Erosion Control; SC - Sediment Control; WC - Water Control

^{3/} Does not include USAR costs for major outlets

Table 74 - Allocation of Costs to Purpose and Cost-Sharing Summary Projects for Early Action, Red River Basin Study Area

| Tributary Basin and Watershed | Planning Status | Cost Allocation Purpose | | | | | | Cost-Sharing | | |
|--|-----------------|-------------------------|------------------|-------------------|-------------------|------------------|----------------|--------------------------|-------------------|-------------------|
| | | Flood Prevention | Drainage | Irrigation | Recreation | Industrial | Water Quality | Total Installation Costs | Federal Funds | Non-Federal Funds |
| dollars | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-19 | A | 5,498,980 | 7,400 | 12,740 | 1,125,090 | 2,073,190 | - | 8,717,400 | 4,812,280 | 3,905,120 |
| 3-25 | C | 4,101,800 | - | - | - | - | - | 4,101,800 | 3,359,500 | 742,300 |
| 3-27 | A | 2,609,470 | - | - | 325,280 | 287,380 | 175,170 | 3,397,300 | 2,213,230 | 1,184,070 |
| 3-29 | A | 328,390 | 2/ 91,610 | - | - | - | - | 420,000 | 326,050 | 93,950 |
| 3-29 | C | 158,740 | - | - | 61,420 | - | - | 309,200 | 221,875 | 87,325 |
| 3-33 | A | 3,059,900 | - | - | - | - | - | 3,059,900 | 2,491,080 | 568,820 |
| Total | | 15,757,280 | 188,050 | 12,740 | 1,511,790 | 2,360,570 | 175,170 | 20,005,600 | 13,424,015 | 6,581,585 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | |
| 3-35 | D | 386,820 | 34,790 | - | 260,700 | - | - | 682,310 | 513,500 | 168,810 |
| 3-39 | A | 1,147,455 | 582,955 | - | - | - | - | 1,730,410 | 1,109,456 | 620,954 |
| 3-40 | D | 494,095 | 115,065 | - | - | - | - | 609,160 | 502,800 | 106,360 |
| 3-41 | C | 1,221,780 | 133,530 | - | 253,530 | - | - | 1,608,840 | 1,305,825 | 303,015 |
| 3-46 | A | 499,975 | 159,735 | - | - | - | - | 659,710 | 526,044 | 133,666 |
| Total | | 3,750,125 | 1,026,075 | - | 514,230 | - | - | 5,290,430 | 3,957,625 | 1,332,805 |
| Blue River | | | | | | | | | | |
| 3-23 | C | 4,391,520 | - | - | 427,440 | 710,910 | 93,460 | 5,623,330 | 3,590,650 | 2,032,680 |
| Total | | 4,391,520 | - | - | 427,440 | 710,910 | 93,460 | 5,623,330 | 3,590,650 | 2,032,680 |
| Boggy Creek | | | | | | | | | | |
| 3-1-2 | A | 2,732,570 | - | - | - | - | - | 2,732,570 | 2,373,510 | 359,060 |
| 3-1-3 | A | 636,270 | - | - | - | - | - | 636,270 | 572,070 | 64,200 |
| 3-2-4 | D | 2,727,070 | - | - | - | 161,430 | - | 2,888,500 | 2,536,250 | 352,250 |
| 3-2-6 | B,D | 4,194,050 | - | - | 403,430 | 179,180 | - | 4,776,660 | 3,972,460 | 804,200 |
| Total | | 10,289,960 | - | - | 403,430 | 340,610 | - | 11,034,000 | 9,454,250 | 1,579,750 |
| Kiamichi River | | | | | | | | | | |
| 3i-2 | A | 391,485 | 90,515 | - | - | - | - | 482,000 | 341,895 | 140,105 |
| 3i-4 | B | 910,605 | - | - | 387,630 | 242,535 | - | 1,540,770 | 981,595 | 559,175 |
| 3i-8 | A | 1,232,120 | - | - | - | - | - | 1,232,120 | 1,209,540 | 22,580 |
| Total | | 2,534,210 | 90,515 | - | 387,630 | 242,535 | - | 3,254,890 | 2,533,030 | 721,860 |
| Harkman Creek | | | | | | | | | | |
| 3-47 | C | 32,700 | 30,200 | - | - | - | - | 62,900 | 35,125 | 27,775 |
| 3-48 | C | 210,580 | 193,600 | - | - | - | - | 404,180 | 231,330 | 172,850 |
| Total | | 243,280 | 223,800 | - | - | - | - | 467,080 | 266,455 | 200,625 |
| Little River | | | | | | | | | | |
| 3j-4 | C | 2,795,760 | - | - | 266,170 | - | - | 3,061,930 | 2,653,060 | 408,870 |
| Total | | 2,795,760 | - | - | 266,170 | - | - | 3,061,930 | 2,653,060 | 408,870 |
| McKinney Bayou | | | | | | | | | | |
| 3-52 | C | 1,044,815 | 447,635 | - | 264,890 | - | - | 1,757,340 | 1,206,685 | 550,655 |
| 3-53 | C | 499,680 | 499,680 | - | - | - | - | 999,360 | 638,620 | 360,740 |
| 3-54 | C | 169,860 | 169,860 | - | - | - | - | 339,720 | 185,955 | 153,765 |
| Total | | 1,714,355 | 1,117,175 | - | 264,890 | - | - | 3,096,420 | 2,031,260 | 1,065,160 |
| Sulphur River | | | | | | | | | | |
| 3k-9 | D | 860,400 | - | - | - | - | - | 860,400 | 760,830 | 99,570 |
| 3k-11 | D | 111,840 | - | - | 175,650 | 10,650 | - | 298,140 | 166,750 | 131,390 |
| 3k-12 | C | 372,320 | - | - | - | - | - | 372,320 | 245,940 | 126,380 |
| 3k-14 | C | 449,660 | - | - | 292,560 | - | - | 742,220 | 541,655 | 200,565 |
| 3k-17 | C | 1,744,430 | - | - | - | - | - | 1,744,430 | 1,293,390 | 451,040 |
| 3k-18 | C | 1,767,440 | - | - | - | - | 51,740 | 1,819,180 | 1,228,900 | 590,280 |
| Total | | 5,306,090 | - | - | 468,210 | 10,650 | 51,740 | 5,836,690 | 4,237,465 | 1,599,225 |
| Posten Bayou | | | | | | | | | | |
| 3-57 | C | 461,600 | 461,600 | - | 415,000 | - | - | 1,338,200 | 836,675 | 501,525 |
| Total | | 461,600 | 461,600 | - | 415,000 | - | - | 1,338,200 | 836,675 | 501,525 |
| Red River Main Stem | | | | | | | | | | |
| 3-60 | D | 39,850 | 39,850 | - | - | - | - | 79,700 | 56,615 | 23,085 |
| Total | | 39,850 | 39,850 | - | - | - | - | 79,700 | 56,615 | 23,085 |
| Loggy Bayou | | | | | | | | | | |
| 3m-1 | A | 138,000 | - | - | - | - | - | 138,000 | 108,000 | 30,000 |
| 3m-7 | C | 2,157,490 | - | - | 331,410 | 1,707,720 | 412,080 | 4,608,700 | 2,090,480 | 2,518,220 |
| 3m-3 | A | 338,513 | 207,474 | 4,772,031 | 2,155,575 | 911,307 | - | 8,384,900 | 3,912,440 | 4,472,460 |
| Total | | 2,634,003 | 207,474 | 4,772,031 | 2,486,985 | 2,619,027 | 412,080 | 13,131,600 | 6,110,920 | 7,020,680 |
| Bayou Pierre | | | | | | | | | | |
| 3n-2 | C | 1,855,215 | - | 419,465 | 613,840 | - | - | 2,888,520 | 2,214,205 | 674,315 |
| Total | | 1,855,215 | - | 419,465 | 613,840 | - | - | 2,888,520 | 2,214,205 | 674,315 |
| Cane River | | | | | | | | | | |
| 3-64 | D | 1,823,410 | - | 174,000 | - | 1,551,640 | - | 3,549,050 | 1,641,580 | 1,907,470 |
| 3-65 | D | 5,183,350 | - | 2,603,050 | 554,380 | - | - | 8,340,780 | 6,237,940 | 2,102,840 |
| 3-66 | D | 1,082,080 | - | 508,950 | 594,930 | - | - | 2,185,960 | 1,552,895 | 633,065 |
| Total | | 8,088,840 | - | 3,286,000 | 1,149,310 | 1,551,640 | - | 14,075,790 | 9,432,415 | 4,643,375 |
| Bayou Rigolette | | | | | | | | | | |
| 3-69 | C | 106,380 | 106,380 | - | - | - | - | 212,760 | 123,825 | 88,935 |
| 3-70 | C | 4,242,190 | 1,130,990 | - | 379,100 | - | - | 5,752,280 | 4,526,635 | 1,225,645 |
| Total | | 4,348,570 | 1,237,370 | - | 379,100 | - | - | 5,965,040 | 4,650,460 | 1,314,580 |
| Red River Backwater | | | | | | | | | | |
| 3-73 | D | 106,350 | 106,350 | - | - | - | - | 212,700 | 151,095 | 61,605 |
| 3-75 | D | 257,480 | 257,480 | - | - | - | - | 514,960 | 365,810 | 149,150 |
| 3-76 | D | 880,260 | 880,260 | - | - | - | - | 1,760,520 | 1,393,955 | 366,565 |
| Total | | 1,244,090 | 1,244,090 | - | - | - | - | 2,488,180 | 1,910,860 | 577,320 |
| Chatlin Lake and Associated Areas | | | | | | | | | | |
| 10-10 | B,D | 153,500 | 153,500 | - | - | - | - | 307,000 | 220,910 | 86,090 |
| 10-11 & 12 | A | 749,777 | 542,943 | - | - | - | - | 1,292,720 | 872,355 | 420,365 |
| 10-13 & 14 | B,D | 1,195,465 | 1,195,465 | - | - | - | - | 2,390,930 | 1,719,100 | 671,830 |
| 10-15 | A | - | - | 4,210,257 | 1,406,203 | - | - | 5,616,460 | 3,153,062 | 2,463,418 |
| 10-16 | B,D | 699,500 | 699,500 | - | - | - | - | 1,399,000 | 999,180 | 400,820 |
| Total | | 2,798,242 | 2,591,408 | 4,210,257 | 1,406,203 | - | - | 11,705,110 | 6,953,367 | 4,942,513 |
| Grand Total | | 68,252,940 | 8,427,407 | 12,700,493 | 10,694,228 | 7,835,942 | 732,450 | 108,643,510 | 74,323,567 | 34,319,943 |

1/ Abbreviations for Planning Status: A - Authorized for operation; B - Workplan investigations underway; C - River Basin watershed investigation report complete; D - Field examination scope studies complete

2/ Includes cost for water control diversions and critical area

3/ Includes \$49,400 for Fish Hatchery water supply

4-2879

Table 73 - Summary of Annual Benefits 1/ - Multiple-Purpose Projects for Early Action, Red River Basin Study Area

| Watershed | Status | Flood Prevention | | Agricultural | Nonagricultural | | Water Management | | Municipal | Water | Quality | Recreation | Redevelopment | Secondary | Total | | |
|--|--------|--------------------|---------------------|------------------|-----------------|------------------|------------------|---------------|------------------|---------------|------------------|-------------------|---------------|-----------|-------|---------------|-------------------|
| | | Damage Reduction | Structural | | Water | Water | Control | Recreation | | | | | | | | Redevelopment | Secondary |
| Watershed | Status | Treatment Measures | Land Use | Irrigation | Drainage | Supply | Control | Recreation | Redevelopment | Secondary | Measures | | | | | Total | |
| | | | | | | | | | | | | | | | | dollars | |
| Intervening Areas - Texas | | | | | | | | | | | | | | | | | |
| 3-19 | A | 4,250 | 206,890* | 1,000 | 2,450 | 1,000 | 67,920 | 0 | 157,920 4/ | 0 | 39,180 | 476,360 | | | | | 476,360 |
| 3-25 | C | 4,200 | 201,300* | 69,800 | 0 | 0 | 0 | 0 | 0 | 0 | 58,900 | 330,000 | | | | | 330,000 |
| 3-26a | C | 20,940 | 276,820* | 59,060 | 0 | 0 | 19,400 | 13,500 | 71,100 | 0 | 62,400 | 502,240 | | | | | 502,240 |
| 3-27 | A | 260 | 2,430* | 31,100 | 0 | 21,100 | 0 | 0 | 0 | 360 | 11,490 | 76,440 | | | | | 76,440 |
| 3-29 | C | 10 | 62,940* | 0 | 0 | 62,740 | 0 | 0 | 7,400 | 480 | 17,160 | 150,760 | | | | | 150,760 |
| 3-33 | A | 3,220 | 205,980* | 0 | 0 | 0 | 0 | 0 | 3,470 4/ | 7,830 | 25,000 | 242,250 | | | | | 242,250 |
| Total | | 42,820 | 696,360 | 160,960 | 2,450 | 94,880 | 87,320 | 13,500 | 239,890 | 5,670 | 214,130 | 1,778,160 | | | | | 1,778,160 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | | | | | | | | | | | |
| 3-35 | D | 1,470 | 30,740* | 9,220 | 0 | 9,460 | 0 | 0 | 16,350 | 0 | 6,220 | 72,540 | | | | | 72,540 |
| 3-39 | A | 7,140 | 46,220* | 132,080 | 0 | 46,220 | 0 | 0 | 0 | 0 | 106,400 | 330,920 | | | | | 330,920 |
| 3-40 | D | 2,650 | 31,750* | 26,900 | 0 | 31,750 | 0 | 0 | 0 | 0 | 8,610 | 99,010 | | | | | 99,010 |
| 3-41 | C | 3,370 | 100,420* | 89,630 | 0 | 36,410 | 0 | 0 | 39,000 | 0 | 50,380 | 315,840 | | | | | 315,840 |
| 3-46 | A | 160 | 10,760* | 17,370 | 0 | 7,100 | 0 | 0 | 2,750 | 5,820 | 4,260 | 48,060 | | | | | 48,060 |
| Total | | 11,330 | 219,890 | 275,800 | 0 | 130,940 | 0 | 0 | 58,100 | 5,820 | 175,870 | 866,420 | | | | | 866,420 |
| Blue River | | | | | | | | | | | | | | | | | |
| 3-23 | C | 14,750 | 186,760* | 113,250 | 0 | 0 | 57,480 | 10,000 | 86,150 2/ | 0 | 65,560 | 519,200 | | | | | 519,200 |
| Total | | 14,750 | 186,760 | 113,250 | 0 | 0 | 57,480 | 10,000 | 86,150 | 0 | 65,560 | 519,200 | | | | | 519,200 |
| Wolf Creek | | | | | | | | | | | | | | | | | |
| 301-2 | A | 10,930 | 120,070* | 32,240 | 0 | 0 | 0 | 0 | 0 | 0 | 19,840 | 172,150 | | | | | 172,150 |
| 301-3 | A | 1,370 | 28,310* | 9,790 | 0 | 0 | 0 | 0 | 0 | 0 | 4,150 | 42,250 | | | | | 42,250 |
| 302-4 | X | | | | | | | | | | | | | | | | |
| 302-6 | B,D | 14,220 | 286,600* | 73,730 | 0 | 0 | 13,530 | 0 | 51,600 4/ | 0 | 0 | 425,460 | | | | | 425,460 |
| Total | | 26,120 | 434,980 | 115,760 | 0 | 0 | 13,530 | 0 | 51,600 | 0 | 23,990 | 639,860 | | | | | 639,860 |
| Fleming River | | | | | | | | | | | | | | | | | |
| 31-2 | A | 280 | 42,810* | 31,590 | 0 | 9,830 | 0 | 0 | 0 | 0 | 10,810 | 97,340 | | | | | 97,340 |
| 31-4 | B | 1,400 | 27,670* | 26,550 | 0 | 0 | 33,340 | 0 | 30,000 | 8,550 | 10,170 | 136,580 | | | | | 136,580 |
| 31-5 | A | 1,060 | 13,130* | 52,340 | 0 | 0 | 0 | 0 | 4,140 4/ | 4,510 | 11,420 | 85,590 | | | | | 85,590 |
| Total | | 3,240 | 83,610 | 110,480 | 0 | 9,830 | 33,340 | 0 | 34,140 | 15,360 | 32,400 | 319,510 | | | | | 319,510 |
| Harkness Creek | | | | | | | | | | | | | | | | | |
| 3-47 | C | 230 | 9,280 | 1,450 | 0 | 9,940 | 0 | 0 | 0 | 0 | 3,880 | 24,580 | | | | | 24,580 |
| 3-48 | C | 1,110 | 46,300 | 4,820 | 0 | 46,470 | 0 | 0 | 0 | 0 | 19,400 | 117,490 | | | | | 117,490 |
| Total | | 1,340 | 55,580 | 6,300 | 0 | 56,410 | 0 | 0 | 0 | 0 | 23,280 | 142,070 | | | | | 142,070 |
| Little River | | | | | | | | | | | | | | | | | |
| 31-4 | C | 6,270 | 73,440 | 24,750 | 0 | 0 | 0 | 0 | 45,750 | 0 | 22,590 | 166,530 | | | | | 166,530 |
| Total | | 6,270 | 73,440 | 24,750 | 0 | 0 | 0 | 0 | 45,750 | 0 | 22,590 | 166,530 | | | | | 166,530 |
| Mekinney Bayou | | | | | | | | | | | | | | | | | |
| 3-52 | C | 3,010 | 130,820 | 47,740 | 0 | 130,820 | 0 | 0 | 61,800 | 0 | 37,120 | 408,300 | | | | | 408,300 |
| 3-53 | C | 4,330 | 192,740 | 22,420 | 0 | 192,740 | 0 | 0 | 0 | 0 | 40,840 | 449,240 | | | | | 449,240 |
| 3-54 | C | 1,730 | 75,190 | 29,390 | 0 | 75,180 | 0 | 0 | 0 | 0 | 17,980 | 197,740 | | | | | 197,740 |
| Total | | 9,070 | 398,750 | 100,050 | 0 | 398,740 | 0 | 0 | 61,800 | 0 | 95,940 | 1,055,280 | | | | | 1,055,280 |
| Sulphur River | | | | | | | | | | | | | | | | | |
| 3k-9 | D | 2,210 | 22,330 | 11,750 | 0 | 0 | 0 | 0 | 0 | 0 | 3,055 | 37,135 | | | | | 37,135 |
| 3k-11 | D | 190 | 3,830 | 1,940 | 0 | 5,000 | 0 | 0 | 37,950 | 0 | 4,810 | 53,530 | | | | | 53,530 |
| 3k-12 | C | 1,390 | 12,150 | 1,600 | 0 | 0 | 0 | 0 | 0 | 0 | 3,010 | 16,740 | | | | | 16,740 |
| 3k-14 | C | 8,250 | 14,860 | 550 | 0 | 0 | 0 | 0 | 33,450 | 0 | 4,890 | 53,750 | | | | | 53,750 |
| 3k-17 | C | 10,810 | 62,820 | 3,860 | 0 | 0 | 0 | 0 | 0 | 0 | 17,780 | 106,460 | | | | | 106,460 |
| 3k-18 | C | 7,200 | 6,350 | 5,410 | 0 | 0 | 0 | 6,900 | 0 | 0 | 13,350 | 92,010 | | | | | 92,010 |
| Total | | 30,050 | 202,340 | 27,110 | 0 | 5,000 | 6,900 | 71,400 | 71,400 | 0 | 46,895 | 359,645 | | | | | 359,645 |
| Poston Bayou-Arkansas | | | | | | | | | | | | | | | | | |
| 3-57 | C | 3,580 | 187,885 | 0 | 0 | 187,885 | 0 | 0 | 36,000 | 0 | 39,050 | 450,820 | | | | | 450,820 |
| Total | | 3,580 | 187,885 | 0 | 0 | 187,885 | 0 | 0 | 36,000 | 0 | 39,050 | 450,820 | | | | | 450,820 |
| Red River Main Stem | | | | | | | | | | | | | | | | | |
| 3-60 | D | 420 | 30,340 | 0 | 0 | 30,340 | 0 | 0 | 0 | 0 | 5,800 | 66,480 | | | | | 66,480 |
| Total | | 420 | 30,340 | 0 | 0 | 30,340 | 0 | 0 | 0 | 0 | 5,800 | 66,480 | | | | | 66,480 |
| Loggy Bayou | | | | | | | | | | | | | | | | | |
| 3m-1 | A | 530 | 3,150 | 3,360 | 0 | 0 | 0 | 0 | 0 | 100 | 2,300 | 8,410 | | | | | 8,410 |
| 3m1-2 | C | 2,210 | 42,210 | 36,860 | 0 | 0 | 101,600 | 26,200 | 62,100 | 0 | 48,200 | 337,170 | | | | | 337,170 |
| 3m2-3 | A | 1,050 | 52,920 | 5,840 | 234,100 | 36,750 | 35,200 | 0 | 193,800 | 0 | 113,200 | 671,850 | | | | | 671,850 |
| Total | | 3,790 | 98,280 | 46,100 | 234,100 | 36,750 | 136,800 | 26,200 | 275,900 | 100 | 163,700 | 1,017,930 | | | | | 1,017,930 |
| Bayou Pierre | | | | | | | | | | | | | | | | | |
| 3n-2 | C | 790 | 52,370 | 38,110 | 27,770 | 0 | 0 | 0 | 37,050 | 0 | 42,150 | 197,450 | | | | | 197,450 |
| Total | | 790 | 52,370 | 38,110 | 27,770 | 0 | 0 | 0 | 37,050 | 0 | 42,150 | 197,450 | | | | | 197,450 |
| Bayou River | | | | | | | | | | | | | | | | | |
| 3-64 | D | 970 | 18,480 | 27,770 | 41,060 | 0 | 94,300 | 0 | 0 | 0 | 14,490 | 184,100 | | | | | 184,100 |
| 3-65 | D | 1,330 | 25,660 | 13,400 | 240,310 | 0 | 0 | 0 | 88,500 | 0 | 9,750 | 378,110 | | | | | 378,110 |
| 3-66 | D | 3,110 | 66,800 | 162,560 | 20,530 | 0 | 0 | 0 | 29,200 | 0 | 48,720 | 328,200 | | | | | 328,200 |
| Total | | 5,410 | 111,030 | 204,220 | 301,900 | 0 | 94,300 | 0 | 118,000 | 0 | 72,960 | 902,410 | | | | | 902,410 |
| Bayou LaPlatte | | | | | | | | | | | | | | | | | |
| 3-69 | C | 1,550 | 44,890 | 29,640 | 0 | 40,110 | 0 | 0 | 0 | 0 | 26,850 | 141,490 | | | | | 141,490 |
| 3-70 | C | 9,170 | 162,100 | 173,220 | 0 | 73,510 | 0 | 0 | 39,000 | 0 | 70,290 | 515,120 | | | | | 515,120 |
| Total | | 10,720 | 206,990 | 202,860 | 0 | 113,620 | 0 | 0 | 39,000 | 0 | 97,140 | 659,610 | | | | | 659,610 |
| Red River Backwater | | | | | | | | | | | | | | | | | |
| 3-71 | D | 2,360 | 107,150 | 0 | 0 | 107,150 | 0 | 0 | 0 | 0 | 20,400 | 234,700 | | | | | 234,700 |
| 3-72 | D | 1,470 | 204,750 | 0 | 0 | 204,750 | 0 | 0 | 0 | 0 | 39,000 | 448,500 | | | | | 448,500 |
| 3-76 | D | 3,450 | 179,350 | 0 | 0 | 179,350 | 0 | 0 | 0 | 0 | 34,160 | 342,860 | | | | | 342,860 |
| Total | | 7,280 | 491,250 | 0 | 0 | 491,250 | 0 | 0 | 0 | 0 | 93,560 | 1,026,060 | | | | | 1,026,060 |
| Chatin Lake & Associated Areas | | | | | | | | | | | | | | | | | |
| 10-10 | B,D | 0 | 95,700 | 0 | 0 | 95,700 | 0 | 0 | 0 | 0 | 19,140 | 210,540 | | | | | 210,540 |
| 10-11&12 | A | 800 | 39,240 | 4,360 | 0 | 31,570 | 0 | 0 | 3,050 | 0 | 23,200 | 101,420 | | | | | 101,420 |
| 10-13&14 | B,D | 0 | 339,260 | 0 | 0 | 339,260 | 0 | 0 | 0 | 0 | 67,850 | 746,370 | | | | | 746,370 |
| 10-15 | A | 0 | 0 | 0 | 231,400 | 0 | 0 | 0 | 92,250 | 0 | 110,310 | 433,960 | | | | | 433,960 |
| 10-16 | B,D | 0 | 230,220 | 0 | 0 | 230,220 | 0 | 0 | 0 | 0 | 48,040 | 508,480 | | | | | 508,480 |
| Total | | 800 | 704,420 | 4,360 | 231,400 | 696,750 | 0 | 0 | 92,250 | 3,050 | 268,340 | 1,999,770 | | | | | 1,999,770 |
| Grand Total | | 178,710 | 4,494,275 2/ | 1,430,460 | 797,620 | 2,247,845 | 427,770 | 56,600 | 1,247,030 | 33,000 | 1,481,555 | 12,216,205 | | | | | 12,216,205 |

1/ Adjusted normalized prices, Water Resources Council, April 1966

2/ In addition, Red River Main Stem benefits aggregating approximately \$29,150 annually accrue to watersheds with asterisks (**)

3/ Abbreviations: A

About 50,000 acres in 100,000 farm ponds will provide incidental recreation benefits. These were not evaluated monetarily.

Damage reduction benefits from land treatment and structural measures include those relating to sediment deposition in existing and authorized reservoirs. Reduction in sediment deposition aggregating 370 acre-feet annually is expected in seven watersheds. This represents monetary benefits of \$2,630 from land treatment and \$10,040 from structural measures. Benefits from reservoir sediment reduction by CNI watersheds are summarized in Exhibit 41.

Annual Costs and Benefit-Cost Comparisons

The operation and maintenance costs for structural installations include costs for routine replacement, maintenance and inspection of all structures and appurtenances. Costs include caretaker's salary for projects that have water quality control, irrigation, or recreation storage.

The amortized annual equivalents of installation costs amount to \$3,995,220. Operation and maintenance costs, estimated at \$994,110 bring the total annual cost of structural measures to \$4,989,330. These costs include \$188,000 for amortization and interest and \$21,400 for maintenance and operation of USAE major outlets for CNI watersheds in McKinney Bayou, Posten Bayou, and Bayou Rigolette Tributary Basins. Costs of USAE improvements in Red River Backwater area watersheds are not included. The status of USAE plans for levee improvement is indefinite at this time and additional studies by the USAE will be requested. However, benefits should be more than adequate to justify the cost of all structural measures.

The average annual benefits totaling \$12,216,205 compared to the annual cost, would produce approximately \$2.45 in benefits for each dollar spent on improvements. Annual equivalents of installation costs, annual operation and maintenance costs, annual benefits, and benefit-cost ratios for individual watershed projects are summarized in Table 76.

Single-Purpose Water and Related Land Resource Development

Recreational Development on National Forest System Lands

The USFS has completed detailed plans for developing water resources and recreation facilities within the Study Area for the 1962-1980 period. Table 77 shows the planned development of impoundments on National Forest lands of the Study Area to 1980. Work on Pine Creek Lake, Oklahoma, was started late in 1966. All other projects are scheduled for completion before 1980. These improvements are single-purpose reservoirs to be constructed with regular National Forest funds and will be developed for recreation. Most water areas will provide fishing, and waterfowl hunting will be developed on four impoundments.

Table 76 - Comparison of Average Annual Benefits and Costs for Structural Measures - Multiple-Purpose Projects for Early Action, Red River Basin Study Area

| Tributary Basin and CN1 Watershed | Status | Amortized Installation Cost | Operation and Maintenance Costs | Total Annual Costs | Benefits | Benefit-Cost Ratio |
|--|--------|-----------------------------|---------------------------------|--------------------|------------------|--------------------|
| - - - - - dollars - - - - - | | | | | | |
| Intervening Areas - Texas | | | | | | |
| 3-19 | A | 285,580 | 28,580 | 314,160 | 476,360 | 1.5:1 |
| 3-25 | C | 134,400 | 58,000 | 192,400 | 330,000 | 1.7:1 |
| 3-25a | C | 111,300 | 43,390 | 154,690 | 502,280 | 3.2:1 |
| 3-27 | A | 17,940 | 2,900 | 20,840 | 76,480 | 3.7:1 |
| 3-29 | C | 11,390 | 13,630 | 25,020 | 150,760 | 6.0:1 |
| 3-33 | A | 100,720 | 8,300 | 109,020 | 242,280 | 2.2:1 |
| Total | | 661,330 | 154,800 | 816,130 | 1,778,160 | 2.2:1 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | |
| 3-35 | D | 24,120 | 12,700 | 36,820 | 72,590 | 2.0:1 |
| 3-39 | A | 106,240 | 14,800 | 121,040 | 330,920 | 2.7:1 |
| 3-40 | D | 25,820 | 7,850 | 33,670 | 99,010 | 2.9:1 |
| 3-41 | C | 52,700 | 27,740 | 80,440 | 315,840 | 3.9:1 |
| 3-46 | A | 30,650 | 6,430 | 37,080 | 48,060 | 1.3:1 |
| Total | | 239,530 | 69,520 | 309,050 | 866,420 | 2.8:1 |
| Blue River | | | | | | |
| 3-23 | C | 184,220 | 17,280 | 201,500 | 519,200 | 2.6:1 |
| Total | | 184,220 | 17,280 | 201,500 | 519,200 | 2.6:1 |
| Boggy Creek | | | | | | |
| 3h1-2 | A | 103,700 | 3,850 | 107,550 | 172,150 | 1.6:1 |
| 3h1-3 | A | 24,150 | 1,250 | 25,400 | 42,250 | 1.7:1 |
| 3h2-4 & 3h2-6 | B,D | 251,110 | 24,500 | 275,610 | 425,460 | 1.5:1 |
| Total | | 378,960 | 29,600 | 408,560 | 639,860 | 1.6:1 |
| Kiamichi River | | | | | | |
| 3i-2 | A | 15,790 | 11,820 | 27,610 | 97,340 | 3.6:1 |
| 3i-4 | B | 50,480 | 20,220 | 70,700 | 136,580 | 1.9:1 |
| 3i-8 | A | 40,360 | 1,080 | 41,440 | 85,590 | 2.1:1 |
| Total | | 106,630 | 33,120 | 139,750 | 319,510 | 2.3:1 |
| Barkman Creek | | | | | | |
| 3-47 | C | 2,500 | 1,790 | 4,290 | 24,580 | 5.7:1 |
| 3-48 | C | 16,080 | 11,760 | 27,840 | 117,490 | 4.2:1 |
| Total | | 18,580 | 13,550 | 32,130 | 142,070 | 4.4:1 |
| Little River | | | | | | |
| 3j-4 | C | 100,310 | 14,470 | 114,780 | 166,530 | 1.5:1 |
| Total | | 100,310 | 14,470 | 114,780 | 166,530 | 1.5:1 |
| McKinney Bayou 2/ | | | | | | |
| 3-52 | C | 122,930 | 49,550 | 172,480 | 408,300 | 2.4:1 |
| 3-53 | C | 47,770 | 28,620 | 76,390 | 449,240 | 5.9:1 |
| 3-54 | C | 44,620 | 14,340 | 58,960 | 197,740 | 3.4:1 |
| Total | | 215,320 | 92,510 | 307,830 | 1,055,280 | 3.4:1 |
| Sulphur River | | | | | | |
| 3k-9 | D | 28,190 | 1,180 | 29,370 | 37,135 | 1.3:1 |
| 3k-11 | D | 9,770 | 9,550 | 19,320 | 53,530 | 2.8:1 |
| 3k-12 | C | 12,200 | 500 | 12,700 | 16,760 | 1.3:1 |
| 3k-14 | C | 24,310 | 12,360 | 36,670 | 53,750 | 1.5:1 |
| 3k-17 | C | 57,150 | 10,190 | 67,340 | 106,460 | 1.6:1 |
| 3k-18 | C | 59,600 | 5,620 | 65,220 | 92,010 | 1.4:1 |
| Total | | 191,220 | 39,400 | 230,620 | 359,645 | 1.6:1 |
| Posten Bayou 2/ | | | | | | |
| 3-57 | C | 118,640 | 42,860 | 161,500 | 450,820 | 2.8:1 |
| Total | | 118,640 | 42,860 | 161,500 | 450,820 | 2.8:1 |

Continued ---

Table 76 - Comparison of Average Annual Benefits and Costs for Structural Measures -
Multiple-Purpose Projects for Early Action, Red River Basin Study Area -- Continued

| Tributary Basin and CNI Watershed | : :Planning :Status ^{1/} | :Amortized :Installation :Cost | :Operation and :Maintenance :Costs | : :Total : Annual Costs | : : Benefits | : Benefit- : Cost : Ratio |
|--|---|--------------------------------------|--|-------------------------------|-------------------|---------------------------------|
| - - - - - dollars - - - - - | | | | | | |
| Red River Main Stem | | | | | | |
| 3-60 | D | 4,600 | 2,400 | 7,000 | 66,480 | 9.5:1 |
| Total | | 4,600 | 2,400 | 7,000 | 66,480 | 9.5:1 |
| Loggy Bayou | | | | | | |
| 3m-1 | A | 4,520 | 360 | 4,880 | 8,910 | 1.8:1 |
| 3m1-7 | C | 150,980 | 55,570 | 206,550 | 337,170 | 1.6:1 |
| 3m2-3 | A | 274,690 | 94,880 | 369,570 | 671,850 | 1.8:1 |
| Total | | 430,190 | 150,810 | 581,000 | 1,017,930 | 1.7:1 |
| Bayou Pierre | | | | | | |
| 3n-2 | C | 91,450 | 21,030 | 112,480 | 197,450 | 1.8:1 |
| Total | | 91,450 | 21,030 | 112,480 | 197,450 | 1.8:1 |
| Cane River | | | | | | |
| 3-64 | D | 116,270 | 6,110 | 122,380 | 196,100 | 1.6:1 |
| 3-65 | D | 273,250 | 45,930 | 319,180 | 378,110 | 1.2:1 |
| 3-66 | D | 71,610 | 40,770 | 112,380 | 328,200 | 2.9:1 |
| Total | | 461,130 | 92,810 | 553,940 | 902,410 | 1.6:1 |
| Bayou Rigolette ^{2/} | | | | | | |
| 3-69 | C | 6,970 | 10,590 | 17,560 | 141,490 | 8.1:1 |
| 3-70 | C | 221,440 | 77,340 | 298,780 | 518,120 | 1.7:1 |
| Total | | 228,410 | 87,930 | 316,340 | 659,610 | 2.1:1 |
| Red River Backwater | | | | | | |
| 3-73 | D | 12,400 | 5,200 | 17,600 | 234,700 | 13.3:1 |
| 3-75 | D | 30,000 | 12,600 | 42,600 | 448,500 | 10.5:1 |
| 3-76 | D | 102,500 | 12,000 | 114,500 | 392,860 | 3.4:1 |
| Total | | 144,900 | 29,800 | 174,700 | 1,076,060 | 6.2:1 |
| Chatlin Lake and Associated Areas | | | | | | |
| 10-10 | B,D | 23,730 | 20,670 | 44,400 | 210,540 | 4.7:1 |
| 10-11 & 12 | A | 61,260 | 8,380 | 69,640 | 101,420 | 1.5:1 |
| 10-13 & 14 | B,D | 95,140 | 34,660 | 129,800 | 746,370 | 5.8:1 |
| 10-15 | A | 184,000 | 23,310 | 207,310 | 433,960 | 2.1:1 |
| 10-16 | B,D | 55,670 | 15,200 | 70,870 | 506,480 | 7.1:1 |
| Total | | 419,800 | 102,220 | 522,020 | 1,998,770 | 3.8:1 |
| <hr/> | | | | | | |
| Grand Total | | 3,995,220 | 994,110 | 4,989,330 | 12,216,205 | 2.4:1 |
| <hr/> | | | | | | |

^{1/} Abbreviations: A - Authorized for operations; B - Workplan investigations underway;
C - River Basin watershed investigation report completed; D - Field examination scope studies completed

^{2/} Includes USAE costs for major outlets

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RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA
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Table 77 - Short-Term ^{1/} Single-Purpose Water Development on National Forests ^{2/}, Red River Basin Study Area

| Administrative Unit Name | Location - State and County | Drainage Area (sq.mi.) | Storage Capacity (acre-feet) | Surface Area (acres) | Principal Use |
|-------------------------------------|-----------------------------|------------------------|------------------------------|----------------------|--------------------------|
| <u>Ouachita National Forest</u> | | | | | |
| <u>Arkansas</u> | | | | | |
| Rock Creek Lake | Polk | 3.5 | 900 | 90 | Recreation |
| Smokey Rock Creek Lake | Polk | 1.5 | 500 | 50 | Recreation |
| Total | | 5.0 | 1,400 | 140 | --- |
| <u>Oklahoma</u> | | | | | |
| Talimena Scenic Drive ^{3/} | LeFlore | 1.5 | 200 | 20 | Recreation |
| America Lake | McCurtain | 4.0 | 320 | 80 | Recreation ^{4/} |
| Caney Lake | McCurtain | 10.0 | 400 | 100 | Recreation ^{4/} |
| Moon Lake | McCurtain | 12.0 | 500 | 125 | Recreation ^{4/} |
| Pine Creek Lake | McCurtain | 2.0 | 50 | 42 | Recreation ^{4/} |
| Total | | 29.5 | 1,470 | 367 | --- |
| Grand Total | --- | 34.5 | 2,870 | 507 | --- |

^{1/} Planned for 6/30/66 to 1980 period

^{2/} Single-purpose development with National Forest funds

^{3/} Name not designated, development integrated with recreation complex of Talimena Scenic Drive

^{4/} "Green-tree reservoir" developments. Water level control for wildfowl feeding and hunting

Recreation facilities to be developed on the impoundments in Table 6 are shown in Exhibit 42. Exhibit 42 shows facilities that will be developed in the June 30, 1966, to 1980 period and includes facilities added to other National Forests recreation developments on the base ^{1/} area.

The four impoundments planned for McCurtain County, Oklahoma, will be developed as "green-tree" reservoirs. Water level control devices are provided in construction that allows the flooding of adjoining hardwood timberlands. With the approach of waterfowl hunting seasons, the timbered areas in the reservoir are flooded to a level compatible with the feeding habits of shallow-water ducks (less than one foot). The areas are opened to the public for hunting during the State open season. Water levels are lowered and the water withdrawn from the

^{1/} All whole counties touched by the Study Area



Duck hunting on National Forest lands. The development of "green-tree" reservoirs for improved waterfowl habitat and public hunting is planned on National Forest lands in Oklahoma. (U. S. Forest Service Photo)



A water development for recreation on National Forest lands. Similar impoundments are planned on the Study Area in Arkansas. (U. S. Forest Service Photo)

4-24879

timberlands before the tree growth begins in the spring. Acorns and other mast and plant materials produced on low-lying hardwood areas are foods preferred by waterfowl such as the mallard, pintail, and teal ducks.

Some impoundments may be developed on National Forest System Lands as USDA proposals for small watershed development (under P. L. 566). Such proposals have been made in the Study Area for the 10-15 year period, on the following areas:

| <u>Watershed Name</u> | <u>CNI Number</u> | <u>County or Parish and State</u> |
|----------------------------|-------------------|-----------------------------------|
| Cocodrie and Little River | 3-66 | Natchitoches, Louisiana |
| Cane River | 3-65 | Natchitoches, Louisiana |
| Bayou Rigolette | 3-70 | Winn & Grant, Louisiana |
| Walnut Bayou | 3-41 | McCurtain, Oklahoma |
| Lower Bois d'Arc Creek | 3-25 | Fannin, Texas |
| Upper Middle Sulphur River | 3k-17 | Fannin, Texas |

The National Forest System has determined that development of these projects is compatible with the objectives and purposes of multiple use on National Forest lands.

A complete study will be made to determine the feasibility and desirability of each preliminary site selection and proposed development. Any conflicts between USDA watershed proposals and the requirements of multiple-use management on National Forest System Lands will be resolved before any such proposals are considered for inclusion in a watershed plan of work.

Other Single-Purpose Reservoir Development

Single-purpose water storage data were developed in areas in which existing, planned, or proposed watershed projects could not meet all of the projected water and related land resource needs. These unsatisfied needs exist in areas in which development is urgently needed within 10-15 years.

Four municipal and industrial water supply sites were located in watersheds considered not feasible for project-type development. Four recreation sites were identified which could provide storage necessary to satisfy the projected recreation needs. One of the sites would be located in a CNI watershed approved for operations and three in watersheds considered not feasible for development. Site locations are shown in Figure 14.

Alexandria, Louisiana, has 1980 municipal and industrial water needs which can be partially satisfied by two reservoirs located in the authorized Bayou Rapides watershed project. One reservoir is located in CNI Watershed 3-68, and the other reservoir is located in CNI Watershed 10-17. Each of these reservoirs is designed to store the approximate yield of the drainage area, but limited to a total

storage of 25,000 acre-feet. One reservoir located in CNI Watershed 3-68 has an additional storage capacity of 36,200 acre-feet.

The towns of Ringgold and Gibsland, Louisiana, have 2080 municipal and industrial requirements which can be satisfied by two reservoirs located in nonfeasible CNI watersheds. The needs for Ringgold can be met by a reservoir located in CNI Watershed 3ol-3 and the needs for Gibsland can be met by a reservoir located in CNI Watershed 3ol-4.

A reservoir storage site to meet recreation needs near Atoka, Oklahoma, is located in CNI Watershed 3hl-2. This watershed is approved for operations.

Reservoir storage sites to meet recreation needs near Shreveport and Texarkana are located in nonfeasible watersheds. Two reservoirs near Shreveport are located in CNI Watershed 3n-5; one site near Texarkana is located in CNI Watershed 3-55.

The total capacity of the reservoirs is 185,260 acre-feet. Of this amount, 53,000 acre-feet is for municipal and industrial water supply, 31,500 acre-feet for recreation, 6,090 acre-feet for sediment accumulation, and 94,670 acre-feet could be additional potential storage for future development. The total surface area of the permanent pools is approximately 6,820 acres of which 2,950 acres are for recreational use. Recreation basic facilities for picnicking, boating, fishing, camping, and swimming were included at the sites with recreation storage. Reservoir storage data are summarized in Table 78.

Table 78 - Pertinent Structural Data- Additional Reservoir Development for Early Action, Red River Basin Study Area

| Tributary Basin and CNI Watershed | : Number : of : Structures | : Drainage : Area above : Structures | : Pool Capacity | | | : Surface Area | | : Additional : Permanent : Storage : Available |
|---|----------------------------------|--|-----------------|--------------|------------|----------------|-----------|---|
| | | | : Recreation | : Industrial | : Sediment | : Pool | : Storage | |
| | number | (sq. mi.) | - - - - - | acre-feet | - - - - - | acres | acre-feet | |
| WATERSHEDS FEASIBLE FOR INITIAL DEVELOPMENT | | | | | | | | |
| Boggy Creek | | | | | | | | |
| 3hl-2 | 1 | 25.1 | 2,010 | - | 950 | 360 | 0 | |
| Subtotal | 1 | 25.1 | 2,010 | - | 950 | 360 | 0 | |
| Bayou Rapides | | | | | | | | |
| 3-68 | 1 | 33.8 | - | 23,500 | 1,500 | 1,600 | 36,200 | |
| 10-17 | 1 | 11.8 | - | 21,400 | 500 | 1,470 | 0 | |
| Subtotal | 2 | 45.6 | - | 44,900 | 2,000 | 3,070 | 36,200 | |
| Total | 3 | 70.7 | 2,010 | 44,900 | 2,950 | 3,430 | 36,200 | |
| WATERSHEDS NOT FEASIBLE FOR DEVELOPMENT | | | | | | | | |
| Bayou Pierre | | | | | | | | |
| 3n-5 | 2 | 65.0 | 21,990 | - | 2,430 | 2,040 | 44,020 | |
| Subtotal | 2 | 65.0 | 21,990 | - | 2,430 | 2,040 | 44,020 | |
| McKinney Bayou | | | | | | | | |
| 3-55 | 1 | 8.0 | 7,500 | - | 300 | 550 | 4,950 | |
| Subtotal | 1 | 8.0 | 7,500 | - | 300 | 550 | 4,950 | |
| Black - Saline | | | | | | | | |
| 3ol-3 | 1 | 5.5 | - | 3,100 | 240 | 340 | 3,700 | |
| 3ol-4 | 1 | 3.8 | - | 5,000 | 170 | 460 | 5,800 | |
| Subtotal | 2 | 9.3 | - | 8,100 | 410 | 800 | 9,500 | |
| Total | 5 | 82.3 | 29,490 | 8,100 | 3,140 | 3,390 | 58,470 | |
| Grand Total | 8 | 153.0 | 31,500 | 53,000 | 6,090 | 6,820 | 94,670 | |

Installation costs based upon USDA design criteria were computed for reservoir site and recreation basic facilities. The estimated installation cost for the reservoirs is \$7,634,390. Of this amount, \$3,636,310 is for municipal and industrial water supply, and \$3,998,080 is for recreation water storage and basic facilities. Of the recreation costs, \$1,281,000 will be assumed by the Federal Government and \$2,717,080 will be assumed by nonFederal interest. All municipal and industrial water supply costs will be assumed by nonFederal interests.

Operation and maintenance costs include costs for structural maintenance and a caretaker's salary for sites with recreation storage. The total operation and maintenance cost is \$69,040 of which \$800 is for municipal and industrial water supply, and \$68,240 is for recreation.

Benefits from municipal and industrial water supply were considered equal to the cost of the reservoirs. The annual costs consisting of the amortized annual equivalent of installation cost plus allowance for operation and maintenance is estimated at \$119,930. Benefits and costs are shown for each watershed with storage for municipal and industrial water supply in Table 79.

Table 79 - Comparison of Benefits and Cost - Additional Reservoir Development for Early Action, Red River Basin Study Area

| Tributary: Basin and: CNI Watershed: | Purpose | : | Annual Costs | | | | : | : |
|--|---------|---|-------------------------|---|---------------|----------------|------------------|--------------|
| | | | Instal- l/ : Cost | Amortized: Instal- l/ : l/ : l/ : | O & M | Total | | |
| ----- dollars ----- | | | | | | | | |
| WATERSHEDS FEASIBLE FOR INITIAL DEVELOPMENT | | | | | | | | |
| Boggy Creek | | | | | | | | |
| 3h1-2 | R | | 1,427,390 | 46,760 | 29,840 | 76,600 | 118,800 | 1.6:1 |
| Subtotal | | | 1,427,390 | 46,760 | 29,840 | 76,600 | 118,800 | 1.6:1 |
| Bayou Rapides | | | | | | | | |
| 3-68 | M | | 1,887,260 | 61,830 | 200 | 62,030 | 62,030 | 1.0:1 |
| 10-17 | M | | 1,175,160 | 38,500 | 200 | 38,700 | 38,700 | 1.0:1 |
| Subtotal | | | 3,062,420 | 100,330 | 400 | 100,730 | 100,730 | 1.0:1 |
| Total | | | 4,489,810 | 147,090 | 30,240 | 177,330 | 219,530 | 1.2:1 |
| WATERSHEDS NOT FEASIBLE FOR DEVELOPMENT | | | | | | | | |
| McKinney Bayou | | | | | | | | |
| 3-55 | R | | 590,500 | 19,340 | 12,800 | 32,140 | 181,500 | 5.6:1 |
| Subtotal | | | 590,500 | 19,340 | 12,800 | 32,140 | 181,500 | 5.6:1 |
| Bayou Pierre | | | | | | | | |
| 3n-5 | R | | 1,980,190 | 64,870 | 25,600 | 90,470 | 673,200 | 7.4:1 |
| Subtotal | | | 1,980,190 | 64,870 | 25,600 | 90,470 | 673,200 | 7.4:1 |
| Black & Saline Lakes | | | | | | | | |
| 3ol-3 | M | | 273,000 | 8,940 | 200 | 9,140 | 9,140 | 1.0:1 |
| 3ol-4 | M | | 300,890 | 9,860 | 200 | 10,060 | 10,060 | 1.0:1 |
| Subtotal | | | 573,890 | 18,800 | 400 | 19,200 | 19,200 | 1.0:1 |
| Total | | | 3,144,580 | 103,010 | 38,800 | 141,810 | 873,900 | 6.2:1 |
| Grand Total | | | 7,634,390 | 250,100 | 69,040 | 319,140 | 1,093,430 | 3.4:1 |

1/ Purpose Abbreviations - R-Recreation, M-Municipal and Industrial Water Supply

Benefits from the potential recreation storage and basic recreation facilities in four reservoirs in three CNI watersheds would amount to \$973,500 annually. These are based on an estimated 649,000 visitor-days of recreation use. The annual cost, consisting of the amortized annual equivalent of installation cost and allowance for operation and maintenance, totals \$199,210. These, compared to the expected benefits, would give a benefit-cost ratio of 4.9:1.0. Benefits and costs are shown for each watershed with potential for recreation in Table 79. A summary of pertinent data, including estimated days of recreation use in potential reservoirs, is shown in Exhibit 43.

The amortized annual equivalent of installation costs for additional storage potential, including municipal and industrial water supply and recreation purposes is \$250,100. Operation and maintenance costs, estimated at \$69,040 bring the total cost to \$319,140. Average annual benefits for the combined purposes total \$1,093,430. These benefits compared to the annual cost would result in a benefit-cost ratio of 3.4:1. Table 79 shows storage purposes and summarized annual costs and benefits by CNI watersheds for all additional storage development recommended for early action.

Land Treatment

Approximately 16,600 square miles of land are included in the projects recommended for early action by the USDA and other agencies. Land treatment is needed on the lands included in these projects. Treatment needs include measures that have a significant effect on reducing runoff, erosion, and sediment production. Treatment also is needed on lands benefiting from drainage improvement and irrigation development. Treatment measures should be designed to improve the woodland and agricultural lands and increase overall farming efficiency.

Land treatment needs have been developed, and it was determined that going programs will not accomplish the needs for project development. Approximately 501,600 acres of land included in projects recommended for early action require acceleration of the installation of land treatment measures.

Recommendations

The U. S. Department of Agriculture recommends that the early-action program be carried out in the basin, with the installation of all elements of the program being initiated prior to 1980;

That in carrying out such program, the USDA will assist local organizations, upon their request, to prepare and carry out subwatershed work plans for the subwatersheds designated in the early-action program;

That in carrying out such program, the USDA will provide financial and other assistance in the installation of structural works of improvement for furthering the conservation, development, utilization, and disposal of water and that such assistance should be provided on a basis comparable to that authorization for similar purposes under other Federal

programs, with such modifications as are necessary and appropriate in the public interest;

That prior to participation in the installation of the upstream structural works of improvement and the measures for sediment and erosion control described herein on non-Federal lands, cooperating non-Federal interests 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; they will acquire, with such Federal financial assistance as is provided for herein, all land rights needed in connection with the installation of such works of improvement; and they will maintain and operate all upstream structural works of improvement and measures for sediment and erosion control on non-Federal lands after installation in accordance with the provisions for non-Federal participation described herein or as may be available for such purposes under other Federal programs;

That the installation of the planned works of improvement may be carried out under Federal construction contracts when requested by the local organization (s);

That the first estimate of costs for the installation of the upstream structural works of improvement is \$116,277,900 of which \$75,604,567 will be assumed by the Federal Government and \$40,673,333 will be assumed by non-Federal interests.

WATERSHED DEVELOPMENT ALTERNATIVES

The USAE proposed early-action reservoir projects in several sub-watersheds that are planned for development under the USDA early-action program. The USDA was requested to modify proposals for USDA project development to accommodate USAE proposals. This resulted in alternatives to the USDA early-action recommended program in several upstream watersheds. USDA recommendations would be modified by combined project plans that include major reservoirs and upstream watershed improvements for CNI Watersheds 3-23, 3-25, 3-25a, 3h2-4, and 3h2-6. Kisatchie Reservoir would eliminate Cane River Tributary Basin upstream watershed development.

Tables 80-83 show pertinent structural data, estimated installation costs, benefit summaries, and average annual benefits and costs for the combined projects for early action. SCS study intensity for the upstream watershed development features of the potential projects is comparable to study intensity shown in Tables 72-77. Benefits were allocated equitably to elements of the combined projects by mutual agreement of the two planning agencies.

Bois d'Arc Creek Watersheds

The combined project plan for CNI Watersheds 3-25 and 3-25a (Bois d'Arc Creek Watersheds, Texas), includes Bonham Reservoir, a site proposed by the USAE, across Bois d'Arc Creek approximately three and one-half miles south of Bonham, two upstream reservoirs above the Bonham Reservoir Site and 20 below the Site, and channel improvement from the proposed Bonham Site to Red River. Approximately 17,730 acre-feet of conservation storage could be provided in three upstream reservoirs. Estimated annual benefits of the combined project are \$1,339,140 and

Table 80 - Pertinent Reservoir and Channel Data - Alternate Potential Multiple-Purpose Watershed Projects for Early Action, Red River Basin Study Area

| Tributary | Basin and Agency | Participation | Watershed Area (sq.mi.) | Drainage Area (sq.mi.) | Number of Reservoirs | Channel Miles | Reservoir Storage | | | Surface Area |
|----------------------------|------------------|---------------|-------------------------|------------------------|----------------------|------------------|-------------------|---------------|---------|----------------|
| | | | | | | | Sediment Control | Flood Control | Other | Permanent Pool |
| Intervening Areas - Texas | | | | | | | | | | |
| 3-25a | SCS | --- | 223 | 79 | 8 | 8.1 | 5,820 | 32,910 | 17,730 | RWM 1,931 |
| | CE | --- | --- | 108 ^{2/} | 1 | 0 | 6,960 | 48,500 | 82,040 | 5,280 |
| 3-25 | SCS | --- | 208 | 96 | 14 | 22.2 | 8,910 | 32,610 | 0 | 1,385 |
| Total | Joint | --- | 431 | 263 | 23 | 30.3 | 21,690 | 114,020 | 99,770 | 8,596 |
| Lower Blue River, Oklahoma | | | | | | | | | | |
| 3-23 | SCS | --- | 360 | 77 | 13 | 0 | 6,010 | 33,920 | 5,050 | RWF 1,155 |
| | CE | --- | --- | 649 ^{3/} | 1 | 0 | 14,480 | 232,200 | 147,020 | 8,980 |
| Total | Joint | --- | 360 | 649 | 14 | 0 | 20,490 | 266,120 | 152,070 | 10,135 |
| Boggy Creek, Oklahoma | | | | | | | | | | |
| 3h2-6 | SCS | --- | 322 | 158 | 44 | 0 | 8,400 | 50,500 | 3,000 | RM 780 |
| | CE | --- | --- | 172 ^{4/} | 1 | 0 | 6,970 | 75,200 | 114,630 | 6,110 |
| 3h2-4 | SCS | --- | 225 | 155 | 25 | 0 | 8,250 | 49,250 | 2,000 | M 450 |
| Total | Joint | --- | 547 | 485 | 70 | 0 | 23,620 | 174,950 | 119,630 | 7,340 |
| Cane River, Louisiana | | | | | | | | | | |
| | CE | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | (Plans I and II) | --- | --- | 277 | 1 | NA ^{5/} | 8,000 | 169,200 | 119,200 | M 9,180 |
| Total | --- | --- | --- | 277 | 1 | NA | 8,000 | 169,200 | 119,200 | 9,180 |

- 1/ R-Recreation; M-Municipal; I-Irrigation; W-Water Quality Control; F-Fish and Wildlife
- 2/ Includes 20 square miles in SCS sites
- 3/ Includes 77 and 219 square miles in SCS sites in CNI Watershed 3-23 and 3-23a, respectively
- 4/ Includes 66 square miles in SCS sites
- 5/ Data for irrigation distribution system not available

Table 81 - Estimated Structural Installation Costs ^{1/} - Alternate Multiple-Purpose Watershed Projects for Early Action, Red River Basin Study Area

| Tributary | Basin and Agency | Participation | Floodwater Retarding Structures | Multiple-Purpose Structures | Channel Improvements | Recreation Facilities | Installation Services | Land Easements and Right of Way | Administration Contracts | Construction | |
|---------------------------|------------------|---------------|---------------------------------|-----------------------------|----------------------|-----------------------|-----------------------|---------------------------------|--------------------------|--------------|------------|
| | | | | | | | | | | Subtotal | |
| Intervening Areas - Texas | | | | | | | | | | | |
| 3-25a | SCS | --- | 419,320 | 729,630 | 403,150 | 165,000 | 1,717,100 | 335,990 | 703,430 | 8,580 | 2,765,100 |
| | CE | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 14,855,000 |
| 3-25 | SCS | --- | 1,018,600 | 0 | 2,451,900 | 0 | 3,470,500 | 695,320 | 761,280 | 17,320 | 4,944,420 |
| Total | Joint | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 22,564,520 |
| Blue River, Oklahoma | | | | | | | | | | | |
| 3-23 | SCS | --- | 758,180 | 587,420 | 0 | 165,000 | 1,537,600 | 415,140 | 511,530 | 6,980 | 2,471,250 |
| | CE | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 20,100,000 |
| Total | Joint | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 22,571,250 |
| Boggy Creek, Oklahoma | | | | | | | | | | | |
| 3h2-6 | SCS | --- | 1,910,000 | 424,625 | 0 | 165,000 | 2,499,625 | 607,150 | 425,500 | 14,780 | 3,547,055 |
| | CE | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 9,930,000 |
| 3h2-4 | SCS | --- | 1,975,000 | 196,000 | 0 | 0 | 2,171,000 | 507,000 | 203,000 | 7,500 | 2,888,500 |
| Total | Joint | --- | --- | --- | --- | Data not available | --- | --- | --- | --- | 16,365,555 |
| Cane River, Louisiana | | | | | | | | | | | |
| | CE (Plan I) | --- | 14,313,300 | --- | NA | 4,324,000 | 18,637,300 | NA | 1,475,800 | NA | 20,113,100 |
| | CE (Plan II) | --- | 14,313,300 | --- | NA | 70,000 | 14,383,300 | NA | 1,475,800 | NA | 15,859,100 |

^{1/} 1966 Price Base

Table 82 - Summary of Average Annual Benefits - Alternate Multiple-Purpose Watershed Projects for Early Action, Red River Basin Study Area

| Tributary | Agency | Participation | Damage Reduction | More in CE | Red River Intensive Reservoir | Land Use | Cost | Recreation | Industrial | Fishing | Other ^{2/} | Total Benefits |
|-----------------------------|--------------|---------------|------------------|------------|-------------------------------|----------|----------------------|------------|------------|-----------|---------------------|----------------|
| - - - - - dollars - - - - - | | | | | | | | | | | | |
| Intervening Areas - Texas | | | | | | | | | | | | |
| 3-25 & 25a | CE | | 121,230 | 0 | 57,270 | --- | 251,000 | 334,900 | 7,000 | 0 | | 771,400 |
| | SCS | | 324,860 | 4,580 | 134,290 | 0 | 71,100 | 19,410 | 0 | 13,500 W | | 567,740 |
| Total | --- | | 446,090 | 4,580 | 191,560 | 0 | 322,100 | 354,310 | 7,000 | 13,500 | | 1,339,140 |
| Blue River, Oklahoma | | | | | | | | | | | | |
| 3-23 | CE | | 137,710 | 177,370 | 58,720 | --- | 493,200 | 240,000 | 10,200 | 0 | | 1,117,200 |
| | SCS | | 73,830 | 2,370 | 29,460 | 5,200 | 75,750 | 0 | 10,400 | 10,000 W | | 207,010 |
| Total | --- | | 211,540 | 179,740 | 88,180 | 5,200 | 568,950 | 240,000 | 20,600 | 10,000 | | 1,324,210 |
| Boggy Creek, Oklahoma | | | | | | | | | | | | |
| 3h2-6,3h2-4 | CE | | 93,530 | 0 | 59,940 | --- | 571,000 | 218,800 | 8,000 | 0 | | 951,270 |
| | SCS | | 253,885 | 0 | 65,045 | 0 | 51,600 ^{1/} | 13,530 | 0 | 0 | | 384,060 |
| Total | --- | | 347,415 | 0 | 124,985 | 0 | 622,600 | 232,330 | 8,000 | 0 | | 1,335,330 |
| Cane River, Louisiana | | | | | | | | | | | | |
| | CE (Plan I) | | 395,900 | 0 | 0 | --- | 2,486,000 | 111,400 | 0 | 235,000 I | | 3,228,300 |
| | CE (Plan II) | | 395,900 | 0 | 0 | --- | 260,000 | 111,400 | 0 | 235,000 I | | 1,002,300 |

1/ Includes incidental benefits

2/ Abbreviations: W-Water quality control, I-Irrigation

Table 83 - Average Annual Benefits and Costs for Structural Measures - Alternate Multiple-Purpose Watershed Projects for Early Action, Red River Basin Study Area

| Tributary | Agency | Participation | Amortized Installation Costs | Operation and Maintenance | Total Annual Costs | Total Annual Benefits | Benefit-Cost Ratio |
|-----------------------------|--------------|---------------|------------------------------|---------------------------|--------------------|-----------------------|--------------------|
| - - - - - dollars - - - - - | | | | | | | |
| Intervening Areas - Texas | | | | | | | |
| 3-25 & 25a | CE | | 486,700 | 118,700 | 605,400 | 771,400 | 1.3:1.0 |
| | SCS | | 252,560 | 86,340 | 348,900 | 567,740 | 1.6:1.0 |
| Total | --- | | 739,260 | 215,040 | 954,300 | 1,339,140 | 1.4:1.0 |
| Blue River, Oklahoma | | | | | | | |
| 3-23 | CE | | 698,100 | 159,700 | 857,800 | 1,117,200 | 1.3:1.0 |
| | SCS | | 80,960 | 14,470 | 95,430 | 207,000 | 2.2:1.0 |
| Total | --- | | 779,060 | 174,170 | 953,230 | 1,324,210 | 1.4:1.0 |
| Boggy Creek, Oklahoma | | | | | | | |
| 3h2-6,3h2-4 | CE | | 339,800 | 131,200 | 471,000 | 951,270 | 2.0:1.0 |
| | SCS | | 210,830 | 22,500 | 233,330 | 384,060 | 1.6:1.0 |
| Total | --- | | 550,630 | 153,700 | 704,330 | 1,335,330 | 1.9:1.0 |
| Cane River, Louisiana | | | | | | | |
| | CE (Plan I) | | - - Not Available | - - | 1,203,600 | 3,228,300 | 2.7:1.0 |
| | CE (Plan II) | | - - Not Available | - - | 735,200 | 1,002,300 | 1.4:1.0 |

annual costs are \$954,300, resulting in a benefit-cost ratio of approximately 1.4:1.0.

The potential benefit area in the combined project plan is estimated at 21,265 acres as compared to 26,430 acres for the potential USDA development plan. Of this difference in acreage, approximately 2,900 acres, consisting of the intensively farmed floodplain, would be inundated by the Bonham Reservoir. Total installation cost of the USDA potential plan of development would be approximately 7.5 million dollars, and installation costs of structural measures in the potential combined project would be approximately 22.6 million dollars. Recreation and municipal and industrial water storage in the USAE reservoir would be additional to that in the USDA developments. Municipal and industrial water supply storage, with dependable yield estimated at 6.2 mgd in the USDA potential development, would be adequate for 100-year needs for Bonham, Texas. Bonham Reservoir in the combined USAE-SCS potential plan includes benefits from commercial fishing.

Lower Blue River Watershed

The combined project plan for CNI Watershed 3-23 (Lower Blue River Watershed) includes Durant Reservoir on Blue River northeast of Wade, and 13 upstream reservoirs above a site proposed by the USAE. An additional 74 upstream reservoirs are planned above the Durant Site in CNI Watershed 3-23a. In CNI Watershed 3-23, 2,000 acre-feet of recreational storage, 2,050 acre-feet of water quality storage, and 1,000 acre-feet of fish and wildlife storage were included in three sites. The combined potential project would have estimated average annual benefits of \$1,324,210 and average annual costs of \$953,230. The benefit-cost ratio is estimated at 1.4:1.0.

The potential benefit area in the combined project plan is estimated at 12,650 acres. Of this amount, the benefit area directly affected by the upstream watershed development portion of the combined project would be confined to 6,719 acres, compared to a potential benefit area of 17,840 acres in the upstream watershed project. This difference consists primarily of 6,620 acres of fertile floodplain inundated by Durant Reservoir. Approximately 2,575 acres of potential benefit area under the USDA potential plan would lie below the Durant Reservoir in the combined project.

Total installation cost of the USDA potential structural developments in Lower Blue River are estimated at \$5,623,330, while installation costs of the structural measures in the combined project are \$22,571,250. Recreation in the Durant Reservoir would be additional to that in the upstream watershed project. Municipal and industrial water storage in the upstream watershed project would be replaced by storage in the Durant Reservoir with a yield of 30 mgd. The upstream watershed project would be adequate for 50-year needs. Existing pipeline and pumping facilities could be used in connection with the municipal and industrial storage in the upstream watershed project, but in order to utilize

water supply from the Durant Reservoir, pipeline and pumping facilities for a considerable higher lift would be required to move water into Durant.

Muddy Boggy Creek Watersheds

The combined project plan for CNI Watersheds 3h2-4 and 3h2-6 (Muddy Boggy Creek) includes Parker Reservoir, a site proposed by the USAE, and 69 upstream reservoirs. Of these, 16 would be above Parker Reservoir and 53 would be below Parker Reservoir.

The potential benefit area in the combined potential project would be approximately 22,000 acres compared to 29,000 acres in the upstream watershed project. An estimated 5,725 acres of potential benefit area in the upstream watershed plan would be inundated by Parker Reservoir in the alternate potential project. Recreation and municipal and industrial water supply with a yield of 47 mgd in the Parker Reservoir is in addition to that proposed in the upstream watershed plan. The upstream watershed project would be adequate for 50-year needs. The Parker Reservoir includes benefits from commercial fishing. The cost of structural measures in the combined plan is estimated at over \$16 million, compared to \$7.6 million for the upstream watershed project. Average annual benefits from the combined potential project were estimated at \$1,335,330, compared to \$425,460 in the upstream watershed project.

Cane River Tributary Basin Watersheds

Two alternative plans for Cane River Tributary Basin Watersheds includes Kisatchie Reservoir, a site proposed by the USAE, on Kisatchie Bayou near its mouth. The reservoir would control approximately 277 square miles of drainage area. It would include storage for irrigation, municipal and industrial water supply, recreation, and flood control purposes. The primary difference between the two plans (Plan I and Plan II) is the degree of recreation development.

In Cane River, Louisiana, the potential benefit area from flood damage reduction for the upstream watershed project is estimated at 64,625 acres; however, monetary benefits would accrue primarily on approximately 41,750 acres of Red River alluvium, most of which would also be benefitted by the USAE potential projects. The total installation cost of the upstream watershed project is estimated at \$14,075,790 compared to costs of \$20,113,100 and \$15,859,100 for the USAE Plan I and Plan II, respectively. The upstream watershed project would include recreation storage and basic recreation facilities at four sites, irrigation storage in four sites, and municipal water in five sites. All potential reservoirs would include sediment and detention storage. The combined surface area of permanent pools in the 38 upstream reservoirs amounts to 9,052 acres, while Kisatchie Reservoir inundates an estimated 9,180 acres. Average annual benefits from the potential upstream watershed project are estimated at \$902,410 compared to \$3,228,300 for USAE Plan I and \$1,002,300 for Plan II.

Exhibit 1. - Production of major crops: Delta and Southern Plains Areas as a percent of national production, 1939-1963, projected 1980

| Year | Barley | | Corn for grain | | Cotton | | Fruits non-citrus | | Oats | | Peanuts | |
|------|---------------------|----------|----------------|----------|--------|----------|-------------------|----------|--------|----------|---------|----------|
| | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern |
| | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains |
| | ----- percent ----- | | | | | | | | | | | |
| 1939 | 0.1 | 4.3 | 4.0 | 4.1 | 31.7 | 29.4 | - | - | 1.4 | 6.4 | 1.8 | 13.0 |
| 1940 | - | 4.0 | 4.9 | 5.9 | 25.5 | 33.1 | 1.5 | 1.3 | 1.2 | 6.5 | 1.1 | 13.8 |
| 1941 | 0.1 | 4.8 | 4.5 | 4.0 | 29.4 | 32.4 | 1.7 | 1.3 | 1.6 | 5.5 | 1.3 | 13.7 |
| 1942 | - | 3.8 | 3.7 | 3.6 | 31.6 | 30.1 | 1.5 | 1.1 | 1.5 | 2.7 | 1.8 | 25.0 |
| 1943 | 0.1 | 2.5 | 3.0 | 3.6 | 32.4 | 29.0 | 0.8 | 0.8 | 1.8 | 4.0 | 1.3 | 15.7 |
| 1944 | 0.1 | 5.1 | 2.9 | 3.0 | 32.4 | 27.7 | 1.3 | 0.9 | 2.5 | 6.1 | 0.6 | 19.2 |
| 1945 | 0.1 | 1.7 | 3.6 | 2.8 | 33.2 | 24.2 | 1.5 | 1.2 | 1.7 | 3.9 | 0.6 | 20.5 |
| 1946 | 0.2 | 2.6 | 2.7 | 2.5 | 29.8 | 24.0 | 1.3 | 0.9 | 1.3 | 4.1 | 0.5 | 25.5 |
| 1947 | - | 1.6 | 3.3 | 3.1 | 28.2 | 33.3 | 1.2 | 0.8 | 1.7 | 5.1 | 0.4 | 23.6 |
| 1948 | 0.1 | 1.0 | 2.7 | 1.9 | 34.2 | 25.3 | 1.4 | 0.6 | 1.4 | 1.8 | 0.5 | 19.8 |
| 1949 | 0.1 | 1.6 | 2.7 | 2.5 | 23.4 | 42.9 | 1.0 | 0.9 | 0.8 | 3.2 | 0.5 | 24.2 |
| 1950 | - | 1.0 | 3.5 | 3.0 | 28.4 | 33.7 | 0.9 | 0.4 | 0.8 | 3.2 | 0.4 | 22.7 |
| 1951 | - | 0.5 | 2.8 | 2.3 | 23.8 | 31.8 | 0.6 | 0.7 | 0.5 | 0.9 | 0.4 | 14.4 |
| 1952 | 0.1 | 0.9 | 1.6 | 1.5 | 26.6 | 29.1 | 0.8 | 0.5 | 0.9 | 2.3 | 0.3 | 10.5 |
| 1953 | 0.1 | 1.3 | 1.9 | 1.2 | 27.2 | 30.9 | 0.9 | 0.5 | 1.6 | 4.2 | 0.3 | 19.0 |
| 1954 | 0.3 | 2.3 | 1.6 | 1.3 | 25.5 | 33.2 | 0.6 | 0.4 | 2.3 | 4.2 | 0.3 | 15.3 |
| 1955 | 0.4 | 1.4 | 2.9 | 1.8 | 28.9 | 32.4 | 0.0 | 0.2 | 2.1 | 2.3 | 0.3 | 24.2 |
| 1956 | 0.5 | 1.8 | 2.2 | 1.0 | 27.2 | 31.4 | 1.0 | 0.5 | 3.0 | 2.6 | 0.2 | 9.1 |
| 1957 | 0.4 | 3.1 | 1.8 | 1.4 | 22.0 | 37.7 | 0.4 | 0.4 | 1.9 | 3.6 | 0.4 | 17.2 |
| 1958 | - | 5.8 | 1.9 | 1.4 | 19.0 | 42.7 | 1.0 | 0.6 | 0.8 | 5.0 | 0.2 | 20.5 |
| 1959 | 0.1 | 5.1 | 1.6 | 1.3 | 24.8 | 35.2 | 0.8 | 0.3 | 1.5 | 3.2 | 0.2 | 22.0 |
| 1960 | 0.1 | 6.3 | 1.2 | 0.9 | 23.7 | 35.7 | 0.8 | 0.4 | 1.2 | 3.2 | 0.1 | 21.7 |
| 1961 | 0.2 | 7.9 | 1.5 | 1.0 | 24.9 | 38.1 | 0.6 | 0.3 | 1.4 | 4.4 | 0.1 | 22.2 |
| 1962 | 0.2 | 3.3 | 0.9 | 1.0 | 24.9 | 35.8 | 0.7 | 0.3 | 1.1 | 2.2 | 0.1 | 22.2 |
| 1963 | 0.1 | 3.2 | 1.0 | 0.7 | 27.8 | 33.7 | 0.7 | 0.3 | 0.5 | 1.9 | 0.1 | 19.0 |
| 1980 | 0.3 | 6.0 | 0.3 | 0.5 | 26.0 | 35.0 | 0.3 | 0.1 | 1.0 | 3.0 | - | 20.0 |

Exhibit 1. - Continued

| Year | Potatoes | | Rice | | Sorghum for grain | | Soybeans | | Sugar cane | | Sweet potatoes | |
|------|---------------------|----------|--------|----------|-------------------|----------|----------|----------|------------|----------|----------------|----------|
| | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern | Delta | Southern |
| | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains | Plains |
| | ----- percent ----- | | | | | | | | | | | |
| 1939 | 1.9 | 1.4 | 55.3 | 28.1 | 0.3 | 62.5 | - | - | - | - | 23.2 | 5.9 |
| 1940 | 1.9 | 1.5 | 52.1 | 30.6 | 0.3 | 53.3 | 1.7 | 0.1 | 75.8 | - | 20.3 | 10.9 |
| 1941 | 1.9 | 2.3 | 61.0 | 22.6 | 0.1 | 64.1 | 2.5 | - | 80.7 | - | 25.5 | 11.2 |
| 1942 | 2.2 | 1.9 | 55.9 | 24.6 | 0.1 | 68.4 | 3.6 | 0.2 | 88.0 | - | 23.8 | 7.8 |
| 1943 | 2.1 | 1.9 | 52.0 | 25.6 | 0.1 | 74.2 | 2.4 | 0.1 | 88.5 | - | 25.1 | 9.7 |
| 1944 | 2.3 | 1.7 | 52.9 | 25.3 | 0.1 | 64.9 | 2.5 | - | 86.3 | - | 25.4 | 9.8 |
| 1945 | 1.6 | 1.3 | 53.2 | 26.4 | 0.2 | 70.1 | 2.5 | - | 83.3 | - | 32.1 | 9.0 |
| 1946 | 1.5 | 1.6 | 51.1 | 24.5 | 0.1 | 75.7 | 3.6 | - | 81.2 | - | 28.5 | 10.4 |
| 1947 | 1.3 | 1.4 | 49.9 | 27.3 | 0.2 | 77.3 | 2.9 | - | 81.0 | - | 26.0 | 9.0 |
| 1948 | 0.9 | 1.2 | 53.4 | 28.7 | 0.3 | 65.8 | 4.0 | - | 83.9 | - | 30.1 | 6.9 |
| 1949 | 0.9 | 1.1 | 48.6 | 26.2 | 0.3 | 69.1 | 4.1 | 0.1 | 81.6 | - | 28.4 | 10.5 |
| 1950 | 0.8 | 0.7 | 48.8 | 29.5 | 0.2 | 73.0 | 7.5 | 0.1 | 82.0 | - | 30.8 | 8.7 |
| 1951 | 0.8 | 0.9 | 47.4 | 29.3 | 0.2 | 58.0 | 6.5 | 0.4 | 78.0 | - | 32.5 | 5.4 |
| 1952 | 0.6 | 0.7 | 46.9 | 28.7 | 0.4 | 66.7 | 7.1 | 0.3 | 79.1 | - | 34.0 | 5.0 |
| 1953 | 0.6 | 0.8 | 47.9 | 28.5 | 0.4 | 58.6 | 4.5 | 0.2 | 79.9 | - | 32.0 | 8.0 |
| 1954 | 0.8 | 0.7 | 54.2 | 26.5 | 0.2 | 62.3 | 5.1 | 0.1 | 81.7 | - | 34.9 | 5.7 |
| 1955 | 0.6 | 0.9 | 53.3 | 26.2 | 0.9 | 69.5 | 9.6 | 0.1 | 83.0 | - | 35.7 | 9.7 |
| 1956 | 0.5 | 0.8 | 51.8 | 23.6 | 1.0 | 64.6 | 9.1 | 0.2 | 80.1 | - | 35.3 | 4.5 |
| 1957 | 0.4 | 1.0 | 51.2 | 25.9 | 1.0 | 46.9 | 9.6 | 0.2 | 78.6 | - | 31.0 | 7.4 |
| 1958 | 0.4 | 1.1 | 48.7 | 26.2 | 0.9 | 47.9 | 12.3 | 0.4 | 76.9 | - | 32.8 | 7.5 |
| 1959 | 0.4 | 1.2 | 50.5 | 24.5 | 0.3 | 51.2 | 15.0 | 0.7 | 74.1 | - | 32.0 | 9.1 |
| 1960 | 0.3 | 1.2 | 51.1 | 23.5 | 0.2 | 47.0 | 13.7 | 0.8 | 78.2 | - | 25.8 | 9.3 |
| 1961 | 0.2 | 1.2 | 52.2 | 21.9 | 0.2 | 53.4 | 11.3 | 0.8 | 77.8 | - | 30.7 | 6.8 |
| 1962 | 0.2 | 1.2 | 50.7 | 24.8 | 0.1 | 45.3 | 12.6 | 0.7 | 56.8 | - | 26.2 | 9.1 |
| 1963 | 0.2 | 1.1 | 52.7 | 26.2 | 0.1 | 48.1 | 11.8 | 0.6 | 62.5 | - | 30.3 | 7.2 |
| 1980 | 0.2 | 0.8 | 49.8 | 23.0 | 0 | 41.0 | 16.0 | 0.5 | 68.0 | - | 29.0 | 8.0 |

Exhibit 1. - Production of major crops: Delta and Southern Plains Areas
as a percent of national production, 1939-1963, projected 1980---
Continued

| Year | Vegetables | | Wheat, all | |
|----------------|---------------------|--------------------|------------|--------------------|
| | Delta | Southern Plains | Delta | Southern Plains |
| | ----- percent ----- | | | |
| 1939 | 2.7 | 7.4 | - | 12.5 |
| 1940 | 2.5 | 6.9 | 0.1 | 11.4 |
| 1941 | 2.2 | 5.6 | - | 8.8 |
| 1942 | 2.6 | 8.0 | - | 12.3 |
| 1943 | 2.0 | 7.3 | - | 9.4 |
| 1944 | 2.4 | 9.1 | 0.2 | 16.1 |
| 1945 | 2.3 | 8.9 | 0.1 | 11.3 |
| 1946 | 2.0 | 8.7 | - | 13.4 |
| 1947 | 1.8 | 8.5 | - | 16.9 |
| 1948 | 1.7 | 8.2 | - | 12.4 |
| 1949 | 1.8 | 8.6 | 0.1 | 16.4 |
| 1950 | 1.7 | 7.5 | - | 6.2 |
| 1951 | 1.4 | 5.4 | - | 5.8 |
| 1952 | 1.3 | 6.3 | 0.1 | 11.1 |
| 1953 | 1.4 | 7.1 | 0.3 | 8.2 |
| 1954 | 1.3 | 7.4 | 0.3 | 10.6 |
| 1955 | 1.8 | 7.4 | 0.2 | 4.3 |
| 1956 | 1.2 | 7.1 | 0.4 | 9.6 |
| 1957 | 1.2 | 7.2 | 0.9 | 8.2 |
| 1958 | 1.1 | 7.9 | 0.4 | 13.0 |
| 1959 | 1.1 | 6.9 | 0.5 | 13.3 |
| 1960 | 0.9 | 7.7 | 0.5 | 15.0 |
| 1961 | 0.9 | 6.7 | 0.6 | 16.5 |
| 1962 | 0.8 | 5.9 | 0.4 | 10.9 |
| 1963 | 0.9 | 6.9 | 0.7 | 10.5 |
| 1980 | 1.0 | 6.5 | 0.5 | 12.5 |

Continued - - - - -

Exhibit 1. - Production of major livestock products: Delta and Southern Plains Areas as a percent of national production, 1939-63, projected 1980

| Year | Broilers | | Beef and veal | | Eggs | | Farm chickens | |
|------|-----------------------------|-----------------|---------------|-----------------|-------|-----------------|---------------|-----------------|
| | Delta | Southern Plains | Delta | Southern Plains | Delta | Southern Plains | Delta | Southern Plains |
| | - - - - - percent - - - - - | | | | | | | |
| 1939 | 9.2 | 4.7 | 3.7 | 15.2 | 3.5 | 8.5 | 4.5 | 7.1 |
| 1940 | 7.6 | 4.1 | 3.5 | 14.3 | 3.2 | 8.6 | 4.5 | 7.0 |
| 1941 | 8.8 | 3.7 | 3.4 | 14.8 | 3.2 | 8.7 | 4.6 | 7.7 |
| 1942 | 6.1 | 4.1 | 3.4 | 15.9 | 3.2 | 8.8 | 4.4 | 7.7 |
| 1943 | 6.7 | 4.1 | 3.5 | 15.7 | 3.3 | 8.9 | 4.3 | 7.5 |
| 1944 | 5.7 | 3.7 | 3.6 | 15.4 | 3.1 | 9.2 | 4.1 | 7.1 |
| 1945 | 5.3 | 3.2 | 3.7 | 15.3 | 3.1 | 8.9 | 3.8 | 6.8 |
| 1946 | 6.1 | 3.4 | 3.9 | 15.1 | 3.0 | 8.1 | 4.3 | 6.4 |
| 1947 | 6.2 | 3.1 | 3.7 | 14.9 | 2.8 | 7.7 | 3.9 | 6.5 |
| 1948 | 7.8 | 3.6 | 3.6 | 15.0 | 2.9 | 7.3 | 4.7 | 6.0 |
| 1949 | 9.2 | 4.7 | 3.5 | 15.6 | 3.0 | 7.1 | 4.4 | 6.2 |
| 1950 | 9.9 | 5.0 | 3.6 | 15.6 | 3.1 | 6.9 | 4.2 | 5.5 |
| 1951 | 11.3 | 6.5 | 3.9 | 15.2 | 3.0 | 6.4 | 3.6 | 5.1 |
| 1952 | 11.9 | 7.2 | 4.2 | 14.8 | 2.8 | 6.5 | 3.6 | 4.4 |
| 1953 | 11.5 | 7.2 | 4.7 | 13.9 | 2.7 | 5.8 | 2.9 | 4.4 |
| 1954 | 11.3 | 7.0 | 4.9 | 13.6 | 2.6 | 5.5 | 2.9 | 4.0 |
| 1955 | 10.7 | 7.4 | 4.9 | 13.7 | 2.5 | 5.4 | 2.9 | 3.6 |
| 1956 | 11.3 | 7.4 | 4.8 | 14.1 | 2.8 | 5.5 | 2.9 | 4.1 |
| 1957 | 12.3 | 7.0 | 5.3 | 12.9 | 2.9 | 5.5 | 3.3 | 3.5 |
| 1958 | 13.4 | 6.7 | 5.0 | 13.4 | 3.0 | 5.5 | 3.8 | 4.4 |
| 1959 | 15.8 | 6.6 | 4.5 | 13.8 | 3.8 | 5.6 | 5.1 | 4.4 |
| 1960 | 16.5 | 6.0 | 4.4 | 14.7 | 4.2 | 5.2 | 4.4 | 4.6 |
| 1961 | 18.5 | 6.2 | 4.5 | 14.8 | 4.9 | 5.4 | 5.1 | 5.3 |
| 1962 | 19.0 | 6.4 | 4.4 | 15.2 | 5.6 | 5.2 | 5.9 | 5.0 |
| 1963 | 20.2 | 6.5 | 4.2 | 15.2 | 6.6 | 5.0 | 7.2 | 4.8 |
| 1980 | 24.0 | 8.0 | 5.3 | 14.0 | 7.0 | 6.0 | 7.0 | 6.0 |

Exhibit 1. - Continued

| Year | Pork | | Milk | | Lamb & mutton | | Turkeys | |
|------|-----------------------------|-----------------|-------|-----------------|---------------|-----------------|---------|-----------------|
| | Delta | Southern Plains | Delta | Southern Plains | Delta | Southern Plains | Delta | Southern Plains |
| | - - - - - percent - - - - - | | | | | | | |
| 1939 | 3.8 | 5.1 | 3.0 | 6.5 | 0.4 | 14.6 | 0.7 | 17.0 |
| 1940 | 3.0 | 4.3 | 2.9 | 6.2 | 0.4 | 15.4 | 0.8 | 15.7 |
| 1941 | 2.9 | 4.3 | 2.9 | 6.3 | 0.4 | 14.2 | 1.0 | 13.4 |
| 1942 | 2.9 | 4.8 | 2.9 | 6.3 | 0.3 | 16.0 | 0.9 | 12.5 |
| 1943 | 3.0 | 5.2 | 3.0 | 6.2 | 0.2 | 14.0 | 0.7 | 11.8 |
| 1944 | 3.0 | 4.6 | 3.0 | 6.1 | 0.3 | 16.9 | 0.7 | 10.3 |
| 1945 | 3.1 | 4.3 | 3.0 | 5.7 | 0.4 | 17.8 | 0.6 | 9.6 |
| 1946 | 3.0 | 4.1 | 2.9 | 5.4 | 0.3 | 16.6 | 0.5 | 8.8 |
| 1947 | 3.2 | 3.8 | 2.9 | 5.2 | 0.3 | 16.7 | 0.6 | 8.9 |
| 1948 | 3.1 | 4.0 | 3.0 | 4.9 | 0.3 | 13.1 | 0.7 | 7.1 |
| 1949 | 2.9 | 3.6 | 2.9 | 4.7 | 0.3 | 16.2 | 0.9 | 7.3 |
| 1950 | 2.8 | 3.5 | 2.9 | 4.9 | 0.3 | 17.5 | 1.5 | 7.4 |
| 1951 | 2.3 | 3.6 | 2.9 | 4.6 | 0.3 | 14.2 | 1.5 | 6.9 |
| 1952 | 2.3 | 3.1 | 2.9 | 4.4 | 0.4 | 12.1 | 1.4 | 7.0 |
| 1953 | 1.9 | 2.3 | 2.9 | 4.3 | 0.5 | 12.2 | 2.4 | 6.5 |
| 1954 | 1.7 | 2.3 | 2.9 | 4.1 | 0.6 | 12.0 | 2.5 | 6.0 |
| 1955 | 1.9 | 2.5 | 2.9 | 4.0 | 0.6 | 11.9 | 2.5 | 6.1 |
| 1956 | 2.2 | 2.6 | 2.8 | 4.0 | 0.5 | 12.6 | 3.3 | 7.5 |
| 1957 | 1.9 | 2.1 | 2.8 | 3.9 | 0.6 | 11.3 | 3.4 | 7.6 |
| 1958 | 1.7 | 2.1 | 2.6 | 3.9 | 0.6 | 12.6 | 3.5 | 6.1 |
| 1959 | 1.7 | 2.5 | 2.6 | 3.8 | 0.3 | 13.7 | 2.9 | 5.7 |
| 1960 | 1.7 | 2.3 | 2.5 | 3.7 | 0.3 | 14.9 | 3.1 | 6.7 |
| 1961 | 1.5 | 2.3 | 2.4 | 3.8 | 0.4 | 15.5 | 3.3 | 6.6 |
| 1962 | 1.4 | 2.2 | 2.4 | 3.7 | 0.3 | 14.4 | 3.0 | 6.4 |
| 1963 | 1.3 | 2.1 | 2.4 | 3.7 | 0.3 | 14.4 | 3.5 | 7.1 |
| 1980 | 1.0 | 1.5 | 2.0 | 3.0 | 0.4 | 12.5 | 5.5 | 8.0 |

4-24879

Exhibit 2. - Land use: Distribution of land area by states and land resource areas, by major land uses, Red River Basin Study Area, 1962

| State and land resource area | Cropland | Pasture range | Forest woodland | Other: land | Total inventoried |
|--------------------------------------|----------|---------------|-----------------|-------------|-------------------|
| : - - - - - thousand acres - - - - - | | | | | |
| Arkansas | | | | | |
| 86 | 23.3 | 48.4 | 31.8 | .5 | 104.0 |
| 131 | 129.6 | 54.4 | 180.3 | 1.8 | 366.1 |
| 133 | 222.9 | 212.2 | 1,307.4 | 11.2 | 1,753.7 |
| 119 | 12.4 | 28.2 | 394.0 | 2.3 | 436.9 |
| Sub-total | 388.2 | 343.2 | 1,913.5 | 15.8 | 2,660.7 |
| Louisiana | | | | | |
| 131 | 453.7 | 397.0 | 813.5 | 44.8 | 1,709.0 |
| 133 | 100.6 | 330.3 | 2,235.9 | 141.8 | 2,808.6 |
| 134 | 19.8 | 38.7 | 50.0 | 1.6 | 110.1 |
| Sub-total | 574.1 | 766.0 | 3,099.4 | 188.2 | 4,627.7 |
| Oklahoma | | | | | |
| 131 | 63.9 | 42.0 | 44.4 | 1.9 | 152.2 |
| 112 | 71.8 | 193.5 | 119.5 | 61.2 | 446.0 |
| 84 | 13.6 | 21.9 | 99.7 | 23.9 | 159.1 |
| 133 | 259.0 | 218.6 | 610.1 | 30.7 | 1,118.4 |
| 85 | 164.5 | 337.0 | 157.8 | 40.0 | 699.3 |
| 119 | 44.1 | 119.2 | 2,042.9 | 81.0 | 2,287.2 |
| 80 | 16.1 | - | .3 | 1.2 | 17.6 |
| Sub-total | 633.0 | 932.2 | 3,074.7 | 239.9 | 4,879.8 |
| Texas | | | | | |
| 86 | 942.5 | 443.0 | 269.6 | 26.7 | 1,681.8 |
| 131 | 70.8 | 37.6 | 66.1 | .1 | 174.6 |
| 133 | 767.6 | 622.7 | 1,849.9 | 17.9 | 3,258.1 |
| 84 | 12.9 | 16.2 | 13.2 | 8.3 | 50.6 |
| Sub-total | 1,793.8 | 1,119.5 | 2,198.8 | 53.0 | 5,165.1 |
| Basin total | 3,389.1 | 3,160.9 | 10,286.4 | 496.9 | 17,333.3 |

Source: CNI 1958, with adjustment to the Red River Basin memo of June 30, 1965. "1962" data represent changes in large water areas and non-inventory acreages.

Exhibit 3. - Land use: Distribution of land by major land uses and states by land resource area groupings, Red River Basin Study Area, 1962

| Land use and states | Land Resource Areas | | | | | Total |
|------------------------|----------------------------|---------|---------|-----------|---------|----------|
| | 86 | 131,134 | 112,85 | 133,84,80 | 119 | |
| | ----- thousand acres ----- | | | | | |
| <u>Cropland</u> | | | | | | |
| Arkansas | 23.3 | 129.6 | - | 222.9 | 12.4 | 388.2 |
| Louisiana | - | 473.5 | - | 100.6 | - | 574.1 |
| Oklahoma | - | 63.9 | 236.3 | 288.7 | 44.1 | 633.0 |
| Texas | 942.5 | 70.8 | - | 780.5 | - | 1,793.8 |
| Sub-total .. | 965.8 | 737.8 | 236.3 | 1,392.7 | 56.5 | 3,389.1 |
| <u>Pasture range</u> | | | | | | |
| Arkansas | 48.4 | 54.4 | - | 212.2 | 28.2 | 343.2 |
| Louisiana | - | 435.7 | - | 330.3 | - | 766.0 |
| Oklahoma | - | 42.0 | 530.5 | 240.5 | 119.2 | 932.2 |
| Texas | 443.0 | 37.6 | - | 638.9 | - | 1,119.5 |
| Sub-total | 491.4 | 569.7 | 530.5 | 1,421.9 | 147.4 | 3,160.9 |
| <u>Forest woodland</u> | | | | | | |
| Arkansas | 31.8 | 180.3 | - | 1,307.4 | 394.0 | 1,913.5 |
| Louisiana | - | 863.5 | - | 2,235.9 | - | 3,099.4 |
| Oklahoma | - | 44.4 | 277.3 | 710.1 | 2,042.9 | 3,074.7 |
| Texas | 269.6 | 66.1 | - | 1,863.1 | - | 2,198.8 |
| Sub-total | 301.4 | 1,154.3 | 277.3 | 6,116.5 | 2,436.9 | 10,286.4 |
| <u>Other</u> | | | | | | |
| Arkansas | 0.5 | 1.8 | - | 11.2 | 2.3 | 15.8 |
| Louisiana | - | 46.4 | - | 141.8 | - | 188.2 |
| Oklahoma | - | 1.9 | 101.2 | 55.8 | 81.0 | 239.9 |
| Texas | 26.7 | 0.1 | - | 26.2 | - | 53.0 |
| Sub-total | 27.2 | 50.2 | 101.2 | 235.0 | 83.3 | 496.9 |
| Basin total | 1,785.8 | 2,512.0 | 1,145.3 | 9,166.1 | 2,724.1 | 17,333.3 |

Source: CNI 1958 with adjustments to the Red River Basin memo of June 30, 1965. "1962" data represent changes in large water areas and non-inventory acreages.

Exhibit 4. - Population: Total, United States, Four-State Region 1/, and Red River Basin, 1940, 1950, 1960, and projected 1980 to 2080

| Year | United States | Four-State Region 1/ | Percent of U.S. | Red River Basin | Percent of U.S. | Red River Basin portion of: | | | |
|------|---------------|----------------------|-----------------|-----------------|-----------------|-----------------------------|--------------|-------------|-----------|
| | | | | | | Arkansas 2/ | Louisiana 3/ | Oklahoma 4/ | Texas 5/ |
| | thousands | thousands | percent | thousands | percent | thousands | thousands | thousands | thousands |
| 1940 | 132,600 | 13,064 | 9.9 | 1,885.0 | 1.42 | 194.8 | 717.9 | 364.8 | 607.5 |
| 1950 | 152,271 | 14,538 | 9.6 | 1,739.0 | 1.14 | 166.0 | 746.0 | 274.2 | 552.8 |
| 1960 | 180,676 | 16,951 | 9.4 | 1,704.2 | 0.94 | 141.7 | 824.3 | 224.3 | 513.9 |
| 1980 | 245,313 | 23,476 | 9.6 | 2,236.7 | 0.91 | 186.1 | 1,137.9 | 254.1 | 658.6 |
| 2000 | 338,219 | 32,459 | 9.6 | 2,948.1 | 0.87 | 244.7 | 1,571.1 | 287.7 | 844.6 |
| 2020 | 469,126 | 45,053 | 9.6 | 3,898.1 | 0.83 | 321.5 | 2,168.3 | 325.8 | 1,082.5 |
| 2040 | 647,394 | 62,533 | 9.6 | 5,172.7 | 0.80 | 422.5 | 2,993.2 | 369.1 | 1,387.9 |
| 2060 | 893,404 | 85,767 | 9.6 | 6,884.9 | 0.77 | 555.2 | 4,131.6 | 418.2 | 1,779.9 |
| 2080 | 1,232,900 | 118,358 | 9.6 | 9,188.1 | 0.74 | 729.5 | 5,703.5 | 473.7 | 2,281.4 |

- 1/ Four-State Region: Arkansas, Louisiana, Oklahoma, Texas
- 2/ Total population for 9 counties, RRB of Arkansas
- 3/ Total population for 20 parishes, RRB of Louisiana
- 4/ Total population for 13 counties, RRB of Oklahoma
- 5/ Total population for 19 counties, RRB of Texas

Source: Series B Census of Population, U. S. Department of Commerce; U. S. Corps of Engineers, New Orleans District population projection study by basins (March 1966)

Exhibit 5 - Projected Land Utilization: Land in Farms, Major Agricultural Use with Crop Distribution, by Major Land Resource Area Groupings, Without Project Development Red River Basin Study Area, Projected 1980

| Land Use | LRA 86 | LRA 131 | LRA 134 | LRA 85,112 | LRA 80, 84,133 | LRA 119 | Total |
|------------------------------------|----------------|----------------|----------------|----------------|----------------|-----------------|-------|
| - - - - - thousand acres - - - - - | | | | | | | |
| Total cropland: | 831.2 | 622.6 | 201.7 | 1,162.1 | 47.2 | 2,864.8 | |
| Cotton | 147.5 | 14.5 | 7.1 | 13.1 | - | 232.2 | |
| Corn, silage | 1.8 | 4.6 | 0.1 | 5.2 | 0.4 | 12.1 | |
| Corn, grain | 20.5 | 15.0 | 2.6 | 7.8 | Z | 45.9 | |
| Oats | 45.0 | 5.9 | 5.0 | 2.2 | - | 58.1 | |
| Barley | 19.5 | - | - | - | - | 19.5 | |
| Sorghum, silage .. | 10.3 | 0.4 | 2.5 | 6.0 | 0.1 | 19.3 | |
| Sorghum, grain ... | 45.9 | 1.0 | 13.0 | 13.7 | 0.1 | 73.7 | |
| Wheat..... | 96.2 | 3.0 | 2.9 | 0.3 | - | 102.4 | |
| Rice | - | 5.5 | - | - | - | 5.5 | |
| Soybeans, forage . | 6.7 | 38.0 | 0.2 | 1.5 | - | 46.4 | |
| Soybeans, beans... | 3.9 | 44.9 | 2.3 | 0.6 | - | 51.7 | |
| Peanuts | 11.0 | Z | 12.4 | 4.6 | - | 28.0 | |
| Sweet Potatoes ... | Z | 14.7 | Z | 5.3 | - | 20.0 | |
| Vegetables | 0.7 | 2.6 | 0.4 | 17.9 | - | 21.6 | |
| Cowpeas | 0.4 | Z | 0.1 | 2.3 | - | 2.8 | |
| Sugarcane/sugar... | - | 1.0 | - | - | - | 1.0 | |
| Field seed crops | | | | | | | |
| (other)..... | 31.6 | 1.4 | 0.7 | 1.3 | - | 35.0 | |
| Alfalfa | 18.7 | 10.4 | 10.6 | 5.9 | - | 45.6 | |
| Other hay | 101.5 | 135.9 | 40.5 | 236.7 | 20.8 | 535.4 | |
| Fruit, non-citrus.: | 1.9 | 6.8 | 0.8 | 5.3 | - | 14.8 | |
| Other | 0.5 | 3.6 | 0.3 | 0.6 | 0.1 | 5.1 | |
| Not harvested: | | | | | | | |
| idle, fallow, etc.: | 38.1 | 64.8 | 27.2 | 146.2 | 3.2 | 279.5 | |
| Pastured | 229.5 | 198.6 | 73.0 | 685.6 | 22.5 | 1,209.2 | |
| Pasture-Range: | 653.4 | 640.6 | 598.2 | 1,227.0 | 148.9 | 3,268.1 | |
| Forest-Woodland: | 261.7 | 1,173.6 | 239.3 | 6,529.3 | 2,500.0 | 10,703.9 | |
| Grazed | 212.0 | 610.3 | 217.8 | 4,309.3 | 1,625.0 | 6,974.4 | |
| Not grazed | 49.7 | 563.3 | 21.5 | 2,220.0 | 875.0 | 3,729.5 | |
| Other land: | 30.9 | 63.3 | 100.4 | 203.8 | 14.6 | 413.0 | |
| Total land in farms | 1,777.2 | 2,500.1 | 1,139.6 | 9,122.2 | 2,710.7 | 17,249.8 | |

Exhibit 6 - Projected Land Utilization: Land in Farms, Major Agricultural Use with Crop Distribution, by Major Land Resource Area Grouping Without Project Development, Red River Basin Study Area, Projected 2010

| Land Use | LRA : 86 | LRA : 131, 134 | LRA : 85, 112 | LRA 80, : 84, 133 | LRA : 119 | Total |
|-----------------------|--------------------------------------|-------------------|------------------|----------------------|--------------|----------|
| | : - - - - - thousand acres - - - - - | | | | | |
| Total cropland: | 795.1 | 592.3 | 193.4 | 1,108.0 | 45.7 | 2,734.5 |
| Cotton | 77.4 | 30.2 | 4.6 | Z | - | 112.2 |
| Corn, silage | 0.7 | 3.0 | 0.1 | 1.8 | - | 5.6 |
| Corn, grain | 6.7 | 16.0 | 0.9 | 2.6 | - | 26.2 |
| Oats | 48.1 | 7.8 | 5.5 | 1.6 | - | 63.0 |
| Barley | 21.0 | - | - | - | - | 21.0 |
| Sorghum, silage .. | 4.0 | 0.5 | 2.6 | 3.0 | 0.1 | 10.2 |
| Sorghum, grain ... | 61.0 | 2.8 | 13.5 | 8.0 | 0.1 | 85.4 |
| Wheat | 106.5 | 4.0 | 3.4 | - | - | 113.9 |
| Rice | - | 5.0 | - | - | - | 5.0 |
| Soybeans, forage .. | 7.1 | 6.8 | 0.3 | 1.8 | - | 16.0 |
| Soybeans, beans .. | 4.3 | 78.2 | 2.7 | 0.8 | - | 86.0 |
| Peanuts | 5.9 | Z | 10.6 | 3.0 | - | 19.5 |
| Sweet Potatoes ... | - | 14.3 | - | 2.6 | - | 16.9 |
| Vegetables | 0.7 | 2.6 | 0.4 | 17.7 | - | 21.4 |
| Cowpeas | Z | - | - | - | - | - |
| Sugarcane/sugar .. | - | 1.0 | - | - | - | 1.0 |
| Field seed crops | | | | | | |
| (other) | 32.4 | 1.4 | 0.7 | 1.3 | - | 35.8 |
| Alfalfa | 19.5 | 14.0 | 10.5 | 6.2 | - | 50.2 |
| Other hay | 110.8 | 155.6 | 44.0 | 255.6 | 22.2 | 588.2 |
| Fruit, non-citrus. : | 1.9 | 6.8 | 0.8 | 5.3 | 0.2 | 15.0 |
| Other | 0.6 | 4.0 | 0.3 | 0.3 | 0.1 | 5.3 |
| Not harvested: | | | | | | |
| idle, fallow, etc : | 25.1 | 65.6 | 26.8 | 125.0 | 3.3 | 245.8 |
| Pastured | 261.4 | 172.7 | 65.7 | 671.4 | 19.7 | 1,190.9 |
| Pasture-Range | 664.2 | 645.1 | 611.4 | 1,323.7 | 167.1 | 3,411.5 |
| Forest-Woodland: | | | | | | |
| Grazed | 249.5 | 1,112.9 | 231.8 | 6,214.9 | 2,436.7 | 10,245.8 |
| Not grazed | 202.1 | 578.7 | 210.9 | 4,101.8 | 1,583.9 | 6,677.4 |
| Other land: | 47.4 | 534.2 | 20.9 | 2,113.1 | 852.8 | 3,568.4 |
| Total land in farms : | 1,756.9 | 2,450.0 | 1,137.8 | 9,001.9 | 2,705.1 | 17,051.7 |

Exhibit 7 - Land Utilization: Land in Farms, Major Agricultural Use with Crop Distribution, by Major Land Resource Area Grouping Without Project Development, Red River Basin, Extrapolated 2080

| Land Use | LRA 86 | LRA 131, 134 | LRA 85, 112 | LRA 80, 133 | LRA 119 | Total |
|----------------------------|---------|--------------|-------------|-------------|---------|----------|
| ----- thousand acres ----- | | | | | | |
| Total cropland: | 940.9 | 668.7 | 196.9 | 1,075.5 | 51.0 | 2,933.0 |
| Cotton | 38.7 | 30.0 | 5.0 | - | - | 73.7 |
| Corn, silage | 0.8 | 4.4 | 0.6 | 2.9 | - | 8.7 |
| Corn, grain | 7.6 | 23.2 | 5.5 | - | - | 36.3 |
| Oats | 55.3 | 12.4 | 6.9 | 2.0 | - | 76.6 |
| Barley | 24.5 | - | - | - | - | 24.5 |
| Sorghum, silage .. | 4.0 | 0.5 | 2.8 | 3.0 | 1.7 | 12.0 |
| Sorghum, grain ... | 96.2 | 8.4 | 14.9 | 10.0 | 0.1 | 129.6 |
| Wheat | 142.0 | 5.1 | 4.5 | - | - | 151.6 |
| Rice | - | 5.0 | - | - | - | 5.0 |
| Soybeans, forage .. | 8.0 | 19.5 | 0.4 | 3.4 | - | 31.3 |
| Soybeans, beans .. | 7.5 | 155.9 | 3.7 | 1.5 | - | 168.6 |
| Peanuts | 5.9 | - | 10.6 | 3.0 | - | 19.5 |
| Sweet potatoes ... | - | 14.3 | - | 2.6 | - | 16.9 |
| Vegetables | 0.7 | 2.6 | 0.4 | 17.7 | - | 21.4 |
| Sugarcane/sugar .. | - | 1.0 | - | - | - | 1.0 |
| Field seed crops | | | | | | |
| (other) | 33.9 | 1.4 | 0.7 | 1.3 | - | 37.3 |
| Alfalfa | 22.0 | 26.9 | 13.0 | 9.1 | - | 71.0 |
| Other hay | 132.5 | 20.6 | 52.2 | 299.6 | 25.0 | 711.3 |
| Fruit, non-citrus .. | 1.9 | 6.8 | 0.8 | 5.3 | 0.7 | 15.5 |
| Other | 0.6 | 4.5 | 0.3 | 0.3 | 0.1 | 5.8 |
| Not harvested: | | | | | | |
| idle, fallow, etc | 23.0 | 39.5 | 25.9 | 75.5 | 3.3 | 167.2 |
| Pastured | 335.8 | 105.7 | 48.7 | 638.3 | 19.7 | 1,148.2 |
| Pasture-Range: | 665.0 | 645.1 | 634.0 | 1,323.7 | 167.1 | 3,434.9 |
| Forest-Woodland: | | | | | | |
| Grazed | 179.0 | 505.0 | 194.8 | 3,617.6 | 1,486.9 | 5,983.3 |
| Not grazed | 42.0 | 466.3 | 19.5 | 1,863.7 | 802.1 | 3,193.6 |
| Other land: | 51.1 | 105.7 | 107.1 | 376.8 | 59.5 | 700.2 |
| Total land in farms | 1,878.0 | 2,390.8 | 1,152.3 | 8,257.3 | 2,566.6 | 16,245.0 |

Exhibit 8 -- Yields: Major crops and pasture, Red River Basin Study Area, 1962, projected
1980, 2010, extrapolated 2080

| Crop and pasture | Unit | Study area average | | | | Land Resource Area 86 | | | | Land Resource Area 131,134 | | | |
|----------------------|------|--------------------|-------|-------|-------|-----------------------|------|------|-------|----------------------------|-------|-------|-------|
| | | 1962 | 1980 | 2010 | 2080 | 1962 | 1980 | 2010 | 2080 | 1962 | 1980 | 2010 | 2080 |
| Cotton | lbs. | 422 | 603 | 870 | 1,508 | 390 | 590 | 830 | 1,400 | 560 | 705 | 1,020 | 1,750 |
| Feed grains: | | | | | | | | | | | | | |
| Corn | bu. | 31 | 50 | 63 | 88 | 30 | 49 | 55 | 69 | 35 | 58 | 68 | 91 |
| Oats | bu. | 26 | 30 | 36 | 48 | 25 | 29 | 34 | 45 | 35 | 37 | 42 | 54 |
| Barley | bu. | 21 | 24 | 27 | 34 | 21 | 24 | 27 | 34 | -- | -- | -- | -- |
| Sorghum | bu. | 31 | 39 | 48 | 71 | 32 | 39 | 49 | 74 | 32 | 51 | 57 | 73 |
| Wheat | bu. | 23 | 25 | 28 | 36 | 23 | 25 | 27 | 35 | 21 | 28 | 38 | 60 |
| Rice | lbs. | 3,250 | 4,640 | 6,120 | 7,640 | -- | -- | -- | -- | 3,250 | 4,640 | 6,120 | 7,640 |
| Soybeans | bu. | 22 | 27 | 41 | 75 | 24 | 27 | 30 | 38 | 22 | 27 | 42 | 77 |
| Peanuts | lbs. | 753 | 850 | 1,170 | 1,802 | 720 | 810 | 950 | 1,090 | -- | -- | -- | -- |
| Sweet potatoes | bu. | 115 | 118 | 130 | 185 | -- | -- | -- | -- | 87 | 91 | 100 | 121 |
| Vegetables | cwt. | 65 | 69 | 92 | 131 | 53 | 58 | 62 | 72 | 62 | 74 | 88 | 120 |
| Alfalfa & mixture | ton | 2.1 | 2.6 | 3.3 | 4.9 | 1.8 | 2.4 | 3.0 | 4.4 | 2.3 | 2.7 | 3.8 | 6.0 |
| Other hay | ton | 1.3 | 1.6 | 2.2 | 3.4 | 1.2 | 1.4 | 1.6 | 2.1 | 1.5 | 1.7 | 2.2 | 3.5 |
| Sugar cane for sugar | ton | 19 | 27 | 33 | 47 | -- | -- | -- | -- | 19 | 27 | 33 | 47 |
| Fruit, non-citrus | ton | 0.6 | 0.8 | 0.9 | 1.4 | 0.6 | 0.8 | 0.9 | 1.4 | 0.6 | 0.8 | 0.9 | 1.1 |
| Pasture & range | AUM | 4.4 | 5.2 | 5.7 | 7.1 | 5.0 | 5.7 | 6.3 | 7.7 | 5.8 | 6.7 | 7.4 | 9.0 |
| Woodland pastured | AUM | 0.3 | 0.3 | 0.3 | 0.3 | 0.6 | 0.6 | 0.6 | 0.6 | 0.3 | 0.3 | 0.3 | 0.3 |
| Cropland pastured | AUM | 5.3 | 6.1 | 7.5 | 10.6 | 6.5 | 7.6 | 9.2 | 12.9 | 7.0 | 8.2 | 10.0 | 14.2 |

Exhibit 8 -- Continued

| Crop and pasture | Unit | Land Resource Area 85, 112 | | | | Land Resource Area 80, 84, 133 | | | | Land Resource Area 119 | | | |
|----------------------|------|----------------------------|------|-------|-------|--------------------------------|------|-------|-------|------------------------|------|------|------|
| | | 1962 | 1980 | 2010 | 2080 | 1962 | 1980 | 2010 | 2080 | 1962 | 1980 | 2010 | 2080 |
| Cotton | lbs. | 210 | 350 | 510 | 900 | 275 | 425 | -- | -- | -- | -- | -- | -- |
| Feed grains: | | | | | | | | | | | | | |
| Corn | bu. | 36 | 40 | 48 | 67 | 28 | 34 | 54 | 68 | 26 | -- | -- | -- |
| Oats | bu. | 22 | 28 | 38 | 62 | 24 | 27 | 32 | 44 | -- | -- | -- | -- |
| Barley | bu. | 23 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Sorghum | bu. | 29 | 35 | 41 | 55 | 30 | 40 | 49 | 70 | 32 | 40 | 49 | 70 |
| Wheat | bu. | 25 | 27 | 29 | 34 | 20 | 25 | -- | -- | -- | -- | -- | -- |
| Rice | lb. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Soybeans | bu. | 22 | 30 | 39 | 61 | 18 | 28 | 37 | 58 | -- | -- | -- | -- |
| Peanuts | lb. | 800 | 940 | 1,320 | 2,207 | 585 | 740 | 1,050 | 1,770 | -- | -- | -- | -- |
| Sweet potatoes | bu. | -- | -- | -- | -- | 168 | 197 | 300 | 540 | -- | -- | -- | -- |
| Vegetables | cwt. | 63 | 72 | 84 | 112 | 77 | 88 | 102 | 135 | 2 | 2 | 2 | 2 |
| Alfalfa & mixture | ton | 2.6 | 2.7 | 3.0 | 4.0 | 2.4 | 2.6 | 3.1 | 4.3 | -- | -- | -- | -- |
| Other hay | ton | 1.3 | 1.7 | 2.3 | 3.6 | 1.3 | 1.7 | 2.4 | 4.0 | 1.0 | 1.1 | 1.4 | 2.1 |
| Sugar cane for sugar | ton | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Fruit, non-citrus | ton | 0.6 | 0.8 | 0.9 | 1.1 | 1.1 | 1.3 | 1.6 | 2.5 | 0.2 | 0.2 | 0.2 | 0.2 |
| Pasture & range | AUM | 4.4 | 5.0 | 5.6 | 7.0 | 3.9 | 4.5 | 5.0 | 6.2 | 3.0 | 3.4 | 3.8 | 4.7 |
| Woodland pastured | AUM | 0.5 | 0.5 | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Cropland pastured | AUM | 4.6 | 5.4 | 6.6 | 9.4 | 4.5 | 5.2 | 6.3 | 8.9 | 4.1 | 4.8 | 5.8 | 8.1 |

Z - Small quantities, or insignificant.

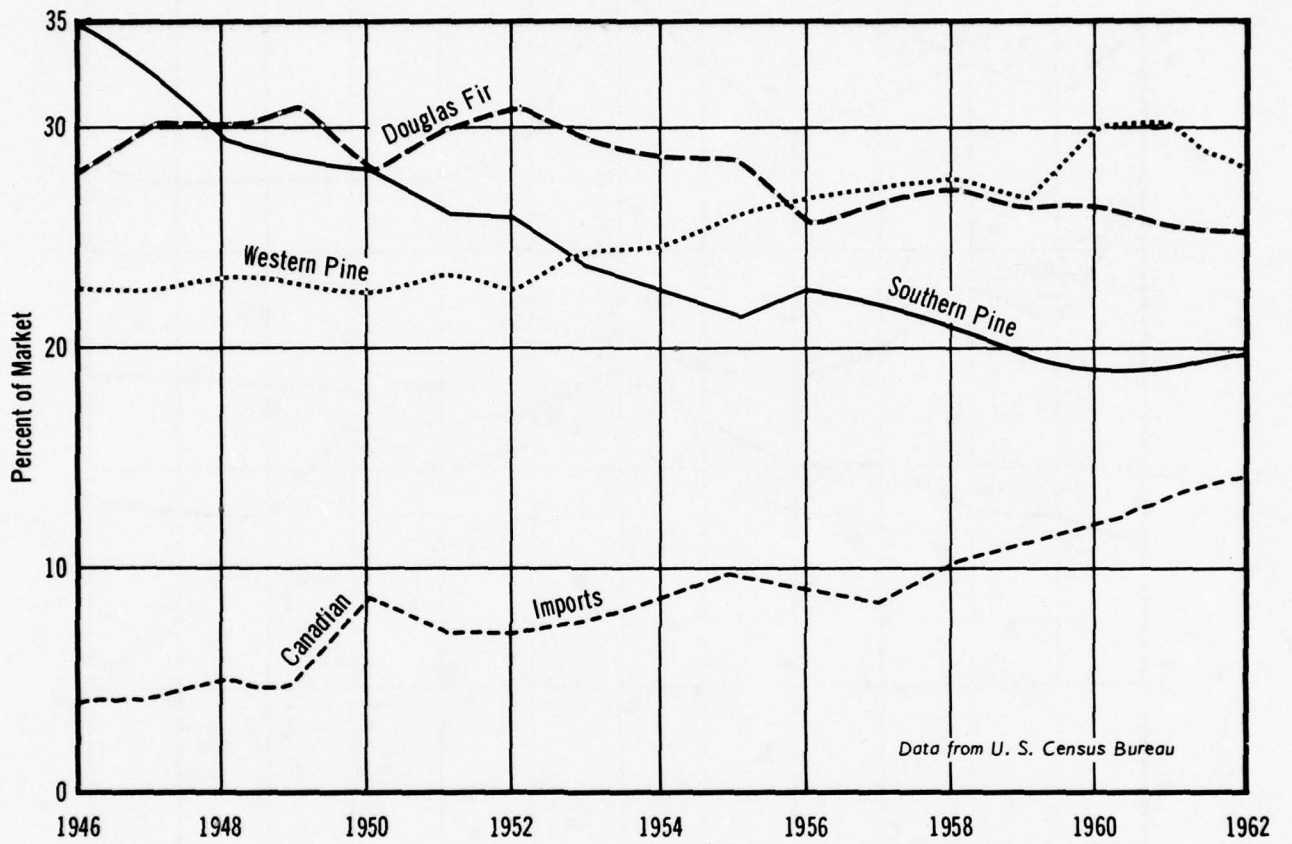


Exhibit 9

REGIONAL COMPETITION FOR SOFTWOOD LUMBER MARKET

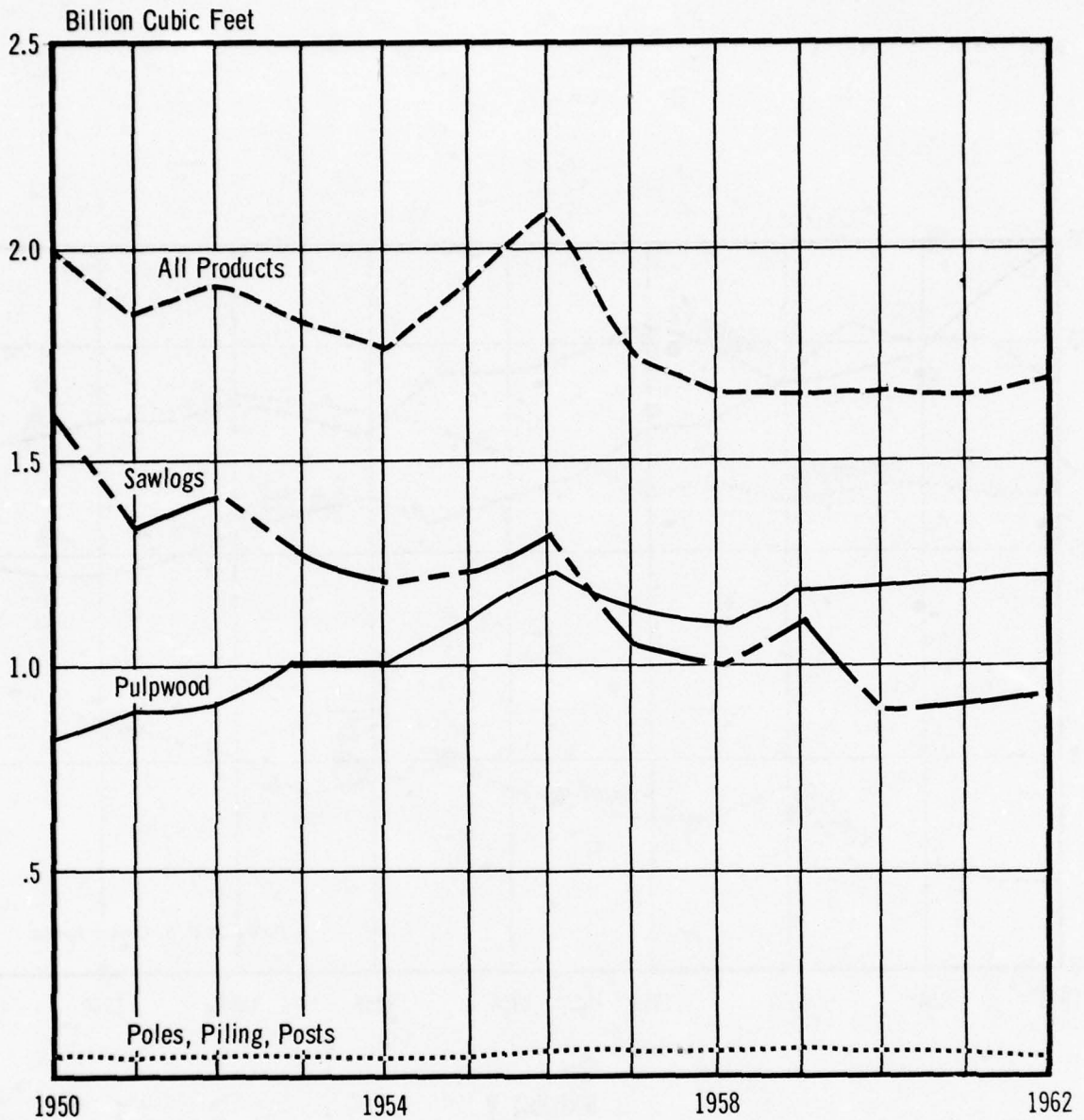


Exhibit 10

THE CHANGING DEMAND FOR SOUTHERN PINE

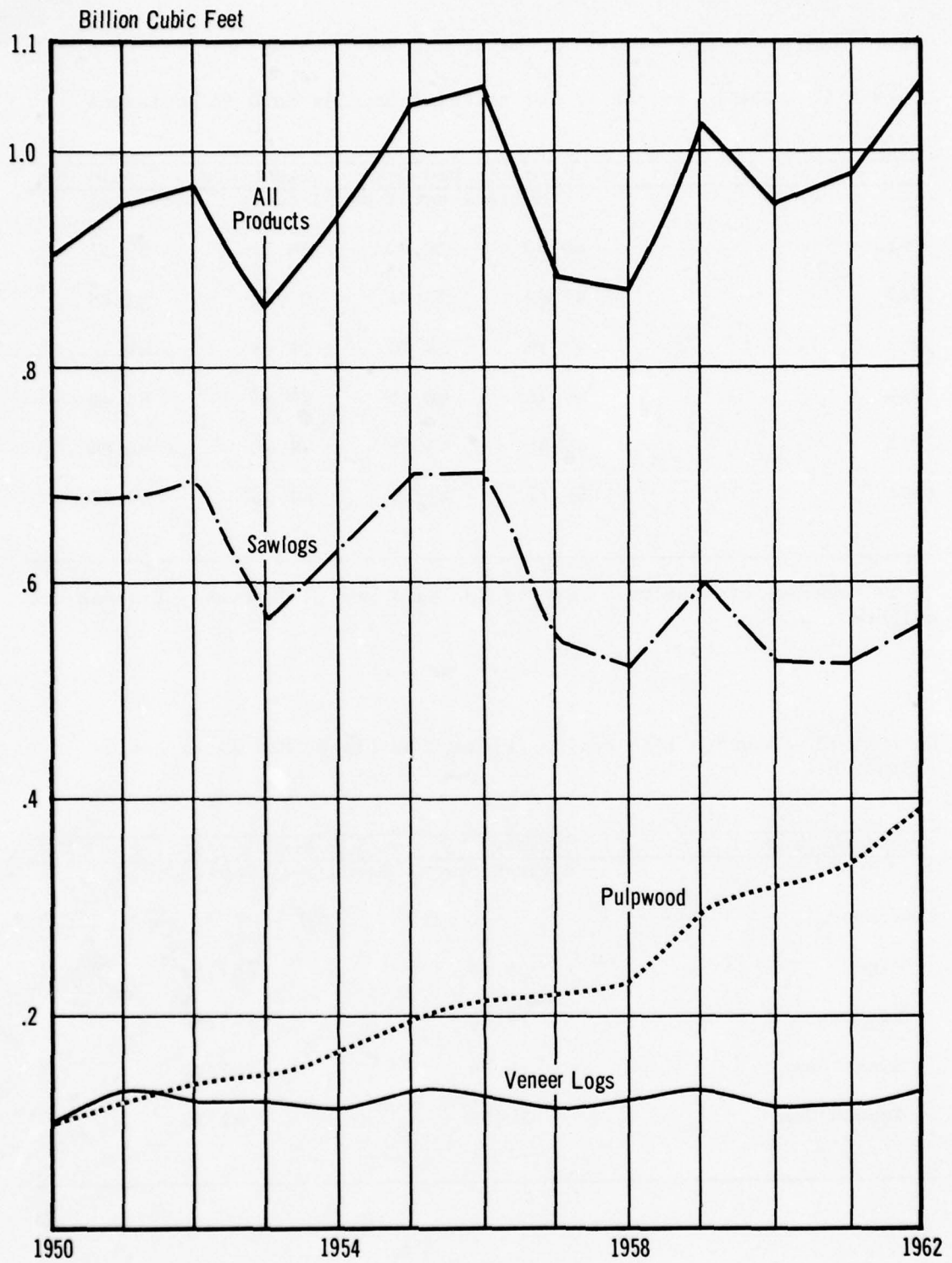


Exhibit II

THE CHANGING DEMAND FOR SOUTHERN HARDWOOD

Exhibit 12 - Sawlog Prices 1/ for selected Species Sold in Louisiana

| Year | : Pine | : Red Oak | : Sweet Gum | : Tupelo Gum |
|------|---------------------------------------|-----------|-------------|--------------|
| | dollars per M board feet, f.o.b. mill | | | |
| 1961 | 48.80 | 37.80 | 38.27 | 39.51 |
| 1962 | 47.82 | 38.91 | 39.11 | 41.85 |
| 1963 | 47.59 | 38.70 | 39.08 | 41.32 |
| 1964 | 48.18 | 40.25 | 43.40 | 43.44 |
| 1965 | 49.45 | 43.99 | 44.00 | 46.84 |
| 1966 | 55.75 | 47.50 | 49.00 | 50.50 |

1/ Average of quarterly reports for each year. Quarterly figures are weighted.

Exhibit 13 - Average 1966 Sawlog Prices, Louisiana, Red River Basin Study Area

| Species & Product | : Stumpage | : Local Delivery Point, f.o.b. |
|-------------------|---------------------------------------|--------------------------------|
| | dollars per M board feet, Doyle Scale | |
| Sawtimber | | |
| Pine | 35.56 | 57.62 |
| Red Oak | 19.10 | 45.90 |
| Sweet Gum | 19.78 | 47.70 |
| Tupelo Gum | 20.50 | 49.75 |

Exhibit 14 - Wholesale Price Indexes for Southern Pine Lumber, U. S.
Average, Red River Basin Study Area

| Year | : Normal : All : Lumber | : Price : Number One : Dimension | : Index : Number Two : Boards |
|---------------------------|-------------------------------|--|-------------------------------------|
| (1957-59 average = 100.0) | - - - - - index - - - - - | | |
| 1961 | 95.8 | 99.7 | 92.7 |
| 1962 | 95.7 | 99.3 | 93.1 |
| 1963 | 95.4 | 99.1 | 92.5 |
| 1964 | 95.5 | 99.8 | 92.7 |
| 1965 | 97.2 | 100.9 | 94.3 |
| 1966 | 106.3* | 108.8* | 104.6* |

* Only eight months of data available

Exhibit 15 - Wholesale Price Indexes for Hardwood Lumber of Selected
Species, U. S. Average, Red River Basin Study Area

| Year | : All hard- : wood lumber | : Select, red : oak, flooring | : Number one : common gum |
|---------------------------|------------------------------|----------------------------------|------------------------------|
| (1957-59 average = 100.0) | - - - - - index - - - - - | | |
| 1961 | 98.5 | 99.1 | 93.4 |
| 1962 | 98.3 | 95.1 | 105.0 |
| 1963 | 101.5 | 101.5 | 110.0 |
| 1964 | 105.4 | 109.2 | 109.4 |
| 1965 | 111.3 | 114.8 | 117.8 |
| 1966 | 125.1* | 135.0* | 146.0* |

* Only eight months of data available

4 24879

Exhibit 16 - Watershed Area and Floodplain Land Use for CNI Watersheds
 Authorized for Operations, December 31, 1962, Red River Basin Study Area

| Tributary | Watershed | Cropland | Pastureland | Woodland | Miscellaneous | Total |
|--|----------------|---------------|---------------|---------------|---------------|---------------|
| CNI Watershed : Area : Cropland : Pastureland : Woodland : Miscellaneous : Total | | | | | | |
| ----- acres ----- | | | | | | |
| Intervening Areas - Texas | | | | | | |
| 3-21 | 46,784 | 1,310 | 1,542 | 965 | 40 | 3,857 |
| Total | 46,784 | 1,310 | 1,542 | 965 | 40 | 3,857 |
| Intervening Areas - Arkansas & Oklahoma | | | | | | |
| 3-36 | 29,575 | 2,388 | 1,498 | 1,437 | 204 | 5,527 |
| Total | 29,575 | 2,388 | 1,498 | 1,437 | 204 | 5,527 |
| Blue River | | | | | | |
| 3-23a | 203,100 | 10,682 | 5,826 | 2,525 | 388 | 19,421 |
| Total | 203,100 | 10,682 | 5,826 | 2,525 | 388 | 19,421 |
| Boggy Creek | | | | | | |
| 3h1-4 | 50,016 | 1,538 | 1,691 | 987 | 87 | 4,303 |
| 3h1-5 | 107,968 | 3,079 | 3,453 | 3,548 | 48 | 10,128 |
| 3h1-6 | 162,240 | 3,473 | 4,340 | 4,342 | 248 | 12,403 |
| 3h2-5 | 23,571 | 12 | 913 | 205 | 12 | 1,142 |
| Total | 343,795 | 8,102 | 10,397 | 9,082 | 395 | 27,976 |
| Sulphur River | | | | | | |
| 3k-8 | 25,000 | 780 | 1,490 | 110 | 70 | 2,450 |
| 3k-13 | 31,400 | 1,800 | 1,220 | 0 | 90 | 3,110 |
| Total | 56,400 | 2,580 | 2,710 | 110 | 160 | 5,560 |
| Loggy Bayou | | | | | | |
| 3m2-4 | 5,550 | 228 | 431 | 35 | 185 | 879 |
| Total | 5,550 | 228 | 431 | 35 | 185 | 879 |
| Bayou Pierre | | | | | | |
| 3n-3 | 57,610 | 3,779 | 2,358 | 1,908 | 61 | 8,106 |
| Total | 57,610 | 3,779 | 2,358 | 1,908 | 61 | 8,106 |
| Bayou Jean de Jean and Bayou Rapides | | | | | | |
| 3-68 | 58,494 | 55 | 220 | 4,915 | 270 | 5,460 |
| 10-17 | 40,406 | 10 | 38 | 864 | 48 | 960 |
| Total | 98,900 | 65 | 258 | 5,779 | 318 | 6,420 |
| Grand Total | 841,714 | 29,134 | 25,020 | 21,841 | 1,751 | 77,746 |

**Exhibit 17 - Floodplain Land Use, Watersheds Considered Feasible for
Development Within 10-15 Years, Red River Basin Study Area**

| Tributary | : | : | : | : | : | : |
|--|----------------|---------------|---------------|---------------|--------------|---------------------|
| Basin and | :Watershed: | : | : | : | : Miscel-: | : |
| CNI Watershed | : Area | :Cropland: | Pastureland: | Woodland: | laneous: | Total $\frac{1}{2}$ |
| - - - - - acres - - - - - | | | | | | |
| Intervening Areas - Texas | | | | | | |
| 3-19 | 168,000 | 7,493 | 3,458 | 461 | 115 | 11,527 |
| 3-25 | 133,363 | 3,719 | 3,828 | 5,778 | 75 | 13,400 |
| 3-25a | 142,438 | 6,882 | 3,144 | 2,874 | 130 | 13,030 |
| 3-27 | 7,334 | 2,000 | 1,040 | 980 | 50 | 4,070 |
| 3-29 | 14,569 | 6,130 | 2,630 | 1,890 | 535 | 11,185 |
| 3-33 | 119,040 | 2,580 | 5,160 | 4,770 | 390 | 12,900 |
| Total | 584,744 | 28,804 | 19,260 | 16,753 | 1,295 | 66,112 |
| Intervening Areas - Arkansas & Oklahoma | | | | | | |
| 3-35 | 16,621 | 1,765 | 3,239 | 2,144 | 72 | 7,220 |
| 3-39 | 43,410 | 8,717 | 18,062 | 0 | 1,676 | 28,455 |
| 3-40 | 55,324 | 3,175 | 6,460 | 0 | 615 | 10,250 |
| 3-41 | 57,483 | 2,245 | 5,560 | 5,310 | 180 | 13,295 |
| 3-46 | 15,380 | 1,018 | 2,411 | 1,907 | 169 | 5,505 |
| Total | 188,218 | 16,920 | 35,732 | 9,361 | 2,712 | 64,725 |
| Blue River | | | | | | |
| 3-23 | 230,651 | 1,800 | 6,264 | 9,686 | 90 | 17,840 |
| Total | 230,651 | 1,800 | 6,264 | 9,686 | 90 | 17,840 |
| Boggy Creek | | | | | | |
| 3h1-2 | 240,301 | 3,956 | 8,109 | 8,094 | 284 | 20,443 |
| 3h1-3 | 30,541 | 422 | 1,327 | 428 | 45 | 2,222 |
| 3h2-4 | 144,253 | 1,200 | 3,600 | 7,080 | 120 | 12,000 |
| 3h2-6 | 206,230 | 3,230 | 6,800 | 6,800 | 170 | 17,000 |
| Total | 621,325 | 8,808 | 19,836 | 22,402 | 619 | 51,665 |
| Kiamichi River | | | | | | |
| 3i-2 | 9,171 | 1,935 | 728 | 917 | 70 | 3,650 |
| 3i-4 | 39,674 | 239 | 1,163 | 1,551 | 30 | 2,983 |
| 3i-8 | 37,997 | 212 | 1,474 | 1,129 | 30 | 2,845 |
| Total | 86,842 | 2,386 | 3,365 | 3,597 | 130 | 9,478 |
| Barkman Creek | | | | | | |
| 3-47 | 2,667 | 725 | 500 | 430 | 45 | 1,700 |
| 3-48 | 44,033 | 2,782 | 1,940 | 1,602 | 166 | 6,490 |
| Total | 46,700 | 3,507 | 2,440 | 2,032 | 211 | 8,190 |

Continued ---

Exhibit 17 - Floodplain Land Use, Watersheds Considered Feasible for
Development Within 10-15 Years, Red River Basin Study Area--Continued

| Tributary | Area | Cropland | Pastureland | Woodland | Miscellaneous | Total |
|---|---------|----------|-------------|----------|---------------|--------|
| CN Watershed: Area : Cropland: Pastureland: Woodland: Miscellaneous: Total 1/ | | | | | | |
| - - - - - acres - - - - - | | | | | | |
| Little River | | | | | | |
| 3j-4 | 94,106 | 1,863 | 2,645 | 1,262 | 240 | 6,010 |
| Total | 94,106 | 1,863 | 2,645 | 1,262 | 240 | 6,010 |
| McKinney Bayou | | | | | | |
| 3-52 | 125,308 | 5,850 | 7,915 | 13,835 | 300 | 27,900 |
| 3-53 | 55,222 | 7,950 | 14,950 | 7,500 | 550 | 30,950 |
| 3-54 | 28,866 | 7,170 | 4,985 | 6,215 | 270 | 18,640 |
| Total | 209,396 | 20,970 | 27,850 | 27,550 | 1,120 | 77,490 |
| Sulphur River | | | | | | |
| 3k-9 | 62,720 | 570 | 1,460 | 1,285 | 105 | 3,420 |
| 3k-11 | 3,840 | 0 | 180 | 0 | 20 | 200 |
| 3k-12 | 19,200 | 94 | 698 | 300 | 10 | 1,102 |
| 3k-14 | 204,600 | 775 | 3,688 | 1,597 | 54 | 6,114 |
| 3k-17 | 135,040 | 987 | 5,077 | 5,428 | 0 | 11,492 |
| 3k-18 | 77,440 | 393 | 3,846 | 3,033 | 0 | 7,272 |
| Total | 502,840 | 2,819 | 14,949 | 11,643 | 189 | 29,600 |
| Posten Bayou | | | | | | |
| 3-57 | 61,306 | 9,460 | 2,740 | 3,520 | 280 | 16,000 |
| Total | 61,306 | 9,460 | 2,740 | 3,520 | 280 | 16,000 |
| Red River Main Stem | | | | | | |
| 3-60 | 24,090 | 3,700 | 2,600 | 2,700 | 0 | 9,000 |
| Total | 24,090 | 3,700 | 2,600 | 2,700 | 0 | 9,000 |
| Loggy Bayou | | | | | | |
| 3m-1 | 8,600 | 0 | 445 | 222 | 0 | 567 |
| 3m-2 | 89,700 | 59 | 1,904 | 7,351 | 99 | 9,913 |
| 3m2-3 | 148,500 | 19,590 | 8,119 | 2,991 | 6,550 | 37,250 |
| Total | 246,800 | 19,649 | 10,468 | 11,064 | 6,649 | 47,830 |
| Bayou Pierre | | | | | | |
| 3n-2 | 92,199 | 1,945 | 1,040 | 4,695 | 0 | 7,680 |
| Total | 92,199 | 1,945 | 1,040 | 4,695 | 0 | 7,680 |
| Cane River | | | | | | |
| 3-64 | 104,181 | 216 | 3,308 | 8,308 | 113 | 11,945 |
| 3-65 | 242,116 | 479 | 11,322 | 22,113 | 306 | 34,220 |
| 3-66 | 103,456 | 131 | 6,313 | 11,857 | 159 | 18,460 |
| Total | 449,753 | 826 | 20,943 | 42,278 | 578 | 64,625 |

Continued ---

Exhibit 17 - Floodplain Land Use, Watersheds Considered Feasible for
Development Within 10-15 Years, Red River Basin Study Area--Continued

| Tributary | Basin and | Watershed: | Cropland: | Pastureland: | Woodland: | Miscellaneous: | Total |
|---|------------------|----------------|----------------|----------------|---------------|----------------|----------------------|
| - - - - - acres - - - - - | | | | | | | |
| Bayou Rigolette | | | | | | | |
| 3-69 | 20,180 | 1,486 | 4,256 | 5,283 | 665 | | 11,690 |
| 3-70 | 247,190 | 4,649 | 13,501 | 18,325 | 842 | | 37,317 |
| Total | 267,370 | 6,135 | 17,757 | 23,608 | 1,507 | | 49,007 |
| Red River Backwater | | | | | | | |
| 3-73 | 38,886 | 5,550 | 1,612 | 24,817 | 795 | | 32,774 |
| 3-75 | 111,025 | 14,123 | 4,571 | 87,941 | 2,076 | | 108,711 |
| 3-76 | 23,617 | 475 | 1,890 | 21,017 | 235 | | 23,617 |
| Total | 173,528 | 20,148 | 8,073 | 133,775 | 3,106 | | 165,102 |
| Chatlin Lake & Associated Area | | | | | | | |
| 10-11 & 12 | 66,157 | 11,620 | 2,580 | 500 | 1,100 | | 15,800 ^{2/} |
| 10-15 | 118,087 | 26,653 | 25,017 | 19,425 | 4,000 | | 75,095 |
| 10-10 | 108,368 | 32,800 | 15,530 | 54,620 | 5,418 | | 108,368 |
| 10-13 | 156,338 | 43,600 | 44,315 | 49,800 | 5,285 | | 143,000 |
| 10-14 | 84,200 | 17,410 | 6,900 | 16,990 | 12,400 | | 53,700 |
| 10-16 | 45,819 | 20,057 | 8,054 | 5,168 | 12,540 | | 45,819 |
| Total | 578,969 | 152,140 | 102,396 | 146,503 | 40,743 | | 441,782 |
| Grand Total | 4,458,837 | 301,880 | 298,358 | 472,429 | 59,469 | | 1,132,136 |

1/ Potential benefit area
2/ Includes Watershed 10-12

Exhibit 18 - Floodplain Land Use, Watersheds Considered Potentially
Feasible for Development After 10-15 Years, Red River Basin Study Area

| Tributary | Basin and CNI Watershed: | Watershed Area | Cropland | Pasture- land | Woodland | Miscel- laneous | Total |
|---|-----------------------------|-------------------|----------|------------------|----------|--------------------|--------|
| ----- acres ----- | | | | | | | |
| Intervening Areas - Texas | | | | | | | |
| 3-30 | | 117,624 | 1,025 | 2,050 | 6,550 | 615 | 10,240 |
| Total | | 117,624 | 1,025 | 2,050 | 6,550 | 615 | 10,240 |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | |
| 3-22 | | 213,576 | 2,319 | 5,227 | 25,536 | 268 | 33,350 |
| 3-26 | | 72,351 | 587 | 2,541 | 2,137 | 40 | 5,305 |
| Total | | 285,927 | 2,906 | 7,768 | 27,673 | 308 | 38,655 |
| Little River | | | | | | | |
| 3j-2 | | 74,444 | 1,680 | 2,210 | 19,010 | 80 | 22,980 |
| Total | | 74,444 | 1,680 | 2,210 | 19,010 | 80 | 22,980 |
| Sulphur River | | | | | | | |
| 3k-15 | | 9,600 | 195 | 750 | 540 | 15 | 1,500 |
| Total | | 9,600 | 195 | 750 | 540 | 15 | 1,500 |
| Posten Bayou | | | | | | | |
| 3-57a | | 27,744 | 2,630 | 1,000 | 1,000 | 145 | 4,775 |
| Total | | 27,744 | 2,630 | 1,000 | 1,000 | 145 | 4,775 |
| <hr/> | | | | | | | |
| Grand Total | | 515,339 | 8,436 | 13,778 | 54,773 | 1,163 | 78,150 |
| <hr/> | | | | | | | |

Exhibit 19 - Floodplain Land Use, Watersheds Considered not Feasible for Development, Red River Basin Study Area

| Tributary Basin : | Watershed: | Cropland: | Pasture- | Woodland: | Miscel- | Total |
|-------------------|------------|-----------|----------|-----------|---------|-------|
| and : | Area : | land : | land : | land : | aneous: | |
| CNI Watershed : | Area : | land : | land : | land : | aneous: | |

- - - - - acres - - - - -

Intervening Areas - Texas

| | | | | | | |
|--------------|---------|--------|--------|---------|-------|---------|
| 3-20 | 21,572 | 100 | 260 | 1,500 | 40 | 1,900 |
| 3-24 | 72,589 | 5,970 | 5,180 | 4,240 | 310 | 15,700 |
| 3-18 | 22,467 | 1,200 | 2,750 | 20,260 | 490 | 24,700 |
| 3-27a & 3-28 | 31,901 | 1,500 | 2,400 | 11,610 | 160 | 15,670 |
| 3-31 | 8,684 | 480 | 600 | 2,980 | 40 | 4,100 |
| 3-38 | 160,515 | 925 | 9,210 | 20,550 | 305 | 30,990 |
| 3-42 | 244,012 | 8,800 | 17,000 | 28,000 | 1,100 | 54,900 |
| 3-44 | 41,881 | 1,730 | 1,730 | 13,490 | 350 | 17,300 |
| Total | 603,621 | 20,705 | 39,130 | 102,630 | 2,795 | 165,260 |

Intervening Areas - Arkansas & Oklahoma

| | | | | | | |
|-------|---------|-------|-------|-------|-----|--------|
| 3-32 | 74,363 | 90 | 797 | 905 | 18 | 1,810 |
| 3-34 | 45,631 | 94 | 925 | 814 | 17 | 1,850 |
| 3-37 | 23,654 | 125 | 418 | 552 | 10 | 1,105 |
| 3-43 | 44,697 | 1,380 | 2,735 | 1,985 | 220 | 6,320 |
| 3-45 | 53,086 | 96 | 877 | 606 | 16 | 1,595 |
| 3-49 | 14,220 | 2 | 66 | 60 | 2 | 130 |
| Total | 255,651 | 1,787 | 5,818 | 4,922 | 283 | 12,810 |

Boggy Creek

| | | | | | | |
|-------|---------|-------|--------|--------|-----|--------|
| 3h-1 | 127,130 | 285 | 4,240 | 23,490 | 285 | 28,300 |
| 3h1-1 | 45,855 | 120 | 2,400 | 9,360 | 120 | 12,000 |
| 3h2-1 | 148,015 | 2,980 | 6,655 | 13,075 | 230 | 22,940 |
| 3h2-2 | 111,854 | 0 | 40 | 744 | 16 | 800 |
| 3h2-3 | 148,643 | 76 | 1,140 | 2,546 | 38 | 3,800 |
| Total | 581,497 | 3,461 | 14,475 | 49,215 | 689 | 67,840 |

Kiamichi River

| | | | | | | |
|-------------|-----------|-------|--------|--------|-----|--------|
| 3i-1 | 281,448 | 385 | 1,930 | 6,845 | 480 | 9,640 |
| 3i-3 | 142,977 | 250 | 1,500 | 4,438 | 62 | 6,250 |
| 3i-5 | 254,778 | 360 | 2,410 | 9,160 | 120 | 12,050 |
| 3i-6 & 3i-9 | 178,483 | 600 | 3,750 | 10,500 | 150 | 15,000 |
| 3i-7 | 232,395 | 360 | 1,790 | 4,940 | 70 | 7,160 |
| Total | 1,090,081 | 1,955 | 11,380 | 35,883 | 882 | 50,100 |

Continued ---

Exhibit 19 - Floodplain Land Use, Watersheds Considered not Feasible for Development, Red River Basin Study Area--Continued

| Tributary Basin: | : | : | : | : | : | : |
|------------------|-------------|------------|------------|------------|------------|---------|
| and | : Watershed | : Cropland | : Pasture- | : Woodland | : Miscel- | : Total |
| CNI Watershed | : Area | : | : land | : | : laneous: | : |

- - - - - acres - - - - -

| | | | | | | |
|------------------|-----------|-------|--------|---------|-------|---------|
| Little River | | | | | | |
| 3j-1 | 38,710 | 1,220 | 785 | 14,995 | 0 | 17,000 |
| 3j-3 | 47,539 | 155 | 550 | 3,080 | 115 | 3,900 |
| 3j-5 | 53,696 | 590 | 1,880 | 9,440 | 40 | 11,950 |
| 3j-6 | 84,857 | 480 | 2,255 | 9,410 | 80 | 12,225 |
| 3j-7 | 85,754 | 430 | 1,005 | 5,690 | 35 | 7,160 |
| 3j-8 | 55,795 | 180 | 890 | 3,335 | 45 | 4,450 |
| 3j-9 | 84,413 | 580 | 3,175 | 7,275 | 40 | 11,070 |
| 3j-10 | 63,713 | 560 | 2,985 | 7,125 | 0 | 10,670 |
| 3j-11 | 83,642 | 240 | 1,395 | 4,990 | 65 | 6,690 |
| 3j-12 | 43,246 | 15 | 135 | 1,500 | 20 | 1,670 |
| 3j-13 | 93,157 | 35 | 250 | 3,325 | 0 | 3,610 |
| 3j-14 | 117,365 | 1,290 | 3,445 | 23,065 | 120 | 27,920 |
| 3j-15 | 122,753 | 454 | 2,266 | 12,250 | 70 | 15,040 |
| 3j-16 | 110,449 | 121 | 819 | 5,250 | 45 | 6,235 |
| 3j-17 | 199,602 | 760 | 2,930 | 34,410 | 70 | 38,170 |
| 3j-18 | 31,639 | 320 | 1,568 | 1,280 | 32 | 3,200 |
| 3j-19 | 217,693 | 420 | 1,570 | 10,110 | 70 | 12,170 |
| 3j-20 | 264,253 | 540 | 3,060 | 8,180 | 50 | 11,830 |
| 3j-21 | 205,021 | 40 | 330 | 3,690 | 40 | 4,100 |
| 3j1-1 | 231,525 | 1,200 | 2,400 | 8,660 | 40 | 12,300 |
| 3j1-2 | 166,569 | 70 | 580 | 6,480 | 70 | 7,200 |
| 3j1-3 | 22,500 | 9 | 135 | 836 | 5 | 985 |
| 3j1-4 | 77,153 | 30 | 250 | 2,790 | 30 | 3,100 |
| 3j1-5 | 38,027 | 15 | 120 | 1,350 | 15 | 1,500 |
| Total | 2,539,071 | 9,754 | 34,778 | 188,516 | 1,097 | 234,145 |
| Bois d'Arc Creek | | | | | | |
| 3-50 | 92,012 | 93 | 4,704 | 2,842 | 76 | 7,715 |
| 3-51 | 62,096 | 105 | 3,835 | 1,260 | 50 | 5,250 |
| Total | 154,108 | 198 | 8,539 | 4,102 | 126 | 12,965 |
| Maniece Bayou | | | | | | |
| 3-56 | 73,818 | 1,760 | 9,020 | 11,000 | 220 | 22,000 |
| Total | 73,818 | 1,760 | 9,020 | 11,000 | 220 | 22,000 |
| McKinney Bayou | | | | | | |
| 3-55 | 36,692 | 2,145 | 2,275 | 10,170 | 30 | 14,620 |
| Total | 36,692 | 2,145 | 2,275 | 10,170 | 30 | 14,620 |

Continued ---

Exhibit 19 - Floodplain Land Use, Watersheds Considered not Feasible for Development, Red River Basin Study Area-- Continued

| Tributary | Watershed | Cropland | Pasture- | Woodland | Miscel- | Total |
|----------------------------|-----------|----------|----------|----------|---------|----------------------|
| Basin and | Area | land | laneous | | | |
| CNI Watershed: | | | | | | |
| - - - - - acres - - - - - | | | | | | |
| Sulphur River | | | | | | |
| 3k-1 | 182,266 | 520 | 2,470 | 29,200 | 310 | 32,500 |
| 3k-2 | 158,224 | 0 | 240 | 5,160 | 600 | 6,000 |
| 3k-3 | 145,910 | 0 | 780 | 3,770 | 50 | 4,600 |
| 3k-4 | 247,040 | 140 | 700 | 6,090 | 70 | 7,000 |
| 3k-5 | 131,840 | 7,700 | 3,670 | 24,960 | 370 | 36,700 |
| 3k-6 | 177,920 | 2,430 | 12,540 | 22,065 | 305 | 37,340 |
| 3k-7 | 5,760 | 2,990 | 0 | 90 | 0 | 3,080 |
| 3k-10 | 175,400 | 2,070 | 12,385 | 7,605 | 470 | 22,530 |
| 3k-16 | 84,456 | 1,630 | 2,500 | 1,620 | 50 | 5,800 |
| 3kl-1 | 248,960 | 0 | 10,780 | 35,160 | 940 | 46,880 |
| 3kl-2 | 97,520 | 1,050 | 10,500 | 9,240 | 210 | 21,000 ^{1/} |
| 3kl-2a | 138,000 | - | - | - | - | - |
| Total | 1,793,296 | 18,530 | 56,565 | 144,960 | 3,375 | 223,430 |
| Red River Main Stem | | | | | | |
| 3-58 | 37,086 | 2,000 | 7,700 | 8,475 | 200 | 18,375 |
| 3-59 | 39,900 | 3,850 | 13,900 | 14,235 | 350 | 32,335 |
| 3-61 | 77,342 | 5,990 | 18,850 | 13,900 | 960 | 39,700 |
| 3-62 | 35,572 | 730 | 1,650 | 3,760 | 100 | 6,240 |
| 3-71 | 92,729 | 4,752 | 16,111 | 24,060 | 4,542 | 49,465 |
| Total | 282,629 | 17,322 | 58,211 | 64,430 | 6,152 | 146,115 |
| Cypress Creek | | | | | | |
| 3L-1 | 54,943 | 38,212 | 10,294 | 5,120 | 269 | 53,895 |
| 3L-2 | 195,500 | 8 | 2,602 | 12,086 | 244 | 14,940 |
| 3L-3 | 113,637 | 18,544 | 5,293 | 4,446 | 163 | 28,446 |
| 3L-4 | 133,298 | 0 | 1,020 | 9,073 | 88 | 10,181 |
| 3L-5 | 151,224 | 0 | 676 | 5,539 | 100 | 6,315 |
| 3L-6 | 124,164 | 30 | 1,299 | 5,277 | 69 | 6,675 |
| 3L-7 | 110,230 | 0 | 0 | 5,158 | 52 | 5,210 |
| 3L-8 | 89,307 | 0 | 1,048 | 5,873 | 69 | 6,990 |
| 3L1-1 | 247,080 | 0 | 4,400 | 22,825 | 275 | 27,500 |
| 3L1-2 | 248,000 | 79 | 4,384 | 11,317 | 160 | 15,940 |
| 3L1-3 | 241,350 | 0 | 3,088 | 16,019 | 193 | 19,300 |
| 3L1-4 | 106,640 | 0 | 0 | 17,523 | 177 | 17,700 |
| 3L1-5 | 243,440 | 479 | 4,785 | 10,527 | 159 | 15,950 |
| 3L1-6 | 249,230 | 686 | 6,880 | 9,460 | 172 | 17,200 |
| Total | 2,308,043 | 58,040 | 45,769 | 140,243 | 2,190 | 246,242 |

Continued ---

Exhibit 19 - Floodplain Land Use, Watersheds Considered not Feasible for Development, Red River Basin Study Area--Continued

| Tributary Basin: | : | : | : | : | : | : |
|-------------------------------|------------------|--------------|---------------|----------------|------------|----------------|
| and | : Watershed: | Cropland | : Pasture- | Woodland | : Miscel- | Total |
| CNI Watershed | : Area | : | : land | : | : laneous: | : |
| - - - - - acres - - - - - | | | | | | |
| Loggy Bayou | | | | | | |
| 3m-2 | 196,102 | 0 | 800 | 10,400 | 0 | 11,200 |
| 3m1-1 | 114,663 | 0 | 1,850 | 16,650 | 0 | 18,500 |
| 3m1-2 | 147,079 | 0 | 3,050 | 14,235 | 0 | 17,285 |
| 3m1-3 | 128,149 | 0 | 915 | 7,595 | 0 | 8,510 |
| 3m1-4 | 43,316 | 30 | 330 | 2,205 | 0 | 2,565 |
| 3m1-5 | 90,200 | 0 | 350 | 10,665 | 0 | 11,015 |
| 3m1-6 | 75,011 | 0 | 700 | 6,300 | 0 | 7,000 |
| 3m1-8 | 87,414 | 0 | 450 | 4,050 | 0 | 4,500 |
| 3m2-1 | 42,123 | 4,105 | 16,420 | 12,850 | 0 | 33,375 |
| 3m2(a)-1 | 158,978 | 0 | 1,000 | 24,365 | 0 | 25,365 |
| 3m2(a)-2 | 54,243 | 0 | 200 | 1,800 | 0 | 2,000 |
| 3m2(a)-3 | 27,229 | 0 | 160 | 2,700 | 0 | 2,860 |
| 3m2(a)-4 | 68,858 | 0 | 100 | 1,170 | 0 | 1,270 |
| 3m2(a)-5 | 57,745 | 0 | 300 | 2,700 | 0 | 3,000 |
| 3m2(a)-6 | 84,769 | 0 | 615 | 5,545 | 0 | 6,160 |
| 3m2(a)-7 | 66,926 | 0 | 310 | 5,400 | 0 | 5,710 |
| 3m2-2 | 21,520 | 1,550 | 4,650 | 6,600 | 0 | 12,800 |
| Total | 1,464,325 | 5,685 | 32,200 | 135,230 | 0 | 173,115 |
| Bayou Pierre | | | | | | |
| 3n-1 | 147,329 | 70 | 1,385 | 5,405 | 70 | 6,930 |
| 3n-4 | 237,162 | 162 | 2,746 | 13,247 | 0 | 16,155 |
| 3n-5 | 228,520 | 0 | 3,520 | 12,420 | 0 | 15,940 |
| Total | 613,011 | 232 | 7,651 | 31,072 | 70 | 39,025 |
| Black and Saline Lakes | | | | | | |
| 3o-1 | 30,374 | 1,580 | 4,070 | 8,900 | 160 | 14,710 |
| 3o-2 | 131,585 | 0 | 130 | 12,950 | 0 | 13,080 |
| 3o-3 | 135,355 | 0 | 370 | 14,000 | 0 | 14,370 |
| 3o1-1 | 76,761 | 185 | 1,220 | 5,255 | 40 | 6,700 |
| 3o1-2 | 111,320 | 0 | 290 | 9,340 | 0 | 9,630 |
| 3o1-3 | 187,234 | 0 | 720 | 20,700 | 0 | 21,420 |
| 3o1-4 | 215,980 | 0 | 2,200 | 21,640 | 0 | 23,840 |
| Total | 888,609 | 1,765 | 9,000 | 92,785 | 200 | 103,750 |
| Nantachie Creek | | | | | | |
| 3-63 | 54,071 | 0 | 200 | 3,890 | 40 | 4,130 |
| Total | 54,071 | 0 | 200 | 3,890 | 40 | 4,130 |

Continued ---

Exhibit 19 - Floodplain Land Use, Watersheds Considered not Feasible for Development, Red River Basin Study Area -- Continued

| Tributary Basin: and CNI Watershed | : : Watershed : Area | : : Cropland : | : : Pasture : land | : : Woodland : | : : Miscel- : laneous | : : Total |
|--|----------------------------|----------------------|--------------------------|----------------------|-----------------------------|----------------------|
| ----- acres ----- | | | | | | |
| Cane River | | | | | | |
| 3-67 | 34,686 | 108 | 234 | 6,974 | 49 | 7,365 |
| Total | 34,686 | 108 | 234 | 6,974 | 49 | 7,365 |
| Bayou Rapides | | | | | | |
| 10-18 | 12,573 | 0 | 0 | 0 | 0 | 0 |
| Total | 12,573 | 0 | 0 | 0 | 0 | 0 |
| Red River Backwater | | | | | | |
| 3-72 | 80,590 | 0 | 5,000 | 30,943 | 0 | 35,943 |
| 3-74 | 65,747 | 0 | - | 63,173 | 0 | 63,173 |
| 3-77 | 14,403 | 4,000 | 1,500 | 50,000 | 2,000 | 57,500 ^{2/} |
| 3-78 | 65,163 | - | - | - | - | - |
| 3-81 | 87,523 | 2,250 | 3,000 | 69,000 | 750 | 75,000 |
| Total | 313,426 | 6,250 | 9,500 | 213,116 | 2,750 | 231,616 |
| Chatlin Lake and Associated Area | | | | | | |
| 10-6 | 9,991 | 950 | 1,100 | 5,200 | 80 | 7,330 |
| 10-19 | 9,583 | 0 | 0 | 0 | 0 | 0 |
| Total | 19,574 | 950 | 1,100 | 5,200 | 80 | 7,330 |
| Grand Total | 13,118,782 | 150,647 | 345,845 | 1,244,338 | 21,028 | 1,761,858 |

1/ Includes Watershed 3k1-2a
2/ Includes Watershed 3-78

Exhibit 20 - Estimated Average Annual Flood Damages ^{1/}, Watersheds
 Authorized for Construction, December 31, 1962, Red River Basin Study
 Area

| Tributary Basin : | Floodwater | | | | | : | : |
|--|----------------|----------------|---------------|----------------|----------------|------------------|---|
| and | : Agricul- | : Nonagri- | : Sedi- | : Erosion | : Indirect | : Total | : |
| CNI Watershed : | tural | cultural | ment | : | : | : | : |
| - - - - - dollars - - - - - | | | | | | | |
| Intervening Areas - Texas | | | | | | | |
| 3-21 | 52,670 | 7,050 | 3,720 | 1,870 | 6,530 | 71,840 | |
| Total | 52,670 | 7,050 | 3,720 | 1,870 | 6,530 | 71,840 | |
| Intervening Areas - Arkansas and Oklahoma | | | | | | | |
| 3-36 | 140,790 | 23,250 | 1,490 | 4,270 | 16,980 | 186,780 | |
| Total | 140,790 | 23,250 | 1,490 | 4,270 | 16,980 | 186,780 | |
| Blue River | | | | | | | |
| 3-23a | 191,440 | 7,170 | 36,290 | 24,380 | 25,920 | 285,200 | |
| Total | 191,440 | 7,170 | 36,290 | 24,380 | 25,920 | 285,200 | |
| Boggy Creek | | | | | | | |
| 3h1-5 | 162,880 | 31,630 | 4,480 | 19,630 | 21,860 | 240,480 | |
| 3h1-6 | 190,640 | 35,840 | 7,300 | 41,580 | 27,530 | 302,890 | |
| 3h2-5 | 7,230 | 1,330 | 1,330 | 1,550 | 610 | 12,050 | |
| 3h1-4 | 29,630 | 1,500 | 3,430 | 12,120 | 5,000 | 51,680 | |
| Total | 390,380 | 70,300 | 16,540 | 74,880 | 55,000 | 607,100 | |
| Sulphur River | | | | | | | |
| 3k-8 | 32,980 | 6,090 | 2,840 | 380 | 4,280 | 46,570 | |
| 3k-13 | 36,420 | 3,010 | 11,110 | 1,750 | 7,840 | 60,130 | |
| Total | 69,400 | 9,100 | 13,950 | 2,130 | 12,120 | 106,700 | |
| Loggy Bayou | | | | | | | |
| 3m2-4 | 9,660 | 29,400 | 630 | 320 | 3,990 | 44,000 | |
| Total | 9,660 | 29,400 | 630 | 320 | 3,990 | 44,000 | |
| Bayou Pierre | | | | | | | |
| 3n-3 | 57,750 | 0 | 940 | 8,610 | 6,720 | 74,020 | |
| Total | 57,750 | 0 | 940 | 8,610 | 6,720 | 74,020 | |
| Bayou Jean de Jean and Bayou Rapides | | | | | | | |
| 3-68 and 10-17 | 2,000 | 0 | 0 | 0 | 0 | 2,000 | |
| Total | 2,000 | 0 | 0 | 0 | 0 | 2,000 | |
| <hr/> | | | | | | | |
| Grand Total | 914,090 | 146,270 | 73,560 | 116,460 | 127,260 | 1,377,640 | |

^{1/} Adjusted normalized prices

Exhibit 21 - Estimated Average Annual Flood Damages for Watersheds
 Considered Feasible for Development Within 10-15 Years, Red River Basin
 Study Area

| Tributary Basin : | Floodwater | : | : | : | : | : |
|-------------------|-------------|-------------|----------|-----------|-------------|-------|
| and | : Agricul-: | Nonagri-: | Sediment | : Erosion | : Indirect: | Total |
| CNI Watershed | : tural | : cultural: | : | : | : | : |

- - - - - dollars - - - - -

Intervening Areas - Texas

| | | | | | | |
|--------------|----------------|----------------|---------------|---------------|----------------|------------------|
| 3-19 | 138,720 | 79,790 | 4,270 | 20,570 | 24,330 | 267,680 |
| 3-25 | 207,200 | 26,800 | 4,500 | 4,000 | 24,200 | 266,700 |
| 3-25a | 294,100 | 63,800 | 1,600 | 5,300 | 36,500 | 401,300 |
| 3-27 | 0 | 0 | 2,570 | 0 | 260 | 2,830 |
| 3-29 | 82,540 | 0 | 210 | 0 | 0 | 82,750 |
| 3-33 | 215,420 | 6,740 | 10,680 | 210 | 17,140 | 250,190 |
| Total | 937,980 | 177,130 | 23,830 | 30,080 | 102,430 | 1,271,450 |

Intervening Areas - Arkansas and Oklahoma

| | | | | | | |
|--------------|----------------|--------------|------------|------------|--------------|----------------|
| 3-41 | 122,640 | 1,000 | 0 | 0 | 4,040 | 127,680 |
| 3-40 | 33,080 | 0 | 0 | 0 | 0 | 33,080 |
| 3-35 | 34,910 | 1,360 | 570 | 230 | 2,720 | 39,790 |
| 3-46 | 10,980 | 270 | 0 | 0 | 420 | 11,670 |
| 3-39 | 42,020 | 0 | 0 | 0 | 0 | 42,020 |
| Total | 243,630 | 2,630 | 570 | 230 | 7,180 | 254,240 |

Blue River

| | | | | | | |
|--------------|----------------|---------------|--------------|---------------|---------------|----------------|
| 3-23 | 201,780 | 40,790 | 6,080 | 20,020 | 26,870 | 295,540 |
| Total | 201,780 | 40,790 | 6,080 | 20,020 | 26,870 | 295,540 |

Boggy Creek

| | | | | | | |
|--------------|----------------|---------------|---------------|---------------|---------------|----------------|
| 3h2-6 | 113,820 | 26,770 | 12,090 | 20,050 | 17,270 | 190,000 |
| 3h2-4 | 56,700 | 10,080 | 7,870 | 11,760 | 8,610 | 95,020 |
| 3h1-2 | 116,440 | 2,600 | 25,210 | 14,920 | 15,920 | 175,090 |
| 3h1-3 | 11,250 | 1,840 | 1,590 | 6,840 | 1,980 | 23,500 |
| Total | 298,210 | 41,290 | 46,760 | 53,570 | 43,780 | 483,610 |

Kiamichi River

| | | | | | | |
|--------------|---------------|--------------|--------------|--------------|--------------|----------------|
| 3i-2 | 43,820 | 0 | 0 | 0 | 0 | 43,820 |
| 3i-4 | 23,150 | 4,940 | 5,140 | 1,320 | 3,450 | 38,000 |
| 3i-8 | 20,890 | 3,440 | 1,260 | 1,840 | 2,740 | 30,170 |
| Total | 87,860 | 8,380 | 6,400 | 3,160 | 6,190 | 111,990 |

Barkman Creek

| | | | | | | |
|--------------|---------------|--------------|----------|----------|--------------|---------------|
| 3-47 | 10,250 | 410 | 0 | 0 | 530 | 11,190 |
| 3-48 | 51,080 | 2,040 | 0 | 0 | 2,660 | 55,780 |
| Total | 61,330 | 2,450 | 0 | 0 | 3,190 | 66,970 |

Continued ----

Exhibit 21 - Estimated Average Annual Flood Damages for Watersheds
 Considered Feasible for Development Within 10-15 Years, Red River Basin
 Study Area--Continued

| Tributary Basin: | Floodwater | | | | | | |
|-----------------------------|---------------|------------------|-----------|-----------|------------|---------|--|
| and | :Agricultural | :Nonagricultural | :Sediment | : Erosion | : Indirect | : Total | |
| CNI Watershed | : tural | : cultural: | : | : | : | : | |
| - - - - - dollars - - - - - | | | | | | | |
| Little River | | | | | | | |
| 3j-4 | 78,010 | 11,130 | 4,760 | 1,200 | 9,510 | 104,610 | |
| Total | 78,010 | 11,130 | 4,760 | 1,200 | 9,510 | 104,610 | |
| McKinney Bayou | | | | | | | |
| 3-52 | 150,370 | 0 | 0 | 0 | 0 | 150,370 | |
| 3-53 | 216,560 | 0 | 0 | 0 | 0 | 216,560 | |
| 3-54 | 86,420 | 0 | 0 | 0 | 0 | 86,420 | |
| Total | 453,350 | 0 | 0 | 0 | 0 | 453,350 | |
| Sulphur River | | | | | | | |
| 3k-9 | 24,900 | 2,440 | 1,170 | 240 | 2,880 | 31,630 | |
| 3k-11 | 240 | 3,230 | 50 | 0 | 350 | 3,870 | |
| 3k-12 | 14,270 | 2,140 | 1,090 | 440 | 1,790 | 19,730 | |
| 3k-14 | 59,250 | 14,960 | 8,850 | 24,100 | 10,710 | 117,870 | |
| 3k-17 | 107,250 | 9,900 | 6,595 | 2,810 | 12,510 | 139,065 | |
| 3k-18 | 80,640 | 7,500 | 1,580 | 1,950 | 9,170 | 100,840 | |
| Total | 286,550 | 40,170 | 19,335 | 29,540 | 37,410 | 413,005 | |
| Posten Bayou | | | | | | | |
| 3-57 | 347,160 | 0 | 0 | 0 | 20,620 | 367,780 | |
| Total | 347,160 | 0 | 0 | 0 | 20,620 | 367,780 | |
| Red River Main Stem | | | | | | | |
| 3-60 | 30,350 | 0 | 0 | 0 | 3,040 | 33,390 | |
| Total | 30,350 | 0 | 0 | 0 | 3,040 | 33,390 | |
| Loggy Bayou | | | | | | | |
| 3m1-7 | 24,150 | 26,250 | 0 | 0 | 5,040 | 55,440 | |
| 3m2-3 | 59,950 | 0 | 0 | 0 | 0 | 59,950 | |
| 3m-1 | 3,150 | 100 | 1,360 | 110 | 520 | 5,240 | |
| Total | 87,250 | 26,350 | 1,360 | 110 | 5,560 | 120,630 | |
| Bayou Pierre | | | | | | | |
| 3n-2 | 48,310 | 10,000 | 270 | 750 | 5,930 | 65,260 | |
| Total | 48,310 | 10,000 | 270 | 750 | 5,930 | 65,260 | |
| Cane River | | | | | | | |
| 3-66 | 83,180 | 1,840 | 350 | 230 | 1,510 | 87,110 | |
| 3-64 | 21,240 | 1,340 | 240 | 160 | 1,100 | 24,080 | |
| 3-65 | 26,910 | 3,040 | 570 | 390 | 2,490 | 33,400 | |
| Total | 131,330 | 6,220 | 1,160 | 780 | 5,100 | 144,590 | |

Continued ---

Exhibit 21 - Estimated Average Annual Flood Damages for Watersheds
 Considered Feasible for Development Within 10-15 Years, Red River Basin
 Study Area-- Continued

| Tributary Basin: | Floodwater | : | : | : | : | : |
|--|------------------|----------------|----------------|----------------|----------------|------------------|
| and | : Agricul- | : Nonagri- | : Sediment: | : Erosion: | : Indirect: | : Total |
| CNI Watershed | : tural | : cultural | : | : | : | : |
| - - - - - dollars - - - - - | | | | | | |
| Bayou Rigolette | | | | | | |
| 3-69 | 51,360 | 2,570 | 0 | 0 | 2,700 | 56,630 |
| 3-70 | 220,540 | 11,300 | 4,100 | 0 | 11,800 | 247,740 |
| Total | 271,900 | 13,870 | 4,100 | 0 | 14,500 | 304,370 |
| Red River Backwater | | | | | | |
| 3-76 | 179,350 | 0 | - | - | 17,930 | 197,280 |
| 3-75 | 272,060 | 0 | - | - | 6,720 | 278,780 |
| 3-73 | 117,860 | 0 | - | - | - | 117,860 |
| Total | 569,270 | 0 | - | - | 24,650 | 593,920 |
| Chatlin Lake & Associated Areas | | | | | | |
| 10-11 & 12 | 53,390 | 0 | - | - | - | 53,390 |
| 10-15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-10 | 162,575 | 0 | - | - | - | 162,575 |
| 10-13 & 14 | 572,860 | 0 | - | - | - | 572,860 |
| 10-16 | 368,250 | 0 | - | - | - | 368,250 |
| Total | 1,157,075 | 0 | - | - | - | 1,157,075 |
| Grand Total | 5,291,345 | 380,410 | 114,625 | 139,440 | 315,960 | 6,241,780 |

1/ Adjusted normalized prices

Exhibit 22 - Water Use 1/ by Heavy Forest Industry, Red River Basin Study Area, 1962 to 1980

| Status of Mill or Expansion | Year of : :Estimated :Period of :Completion | Town | County or Parish | Pulp :Capacity :and Process :(Tons/day) | Ground :(mil.gal./day) | Surface :(mil.gal./day) | Surface Source | Status of Water : Supply | Effluent Disposal : (act. or probable) |
|-----------------------------|--|------------|------------------------|--|---------------------------|----------------------------|-------------------------------|------------------------------------|---|
| | | | | | | | | | |
| ARKANSAS: | | | | | | | | | |
| Under Construction | 1968 | Ashdown | Little River | 400-BK 200-G | --- | 25 | Millwood Reservoir | Max. of 75 mm. is available | Red River |
| Planned | 1970-80 | Fulton | Hempstead | est. 600-K | --- | est. 25 | Red River | | Red River |
| LOUISIANA: | | | | | | | | | |
| Operating | --- | Springhill | Webster | 725-BK 850-K | est. 15 | est. 35 | Lake Erling (Bodeau Bayou) | Est.: Needs may increase in future | Bodeau Bayou, Loggy Bayou, Red River |
| Operating | --- | Shreveport | Caddo | 135-G | 1.25 | --- | | Est.: No substantial increases | Red River |
| Under Construction | 1968 | Pineville | Rapides | 300-K 200-BK | 25 | Some use likely | Castor Creek (Rapides Parish) | Est.: Initial needs are available | Red River |
| Feasible | 1970-80 | | Grant or Rapides | est. 600-K | --- | 25 | Lake Iatt (Grant Parish) | Max. of 60 mm. was planned | Red River |
| Feasible | 1970-80 | | Natchitoches or Grant | est. 600-K | Some use likely | est. 25 | Non established | Est.: 35-40 mm. will be needed | Red River |
| OKLAHOMA | | | | | | | | | |
| Feasible | 1970-80 | Hugo | Choctaw | est. 600-K | est. 35 | est. 35 | Hugo Reservoir | Res. Construction authorized | Lower Kiamichi River |
| TEXAS | | | | | | | | | |
| Planned | 1970-80 | New Boston | Bowie | est. 600-K | --- | est. 25 | Red River and Barkman Creek | Tentative approval by State | Red River |
| Planned | 1970-80 | Texarkana | Bowie | est. 660-K | est. 35 | est. 35 | Impoundment to be constructed | To be reserved in State Water Plan | Red River |

PAPER-MAKING PROCESSES: K - Kraft (Sulphate); BK - Bleached Kraft; G - Groundwood

NOTE: 600 tons is considered the minimum efficient operating capacity for pulp and paper mills. Once established, they tend to expand to fit the available raw material. Market conditions for pulp products are favorable for the foreseeable future.

1/ Net needs based on reasonable reuse.

Exhibit 23 - Land Capability Class and Subclass Distribution by Major Land Uses, Arkansas, 1962 Conditions

| Land Capability Class and Subclass | Cropland | Grazing Land | Woodland | Miscellaneous Land | Total |
|------------------------------------|--------------|--------------|----------------|--------------------|----------------|
| ----- thousand acres ----- | | | | | |
| Class I Total | 60.1 | 33.8 | 74.6 | - | 168.5 |
| Subclass IIE | 102.8 | 95.5 | 267.8 | - | 466.1 |
| Subclass IIS | 63.2 | 23.8 | 21.4 | - | 108.4 |
| Subclass IIW | 21.3 | 9.1 | 76.6 | - | 107.0 |
| Class II Total | 187.3 | 128.4 | 365.8 | - | 681.5 |
| Subclass IIIe | 97.0 | 71.1 | 328.2 | - | 496.3 |
| Subclass IIIS | - | 0.8 | 7.3 | - | 8.1 |
| Subclass IIIW | 30.1 | 40.6 | 256.8 | - | 327.5 |
| Class III Total | 127.1 | 112.5 | 592.3 | - | 831.9 |
| Subclass IVE | 5.4 | 22.8 | 145.0 | - | 173.2 |
| Subclass IVS | 3.7 | 3.1 | 6.0 | - | 12.8 |
| Subclass IVW | 1.0 | 12.6 | 168.7 | - | 182.3 |
| Class IV Total | 10.1 | 38.5 | 319.7 | - | 368.3 |
| Subclass VW | 1.4 | 16.0 | 235.1 | - | 302.5 |
| Class V Total | 1.4 | 16.0 | 285.1 | - | 302.5 |
| Subclass VIE | 1.3 | 12.6 | 146.7 | - | 160.6 |
| Subclass VIS | 0.9 | - | 15.4 | - | 16.3 |
| Class VI Total | 2.2 | 12.6 | 162.1 | - | 176.9 |
| Subclass VIIe | - | 1.0 | 35.5 | - | 36.5 |
| Subclass VIIS | - | 0.4 | 78.4 | - | 78.8 |
| Class VII Total | - | 1.4 | 113.9 | - | 115.3 |
| Unclassified | - | - | - | 15.8 | 15.8 |
| Total | 388.2 | 343.2 | 1,913.5 | 15.8 | 2,660.7 |

Continued ---

Exhibit 23 - Land Capability Class and Subclass Distribution by Major Land Uses, Louisiana, 1962 Conditions--Continued

| Land Capability Class and Subclass | Cropland | Grazing Land | Woodland | Miscellaneous Land | Total |
|------------------------------------|--------------|--------------|----------------|--------------------|----------------|
| ----- thousand acres ----- | | | | | |
| Class I Total | 169.9 | 63.2 | 25.2 | 13.5 | 271.8 |
| Subclass IIe | 72.0 | 89.7 | 335.6 | 50.9 | 548.2 |
| Subclass IIIs | 2.2 | 1.2 | 28.7 | 2.0 | 34.1 |
| Subclass IIw | 145.8 | 142.2 | 203.8 | 21.2 | 513.0 |
| Class II Total | 220.0 | 233.1 | 568.1 | 74.1 | 1,095.3 |
| Subclass IIIe | 41.2 | 106.0 | 517.3 | 42.2 | 706.7 |
| Subclass IIIIs | 3.7 | 3.8 | 84.5 | 7.8 | 99.8 |
| Subclass IIIw | 129.9 | 171.5 | 362.4 | 12.0 | 675.8 |
| Class III Total | 174.8 | 281.3 | 964.2 | 62.0 | 1,482.3 |
| Subclass IVe | 7.4 | 31.4 | 186.6 | 23.8 | 249.2 |
| Subclass IVs | 0.1 | 0.8 | 5.4 | 0.2 | 6.5 |
| Subclass IVw | - | 13.4 | 169.3 | 0.7 | 183.4 |
| Class IV Total | 7.5 | 45.6 | 361.3 | 24.7 | 439.1 |
| Subclass Vw | 1.1 | 103.0 | 836.0 | 3.1 | 943.2 |
| Class V Total | 1.1 | 103.0 | 836.0 | 3.1 | 943.2 |
| Subclass VIe | 0.6 | 14.9 | 142.0 | 4.3 | 161.8 |
| Class VI Total | 0.6 | 14.9 | 142.0 | 4.3 | 161.8 |
| Subclass VIIe | 0.2 | 24.6 | 183.1 | 5.0 | 212.9 |
| Subclass VIIs | - | 0.3 | 19.5 | 1.5 | 21.3 |
| Class VII Total | 0.2 | 24.9 | 202.6 | 6.5 | 234.2 |
| Total | 574.1 | 766.0 | 3,099.4 | 188.2 | 4,627.7 |

Continued---

Exhibit 23 - Land Capability Class and Subclass Distribution by Major Land Uses, Oklahoma, 1962 Conditions--Continued

| Land Capability Class and Subclass | Cropland | Grazing Land | Woodland | Miscellaneous Land | Total |
|------------------------------------|--------------|--------------|----------------|--------------------|----------------|
| - - - - - thousand acres - - - - - | | | | | |
| Class I Total | 97.4 | 29.1 | 50.5 | 4.4 | 181.4 |
| Subclass IIe | 174.0 | 126.5 | 78.1 | 34.6 | 413.2 |
| Subclass IIs | 28.2 | 11.6 | 2.6 | 6.2 | 48.6 |
| Subclass IIw | - | 5.8 | 36.3 | 0.5 | 42.6 |
| Class II Total | 202.2 | 143.9 | 117.0 | 41.3 | 504.4 |
| Subclass IIIe | 219.5 | 244.7 | 158.9 | 85.4 | 708.5 |
| Subclass IIIw | 46.0 | 36.3 | 69.4 | 2.3 | 154.0 |
| Class III Total | 265.5 | 281.0 | 228.3 | 87.7 | 862.5 |
| Subclass IVe | 29.4 | 100.4 | 115.8 | 21.3 | 266.9 |
| Subclass IVs | - | 1.5 | 10.3 | 3.7 | 15.5 |
| Subclass IVw | 0.6 | 6.9 | 14.6 | 0.9 | 23.0 |
| Class IV Total | 30.0 | 108.8 | 140.7 | 25.9 | 305.4 |
| Subclass Vw | 20.7 | 52.5 | 344.3 | 16.9 | 434.4 |
| Class V Total | 20.7 | 52.5 | 344.3 | 16.9 | 434.4 |
| Subclass VIe | 17.1 | 112.8 | 343.9 | 59.5 | 533.3 |
| Class VI Total | 17.1 | 112.8 | 343.9 | 59.5 | 533.3 |
| Subclass VIIs | 0.1 | 204.1 | 1,850.0 | 4.2 | 2,058.4 |
| Class VII Total | 0.1 | 204.1 | 1,850.0 | 4.2 | 2,058.4 |
| Total | 633.0 | 932.2 | 3,074.7 | 239.9 | 4,879.8 |

Continued ---

Exhibit 23 - Land Capability Class and Subclass Distribution by Major Land Uses, Texas, 1962 Conditions--Continued

| Land Capability Class and Subclass | : Cropland | : Grazing Land | : Woodland | : Miscellaneous Land | : Total |
|------------------------------------|----------------|----------------|----------------|----------------------|----------------|
| - - - - - thousand acres - - - - - | | | | | |
| Class I Total | 48.0 | 21.3 | 12.4 | - | 81.7 |
| Subclass IIe | 416.9 | 124.0 | 72.5 | - | 613.4 |
| Subclass IIs | 250.1 | 74.8 | 74.1 | - | 399.0 |
| Subclass IIw | 23.5 | 5.1 | 2.9 | - | 31.5 |
| Class II Total | 690.5 | 203.9 | 149.5 | - | 1,043.9 |
| Subclass IIIe | 691.2 | 433.5 | 384.1 | - | 1,508.8 |
| Subclass IIIs | 53.3 | 25.3 | 47.0 | - | 125.6 |
| Subclass IIIw | 12.5 | 13.3 | 83.8 | - | 109.6 |
| Class III Total | 757.0 | 472.1 | 514.9 | - | 1,744.0 |
| Subclass IVe | 115.2 | 113.2 | 228.1 | - | 456.5 |
| Subclass IVs | 0.6 | - | - | - | 0.6 |
| Subclass IVw | 25.3 | 27.4 | 222.7 | - | 275.4 |
| Class IV Total | 141.1 | 140.6 | 450.8 | - | 732.5 |
| Subclass Vw | 81.9 | 151.7 | 578.7 | - | 812.3 |
| Class V Total | 81.9 | 151.7 | 578.7 | - | 812.3 |
| Subclass VIe | 9.7 | 14.4 | 175.2 | - | 199.3 |
| Subclass VI s | - | 2.8 | 0.6 | - | 3.4 |
| Class VI Total | 9.7 | 17.2 | 175.8 | - | 202.7 |
| Subclass VIIe | 64.3 | 112.7 | 314.9 | - | 491.9 |
| Subclass VII s | - | - | 1.8 | - | 1.8 |
| Class VII Total | 64.3 | 112.7 | 316.7 | - | 493.7 |
| Unclassified | 1.3 | - | - | 53.0 | 54.3 |
| Total | 1,793.8 | 1,119.5 | 2,198.8 | 53.0 | 5,165.1 |

Continued -----

Exhibit 23-Land Capability Class and Subclass Distribution by Major Land Uses, Red River Basin Study Area, 1962 Conditions--Continued

| Land Capability Class and Subclass | : Cropland | : Grazing Land | : Woodland | : Miscellaneous Land | : Total |
|------------------------------------|----------------|----------------|-----------------|----------------------|-----------------|
| ----- thousand acres ----- | | | | | |
| Class I Total | 375.4 | 147.4 | 162.7 | 17.9 | 703.4 |
| Subclass IIe | 765.7 | 435.7 | 754.0 | 85.5 | 2,040.9 |
| Subclass IIs | 343.7 | 111.4 | 126.8 | 8.2 | 590.1 |
| Subclass IIw | 190.6 | 162.2 | 319.6 | 21.7 | 694.1 |
| Class II Total | 1,300.0 | 709.3 | 1,200.4 | 115.4 | 3,325.1 |
| Subclass IIIe | 1,048.9 | 855.3 | 1,388.5 | 127.6 | 3,420.3 |
| Subclass IIIs | 57.0 | 29.9 | 138.8 | 7.8 | 233.5 |
| Subclass IIIw | 218.5 | 261.7 | 772.4 | 14.3 | 1,266.9 |
| Class III Total | 1,324.4 | 1,146.9 | 2,299.7 | 149.7 | 4,920.7 |
| Subclass IVe | 157.4 | 267.8 | 675.5 | 45.1 | 1,145.8 |
| Subclass IVs | 4.4 | 5.4 | 21.7 | 3.9 | 35.4 |
| Subclass IVw | 26.9 | 60.3 | 575.3 | 1.6 | 664.1 |
| Class IV Total | 188.7 | 333.5 | 1,272.5 | 50.6 | 1,845.3 |
| Subclass Vw | 105.1 | 323.2 | 2,044.1 | 20.0 | 2,492.4 |
| Class V Total | 105.1 | 323.2 | 2,044.1 | 20.0 | 2,492.4 |
| Subclass VIe | 28.7 | 154.7 | 807.8 | 63.8 | 1,055.0 |
| Subclass VI s | 0.9 | 2.8 | 16.0 | - | 19.7 |
| Class VI Total | 29.6 | 157.5 | 823.8 | 63.8 | 1,074.7 |
| Subclass VIIe | 64.5 | 138.3 | 533.5 | 5.0 | 741.3 |
| Subclass VII s | 0.1 | 204.8 | 1,949.7 | 5.7 | 2,160.3 |
| Class VII Total | 64.6 | 343.1 | 2,483.2 | 10.7 | 2,901.6 |
| Unclassified | 1.3 | - | - | 68.8 | 70.1 |
| Total | 3,389.1 | 3,160.9 | 10,286.4 | 496.9 | 17,333.3 |

Source: 1958 National Inventory of Soil and Water Conservation Needs adjusted to 1962 conditions and rounded to nearest 100 acres

Exhibit 24 - Status and Management Policy of Federally Owned Forest Lands, Red River Basin Study Area, 1962

| State, County or Parish and Installation | Total Area | Forested Area | Other Area | Accessible to Public | Type of Land Management |
|--|----------------|------------------|---------------|-------------------------|---|
| | acres | | | | |
| Arkansas | | | | | |
| Howard | | | | | |
| Ouachita National Forest | 300 | 300 | - | 300 | Multiple-use, includes recreation |
| Lafayette | | | | | |
| Bodcau Reservoir, CE | 1,150 | 1,150 | - | 1,150 | Multiple-use, principally hunting available for other recreation |
| Polk | | | | | |
| Ouachita National Forest | 105,500 | 105,500 | - | 105,500 | Multiple-use, includes recreation |
| TOTAL, Arkansas | 106,950 | 106,950 | - | 106,950 | |
| Louisiana | | | | | |
| Bossier | | | | | |
| Barksdale Air Force Base | 22,031 | 17,642 | 4,389 | Limited (17,642) | Multiple forest use, public use by special permit only |
| Bodcau Reservoir, CE | 26,490 | 26,490 | - | 26,490 | Multiple-use, principally hunting available for other recreation |
| La. Ordnance Plant (AMC) | 1,600 | 1,600 | - | None | Timber, W/S protection and wildlife production |
| Total, Bossier Parish | 50,121 | 45,732 | 4,389 | 26,490 | |
| Claiborne | | | | | |
| Kisatchie National Forest | 500 | 500 | - | 500 | Multiple-use, includes recreation |
| Grant | | | | | |
| Kisatchie National Forest | 41,800 | 41,800 | - | 41,800 | Multiple-use, includes recreation |
| Natchitoches | | | | | |
| Kisatchie National Forest | 122,000 | 122,000 | - | 122,000 | Multiple-use, includes recreation |
| Camp Polk Military Reservation | 4,900 | 4,900 | - | None | Limited management for timber production and W/S protection |
| Total, Natchitoches Parish | 126,900 | 126,900 | - | 122,000 | |
| Rapides | | | | | |
| England Air Force Base | 2,400 | - | 2,400 | None | No area for recreational development |
| Kisatchie National Forest | 7,100 | 7,100 | - | 7,100 | Multiple-use, includes recreation |
| Miscellaneous parcels | 1,735 | - | 1,735 | None | No area for recreation development |
| Total Rapides Parish | 11,235 | 7,100 | 4,135 | 7,100 | |
| Sabine | | | | | |
| Camp Polk Military Reservation | 5,400 | 5,400 | - | None | Limited Management for timber production and W/S protection |
| Vernon | | | | | |
| Camp Polk Military Reservation | 4,500 | 4,500 | - | None | Limited Management for timber production and W/S protection |
| Webster | | | | | |
| Bodcau Reservoir, CE | 9,400 | 9,400 | - | 9,400 | Multiple-use, principally hunting, Available for other recreation |
| Kisatchie National Forest | 11,684 | 11,684 | - | 11,684 | Multiple-use, includes recreation |
| La. Ordnance Plant (AMC) | 11,900 | 4,289 | 7,611 | None | Timber and wildlife production and W/S protection |
| Total, Webster Parish | 32,984 | 25,373 | 7,611 | 21,084 | |
| Winn | | | | | |
| Kisatchie National Forest | 59,300 | 59,300 | - | 59,300 | Multiple-use, includes recreation |
| TOTAL, Louisiana | 332,740 | 316,605 | 16,135 | 278,274 | |
| Oklahoma | | | | | |
| LeFlore | | | | | |
| Ouachita National Forest | 85,300 | 85,300 | - | 85,300 | Multiple-use, includes recreation |
| McCurtain | | | | | |
| Ouachita National Forest | 50,300 | 50,300 | - | 50,300 | Multiple-use, includes recreation |
| Pittsburg | | | | | |
| Naval Ordnance Depot | 4,300 | 1,280 | 3,020 | None | Wildlife production |
| TOTAL, Oklahoma | 139,900 | 136,880 | 3,020 | 135,600 | |
| Texas | | | | | |
| Bowie | | | | | |
| Red River Depot and Lone Star Ordnance Plant (AMC) | 35,725 | 28,000 | 7,725 | None | Timber and wildlife production and W/S protection |
| Texarkana Reservoir, CE 1/ | 35,500 | 34,850 | 650 | 34,850 | Limited multiple-use, dedicated mostly to recreation |
| Federal Correctional Inst. | 875 | - | 875 | None | Not available for recreation |
| Total, Bowie | 72,100 | 62,850 | 9,250 | 34,850 | |

Exhibit 24 - Status and Management Policy of Federally Owned Forest Lands, Red River Basin Study Area, 1962--
Continued

| State, County or Parish and Installation | Total Area | Forested Area | Other Area | Accessible to Public | Type of Land Management |
|--|----------------------|------------------|---------------|-------------------------|--|
| - - - - - acres - - - - - | | | | | |
| Camp Ferrells Bridge Reservoir, CE | 1,200 | 1,200 | - | 1,200 | Limited multiple-use, dedicated mostly to recreation |
| Cass Texarkana Reservoir, CE | 22,600 | 22,175 | 425 | 22,175 | Limited multiple-use, dedicated mostly to recreation |
| Fannin Panhandle National Grasslands | 19,028 ^{2/} | 530 | 18,498 | 19,028 | Managed range lands and 1,070 acres water. Available for recreation |
| Grayson Texhoma Reservoir, CE | 600 | - | 600 | 600 | Used mainly for recreation |
| Harrison Longhorn Arsenal (AMC) | 8,600 | 4,500 | 4,100 | None | Timber and wildlife production and W/S protection. No recreation |
| Marion Ferrell's Bridge Reservoir, CE | 6,100 | 5,740 | 360 | 5,740 | Limited multiple-use, dedicated mostly to recreation |
| Morris Ferrell's Bridge Reservoir, CE | 1,000 | 1,000 | - | 1,000 | Limited multiple-use, dedicated mostly to recreation |
| Upshur Ferrell's Bridge Reservoir, CE | 2,300 | 2,300 | - | 2,300 | Limited multiple-use, dedicated mostly to recreation |
| TOTAL, Texas | 133,528 | 100,295 | 33,233 | 86,893 | |

^{1/} Corps of Engineers management of reservoir lands does not include regular timber harvest. Entire area will probably be devoted to meeting recreation demands.

^{2/} This area was included in inventoried lands in 1958 CNI. No commercial forest land.

Exhibit 25 - 1962 Summarization of Treatment Accomplished on Private Forest Lands, Red River Basin Study Area

| Measure | : | Total Acres to 12/31/62 |
|--------------------------|---|----------------------------|
| Field Planting | : | 306,290 |
| Interplanting | : | 23,900 |
| Underplanting | : | 25,900 |
| Timber stand improvement | : | 657,500 |
| Total | : | 1,013,590 |

Source: State Forest agencies and SCS records, reports by forest industry

Exhibit 26 - 1953-62 (10-year) Summarization of Treatment Accomplished on National Forest System Lands, Red River Basin Study Area

| Measure | : | Unit | : | Total Installed 1953 - 62 |
|-------------------------------|---|-------|---|------------------------------|
| Tree planting | : | Acres | : | 42,894 |
| Timber stand improvement | : | Acres | : | 253,307 |
| Range improvement (reseeding) | : | Acres | : | 2,012 |
| Erosion control | : | Acres | : | 2,244 |
| Channel stabilization | : | Miles | : | 13 |
| Total | : | Acres | : | 300,457 |
| | : | Miles | : | 13 |

Exhibit 27 - 1962 Development of Recreation Facilities on National Forest System Lands on Base Area, Red River Basin Study

| Use | Unit | Number | Acres | Miles |
|-------------------|-----------------|--------|-------|-------|
| Camping | Family Unit | 132 | 65 | |
| Picnicking | Family Unit | 177 | 77 | |
| Hiking | Trail | 4 | | 3.5 |
| Vistas | Stop <u>1</u> / | 2 | 1 | |
| Swimming | Area <u>2</u> / | 10 | 19 | |
| Boating | Area <u>3</u> / | 4 | 1,060 | |
| Total Development | | | 1,222 | 3.5 |

1/ Includes parking area

2/ Includes beach area with bathhouse and showers

3/ Includes dock or ramp facilities

Exhibit 28 - 1963 - June 30, 1966, Development of Recreation Facilities on National Forest System Lands, Base Area, Red River Basin Study

| Use | Unit | Number | Acres | Miles |
|-------------------|-----------------|--------|-------|-------|
| Camping | Family Unit | 145 | 50 | |
| Picnicking | Family Unit | 79 | 25 | |
| Hiking | Trail | 1 | | .5 |
| Vistas | Stop <u>1</u> / | 4 | 4 | |
| Swimming | Area <u>2</u> / | 3 | 4 | |
| Boating | Area <u>3</u> / | 1 | 8 | |
| Total Development | | 233 | 91 | .5 |

1/ Includes parking areas

2/ Includes beach area with bathhouse and showers

3/ Includes dock or ramp facilities

Exhibit 29 - Summary of livestock and livestock products requirements, Red River Basin Study Area, 1962, 1980, and 2010

| Commodity | Unit | 1962 | 1980 | 2010 |
|---------------------------------|------|------------------|---------|---------|
| | | - | - | - |
| | | - millions - - - | | |
| Beef and veal <u>1/</u> | Lbs. | 622.9 | 1,131.9 | 2,339.1 |
| Lamb and mutton <u>1/</u> | Lbs. | 2.0 | 3.0 | 8.0 |
| Pork <u>1/</u> | Lbs. | 85.5 | 69.2 | 115.5 |
| Chickens <u>1/</u> | Lbs. | 13.0 | 18.1 | 35.1 |
| Turkeys <u>1/</u> | Lbs. | 4.9 | 16.7 | 29.4 |
| Milk <u>2/</u> | Lbs. | 565.9 | 1,061.4 | 2,841.8 |
| Eggs | No. | 571.4 | 1,693.7 | 2,782.4 |

1/ Live weight

2/ Fat solid basis

Note: Requirements conform to July 1965 ERS data. "Current and Projected Agricultural Product Requirements, U.S." Table 4, page 8

Exhibit 30 - Food and Fiber Requirements, Red River Basin Study Area, 1962
projected 1980 and 2010

| Crop | Unit | 1962 | 1980 | 2010 |
|---------------------------|--------------|-----------------------|---------|---------|
| | | - thousands - - - - - | | |
| Cotton | 500# bale | 323 | 175 | 249 |
| Feed grains: | | | | |
| Corn | Bu. | 6,136 | 2,146 | 3,470 |
| Oats | Bu. | 1,264 | 1,169 | 2,063 |
| Barley | Bu. | 350 | 870 | 1,765 |
| Sorghum, grain | Bu. | 1,882 | 4,435 | 6,818 |
| Feed units: | | 495,261 | 427,369 | 692,700 |
| Wheat | Bu. | 2,014 | 5,565 | 6,661 |
| Rice | Lbs. | 269,300 | 424,400 | 524,900 |
| Soybeans | Bu. | 1,684 | 5,626 | 8,159 |
| Peanuts | Lbs. | 46,162 | 48,040 | 78,430 |
| Sweet Potatoes | Bu. | 4,183 | 5,120 | 8,410 |
| Vegetables | Cwt. | 1,613 | 1,955 | 3,206 |
| Alfalfa & mixture | Ton | 171 | 257 | 417 |
| Other hay | Ton | 823 | 1,271 | 2,355 |
| Sugarcane for sugar | Ton | 35 | 210 | 439 |
| Fruits, non-citrus | Ton | 17 | 11 | 25 |
| Miscellaneous | | | | |

Note: Requirements conform to July 1965 ERS data, "Current and Projected Agricultural Product Requirements, U. S.," and "U. S. Feed Grain Requirements"

Exhibit 31 - Annual Household Water Requirements: Rural Farm and Rural Non-farm, Red River Basin Study Area, 1962, 1980, and 2010

| Year | Gallons Used per day per person ^{1/} | Annual household water requirement | | |
|------|---|------------------------------------|----------------|--------|
| | | Rural farm | Rural non-farm | Total |
| | | - - - million gallons - - - | | |
| 1962 | 70 | 4,928 | 17,848 | 22,776 |
| 1980 | 100 | 4,515 | 26,773 | 31,288 |
| 2010 | 119 | 3,705 | 33,549 | 37,254 |

^{1/} Estimates based on research conducted within the Red River Basin Study Area

Exhibit 32 - Livestock numbers and Water Requirements, Red River Basin Study Area ^{1/}, 1962, Projected 1980 and 2010

| Livestock | Livestock Number | | | Daily Water Use Per Head | Annual Water Requirements | | |
|-----------------------------|-------------------|---------|---------|-----------------------------|------------------------------|--------|--------|
| | 1962 | 1980 | 2010 | | 1962 | 1980 | 2010 |
| | - - thousands - - | | | gallons - - million gallons | | | |
| Cattle & calves | 2,110 | 2,808 | 3,970 | 15 | 11,552 | 15,374 | 21,736 |
| Horses & mules | 58 | 38 | 23 | 10 | 212 | 139 | 84 |
| Hogs & pigs | 305 | 252 | 230 | 3 | 334 | 276 | 252 |
| Sheep & lambs | 58 | 68 | 85 | 2 | 42 | 52 | 62 |
| Broilers ^{2/} | 70,159 | 107,450 | 225,645 | .04 | 236 | 362 | 760 |
| Chickens, 4 mos. & older | 3,460 | 7,907 | 9,884 | .04 | 51 | 115 | 144 |
| Turkeys | 228 | 248 | 281 | .06 | 5 | 5 | 6 |
| Total | - | - | - | - | 12,432 | 16,323 | 23,044 |

^{1/} Whole counties are represented in the four Basin States of Arkansas, Louisiana, Oklahoma, & Texas

^{2/} Assumed 12 weeks for total broiler production

Exhibit 33 - Recreation Demand: Existing and Projected Total Annual, Summer, and Average Sunday Demand in Activity Occasions by Sub-areas, Red River Basin Study Area, 1960, 1980, and 2020

| Activity or Activity Group | Average Summer Sunday | | | | | | Total Summer | | | | | | Total Annual | | | | | |
|----------------------------------|-----------------------|------------------------------|---------|-----------|--------------------|------------------------------|--------------|----------|--------------------|------------------------------|----------|-----------|--------------|--|--|--|--|--|
| | Participation | Demand in Activity Occasions | | | Participation | Demand in Activity Occasions | | | Participation | Demand in Activity Occasions | | | | | | | | |
| | Rate Per (\$1,000) | 1960 | 1980 | 2020 | Rate Per (\$1,000) | 1960 | 1980 | 2020 | Rate Per (\$1,000) | 1960 | 1980 | 2020 | | | | | | |
| Sub-area 1 | | | | | | | | | | | | | | | | | | |
| Canoeing | 0.0011 | 190 | 400 | 1,300 | 0.034 | 5.9 | 11.3 | 39.1 | 0.056 | 9.7 | 18.7 | 64.4 | | | | | | |
| Boating, Sailing and Waterskiing | 0.0212 | 3,690 | 7,100 | 24,400 | 0.689 | 119.9 | 229.9 | 792.8 | 1.367 | 237.8 | 456.1 | 1,573.0 | | | | | | |
| Swimming | 0.0684 | 11,900 | 22,800 | 78,700 | 2.224 | 386.9 | 742.0 | 2,559.1 | 3.104 | 540.0 | 1,035.7 | 3,571.7 | | | | | | |
| Subtotal | - | 15,780 | 30,300 | 104,400 | - | 512.7 | 983.2 | 3,391.0 | - | 787.5 | 1,510.5 | 5,209.1 | | | | | | |
| Camping | 0.0115 | 2,000 | 3,800 | 13,200 | 0.213 | 37.1 | 71.1 | 245.1 | 0.443 | 77.1 | 147.8 | 509.8 | | | | | | |
| Picnicking | 0.0226 | 3,930 | 7,500 | 26,000 | 0.734 | 127.7 | 244.9 | 844.6 | 1.552 | 270.0 | 517.8 | 1,785.9 | | | | | | |
| Subtotal | - | 5,930 | 11,300 | 39,200 | - | 164.8 | 316.0 | 1,089.7 | - | 347.1 | 665.6 | 2,295.7 | | | | | | |
| Playing Games | 0.0051 | 890 | 1,700 | 5,900 | 0.165 | 28.7 | 55.1 | 189.9 | 0.721 | 125.4 | 240.6 | 829.6 | | | | | | |
| Fishing (Incidental) | 0.0076 | 1,320 | 2,500 | 8,700 | 0.246 | 42.6 | 82.1 | 283.1 | 0.593 | 103.2 | 197.9 | 682.4 | | | | | | |
| Sightseeing | 0.0276 | 4,800 | 9,200 | 31,800 | 0.896 | 155.9 | 299.0 | 1,031.0 | 2.851 | 496.0 | 951.2 | 3,280.6 | | | | | | |
| Hiking | 0.0029 | 500 | 1,000 | 3,300 | 0.095 | 16.5 | 31.7 | 109.3 | 0.196 | 34.1 | 65.4 | 225.5 | | | | | | |
| Nature Walks | 0.0095 | 1,650 | 3,200 | 10,900 | 0.308 | 53.6 | 102.8 | 354.4 | 1.485 | 258.4 | 495.5 | 1,708.8 | | | | | | |
| Subtotal | - | 9,160 | 17,600 | 60,600 | - | 297.5 | 570.7 | 1,967.7 | - | 1,017.1 | 1,950.6 | 6,726.9 | | | | | | |
| Total | - | 30,870 | 59,200 | 204,200 | - | 975.0 | 1,869.9 | 6,448.4 | - | 2,151.7 | 4,126.7 | 14,231.7 | | | | | | |
| Sub-area 2 | | | | | | | | | | | | | | | | | | |
| Canoeing | 0.0011 | 130 | 274 | 1,110 | 0.034 | 4.1 | 8.5 | 34.2 | 0.056 | 6.8 | 13.9 | 56.4 | | | | | | |
| Boating, Sailing and Waterskiing | 0.0212 | 2,560 | 5,280 | 21,360 | 0.689 | 83.4 | 171.6 | 694.1 | 1.367 | 165.4 | 340.5 | 1,377.2 | | | | | | |
| Swimming | 0.0684 | 8,280 | 17,040 | 68,910 | 2.224 | 269.1 | 554.0 | 2,240.5 | 3.104 | 375.5 | 773.2 | 3,127.1 | | | | | | |
| Subtotal | - | 10,970 | 22,594 | 91,380 | - | 356.6 | 734.1 | 2,968.8 | - | 547.7 | 1,127.6 | 4,560.7 | | | | | | |
| Camping | 0.0115 | 1,390 | 2,860 | 11,580 | 0.213 | 25.8 | 53.1 | 214.6 | 0.443 | 53.6 | 110.4 | 446.3 | | | | | | |
| Picnicking | 0.0226 | 2,730 | 5,630 | 22,770 | 0.734 | 88.8 | 182.8 | 739.4 | 1.552 | 187.8 | 386.6 | 1,563.5 | | | | | | |
| Subtotal | - | 4,120 | 8,490 | 34,350 | - | 114.6 | 235.9 | 954.0 | - | 241.4 | 497.0 | 2,009.8 | | | | | | |
| Playing Games | 0.0051 | 620 | 1,270 | 5,140 | 0.165 | 20.0 | 41.1 | 166.2 | 0.721 | 87.2 | 179.6 | 726.4 | | | | | | |
| Fishing (Incidental) | 0.0076 | 920 | 1,890 | 7,660 | 0.246 | 29.8 | 61.3 | 247.8 | 0.593 | 71.7 | 147.7 | 597.4 | | | | | | |
| Sightseeing | 0.0276 | 3,340 | 6,880 | 27,800 | 0.896 | 108.4 | 223.2 | 902.6 | 2.851 | 344.9 | 710.2 | 2,872.2 | | | | | | |
| Hiking | 0.0029 | 350 | 720 | 2,920 | 0.095 | 11.5 | 23.7 | 95.7 | 0.196 | 23.7 | 48.8 | 197.5 | | | | | | |
| Nature Walks | 0.0095 | 1,150 | 2,370 | 9,570 | 0.308 | 37.3 | 76.7 | 310.7 | 1.485 | 179.7 | 369.9 | 1,496.0 | | | | | | |
| Subtotal | - | 6,380 | 13,130 | 53,090 | - | 207.0 | 426.0 | 1,722.6 | - | 707.2 | 1,456.2 | 5,889.5 | | | | | | |
| Total | - | 21,470 | 44,214 | 178,820 | - | 678.2 | 1,396.0 | 5,645.4 | - | 1,496.3 | 3,080.8 | 12,460.0 | | | | | | |
| Sub-area 3 | | | | | | | | | | | | | | | | | | |
| Canoeing | 0.0011 | 490 | 1,020 | 4,320 | 0.034 | 15.2 | 31.6 | 133.5 | 0.056 | 25.0 | 52.1 | 219.9 | | | | | | |
| Boating, Sailing and Waterskiing | 0.0212 | 9,460 | 19,730 | 83,230 | 0.689 | 307.3 | 611.4 | 2,705.0 | 1.367 | 609.7 | 1,272.0 | 5,366.9 | | | | | | |
| Swimming | 0.0684 | 30,500 | 63,650 | 268,540 | 2.224 | 991.9 | 2,069.4 | 8,731.5 | 3.104 | 1,384.4 | 2,888.3 | 12,186.5 | | | | | | |
| Subtotal | - | 40,450 | 84,400 | 356,090 | - | 1,314.4 | 2,752.1 | 11,570.0 | - | 2,019.1 | 4,212.4 | 17,773.3 | | | | | | |
| Camping | 0.0115 | 5,130 | 10,700 | 45,150 | 0.213 | 95.0 | 198.2 | 451.5 | 0.443 | 197.6 | 412.2 | 1,739.2 | | | | | | |
| Picnicking | 0.0226 | 10,080 | 21,030 | 88,730 | 0.734 | 327.4 | 683.0 | 2,881.7 | 1.552 | 692.2 | 1,444.1 | 6,093.2 | | | | | | |
| Subtotal | - | 15,210 | 31,730 | 133,880 | - | 422.4 | 881.2 | 3,333.2 | - | 889.8 | 1,856.3 | 7,832.4 | | | | | | |
| Playing Games | 0.0051 | 2,270 | 4,750 | 20,020 | 0.165 | 73.6 | 153.5 | 647.8 | 0.721 | 321.6 | 570.9 | 2,830.7 | | | | | | |
| Fishing (Incidental) | 0.0076 | 3,390 | 7,070 | 29,840 | 0.246 | 109.7 | 228.9 | 965.8 | 0.593 | 264.5 | 551.8 | 2,328.1 | | | | | | |
| Sightseeing | 0.0276 | 12,300 | 25,680 | 108,360 | 0.896 | 399.6 | 833.7 | 3,517.7 | 2.851 | 1,271.5 | 2,652.8 | 11,198.2 | | | | | | |
| Hiking | 0.0029 | 1,290 | 2,700 | 11,360 | 0.095 | 42.4 | 88.4 | 373.0 | 0.196 | 87.4 | 182.4 | 769.5 | | | | | | |
| Nature Walks | 0.0095 | 4,240 | 8,840 | 37,300 | 0.308 | 137.4 | 286.6 | 1,209.2 | 1.485 | 662.3 | 1,381.8 | 5,830.2 | | | | | | |
| Subtotal | - | 23,490 | 49,040 | 206,880 | - | 762.7 | 1,591.1 | 6,713.5 | - | 2,607.3 | 5,439.7 | 22,951.7 | | | | | | |
| Total | - | 79,150 | 165,170 | 696,850 | - | 2,499.5 | 5,224.4 | 21,616.7 | - | 5,516.2 | 11,508.4 | 48,557.4 | | | | | | |
| Sub-area 4 | | | | | | | | | | | | | | | | | | |
| Canoeing | 0.0011 | 1,410 | 3,150 | 11,770 | 0.034 | 43.6 | 97.4 | 363.7 | 0.056 | 71.9 | 160.3 | 599.0 | | | | | | |
| Boating, Sailing and Waterskiing | 0.0212 | 27,220 | 60,700 | 226,750 | 0.689 | 884.6 | 1,972.7 | 7,369.4 | 1.367 | 1,755.1 | 3,913.9 | 14,621.1 | | | | | | |
| Swimming | 0.0684 | 87,820 | 195,840 | 731,590 | 2.224 | 2,855.4 | 6,367.6 | 23,787.4 | 3.104 | 3,985.2 | 8,887.2 | 33,200.0 | | | | | | |
| Subtotal | - | 116,450 | 259,690 | 970,110 | - | 3,783.6 | 8,437.7 | 31,520.5 | - | 5,812.2 | 12,961.4 | 48,420.1 | | | | | | |
| Camping | 0.0115 | 14,760 | 32,930 | 123,000 | 0.213 | 273.5 | 609.8 | 2,278.2 | 0.443 | 568.8 | 1,268.4 | 4,738.2 | | | | | | |
| Picnicking | 0.0226 | 29,020 | 64,710 | 241,720 | 0.734 | 942.4 | 2,101.5 | 7,850.7 | 1.552 | 1,992.6 | 4,443.6 | 16,600.0 | | | | | | |
| Subtotal | - | 43,780 | 97,640 | 364,720 | - | 1,215.9 | 2,711.3 | 10,128.9 | - | 2,561.4 | 5,712.0 | 21,338.2 | | | | | | |
| Playing Games | 0.0051 | 6,550 | 14,600 | 54,550 | 0.165 | 211.8 | 472.4 | 1,764.8 | 0.721 | 925.7 | 2,064.3 | 7,711.7 | | | | | | |
| Fishing (Incidental) | 0.0076 | 9,760 | 21,760 | 81,290 | 0.246 | 315.8 | 704.3 | 2,631.2 | 0.593 | 761.4 | 1,607.8 | 6,342.6 | | | | | | |
| Sightseeing | 0.0276 | 35,440 | 79,020 | 315,200 | 0.896 | 1,150.4 | 2,565.4 | 9,583.4 | 2.851 | 3,660.4 | 8,152.8 | 30,493.7 | | | | | | |
| Hiking | 0.0029 | 3,720 | 8,300 | 31,020 | 0.095 | 122.0 | 272.0 | 1,016.1 | 0.196 | 251.6 | 561.2 | 2,096.4 | | | | | | |
| Nature Walks | 0.0095 | 12,200 | 27,200 | 101,610 | 0.308 | 395.4 | 881.8 | 3,294.3 | 1.485 | 1,906.6 | 4,251.8 | 15,883.2 | | | | | | |
| Subtotal | - | 67,670 | 150,880 | 563,670 | - | 2,195.4 | 4,895.9 | 18,289.8 | - | 7,505.7 | 16,737.9 | 62,527.6 | | | | | | |
| Sub-area Total | - | 227,900 | 508,210 | 1,898,500 | - | 7,194.9 | 16,044.9 | 59,939.2 | - | 15,879.3 | 35,411.3 | 132,285.9 | | | | | | |
| Basin Total | - | 359,390 | 776,794 | 2,978,370 | - | 11,347.6 | 24,535.2 | 93,649.7 | - | 25,043.5 | 54,127.2 | 207,535.0 | | | | | | |

Exhibit 34 - County Income: Population and Per Capita Personal Income, by Sub-area, State and County, Red River Basin Study Area, 1960

| Sub-area by state and county | 1960 population | Per capita personal income | County income |
|---------------------------------|--------------------|----------------------------------|---------------------|
| | | dollars | thousand dollars |
| <u>Sub-area 1</u> | | | |
| Oklahoma: | | | |
| Atoka | 10,352 | 773 | 8,002 |
| Bryan | 24,252 | 1,072 | 25,998 |
| Choctaw | 15,637 | 895 | 13,995 |
| Coal | 5,546 | 1,082 | 6,001 |
| Hughes | 15,144 | 1,123 | 17,007 |
| Johnston | 8,517 | 1,057 | 9,002 |
| Murray | 10,622 | 1,318 | 14,000 |
| Pittsburg | 34,360 | 1,193 | 40,991 |
| Pontotoc | 28,089 | 1,388 | 38,988 |
| Total | 152,519 | 1,141 | 173,984 |
| <u>Sub-area 2</u> | | | |
| Arkansas: | | | |
| Hempstead | 19,661 | 966 | 18,993 |
| Howard | 10,878 | 1,011 | 10,998 |
| Little River | 9,211 | 868 | 7,995 |
| Polk | 11,981 | 1,002 | 12,005 |
| Sevier | 10,156 | 985 | 10,004 |
| Oklahoma: | | | |
| Latimer | 7,738 | 1,034 | 8,001 |
| LeFlore | 29,106 | 996 | 28,990 |
| McCurtain | 25,851 | 619 | 16,002 |
| Pushmataha | 9,088 | 880 | 7,997 |
| Total | 133,670 | 905 | 120,985 |
| <u>Sub-area 3</u> | | | |
| Arkansas: | | | |
| Miller | 31,686 | 1,136 | 35,995 |
| Texas: | | | |
| Bowie | 59,971 | 1,334 | 80,001 |
| Delta | 5,860 | 1,024 | 6,001 |
| Fannin | 23,880 | 1,131 | 27,008 |
| Franklin | 5,101 | 1,176 | 5,999 |
| Grayson | 73,043 | 1,492 | 108,980 |
| Hopkins | 18,594 | 1,237 | 23,001 |
| Hunt | 39,399 | 1,396 | 55,001 |
| Lamar | 34,234 | 1,198 | 41,012 |
| Red River | 15,682 | 1,020 | 15,996 |
| Titus | 16,785 | 1,370 | 22,995 |
| Wood | 17,653 | 1,360 | 24,008 |
| Total | 341,888 | 1,304 | 445,997 |

Exhibit 34 - County Income: Population and Per Capita Personal Income by Sub-area, State and County, Red River Basin Study Area, 1960--continued

| Sub-area by state and county | 1960 population | Per capita personal income | County income |
|---------------------------------|--------------------|----------------------------------|---------------------|
| | | dollars | thousand dollars |
| Sub-area 4 | | | |
| Arkansas: | | | |
| Columbia | 26,400 | 1,174 | 30,994 |
| Lafayette | 11,030 | 816 | 9,000 |
| Nevada | 10,700 | 841 | 8,999 |
| Louisiana: | | | |
| Avoyelles | 37,606 | 824 | 30,987 |
| Bienville | 16,726 | 1,016 | 16,994 |
| Bossier | 57,622 | 1,371 | 79,000 |
| Caddo | 223,859 | 1,693 | 378,993 |
| Catahoula | 11,421 | 788 | 9,000 |
| Claiborne | 19,407 | 1,082 | 20,998 |
| DeSoto | 24,248 | 866 | 20,999 |
| Evangeline | 31,639 | 759 | 24,014 |
| Grant | 13,330 | 900 | 11,997 |
| LaSalle | 13,011 | 1,153 | 15,002 |
| Lincoln | 28,535 | 1,156 | 32,986 |
| Natchitoches | 35,653 | 841 | 29,984 |
| Rapides | 111,351 | 1,176 | 130,949 |
| Red River | 9,978 | 802 | 8,002 |
| Sabine | 18,564 | 1,023 | 18,991 |
| St. Landry | 81,493 | 810 | 66,009 |
| Webster | 39,701 | 1,285 | 51,016 |
| Winn | 16,034 | 998 | 16,002 |
| Texas: | | | |
| Camp | 7,849 | 1,147 | 9,003 |
| Cass | 23,496 | 1,107 | 26,010 |
| Gregg | 69,436 | 1,685 | 117,000 |
| Harrison | 45,594 | 1,184 | 53,983 |
| Marion | 8,049 | 870 | 7,003 |
| Morris | 12,576 | 1,352 | 17,003 |
| Panola | 16,870 | 1,126 | 18,996 |
| Upshur | 19,793 | 1,212 | 23,989 |
| Total | 1,041,971 | 1,232 | 1,283,903 |

Note: The total PCPI for each sub-area is a weighted average based on population and PCPI by county

Exhibit 35 - Preliminary Allocation of Fishing Use to Proposed United States Department of Agriculture Reservoir Projects, Red River Basin Study Area, 1980 and 2020 1/

| State | : CNI : Watershed | : Normal Pool (Acres) | : M/D Fishing | |
|------------------|----------------------|--------------------------|----------------|----------------|
| | | | : 1980 | : 2020 |
| <u>1980</u> | | | | |
| <u>Arkansas</u> | 3j-4 | 60 | 700 | 900 |
| | 3-52 | 230 | 2,800 | 3,500 |
| | 3-56 | 80 | 1,000 | 1,200 |
| | 3-57 | 110 | 1,300 | 1,700 |
| | 3m-1-7 (3) | 194 | 2,300 | 2,900 |
| | 3m-1-7 (7) | 170 | 2,000 | 2,600 |
| | Sub-total | 844 | 10,100 | 12,800 |
| <u>Louisiana</u> | 3m-2-3 (1) | 1,050 | 15,800 | 21,000 |
| | 3m-2-3 (2) | 170 | 2,600 | 3,400 |
| | 3n-2 | 1,950 | 29,300 | 39,000 |
| | 3-65 (21) | 60 | 900 | 1,200 |
| | 3-65 (1) | 100 | 1,500 | 2,000 |
| | 3-65 (35) | 80 | 1,200 | 1,600 |
| | 3-66 | 80 | 1,200 | 1,600 |
| | 3-70 | 480 | 7,200 | 9,600 |
| | 3-68 & 10-17 | 1,030 | 15,500 | 20,600 |
| | Sub-total | 5,000 | 75,200 | 100,000 |
| <u>Oklahoma</u> | 3-23 | 235 | 1,200 | 1,600 |
| | 3-35 | 100 | 500 | 700 |
| | 3-41 | 100 | 500 | 700 |
| | 3i-4 | 345 | 1,700 | 2,400 |
| | Sub-total | 780 | 3,900 | 5,400 |
| <u>Texas</u> | 3-19 (35) | 250 | 4,300 | 4,500 |
| | 3-19 (38) | 52 | 900 | 1,000 |
| | 3-25a | 340 | 5,800 | 6,100 |
| | 3-29 | 24 | 400 | 500 |
| | 3k-14 | 306 | 5,200 | 5,500 |
| | Sub-total | 972 | 16,600 | 17,600 |
| Totals | | 7,596 | 105,800 | 135,800 |

Continued ---

Exhibit 35 - Preliminary Allocation of Fishing Use to Proposed United States Department of Agriculture Reservoir Projects, Red River Basin Study Area, 1980 and 2020 1/-- Continued

| State | : CNI : : Watershed : | Normal Pool : (Acres) : | M/D Fishing 2020 |
|-----------------|--------------------------|----------------------------|---------------------|
| <u>2020</u> | | | |
| <u>Arkansas</u> | 3-57 | 60 | 900 |
| <u>Texas</u> | 3k-11 | 187 | 3,200 |
| <hr/> | | | |
| Totals | | 247 | 4,100 |
| <hr/> | | | |

1/ Methodology developed by Bureau of Sport Fisheries and Wildlife. Based on fishing needs for impounded waters for the individual states. Plans proposed by other Federal and State agencies will offer competitive opportunities and change these gross allocations presented.

Exhibit 36 - Existing and Projected "Average Summer Sunday" Demand and Needs for Water-Orientated Recreation Facilities, with Needs Expressed in Facilities, Sub-area 4 1/, Red River Basin Study Area

| Supply and demand by time period | Boating | Swimming | Camping | Picnicking |
|-------------------------------------|--------------|-------------|--------------|---------------|
| | Act. Occ. | Act. Occ. | Act. Occ. | Act. Occ. |
| <u>1960</u> | | | | |
| Average Summer Sunday demand | 27,220 | 87,820 | 14,760 | 29,020 |
| Supply: | | | | |
| Public & private | 36,567 | 11,498 | 3,729 | 15,429 |
| SCS <u>2/</u> | - | - | - | - |
| Unsatisfied demands | +9,347 | 76,322 | 11,031 | 13,591 |
| Needs expressed in facilities | - | 127 acres | 2,206 units | 1,359 tables |
| <u>1980</u> | | | | |
| Average Summer Sunday demand | 60,700 | 195,840 | 32,930 | 64,710 |
| Supply: | | | | |
| Public & private <u>3/</u> | 36,567 | 17,864 | 6,930 | 23,292 |
| 1980 SCS | 2,777 | 17,340 | 1,608 | 13,055 |
| Unsatisfied demand | 21,356 | 160,636 | 24,392 | 28,363 |
| Needs expressed in facilities | 42,712 acres | 268 acres | 4,878 units | 2,836 tables |
| <u>2020</u> | | | | |
| Average Summer Sunday demand | 226,750 | 731,590 | 123,000 | 241,720 |
| Supply: | | | | |
| Public & private <u>3/</u> | 36,567 | 17,864 | 6,930 | 23,292 |
| 2020 SCS | 2,804 | 54,600 | 5,235 | 32,900 |
| Unsatisfied demand | 187,379 | 659,126 | 110,835 | 185,528 |
| Needs expressed in facilities | 374,758 | 1,099 acres | 22,167 units | 18,553 tables |

Continued ---

1/ Sub-area 4 includes the following counties: Columbia, Lafayette, and Nevada (Arkansas); Avoyelles, Bienville, Bossier, Caddo, Catahoula, Claiborne, DeSoto, Evangeline, Grant, LaSalle, Lincoln, Natchitoches, Rapides, Red River, Sabine, St. Landry, Webster, Winn, (Louisiana); and Camp, Cass, Harrison, Marion, Morris, Upshur, Panola, and Gregg (in Texas).

2/ No Soil Conservation Service projects prior to December 31, 1962 with recreation facilities.

3/ Projected data for 1980 and 2020 are an enlargement of existing facilities that were reported on December 31, 1962. (Table 66) These data do not include SCS facilities.

NOTE: Projected 1980 and 2020 public supply data are not available at this time. When proposed plans for project development are received by BOR, public supply will be delineated by Federal, State, and local agency, including SCS projects.

Exhibit 36 - Existing and Projected "Average Summer Sunday" demand and needs for Water-Orientated Recreation Facilities, with Needs Expressed in Facilities, Sub-area 3 ^{1/}, Red River Basin Study Area--Continued

| Supply and demand by time period | Boating | Swimming | Camping | Picnicking |
|-------------------------------------|---------------|-----------|-------------|--------------|
| | Act. Occ. | Act. Occ. | Act. Occ. | Act. Occ. |
| <u>1960</u> | | | | |
| Average Summer Sunday demand | 9,460 | 30,500 | 5,130 | 10,080 |
| Supply: | | | | |
| Public & private | 16,558 | 1,852 | 2,148 | 7,570 |
| SCS ^{2/} | - | - | - | - |
| Unsatisfied demand | +7,098 | 28,648 | 2,982 | 2,510 |
| Needs expressed in facilities | | 48 acres | 596 units | 251 tables |
| <u>1980</u> | | | | |
| Average Summer Sunday demand | 19,730 | 63,650 | 10,700 | 21,030 |
| Supply: | | | | |
| Public & private ^{3/} | 16,558 | 2,886 | 3,991 | 11,430 |
| 1980 SCS | 601 | 4,020 | 368 | 2,870 |
| Unsatisfied demand | 2,571 | 56,744 | 6,341 | 6,730 |
| Needs expressed in facilities | 5,142 acres | 95 acres | 1,268 units | 673 tables |
| <u>2020</u> | | | | |
| Average Summer Sunday demand | 83,230 | 268,540 | 45,150 | 88,730 |
| Supply: | | | | |
| Public & private ^{3/} | 16,558 | 2,886 | 3,991 | 11,430 |
| 2020 SCS | 695 | 14,760 | 1,470 | 8,190 |
| Unsatisfied demand | 65,977 | 250,894 | 39,689 | 69,110 |
| Needs expressed in facilities | 131,954 acres | 418 acres | 7,938 units | 6,911 tables |

Continued ---

^{1/} Sub-area 3 includes the following counties: Miller (Arkansas); Bowie, Delta, Fannin, Franklin, Grayson, Hopkins, Hunt, Lamar, Red River, Titus, and Wood (in Texas)

^{2/} No Soil Conservation Service projects prior to December 31, 1962 with recreation facilities.

^{3/} Projected data for 1980 and 2020 are an enlargement of existing facilities that were reported on December 31, 1962. (Table 66) These data do not include SCS facilities.

Exhibit 36 - Existing and Projected "Average Summer Sunday" Demand and Needs for Water-Orientated Recreation Facilities, with Needs Expressed in Facilities, Sub-area 2, 1/ Red River Basin Study Area --- Continued

| Supply and demand by time period | Boating | Swimming | Camping | Picnicking |
|-------------------------------------|-----------|-----------|-------------|------------|
| | Act. Occ. | Act. Occ. | Act. Occ. | Act. Occ. |
| 1960 | | | | |
| Average Summer Sunday demand | 2,560 | 8,280 | 1,390 | 2,730 |
| Supply: | | | | |
| Public & private | 4,818 | 1,199 | 2,431 | 7,468 |
| SCS 2/ | - | - | - | - |
| Unsatisfied demand | +2,258 | 7,081 | +1,041 | +4,738 |
| Needs expressed in facilities | - | 12 acres | - | - |
| 1980 | | | | |
| Average Summer Sunday demand | 5,280 | 17,040 | 2,860 | 5,630 |
| Supply: | | | | |
| Public & private 3/ | 4,818 | 1,863 | 4,528 | 11,274 |
| 1980 SCS | 302 | 3,000 | 180 | 1,440 |
| Unsatisfied demand | 160 | 12,177 | +1,848 | +7,084 |
| Needs expressed in facilities | 320 acres | 20 acres | - | - |
| 2020 | | | | |
| Average Summer Sunday demand | 21,360 | 68,910 | 11,580 | 22,770 |
| Supply: | | | | |
| Public & private 3/ | 4,818 | 1,863 | 4,528 | 11,274 |
| 2020 SCS | 302 | 6,600 | 660 | 3,500 |
| Unsatisfied demand | 16,240 | 60,447 | 6,392 | 7,996 |
| Needs expressed in facilities | 32,480 | 101 acres | 1,278 units | 800 tables |

Continued ---

1/ Sub-area 2 includes the following counties: Hempstead, Howard, Little River, Polk, and Sevier, in Arkansas; and Latimer, LeFlore, McCurtain, and Pushmataha in Oklahoma.

2/ No Soil Conservation Service projects prior to December 31, 1962 with recreation facilities

3/ Projected data for 1980 and 2020 are an enlargement of existing facilities that were reported on December 31, 1962. (Table 66) These data do not include SCS facilities.

Exhibit 36 - Existing and Projected "Average Summer Sunday" Demand and Needs for Water-Orientated Recreation Facilities, with Needs Expressed in Facilities, Sub-area 1 ^{1/}, Red River Basin Study Area - Continued

| Supply and demand by time period | Boating | Swimming | Camping | Picnicking |
|-------------------------------------|--------------|-----------|-------------|--------------|
| | Act. Occ. | Act. Occ. | Act. Occ. | Act. Occ. |
| <u>1960</u> | | | | |
| Average Summer Sunday demand | 3,690 | 11,900 | 2,000 | 3,930 |
| Supply: | | | | |
| Public & private | 6,907 | 1,233 | 1,756 | 3,595 |
| SCS ^{2/} | - | - | - | - |
| Unsatisfied demand | +3,217 | 10,667 | 244 | 335 |
| Needs expressed in facilities | - | 18 acres | 49 units | 34 tables |
| <u>1980</u> | | | | |
| Average Summer Sunday demand | 7,100 | 22,800 | 3,800 | 7,500 |
| Supply: | | | | |
| Public & private ^{3/} | 6,907 | 1,233 | 3,264 | 5,427 |
| 1980 SCS | 117 | 720 | 75 | 560 |
| Unsatisfied demand | 76 | 20,847 | 461 | 1,513 |
| Needs expressed in facilities | 152 acres | 35 acres | 92 units | 151 tables |
| <u>2020</u> | | | | |
| Average Summer Sunday demand | 24,400 | 78,700 | 13,200 | 26,000 |
| Supply: | | | | |
| Public & private ^{3/} | 6,907 | 1,233 | 3,264 | 5,427 |
| 2020 SCS | 117 | 2,400 | 270 | 1,400 |
| Unsatisfied demand | 17,376 | 75,067 | 9,666 | 19,173 |
| Needs expressed in facilities | 34,752 acres | 125 acres | 1,933 units | 1,917 tables |

^{1/} Sub-area 1 includes the following counties in Oklahoma: Atoka, Bryan, Choctaw, Coal, Hughes, Johnston, Murray, Pittsburg, and Pontotoc.

^{2/} No Soil Conservation Service projects prior to December 31, 1962 with recreation facilities

^{3/} Projected data for 1980 and 2020 are an enlargement of existing facilities that were reported on December 31, 1962. (Table 66) These data do not include SCS facilities.

Exhibit 37 - Projected Land Utilization to Satisfy Food and Fiber Requirements: Land in Farms, Major Agricultural Use with Crop Distribution, by Major Land Resource Area Groupings, With Project Development, Red River Basin Study Area, 1980

| Land Use | LRA 86 | LRA 131,134 | LRA 85, 112 | LRA 80, 84, 133 | LRA 119 | Study Area Total |
|--------------------------------------|---------|-------------|-------------|-----------------|---------|------------------|
| : - - - - - thousand acres - - - - - | | | | | | |
| Total cropland: | 1,174.5 | 892.4 | 271.7 | 1,367.8 | 56.4 | 3,762.8 |
| Cotton | 91.8 | 35.9 | 4.2 | 5.7 | - | 137.6 |
| Corn, silage | 1.8 | 4.6 | 0.1 | 5.2 | 0.4 | 12.1 |
| Corn, grain | 19.6 | 12.7 | 2.3 | 6.5 | Z | 41.1 |
| Oats | 30.6 | 3.5 | 2.9 | 1.4 | - | 38.4 |
| Barley | 36.3 | - | - | - | - | 36.3 |
| Sorghum, silage | 10.3 | 0.4 | 2.5 | 6.0 | 0.1 | 19.3 |
| Sorghum, grain | 71.4 | 4.2 | 20.2 | 21.5 | 0.1 | 117.4 |
| Wheat | 207.2 | 6.5 | 5.9 | 2.7 | - | 222.3 |
| Rice | - | 5.5 | - | - | - | 5.5 |
| Soybeans, forage | 6.7 | 38.0 | 0.2 | 1.5 | - | 46.4 |
| Soybeans, beans | 15.6 | 169.4 | 9.0 | 2.4 | - | 196.4 |
| Peanuts | 22.1 | Z | 24.8 | 9.2 | - | 56.1 |
| Sweet potatoes | Z | 31.6 | Z | 11.4 | - | 43.0 |
| Vegetables | 0.7 | 2.7 | 0.4 | 19.0 | - | 22.8 |
| Cowpeas | 0.4 | Z | 0.1 | 2.3 | - | 2.8 |
| Sugarcane/sugar | - | 1.0 | - | - | - | 1.0 |
| Field seed crops | | | | | | |
| (other) | 31.6 | 1.4 | 0.7 | 1.3 | - | 35.0 |
| Alfalfa | 38.6 | 15.2 | 21.1 | 9.9 | - | 84.8 |
| Other hay | 140.4 | 188.0 | 59.3 | 343.5 | 30.0 | 761.2 |
| Fruit, noncitrus | 1.2 | 5.0 | 1.3 | 3.8 | - | 11.3 |
| Other | 0.5 | 3.6 | 0.3 | 0.6 | 0.1 | 5.1 |
| Not harvested: | | | | | | |
| idle, fallow, etc. | 30.0 | 41.5 | 21.5 | 98.0 | 3.2 | 194.2 |
| Pastured | 417.7 | 321.7 | 94.9 | 815.9 | 22.5 | 1,672.7 |
| Pasture-range | 305.5 | 685.2 | 558.3 | 1,024.5 | 153.2 | 2,726.7 |
| Forest-woodlands | 201.9 | 815.0 | 200.0 | 6,096.6 | 2,481.4 | 9,794.9 |
| Grazed | 179.8 | 343.4 | 136.0 | 3,241.6 | 1,364.8 | 5,265.6 |
| Not grazed | 22.1 | 471.6 | 64.0 | 2,855.0 | 1,116.6 | 4,529.3 |
| Other land | 32.4 | 76.0 | 105.4 | 264.9 | 19.0 | 497.7 |
| Total land in farms | 1,714.3 | 2,468.6 | 1,135.4 | 8,753.8 | 2,710.0 | 16,782.1 |

Exhibit 38 - Municipal Water Supply Benefits - Potential Multiple-Purpose
Projects for Initial Development, Red River Basin Study Area

| Tributary Basin and CNI Watershed | Location | Water Supply Storage | Water Supply Benefits |
|---|-----------------------------------|----------------------------|-----------------------------|
| | | acre-feet | dollars |
| Intervening Area -Texas | | | |
| 3-19 | Sherman, Bells and Howe, Texas | 24,127 | 67,920 |
| 3-25a | Bonham, Texas | 10,400 | 19,400 |
| Total | | 34,527 | 87,320 |
| Blue River | | | |
| 3-23 | Durant, Oklahoma | 8,060 | 57,480 |
| Total | | 8,060 | 57,480 |
| Boggy Creek | | | |
| 3h2-4 | Atoka, Oklahoma | 2,000 | 6,750 |
| 3h2-6 | Allen, Oklahoma | 2,000 | 6,780 |
| Total | | 4,000 | 13,530 |
| Kiamichi River | | | |
| 3i-4 | Antlers, Oklahoma | 5,600 | 33,340 |
| Total | | 5,600 | 33,340 |
| Sulphur River | | | |
| 3k-11 | Deport, Texas | 354 | 5,000 |
| Total | | 354 | 5,000 |
| Loggy Bayou | | | |
| 3m1-7 | Magnolia, Arkansas | 20,300 | 101,600 |
| 3m2-3 | Bossier City, Louisiana | 4,350 | 35,200 |
| Total | | 24,650 | 136,800 |
| Cane River | | | |
| 3-64 | Provencal, Louisiana | 52,560 | 94,300 |
| Total | | 52,560 | 94,300 |
| Grand Total | | 129,751 | 427,770 |

Exhibit 39 - Water Quality Control Benefits - Potential-Multiple Purpose
 Projects for Initial Development, Red River Basin Study Area

| Tributary Basin and CNI Watershed | Pollution Source | Water Quality Control Storage | Water Quality Control Benefits |
|---|-----------------------------------|----------------------------------|-----------------------------------|
| | | acre-feet | dollars |
| Intervening Area - Texas 3-25a | Bonham, Texas | 5,750 | 13,500 |
| Blue River 3-23 | Durant, Okla. | 2,050 | 10,000 |
| Sulphur River 3k-18 | Commerce and Wolfe City, Texas | 700 | 6,900 |
| Loggy Bayou 3ml-7 | Magnolia, Ark. | 6,000 | 26,200 |
| Total | --- | 14,500 | 56,600 |

Exhibit 40 - Recreation Benefits - Potential Multiple-Purpose Projects
for Initial Development, Red River Basin Study Area

| Tributary Basin and CNI Watershed | Number of Multiple-purpose Structures | Estimated Days of Recreation Use | Recreation Benefits |
|---|---|-------------------------------------|------------------------|
| dollars | | | |
| Intervening Area - Texas | | | |
| 3-19 | 2 | 116,370 | 157,920 2/ |
| 3-25a | 1 | 47,400 | 71,100 |
| 3-29 | 1 | 7,400 | 7,400 |
| 3-33 | - | 7,000 | 3,470 2/ |
| Total | 4 | 178,170 | 239,890 |
| Intervening Area - Oklahoma - Arkansas | | | |
| 3-35 | 1 | 10,900 | 16,350 |
| 3-41 | 1 | 26,000 | 39,000 |
| 3-46 | - | 6,810 | 2,750 2/ |
| Total | 2 | 43,710 | 58,100 |
| Blue River | | | |
| 3-23 | 1 | 50,500 | 75,750 |
| Total | 1 | 50,500 | 75,750 |
| Boggy Creek | | | |
| 3h2-2 | 1 | 26,400 | 51,600 2/ |
| Total | 1 | 26,400 | 51,600 |
| Kiamichi River | | | |
| 3i-4 | 1 | 30,000 | 30,000 |
| 3i-8 | - | 5,000 | 4,140 2/ |
| Total | 1 | 35,000 | 34,140 |
| Little River | | | |
| 3j-4 | 1 | 30,500 | 45,750 |
| Total | 1 | 30,500 | 45,750 |
| McKinney Bayou | | | |
| 3-52 | 1 | 41,200 | 61,800 |
| Total | 1 | 41,200 | 61,800 |
| Sulphur River | | | |
| 3k-11 | 1 | 25,300 | 37,950 |
| 3k-14 | 1 | 22,300 | 33,450 |
| Total | 2 | 47,600 | 71,400 |
| Posten Bayou - (Arkansas) | | | |
| 3-57 | 1 | 24,000 | 36,000 |
| Total | 1 | 24,000 | 36,000 |

Exhibit 40 - Recreation Benefits - Potential Multiple-Purpose Projects
for Initial Development, Red River Basin Study Area--Continued

| Tributary Basin and CNI Watershed | Number of Multiple-Purpose Structures | Estimated Days of Recreation Use | Recreation Benefits ^{1/} |
|---|---|-------------------------------------|-----------------------------------|
| | | | dollars |
| Loggy Bayou | | | |
| 3m1-7 | 1 | 54,720 | 82,100 |
| 3m2-3 | 2 | 129,200 | 193,800 |
| Total | 3 | 183,920 | 275,900 |
| Bayou Pierre | | | |
| 3n-2 | 1 | 24,700 | 37,050 |
| Total | 1 | 24,700 | 37,050 |
| Cane River | | | |
| 3-65 | 3 | 59,000 | 88,500 |
| 3-66 | 1 | 19,700 | 29,500 |
| Total | 4 | 78,700 | 118,000 |
| Bayou Rigolette | | | |
| 3-70 | 1 | 26,000 | 39,000 |
| Total | 1 | 26,000 | 39,000 |
| Chatlin Lake and Associated Areas | | | |
| 10-15 | 2 | 95,500 | 92,250 |
| Total | 2 | 95,500 | 92,250 |
| Grand Total | 25 | 885,900 | 1,236,630 |

^{1/} Adjusted normalized prices, Water Resources Council, April 1966

^{2/} Includes incidental recreation claimed from sediment pools

Exhibit 41 - Benefits from Reservoir Sediment Reduction - Potential
 Multiple-Purpose Projects for Initial Development, Red River Basin Study
 Area

| Tributary : | Reduction : | | Average Annual Benefits | |
|---------------------------------|--------------|----------------------|-------------------------|------------|
| Basin and : | in Annual : | | | |
| CNI : | Sediment : | Reservoir Affected : | Land : | |
| Watershed : | Deposition : | | Treatment : | Structures |
| | acre-feet | | - - dollars | - - - |
| Intervening Area - Texas | | | | |
| 3-25 | 12 | Lake Davy Crockett | 30 | 570 |
| | | Coffee Mill Lake | | |
| 3-33 | 20 | Lake Crook | 320 | 780 |
| Total | 32 | | 350 | 1,350 |
| Boggy Creek | | | | |
| 3h1-2 | 133 | Boswell Reservoir | 510 | 5,620 |
| 3h1-3 | 15 | Boswell Reservoir | 50 | 740 |
| Total | 148 | | 560 | 6,360 |
| Little River | | | | |
| 3j-4 | 24 | Millwood Reservoir | 370 | 230 |
| Total | 24 | | 370 | 230 |
| Sulphur River | | | | |
| 3k-17 | 138 | Cooper Reservoir | 1,200 | 870 |
| Total | 138 | | 1,200 | 870 |
| Bayou Rigolette | | | | |
| 3-70 | 28 | Lake Iatt | 150 | 1,230 |
| Total | 28 | | 150 | 1,230 |
| <hr/> | | | | |
| Grand Total | 370 | --- | 2,630 | 10,040 |
| <hr/> | | | | |

Exhibit 42 - 7/1/66 - 1980 Development, Recreational Facilities on
National Forest System Lands on Base 1/ Area, Red River Basin Study Area

| Use | : | Unit | : | Number | : | Acres |
|--------------------|---|-------------|---|--------|---|-----------------|
| Camping | | Family Unit | | 673 | | 278 |
| Picnicking | | Family Unit | | 425 | | 149 |
| Vistas <u>2/</u> | | Stop | | 12 | | 12 |
| Swimming <u>3/</u> | | Area | | 9 | | 26 |
| Boating <u>4/</u> | | Area | | 6 | | 589 |
| Total Development | | | | 1,125 | | 1,054 <u>5/</u> |

1/ Includes whole counties touched by physical basin

2/ Includes parking and viewing area and sanitary facilities

3/ Includes beach area with bathhouse, sanitary facilities and suitable adjacent water

4/ Includes dock or ramp facilities, sanitary facilities, and available water area

5/ Water area keyed to this recreational development (with some hunting and fishing): 2,570 acres

Exhibit 43 - Recreation Benefits - Additional Potential Developments for
Recreation to Meet 1980 Needs, Red River Basin Study Area

| Tributary Basin and CNI Watershed | : | Number of Structures | : | Estimated Days of Recreation Use | : | Recreation Benefits <u>1/</u> |
|---|---|----------------------------|---|--|---|----------------------------------|
| | | | | | | dollars |
| Boggy Creek | | | | | | |
| 3h1-2 | | 1 | | 79,200 | | 118,800 |
| Total | | 1 | | 79,200 | | 118,800 |
| McKinney Bayou | | | | | | |
| 3-52 | | 1 | | 121,000 | | 181,500 |
| Total | | 1 | | 121,000 | | 181,500 |
| Bayou Pierre | | | | | | |
| 3n-5 | | 2 | | 448,800 | | 673,200 |
| Total | | 2 | | 448,800 | | 673,200 |
| Grand Total | | 4 | | 649,000 | | 973,500 |

1/ Adjusted normalized prices, Water Resources Council, April 1966