LOWER COLORADO REGION
Comprehensive Framework Study

APPENDIX VI
LAND RESOURCES AND USE
APPENDIX VIII
WATERSHED MANAGEMENT
JUNE 1971

PREPARED BY:

LOWER COLORADO REGION STATE – FEDERAL
INTERAGENCY GROUP FOR THE
PACIFIC SOUTHWEST INTERAGENCY COMMITTEE

APPENDIXES TO THE MAIN REPORT

LOWER COLORADO REGION

LOWER COLORADO REGION

COMPREHENSIVE FRAMEWORK STUDY

APPENDIX VI LAND RESOURCES AND USE

APPENDIX VIII WATERSHED MANAGEMENT

This report of the Lower Colorado Region Framework Study State-Federal Interagency Group was prepared at field-level and presents a framework program for the development and management of the water and related land resources of the Lower Colorado Region. This report is subject to review by the interested federal agencies at the departmental level, by the Governors of the affected States and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

June 1971

"The argument is increasingly heard that a fundamental contradiction has arisen between economic growth and the quality of life, so that to have one, we must forsake the other.

"The answer is not to abandon growth but to redirect it."

Richard M. Nixon

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SUMMARY

SUMMARY

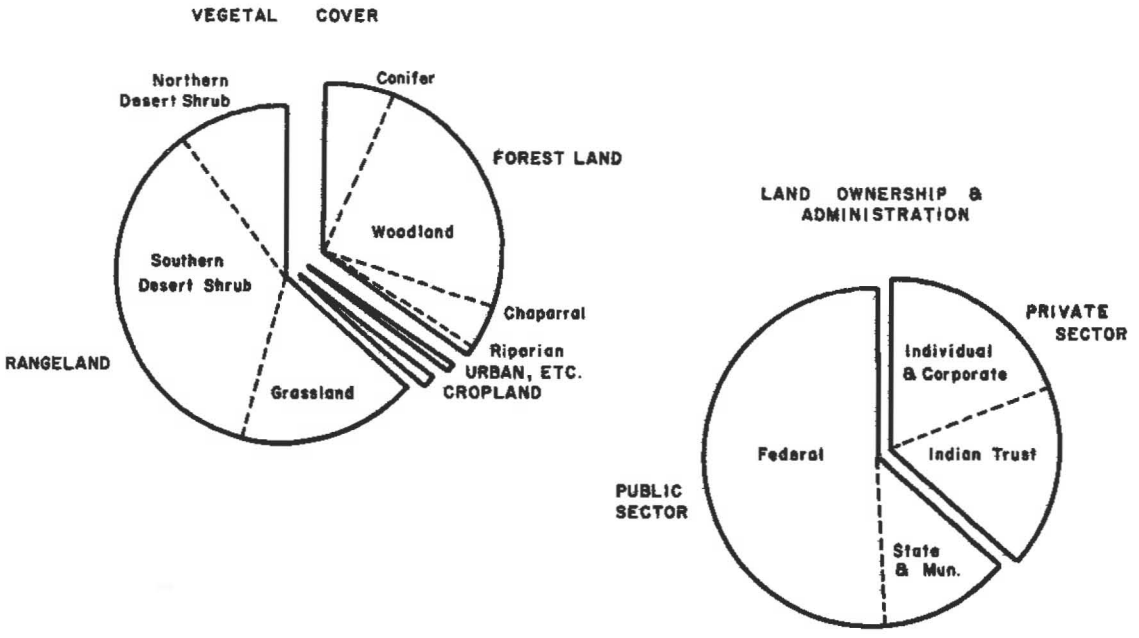
The basic purposes of the Land Resources and Use and Watershed Management appendixes are to express the interrelationships of land and water and to provide, for the years 1980, 2000, and 2020, a broad guide to the wise use, treatment, and management of land resources in the Lower Colorado Region to maintain and improve the productivity and environmental stability of the land base. The information presented in this appendix should provide most of the land-oriented data required for the other appendixes and for the Main Report.

The Lower Colorado Region, as defined for purposes of this water and related land resource study, occupies 90,328,000 acres (141,137 square miles) in the Pacific Southwest area of the United States. The 1965 population of the Region was 1,847,300 (hydrologic area).

Elevations within the Region range from slightly under 100 feet above sea level near Yuma, Arizona to over 12,500 feet on Humphreys Peak near Flagstaff, Arizona. Although aspect, latitude, prevailing winds, and storm patterns directly influence temperature and precipitation, the range in elevation is the major influence. A combination of these factors present variable management problems related to the associated activity, vegetation, erosion, water yield, etc.

The Lower Colorado Region has a wide variation in vegetal cover types. The forest types extend from the small alpine areas on top of the highest mountain peaks; through the coniferous forest zones of spruce-fir, Ponderosa pine, and the pinon-juniper and oak woodlands, and the chaparral types. The rangeland type extends from the forest type through the northern and southern desert shrubs, the northern and desert grasslands, down through a small area of true desert near the mouth of the Colorado River on the boundary between Mexico and Arizona. Scattered throughout the Region are areas of cultivated land, including irrigated pasture, with the largest blocks in the lower Gila and the southern half of the Lower Main Stem subregions. More than 500,000 acres of the Region are developed as urban and industrial areas. More than 340,000 acres of the Region are occupied by water in the form of streams, lakes, impoundments, and reservoirs.

About 52 percent of the total land is federally owned, 12 percent is in state and other public ownership, and 36 percent is private land. About one-half of the latter is in Indian reservations held in trust by the federal government.



In 1965, about 2 percent of the Region was in cropland, 64 percent pasture and range, 33 percent forest and woodland, and less than 1 percent in urban, transportation, utilities, etc. More than 76 million acres were grazed by domestic livestock on rangeland, forest land, and cropland. Commercial timber was produced on about 5.5 million acres. About 5.5 million acres within the Region were designated for outdoor recreation, almost 3 million acres being in the national parks and monuments. More than 0.8 million acres were in designated wilderness areas and 1.9 million acres were managed primarily for fish and wildlife. An estimated 75,000 acres are utilized for production of mineral resources. More than 4.1 million acres were within military reservations.

Most land is suitable for more than one use. The general characteristics of the land - topography, soil, elevation, native vegetation, climate, etc. - determines the suitability of the land to support kinds and combinations of uses. An inventory and analysis of land suitability and availability reveals that, while there are sufficient suitable lands available for land use considered in the study, there will need to be widespread adoption of the multiple-use principle in order that the projected requirements for all uses may be fulfilled. A summary comparison of land suitability and availability with requirements projected to the year 2020 follows:

Land Use	Use in 1965 [1]	Suitable & Available 1965	Projected Requirements 2020 [1]
	--------- 1,000 acres ----------		
Cultivation (irrigated)	1,785	16,620	1,833
Cultivation (nonirrigated)	31	188	19
Livestock Grazing	76,054	76,054	65,807
Timber Production	5,458	5,458	5,044
Urban and Industrial	513	N/A [2]	1,564
Outdoor Recreation [3]	5,542	N/A	6,146
Wilderness	861	3,458	3,458
Military	4,126	N/A	N/A
Mineral Production	75	N/A	223
Fish and Wildlife [4]	1,858	1,858	15,020
Water Yield Improvement	114	3,685	1,414
Transportation & Utilities	660	N/A	1,145
Flood Control [5]	77	N/A	336

1/ Compatible uses are not excluded.

2/ N/A signifies not applicable.

3/ Designated outdoor recreation areas.

4/ Designated lands available for hunter use but not excluding other compatible uses.

5/ Area required for impoundments and structural works.

Watershed management is the analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of man. This process is complicated in the Region because of the complex land ownership and administration pattern. Major problems involved in the protection and management of the Region's watershed lands include erosion, inadequate water yield, upstream floodwater and sediment damage, degrading water quality, wildfire damage, water supply deficiency, and those environmental quality problems directly related to land use and management of land resources.

Watershed protection problems and needs are projected on the basis of expected development and growth with no additional protection or improvement measures installed after 1965. Average annual upstream floodwater and sediment, erosion, and wildfire damages are $28.9 million, $6.7 million, and $5.7 million, respectively, based on 1965 conditions; a total damage of $41.3 million. These damages are projected to increase to about $272.0 million by 2020.

Over the past several years, significant advances have been made in watershed management practices and techniques by landowners and public land managers. The goal has been to minimize the effects of changes in the ecological balance that man's first activities had disrupted, and to modify it to create greater benefits for man.

Although most land has had some treatment, there is no accurate method for determining what portion of the total area had received adequate land treatment and management by 1965. On an equivalent acre basis, using present standards, sufficient measures had been installed to adequately treat about 37 percent of the irrigated cropland in the Region. While most public forest and range lands utilized by domestic livestock are under some form of improved livestock management, only 15 percent of these lands benefit from completed management programs. Less than 10 percent of the commercial timberland in the Region has been developed and is being managed for the maximum production of timber products. An estimated 25 percent of the measures and treatment needed for the efficient development and management of urban and other lands have been provided for based upon the 1965 needs of the people. In nearly all cases, the measures and practices meeting the standards in 1965 are expected to be inadequate in the near future because of improved technology and a limited useful life. All will require maintenance and rehabilitation.

Cooperative type projects constructed by 1965 include 17 upstream flood prevention projects and one agricultural water management project. Between 1965 and 1970, four additional upstream flood prevention projects were completed.

The suggested program was divided into two categories; Land Treatment and Management and Upstream Flood Prevention. In formulation of the land treatment and management part of the program a distinction was made between that portion which is "water related" and that portion which is "associated." The water related portion is that which has significant effects on the water resource. The associated portion is primarily production oriented. The upstream flood prevention program was considered totally water related.

Land Treatment and Management

The land treatment and management program includes water related practices and measures which improve the quantity, quality, and timing of runoff; reduce erosion and sediment production; and improve the efficiency of irrigation water use. The associated practices and measures are needed to meet the requirements for production of food and fiber.

The suggested program represents a composite level program which reconciles environmental protection, and production objectives. It is necessary to satisfy the projected requirements and insure the improvement of production of all resources and uses from water and related land on a sustained yield basis.

As the plan was formulated esthetic values and environmental factors were of primary consideration. Ideally the land treatment and management program should harmonize with all water and related resource development programs required to satisfy present and projected demands within the Region.

Total cost of the suggested program by time frame is presented in the following tabulation:

Suggested Land Treatment and Management Program
Regional Summary ($ million)

Costs	1966-1980	1981-2000	2001-2020
Installation			
Water Related	236.4	426.2	281.8
Associated	43.3	99.1	47.7
Total	279.7	525.3	329.5
OM&R			
Water Related	23.8	57.6	70.7
Associated	5.2	9.5	13.3
Total	29.0	67.1	84.0

Note: Installation costs are total for the time frame; OM&R costs represent the annual cost in the last year of the time frame.

Of the total installation cost, about 20 percent would be on cropland, 22 percent on rangeland, 56 percent on forest land, and 2 percent on urban and other land. About 68 percent of this cost would be federal expenditures and the other 32 percent would be nonfederal.

In comparing the annual rate of expenditure for installation cost of the suggested program with the annual rate of expenditure for the going program (average for the 1965-70 period): The suggested program rate would be 2.3 times the going program rate for the 1966-1980 time frame; 3.1 times for the 1981-2000 time frame; and 2.0 times for the 2001-2020 time frame.

On an equivalent basis, a total of 19.7 million acres would be adequately treated during the 1966-1980 time frame; 27.3 million acres during 1981-2000; and 17.1 million acres during 2001-2020.

Implementation of the suggested program would minimize irreversible losses of the land resources and preserve the freedom of choice for future resource users. A carefully designed and widely applied program will enhance rural development opportunities by providing protection of the land resource base, more efficient production and water use, increased recreation opportunities, improved fish and wildlife habitat, increased and stabilized patterns of streamflow, and reduction of sediment yield. It may also help to relieve population pressures on cities thereby promoting a more healthful urban environment.

Upstream Flood Prevention

The upstream flood prevention portion of the program is considered water related. This portion includes those larger structural measures required to reduce flood damages occurring within watersheds with drainage areas of 250,000 acres or less. In development of the structural program consideration was given to the degree of flood damage prevention which could be accomplished through use of non-structural measures. Considered were such measures as zoning, open space regulation, tax adjustments, flood forecasting, and building codes. Utilization of the nonstructural program is a major requirement in future community planning. Needed land treatment practices and measures are included in the program for flood control; these are described in the "Land Treatment and Management" section.

The principal function of upstream corrective measures is to control floodwaters so that the risk of flood damage for any portion of the upstream flood plain is compatible with the use. Environmental quality was one of the primary considerations in the formulation of the upstream flood control program. The program must be fully coordinated with other existing and planned water and related land resource development within the Region to insure that maximum multiple use is made of

water impoundments and other features for fish and wildlife, for outdoor recreation, and other beneficial uses.

In the suggested program are 163 projects which include 230 impoundments, 730 miles of channel improvement, and 153 miles of levees. About 11,500 square miles of drainage area would be controlled.

Total cost of the program by time frame is summarized for the Region in the following tabulation. About 91 percent of the total installation cost is federal.

Costs of the Suggested Upstream Structural Measures for Flood Prevention

Costs Measures	1966-1980	1981-2000	2001-2020
Installation Cost ($1,000)			
Levees and Channels	54,351	103,690	46,849
Flood Control Reservoirs	98,337	57,666	31,890
Total	152,688	161,356	78,739
Annual OM&R Costs ($1,000)			
Levees and Channels	151	249	188
Flood Control Reservoirs	445	269	190
Total	596	518	378

The program would be effective in reduction of upstream floodwater and sediment damages. Average annual damages would be reduced from about $228 million (without the program) in 2020 to about $55 million with the suggested program. A high intensity use area of about 1.7 million acres would be provided protection. There would also be opportunities for multiple use of the structural sites.

LOWER COLORADO REGION COMPREHENSIVE FRAMEWORK STUDY

APPENDIX VI - LAND RESOURCES AND USE
APPENDIX VIII - WATERSHED MANAGEMENT

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Photo Credit Abbreviations

BIA - Bureau of Indian Affairs
BLM - Bureau of Land Management
BSF&W - Bureau of Sport Fisheries and Wildlife
CE - U. S. Corps of Engineers
Double V - Double V Photo, Wickenburg, Arizona
FS - Forest Service
MCES - Maricopa County Extension Service
NPS - National Park Service
SRP - Salt River Project
SCS - Soil Conservation Service

INTRODUCTION

CHAPTER A - INTRODUCTION

Twentieth century man finds his landscape essentially formed, and the evidences of either good or poor management upon the face of the nonurban lands. It is on or from this portion of the environment that we draw the food, fiber, water, and enjoyment for a demanding civilization. The land and its resources are available, and technology is within our grasp with which to improve them or destroy them. The "good earth," as viewed so spectacularly from space, awaits our judgment and our acts of stewardship regarding the various resources of the land.

The shape of the earth's surface to a large degree has been carved by water in its journey from the atmosphere to the sea. As the principal geomorphic agent, water transports soil, rock, and organic matter from one place to another. In this process, nature seeks a balance of forces at work. Vegetation produced by moisture and the earth's minerals provides a protective cover that moderates geologic erosion and helps to maintain water quality. At the same time, soil is produced which is a reservoir of minerals and organic materials that man draws upon to feed, clothe, and supply a hungry and demanding civilization. But in the process, man also alters nature's dynamic equilibrium, land and resources are sometimes damaged and restoration measures become necessary.

Land treatment and management programs are needed not only to protect and enhance land resources such as soil, vegetation, and wildlife and to improve the living environment, but also to insure the optimum combination of water quantity and water quality at a given location. Most conservation practices enhance the quality of water while also ameliorating the quality of related land resources. Use and development of the land may damage or destroy the archeological resource base which is the sole source of information on the history of the American Indian prior to the seventeenth century A.D.

Conflicts are inevitable in the competition for land and water resources. The growing demands for these resources raise important policy issues: Natural resources based production and conservation on one hand versus the rapidly increasing demands for space for urban development on the other. An effective land and water resources development program should minimize conflict between the various preservation, conservation, land use, and development policies. The principle of multiple use and sustained yield management of land and water resources provides for the coordination of these resources and activities on a given area so they will best meet the needs of the American people without impairment of the production of the land. Land management agencies and many private landowners have adopted the

multiple-use concept of land management. Land used for production of timber, livestock forage, and/or crops also provides the base to meet the demands for recreation, wildlife, high quality water, and pleasant surroundings. Open space land in metropolitan areas can also be used for multiple-purpose management programs.

PURPOSE AND SCOPE

The basic purposes of the Land Resources and Use and Watershed Management appendixes are to express the interrelationships of land and water and to provide, for the years 1980, 2000, and 2020, a broad guide to the wise use, treatment and management of land resources in the Lower Colorado Region to maintain and improve the productivity and environmental stability of the land base.

Three basic considerations are involved in achieving the purposes of the appendixes. They are (a) the timely development and management of the land and water resources as essential aids to the economic development and growth of the Region, (b) the protection of land resources to insure their availability for best use as needed, and (c) the well-being of all the people as the overriding determinant in the planning process.

The guidelines set forth by the Water Resources Council 1/ determined the scope and intensity of this study.

Major items of scope are as follows:

1. These appendixes are based on reconnaissance type investigations and provide an inventory of land resource data; a broad-scale analysis of land resource problems; and furnish general appraisals of the probable nature, extent and timing of measures for their solution, for use in the formulation of framework plans.

2. These appendixes are concerned with land resources, the uses and suitability of these resources as well as their availability, treatment and management.

3. These appendixes considered all areas within the Region, and all purposes served by the conservation, development, and use of the land resources.

1/ "Guidelines for Framework Studies," October 1967, Water Resources Council.

4. The appendixes used available data, reasoned approximations, and judgment of experienced planners.

5. Alternative programs and an indication of their accomplishments by time frame were studied in order to appraise the effects of various intensities of implementation. Using the "with and without" approach the following alternatives were studied:

   a. No Program - no funding after 1965.

   b. Going Program - continuation of the 1965 level of funding.

   c. Suggested Program - sufficient funding to most nearly satisfy the projected multiple objections.

6. Regional and subregional economic projections were used as a base for formulating the programs (see Chapter K). The needs for food, fiber, water, and related goods and services relevant to land resource development are expressed in terms of product output and translated to acres of land.

7. The programs recognize the capacity of the land base to provide for multiple uses and yield a variety of outputs, including water, in determining the extent to which the needs or demands can be met.

8. The programs are based upon the suitability and availability of the land resource to provide effectively for anticipated uses.

9. Cost estimates are provided for broad components of the suggested programs, based on constant 1965 prices.

10. These appendixes appraise the urgency of land resource problems and watershed management needs and the opportunities available for solving or fulfilling them through existing authorities. They identify remaining problems and needs and suggest approaches for their solution. In addition, they suggest more detailed studies in the near future leading to the authorization of action programs to meet desired objectives.

The early drafts of the Land Resources and Use and the Watershed Management appendixes were prepared as separate reports. However, due to the amount of duplication of maps, tables, and narrative, the apparent overlapping of program elements relating to land use and watershed management and the additional publication costs, the later

drafts of the Land Resources and Use and the Watershed Management appendixes were assembled in one volume. This treatment molds them into one appendix.

RELATION TO OTHER PARTS OF THE REPORT

The data gathered for the preparation of this appendix should provide most of the land oriented information required for the other appendixes and for the Main Report. In addition, data pertaining to land resources, or the use of these resources, which are compiled for the preparation of other appendixes, are summarized in this appendix. Examples of the latter are outdoor recreational use of land (summarized from the Recreation Appendix), fish and wildlife habitat (Fish and Wildlife Appendix), and irrigated crop production (Irrigation and Drainage Appendix). The authors intended that the readers of this appendix should be referred to other appropriate appendixes for further details on these subjects.

Details on the development of projections of economic activity, which provided the basis for program formulation, are described in the Economic Base and Projections Appendix although comparisons of alternate projections as related to land are described in Chapter K of this report. Economic values associated with the various products of the land may also be found in the economic Base and Projections Appendix, although relative crop yields and carrying capacities of rangeland and the like are frequently alluded to in this appendix as indicators of land productivity and potential.

Irrigation Soil Classes are described and summarized in this appendix for the purpose of indicating the extent of the Region suitable for development of irrigated cropland. However, for Irrigation Land Classes and details on development and management of land and water for irrigated crop production the reader is referred to the Irrigation and Drainage Appendix.

Although all pertinent data on water resources are summarized in the Water Resources Appendix, the effect watershed management has on the quality and quantity of water is discussed in this report.

The Water Quality Appendix contains data on present and future quality of water and its effects or possible effects on future production, people, etc. This report relates the watershed management role in reducing erosion, sediment (the largest single pollutant of water) and dissolved solids.

The complete (upstream and downstream) floodwater and sediment situation is described in the Flood Control Appendix. That portion of

the floodwater and sediment damages and the alternatives to reduce those damages, attributable to upstream watersheds (drainage areas of 250,000 acres or less), are presented in this report as part of the total watershed management program.

This report describes the overall management of land resources in the Region, but does not describe in detail all land management activities.

CHARACTERISTICS OF THE REGION

The Lower Colorado Region, as defined for purposes of this water resource study, occupies 141,137 square miles in the Pacific Southwest area of the United States. Of this total area, 532 square miles is water (permanent inland water bodies having 40 acres or more of surface area and streams, sloughs, estuaries and canals 1/8 of a statute mile or more in width).

The Region is bounded on the east by the Continental Divide in New Mexico and on the west by California and approximately the 115° 30' line of longitude in Nevada. The northern boundary extends from northeast of Ely, Nevada, southeasterly along the northern boundary of Muddy River drainage, east on the northern boundary of Virgin River and Kanab Creek drainages in Utah, southeast to Lee Ferry, Arizona, east-southeast on the northern boundary of Little Colorado River drainage. The southern boundary is Mexico, although some drainage flows into Mexico while others originate in Mexico and flow into the Lower Colorado Region. Examples are Whitewater Draw and the Santa Cruz River respectively. The Region includes the Colorado River drainage in the United States below Lee Ferry, Arizona, except that occurring in California. In addition, it includes several closed basins in Arizona, Nevada, and New Mexico. The Region encompasses most of Arizona and significant areas of Nevada, New Mexico, and Utah. See Map 1.

For purposes of this study the Lower Colorado Region was divided into three subregions: Lower Main Stem, Little Colorado, and Gila. Table 1 gives the total area (land and water) of these hydrologic subregions.

The 1965 hydrologic area population of the Region was 1,847,300. Of the total population, the Lower Main Stem Subregion had 312,800, Little Colorado Subregion 151,300, and the Gila Subregion 1,383,200. About 45 percent of the total population was concentrated in the three major cities of Las Vegas, Nevada and Phoenix and Tucson, Arizona. In 1960 nearly 74 percent of the population was classified as urban and 26 percent as rural.

The following tabulation shows the 1965 population and the projected population for 2020. More detailed population information for the economic area of the Region may be found in Appendix IV, Economic Base and Projections.

Lower Colorado Region
Population
(1,000)

Hydrologic Area	1965		Projected 2020	
	Population	% of Total	Population	% of Total
Lower Main Stem	312.8	16.9	1,874.7	27.3
Little Colorado	151.3	8.2	389.4	5.7
Gila	1,383.2	74.9	4,612.7	67.0
Lower Colorado Region	1,847.3	100.0	6,876.8	100.0

Source: Modification of the OBE-ERS Projections by States in the Region.

LEGEND

Region Boundary
Subregion Boundary
State Boundary
County Boundary

LOCATION MAP

GREAT BASIN REGION

UPPER COLORADO REGION

LOWER MAIN STEM GILA

CALIFORNIA REGION

LITTLE COLORADO

RIO GRANDE REGION

NYE
LINCOLN
WHITE PINE
IRON
WASHINGTON
KANE
CLARK
MOHAVE
COCONINO
YAVAPAI
YUMA
MARICOPA
PINAL
GILA
GRAHAM
GREENLEE
NAVAJO
APACHE
McKINLEY
SANTA CRUZ
PIMA
COCHISE
GRANT
HIDALGO
CATRON
VALENCIA

ELY
PIOCHE
ST. GEORGE
KANAB
LAS VEGAS
KINGMAN
FLAGSTAFF
HOLBROOK
GALLUP
PRESCOTT
ST. JOHNS
PHOENIX
GLOBE
FLORENCE
SAFFORD
CLIFTON
SILVER CITY
LORDSBURG
TUCSON
BISBEE
NOGALES
YUMA

UTAH
ARIZONA
COLORADO
NEVADA
CALIFORNIA
NEW MEXICO
MEXICO

Lake Powell
Lee Ferry
Lake Mead
Lake Mohave
Lake Havasu
Lake Pleasant
Horseshoe Reservoir
Bartlett Reservoir
Roosevelt Lake
Apache Lake
Canyon Lake
San Carlos Lake
Imperial Reservoir
Painted Rock Reservoir
Alamo Reservoir
Willcox Playa

MAP 1

COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
ARIZONA, NEVADA,
NEW MEXICO & UTAH

16 0 16 32 MILES
SCALE 1: 3,168,000
ALBERS EQUAL-AREA PROJECTION

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Table 1 - Total Area by State and Subregion
Lower Colorado Region, 1965

Subregion No.	Name	Unit	Arizona	Nevada	New Mexico	Utah	Total
1	Lower Main Stem	Acres	22,882,000	11,078,000	--	2,234,000	36,194,000
		Sq. Miles	35,754	17,310	--	3,490	56,554
2	Little Colorado	Acres	13,867,000	--	3,398,000	--	17,265,000
		Sq. Miles	21,667	--	5,310	--	26,977
3	Gila	Acres	31,719,000	--	5,149,000	--	36,868,000
		Sq. Miles	49,561	--	8,045	--	57,606
	TOTAL	Acres	68,468,000	11,078,000	8,547,000	2,234,000	90,327,000 1/
		Sq. Miles	106,982	17,310	13,355	3,490	141,137

1/ Due to rounding this figure may appear elsewhere in this appendix as 90,328,000

Employment within the Lower Colorado Region totaled 675,700 in 1965. Employment by sectors for 1965 and projections for 2020 are given in the following tabulation. Additional employment information may be found in the Economic Base and Projections Appendix.

Lower Colorado Region
Employment
(1,000)

Sector	Estimated 1965		Projected 2020	
	Employment	% of Total	Employment	% of Total
Agriculture 1/	39.20	5.7	43.16	1.5
Forestry 2/	.91	0.1	.78	-
Mining	17.90	2.6	17.05	0.6
Manufacturing	90.87	14.5	477.95	16.9
Trade	125.90	18.4	503.26	17.8
Services	178.20	26.1	1,043.58	36.9
Transportation	21.50	3.1	66.02	2.3
Contract Construction	56.60	8.3	183.53	6.5
Rentals	32.10	4.7	156.83	5.5
Utilities	20.40	3.0	82.74	2.9
Other 3/	92.12	13.5	258.60	9.1
Total	675.70	100.0	2,833.50	100.0

1/ Includes agricultural service businesses.

2/ Includes only private sector employment in commercial timberland management and harvesting.

3/ Government, professional services, domestic, and miscellaneous employment.

HISTORY OF LAND USE

CHAPTER B - HISTORY OF LAND USE

Man has occupied and used the land in the Lower Colorado Region for many centuries. About 6,000 B.C. a desert culture of Archaic Stage emerged. Artifacts of this period indicate that Man had adapted to an intensive use of a wide variety of plant and animal species as the subsistence base in the harsh desert and semi-arid uplands. It is during the later periods of the Archaic Stage that the people of the desert culture began to specialize into regionally identifiable groupings out of which the Hohokam, Mogollon, Anasazi and Patayan prehistoric cultures emerged. These cultures are ancestral to several surviving historic and modern American Indian peoples. It is estimated that before 300 B.C. some Indian tribes settled in permanent locations along the Gila and Salt rivers and tributaries, and in the area north of the Little Colorado River in the Little Colorado Subregion.

Anasazi-culture Indians were the first settlers in southern Nevada, living along the river bottoms of the Muddy, the Virgin, and the other perennial streams of the area, particularly in the vicinity of the Virgin River and Beaver Dam Wash and along the lower Virgin River Valley. These Indian settlement sites, probably belonging to the Virgin Branch of Southwestern Anasazi culture, may date back to 500 A.D. However, by A.D. 1150, the Indians had largely abandoned their settlements. Evidence at these sites indicates that these early Indians probably developed a primitive system of agriculture and utilization of streamflow. Both the earlier and latter-day Indian settlements were influenced by the availability of fair-to-good-quality domestic and irrigation water.

The Hohokam Indians began farming the desert valleys of the Salt and Gila rivers about 300 B.C., by diverting water into more than 125 miles of canals. They were able to cultivate and harvest squash, corn, beans and cotton. In the middle 1300's it is estimated that no fewer than 15,000 people inhabited these valleys. At the height of their culture these Indians were irrigating about 250,000 acres.

The Hohokam mysteriously vanished about 1400 A.D. leaving behind the shadowy tracings of their irrigation system etched on the desert floor as a pattern for modern man to follow when he developed a far more elaborate plan to irrigate the desert valleys. The Spanish explorers found the ancestors of the Pima and Maricopa Indians irrigating crops from the Gila and Salt rivers, but to a much lesser extent than the Hohokam.

The Hopi, Zuni and other Indian tribes developed pueblo communities on the mesas of northern Arizona and New Mexico. They raised corn, pumpkins, and beans in areas surrounding these mesa communities, mostly

without the help of irrigation. Unlike the Hohokam to the south, these pueblo Indians to the north continue to inhabit their mesa homes and farm the surrounding areas much as they did before the coming of the white man.

The first beef animals were introduced into Mexico from Spain in 1521 by Villalobos. In 1539 and 1540 the Spaniards introduced the first horses, sheep, and cattle into what is now Arizona in the Lower Colorado Region. The Spanish missions became the livestock and farming centers in the mid 1700's. However, the livestock population in the Region did not increase to any extent before the 1860's because of marauding Indians and outlaws.

The first whites to enter the Colorado River portions of the State of Nevada were Spanish explorers and traders. The first American explorations of southern Nevada were made by Jedediah Smith in 1826, enroute from Great Salt Lake to southern California. Smith at that time noted the muddy and brackish nature of the Virgin's waters, and commented on the agricultural practices of the Indians he saw there. They were raising corn and pumpkins, which would imply at least a basic system of irrigation for the growth of such crops.

In the early 1800's and until the outbreak of the Civil War, miners and mine owners had small herds of cattle and sheep, and where climatic conditions were favorable farming operations were carried on around the mining communities. During the Civil War the protection of the troops was withdrawn and by 1865 there was very little farming or livestock raising in what is now the Lower Colorado Region.

The early settlement and development of southern Nevada is largely the history of the Mormon colonies called by the Mormon Church during the period 1855-1880. The first of several of these Mormon settlements to be established was around the springs and meadows of the Las Vegas Valley in June 1855. Life was grim and hard in all these settlements; flooding, destructive rivers and streams periodically tore out and wrecked all the laboriously laid out ditches and fields. Indians stole and destroyed, there were clouds of mosquitos from spring until fall, the climate was dry and scorchingly hot, the desert winds blew constantly, and the colonies were far from markets and sources of supply.

The remains of the Indians' abandoned canals provided the inspiration and challenge of again making the desert valleys green. In 1867 the Swilling Irrigation Canal Company was organized to bring water from the Salt River to irrigate the land near the east edge of the present-day city of Phoenix. The first canal was completed in March 1867. The new area prospered, food was grown for the army personnel and residents of the valley and nearby mining camps and hay was grown for the army

horses at Fort McDowell. More settlers migrated to the valley and by 1888 additional canals had been constructed and more than 100,000 acres were under cultivation. This historic era was the beginning of present agricultural development in central Arizona. In the early 1870's the St. George area in southwestern Utah was settled by colonists from the Salt Lake settlement, who developed irrigation using water diverted from the Virgin River and tributary streams.

The period of 1870 to 1890 was an era of expansion in the farming, mining, livestock grazing, and timber industries. During this same period the Southern Pacific Railroad constructed a line across the southern part of the Region. The Atlantic and Pacific Railroad, later to become the Santa Fe, tapped the northern and central part of New Mexico and Arizona, and the Union Pacific Railroad was built to supply transportation into the Nevada and Utah portions of the Region.

During this period the first sawmills were built in the mining communities of southern and central Arizona to supply railroad ties, bridge timbers, and camp construction lumber to the railroads. Mills were built in the Charleston Mountains in Nevada to supply lumber for the expanding towns of Las Vegas and Tonopah, and in southwestern Utah to supply lumber for the expanding agricultural communities in the St. George and Hurricane areas.

From 1884 to 1890 cattle feeding operations in the Salt and Gila farming areas became an integral part of the livestock, farming enterprise. However, the drought of 1891 to 1894 was disasterous to the livestock industry. It is estimated that there was some 50 to 75 percent mortality in the range livestock in central and southern Arizona during the months of May, June, and July in 1893. In addition, an estimated 200,000 head of cattle were shipped out to feed in California, Wyoming, Colorado, New Mexico, and Texas. Much of the thin layer of top soil on the heavily grazed lands was lost through gully and sheet erosion and, with it, the ability of the range to produce maximum yields of forage. This same drought resulted in extensive crop failures in the Salt, Gila, and San Pedro valleys of Arizona and New Mexico.

The construction of Roosevelt Dam and the formation of the Salt River Valley Water Users' Association in 1903 stimulated farming in the central Arizona area, and marked the beginning of stabilized irrigated agriculture in the desert areas in the southwest that had been dependent upon erratic river flow for irrigation water. Cotton, later to become one of the most important crops in the Region, was first grown commercially during this period.

National forests were established between 1898 and 1908 bringing some control to the use of the mountain livestock ranges in the Region

and stabilized the livestock industry dependent upon these grazing lands. In addition, the establishment of the National Forest System was recognition of the necessity to protect and manage the timber and watershed lands of the Region.

Following the cattle boom between 1895 and 1910 sheep were brought into the range areas of the Region in large numbers, reaching a peak in 1912. During the period 1914 to 1918 mining, farming, livestock grazing, and timber production were greatly expanded to provide for the needs of the Nation during World War I. In the late 1920's and 1930's irrigation from deep wells was developed. The Roosevelt Irrigation District west of Phoenix (organized in 1928 as a drainage and irrigation district) was the first organized group of water users dependent entirely upon pump water for supplying irrigation needs.

Between 1920 and 1940 additional water storage reclamation projects were constructed on the Salt, Gila, and Verde rivers, and the main stem of the Colorado. During this period irrigated agriculture doubled from about one-half million acres to almost one million acres. Hoover Dam, the world's highest dam of that time, was completed in 1935. This dam and reservoir provide for improved navigation, river regulation, flood control, and water for irrigation and the generation of electric energy in the Lower Colorado Region and southern California. The reservoir originally had a storage capacity of 31.2 million acre-feet of water. Total generating capacity of the power plant exceeds 1.3 million kw.

Improved management of the open public domain lands, brought about by the passage of the Taylor Grazing Act of 1934, resulted in range improvement and a degree of stability of the livestock on most of the public lands in the Region.

Beginning in the early 1940's, during and following World War II, all types of land use expanded with an increase of population from 582,467 people in 1940 to 1,847,000 people in 1965. It was during this period that recreation and tourism accelerated, becoming the third largest industry by 1965. By 1965 the public land management agencies and a large majority of the private landowners had initiated active programs for improvement of the grazing lands and resources of the Region. Although the number of range livestock in the Region is far below the maximum number in 1918, improvement in the ranges through improved management has permitted an increase in stocking in many cases.

The number of sawmills in the Lower Colorado Region reached a peak in 1946 with 71 cutting 350 million board feet of lumber. By 1965 the number of mills had declined to 31; however, the production of lumber had increased to 475 million board feet. In addition to the lumber

and lumber products, a pulp and paper mill went into production in 1961 in the Little Colorado Subregion (at Snowflake, Arizona) and by 1965 it had an annual utilization of 150,000 cords of pulp wood.

The increasing demands for all resources of the lands and waters of the Region following World War II emphasized the need for legalizing the multiple-use management systems practiced on the lands administered by the Forest Service and Bureau of Land Management. The Multiple Use-Sustained Yield Act of June 12, 1960, and the Classification and Multiple Use Act of September 19, 1964, declared it a Congressional policy that these lands "shall be administered and developed, so that its various resources are utilized in the best combination -- on a sustaining basis -- to meet the social, economic and environmental needs of the people, both local and national." The Classification and Multiple Use Act provides for management as well as classification.

During the 1940 to 1965 period the area of land developed for irrigation expanded from about one million to more than one and one-half million acres. During this same period some of the land previously developed for irrigated agriculture was converted to urban and industrial use. The national needs during and immediately after World War II, and until cotton quotas were imposed in the early 1950's, resulted in numerous desert valley areas in the Gila and Lower Main Stem subregions being developed for irrigation from deep wells. The construction of a natural gas line from Texas supplied the necessary fuel for operating the pumps in the Eloy and Gillespie areas. Deer Valley, Magma, and other areas were also developed for irrigation from deep wells. Portions of some areas developed during this period were later abandoned and reverted to desert when the ground water supplies were exhausted, developed excessive salts, or became too deep for economical operation. In the late 1950's, deep wells were developed in the vicinity of Willcox, Arizona to supply water for extensive irrigated agriculture specializing in fruits, nuts, vegetables, and more recently, sorghums.

Prior to 1940 much of the land in the Wellton-Mohawk area of Arizona was abandoned when the quality of the ground water made it unfit for use. In 1952 water from the Colorado River became available and most of the land that had previously been farmed went back into production. Between 1940 and 1965, about 150,000 acres of land in the Lower Main Stem Subregion, including 44,000 acres of the Colorado River Indian Reservation, were developed utilizing water from the Colorado River supplemented by wells.

Rapid expansion of the urban and industrial areas of the Region, especially in the Phoenix and Tucson areas, resulted in the urbanization of nearly 100,000 acres of previously irrigated agricultural land during the 1940-1965 period. The irrigated farm land in Las Vegas

valley was almost completely converted to urban and industrial use during this same period.

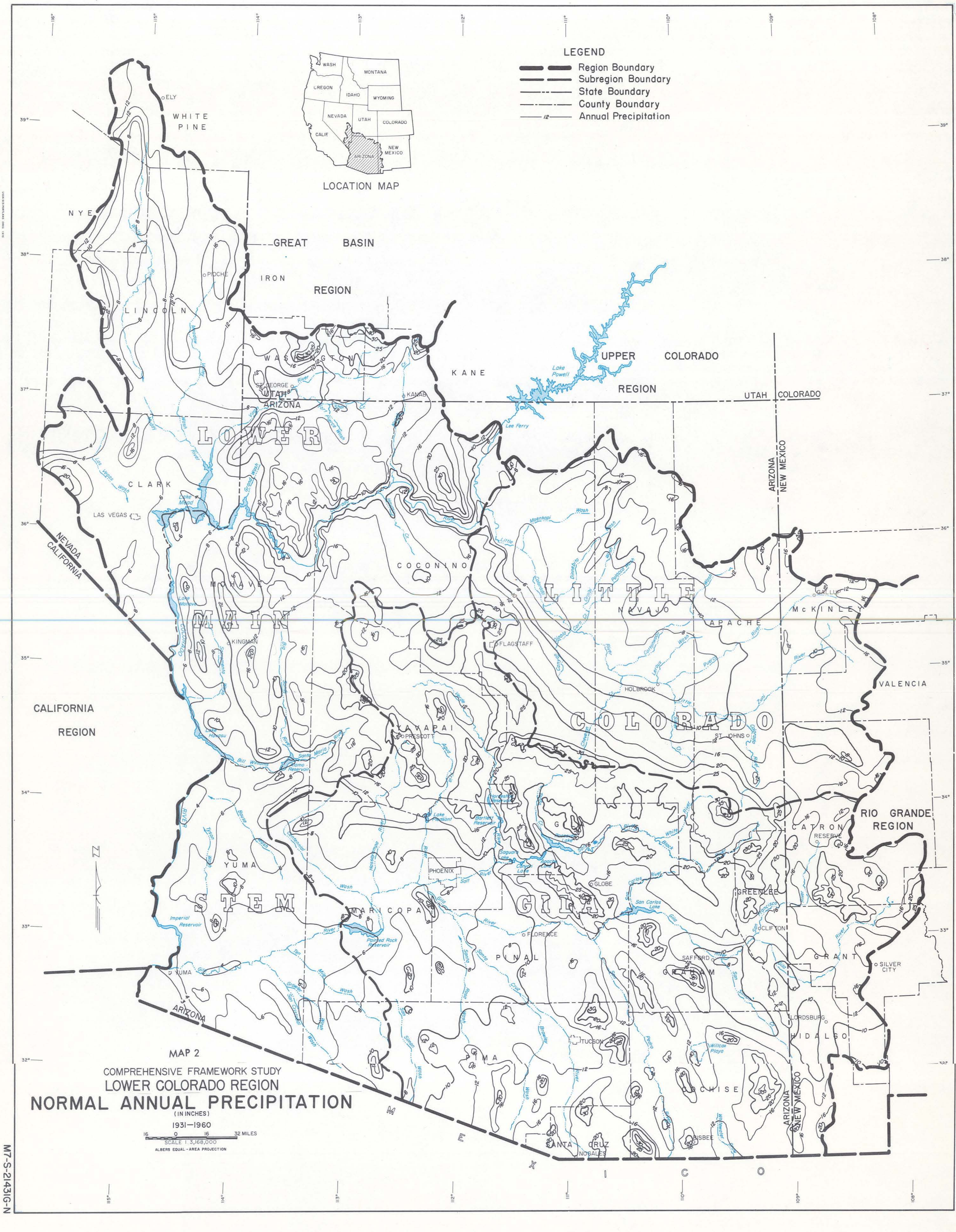
Photo 1. Citrus groves being replaced by housing developments SCS

Improvement of the highway system together with the increasing recreation demand has resulted in abandonment of many of the farming enterprises on the ranch headquarters and farmsteads in the mountainous central and northern portions of the Region. Many of these small irrigated and dry farms have been converted into summer home developments or other recreation oriented uses. Other areas formerly developed for production of hay and stock feed to supply the logging and timber industries have reverted to livestock range following the conversion of the timber industry from horse to machine operation. Likewise, much of the dry farming formerly necessary on the Indian reservations to supply corn, beans, etc. for local consumption has been abandoned with improved transportation and the improvement of living standards.

During the 1940 to 1965 period the mineral industry experienced cyclic but continually expanding growth. Commercial production since 1940 in the Lower Colorado Region has included 42 different mineral commodities. Copper has been the leading mineral commodity produced in the Lower Colorado Region since 1940. The production of copper more than doubled between 1940 and 1965, reaching a total of more than 700,000 short tons in 1965. Over 60 percent of the copper produced in the United States is mined in the Lower Colorado Region. By-products of the copper mining industry include silver, gold, and molybdenum. Uranium, vanadium, lead, zinc, asbestos, pearlite, sand, gravel, and cement are other important minerals that have gained in importance in

the Region since 1940. The cement, sand, and gravel output is tied closely to the extraordinary growth and development of the Region, particularly near the urban and population centers.

GENERAL DESCRIPTION OF THE RESOURCE BASE



MAP 2

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

NORMAL ANNUAL PRECIPITATION

(IN INCHES)

1931—1960

SCALE 1:3,168,000

ALBERS EQUAL-AREA PROJECTION

M7-S-21431G-N

CHAPTER C - GENERAL DESCRIPTION OF THE LAND RESOURCE BASE

TOPOGRAPHY AND CLIMATE

Elevations within the Region range from slightly under 100 feet above sea level near Yuma, Arizona to over 12,500 feet on Humphreys Peak near Flagstaff, Arizona. The northeastern portion of the Region is characterized as a broad, nearly level plateau dissected by canyons and escarpments. The Mogollon Rim which traverses the Region in a southeasterly to northwesterly direction provides the beginning of the transition between this level plateau and the southern portion of the Region. The western and southwestern portion of the Region is characterized by its broad, flat alluvial-filled valleys interspersed with stark, nearly barren mountain ridges. The southeastern section of the Region is generally rolling upland with scattered mountain ranges. Ancient volcanic cones and reddish-black lava flows occur throughout the Region to lend further display to the varied topography. The significant variations in topography, elevations, and land shapes have a direct and strong bearing on the climate.

The daily average January temperatures are 20° to 30° in the north and northeast portion of the Region to above 50° in the southwestern desert. Daily average July temperatures range from about 70° in the areas above 7,000 feet to above 90° in the areas below 1,500 feet in elevation. See Figures 1 and 2. This wide range in daily average temperature is an important factor in the determination of land treatment and management programs that compliment the activity, vegetation, etc. in various parts of the Region.

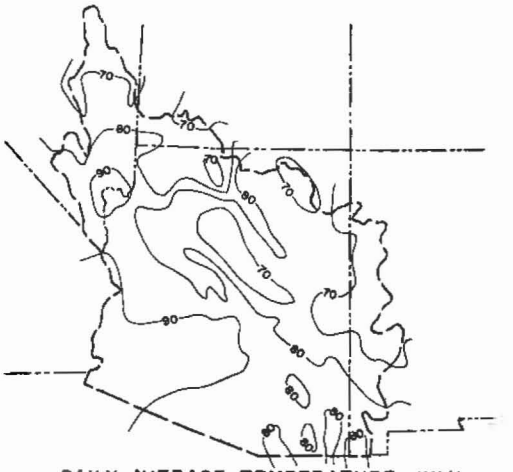
The mean length of the frost-free period in the Region varies from less than 90 to more than 330 days. See Figure 3. The shorter frost-free periods are found in areas above 7,500 feet elevation. The frost-free periods increase to nearly yearlong below 1,000 feet in desert areas.

The higher elevations of the central and northeast portions of the Region get considerable amounts of snow during the colder months. The San Francisco and White Mountains receive between 8 and 11 feet of snow in some years. Generally however, there is less than 4 feet of snowfall each year. Temperatures are usually near freezing and the snow may remain on the ground for several months. There are a few isolated areas in the remainder of the Region that receive more than 4 feet of snow during a normal year. These areas are in the mountain ranges that rise above 7,000 feet. Most of the Region's supply of surface water for irrigation originates as snowmelt; therefore, proper management of these areas is critical.

FIGURE 1

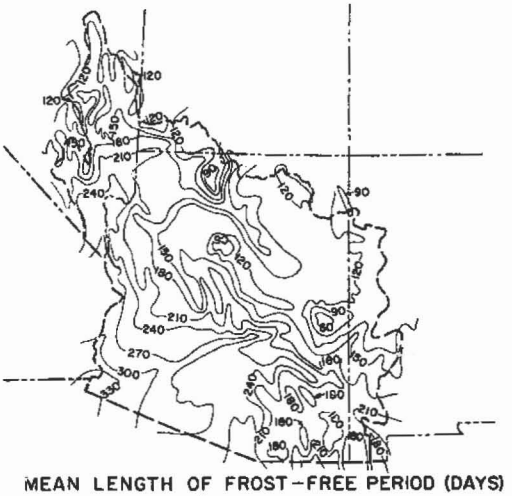
DAILY AVERAGE TEMPERATURE, JANUARY
(°F)

FIGURE 2



DAILY AVERAGE TEMPERATURE, JULY
(°F)

FIGURE 3



MEAN LENGTH OF FROST-FREE PERIOD (DAYS)
BETWEEN LAST 32° F TEMPERATURE IN SPRING
AND FIRST 32° F TEMPERATURE IN AUTUMN

Photo 2. Alpine Snow Field, Mount Baldy, Arizona — FS

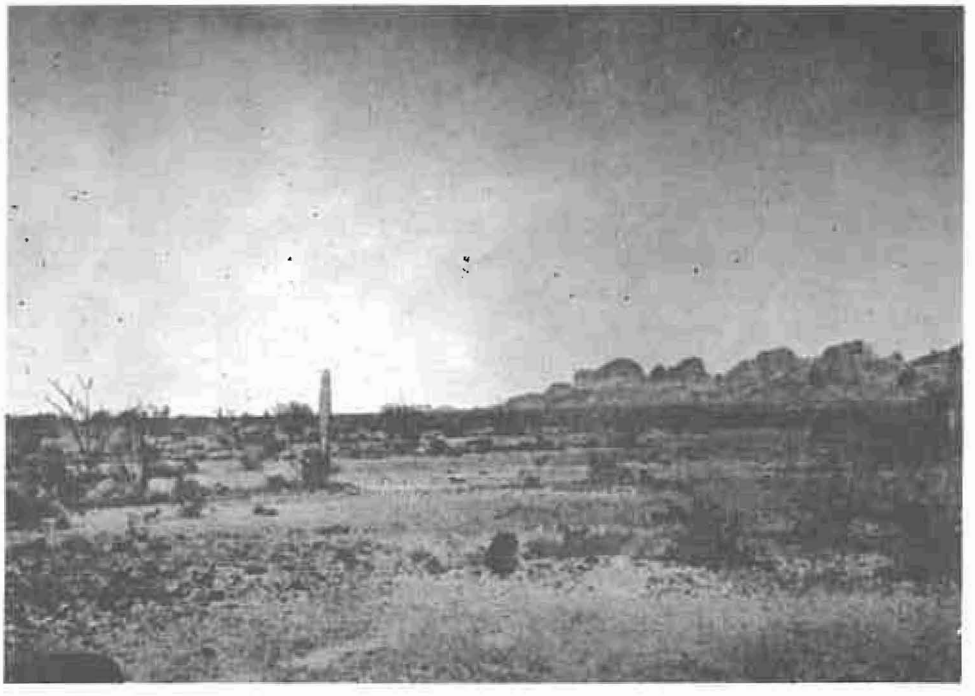


Photo 3. Hot, dry desert in southern Arizona — SCS

In the desert portions of the Region, snow is a rarity. When it does fall it melts rapidly. The lower elevations in the southeast portion of the Region receive between one and six inches of snow annually.

In the higher elevations, generally above 7,000 feet, precipitation occurs as rain between spring and fall and as snow during the winter. Rainstorms may occur throughout the year in the desert and foothill sections, but are more frequent during July through September and again during December through March. Precipitation ranges from general showers to local violent thunderstorms which often cause flooding from normally dry or nearly dry stream channels. These intensive storms cause high runoff and the accompanying floodwater, erosion, and sediment damage.

About one-half of the Region receives an average of less than 10 inches of precipitation per year, more than 30 percent receive between 10 and 20 inches and less than 20 percent of the total area receives over 20 inches (see Map 2). This wide range in precipitation presents management problems related to the associated vegetation, erosion, water yield, etc.

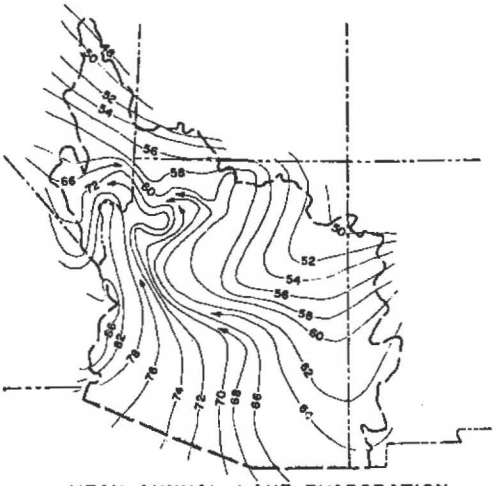
The mountain ranges that are the headwaters of the major perennial rivers are the areas of highest precipitation; a few of the higher peaks receive more than 30 inches of precipitation per year. The southwest portion of the Region is extremely dry, with fewer than 8 inches annual precipitation.

There are two distinct moisture sources. Winter precipitation is associated with moisture moving into the area from the Pacific Ocean, while the Gulf of Mexico and Gulf of California supplies moist air for the Region's summer rains. Winter rains usually occur as gentle showers over a large area sometimes lasting for several days. Local summer thunderstorms which usually cover only small areas are usually of high intensity and of short duration and produce many of the destructive flash floods well-known in the southwest.

Photo 4. Area of high water yield, mixed conifer, White Mountain area FS

At the lower elevations the combination of high temperatures and low humidity causes high rates of evaporation and transpiration. The mean annual lake evaporation rates vary from 48 inches at higher elevations in the north to 86 inches in the southwestern portion of the Region. See Figure 4. In the alluvial valleys of the west and southwest portions of the Region, where the need for water is greatest, precipitation is least and the rate of evapotranspiration is highest. Special management programs are necessary in this area to reduce water losses.

FIGURE 4



MEAN ANNUAL LAKE EVAPORATION
(INCHES)

Streamflow is extremely variable in both frequency and duration. Many of the streams are intermittent while others have been controlled for beneficial use. Periodically, however, torrential rains cause flooding from normally dry stream channels. Prolonged periods of winter and early spring runoff are infrequent.

Ground water represents an important portion of the Region's water supply. Recharge to the alluvial aquifer systems is limited by both climatic and geologic factors.

Details on streamflow and ground-water characteristics such as quantity and quality, and uses for mankind are presented in the Water Resources and Water Quality appendixes.

SOILS

The soils of the Lower Colorado Region are inherent to the parent materials of the two broad physiographic provinces; the Colorado Plateau Province that occupies the northeast part, and generally the higher elevations, of the Region and the Basin and Range Province that covers the remainder of the Region (see Map 3). (Some authorities prefer to show the division line between the Colorado Plateau Province and the Basin and Range Province along the Mogollon Rim.) Elevations of the Plateau Province range from approximately 4,000 feet above sea level to over 12,000 feet on Humphreys Peak north of Flagstaff, Arizona. Elevations of the Basin and Range Province range from slightly under 100 feet above sea level near Yuma, Arizona, in the extreme southwestern corner of the Region, to nearly 12,000 feet on Mt. Charleston just west of Las Vegas, Nevada.

Soils have formed on granitic, metamorphic, volcanic and sedimentary rocks and, to a lesser extent, on alluvium derived from these rocks.

In the Colorado Plateau Province the major parent materials are sedimentary rocks that range from limestone to sandstone and shales. Also, in some areas the soils occur on alluvium and on volcanic rocks which either intruded or covered sedimentary rocks. In the Basin and Range Province most of the soils have developed on alluvium materials derived from the igneous and sedimentary rocks that comprise the mountain ranges typical of the Province.

As shown in Map 3, the Colorado Plateau and the Basin and Range provinces have been further divided into three sections each for orientation of the following discussion of more detailed soil characteristics.

The Colorado Plateau Province comprises the entire Little Colorado Subregion and a portion of both the Gila and Lower Main Stem subregions. In general, the soils in this Province are shallow in depth to the parent material, often quite erodible, and are severely dissected in places. Most of the soils on the Plateau are on gentle slopes except those in the mountains. The soils in the mountains, on steep to very steep slopes, are shallow to very shallow. Most of the soils in this Province have textures favorable to the entrance and movement of water, except where developed from clayey materials. Some of these slowly permeable soils border the Little Colorado River in Arizona and are a significant source of sediment.

MAP 3

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

PHYSIOGRAPHIC PROVINCES

M7-N-21431K

The Province contains three sections, i.e. Flagstaff-Navajo, Grand Canyon, and Tonto. The latter two are often referred to as the transition zone between the Colorado Plateau and the Basin and Range Province and contain no large areas of level and deep soil. The Grand Canyon section, which includes the area north of the Colorado River, has generally level to moderately undulating topography but the soils are often shallow and are occasionally dissected. Many of the soil bodies are medium to coarse textured, slightly saline, and easily eroded.

The Flagstaff-Navajo section includes almost all of the Little Colorado Subregion. This Subregion contains only a small percentage of the presently irrigated soils, but most of the dry farming practiced in the Lower Colorado Region is in this area. The soil bodies range in texture from coarse textured sandy material to deep, dense clay loams and clays. They are easily eroded, are often highly saline, and support sparse vegetative growth. Land at the higher elevations in this Subregion is generally forested except for interspersed open areas. Most of the timber products from the Lower Colorado Region and much productive grazing is derived from this Subregion.

The Basin and Range Province is characterized by steep, generally barren northwest-southeast trending mountains and broad alluvial-filled valleys. Most of the soils in the basins and valleys of this Province are deep, level to nearly level, and have textures favorable to both water entrance and soil workability. The soils on the mountains of this Province are very shallow to moderately deep, are on steep to very steep slopes, and generally have loamy to clayey textures. In places these soils are very stony and/or rocky. Important source areas for sediment in this Province are in the valley of the San Pedro River and along the Gila River between San Carlos Lake and the Arizona-New Mexico boundary. This Province has been divided into three sections because of physiographic and climatic differences.

The Mexican Highland section occupies the southeast corner of the Lower Colorado Region and reflects the transition zone between the desert valleys of southwestern Arizona and the semidesert grassland areas extending to the Continental Divide in New Mexico. The section is somewhat higher in elevation than the western valleys and has slightly more rainfall. The soils in this section are usually deep and are medium or moderately fine in texture.

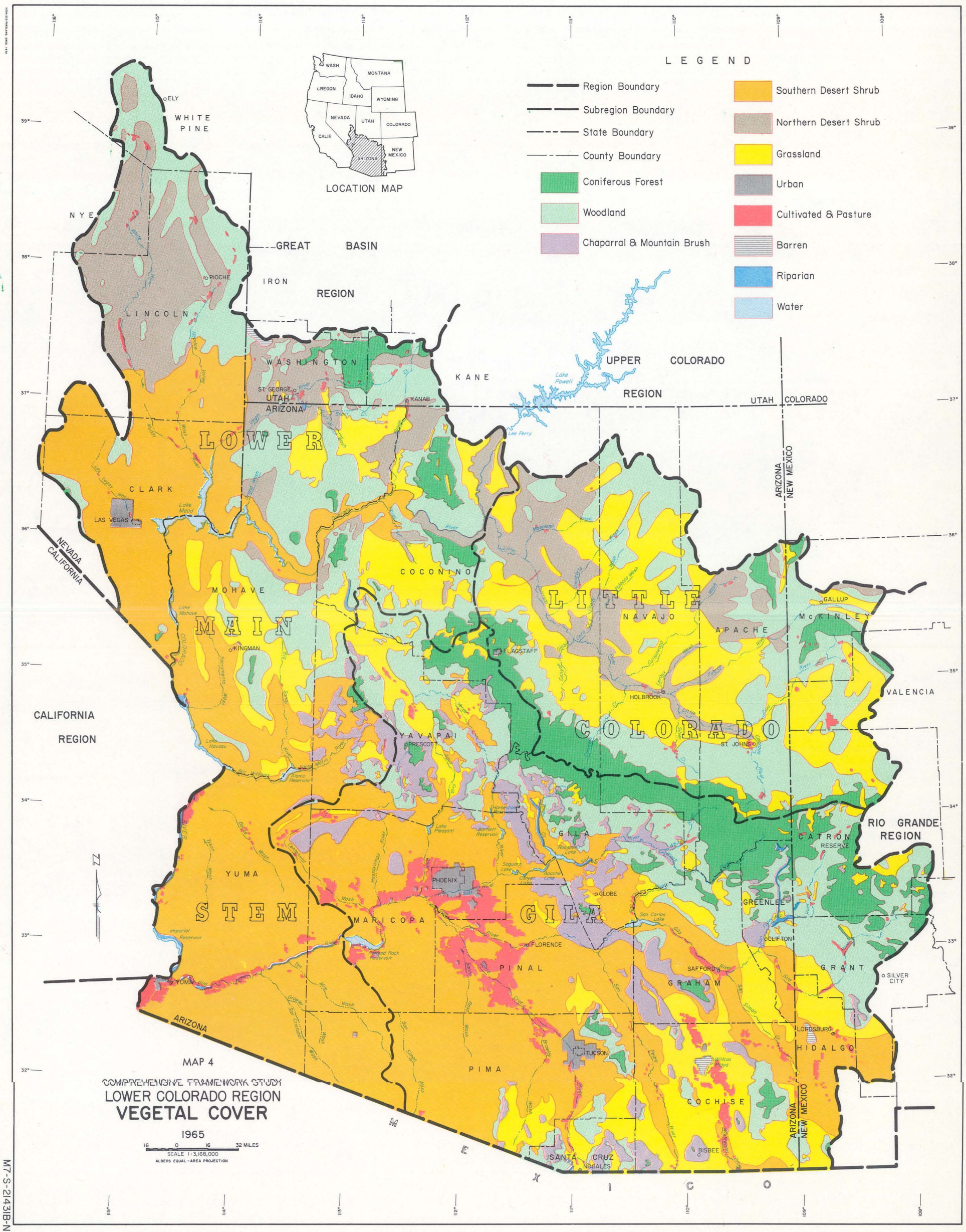
The Sonoran Desert section of this Province is representative of the physiographic characteristics of the southwestern desert portions of Arizona. It contains most of the presently irrigated land of the Lower Colorado Region. Yearlong growing seasons are common and all crops are grown under irrigation. The mountainous areas of this section are steep and have little vegetal cover. The soils in the

gently sloping alluvial-filled valleys are deep, quite hetrogeneous in texture and have smooth to gently undulating topography. The soils are quite low in organic material and have not been leached of soil nutrients. The third part of this Province is the Mohave section which comprises the northwest portion of the Lower Colorado Region. This section consists largely of the lower canyon section of the Colorado River and minor tributary streams of southeastern Nevada and southwestern Utah. Soil textures vary from coarse sands to clay, and the soils are generally shallow except in the narrow alluvial valleys of streams. In some locations the soil profiles have soluble salts in quantities sufficient to inhibit or prevent plant growth.

For information regarding the suitability of land for various uses, refer to Land Suitability and Availability section of Chapter E.

VEGETAL COVER AND RELATED CATEGORIES

The Lower Colorado Region has a wide variation in "vegetative cover types and related categories." The forest types extend from the small alpine areas on top of Mt. Baldy in the White Mountains, the tip of Humphreys Peak in the San Francisco Peaks, and the crest of Charleston Mountain, Nevada; through the coniferous forest zones of spruce-fir, Ponderosa pine, and the pinon-juniper and oak woodlands, and the chaparral types. The rangeland type extends from the forest type through the northern and perennial and ephemeral southern desert shrub types, the northern and southern grasslands, down through a small area of true desert near the mouth of the Colorado River on the boundary between Mexico and Arizona. Scattered throughout the Region are areas of cultivated land, including irrigated pasture, with the largest blocks in the lower Gila and the southern half of the Lower Main Stem subregions. More than 500,000 acres of the Region are developed as urban and industrial areas. More than 300,000 acres of the Region are occupied by water in the form of streams, lakes, impoundments, and reservoirs. See the Vegetal Cover Map, Map No. 4. The vegetative cover type is dependent upon the precipitation, topography, soil, and climate. Each type is limited to rather specific ranges in elevation as shown in Figure 5. The extent of vegetal cover and related categories is shown in Table 2.



MAP 4

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION
VEGETAL COVER

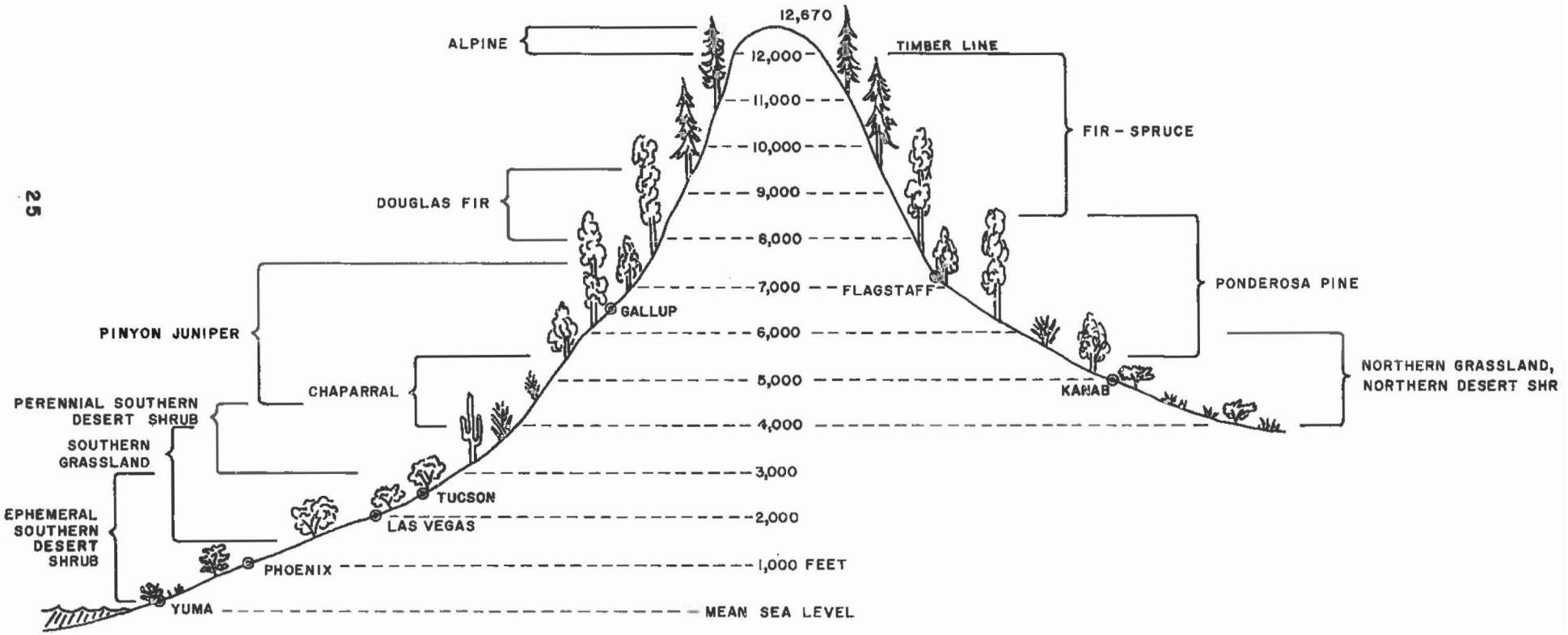
1965

M7-S-2143B-N

LAND OWNERSHIP AND ADMINISTRATION

FIGURE 5

GENERAL ELEVATION OF RANGES OF PRINCIPAL VEGETAL COVER TYPES IN THE LOWER COLORADO REGION



Adopted from "Southern Trees - A Guide to Native Species of New Mexico and Arizona"
by Elbert L. Little, Jr.

Table 2
Lower Colorado Region
Vegetal Cover and Related Categories - 1965
Area (1000 Acres)

	Lower Main Stem Subregion	Little Colorado Subregion	Gila Subregion	Total Lower Colorado Region
Conifer	1,068	1,702	3,752	6,522
Woodland	7,396	5,609	6,898	19,903
Chaparral	439	-	3,027	3,466
Riparian	52	-	54	106
Subtotal (Forest Land)	8,955	7,311	13,731	29,997
Southern Desert Shrub	17,111	-	15,026	32,137
Northern Desert Shrub	5,628	2,919	-	8,547
Grassland	3,765	6,940	6,197	16,902
Subtotal (Rangeland)	26,504	9,859	21,223	57,586
Urban & Industrial	129	19	365	513
Cropland	332	63	1,421	1,816
Water	249	13	78	340
Barren	26	-	50	76
Total	36,195	17,265	36,868	90,328

Alpine

The alpine area occurs above timber line, about 12,000 feet in elevation. There are less than 10,000 acres alpine and subalpine areas in the Region. Because of the short frost-free growing season (frost may occur at any time of the year) the vegetation is limited to short grasses and sedges, hardy forbs, and alpine fir, subalpine willows, and other low shrubby plants. The principal plant species in this alpine zone, above timber line, include a number of species of sedges, alpine timothy, thurber fescue, areanaria, geraniums, bluebell, and a few species of alpine clovers. These areas are too small to include on the cover type map.

Photo 5. Alpine Zone FS

Coniferous Forest

The coniferous forest in the Lower Colorado Region extends from an elevation of about 4,700 feet to timber line.

Spruce-Fir

The spruce-fir timber type extends from about 8,500 feet to timber line. The dominant tree species in this type include Engleman spruce, white fir and cork bark fir. Other components of the type include aspen and limber and Mexican white pine with willow, alder, birches, and currants and gooseberries growing along the streambeds and most areas. Interspersed throughout this spruce-fir type are numerous subalpine and wet mountain meadows and grasslands. These meadows and grasslands characteristically are parklike openings between 9,000 feet and timber line. The vegetation consists of lush growth of grasses and grasslike plants and forbs with the sedges, rushes, Arizona and thurber fescue, and mountain timothy being the most important. Geraniums, peavines, bluebells, vetch, and clover make up the most important forbs.

Photo 6. Spruce-Fir Forest FS

Ponderosa Pine-Douglas Fir

The Ponderosa pine timber type provides most of the commercial forest land in the Lower Colorado Region. This type extends from an elevation of about 5,500 feet to 9,500 feet with Douglas fir providing an important component of the timber type between the elevations of

8,000 and 9,500 feet. Other woody components of this type include mountain maple, alder, alligator and prostrate junipers, Gamble oak and Arizona locust. The grass and forb understory in the open and semi-open stands of Ponderosa pine and associated species include Arizona fescue, mountain muhly, muttongrass, western wheatgrass, pine dropseed, and blue grama. The forbs include geranium, peavine, vetches, and clovers.

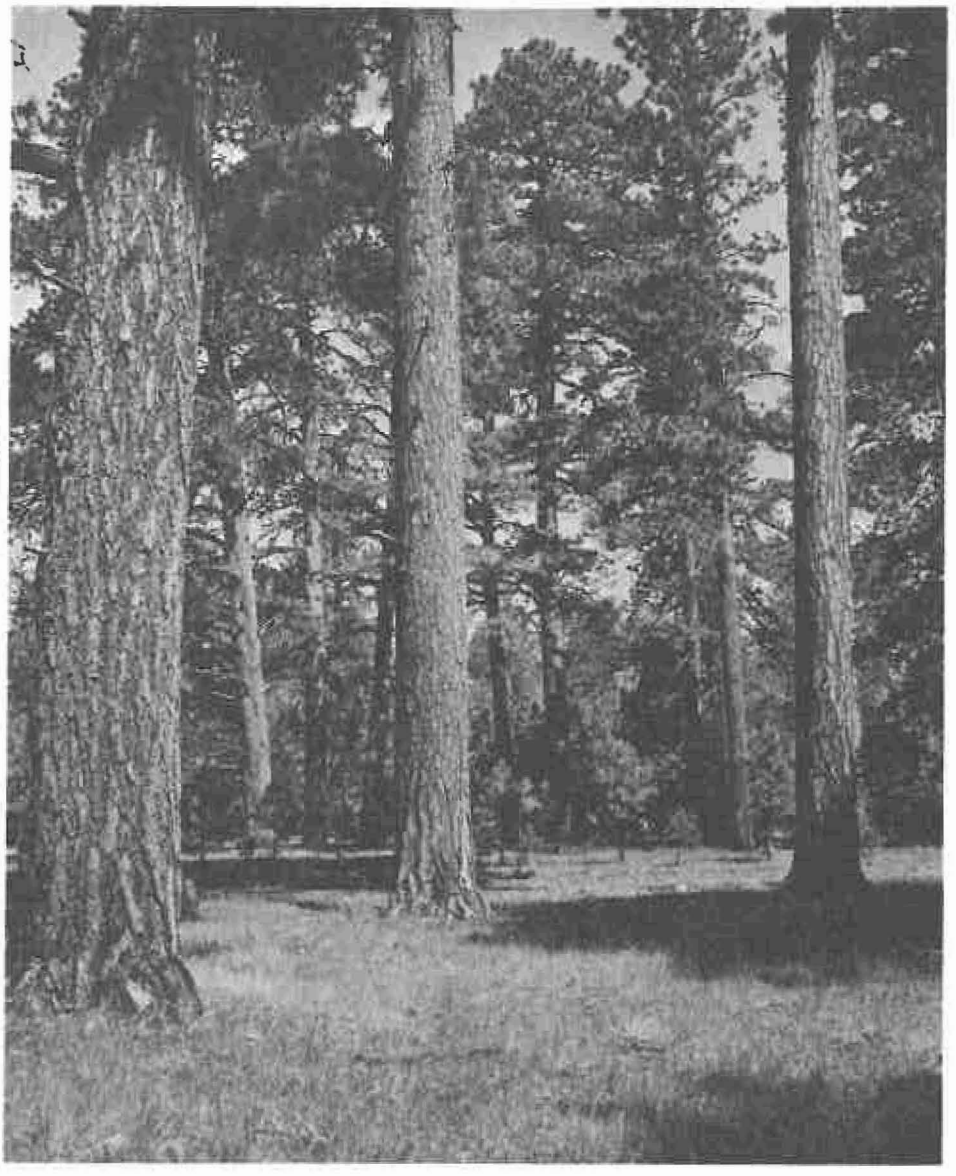


Photo 7. Ponderosa Pine Forest FS

Bristlecone Limber Pine

A very small area, less than 10,000 acres, of bristlecone and limber pine occurs along the crest of the White Pine, Quinn, and Ward mountains in the northern tip of the Region in Nevada. Other components of the type include mountain mahogany, cercocarpus, serviceberry, and ceanothus. The principal grass and forb species include blue bunch wheatgrass, blue grass, and Idaho fescue, with bluebells, geraniums, and peavines making up the principal forbs.

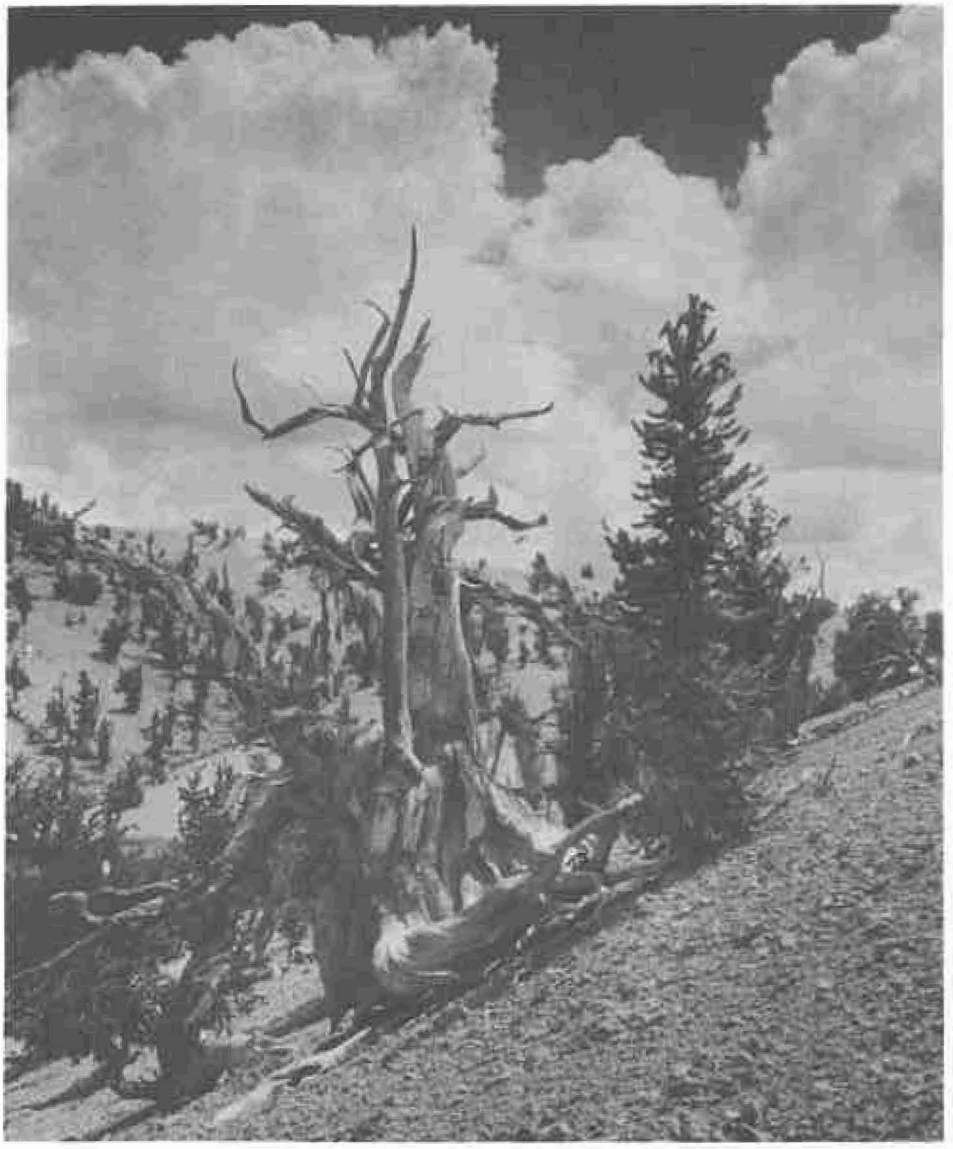


Photo 8. Bristlecone Pine Forest FS

Woodland

Pinon-Juniper

The pinon-juniper type occurs at elevations above 4,500 feet and generally occupies an area immediately below the Ponderosa pine, in the central and northern part of the Region. The principal species in this type include one-seeded juniper, Utah juniper, alligator juniper, and pinon pine, with an understory of Emory and Gamble oak, ceanothus, bitterbrush, and cliff rose. There is some big sagebrush in the northern half of the Region. The sideoats grama, blue grama, muttongrass, galleta, threeawn grass, sand dropseed, and Arizona fescue make up the principal grass species. Hawksbeard, filaria, peavines, and vetches make up the forbs in the understory.

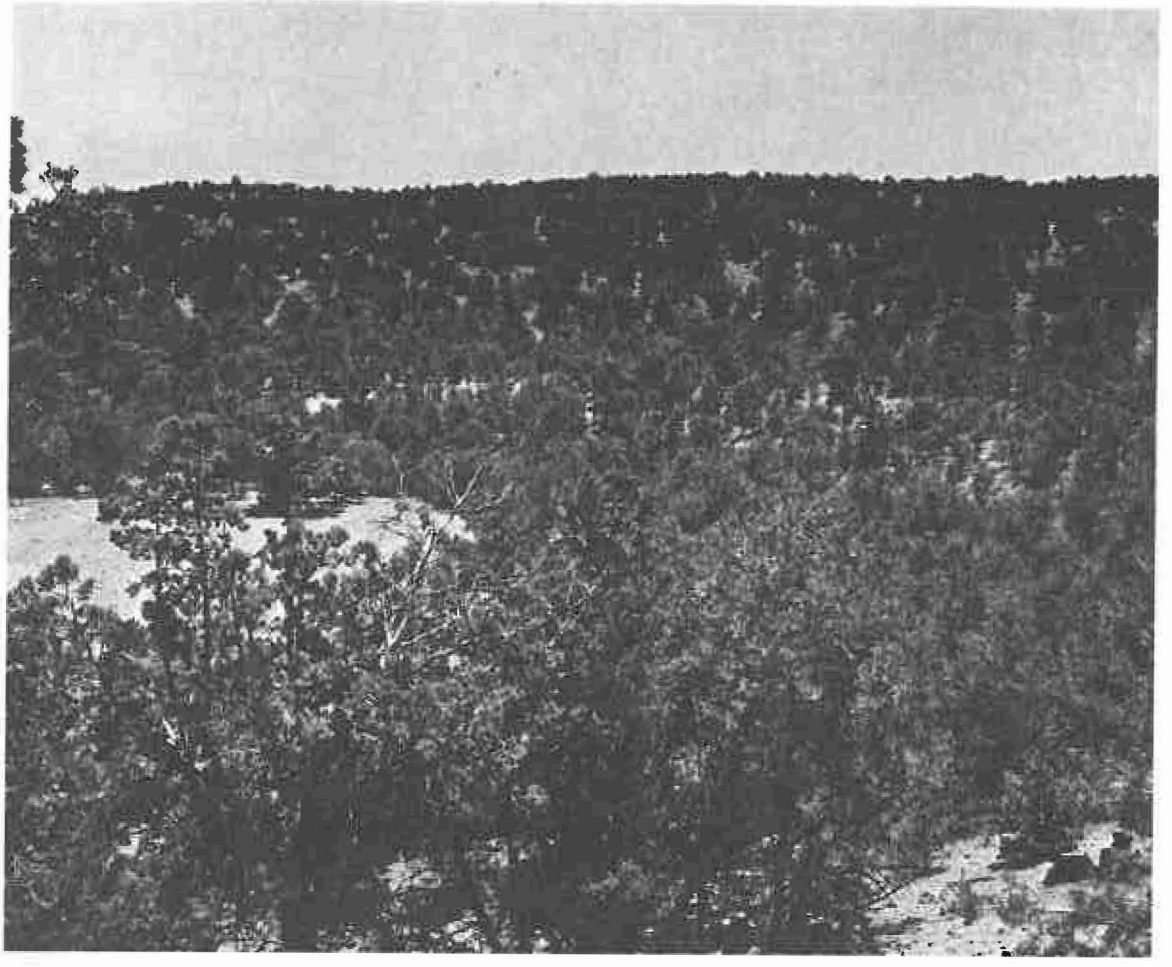


Photo 9. Pinon-Juniper Woodland FS

Oak Woodland

The oak woodland type occupies the foothills and mountains in the southeastern part of the Region between the elevations of 4,500 and 6,000 feet. The principal species include the Emory oak, Mexican blue oak and Arizona white oak. Serviceberry, false mesquite, ceanothus, cliff rose, Apache plume, and numerous species of cacti are present in the type. Under normal conditions the oak woodland type has a good stand of bluestem, sideoats, black and blue grama, curley mesquite, sprangletop, June grass, muttongrass, sand dropseed, and Arizona cottontop. Filaria, wooly buckwheat, and deer vetch are the principal forbs in this type.

Photo 10. Oak Woodland FS

Chaparral and Mountain Brush

The most extensive areas of the chaparral vegetative type in the Region lies south of the main Ponderosa pine forest in central Arizona between the elevations of 4,000 and 5,500 feet. Scrub liveoak, mountain mahogany, manzanita, desert ceanothus, laurel and hollyleaf buckthorn with individual junipers, pinon pines and scrubb yellow pine sometimes forming a scattered overstory of the chaparral type. Sideoats, black, blue, and hairy grama, lovegrasses, curley mesquite, galleta, sprangletop, vine mesquite, and Arizona cottontop are the principal grass species. Filaria, deer vetch and Indian buckwheat make up most of the forbs.

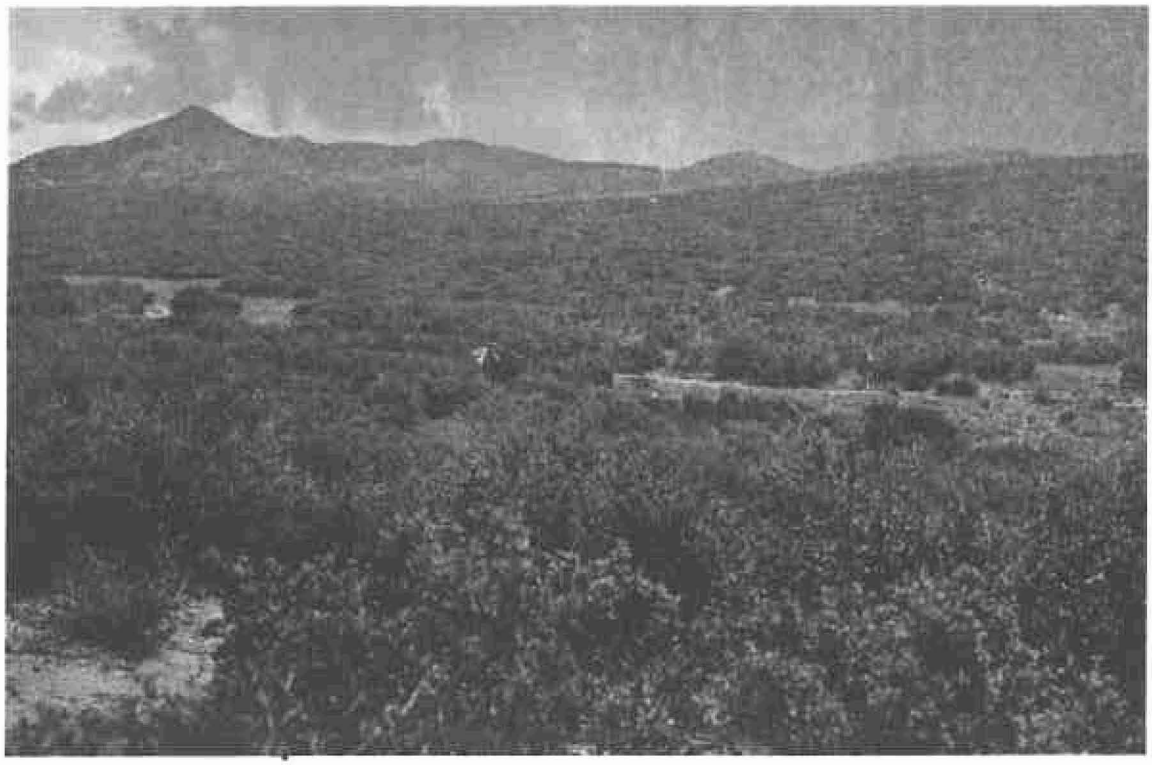


Photo 11. Chaparral-Mountain Brush FS

Riparian

The riparian type is scattered along the drainages throughout the entire Region in narrow strips, some of which cannot be shown on the Vegetal Cover Map. About 106,000 acres of this vegetative type does occur along the main Colorado River in southwest Arizona and along the Gila and Salt rivers in blocks of significant size. The dominant plants in this type include salt cedars, cottonwood, baccharis, and willow in the lower elevations, with alder, maple, ash, walnut, and locust occurring along the streams in the elevations above 5,000 feet. Mesquite and sycamore occur in the type at lower elevations along with arrow weed, bermuda, and saltgrass. In the higher mountains shrubby willows and alder are the principal understory occurring along the streams and wet spots.

Photo 12. Riparian Warm Climate
SRP

Photo 13. Riparian Cool Climate
FS

Northern Desert Shrub

The northern desert shrub or sagebrush vegetative type in the Lower Colorado Region is confined largely to the Little Colorado drainage, the area north of the Colorado River in Arizona and Utah, and the northern third of the Region in Nevada. 1/ The vegetative type extends from 4,000 feet to 6,000 feet in elevation. Big sagebrush is the predominant overstory plant over most of the area occupied by the northern desert shrub type, with black brush being quite common in southern Utah and northern Arizona (Arizona Strip), and some greasewood and shadscale in localized areas in the northern part of the Region in Nevada. Other shrub species occurring in this type include four-wing salt bush, winterfat, buckwheat, serviceberry, and snakeweed. Western wheatgrass, Indian rice, sideoats grama, blue grama, galleta, sacaton, sand dropseed, and needle and thread grass make up the understory grasses. Bluebell and Indian wheat are the principal forbs found in the northern desert shrub community.

Photo 14. Northern Desert Shrub FS

1/ The "salt desert shrub" type, a significant type in the adjoining Great Basin Region, was not separated out in this Region. The salt desert shrub type occurs in the Nevada and Utah portions of the Lower Colorado Region.

Southern Desert Shrub

Perennial

The perennial southern desert shrub types occur in the southern and western portion of the Region between 3,000 and 4,500 feet in elevation. The type is characterized by cacti, including the saguaro, cholla, and prickly pear. Palo Verde, ocotillo, creosote bush, catclaw, rabbit bush, mesquite, coffee berry, tar bush, and bursage are the important woody plants in this type. Indian buckwheat and filaria are the most important forbs in the type, while black grama, bromegrass, tobosa, spike muhly, and threeawn provide most of the grasses.

Photo 15. Perennial Southern Desert Shrub FS

Ephemeral

The ephemeral southern desert shrub types occur along the western part of the Region, usually at elevations below 3,000 feet and less than 8 inches of annual rainfall. The type is composed largely of creosote bush with some bursage growing in open stand with little to no perennial ground cover. Numerous annual forbs and annual grasses may occur during favorable periods of moisture.

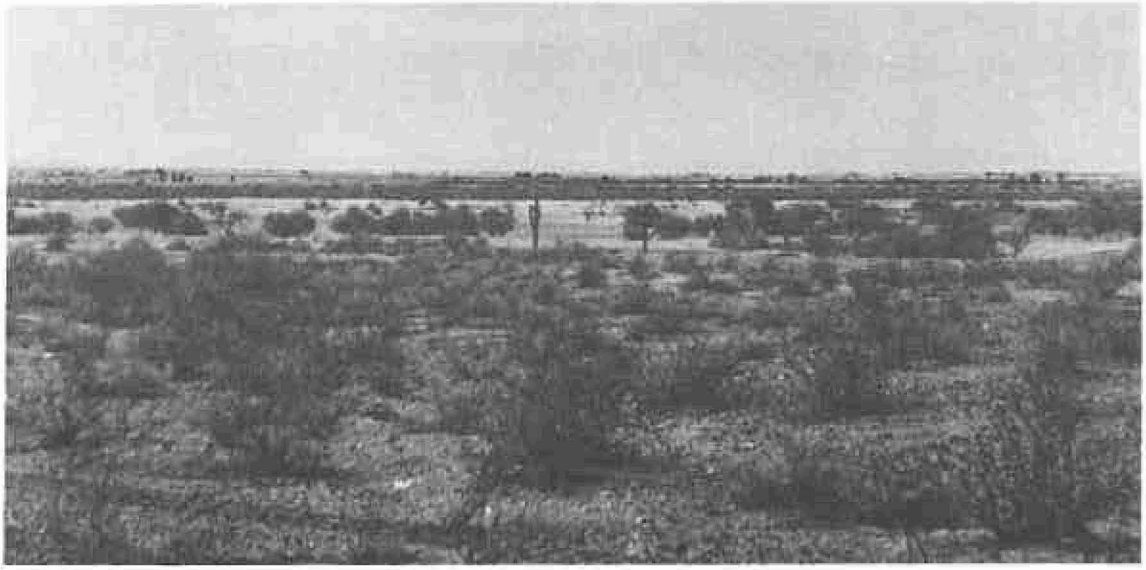


Photo 16. Ephemeral Southern Desert Shrub BLM

Grassland

Northern Grassland

The northern grassland types occur on extensive areas in Arizona and New Mexico north of the Mogollon Rim, Mogollon mountains, and north of the Colorado River in northwestern Arizona and southwestern Utah. Generally it occurs at elevations above 4,000 feet. The type ranges from the short grass community on the dryer sites to the mid grass and tall grass communities on the more favorable sites. Blue

grama, sideoats grama, hairy grama, and galleta are the principal species in the short grass type. Western wheatgrass, Sandberg blue grass, big bluestem, little bluestem, Indian rice, lovegrass, sand dropseed, and needlegrass make up the principal species in the mid grass and tall grass communities. Winterfat, filaria, and Indian buckwheat are the principal forbs, while big sagebrush and service-berry occur in limited amounts throughout the type.

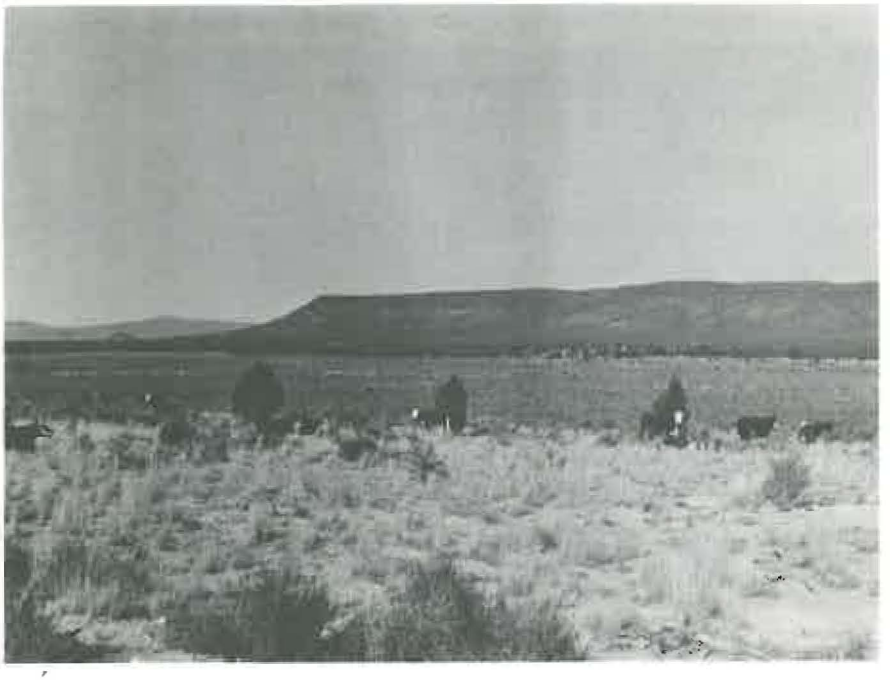


Photo 17. Northern Grassland BLM

Southern Grassland

The southern grassland occurs below the Mogollon Rim in the south-eastern portion of the Region. The type occurs generally below 4,000 feet in elevation. Black grama, sideoats, blue grama, and tobosa, sand dropseed and Arizona cottontop are the dominant grass species

making up this type. Scattered individual oak trees may occur forming a thin overstory in some areas. Four-wing salt bush, mesquite, and cacti occur in limited quantities throughout the type.

Photo 18. Southern Grassland FS

Cultivated and Pasture

Nearly all of the cultivated and irrigated pasture of the Region is located in the southern portion of the Region along the main stem of the Colorado and Gila rivers, together with the Salt, Verde, and Santa Cruz valleys. Important areas also occur in the southeastern corner of the Region in the Sulphur Springs Valley, upper Gila, and San Simon areas. Smaller, but important, cultivated areas are located in southwestern Utah along the Virgin River, and along the Muddy River, White River, and Meadow Valley Wash in Nevada. A few communities in the Little Colorado drainage have sizeable areas devoted to agriculture and improved pasture. In addition, there are many small isolated tracts from a few acres to several hundred acres scattered throughout the entire Region that have been developed for cropland or improved irrigated pasture.

The western and central valleys of the southern half of the Region are suitable for most cultivated crops. The cool climate crops are grown during the fall, winter, and spring seasons, while crops adapted to the warmer temperatures are grown during the summer season. Winter vegetables, cotton, and citrus are limited to this lower, warmer section of the Region.

Small grains, tame and native grasses, and alfalfa make up the typical improved pastures in the higher elevations. Cool season vegetables, hardy fruits, and cereal grains are common cultivated crops above 5,000 feet elevation.

Photo 19. Irrigated Crop Production SCS

Urban

Of the more than 500,000 acres of land devoted to urban and industrial development, more than 350,000 acres are included in the greater Las Vegas, Phoenix, and Tucson urban centers. The cities of Yuma, Flagstaff, Gila Bend, Arizona; St. George, Utah; and Gallup and Lordsburg, New Mexico occupy nearly 66,000 acres of the urban and industrial lands of the Region.

Water

Impoundments

Most of the 340,000 acres of water surface in the Region is included in the impoundments along the Colorado River from Lake Mead to the Mexican border and in the reservoirs on the Salt, Verde, and upper Gila rivers. There are numerous other small impoundments scattered throughout the Region.

Photo 20. Lynx Lake, near Prescott, Arizona SCS

Live Streams and Natural Lakes

Live streams and natural lakes make up only a very small percentage of the water in the Region. A few of the larger rivers and streams; Virgin, Colorado, Upper Santa Cruz, Upper Gila, Bill Williams, Salt, Verde, Tonto, San Pedro and Little Colorado generally have a continuous flow through all or portions of their reaches. The lower Gila and Salt rivers are largely controlled by reservoirs and flow

only periodically. The smaller live streams making up the headwaters and most natural lakes are usually located in the higher forested portions of the Region.

Photo 21. Live Stream FS

Wetlands

The wetlands of the Region are generally found along the lower main stem of the Colorado River from Lake Mohave to the International Boundary. An area of several thousand acres occurs above Gillespie Dam north of Gila Bend, Arizona on the Gila River. Cottonwood, mesquite, baccharis, arrow weed, and willow are the dominant tree and

shrub species. Cattails, bulrushes, reed grasses, salt grasses, and water lilies provide the shorter vegetative growth.

Photo 22. Wetlands in the Desert BSF&W

Barren

Scattered barren areas occur throughout much of the Lower Colorado Region. These areas range in character from wind-blown sandstone in the Navajo Reservation, to the volcanic rock and cinder areas as exemplified in the Sunset Crater National Monument, to areas of geologic erosion with the rock cliffs, sculptured forms, and talus slopes of the Grand Canyon, to barren desert areas and sand dunes of the southwestern desert lands, and the alkaline dry lake beds of the numerous closed basins in the Region.

Three areas are of sufficient size to show on the Vegetal Cover Map. The Willcox Playa in southeastern Arizona and the Alkali Flats in southwest New Mexico are salt flats devoid of any type of vegetation. During periods of abnormal precipitation, water may accumulate in these dry lake beds for short periods of time. These two barren areas have a

total area of about 50,000 acres. About 26,000 barren acres in southeastern Utah is an area of geologic erosion. The area consists of volcanic and granitic rock, with a few scattered small areas of very thin soil supporting sparse stands of mountain mahogany and Gamble oak, with an understory of grama grass and annual forbs.

Ownership and management responsibilities as related to vegetal cover types are tabulated in Table 3.

The land ownership and administration acreage figures may not agree with individual agency records because of the computer program used, lack of data or time and money.

Table 3
Lower Colorado Region
Land Ownership & Administration by Vegetal Cover Type
(1000 Acres)

Lower Main Stem Subregion

Land Ownership & Administration \ Vegetal Cover Type	Conifer Forest	Woodland	Chaparral	Southern Desert Shrub	Northern Desert Shrub	Grassland	Riparian	Urban	Cropland	Barren	Total Land Area
Federal Land Administered by:											
Forest Service	559	793	109	108	282	186	-	-	-	20	2,057
B.L.M.	41	3,732	94	7,242	4,419	1,224	7	-	-	5	16,764
B.S.F.&W.	-	173	2	1,484	27	3	15	-	-	-	1,704
Nat'l Park Service	195	669	-	1,671	103	33	-	-	-	-	2,671
Bureau of Rec.	10	114	-	219	22	53	-	-	-	-	418
Defense	-	-	-	2,829	-	-	-	-	-	-	2,829
Defense & B.S.F.&W.	-	-	-	806	-	-	-	-	-	-	806
Other	-	-	-	8	6	-	-	-	-	-	14
State	7	560	167	797	143	762	9	-	11	-	2,456
Other Public	3	-	-	-	-	-	-	-	-	-	3
Individual or Corporate	198	867	67	1,286	340	1,238	19	127	252	1	4,395
Indian	55	488	-	661	286	266	2	2	69	-	1,829
Total Land Area	1,068	7,396	439	17,111	5,628	3,765	52	129	332	26	35,946

Table 3
Lower Colorado Region
Land Ownership & Administration by Vegetal Cover Type
(1000 Acres)

Little Colorado Subregion

Land Ownership & Administration \ Vegetal Cover Type	Conifer Forest	Woodland	Chaparral	Southern Desert Shrub	Northern Desert Shrub	Grassland	Riparian	Urban	Cropland	Barren	Total Land Area
Federal Land Administered by:											
Forest Service	1,282	803	-	-	-	237	-	-	-	-	2,322
B.L.M.	55	388	-	-	20	398	-	-	-	-	861
B.S.F.&W.	-	-	-	-	-	-	-	-	-	-	-
Nat'l Park Service	6	23	-	-	23	107	-	-	-	-	159
Bureau of Rec.	-	-	-	-	-	-	-	-	-	-	-
Defense	4	3	-	-	-	6	-	-	-	-	13
Defense & B.S.F.&W.	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
State	22	751	-	-	118	789	-	-	-	-	1,680
Other Public	-	-	-	-	-	-	-	-	-	-	-
Individual or Corporate	123	1,323	-	-	306	2,260	-	18	47	-	4,077
Indian	210	2,318	-	-	2,452	3,143	-	1	16	-	8,140
Total Land Area	1,702	5,609	-	-	2,919	6,940	-	19	63	-	17,252

Table 3
Lower Colorado Region
Land Ownership & Administration by Vegetal Cover Type
(1000 Acres)

Gila Subregion

Land Ownership & Administration \ Vegetal Cover Type	Conifer Forest	Woodland	Chaparral	Southern Desert Shrub	Northern Desert Shrub	Grassland	Riparian	Urban	Cropland	Barren	Total Land Area
Federal Land Administered by:											
Forest Service	2,612	4,152	1,692	1,438	-	652	50	-	-	-	10,596
B.L.M.	2	215	416	3,596	-	818	-	-	-	15	5,062
B.S.F.&W.	-	-	-	-	-	-	-	-	-	-	-
Nat'l Park Service	22	30	3	38	-	1	-	-	-	-	94
Bureau of Rec.	-	-	-	-	-	-	-	-	-	-	-
Defense	16	-	29	315	-	46	-	2	-	27	435
Defense &B.S.F.&W.	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	22	64	-	-	-	-	-	-	86
State	32	440	353	3,359	-	2,136	1	-	113	6	6,440
Other Public	-	-	-	22	-	-	-	-	-	-	22
Individual or Corporate	74	709	350	2,684	-	2,232	3	355	1,203	2	7,612
Indian	994	1,352	162	3,510	-	312	-	8	105	-	6,443
Total Land Area	3,752	6,898	3,027	15,026	-	6,197	54	365	1,421	50	36,790

Table 3
Lower Colorado Region
Land Ownership & Administration by Vegetal Cover Type
(1000 Acres)

Regional Summary

Land Ownership & Administration \ Vegetal Cover Type	Conifer Forest	Woodland	Chaparral	Southern Desert Shrub	Northern Desert Shrub	Grassland	Riparian	Urban	Cropland	Barren	Total Land Area
Federal Land Administered by:											
Forest Service	4,453	5,748	1,801	1,546	282	1,075	50	-	-	20	14,975
B.L.M.	98	4,335	510	10,838	4,439	2,440	7	-	-	20	22,687
B.S.F.&W.	-	173	2	1,484	27	3	15	-	-	-	1,704
Nat'l Park Service	223	722	3	1,709	126	141	-	-	-	-	2,924
Bureau of Rec.	10	114	-	219	22	53	-	-	-	-	418
Defense	20	3	29	3,144	-	52	-	2	-	27	3,277
Defense & B.S.F.&W.	-	-	-	806	-	-	-	-	-	-	806
Other	-	-	22	72	6	-	-	-	-	-	100
State	61	1,751	520	4,156	261	3,687	10	-	124	6	10,576
Other Public	3	-	-	22	-	-	-	-	-	-	25
Individual or Corporate	395	2,899	417	3,970	646	5,730	22	500	1,502	3	16,084
Indian	1,259	4,158	162	4,171	2,738	3,721	2	11	190	-	16,412
Total Land Area	6,522	19,903	3,466	32,137	8,547	16,902	106	513	1,816	76	89,988

CHAPTER D - LAND OWNERSHIP AND ADMINISTRATION

The territory that includes the Lower Colorado Region was obtained by the United States from the "Cession from Mexico" (1848) and the Gadsden Purchase (1853). Included were lands previously granted to private ownership by the King of Spain. These were known as Spanish Land Grants and were recognized as private land by the U. S. Government. All the remaining area became a part of the nation's public domain. Withdrawals for national forests, national parks and other purposes from the public domain lands have created the current pattern of ownership and administration of land.

By 1965 about 18 percent of the total had become individual or corporate, 18 percent Indian trust, 12 percent state and municipal, with 52 percent remaining in federal ownership.

The basic land ownership and administration statistics are presented in Figure 6 and in Table 4. The land ownership and administration acreage figures may not agree with individual agency records because of the computer program used, lack of data or time and money. Location is shown on Map 5, Land Ownership and Administration.

The Department of the Interior and the Department of Agriculture administer 91 percent of the federal lands in the Region. Some four million acres are also administered partially or wholly by the Department of Defense. In addition to the management of federal lands, the Interior Department, Bureau of Indian Affairs holds in trust for the Indian tribes the title to reservation lands. The United States also holds in trust status for individual members of Indian tribes who are recipients of allotments, or for their heirs, title to such allotted lands of individual ownership. As trustee, the federal government is responsible for the protection and management of these lands. Administration is by the Bureau of Indian Affairs.

The Bureau of Land Management currently administers about 23 million acres or about 25 percent of the land area. These lands represent the remaining public domain. They are generally located in the more arid areas where vegetation is sparse.

The Classification and Multiple Use Act of 1964 directed the Secretary of the Interior to determine which of the public lands administered by BLM should be classified as suitable for either disposal or retention for multiple-use management. Lands classified for disposal can be transferred to states, counties, municipalities, and private interests to meet their specific needs.

Some public domain lands are withdrawn for specific purposes and administered by other agencies or managed jointly. Lands withdrawn for military purposes, power sites, and recreation areas are examples. Special use arrangements are made with private individuals or concerns for the use of public domain for concessions or other uses not covered by existing public land laws.

Another Interior Department agency with significant administrative responsibility is the National Park Service. The first national parks and monuments were established from public domain lands. Later national parks and monuments were established when lands were acquired by the states or through private philanthropy and donated to the federal government. Only recently have federal funds been authorized for the acquisition of lands for inclusion in the National Park System.

The Bureau of Sport Fisheries and Wildlife administers lands to protect wildlife in danger of extinction, resting areas for migratory waterfowl, hatching and growing fish for stocking and related uses.

The Bureau of Reclamation withdrawals for the preservation of power and reservoir sites are managed for recreation and other uses as well. Lands withdrawn for military purposes are managed by the Department of Defense usually as single purpose use. However, some of these lands support grazing, recreation and other uses that do not interfere with the military use.

Within the Department of Agriculture, the Forest Service is the only land management agency. The Forest Service administers the lands reserved from public domain or acquired through purchase or exchange and established as the National Forest System. This includes 14,975,000 acres or 17 percent of the Region. About 825,000 acres of the land within national forest boundaries are private, state, or other nonfederal land. These lands consist of farms or ranches, small communities or towns, state or local parks or recreation areas, public reservoirs, etc.

A large share of state ownership resulted from land grants to states for aid to education. The school land grants were provided for at statehood, but title did not pass until the lands were surveyed. Variations are found in the amount of grants depending on time and circumstances of admission to statehood. Utah received four sections per township, while Nevada received two sections on lands already surveyed. In 1880 Nevada waived their rights on unsurveyed lands and were allowed to select 2,000,000 acres of land anywhere in the state. Arizona was granted four sections per township of public domain lands for support of public schools. This included some 9,180,000 acres. In addition, Arizona was granted lands to support penitentiaries, military institutes, for payment of bonds, and for similar purposes

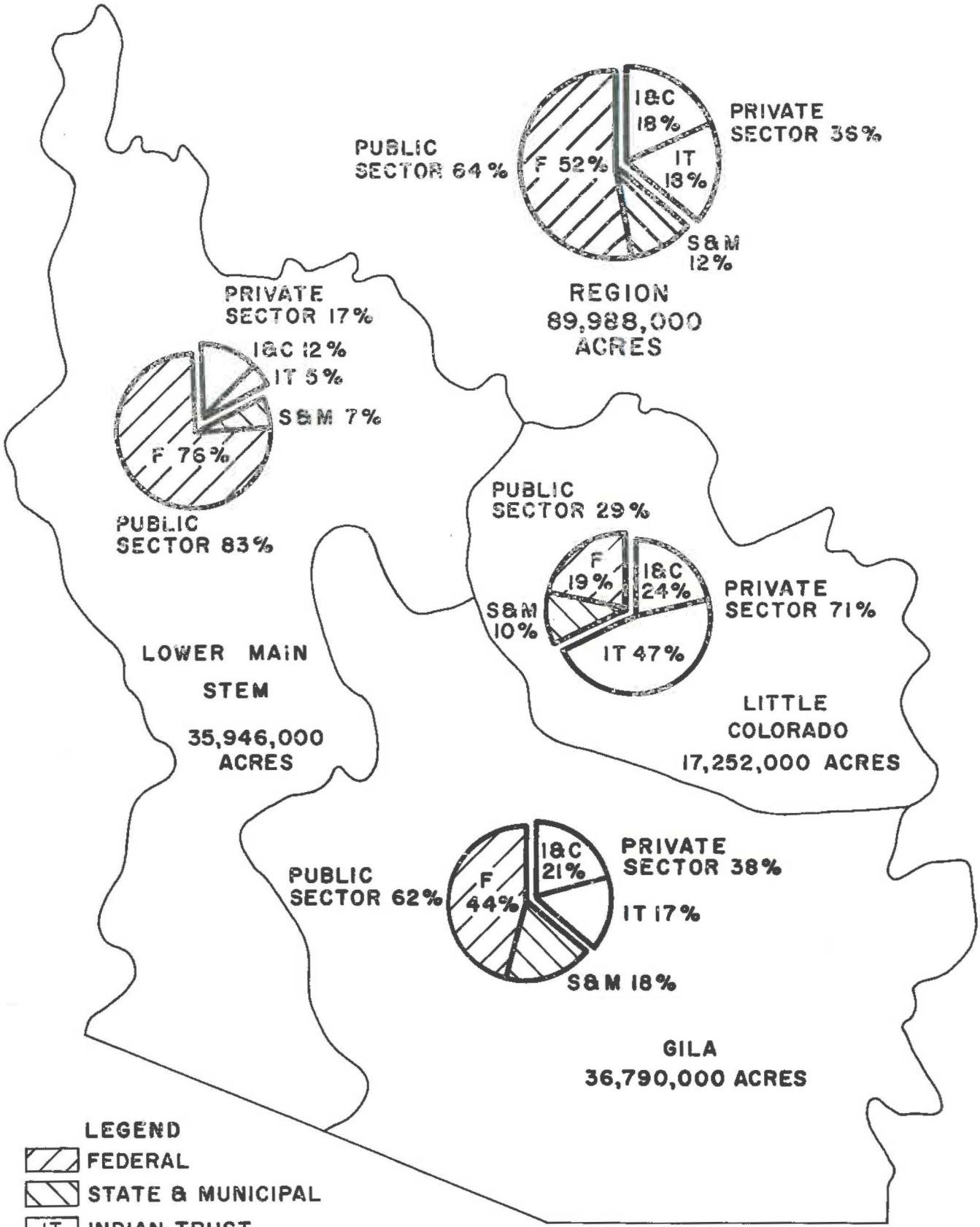


FIGURE 6
LOWER COLORADO REGION
LAND OWNERSHIP AND ADMINISTRATION
1965

Table 4
Lower Colorado Region
Land Ownership and Administration

Lower Main Stem Subregion
1965

Land Ownership & Administration	Area			
	State of Arizona	State of Nevada	State of Utah	Total
	(Thous. ac)	(Thous. ac)	(Thous. ac)	(Thous. ac)
Federal Lands				
Administered by Dept. of Agri.				
Forest Service	1,432	336	289	2,057
Administered by Dept. of Int.				
Bureau of Land Management	7,526	8,123	1,115	16,764
Bureau of Sport Fisheries & Wildlife	772	932	0	1,704
National Park Service	2,091	441	139	2,671
Other (Bureau of Reclamation)	364	54	0	418
Administered by Dept. of Def.	3,109 1/	526 2/	0	3,635
Other	0	14 3/	0	14
Subtotal Federal Lands	(15,294)	(10,426)	(1,543)	(27,263)
State-Owned Lands	2,280	39	137	2,456
Other Public Lands	3	0	0	3
Subtotal Non-Federal Public Lands	(2,283)	(39)	(137)	(2,459)
Privately-Owned Lands				
Individual or Corporate	3,368	473	554	4,395
Indian Trust Lands 4/	1,824	5	0	1,829
Subtotal Private Lands	(5,192)	(478)	(554)	(6,224)
Total	22,769	10,943	2,234	35,946

1/ Includes Cabeza Prieta Game Refuge which is administered jointly with BSF&W.
2/ This includes Desert Game Refuge administered jointly with BSF&W.
3/ Administered by County, State, etc.
4/ All BIA administered lands appear as line item "Indian Trust."

(1 of 4)

Table 4
Lower Colorado Region
Land Ownership and Administration

Little Colorado Subregion
1965

Land Ownership & Administration	Area		
	State of Arizona	State of New Mexico	Total
	(Thous. ac)	(Thous. ac)	(Thous. ac)
Federal Lands			
Administered by Dept. of Agri.			
Forest Service	1,990	332	2,322
Administered by Dept. of Int.			
Bureau of Land Management	313	548	861
Bureau of Sport Fisheries & Wildlife	0	0	0
National Park Service	159	0	159
Other (Bureau of Reclamation)	0	0	0
Administered by Dept. of Def.	0	13	13
Other	0	0	0
Subtotal Federal Lands	(2,462)	(893)	(3,355)
State-Owned Lands	1,354	326	1,680
Other Public Lands	0	0	0
Subtotal Non-Federal Public Lands	(1,354)	(326)	(1,680)
Privately-Owned Lands			
Individual or Corporate	2,989	1,088	4,077
Indian Trust Lands 1/	7,052	1,088	8,140
Subtotal Private Lands	(10,041)	(2,176)	(12,217)
Total	13,857	3,395	17,252

1/ Includes BIA administered lands.

(2 of 4)

Table 4
Lower Colorado Region
Land Ownership and Administration

Gila Subregion
1965

Land Ownership & Administration	Area		
	State of Arizona	State of New Mexico	Total
	(Thous. ac)	(Thous. ac)	(Thous. ac)
Federal Lands			
Administered by Dept. of Agri.			
Forest Service	8,103	2,493	10,596
Administered by Dept. of Int.			
Bureau of Land Management	4,104	958	5,062
Bureau of Sport Fisheries & Wildlife	0	0	0
National Park Service	94	0	94
Other (Bureau of Reclamation)	0	0	0
Administered by Dept. of Def.	435	0	435
Other	86	0	86
Subtotal Federal Lands	(12,822)	(3,451)	(16,273)
State-Owned Lands	5,674	766	6,440
Other Public Lands	22	0	22
Subtotal Non-Federal Public Lands	(5,696)	(766)	(6,462)
Privately-Owned Lands			
Individual or Corporate	6,680	932	7,612
Indian Trust Lands 1/	6,443	0	6,443
Subtotal Private Lands	(13,123)	(932)	(14,055)
Total	31,641	5,149	36,790

1/ Includes BIA administered lands.

(3 of 4)

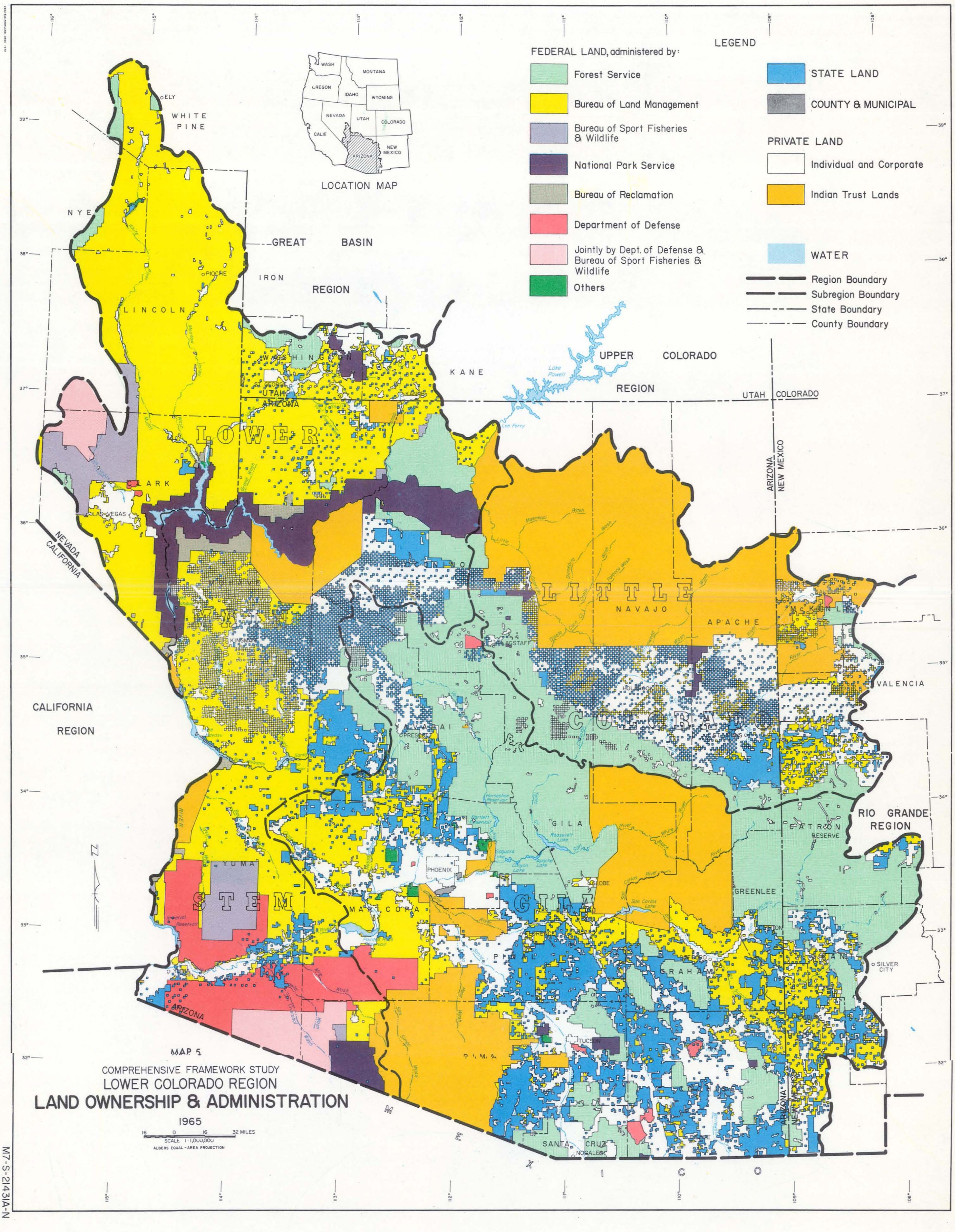
Table 4
Lower Colorado Region
Land Ownership and Administration

Region Summary 1/
1965

Land Ownership & Administration	Area				
	State of Arizona	State of Nevada	State of Utah	State of New Mexico	Total
	(Thous. ac)	(Thous. ac)	(Thous. ac)	(Thous. ac)	(Thous. ac)
Federal Lands					
Administered by Dept. of Agri.					
Forest Service	11,525	336	289	2,825	14,975
Administered by Dept. of Int.					
Bureau of Land Management	11,943	8,123	1,115	1,506	22,687
Bureau of Sport Fisheries & Wildlife	772	932	0	0	1,704
National Park Service	2,344	441	139	0	2,924
Other (Bureau of Reclamation)	364	54	0	0	418
Administered by Dept. of Def.	3,544	526	0	13	4,083
Other	86	14	0	0	100
Subtotal Federal Lands	(30,578)	(10,426)	(1,543)	(4,344)	(46,891)
State-Owned Lands	9,308	39	137	1,092	10,576
Other Public Lands	25	0	0	0	25
Subtotal Non-Federal Public Lands	(9,333)	(39)	(137)	(1,092)	(10,601)
Privately-Owned Lands					
Individual or Corporate	13,037	473	554	2,020	16,084
Indian Trust Lands	15,319	5	0	1,088	16,412
Subtotal Private Lands	(28,356)	(478)	(554)	(3,108)	(32,496)
Total	68,267	10,943	2,234	8,544	89,988

1/ All previous footnotes are applicable

(4 of 4)



MAP 5

COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
LAND OWNERSHIP & ADMINISTRATION
1965

SCALE 1:1,000,000
ALBERS EQUAL-AREA PROJECTION

M7-S-2143A-N

to bring the total acreage in the Lower Colorado Region as of 1965 to 9,308,000 acres. New Mexico was granted approximately 13,000,000 acres originally on the general basis of four sections per township. Transactions since the original grant leave the state in control of about 9,476,000 acres.

State land in Arizona is administered by the State Land Department. The State Land Commissioner, as executive officer of the Land Department, interprets and administers all laws pertaining to these lands. Small parcels of state land are administered by the State Highway Commission, the State Game and Fish Department, State Parks Board, and the universities.

New Mexico state trust lands are managed by the Commissioner of Public Lands with assistance from state agencies. The agencies include the State Park Commission, the State Forestry Commission, the State Department of Game and Fish, the State Engineer (for use of water from state lands), the State Highway Department, and others dealing with land use.

State land in Utah is under the jurisdiction of the Department of Natural Resources. Within this department most of the land is managed by the Division of State Lands.

Most state land in Nevada is controlled by the Department of Conservation and Natural Resources.

Individual or corporate lands, other than the original Spanish land grants, have been obtained from public domain under various land laws. They include about 18 percent, or 16 million acres, of the Region.

Indian trust lands have been obtained from public domain under various treaties and orders. They include about 16 million acres, or 18 percent, of the Region.

In the early 1850's railroad land grant laws were passed to encourage and assist building railroads in vacant and sparsely settled sections of the country. This resulted in a shift of large acreages from federal to private ownership. The Santa Fe Railroad received government grants for alternate sections of land in strips approximately 20 miles on each side of the railroad through portions of the Lower Colorado Region. These grants caused a checkerboard pattern of landownership. The railroads sold this land to individuals, corporations, municipalities, etc.

In order to encourage individual development of the public domain in the west, Congress passed various homestead acts and the Desert Land Act. Under these laws it was possible for a citizen of the United States

over 21 years of age to acquire land at a very low cost by settling and developing it. Such lands are found scattered throughout the Region, generally in the fertile valleys where water was available. A small amount of land is still being disposed of today for specific purposes under appropriate laws, but such dispositions have steadily decreased. Today it is difficult to find land that will meet the requirements of these laws. Some public domain is sold or exchanged to private and nonfederal entities when the best public interest is served.

Most of the private lands are considered agricultural. Individual and corporate ownership units vary from 10 acres to over 100,000 acres. In 1965 there were about 7,900 separate operating units in the Region. This number has been decreasing from about 23,000 in 1939, to 12,000 in 1949, and to 9,000 in 1959.

The number of operating units by economic class in 1964 are as follows:

Region	Lower Main Stem	Little Colorado	Gila	(Value of Products Sold) In Dollars
1,738	284	28	1,426	$40,000 or more
765	155	37	573	20,000 to 40,000
773	136	46	591	10,000 to 20,000
770	148	67	555	5,000 to 10,000
754	160	53	541	2,500 to 5,000
668	120	36	512	50 to 2,500
2,471	527	268	1,676	Other (part time, etc.)
7,939	1,530	535	5,874	Totals

Large corporations, about 650 units of 500 irrigated acres or more, are included in the $40,000 or more category and are found mainly in the southern parts of the Gila and Lower Main Stem subregions. Small units that are considered uneconomical in supporting themselves are shown in the last four categories (about 20 percent of the total number of units). Over 50 percent of these units are operated by the owners, about 11 percent by tenants, some 5 percent by paid managers, and the remaining operators are classified as part time, retired, hobby, institutional, etc.

LAND RESOURCES AND USE

CHAPTER E - LAND RESOURCES AND USE

PRESENT USES AND PROJECTED REQUIREMENTS

Land in the Lower Colorado Region is used in many ways. Some uses are as old as the resource itself. Almost all uses, by man, modify the environment to some extent. In some cases resource deterioration may result.

Man-caused changes need not be destructive, however. The land can be used for the production of food and fiber, water yield, forage, recreation, wildlife, etc. while still maintaining the productive capacity of the resources. This requires proper planning and restraint.

Land Resource Groups in the Lower Colorado Region in 1965 are summarized in Table 5.

Table 5
Lower Colorado Region
Land Resource Groups
(1,000 Acres)

Land Resource Groups	Lower Main Stem	Little Colorado	Gila	Region Totals
Cropland 1/	332	63	1,421	1,816
Rangeland	26,504	9,859	21,223	57,586
Forest Land	8,955	7,311	13,731	29,997
Urban and Built-up	129	19	365	513
Other	26	0	50	76
Total Land Area	35,946	17,252	36,790	89,988

1/ Includes irrigated pasture, acres planted but not harvested, acres developed for irrigation but idle or fallow in 1965, farmsteads, farm roads, farm irrigation canals, etc.

Most land has more than one use. Vast areas of land, such as grassland and forest land, support many varied uses (wildlife propagation, recreation, watershed, etc.). Some uses are nearly exclusive such as urban, developed recreation, and cultivation. Such uses usually cannot exist, in significant amounts, at the same time on the same land area without some downgrading of the uses or deterioration of the resources. Many uses, however, are compatible when proper planning and effective management are provided.

The principle of "multiple use" has come to be regarded as a key to guiding good land management. Most public-land-managing agencies and many private landowners have endorsed and followed this multiple-use principle for a number of years.

Multiple use is a system of planning and applying management on areas of land which emphasizes the protection, development, and use of its various resources so they are utilized in the best combination - on a sustaining basis - to meet the social, economic, and environmental needs of the people. Periodic adjustments are required and desirable to conform with changing needs and conditions. Based upon landowners' goals, legislative or administrative direction, and land capabilities, not all resources are used on some land. Coordination in the uses of the various resources is directed toward achieving an optimum output and a desirable balance in the harvest of products and enjoyment of services from the land while maintaining a quality environment. It is not necessary that the combination of uses give the greatest dollar return or the greatest unit output. Often, though, maximum outputs from the use of one or more of the resources may be attained without loss of other values. This study uses the term "multiple use" within this framework.

Multiple use of the land base by land resource group is shown in Table 6. The table suggests the kinds of use combinations involved in multiple-use management as of 1965. The "Projected Output from Land Under Alternative Program Levels" Table 48 (page 223) shows the anticipated outputs from the land for the last year in each projection period.

Changing technologies, needs of people, and resource situations will, to a large extent, determine the management direction and the coordination needed to foster optimum production. Within the foreseeable technologies, there is a limit to the amount of goods and services that a land base can yield. As the pressures for more production, less pollution, and quality environment increase, sound land management objectives will need increasingly to recognize and emphasize the management of all the land for the greatest total benefit of all the people.

Table 6
LAND USE, 1965
(Areas in thousands of acres)

Present Land Use

Lower Colorado Region
Lower Main Stem Subregion

Land Resource Groups	Area of LRG's (1965) 2/	Cultivation		Grazing	Timber Production	Urban & Industrial	Outdoor Recreation		Designated Wilderness	Military	Mineral Production	Fish & Wildlife		Watershed		Transp. and Utilities
		Irrig.	Non-irrig.				3/ Desig.	Un-desig.				4/ Desig.	Un-desig.	Class.	Un-class.	
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Cropland 1/	332	267	5	132	0	-	-	250	0	-	-	-	332	0	332	20
Rangeland	26,504	0	0	20,600	-	-	3,203	20,612	0	3,652	4	1,148	23,929	0	26,504	100
Forest Land	8,955	0	0	7,238	873	-	1,304	5,705	0	-	1	675	7,493	0	8,955	45
Urban	129	-	-	-	-	129	10	30	0	-	-	-	128	0	129	56
Barren	26	0	0	0	0	-	-	26	0	0	0	0	26	0	26	-
Total	35,946	267	5	27,970	873	129	4,247	26,623	0	3,652	5	1,823	31,908	0	35,946	221

1/ Including Pasture
2/ Land Resource Groups
3/ Includes National Parks, City Parks, County Parks, Public Campgrounds, etc.
4/ Another 1.4 million acres were managed primarily for wildlife but were not available to the hunter.

NOTE: Dash indicates small acreage

Table 6
LAND USE, 1965
(Areas in thousands of acres)

Present Land Uses

Lower Colorado Region
Little Colorado Subregion

Land Resource Group	Area of LRG's (1965) 2/	Cultivation		Grazing	Timber Production	Urban & Industrial	Outdoor Recreation		Designated Wilderness	Military	Mineral Production	Fish & Wildlife		Watershed		Transp. and Utilities
		Irrig.	Non-irrig.				3/ Desig.	Un-desig.				Desig.	Un-desig.	Class.	Un-class.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Cropland 1/	63	28	16	36	0	-	-	52	0	-	-	-	63	0	63	3
Rangeland	9,859	0	0	9,381	-	-	175	7,985	0	21	5	8	9,851	3	9,856	32
Forest Land	7,311	0	0	7,187	1,419	-	26	6,886	0	-	2	8	7,303	12	7,299	20
Urban	19	-	-	-	-	19	2	2	0	-	-	-	18	0	19	8
Barren	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	-
Total	17,252	28	16	16,604	1,419	19	203	14,925	0	21	7	16	17,235	15	17,237	63

1/ Including Pasture
2/ Land Resource Groups
3/ Includes National Parks, City Parks, County Parks, Public Campgrounds, etc.

NOTE: Dash indicates small acreage

Table 6
LAND USE, 1965
(Areas in thousands of acres)

Present Land Uses

Lower Colorado Region
Gila Subregion

Land Resource Group	Area of LRG's (1965) 2/	Cultivation		Grazing	Timber Production	Urban & Industrial	Outdoor Recreation		Designated Wilderness	Military	Mineral Production	Fish & Wildlife		Watershed		Transp. and Utilities
		Irrig.	Non-irrig.				3/ Desig.	Un-desig.				Desig.	Un-desig.	Class.	Un-class.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Cropland 1/	1,421	895	-	412	0	-	-	1,000	0	-	-	-	1,333	0	1,421	88
Rangeland	21,223	0	0	20,777	-	-	655	12,000	10	402	13	12	12,157	4	21,219	123
Forest Land	13,731	0	0	10,291	3,166	-	401	8,000	851	51	50	7	13,681	20	13,719	65
Urban	365	-	-	-	-	365	36	100	0	-	-	-	65	0	365	100
Barren	50	0	0	0	0	-	0	50	0	-	0	0	50	0	50	-
Total	36,790	895	-	31,480	3,166	365	1,092	21,150	861	453	63	19	36,286	24	36,774	376

1/ Including Pasture
2/ Land Resource Groups
3/ Includes National Parks, City Parks, County Parks, Public Campgrounds, etc.

NOTE: Dash indicates small acreage

Table 6
LAND USE, 1965
(Areas in thousands of acres)

Present Land Uses — Lower Colorado Region

Land Resource Groups	Area of (1965) 2/	Cultivation		Grazing	Timber Production	Urban & Industrial	Outdoor Recreation		Designated Wilderness	Military	Mineral Production	Fish & Wildlife		Watershed		Transp. & Utilities
		Irrig.	Non-irrig.				3/ Desig.	Un-desig.				4/ Desig.	Un-desig.	Class.	Un-class.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Cropland 1/	1,816	1,190	21	580	0	-	-	1,302	0	-	-	-	1,728	0	1,816	111
Rangeland	57,586	0	0	50,758	-	-	4,033	40,597	10	4,075	22	1,168	54,937	7	57,579	255
Forest Land	29,997	0	0	24,716	5,458	-	1,461	15,591	851	51	53	690	28,477	32	29,973	130
Urban	513	-	-	-	-	513	48	132	0	-	-	-	211	0	513	164
Barren	76	0	0	0	0	-	0	76	0	-	0	0	76	0	76	-
Total	89,988	1,190	21	76,054	5,458	513	5,542	57,698	861	4,126	75	1,858	85,429	39	89,957	660

1/ Including Pasture
2/ Land Resource Groups
3/ Includes National Parks, City Parks, County Parks, Public Campgrounds, etc.
4/ Another 1.4 million acres were managed primarily for wildlife but were not available to the hunter.

NOTE: Dash indicates small acreage

Cultivation

The availability of suitable irrigation water, in terms of both quantity and quality, has been the major determining factor in the location and amount of irrigated land in the Basin and Range Province (see Map 3). In this area there are vast areas of soil suitable for irrigation. The nearly yearlong growing season makes this area ideal for irrigated crop production. Yields per acre for most irrigated crops are among the highest in the nation.

Irrigated farming in the Colorado Plateau Province has developed primarily along major streams where soils are productive, of uniform slopes, and where suitable water is available. Irrigated crop production in this area is limited because of the relatively short growing season (75-150 days).

The Region's total cropland area contains about 1.8 million acres. Of this amount, about 77 percent is in the Gila Subregion, some 21 percent is in the Lower Main Stem Subregion, and less than 2 percent is in the Little Colorado Subregion. Only 31,000 acres of the Region's total cropland are nonirrigated.

Most of the irrigated cultivated areas in the Gila Subregion are around Phoenix and southeast in the Casa Grande area and Santa Cruz valleys. Smaller irrigated areas are found in the eastern portion of the subregion in Arizona and New Mexico. The irrigated acreage in the Lower Main Stem Subregion is concentrated around Yuma and along the Colorado and lower Gila rivers in Arizona. Smaller areas lie along the White and Muddy rivers in Nevada and the Virgin River in Utah. The Little Colorado Subregion contains smaller, scattered areas along the Little Colorado River and many of its tributaries. Most of the products of these small irrigated areas are consumed locally, especially by the Indians on reservations.

Refer to Map 4, Vegetal Cover, for extent of cultivated lands, and the Irrigation and Drainage Appendix for additional information on irrigated lands.

Water for irrigation is usually the limiting factor in crop production. More land is developed for irrigation than is used annually. The acreage planted to crops increases when the quantity of water in storage is above average at the beginning of the crop years.

The long growing season (250-330 days) at the lower elevations of the Gila and Lower Main Stem subregions make it possible to produce crops on most of this irrigated land anytime during the year. Crops adapted to cool temperatures (vegetables, small grains, etc.) are grown during the cooler months, crops such as cotton and sorghum are grown during the warmer months. Citrus is in danger of frost only for

a short time during the year. In most of this area it is possible to produce two or more crops per year. In 1965, about 125,000 acres in this area produced two or three crops.

Irrigated land in other sections of the Region is not used as intensively and supports crops such as forage and small grains with row crops occasionally.

Much of the irrigated land is highly developed. The land has naturally uniform slopes or has been leveled for the most efficient border type of irrigation methods. Modern irrigation systems and irrigation techniques are used. Some of the systems are highly automated with surface irrigation timed by clocks which control electrically operated valves.

The Region's farmers generally have taken advantage of the technology available to them and have incorporated new technologies into their operations as they become available and where appropriate. It is expected that the Region will continue to be responsive to and benefit from technological advances.

Of the four main sources of income (manufacturing, mining, agriculture, and tourism) agriculture produces approximately 20 percent of the total and employs about 7.2 percent of the Region's labor force. The major agricultural enterprise is cash crops such as cotton, barley, alfalfa, sorghum, vegetables, and citrus. Practically all production of these crops is on irrigated land. In 1965, approximately 55 percent of the Region's agricultural income was related to crop production.

As shown on Table 7, yields of most irrigated crops in the Region are high compared with those of other regions of the United States.

Table 7
Lower Colorado Region
Irrigated Crop Distribution, Yields, Rank in Average Yield Per Acre [1], and Percent of Total U. S. Irrigated Acreage by Major Crops-1965

Major Crop	Crop Distribution (Percent) [2]	Crop Yield Range in Yield Per Acre	Rank	Percent of Total U. S. Irrigated Acreage for Crop
Barley	14	1600-5000 lbs.	1	8.7
Sorghum	15	3500-7500 lbs.	1	4.0
Alfalfa Hay	17	4-10 tons	2	3.7
Cotton (All)	28	500-1500 lbs.	2	9.7
Cotton (America-Egypt)	(3)	500-750 lbs.	1	44.0
Citrus Fruit	3	8-10 tons	N.A.	2.1
Vegetables	6	150-200 cwt.	N.A.	5.6
Other	17	-	-	-

1/ In comparison with the other 19 Water Resource Regions of the United States.

2/ By acres harvested

NOTE: Refer to the Economic Base and Projections and Irrigation and Drainage appendixes for further details.

The Region produces a significant amount of the national supply of early summer, late fall, spring and winter vegetables and melons. Table 8 indicates the relative importance of the Region in supplying this demand.

Table 8
Percent of National Supply of Vegetables and Melons
Supplied by the Lower Colorado Region
1965

Crops	Period of Year	Percent
Vegetables		
Broccoli	Winter	19
Carrots	Spring	100
Cauliflower	Winter	32
Lettuce	Winter	26
Lettuce	Early Spring	52
Lettuce	Late Fall	100
Onions	Late Spring	35
Melons		
Cantaloupes	Spring	52
Cantaloupes	Early Summer	12
Honeydews	Early Summer	100

In 1965 there were about 39,000 acres planted to citrus in the Region. Of this acreage 53 percent was producing oranges, 23 percent grapefruit, and 24 percent lemons. Citrus is grown in the lower elevations of the Gila and Lower Main Stem subregions where the growing season is nearly yearlong. Because of the unique climate in this area of the Region, there is a vast acreage of land suitable for expansion of citrus production as the need arises.

Irrigated lands of the Region provide pasture in crop rotation and permanent pasture. Grass and legume pastures help control soil erosion and reduce water runoff. They are also soil conditioning crops which increase soil fertility and improve soil structure.

About 38,000 acres of irrigated land are devoted to pasture. The Gila Subregion contains about 80 percent of this total with 15 percent in the Lower Main Stem and 5 percent in the Little Colorado subregions.

Irrigated pastures, which make up a very small percent of the total agricultural sector of the economy, are generally used in dairy cattle and feeder cattle operations and for horses. Intensity of use is similar throughout the Region with more production expected and obtained from the irrigated land in the valley areas than from higher elevation lands with shorter growing seasons. Yields range from about 9 animal unit months per acre per year to 20 or more.

Grazing of livestock animals on irrigated pasture and after harvest of other crops is a common practice and occurs on more than 540,000 acres.

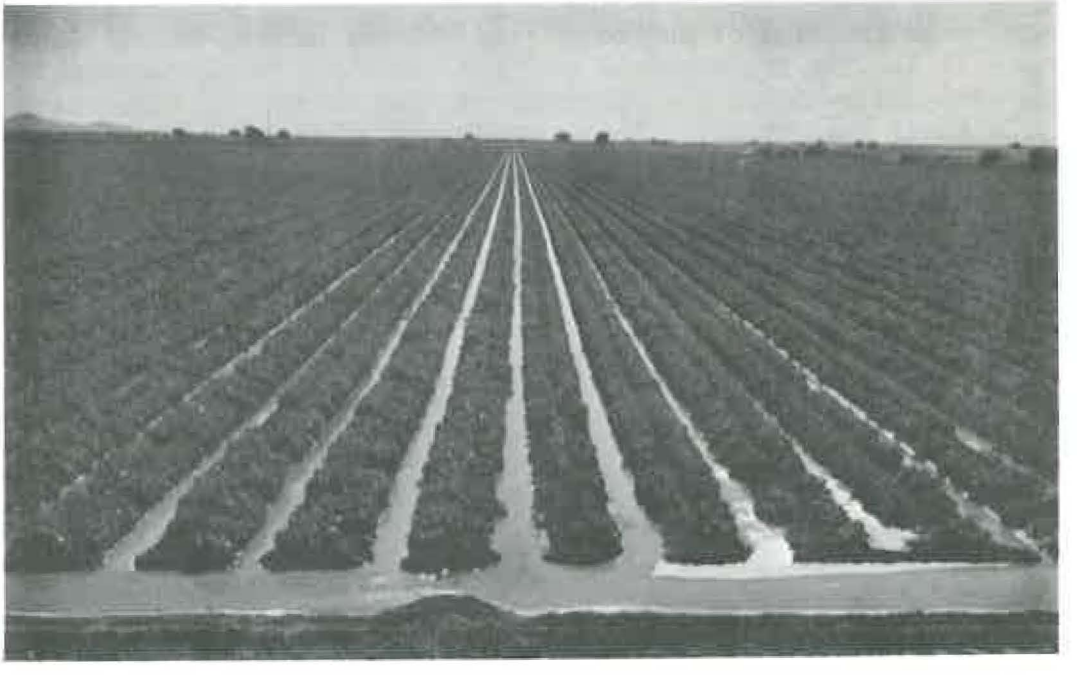


Photo 23. Irrigated Crop Production MCES

Irrigated lands are compatible with some kinds of recreation use. Sightseeing, family outings, horseback riding, nature study, hunting, some fishing in irrigation canals and farm ponds, and picnicking are recreation activities using this land.

There were 31,000 acres of nonirrigated cropland in the Region in 1965. This cropland is located on gently to moderately sloping lands above 4,000 feet elevation with annual precipitation of 16 inches or more. About 21,000 acres of the total were harvested in 1965. The remaining area, about 10,000 acres, includes idle and fallow, crop failures, roads, farmsteads, etc.

The most successfully dry farmed area is found between 5,000 and 8,000 feet in elevation with 20 inches or more average annual precipitation. Crop failure in years of below average annual precipitation is significant below these limits. Other problems in nonirrigated farming include short growing season, which limits the choice of crops, and the low precipitation rate (less than two inches in some years) during the growing season.

More than one-half of the production from nonirrigated cropland is consumed in the local area where grown. Although this represents a very small fraction of the total agricultural output for the Region, it is very important in the locality where it is produced. Indians on reservations are dependent on this source for a substantial part of their food supply. More details may be found in the Economic Base and Projections Appendix.

Table 9 presents the major nonirrigated crops and their range in yields for 1965.

Table 9
Lower Colorado Region
Major Nonirrigated Crops and Yield - 1965

Nonirrigated Crops	General Range in Yields
Dry Beans	200-500 lbs/ac
Corn - grain	300-700 lbs/ac
Oats	400-1,000 lbs/ac
Cereal grain - grain	500-1,000 lbs/ac
Tame hay	3/4-2 tons/ac
Grass - hay	3/4-1½ tons/ac
Grass - pasture	3/4-2½ AUMs/ac

Most irrigated and nonirrigated cropland is associated with a livestock operation and is grazed after crop harvest. They frequently provide food and sometimes cover for some species of wildlife. Hunting, sightseeing, nature study, and horseback riding are compatible uses.

Cultivated land provides food, cover, and water for many species of wildlife. These are the three basic requirements for survival. The kind of crop, its maturity, and the type of vegetation adjoining it are but a few of the many factors determining the species which will use this land, and the benefit this species will derive from the land.

Doves, for example, may feed in a grain field, and drink from the adjacent irrigation waters. But they must seek roosting and nesting cover elsewhere. These same doves often roost and nest to some degree in a citrus orchard, and may again find water here. But they must go elsewhere for food. The limiting factor determining the population of the species may or may not be cultivated crops or practices.

Human activity on cultivated lands tends to affect native wildlife habitat and may result in changing or introducing other species. Activities such as cultivating, irrigating, and spraying necessary for high agriculture production may in some cases be sufficient disturbance to limit wildlife activities on and adjacent to agricultural lands.

Table 10 presents present and projected values of crop production in the Region, by subregions. Table 11 shows present and projected acreage of lands required for crop production.

Table 10
Lower Colorado Region
Total Value of Crop Production
(million dollars - 1960 prices)

Subregion	1965	Projections 1/		
		1980	2000	2020
Lower Main Stem	87.2	140.4	195.1	269.1
Little Colorado	2.1	2.9	4.3	6.1
Gila	250.0	356.6	504.3	656.6
Total Region	339.3	499.9	703.7	931.8

1/ These projections, and all others in this appendix with the exception of those in Chapter K, are based on the Modified OBE-ERS projected level of development. For a comparison of alternative projections, see Chapter K.

Table 11
Lower Colorado Region
Land Required for Crop Production
(1,000 Acres)

Subregion	1965	Projections 1980	2000	2020
Total Cropland Area	1,816	1,891	1,905	1,852
Lower Main Stem	(332)	(386)	(388)	(409)
Little Colorado	(63)	(65)	(61)	(56)
Gila	(1,421)	(1,440)	(1,456)	(1,387)
Irrigated	1,785	1,863	1,882	1,833
Lower Main Stem	(324)	(379)	(382)	(403)
Little Colorado	(40)	(44)	(44)	(43)
Gila	(1,421)	(1,440)	(1,456)	(1,387)
Nonirrigated	31	28	23	19
Lower Main Stem	(8)	(7)	(6)	(6)
Little Colorado	(23)	(21)	(17)	(13)
Gila	(-)	(-)	(-)	(-)
Total Planted Acreage 1/	1,211	1,365	1,445	1,474
Lower Main Stem	(272)	(332)	(344)	(370)
Little Colorado	(44)	(48)	(48)	(46)
Gila	(895)	(985)	(1,053)	(1,058)
Irrigated	1,190	1,346	1,428	1,459
Lower Main Stem	(267)	(327)	(339)	(366)
Little Colorado	(28)	(34)	(36)	(35)
Gila	(895)	(985)	(1,053)	(1,058)
Nonirrigated	21	19	17	15
Lower Main Stem	(5)	(5)	(5)	(4)
Little Colorado	(16)	(14)	(12)	(11)
Gila	(-)	(-)	(-)	(-)
Total Harvested Acreage 2/	1,263	1,489	1,580	1,613
Lower Main Stem	(283)	(363)	(376)	(405)
Little Colorado	(42)	(37)	(39)	(40)
Gila	(938)	(1,089)	(1,165)	(1,168)
Irrigated	1,242	1,470	1,563	1,598
Lower Main Stem	(278)	(358)	(371)	(401)
Little Colorado	(26)	(23)	(27)	(29)
Gila	(938)	(1,089)	(1,165)	(1,168)
Nonirrigated	21	19	17	15
Lower Main Stem	(5)	(5)	(5)	(4)
Little Colorado	(16)	(14)	(12)	(11)
Gila	(-)	(-)	(-)	(-)

1/ The total planted acreage is equal to the total cropland area less: the acreage of public and private roads, ditches, utilities, etc. within cropland areas; the acreage on farms not developed for irrigation; and idle and fallow cropland.

2/ The total harvested acreage is equal to the total planted acreage, plus the acreage double cropped, less the acreage planted but not harvested because of floods, insects, disease, hail, unfavorable markets, etc.

NOTE: A dash (-) indicates an insignificant acreage.

Livestock Grazing

The total area useable for grazing by domestic livestock is about 76 million acres, 84 percent of the total land area of the Region. About 21 percent of the grazing land is in private ownership, 14 percent state and county ownership, 20 percent in Indian trust, and the remaining 45 percent is owned by the federal government.

The following tabulation indicates subregional distribution of grazing lands and the amounts in federal and nonfederal ownership:

Lower Colorado Region
Area Used by Domestic Livestock 1/
(1,000 Acres)
1965

	Lower Main Stem Subregion	Little Colorado Subregion	Gila Subregion	Lower Colorado Region Total
Federal Land	20,138	2,491	13,222	35,851
Nonfederal Land	7,832	14,113	18,258	40,203
Total	27,970	16,604	31,480	76,054

1/ Includes pasture and aftermath grazing on cropland which totaled 542,000 acres in the Region in 1965.

The land area produces an annual average of about 7,876,000 animal unit months (AUMs) of forage production on native grazing lands. 2/ In addition, grazing aftermath of crops on cultivated land and permanent pastures supply about 600,000 AUMs. An estimated 30 percent of this 8.5 million AUMs forage production is on private, 16 percent on state and county, 18 percent on Indian trust lands, and 36 percent on federally-owned lands.

2/ See Economic Base and Projections Appendix for further detail.

Livestock on grazing lands within the Region numbered approximately 1.1 million in 1965. Distribution of the total number of livestock and AUMs used was about as follows:

Kind of Livestock	Percent of total number	Percent of total forage
Cattle	42	73
Sheep	48	15
Horses	4	10
Goats	6	2

The native grazing lands of the Lower Colorado Region present a wide variance in complexities and resource values. These variations are the result of differences in topography, climate, elevations, vegetative types, and soil type. Lands that are suitable for use by domestic livestock will, under proper management, support a livestock industry indefinitely and continue to be an important and integral part of the economic framework of the Region. Some of the Region cannot be grazed by livestock because of rough topography, dense shrub and timber stands, poor soil, deficient precipitation, and lack of water development. About 7 million acres in the southwest part of the Region and along the Colorado River at elevations below 3,000 feet (where the average annual precipitation is less than 8 inches) are generally utilized by livestock only during the years when precipitation is above average. Areas above 3,000 feet in elevation and having more than 8 inches of precipitation support perennial vegetation and have a dependable carrying capacity.

Seasons of forage growth between 2,500 and 5,500 feet in elevation occur in both the spring, and midsummer to fall (February to March and July to November) when moisture is adequate. Forage growth below 2,500 feet in elevation follows periods of precipitation and varies from year to year. Above 5,500 feet in elevation, forage growth is limited to the spring and early summer seasons (April to June).

The estimated average carrying capacity of the native grazing lands of the Region will increase from 7.9 million animal unit months to 9.4 million animal unit months by the year 2020. Most livestock grazing lands in the Region can be improved through intensive management, revegetation, and other improvements. The increase in carrying capacity is expected as livestock management techniques are improved and as grazing land improvements, revegetation of depleted ranges,

conversion of desert shrub, chaparral and pinon-juniper types to grass, and installation of livestock management fences, water developments, etc. are installed.

Photo 24. Livestock Use of Southern Grassland FS

The following tabulation indicates average carrying capacity of native grazing lands, improved pasture and aftermath grazing on cropland:

Lower Colorado Region
Carrying Capacity 1965
(1,000 AUM's)

	Lower Main Stem Subregion	Little Colorado Subregion	Gila Subregion	Lower Colorado Region Total
Federal Land	1,164	264	1,613	3,041
Nonfederal Land	647	1,733	3,032	5,412
Total	1,811	1,997	4,645	8,453

Areas above 7,000 feet are generally used during the summer season with cattle moved to lower elevations during the winter months. Sheep are grazed on the high mountain ranges (above 7,000 feet elevation) during the summer and "wintered" on desert shrub or cropland at the lower elevations.

The condition of the grazing lands on the Navajo Indian Reservation has been the result of a unique set of circumstances. Traditionally the Navajo family has a small herd of sheep and goats that are an important part of the family way of life. Because the Indians have been dependent on horses for transportation the herds were grazed close to home. This has not been conducive to good management of the grazing resource. In 1965 there were an estimated 205,000 head of sheep, 62,000 head of goats, and 15,000 head of horses owned by 6,000 individuals, grazed in this manner.

Photo 25. Livestock are important to the Navajo way of life. BIA

Conditions are slowly changing for the better. Cattle are replacing the family bands of sheep and goats and the pickup truck and the automobile are replacing the horse. Cattle are the usual class of livestock on the other Indian lands of the Region.

Livestock use of rangelands in the Lower Colorado Region is not commonly oriented toward producing the final livestock product. The livestock ranges are generally more adaptable to the production of cattle and lambs to supply the feeder livestock industry. Beef cattle are the predominant class of range livestock produced in the Region although there is an important sheep raising industry that utilizes the mountain and desert grazing lands. In the higher elevations of the Region where forage production is primarily dependent upon winter and spring precipitation, the domestic livestock forage resource is generally utilized for maintenance of the cow-calf industry and for the summering of ewes, that lamb in October and November, supplying lambs for the valley feedlots. In the southern low elevation areas of the Region, livestock grazing operations often include fall, winter, and spring forage for weaner calves produced at the higher elevations or imported from outside the Region. These animals partially supply the need for the feeder livestock industry. The bands of ewes utilize the lower desert shrub and chaparral types for spring grazing from the time the lambs are weaned in February or March until ewes can again be moved to the higher coniferous forest in April and May.

Photo 26. High country grazing lands FS

In addition to domestic livestock, herds of wild horses roam the rangelands of the Region. Some 3,000 are estimated to be in the Lower Main Stem Subregion in Nevada. An equal or greater number of wild horses exist in the remainder of the Region.

The range livestock industry developed as one of the basic industries of the Lower Colorado Region during the earliest settlement, in the mid 1700's. In 1965 there were about 1,750 ranches in the Region, providing 9,700 man-years of employment. The total gross output of the range livestock industry for 1965 with projections is shown in Table 12.

Table 12
Lower Colorado Region
Total Gross Output with Projections -
Range Livestock Industry
($1,000)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	17,626	18,004	19,257	20,651
Little Colorado	12,208	14,198	18,657	23,201
Gila	57,344	58,729	61,500	64,339

Nonirrigated pasture is limited in extent in the Region. Generally above elevations of about 5,000 feet there is an annual precipitation of 14 inches per year or more which is necessary for establishing tame grass-legume or small grain production of forage for pasture. About 2,000 acres of land produce such pasture at least part of the time. Most of these acres are in the Little Colorado Subregion.

The economic importance of nonirrigated pasture is less than that of irrigated pasture. Production may range from near one ton to more than two tons of dry forage per acre. The higher yielding tame grasses such as orchard, brome, and fescues are normally used with or without legumes such as alfalfa and clovers. Small grains (oats, barley, or rye) are also pastured. The aftermath of these and other crops is grazed after harvest.

Fully developed and properly managed, grazing land will, in most cases, enhance the wildlife and watershed resources and values. Some of the better grazing lands in the Lower Colorado Region are the commercial timber lands and under proper management practices timber harvesting will improve the grazing values.

The following table compares present (1965) livestock grazing with projected carrying capacity:

Table 13
Lower Colorado Region
Livestock Grazing Capacity 1/ - 1965 and Projected
(1,000 AUMs)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	1,811	1,890	1,996	2,093
Little Colorado	1,997	2,052	2,225	2,330
Gila	4,645	4,806	5,389	5,936
Total	8,453	8,748	9,610	10,359

1/ Includes native grazing lands, improved pasture, and aftermath grazing on cropland.

Through the projection period land requirements for all uses expand with the exception of land required for livestock grazing. This is due to grazing land being converted to other uses. With substantial increased demand for red meat in each time frame, it was assumed that all land available for livestock grazing would be utilized to the fullest extent.

Table 14 compares 1965 land required for livestock grazing with projected requirements.

Table 14
Lower Colorado Region
Land Required for Livestock Grazing - 1965 and Projected
(1,000 acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	27,970	26,769	24,017	20,608
Native Grazing Lands	(27,838)	(26,618)	(23,866)	(20,475)
Crop Aftermath	(127)	(144)	(142)	(122)
Pasture	(5)	(7)	(9)	(11)
Little Colorado	16,604	16,429	16,263	16,057
Native Grazing Lands	(16,568)	(16,388)	(16,226)	(16,026)
Crop Aftermath	(34)	(38)	(34)	(27)
Pasture	(2)	(3)	(3)	(4)
Gila	31,480	30,541	29,622	29,142
Native Grazing Lands	(31,068)	(30,160)	(29,233)	(28,781)
Crop Aftermath	(381)	(340)	(338)	(300)
Pasture	(31)	(41)	(51)	(61)
Total Region	76,054	73,739	69,902	65,807
Native Grazing Lands	(75,474)	(73,166)	(69,326)	(65,282)
Crop Aftermath	(542)	(522)	(513)	(449)
Pasture	(38)	(51)	(63)	(76)

Timber Production

There are 30 million acres of forest land in the Lower Colorado Region. In general, the forests occur at the higher elevations, roughly within the elevational range between 4,000 and 12,000 feet above sea level. The average range of the principal forest types is shown on Figure 5. There are local variations of these ranges due to differences in soils, exposure, precipitation, and other environmental factors.

The forest land, 33 percent of the Region, has outstanding values for water production, recreation, wildlife, livestock grazing, timber products, wilderness, and ecological and hydrological research and study areas.

Of the 30 million acres of forest land, 24 million acres are classed as nonproductive for the production of commercial timber products. This 80 percent of the forest land includes areas of chaparral and mountain brush and pinon-juniper and oak woodland, and the area of coniferous types growing under adverse conditions usually in the lower elevation fringe areas or the area just below timber line in the higher elevations. About one million acres or four percent of this nonproductive class of forest land is included in the national parks, wildernesses, and other areas reserved for recreation, watershed, and scientific purposes. See Figure 7.

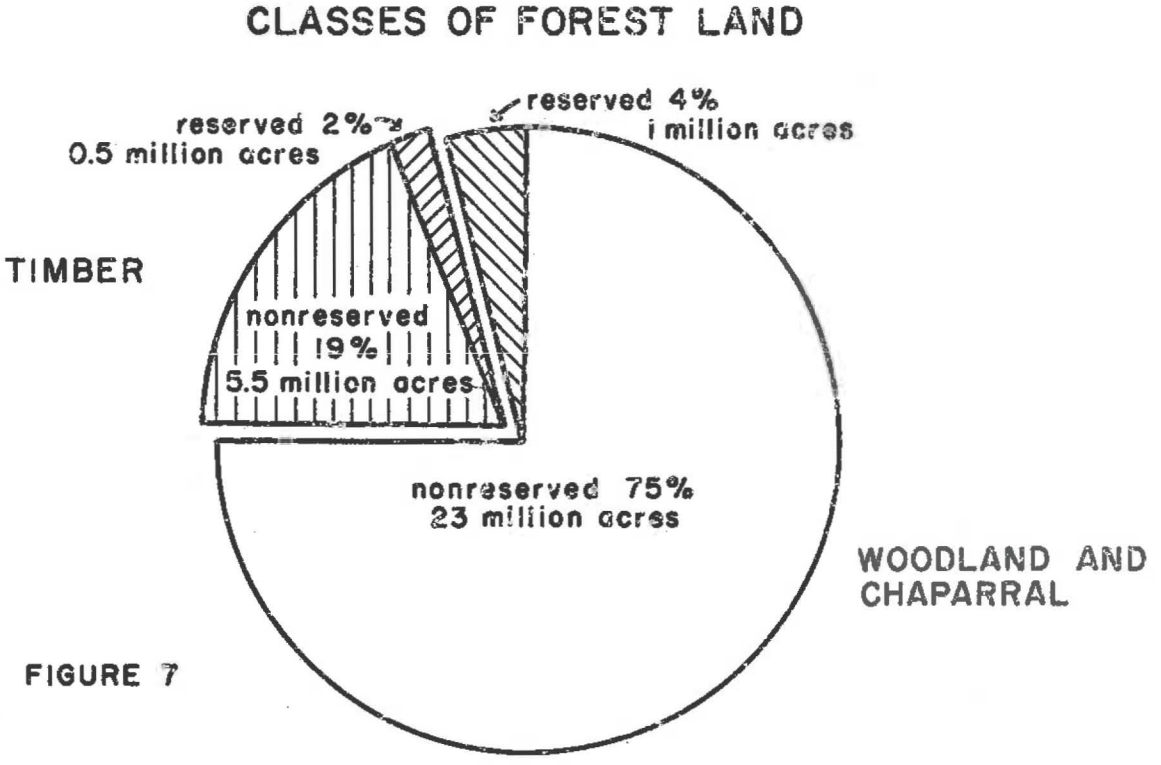


FIGURE 7

Six million acres of the forest land in the Region are capable of producing commercial timber products. Of this six million acres of productive timber-producing land, one-half million acres are included within wilderness, national parks, and scientific areas that are reserved from commercial timber harvesting.

The outstanding feature of the distribution of the commercial timber type in the Region is the largely unbroken block that extends for more than 300 miles along the Colorado Plateau. This block of commercial timber begins on the east at the Continental Divide in the Black Range of New Mexico. It extends westward through the Mogollon Mountains in New Mexico, White Mountains in eastern Arizona, and westward along the Mogollon Rim and Colorado Plateau to the Grand Canyon. The North Kaibab Plateau is an extension of this block north of the Grand Canyon. Ninety-one percent of the timber in this block is Ponderosa pine and is the largest single block of Ponderosa pine in the United States. Other species include Douglas fir four percent, fir-spruce three percent, and aspen, cottonwood and other hardwoods two percent. Other areas large enough to support timber operations include the southern portion of the Chuska Mountains (included in the Lower Colorado Region) in Arizona and New Mexico and the Zuni Mountains in New Mexico; a small area within the Haulapai Indian Reservation south of the Colorado River in western Arizona, and the Dixie National Forest in southwestern Utah.

Other areas of the commercial timber type occur on the crests of the small scattered mountain ranges and peaks, above 4,700 feet in elevation in the Gila and Lower Main Stem subregions. These cool coniferous forest areas are generally too small and scattered to support an economical timber operation, and have very high esthetic, recreation, and other environmental values. It is expected that these environmental values near the principal centers of population of the Region will preclude commercial timber harvesting during the projection period.

The 5.5 million acres of forest land in the Lower Colorado Region are classified as commercial timberland 1/ in 1965. Nearly all of the commercial timberland is on the national forests (69 percent) and the Indian reservations (23 percent). The states and counties own and manage 1 percent; 5 percent is owned by farmers and ranchers; and 2 percent by other private operators including timber companies. See Table 15. It is estimated that the increasing values of these forest properties for other uses, especially recreation and urban developments, will result in nearly one-half (150,000 acres) of these

1/ Forest land capable of, and available for, production of more than 20 cubic feet of industrial wood per acre per year.

Table 15
Lower Colorado Region
Present and Projected Area
of Commercial Timberland by Status
(1000 Acres)

Subregion	Nat'l Forest	B.L.M.	Total Federal	Indian Reser-vations	State & Counties	Small Owner Farm & Ranch	Other 1/ Misc. Private	Total Non-Fed.	Total Fed. & Non-Fed.
1965									
Lower Main Stem	844	6	850	0	3	10	10	23	873
Little Colorado	1,049	0	1,049	199	30	75	66	370	1,419
Gila	1,889	7	1,896	1,070	12	174	14	1,270	3,166
Lower Colo. Reg.	3,782	13	3,795	1,269	45	259	90	1,663	5,458
1980									
Lower Main Stem	824	1	825	0	3	8	9	20	845
Little Colorado	1,042	0	1,042	199	29	63	63	354	1,396
Gila	1,880	5	1,885	1,068	12	139	13	1,232	3,117
Lower Colo. Reg.	3,746	6	3,752	1,267	44	210	85	1,606	5,358
2000									
Lower Main Stem	824	0	824	0	3	4	7	14	838
Little Colorado	999	0	999	199	29	48	58	334	1,333
Gila	1,770	0	1,770	1,066	11	124	11	1,212	2,982
Lower Colo. Reg.	3,593	0	3,593	1,265	43	176	76	1,560	5,153
2020									
Lower Main Stem	820	0	820	0	3	3	5	11	831
Little Colorado	980	0	980	196	28	30	50	304	1,284
Gila	1,740	0	1,740	1,067	11	101	10	1,189	2,929
Lower Colo. Reg.	3,540	0	3,540	1,263	42	134	65	1,504	5,044

1/ Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of individual owners.

privately-owned commercial timberlands being converted to other uses by 2020. Commercial timber operations on sizeable areas of other public and privately-owned forest lands will be eliminated to satisfy the need for additional developed recreation areas, and esthetic considerations during the projection period.

Photo 27. Recreation and urban uses replacing timber production on private forest lands FS

More than 90 percent of the volume of growing stock (7.5 billion cubic feet) of the commercial timber in the Region is in saw timber-sized trees, with about two-thirds of this in trees 19 inches in diameter or larger. More than nine-tenths of the commercial timber area support saw timber stands, while about three percent of the area is nonstocked. Most of the remaining area supports pole-sized stands. Saw timber stands generally have a well stocked understory of seedling- and sapling-sized trees. There is a shortage of timber in the pole and small saw timber sizes (under 12 inches in diameter). See Table 16. The planned timber management and harvesting programs will only start the needed adjustments in areas of these age classes in short supply

Table 16
Lower Colorado Region
Present and Projected Volume and Area of Growing Stock
on Commercial Timberlands by Stand Classes

Subregion	Saw Timber (Mil.Cu.Ft.)	Pole Timber (Mil.Cu.Ft.)	Total Volume (Mil.Cu.Ft.)	Saw Timber (1000 Ac)	Pole Timber (1000 Ac)	Seedling-Sapling (1000 Ac)	Non-Stocked (1000 Ac)	Total Area (1000 Ac)
1965								
Lower Main Stem	1,086	108	1,195	808	26	9	30	873
Little Colorado	1,765	176	1,942	1,312	43	15	48	1,419
Gila	3,940	395	4,333	2,929	98	32	107	3,166
Lower Colo. Reg.	6,791	679	7,470	5,049	167	56	185	5,458
1980								
Lower Main Stem	1,030	140	1,170	775	35	15	20	845
Little Colorado	1,680	220	1,900	1,266	70	30	30	1,396
Gila	3,780	500	4,280	2,889	90	40	98	3,117
Lower Colo. Reg.	6,490	860	7,350	4,930	195	85	148	5,358
2000								
Lower Main Stem	923	200	1,123	763	50	15	10	838
Little Colorado	1,430	420	1,850	1,188	90	45	10	1,333
Gila	3,560	650	4,210	2,752	105	65	60	2,982
Lower Colo. Reg.	5,913	1,270	7,183	4,703	245	125	80	5,153
2020								
Lower Main Stem	770	300	1,070	731	70	25	5	831
Little Colorado	750	1,050	1,800	1,117	100	60	7	1,284
Gila	2,880	1,250	4,130	2,716	130	75	8	2,929
Lower Colo. Reg.	4,400	2,600	7,000	4,564	300	160	20	5,044

during the projection periods. Needed adjustments in the timber volume by tree or stand size will be well under way, by the end of the projection period, under the programmed timber management and harvesting plans. The nonstocked commercial timberlands will be artificially reforested by 2000, and present and future timber management programs will provide for reforestation, either naturally or artificially, as an integral part of the timber harvesting programs.

Photo 28. Mature pine with understory of seedlings and saplings FS

Timber management must become increasingly intensive to meet the projected demand for timber products from the shrinking area of commercial timberlands in the Region. Precommercial thinning has been made on some 35,000 acres of dense sapling and small pole timber stands.

To meet the need of timber products in the projection period, and in future years, an estimated one-half million acres of existing young precommercial timber stands must be thinned, along with reforesting the "nonstocked" timber producing lands of the Region. Timber management plans for the spruce-fir and selected areas of the Douglas fir timber types provide for a natural or artificial regeneration to be achieved through clear cutting in small blocks or strips on public-owned and Indian reservation lands. The Ponderosa pine type will be regenerated by either a seed tree or shelter-wood cut. Should improved timber management techniques become available through research and refined technology, they will be employed. The use of this silvicultural practice will be influenced by the importance and values of the esthetic recreation and wildlife resources that might be adversely affected. Research and barometer watersheds have indicated a potential average annual increase in water yield of from 10 to as much as 50 percent during years of normal precipitation.

It is estimated that approximately 40 percent of the commercial timberlands in the Region will be under even-aged management by 2020. See Table 17.

Table 17
Lower Colorado Region
Improved Timber Management Projections
(1,000 Acres)

Management Practice	Subregion			Lower Colorado Region
	Lower Main Stem	Little Colorado	Gila	
1965-1980				
Planting	5	15	35	55
Precommercial Thinning	20	40	80	140
Intensive Management 1/	75	125	400	600
1981-2000				
Planting	15	20	40	75
Precommercial Thinning	50	100	200	350
Intensive Management 1/	125	400	275	800
2001-2020				
Planting	10	15	30	55
Precommercial Thinning	10	10	30	50
Intensive Management 1/	125	375	275	775
Total 1965-2020				
Planting	30	50	105	185
Precommercial Thinning	80	150	310	540
Intensive Management 1/	325	900	950	2,175

1/ Includes area planted and area thinned.

Approximately 85 percent of the commercial timber is Ponderosa pine, 6 percent Douglas fir, 7 percent fir and spruce, and 3 percent other species including aspen, cottonwood, and other hardwoods. This ratio will remain about the same through the projection period.

The total output of timber products for the base year (1965) amounted to about 87 million cubic feet. Eighty-four percent of the timber harvested is in the form of saw logs, 14 percent pulpwood, and 2 percent other industrial wood products. See Table 18. Of the 39 wood conversion plants in this Region in 1965, 33 were sawmills, 2 manufactured house logs, 2 pulp and paper and 2 excelsior and poles. Twenty-two of the sawmills were in the Little Colorado Subregion, 8 in the Gila Subregion, and 2 in the Lower Main Stem Subregion. The two house log plants were in the Gila Subregion, and both of the pulp and paper plants were in the Little Colorado Subregion.

Projections indicate that the production of lumber and sawmill products will increase until about 2000 with a decrease in lumber production between 2000 and 2020. The production of pulpwood will increase more than five times by 2020 and veneer, plywood, and particle board plants will utilize about 38 million cubic feet of timber by 2020.

Approximately $30,000 worth of wood and other forest products were harvested from the "unproductive" (chaparral and pinon-juniper-woodland) forest types in 1965. Most of these products were taken from the pinon-juniper type with Christmas trees being the principal item. Other products include boughs, fence posts, fuel wood, wildings, pinon nuts, manzanita, and other products. It is estimated that the use of these "inferior forest species" will more than triple by the end of the projection period.

Table 18
Lower Colorado Region
Present and Projected Timber Products Harvested
and Net Annual Growth on Commercial Timberlands
(Million Cu.Ft.)

Subregion	Saw Logs Harvested 1/	Pulpwood Harvested	Other Wood Products Harvested	Total Timber Harvested	Net Annual Growth
1965					
Lower Main Stem	12	0	1	13	20
Little Colorado	19	8	1	28	30
Gila	42	3	1	46	50
Lower Colo. Reg.	73	11	3	87	100
1980					
Lower Main Stem	13	1	1	15	20
Little Colorado	20	19	1	40	50
Gila	43	10	2	55	50
Lower Colo. Reg.	76	30	4	110	120
2000					
Lower Main Stem	12	3	2	17	25
Little Colorado	41	30	2	63	60
Gila	28	19	3	50	60
Lower Colo. Reg.	81	52	7	130	145
2020					
Lower Main Stem	12	6	2	20	35
Little Colorado	29	38	3	70	75
Gila	21	25	4	50	60
Lower Colo. Reg.	62	69	9	140	170

1/ Includes harvested for veneer and particle board.

The timber and dependent industries have been important to the economy of the Lower Colorado Region for more than 100 years. In 1965 the timber industry generated nearly 175 million dollars into the Region's economy. The industry employed nearly 10,000 employees in 1965, with a total of more than 7.7 thousand man-years employment. Projection indicates that by 2020 the industry will provide nearly 11,000 man-years employment with a total gross output of nearly 325 million dollars. See Table 19.

Photo 29. Timber Harvesting FS

The Economics Appendix IV provides additional information and detail on the economic and employment opportunities in the timber industries. The "commercial timber" and the "productive reserved" timber types provide the greatest total value and variety of resources and uses of any of the natural vegetative types in the Region.

Table 19
Lower Colorado Region
Present and Projected Employment
in Timber-Based Industries 1/
(Man Years) and Total Gross Output (Thousand Dollars)

Subregion	Timber Mgt.	Timber Harvest	Sawmills & Plan. Mills	Veneer & Plywood Plants	Particle Board Plants	Pulp, Paper & Allied Products	Other Timber Products	Total Man-Yrs.	Total 2/ Gross Output ($1,000)
1965									
Lower Main Stem	395	120	465	0	0	0	125	1,105	65,280
Little Colorado	410	325	1,515	0	0	1,465	335	4,050	64,358
Gila	410	460	1,080	0	0	270	345	2,560	44,587
Lower Colo. Reg.	1,215	905	3,060	0	0	1,735	805	7,715	174,225
1980									
Lower Main Stem	500	225	715	0	0	0	245	1,685	35,363
Little Colorado	525	395	865	585	125	1,420	635	4,550	81,918
Gila	580	445	970	0	125	405	635	3,160	64,998
Lower Colo. Reg.	1,605	1,065	2,550	585	250	1,825	1,515	9,395	182,279
2000									
Lower Main Stem	675	255	670	170	125	0	340	2,235	58,468
Little Colorado	750	425	515	405	350	1,320	735	4,500	102,978
Gila	875	380	970	170	125	540	735	3,795	105,725
Lower Colo. Reg.	2,300	1,060	2,155	745	600	1,860	1,810	10,530	267,171
2020									
Lower Main Stem	800	260	560	180	125	0	430	2,355	71,137
Little Colorado	1,000	415	340	400	350	1,180	775	4,460	116,602
Gila	1,200	345	795	220	125	700	795	4,180	134,951
Lower Colo. Reg.	3,000	1,020	1,695	800	600	1,880	2,000	10,995	322,690

1/ Includes total employment (public and private) timber-based industries on commercial timberlands.
2/ Does not include secondary manufacturing products and processes (furniture, cardboard boxes, paper products, etc.)

Other Forest Resources

The coniferous timber type lands in the Region provide more than 2.8 million acre-feet of surface water and an undetermined but important volume of underground water annually that is utilized by industries, agriculture, and urban users in the cities and valleys of the Region.

More than one million animal unit months grazing by domestic livestock are dependent upon the forage resource of the coniferous forest lands. The commercial timberlands, particularly the Ponderosa pine type, provide some of the better domestic livestock range in the Region.

Nearly one-half of the cold-water fishing in the Region occurs in waters within the coniferous forests and is dependent upon maintaining these forest lands and cover. These same timberlands are the home of much of the wildlife resources of the Region. Timber management and harvest programs are being designed to maintain these fish and wildlife resources, and in some areas they will be enhanced through special timber management programs.

Since World War II the recreational uses of the high cool timberlands in the Region have increased nearly twentyfold. Pleasure driving, picnicking, and camping have increased the most and provide nearly 90 percent of the forest recreation use. Timber management and harvesting programs are designed to mitigate and maintain the esthetic and recreation resource values.

More than 100,000 acres of public-owned commercial timberlands have been included within developed recreation areas and esthetic zones adjacent to roads, trails, water areas, recreation areas, summer homes, etc. Timber management and harvesting programs within these developed and esthetic zones provide for maintaining the natural beauty for the enjoyment of the forest users. Similar programs are being incorporated in private timberlands.

Photo 30. Timber managed to maintain natural beauty in roadside zone FS

The timber resources on all public-owned lands and most of the private-owned lands in the Region are protected, developed, and managed to utilize the timber resource so it will contribute its greatest social and economic benefits on a sustained yield basis, in harmony with the protection, development, and use of the range, wildlife, recreation, water, and other resources and activities of the commercial timberlands.

Urban and Industrial

Most of the urban and industrial land use in the Lower Colorado Region is in the Basin and Range Province. Other than small amounts of grazing land, nearly all of the development has taken place in the valleys on lands that are highly suitable for irrigation. Soils are deep and in most cases have an available surface or ground water supply. In fact, much of the urban and industrial development occupies land in active irrigation districts or outlying irrigated areas. Approximately 90,000 acres of the 257,000 acres within a major irrigation project area in central Arizona are now urbanized. Of the remaining urban and industrial areas in the Region, only a very small portion is on lands suitable for mineral, timber production, or other nonagricultural uses.

Urban and industrial developments occupied approximately 513,000 acres of the Lower Colorado Region in 1965. Individual developments range in size from Phoenix's 158,000 acres down to small unincorporated towns of less than a square mile. Population densities are generally lowest for the large towns with their sprawling suburbs; hence, average densities range from about 3.5 people per acre for Phoenix to a high of about 10 people per acre for a typical small town. Figure 8 shows present and projected population densities for the Region, by subregion. Industrial users of land are generally within urbanized areas; only the mining industry occupies large blocks of land outside of the urban areas.

In general, urban and industrial land developments are not compatible with other uses. However, there is incidental agriculture, nongame wildlife, water yield, and important outdoor recreation use. The larger cities have recreation areas set aside. Phoenix' South Mountain Park with 60,000 acres is a good example.

Photo 31. Urban sprawl - Phoenix, Arizona

Landis Aerial Surveys Photo

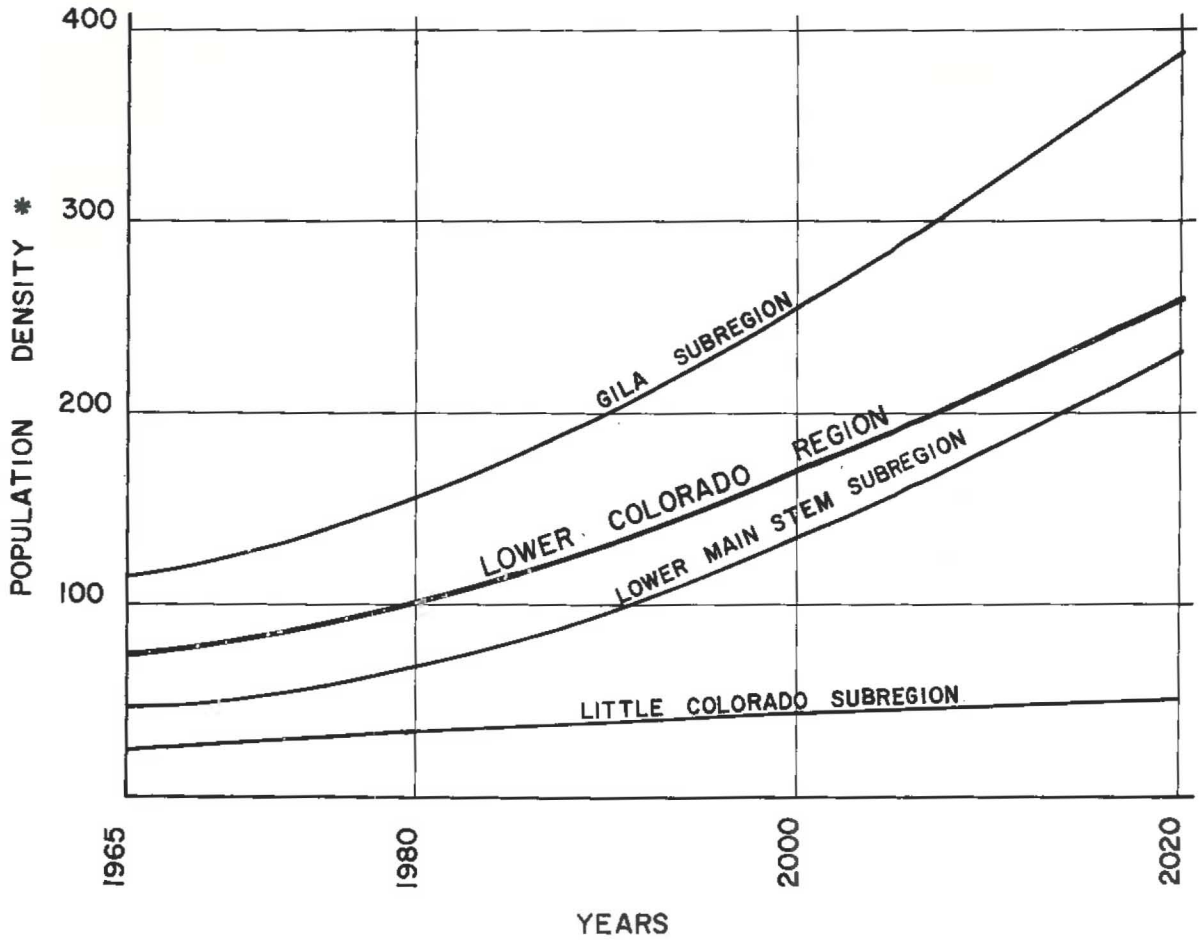


FIGURE 8

POPULATION DENSITY

1965 - 2020

* PERSON PER SQUARE MILE OF PRIVATE AND CORPORATE OWNED LAND

The following table compares present urban and industrial land use with projections.

Table 20
Lower Colorado Region
Present and Future Requirements
for Urban and Industrial Land Use
(1,000 Acres)

	1965	Projections		
		1980	2000	2020
Lower Main Stem	129	286	460	530
Little Colorado	19	78	98	135
Gila	365	499	672	899
Total Region	513	863	1,230	1,564

Outdoor Recreation

The Lower Colorado Region provides an exceptionally wide variety of outdoor recreation opportunities. The Lower Colorado, the Salt and the Gila rivers and impoundments offer all forms of water recreation throughout the year. The deserts provide winter recreation, including camping, picnicking, hiking, trail riding, rockhounding, and pleasure driving. The clear, cold mountain streams and cool forests of the higher elevations provide summer outdoor recreation for the local resident and tourist alike. Numerous high mountain areas, including the White Mountains of western New Mexico and eastern Arizona, the San Francisco and Bill Williams mountains in central Arizona, the Pine Valley Mountains in southwestern Utah, Charleston Mountains in southern Nevada and Mt. Lemmon in southern Arizona, provide opportunities for the enjoyment of winter sports activities within a few miles of the mild desert recreation areas and principal winter resort centers of the Region. Golf, tennis and other outdoor sports are available year-round in the major centers of population throughout the Region.

Practically all of the land in the Region has something of interest to the outdoor recreationist. Areas most valuable are generally those which have some special attractions such as rivers, streams, lakes and reservoirs, coniferous forests, areas of unusual archeological, historical, botanical, scenic, and geological values. The White Mountains, Colorado Plateau, San Francisco Peaks areas of Arizona and New Mexico, the Charleston Mountains near Las Vegas in Nevada, and the Pine Valley Mountains of southwestern Utah are nationally known summer recreation areas for both tourist and local inhabitants. The geologic wonders of the Grand Canyon and Zion national parks and the Petrified Forest National Monument attract tourist and recreationists alike from around the world.

Photo 32. Enjoying the wonder of Grand Canyon NPS

The Organ Pipe Cactus National Monument in southern Arizona, the desert mountains of the Superstition Wilderness Area and the desert areas of the Gila and Colorado rivers, provide unexcelled recreation opportunities for winter tourist and local citizens interested in desert flora and fauna. For those interested in archeology the Casa Grande, the Montezuma Castle, the Tonto and Wupatki national monuments provide nationally known areas for study and recreation.

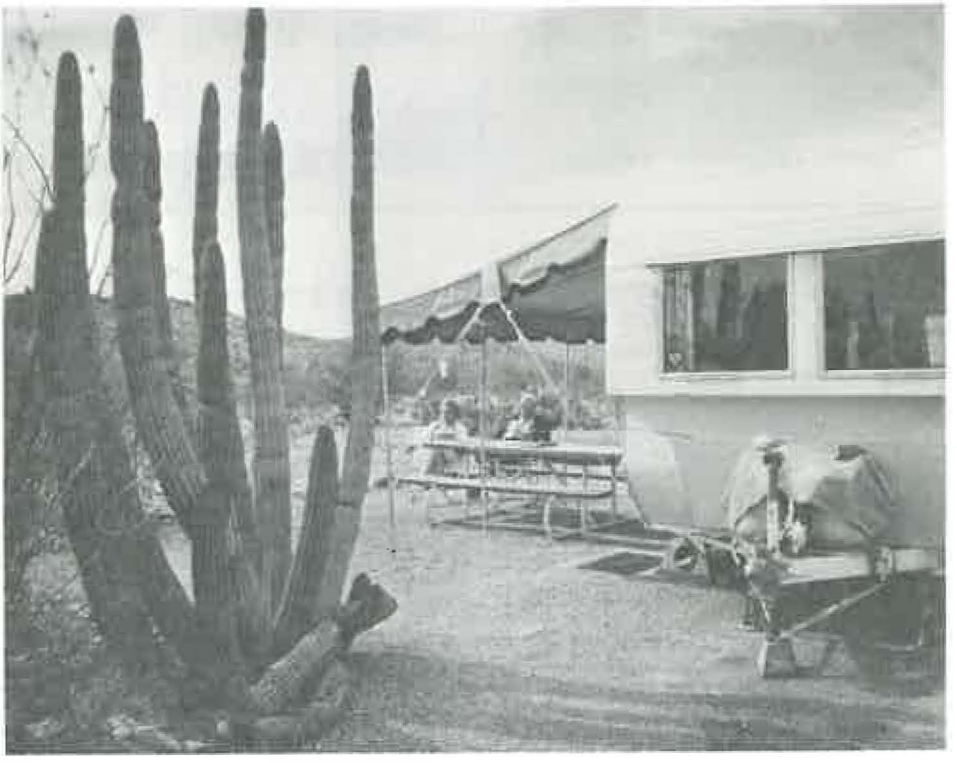


Photo 33. Winter Visitors - Organ Pipe Cactus National Monument NPS

The "outdoor recreation" resources of the Region provided more than 138 million recreation days use in 1965. As shown in Table 21, this is expected to increase to more than 900 million by 2020.

Table 21
Lower Colorado Region
Outdoor Recreation Demand - 1965 and Projections
(1,000 recreation days) 1/

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	41,645	92,430	193,601	313,082
Little Colorado	19,381	35,904	63,171	101,091
Gila	77,158	139,271	283,005	503,408
Lower Colorado Region	138,184	267,605	539,777	917,581

1/ Recreation day is a visit by one person for all or a portion of one 24-hour day.

The above recreation use does not include driving or walking for pleasure. It is estimated that one-fourth of the total recreation use in the Region is spent in viewing scenery and in enjoying the unique and unusual surroundings. This form of outdoor recreation is especially popular during the winter tourist season. Administration and management of most public lands (federal, state, and local) provide for the maintenance and enhancement of the esthetic values along highways, roads, trails, waterways, and areas having important recreation and other public use. Private utility companies in the Region are sometimes providing for preservation of scenic values in new construction and reconstructing existing facilities to enhance the attractiveness of their installation and surrounding area. Land developers in the rural and urban areas of the Region are providing for protecting and improving the natural beauty of the landscape.

About one-fifth of the Lower Colorado Region is within the boundaries of Indian reservations. The Indian tribes are developing outdoor recreation attractions on these reservations as one of their important natural resources. The Forest Service, Bureau of Land Management, Bureau of Sport Fisheries and Wildlife, National Park Service, and the State Parks and Fish and Game departments of the

four states in the Lower Colorado Region, as well as many of the counties and private landowners, are developing the camp, picnic, and resort opportunities of the Region.

Designated recreation lands are those lands where recreation use is the primary consideration in management. These lands include high use areas, unique natural areas, primitive areas, and historic and cultural sites. Areas of intensive recreation use within urban developments are excluded. All lands are important and are used for recreation. Only designated recreation lands are shown as requirements in Table 22. However, to satisfy the total recreation demand, it is assumed that recreation use of virtually all land will continue.

Table 22
Lower Colorado Region
Land Required for Designated Outdoor Recreation
(1,000 acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	4,247	4,570	4,609	4,660
Little Colorado	203	206	246	262
Gila	1,092	1,112	1,157	1,224
Lower Colorado Region	5,542	5,888	6,012	6,146

Of the total area shown in Table 22, Table 23 shows that portion which has been or is projected to be developed for high density recreation use or for substantial development for a wide variety of specific recreation uses. In the first category are included such areas as: bathing beaches, artificial lakes, golf courses, and playing fields. In the second category are included areas such as: campgrounds, picnic areas, winter sports areas, and those areas developed for nature walks and water sports.

Table 23
Lower Colorado Region
Areas Developed for Outdoor Recreation
(Acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	3,725	7,868	16,614	35,517
Little Colorado	1,716	3,470	5,916	8,972
Gila	11,682	50,407	121,992	221,144
Lower Colorado Region	17,123	61,745	144,522	265,633

Photo 34. Picnicking at forest campground FS

The high mountain areas of the Region provide excellent quality winter sports activities including skiing, snowmobiling, and family winter recreation. Excellent winter sports areas have been developed in the mountains of southern Arizona, the Coconino Plateau, the White Mountain area of central and eastern Arizona, the Pine Valley Mountains of southwestern Utah and Mount Charleston near Las Vegas, Nevada. These high mountain areas provide recreation opportunities for the winter sports enthusiasts attracting visitors from New Mexico, Texas, and California, as well as for the winter tourist and local winter sport enthusiasts of the Region.

Photo 35. Winter Recreation in the Southland FS

As of 1965, the live streams and lakes in the Region provided about 219,000 acres of water for recreation use. Nearly every live stream or lake has a developed recreation site or has potential for recreation development. That portion of the Colorado River in this Region provided more than nine million visitor days of water-based recreation in 1965. Most of the users were residents of Arizona, California, Nevada and Utah. The lakes on the Salt, Verde and Gila rivers provided 825,000 visitor days of water-based recreation for local residents and visitors.

Most reservoirs are managed as multiple-purpose projects. They are managed to provide the maximum recreation benefits consistent with maintaining other values; power, irrigation, flood control, and fish and wildlife.

The extensive areas of public lands administered by Forest Service, Bureau of Land Management, Bureau of Sport Fisheries and Wildlife, National Park Service, state and county parks, state game and fish departments, and others, provide almost unlimited opportunities for dispersed recreation such as hiking, riding, rockhounding, pleasure driving, hunting, fishing, and general enjoyment of the desert, mountain, and forest environment. These recreation resources and opportunities are being coordinated with all other resources of these public lands to provide the greatest total benefits to the people of the communities and Nation.

The cities, towns, and villages of the Lower Colorado Region are particularly aware of the value of a need for outdoor recreation opportunities offered in city parks and golf courses. The cities of Phoenix, Tucson, and Las Vegas, the primary recreation and resort cities of the Lower Colorado Region, as well as other communities of the Region, provide both public and private opportunities for outdoor recreation for the local citizens and tourist.

Photo 36. Enjoying the forest surroundings FS

Recreation and tourism have grown into a multi-million dollar industry in the Lower Colorado Region. The outdoor recreation opportunities provided by the forest, mountain, desert, and water areas of the Region, as well as the opportunities provided by intensively developed city, county, and other local government recreation areas, are an important factor in this expanding tourist industry, as well as strong attraction for other types of industrial development. Additional detailed information may be found in Recreation Appendix XII.

Wilderness, and Wild and Scenic Rivers

Wilderness

For purposes of this study a wilderness or primitive area will be considered as an area of 5,000 acres or more of undeveloped federal land, retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to protect its natural conditions.

In 1924 the Gila Wilderness Area in New Mexico was designated by the Forest Service for wilderness management. After the establishment of this first wilderness area in the United States, 11 additional areas on national forests in the Lower Colorado Region were classified as wilderness or primitive areas. In 1964 Congress incorporated six of these areas in the National Wilderness Preservation System under the Wilderness Act of September 3, 1964. By the same Act, the designated primitive areas on the national forests and other areas within the national forests, national parks and monuments, and recreation areas administered by the National Park Service, will be studied for inclusion in the Wilderness Preservation System by 1980. They may not be classified until the 1980-2000 time frame. See Table 24. The National Park Service plans to study roadless areas in Saguaro, Grand Canyon, Organ Pipe, Lake Mead, Zion, and Wapatki for possible future inclusion in the system. Fifty-five thousand acres, administered by the National Park Service, in the Lower Colorado Region have been recommended for inclusion in the Wilderness Preservation System. Lands administered by the Bureau of Sport Fisheries and Wildlife amounting to 1,645,000 acres in the Region are being reviewed for suitability for inclusion in the Wilderness Preservation System.

An area of 5,667 acres, administered by the Bureau of Land Management, in the Gila Subregion has been designated by the Secretary of Interior as the "Aravaipa Primitive Area" for protection and management of the wilderness values. Projections indicate that by 1974 about 25,000 acres of land administered by the Bureau of Land Management will be designated as "primitive areas" for wilderness management and protection.

Photo 37. Primitive Area and Use BLM

Lands managed as wilderness in the Lower Colorado Region are unique in that they include a variety of climate, land, and vegetative types. They range from the lower Sonoran desert to the alpine tundra above timber line. The rugged desert beauty of the Superstition Wilderness, the primeval timberlands of the Gila Wilderness, desert scenic Canyon Gorge of the Aravaipa Primitive Area, the rugged beauty and unique geologic formations of the Chiricahua Wilderness, and the alpine tundra of the Mount Baldy Primitive Area are but a few of the diverse geologic, vegetative, and climatic types.

Photo 38. Wilderness use tripled between 1955 and 1965. FS

In 1965 more than 150,000 visitor days were spent in the wilderness and primitive areas in the Lower Colorado Region. More than 33,000 visitor days were spent in the Superstition Wilderness and 70,000 visitor days were spent in the Gila Wilderness. More than 3,000 visitor days were spent in the Mount Baldy Primitive Area which includes 7,000 acres of the Apache National Forest and 7,000 acres of the Fort Apache Indian Reservation set aside by the White Mountain Apache Tribe to compliment the adjacent area. Use of the wildernesses and primitive areas in the Region in 1965 was more than three times the use in 1955.

Table 24
Lower Colorado Region
National Wilderness Preservation System
1965
Acres

Wilderness

Name	Administering Agency	Subregion	Area
Gila Wilderness	FS	Gila	433,916
Chiricahua Wilderness	FS	Gila	18,000
Galiuro Wilderness	FS	Gila	52,717
Mazatzal Wilderness	FS	Gila	205,346
Sierra Ancha Wilderness	FS	Gila	20,850
Superstition Wilderness	FS	Gila	124,140
Total Wilderness			854,969

Primitive Areas

Name	Administering Agency	Subregion	Area
Black Range	FS	Gila	169,984
Blue Range	FS	Gila	211,470
Gila	FS	Gila	132,788
Mt. Baldy	FS	Little Colorado	7,400 1/
Pine Mountain	FS	Gila	16,399
Sycamore Canyon	FS	Gila	49,590
Aravaipa	BLM	Gila	5,667 2/
Total Primitive Areas			593,298

Designated for Study for Suitability of Wilderness Classification

Name	Administering Agency	Subregion	Area
Petrified Forest	NPS	Little Colorado	50,260 3/
Chiricahua	NPS	Gila	4,685 3/
Havasu Lake	BSFW	Lower Main Stem	17,000
Kofa	BSFW	Lower Main Stem	202,000
Castle Dome	BSFW	Lower Main Stem	125,000
Imperial	BSFW	Lower Main Stem	12,000
Cabeza Prieta	BSFW	Lower Main Stem	624,000
Desert Wildlife Refuge	BSFW	Lower Main Stem	665,000 4/
Total			1,699,945

1/ Included in the Wilderness Preservation System in 1970 and area adjusted to 6,975 acres.
2/ Area designated by Secretary of Interior as Primitive Area.
3/ Recommended to Congress for inclusion in Wilderness Preservation System.
4/ Approximately 835,000 acres, not shown, will be reviewed if and when area is no longer needed for military operations.

The increasing appreciation and demand for wilderness environment is expected to continue through the projection period. As the resources (timber, livestock forage, intensive recreation, wildlife, etc.) are developed, and as the transportation systems in the natural environment areas are expanded and improved, the demand for use of classified wildernesses will increase. Before 1980 those wildernesses or portions of wildernesses easily accessible to the principal centers of population, and those wildernesses having special attractions will be utilized to their capacity and will require limits and controls on the use. Projections indicate there will be nearly 3.5 million acres of classified wilderness in the Region with a capacity of 1.1 million visitor days per year by 2020. See Table 25. The demand for more than 18 million visitor days per year may be expected by 2020.

Areas within the Wilderness Preservation System are closed to all forms of motorized transportation. They are open to most forms of outdoor recreation, to hunting and fishing, to the grazing of livestock where established prior to the effective date of the Wilderness Act, and for other uses (scenic, scientific, educational, conservation, and historical), so long as the wilderness character of the area is preserved. Prospecting for the purpose of gathering information about mineral or other resources will be permitted until December 31, 1983, so long as such activity is carried on in a manner compatible with the preservation of the wilderness environment. 1/ The harvesting of timber for commercial purposes is not permitted within the areas included in the Wilderness Preservation System. Permanent roads will not be constructed within the wilderness area nor shall the use of motor vehicles, motorized equipment, or motor boats, landing of aircraft or other forms of mechanical transport be permitted, and no structure or installation may be constructed. Resources and uses within the wildernesses are managed, within the wilderness concept, to maintain a vegetative cover to prevent erosion and water pollution.

1/ Hunting, prospecting or use by domestic livestock are usually not permitted on lands administered by the National Park Service and these activities are not permitted on wildernesses within the national parks and monuments.

Table 25
Lower Colorado Region
Area and Use of Classified Wilderness 1/

Subregion	1965		Available Area and Use					
			1980		2000		2020	
	Area (1,000 Ac.)	Use (1,000 visitor days)	Area (1,000 Ac.)	Use (1,000 visitor days)	Area (1,000 Ac.)	Use 2/ (1,000 visitor days)	Area (1,000 Ac.)	Use 2/ (1,000 visitor days)
Lower Main Stem	0	0	0	0	1,700	400	2,000	500
Little Colorado	0	0	58	30	58	40	58	40
Gila	861	80	1,400	500	1,400	600	1,400	600
Lower Colorado Region	861	80	1,458	530	3,158	1,040	3,458	1,140

1/ Includes only areas classified under the Wilderness Preservation Act of September 3, 1964, and formally designated by the Bureau of Land Management as Primitive Areas under the Land Classification and Multiple Use Act, P.L. 88-607 (Aravaipa - 5,667 ac.)

2/ Limited to the capacity, about one-fifth of the projected demand.

Wild and Scenic Rivers

As of 1965 some rivers or sections of rivers had been studied or recommended for study to be included in the Wild and Scenic Rivers Act. This Act, P.L. 90-549, enacted in 1968 did not include any rivers in the Lower Colorado Region.

Military and Related Uses

Most of the land used for military and related purposes in the Region is barren desert or semiarid mountainous terrain. Large areas in southwestern Arizona, southern Nevada, and western New Mexico are used by the Army, Air Force, and the Marine Corps to test military equipment and weapons, to give gunnery and bombing training to military personnel, and for ordnance depots. This land has been selected for testing of dangerous equipment and for training of personnel in its use because it is located far away from developed areas and because there is a low demand for other uses except for desert game ranges. Generally, the land is not readily suited for agriculture and does not yield minerals in economical quantities.

Table 26 shows the acreage of land used for military purposes in the three subregions and in the four states in the Region.

Table 26
Lower Colorado Region
Land Used for Military Purposes - 1965

State	Subregion			Total
	Lower Main Stem	Little Colorado	Gila	
	Acres	Acres	Acres	Acres
Arizona	3,171,000	0	453,000	3,624,000
Nevada	481,000	0	0	481,000
New Mexico	0	21,000	0	21,000
Utah	0	0	0	0
Total	3,652,000	21,000	453,000	4,126,000

With the exception of the bombing and gunnery ranges, all of the military facilities have heavy economic impact on the surrounding areas. They employ large numbers of civilians and the demand for goods and services for military personnel stationed at the bases create many employment opportunities in nearby cities. The military range facilities, such as Las Vegas Bombing and Gunnery Range, Nevada, and the Luke Bombing and Gunnery Range, Arizona, in themselves do not create a significant economic impact on local areas. However, the bases associated with those ranges would not exist if it were not for the large amount of land available for military range purposes. At present, there is no significant demand for the military reservations except for game refuges and recreation. Currently, in some instances, the military is encouraging the multiple use of the reservations to include fish and wildlife management and recreation when consistent with the basic mission of the facility and the safety of the user.

Mineral Production

The actual acreage used for mineral production is a very small percentage of the total land area. As an example, the open-pit copper mine at Morenci, Arizona, which is one of the largest mines in the world, requires less than a township of land for the mine, mill, smelter, tailings, ponds, waste dumps, and the town itself. Lands producing minerals while small in extent are intensively used. Their economic importance is great and their compatibility with other uses is low. These lands are almost entirely in private ownership.

Mineral deposits are scattered over a significant portion of the Region. More than 10 percent of the national forest lands and over 25 percent of the public domain lands in the Lower Colorado Region are covered by legally located mineral claims. These mineral deposits will be developed as the demand and improved technologies make development feasible. It is difficult and often impossible for public land managers to know where the mineral claims are located. Holders of valid mineral claims are assured, under existing laws, the right to construct a road or other means of access to valid mineral claims, and are entitled to the use of any of the surface necessary for exploration and development of the claim. These provisions for location and development make it difficult for the land managing agency to control environmental impacts. Where the deposits are valuable the locator may acquire title to the land within his claim or claims upon payment of a nominal sum. Usually most lands covered by mineral claims are managed according to multiple-use principles prior to the time they may be developed for mineral production.

Generally the lands administered by the National Park Service and Bureau of Sport Fisheries and Wildlife are closed to mineral entry.

Federal lands included in the wilderness system will be closed to mineral entry after December 31, 1983. In addition, 209,000 acres of national forest lands and 967,000 acres of public domain lands have been withdrawn from mineral entry for recreation, research, watershed protection, public use, scenic and environmental values.

Many of the old mineral developments and mining camps are popular resort, tourist and outdoor recreation attractions. Jerome, Bumblebee, Tombstone, and the Vulture Mine near Wickenburg are examples.

Mineral production constitutes one of the primary sources of new wealth in the Lower Colorado Region. In 1968, the value of minerals and metals exceeded $626 million in Arizona alone. It supplied well over 50 percent of the total U. S. production of copper and substantial amounts of gold, silver, molybdenum and other metallic and nonmetallic minerals.

The following table compares mineral industry land use in 1965 with projected requirements.

Table 27
Lower Colorado Region
Land Required for Active Mineral Production 1/
(1,000 acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	5	9	10	11
Little Colorado	7	28	41	84
Gila	63	78	105	128
Total Region	75	115	156	223

1/ Does not include areas being utilized for prospecting, assessment work, and access to mineral claims.

Fish and Wildlife

Fishery resources of the Lower Colorado Region are predominantly the result of man-made facilities. These resources range in quality from poor, shallow, polluted areas to clear, cold mountain streams and large multiple-purpose reservoirs such as Lake Mead. Fish species occurring in the Region vary from marine striped bass in the Colorado River, through a wide variety of warm-water species associations, to rainbow and native trout in the colder waters of the Region. Public recreation use of many existing fishery resources is hampered by lack of access and facilities; however, much of the quality fisheries are the result of lack of access and facilities, and these situations must be carefully studied prior to opening them up. Fishermen contributed approximately $50 million in 1965 to the economy of the Region. Land use changes may affect the fishery resource adversely or beneficially.

Photo 39. Stream improvement for fish habitat FS

Wildlife resources of the Lower Colorado Region occur in all of the vegetative cover type zones from the lower desert areas to above timber line. Big game species, represented by mule deer, white-tailed deer, black bear, desert bighorn sheep, pronghorn antelope, javelina (collared peccary), elk, and wild turkey, occur within the Region where suitable habitat is available.

Wildlife game species are somewhat adaptable, and may occur in a variety of habitats. Hunter use of upland game species occurs throughout most of the Region, being limited in those areas where firearms limitations are imposed.

The Region contains habitat that supports many other species of birds, mammals and reptiles. Migrating waterfowl depend on rather small areas of wetland type habitat throughout the Region. The arid character and habitat of the desert supports some species that are unique to this area. The riparian vegetation is an important habitat type for many wildlife species, particularly in the desert. Sightseers, photographers, study groups, and others enjoy the search for and observation of all forms of wildlife.

The compatibility of some wildlife species with other land uses cannot be generalized. Species such as the desert bighorn sheep and the wild turkey will not sustain wild populations if more than mildly disturbed in their native habitat.

Hunting in this Region is vitally important to the well-being of the people, as well as being important economically. It is estimated that expenditures on hunting activities in the Lower Colorado Region contribute in excess of 25 million dollars to the Region's economy annually.

Table 28
Lower Colorado Region
Land Requirements for Fish and Wildlife 1/
(1,000 acres)

Subregion	1965 2/	Projections		
		1980	2000	2020
Lower Main Stem	1,823	3,326	5,330	12,680
Little Colorado	16	47	226	476
Gila	19	173	1,619	1,864
Total Region	1,858	3,546	7,175	15,020

1/ Designated lands available for hunter use but not excluding other compatible uses.

2/ Another 1.4 million acres were managed primarily for wildlife in 1965 but were not available for hunting because of access restrictions.

Water Yield Improvement

Every acre in the Region can be considered as watershed, and management of every resource and activity has an effect upon water yield. Water yields vary depending upon the topography, climate, vegetation, and soils. Conditions of the watershed are affected by past and present use.

The growing population with its increasing demands upon the land and water resources has created a greater need for protecting the water quality and increasing the water yield. The public is becoming increasingly aware of this need.

Research studies were initiated in the Region before 1920 by the Forest Service to provide direction for improved water yield on the forest and range lands of the Southwest. The Bureau of Reclamation, Geological Survey, state land departments, and colleges and universities have conducted related studies in watershed management since the 1940's, with special emphasis on increasing the water yield and improving the water quality, particularly from the forest and range lands.

Photo 40. Structure for studying the effect of watershed treatment on water yield FS

Water is a critical factor in the economy and future development of the Region and the entire Southwest. Underground reserves are being depleted; the annual pumping rate in the Salt River Valley alone is about three times the annual recharge and other underground basins are being depleted as fast or faster. As the water level in the underground basins decline, water quality deteriorates in most uses. Other water sources are being sought, including additional water from watersheds within the state.

A hydrologic reconnaissance and analysis has been made for the national forest lands in the Southwest to determine the potential increase in water yield and decrease in sediment. Based upon this survey and analysis, together with hydrologic studies by the Geological Survey and others, water yield improvement program involving vegetation management can be an effective and efficient means of augmenting existing water supplies in water-short areas.

The forest lands of the Region contribute an average of about 90 percent, 2.8 million acre-feet, of the water to the streamflow annually. In addition, the forest lands contribute an important but unmeasured quantity of water to the underground aquifers.

Table 29 compares the area treated for water yield improvement in 1965 with projected requirements. The treatment consists of modifying the practices of timber harvesting and of converting chaparral, mountain brush, and deeper-rooted riparian trees and shrubs to grasses.

Table 29
Lower Colorado Region
Land Requirements for Water Yield Improvement
(1,000 acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	4	49	99	149
Little Colorado	50	115	245	425
Gila	60	200	620	840
Total Region	114	364	964	1,414

TABLE 31

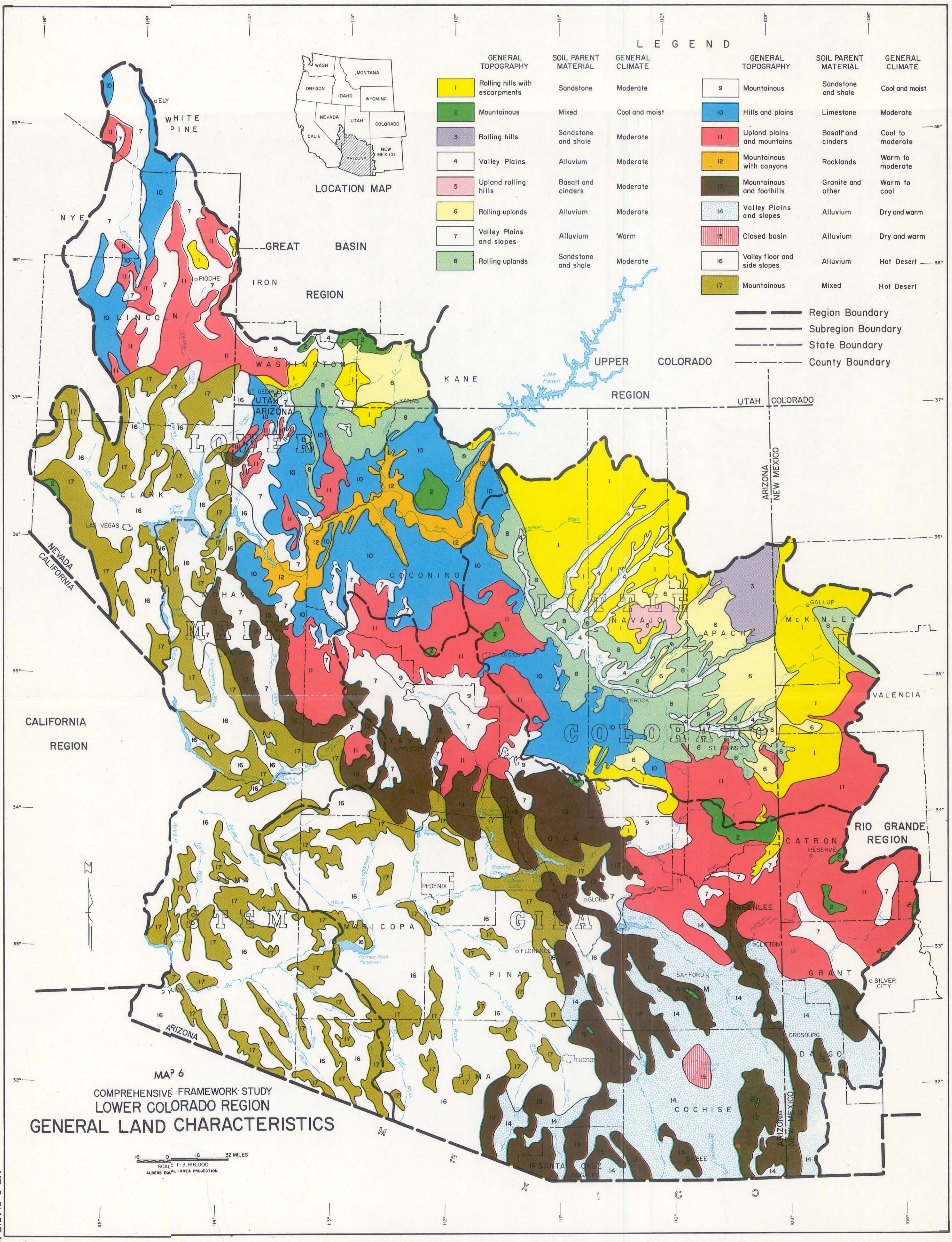
LOWER COLORADO REGION

GENERAL LAND CHARACTERISTICS AND SUITABILITY FOR USE

MAP SYMBOL	GENERAL LAND CHARACTERISTICS								GENERAL SUITABILITY FOR USE 1/					
	Topographic Position	Elev. in Ft.	Soil Parent Material	Soil Depth	Mean Ann. Precip. in Inches	Mean Ann. Temp. F°	Ave. Frost-Free Period in Days	Dominant Native Vegetation	Livestock Grazing	Native Timber Production	Cropland (irrigated unless other noted)	Native Wildlife Habitat 2/	Outdoor Recreation	Surface Water Yield
1	Gentle Slopes, Escarpments, Ledges & Breaks	5,000 to 7,500	Sandstone & some Shale	Very shallow to shallow, locally deep	6 to 16	49 to 53	100 to 170	Grass, Shrubs & Pinon-Juniper Woods	F to G		P to F-deep soils	G to F Mule Deer, Antelope & Turkey	F to G (cool summer)	P to F
2	Mountainous	8,000 to 12,000	Basalt, Limestone, Sandstone & Alluvium	Very shallow to shallow, locally stony	20 to 35+	32 to 40	30 to 70	Mixed Conifer Forest & Alpine	P to F	G to E	P	G to F Most species Big Game	G to E (cool summer & wintersports)	E
3	Rolling, Sloping Hills, Escarpments, Ridges & Canyons	6,500 to 7,500	Sandstone & Shale	Very shallow to shallow, locally deep	10 to 16	47 to 52	100 to 160	Wooded, Shrubs, Grass & Conifer Forest	F to G	F to G	P to G-deep soils	F to G Mule Deer, Antelope & Upland Game	F to G (cool summer)	F to G
4	Flood Plains, Rolling Hills, & Local Sand Dunes	4,000 to 5,500	Alluvium & Aeolian	Deep to Mod. Deep (medium texture)	6 to 13	50 to 55	110 to 200	Shrubs & Grass	F to G		G to E	F to G Upland Game & Mule Deer F to E Upland Game	P to G (cool summer)	P
5	Uplands & Rolling Plains	5,500 to 6,700	Basalt & Cinders with Alluvium	Mod. Deep to Deep	8 to 11	48 to 54	110 to 200	Grass & Shrubs	P to G		F to G	P to F Mule Deer & Upland Game	P to G (cool summer)	P to F
6	Uplands Rolling Hills, & Local Sand Dunes	5,500 to 6,000	Old Alluvium & Sandstone	Mod. Deep to Deep (sandy)	8 to 11	48 to 54	110 to 180	Wooded, Shrubs & Grass	F to G		F to G	F to F W.T. Deer & Upland Game G to F Antelope	F to G (cool summer)	P to F
7	Gentle Slopes & Valleys	4,000 to 6,500	Alluvium	Mod. Deep to Deep	6 to 16	56 to 62	190 to 228	Wooded, Shrubs, Grass & Conifer Forest on cool, moist sites	P to F	P - warm dry sites to G - cool moist sites	P to G	F to F Upland Game & Mule Deer	G to E (cool summer)	P to F
8	Plains, Rolling Hills, Some Breaks & Escarpments	4,500 to 5,500	Interbedded Sandstone & Shale	Very Shallow to Mod. Deep, some Deep (generally clayey)	6 to 16	50 to 55	110 to 200	Wooded & Grass	P to F		P to G	P to G Deer, Turkey & Bear F to F Antelope	P to F (cool summer)	P
9	Mountain Slopes, Breaks & Canyons	5,000 to 8,000	Shale & Sandstone	Very Shallow to Mod. Deep (stony)	16 to 30	39 to 50	70 to 130	Wooded, Grass, Shrubs & Conifer Forest	P to G	P - warm dry sites to G - cool moist sites G to E for Ponderosa Pine	P to G-deeper soils Irr. & non-irr.	G Deer, Bear, Turkey, Elk & Javelina - lower elev.	G to E (cool summer)	G to E
10	Gentle, Sloping Hills with Narrow Canyons	4,500 to 7,000	Limestone	Very Shallow to Shallow	8 to 30	47 to 55	60 to 150	Wooded, Grass, Shrubs & some Conifer Forest in areas above 18" ppt.	P to G	P - warm dry sites to G - cool moist sites	P (except small local areas)	E Deer, Elk, Antelope, Turkey & Bear	G to E (cool summer)	P to G
11	Rolling Plains, Canyons, Rock Ledges, & Mountain Slopes	5,000 to 8,000	Basalt, Cinders & Tuff	Shallow to generally Deep (stony & clayey)	12 to 30	39 to 50	70 to 130	Wooded, Grass, Shrubs & Conifer Forest in areas above 18" ppt.	P to F	P - warm dry sites to G - cool moist sites	P to G irr. & non-irr.	G to E Deer, Elk, Antelope & Turkey	G to E (cool summer)	F to E
12	Mountain Slopes with Deep Canyons & Escarpments	2,500 to 5,000	Canyon-lands, Rocklands & Alluvium	Very Shallow to Shallow (Rocky)	8 to 12	50 to 56	130 to 250	Bare rock to Wooded & Grass	P to F		P	F to E Deer, Turkey & Bighorn Sheep	P to E (Grand Canyon)	P to F
13	Mountain Slopes	3,000 to 5,500	Mixed Granite, Rhyolite, & Gnesis	Very Shallow to Deep (stony)	14 to 30	48 to 56	60 to 160	Shrubs, Grass, Pinon-Juniper Woods & Conifer Forests in areas above 18" ppt.	P to G	P - warm dry sites to G - cool moist sites	P-shallow soil to G-deep soil	G to E Deer, Bear, Javelina, Antelope, Turkey, Quail & Non-game Species	P to G	F to E
14	Gentle Slopes & Valley Floors	3,500 to 5,000	Recent & Old Alluvium	Mod. Deep to Deep	8 to 16	58 to 62	175 to 210	Grass, Shrubs & Woods	G to E		G to E	F to E Mule Deer Javelina & Quail F to E Rare Species	F to G (mild winter)	P to F
15	Valley Floors & Closed Basin	4,100 to 4,200	Alluvium	Deep & Dense (Saline)	Near 10	58 to 62	175 to 210	Barren & Grass	P		P	E Waterfowl & Non-game Species	P to G	P
16	Gentle Slopes & Valley Floors	125 to 3,500	Alluvium	Deep to Very Deep	3 to 10	62 to 72	220 to Yearlong	Cacti, Annual Grass & Shrubs	P to F		G to E	F to E Mule Deer, Sonoran Antelope, E For all wildlife in riparian areas	P to E (near water all year)	P
17	Desert Mountains & Slopes	500 to 4,000	Granite, Schist, Rhyolite & Basalt	Shallow to Mod. Deep	4 to 14	55 to 65	190 to Near Yearlong	Cacti, Annual Grass to Perennial Grass & Shrubs	P to F		P	F to E Desert Bighorn Sheep, Mule Deer & Javelina at higher elev.	(warm winters) P-summertime to E-wintertime	P to F

1/ General Rating P - Poor
F - Fair
G - Good
E - Excellent

2/ This habitat supports many bird, reptile and other forms of wildlife but are too numerous to list.


LEGEND
GENERAL TOPOGRAPHY | SOIL PARENT MATERIAL | GENERAL CLIMATE
1 Rolling hills with escarpments | Sandstone | Moderate
2 Mountainous | Mixed | Cool and moist
3 Rolling hills | Sandstone and shale | Moderate
4 Valley Plains | Alluvium | Moderate
5 Upland rolling hills | Basalt and cinders | Moderate
6 Rolling uplands | Alluvium | Moderate
7 Valley Plains and slopes | Alluvium | Warm
8 Rolling uplands | Sandstone and shale | Moderate
9 Mountainous | Sandstone and shale | Cool and moist
10 Hills and plains | Limestone | Moderate
11 Upland plains and mountains | Basalt and cinders | Cool to moderate
12 Mountainous with canyons | Rocklands | Warm to moderate
13 Mountainous and foothills | Granite and other | Warm to cool
14 Valley Plains and slopes | Alluvium | Dry and warm
15 Closed basin | Alluvium | Dry and warm
16 Valley floor and side slopes | Alluvium | Hot Desert
17 Mountainous | Mixed | Hot Desert
Region Boundary
Subregion Boundary
State Boundary
County Boundary
LOCATION MAP
WASH
MONTANA
OREGON
IDAHO
WYOMING
NEVADA
UTAH
COLORADO
CALIF.
ARIZONA
NEW MEXICO
GREAT BASIN REGION
UPPER COLORADO REGION
CALIFORNIA REGION
RIO GRANDE REGION
LOWER
LITTLE COLORADO
MAIN
STEM
GILA
WHITE PINE
NYE
LINCOLN
CLARK
IRON
WASHINGTON
KANE
KANAB
COCONINO
MOHAVE
YAVAPAI
NAVAJO
APACHE
McKINLEY
VALENCIA
CATRON
GREENLEE
GRANT
HIDALGO
COCHISE
GRAHAM
PIMA
PINAL
MARICOPA
SANTA CRUZ
GILA
ELY
PIOCHE
ST. GEORGE
LAS VEGAS
FLAGSTAFF
PRESCOTT
HOLBROOK
ST. JOHNS
GALLUP
PHOENIX
GLOBE
FLORENCE
SAFFORD
CLIFTON
SILVER CITY
LORDSBURG
TUCSON
BISBEE
YUMA
Lake Powell
Lee Ferry
UTAH COLORADO
ARIZONA NEW MEXICO
NEVADA CALIFORNIA
MEXICO
RESERVE
MAP 6
COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
GENERAL LAND CHARACTERISTICS
16 0 16 32 MILES
SCALE 1:3,168,000
ALBERS EQUAL-AREA PROJECTION

M7-S-21431F-N

About 39,000 acres of national forest lands in the Region are included in "classified watersheds" to provide for high quality domestic water. Six areas have been designated as municipal watersheds under agreement between the Forest Service and the local municipality.

Other federal and most state-owned lands included within the watershed of municipalities are managed to maintain high water quality as provided for in the agency land management plans. These management programs provide for control of livestock use, camping, timber harvesting practices, and residential and industrial developments, including summer homes and resorts.

Transportation and Utilities

Demands for additional land for transportation and utilities have kept pace with the rapid regional growth which mushroomed in the 1950's. We can expect to see even greater demands for this type of land use in the future as the regional population continues to soar.

Main highways, railroads, and airports effectively exclude almost all other land uses. However, these facilities exist within such a large area that generally they do nothing more than break the country up into large blocks. Resultant land management problems are generally local ones centered around such factors as road erosion, reduced access along freeways, the stimulation of land use change near major freeway interchanges, and disruption of local grazing patterns and cattle movements. The most serious problem is the continued reduction in the taxable land base associated with highway rights-of-way encroachment upon private land. In this Region only 18 percent of the land is privately owned. Beneficially, facilities such as main traveled roads and service roads open up previously inaccessible areas to industry and recreation and facilitate better management of the natural resource. Additionally, a wealth of jeep roads, horse and foot trails permit access to virtually all portions of the Region.

Transportation and utilities play a key role in the economic development of the Lower Colorado Region. Improved utility services and increased production of power and water are essential if industry and a growing population are to be supported. Also, in this Region remote from the traditional market centers of the Nation, transportation assumes an especially vital role. Interstate railroad freight amounts to more than 25,000,000 tons annually. Of this, roughly one-third originates from within the Region and approximately one-third terminates within the Region. Because of excellent climatic conditions, the Lower Colorado Region supports some of the heaviest flight traffic to be found anywhere. This climate is also a factor in the establishment of heavily used trucking routes through the Region. Twenty-five percent of all motor vehicle traffic is commercial. An estimated 30,000 people are employed by the transportation and utilities industry.

Telephone, canal, electric power, and buried pipeline rights-of-way often modify existing uses. Irrigation canals provide fishing opportunities and canal side trails for horseback riding or hiking may be provided in urban areas. Rights-of-way for overhead transmission lines can be designed to harmonize with the surrounding environment while at the same time creating openings for wildlife. Erosion control seeding along these rights-of-way can include wildlife feed. Water storage reservoirs exclude timber, forage, and crop production but often enhance other uses such as recreation and

Photo 41. Transportation, Interstate System, Phoenix, Arizona — Arizona Highway Dept.

fisheries. Management must be aimed at achieving maximum multiple benefits where possible. For example, management of reservoir storage requires the coordination of various needs and interest groups. In some instances, reservoir water levels are adjusted when possible to assure a desirable fish spawn. As uses are intensified the need for closer coordination will become necessary.

The following table compares 1965 use of land for transportation and utilities with projected requirements:

Table 30
Lower Colorado Region
Land Requirements for Transportation and Utilities
(1,000 acres)

Subregion	1965	Projections		
		1980	2000	2020
Lower Main Stem	221	266	318	357
Little Colorado	63	103	130	136
Gila	376	489	582	652
Total Region	660	858	1,030	1,145

Archeological Resources

The Region's archeological resources are highly significant to the understanding of the prehistory of the nuclear Southwest. The unstudied archeological resources of the area are analogous to pages in the only copy of a book on the history and activities of Man over the past 15,000 to 20,000 years. The science of reading this archeological book is well developed and its ability to translate the significance and meaning of the archeological record is constantly increasing. Modern man, with his necessary demands for development of resources to meet his modern needs, is sometimes removing archeological pages from the one and only book on the prehistory of aboriginal America.

LAND SUITABILITY AND AVAILABILITY

Land suitability and availability is a system to classify land areas according to their potential to satisfy needs. Suitability, in general, is based upon physical land characteristics and relationships among land resources and uses. Land availability emphasizes legal and institutional constraints on the land. Water quality and quantity were not considered as constraints in determining land suitability and availability, nor were economic criteria.

Land suitability is relative and, therefore, needs qualification. For example, there are nearly 40 million acres of land in the Lower Colorado Region which contain soils suitable for cultivation. However, the astronomical cost that would be required to develop that acreage for irrigated agriculture, and the water required, as well as the limitations of the market to absorb the output precludes serious consideration of but a small portion of this potential.

Similarly, with regard to land suitability for outdoor recreation, it might be safe to say that virtually all of the Region's land is suitable for some type of recreation activity. Even the highways could qualify since it is from his car one does much of his sightseeing.

Suitability of land for livestock grazing is relative indeed. Certainly one does not find many vast, lush pastures in this Region since there is, for the most part, insufficient rainfall. However, much of the Region's rangeland is productive relative to land costs and is, therefore, considered suitable for this use.

Most land is suitable for more than one use. The general characteristics of the land - topography, soil, elevation, native vegetation, climate, etc. - determines the suitability of the land to support kinds and combinations of uses. In planning the management and use of land these factors must be considered to minimize conflicts between uses, to reduce the cost of land use changes and to enhance and maintain related water resources.

Within a range, some of these characteristics and interpretations for selected uses were grouped and are shown in Table 31, General Land Characteristics and Suitability for Use. Map 6, General Land Characteristics, indicates the general location and extent of these groups. See Cropland Suitability Map 7, and Water Yield Augmentation Map 8, for further location and extent on these uses. The general location for suitability for timber production is indicated by the "coniferous timber" portion of the Vegetal Cover Map (Map 4).

LEGEND

- Region Boundary
- Subregion Boundary
- State Boundary
- County Boundary

- Cropland 1965
- Soil Suitable for Irrigated Cropland
- Soil Unsuitable for Irrigated Cropland
- Soil Suitable for Irrigated and Non-Irrigated Cropland
- Water

LOCATION MAP

GREAT BASIN REGION

UPPER COLORADO REGION

LOWER COLORADO REGION

CALIFORNIA REGION

RIO GRANDE REGION

MAP 7

COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION

CROPLAND SUITABILITY

16 0 16 32 MILES
SCALE 1:3,168,000
ALBERS EQUAL-AREA PROJECTION

M7-S-2143IC-N

Cultivation

The Region contains almost 40 million acres with soils suited for irrigated agricultural production; of this amount, slightly over 16 million were considered of high quality (Class A or B). The Little Colorado Subregion contains 7,202,000 acres of suited soil; the Lower Main Stem Subregion contains 13,298,000 acres; and the Gila Subregion contains 19,260,000 acres. Four soil irrigation classes were established based on soil limitations that influenced their suitability for sustained use under irrigation. A brief description of each of the classes mapped is as follows:

Class A - None to slight soil limitations for sustained use under irrigation. Soils placed in this group are suited for production of all crops climatically adapted to the area where these soils occur. They are deep, medium textured, generally level to slightly sloping, contain a minimum of soluble salts, have no drainage deficiencies, and have essentially no erosion problems.

Class B - Moderate soil limitations for sustained use under irrigation. These soils are nearly as good as the Class A group; however, they do have minor deficiencies that are easily corrected. They can be coarser or finer textured, have less depth, undulating to steeper topography, minor drainage or erosion problems, and a higher concentration of soluble salts than the Class A group. However, their productive potential is favorable for all climatically adapted crops when cultivated and furnished with an adequate water supply.

Class C - The Class C group of soils is less suited for general crop production. They may be coarse or fine textured; quite shallow or stony; have adverse topographic, drainage, or salinity characteristics; or they exist in narrow drainageways or on steep slopes. However, when supplied with adequate water and good management practices they can be farmed beneficially over a long period of time.

Class D - Very severe soil limitations for sustained use under irrigation. Soils placed in this class are generally restricted to a narrow variety of crops. They may be shallow, excessively stony, coarse or fine textured, slowly permeable, very steep, quite saline, or have other adverse conditions which limit the soils to a particular crop or require outstanding management to be profitably farmed. However, they can be a beneficial portion of the overall area suited for irrigated agriculture.

These soils all have a minimum depth of over 10 inches, are not excessively saline or droughty, can be worked with cultural machinery, and can be leveled and developed for crop production when adequate amounts of water and favorable climate are available.

A Class E group of soils was also established to designated those soils not considered suited for irrigation. This group of soils totals some 50 million acres and, although considered not suited for crop production, contain resource potential for essentially all other land uses. It is in this group of soils that much of the recreation and fish and wildlife potential exists. Likewise, much of the timber production and mineral resources occur on the Class E areas. Materials used in the building and construction industries, such as sand, gravel, clays, ceramic sands, gypsum, building stones, and facing stones are also generally found in the Class E type soils areas. Also, it is often within this area that erosive forces are more likely to develop, and rapid sheet runoff from local storms cause flood damage.

The following table presents by soil classes the acreages by states and subregions. Figure 9 also indicates the relative magnitude of the soil areas by percentage and acreage for each of the subregions and for the Region.

Map 7 Cropland Suitability, shows the distribution of presently irrigated (1965) lands and the location of soils suitable for crop production. This map is of general nature and is not in enough detail to locate small specific areas.

The availability of land for cropland depends upon the demand for crop production relative to the needs and values of the land for other resources, uses, and activities, the availability and location of water for irrigation, the ownership and management responsibilities. Generally, privately-owned land near presently irrigated areas is most readily available. If new sources of water become available and the need for other resources and uses permit, land ownership may need to change from federal to private to allow for increased cropland use. There is no anticipated shortage of land available for this use.

Table 32
Lower Colorado Region
Acreage of Irrigation Soil Classes
(1,000 acres)

State	Sub-region	Irrigation Soil Classes A	B	C	D	Total A-D	E	Total 1/
Arizona	1	1,408	3,043	3,401	2,805	10,657	12,112	22,769
	2	1,083	1,145	2,312	1,635	6,175	7,682	13,857
	3	4,501	3,541	5,175	4,359	17,576	14,065	31,641
		6,992	7,729	10,888	8,799	34,408	33,859	68,267
New Mexico	2	74	305	569	79	1,027	2,369	3,396
	3	245	512	722	205	1,684	3,465	5,149
		319	817	1,291	284	2,711	5,834	8,545
Nevada	1	60	209	705	1,409	2,383	8,560	10,943
		60	209	705	1,409	2,383	8,560	10,943
Utah	1	10	37	110	101	258	1,975	2,233
		10	37	110	101	258	1,975	2,233
Subregion								
1 Lower Main Stem		1,478	3,289	4,216	4,315	13,298	22,647	35,945
2 Little Colorado		1,157	1,450	2,881	1,714	7,202	10,051	17,253
3 Gila		4,746	4,053	5,897	4,564	19,260	17,530	36,790
REGION TOTAL		7,381	8,792	12,994	10,593	39,760	50,228	89,988

1/ Totals do not necessarily agree due to rounding.

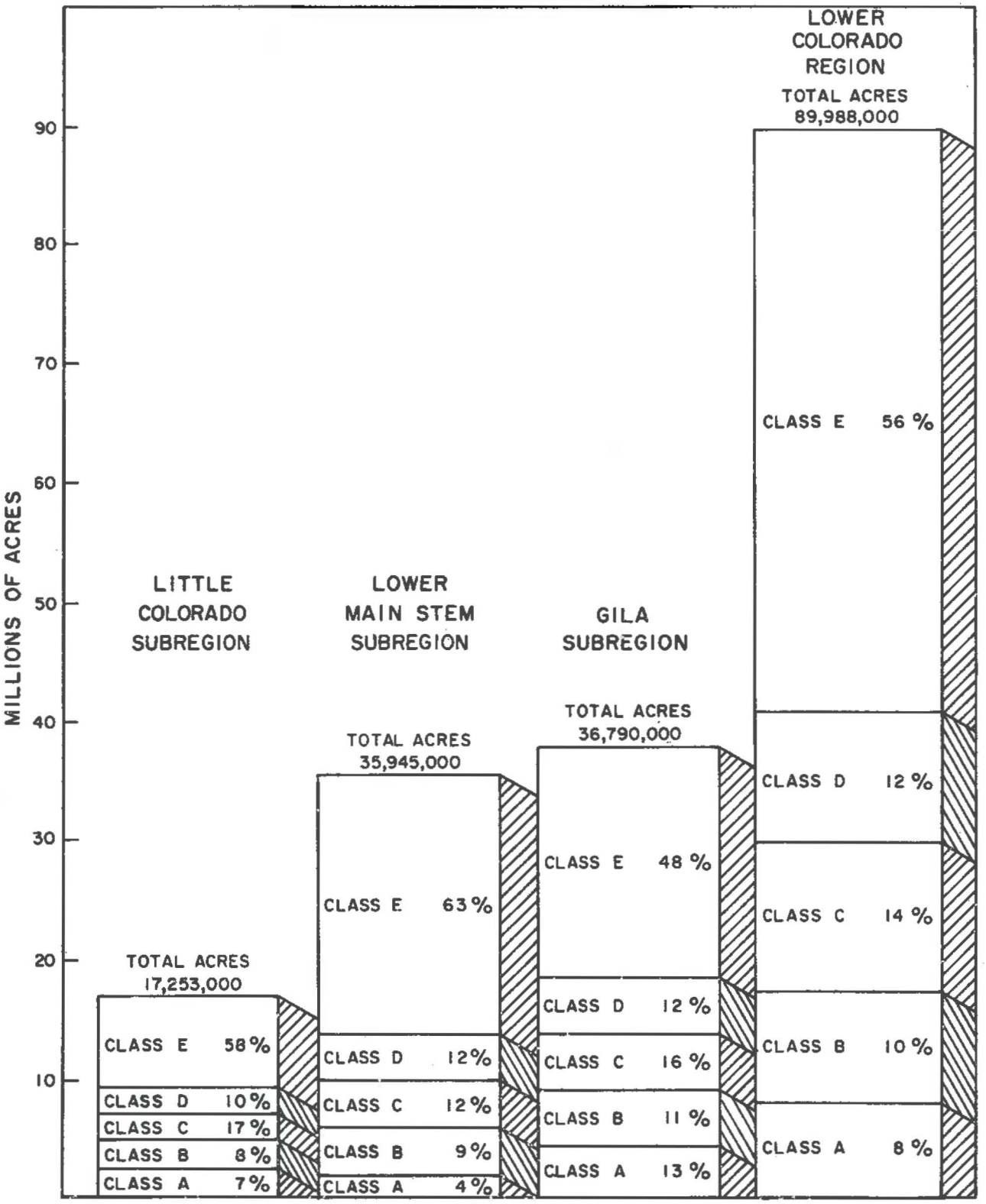


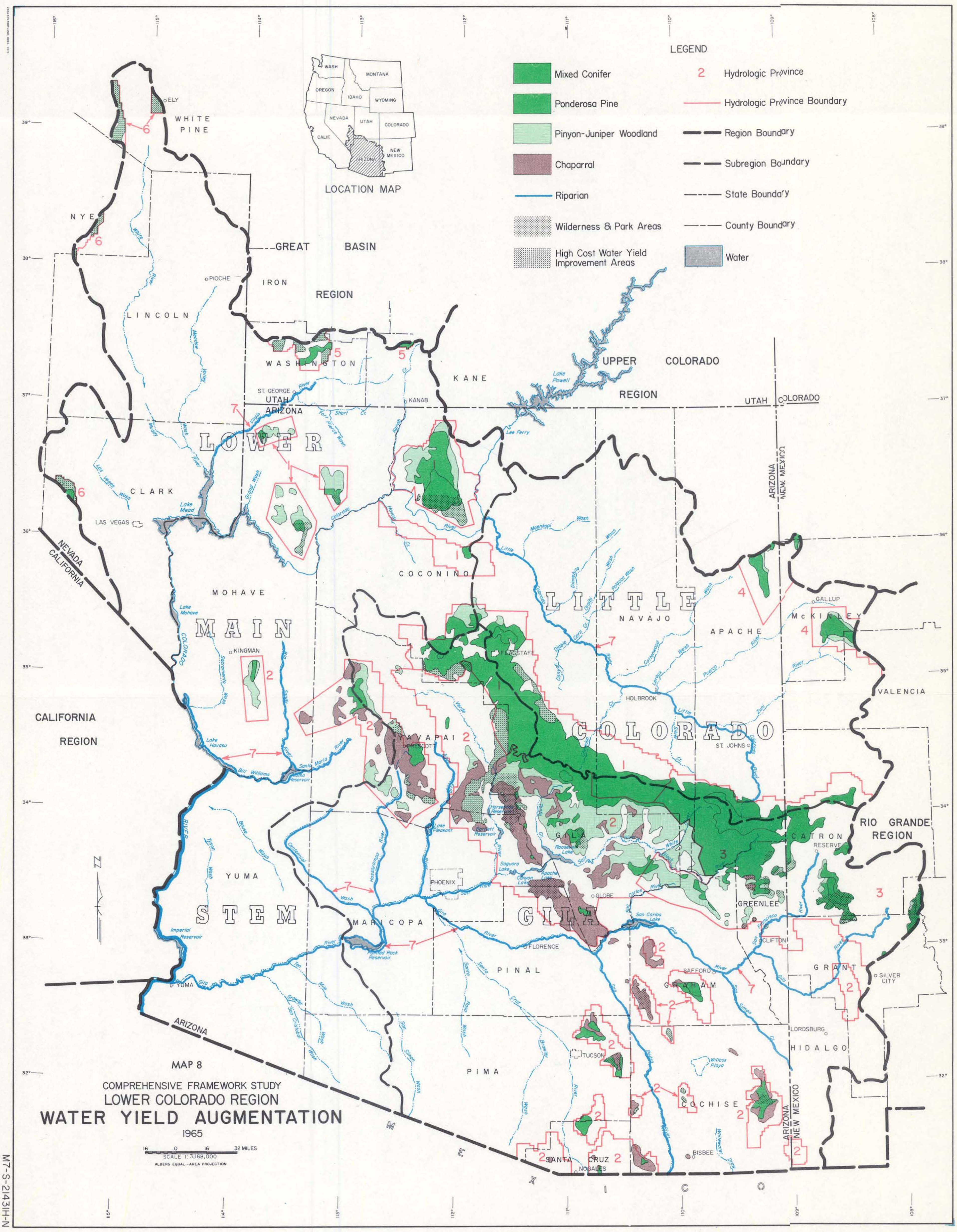
FIGURE 9

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

IRRIGATION SOIL CLASSES

HYDROLOGIC SUBREGION



MAP 8

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

WATER YIELD AUGMENTATION

1965

SCALE 1:3,168,000 (16 0 16 32 MILES)

ALBERS EQUAL-AREA PROJECTION

M7-S-21431H-N

Ownership and administration of lands having irrigable and nonirrigable soils in the Lower Colorado Region are shown in Table 33. The following is a summary comparison of these soils and status:

	(1,000 acres)		
Land Status	Irrigable Soils	Nonirrigable Soils	Total Land Area
Federal	16,538	30,353	46,891
State	6,602	3,999	10,601 1/
Indian Trust	6,003	10,409	16,412
Individual & Corporate	10,617	5,467	16,084
	39,760	50,228	89,988

1/ Includes 25,000 acres of other public

The percentages of land classified as having irrigable soils are 35 percent for federal, 37 percent for Indian, 62 percent for state, and 66 percent for individual and corporate.

There are about 1.6 million acres within the Lower Colorado Region having suitable soils and sufficient precipitation for nonirrigated crop production (see Map 7). The 1.6 million acres are also suited for irrigated crop production. However, nearly all of this land is covered by coniferous forest with high values for recreation, timber production, wildlife, watershed, and similar public uses. It is anticipated that, for reasons both economic and esthetic, there will be little pressure to develop any appreciable acreage for nonirrigated crop production.

Table 33
Lower Colorado Region
Land Ownership and Administration 1/
by Irrigable and Nonirrigable Soils

Lower Main Stem Subregion
(1,000 Acres)

Land Ownership and Administration	Irrigable Soils	Nonirrigable Soils	Total Land Area
Federal Land Administered by:			
Forest Service	388	1,669	2,057
B.L.M.	5,710	11,054	16,764
B.S.F.&W.	586	1,118	1,704
Nat'l Park Service.	451	2,220	2,671
Bureau of Reclamation	169	249	418
Defense	1,701	1,128	2,829
Defense & B.S.F.&W.	482	324	806
Others	6	8	14
State	1,053	1,403	2,456
Other Public	3	-	3
Indiv. or Corp.	2,286	2,109	4,395
Indian	463	1,366	1,829
Total Land Area	13,298	22,648	35,946

(1 of 4)

Table 33
Lower Colorado Region
Land Ownership and Administration 1/
by Irrigable and Nonirrigable Soils

Little Colorado Subregion
(1,000 Acres)

Land Ownership and Administration	Irrigable Soils	Nonirrigable Soils	Total Land Area
Federal Land Administered by:			
Forest Service	999	1,323	2,322
B.L.M.	382	479	861
B.S.F.&W.	-	-	-
Nat'l Park Service	47	112	159
Bureau of Reclamation	-	-	-
Defense	9	4	13
Defense & B.S.F.&W.	-	-	-
Others	-	-	-
State	953	727	1,680
Other Public	-	-	-
Indiv. or Corp.	2,268	1,809	4,077
Indian	2,544	5,596	8,140
Total Land Area	7,202	10,050	17,252

Table 33
Lower Colorado Region
Land Ownership and Administration 1/
by Irrigable and Nonirrigable Soils

Gila Subregion
(1,000 Acres)

Land Ownership and Administration	Irrigable Soils	Nonirrigable Soils	Total Land Area
Federal Land Administered by:			
Forest Service	2,412	8,184	10,596
B.L.M.	2,922	2,140	5,062
B.S.F.&W.	-	-	-
Nat'l Park Service	13	81	94
Bureau of Reclamation	-	-	-
Defense	226	209	435
Defense & B.S.F.&W.	-	-	-
Others	35	51	86
State	4,582	1,858	6,440
Other Public	11	11	22
Indiv. or Corp.	6,063	1,549	7,612
Indian	2,996	3,447	6,443
Total Land Area	19,260	17,530	36,790

Table 33
Lower Colorado Region
Land Ownership and Administration 1/
by Irrigable and Nonirrigable Soils

Regional Summary
(1,000 Acres)

Land Ownership and Administration	Irrigable Soils	Nonirrigable Soils	Total Land Area
Federal Land Administered by:			
Forest Service	3,799	11,176	14,975
B.L.M.	9,014	13,673	22,687
B.S.F.&W.	586	1,118	1,704
Nat'l Park Service	511	2,413	2,924
Bureau of Reclamation	169	249	418
Defense	1,936	1,341	3,277
Defense & B.S.F.&W.	482	324	806
Other	41	59	100
State	6,588	3,988	10,576
Other Public	14	11	25
Indiv. or Corp.	10,617	5,467	16,084
Indian	6,003	10,409	16,412
Total Land Area	39,760	50,228	89,988

1/ The land ownership and administration acreage figures may not agree with individual agency records because of the computer program used, lack of data or time and money.

(4 of 4)

Livestock Grazing

Livestock grazing suitability depends on the ability of the land to produce useable kinds and amounts of livestock forage, and land characteristics that permit utilization without damage to the soils and other resources. Precipitation, soils, elevation, topography, past and present use pressures, and distribution of livestock water are the more important factors affecting the suitability of land for livestock grazing.

Most area of vegetal cover, except barren are suitable for livestock grazing. Some of the Region is not suitable for livestock use because of inaccessibility, rough topography, unstable soils and/or dense, woody vegetation. Approximately one-third of the southern desert shrub area is below 3,000 feet elevation and has a normal annual precipitation less than 8 inches per year. Portions of this area are not reliable, on a yearly basis, for livestock grazing. Cropland areas are suitable when crop aftermath provides forage. See the Vegetal Cover Map, No. 4, and Table 34, Suitability for Livestock Grazing, for general location and extent of these lands.

Table 34
Lower Colorado Region
Suitability for Livestock Grazing

Vegetal Cover Type	General Topography	Range in Elevation	Range in Precipitation Average Annual in Inches/Year	Area Considered Suitable for Livestock Grazing Ac. in 1,000's
Grassland	Uplands	4,000-12,000	16-30+	16,902
Northern Desert Shrubland	Uplands	4,000-6,000	8-16	8,387
Coniferous Forest Land	Mountains	5,500-12,000	20-30+	5,544
Woodland	Foothills	4,500-7,500	8-18	19,306
Chaparral and Mtn. Brushlands	Foothills	4,000-5,500	12-20	3,396
Southern Desert Shrubland	Very broad valleys with some mountains	Near sea level to 4,500	3 or less to 12	31,497
Crop Aftermath) Irrigation Pasture)	-	-	-	1,000
Total				85,032

Native forage production is highest per acre on the grasslands in the southeast portion of the Region and along streams, and on mountain meadows and savannas where there is more than 16 inches average annual precipitation. The northern desert shrub ranks next in forage production followed by coniferous forest lands, northern grasslands, woodlands, chaparral and mountain brushlands, and southern desert shrublands.

Most grazing lands are available on a multiple-use basis. Areas not available are most national parks and monuments, parts of military reservations, parts of wildlife refuges, most urban areas, roads, airports, and most intensively used recreation areas. Other use pressures may, at times, tend to reduce the availability of an area for livestock grazing.

Timber Production

Almost 30 million acres of land in the Lower Colorado Region are capable of producing forest (wood) products under natural conditions. Nearly 24 million acres of the forest lands are considered as unproductive for production of commercial timber products. These noncommercial areas include: areas of chaparral and pinon-juniper and oak woodland, usually growing at elevations and sites where precipitation is inadequate for growth of commercial timber species; submarginal sites, within the commercial timber areas because of poor or shallow soil; areas where the land has an excessive potential for erosion if the vegetative cover is disturbed; and areas capable of producing commercial timber but so small and isolated that timber harvesting operations are not feasible (such as the small timber areas on the mountain peaks in the southeast and northwest portions of the Region), and small stands of hardwood (riparian) trees scattered throughout the Region. About six million acres are suitable for the production of commercial timber products.

Table 35
Lower Colorado Region
Forest Land - Suitability
(1,000 Acres)

	Total Region	Subregion		
		Lower Main Stem	Little Colorado	Gila
Area Suitable for Commercial Timber Production 1/	6,173	1,063	1,510	3,600
Land Unproductive for Commercial Timber Production	23,718	7,840	5,801	10,077
Total	29,891	8,903	7,311	13,677

1/ Land capable of producing economically available useable crops of wood (usually saw timber).

Ponderosa pine occupies more than five million acres (91 percent) of the commercial timber producing land. It occupies many areas in the Region between 5,500 and 8,500 feet in elevation; however, most of the Ponderosa pine type occurs in an unbroken block of more than 300 miles in length along the Mogollon Plateau between the Black Range in western New Mexico to the Grand Canyon in Arizona. The North Kaibab Plateau in northern Arizona, the Defiance Plateau in eastern Arizona and the Zuni Mountains in western New Mexico are other areas producing commercial timber stands of Ponderosa pine.

Areas in the Region capable of supporting fir-spruce stands of commercial timber include about 155,000 acres between the elevations of 8,500 feet and 12,000 feet. These areas include the White Mountains in eastern Arizona and western New Mexico, the San Francisco Peaks in north central Arizona, and the Pine Valley Mountains in southwestern Utah.

About four percent (235,000 acres) of the Region between the elevations of 8,000 and 9,500 feet are suitable for production of commercial Douglas fir timber. These Douglas fir stands usually occupy the cooler, damper sites in the Ponderosa pine type and the warmer, drier sites in the fir-spruce type.

Apache pine, Chihuahua pine, and Arizona pine replace the Ponderosa pine in the mountains of the southern portion of the Region. There are about 115,000 acres of commercial hardwood timber stands including principally aspen and cottonwood with small amounts of oak and walnut. Aspen occupies areas above 8,000 feet, generally following fires in the fir-spruce or Douglas fir sites. Cottonwood suitable for commercial timber production occurs in the valleys and high water table lands from the Lower Colorado River below 1,000 feet in elevation to the mountain valleys and streambanks above 5,000 feet in elevation.

Table 36
Lower Colorado Region
Area Suitable for Production of Commercial Timber
(1,000 Acres)

Subregion	Total	Douglas Fir	Ponderosa Pine	Fir-Spruce	Other Softwood	Hardwoods
Lower Main Stem	1,063	96	801	110	0	56
Little Colorado	1,510	17	1,437	18	1	37
Gila	3,600	122	3,425	28	3	22
Total	6,173	235	5,663	156	4	115

Extensive areas of land in all subregions may be considered as suitable for growing commercial timber crops if developed for irrigation. Production of commercial timber crops in the Lower Colorado Region on irrigated land is not considered as practical or economically feasible.

An estimated 666,000 acres of commercial timber producing lands in the Lower Colorado Region are included within the boundaries of national parks, monuments, and recreation areas; wilderness and primitive areas; developed recreation areas on both public and private-owned lands; and high value scenic areas such as viewing areas and buffer strips adjacent to highways and recreation roads. The total area suitable and available for the production of commercial crops of timber in the Region is approximately 5.5 million acres.

It is estimated that nearly one-half million acres of available commercial timberland will be converted to recreation, residential,

transportation and utility rights-of-way, and other uses between 1965 and 2020. Land "suitable" and "available" for production of commercial timber crops in the Lower Colorado Region is estimated to be about five million acres by the end of the projection period 2020 (refer to Table 15, Present and Projected Area of Commercial Timberland by Status).

Urban and Industrial

Most land in the Region is suited for urban and industrial use. Lands undesirable for these uses but not precluded from such use include steep lands, lands subject to flood, and, in general, lands which require high development costs. Because economics generally favor land development for urban and industrial use as compared with competing uses, availability of land for these uses is not considered a restraint.

Important considerations in developing land for urban and industrial use include the location of dependent industries and markets, adequate transportation facilities, the availability of water supplies and other municipal services, and environmental considerations.

If past trends were to continue, future population growth and industrial development would be expected to take place primarily in close proximity to existing urban centers. Suitable land is available within present corporate boundaries and surrounding areas to accommodate part of the anticipated future expansion. In 1965 about 513,000 acres of land were used for urban and industrial purposes. By 2020 an additional 1,051,000 acres will be needed.

Outdoor Recreation

The scope of recreation as it makes demands for space--both land and water--is exceptionally broad. As far as the Comprehensive Framework Studies are concerned, some 19 recreation activities were considered, see the Recreation Appendix, as requiring facilities and/or space for their enjoyment and pursuit. These include the following:

- Picnicking
- Attending Outdoor Sports Events
- Nature Walks
- Attending Outdoor Concerts, etc.
- Playing Outdoor Games, etc.
- Bicycling
- Horseback Riding
- Swimming
- Boating other than Sailing, Canoeing
- Water-Skiing
- Sailing and Canoeing
- Sledding or Tobogganing
- Ice Skating
- Snow Skiing
- Fishing
- Hunting
- Camping
- Hiking
- Mountain Climbing
- Miscellaneous

In addition to those 19 activities listed there are many rapidly expanding activities in the Region such as: dune buggying, jeep caravaning, motorcycling, snowmobiling, rockhounding, sand skiing, sail planing and soaring.

Each of these activities requires certain facilities and conditions. Assessing the suitability of land for any of them is a problem, however, since there are few features, either cultural or natural, common to all of them.

The suitability of land for playing outdoor games and sports, attending outdoor concerts and dramas, bicycling, ice skating and pool swimming, for example, is very difficult to assess. With sufficient investment, any parcel of land can be developed to provide opportunities for participating in these activities. Many of them take place in urban communities with little regard for soil type, slope, vegetation or other physical attributes.

A noteworthy opportunity exists for the development of selected recreational facilities on undeveloped, flood-prone lands within urban areas. In this Region there are more than 60,000 acres which met these criteria in 1965. Of this total area, more than 36,000 acres are located in the Lower Main Stem, 6,000 acres in the Little Colorado, and 17,500 acres in the Gila subregions.

Picnicking and camping, on the other hand, do generally require natural environments for their enjoyment. Again, however, the level of investment can make even undesirable areas attractive. Some people prefer desert environments, others mountain forests and still others city parks. Some people alternate in their choice among the available opportunities.

Mountain climbing and hiking, it might seem, require particular resource characteristics. The question becomes one of determining whether a mountain is "suitable" for climbing. Some mountains that may seem unsuited actually are suited to a few highly trained people who are expert in the use of ropes and safety techniques. Less imposing slopes may be best suited to beginners or hikers. Rock climbing of outcrops within urban areas has become popular--belying the image of climbing as a rugged and remote experience.

Fishing, hunting, and horseback riding are activities requiring rather more definite resource qualities. The fishing and hunting needs are closely related to habitat management and are considered in detail in the Fish and Wildlife Appendix. Horseback riding usually requires a natural or rural environment.

In short, it does not appear reasonable to treat recreation in the same way as grazing or agriculture. If it were possible to develop

data on the need for forest as opposed to desert recreation experiences, there might have been some basis for judging suitability by vegetative cover. This is not a very meaningful approach, however, since recreation is a social phenomenon that is basically a function of available time and income. The resource is essential, of course, but more for the space it provides than for any particular vegetative type, soil or slope. The physical character of the land often enhances the recreation experience and sets limits on available opportunities.

Wilderness, and Wild and Scenic Rivers

There are unique recreation resources, however, the value of which depends almost entirely on their special character. Usually they are irreplaceable and must be protected rather than developed. Their value is often intangible, but the rationale for their preservation is no less worthy than that based on economics. Indeed, preserving some of our unique natural and cultural heritage is an essential expression of our national goals.

Among the most significant of these areas are the following:

Wilderness Areas
Wild and Scenic Rivers
Unique Natural Areas
Historic Areas
Archeologic Areas

Each of the above is characterized by unique attributes that can be rather well defined. The criteria for preserving wilderness areas, for instance, is set forth in detail in the Wilderness Act (Public Law 88-577):

> "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; has outstanding opportunities for solitude or a primitive and unconfined type of recreation; has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and may also contain ecological, geological or other features of scientific, educational, scenic or historical value."

Wild and Scenic Rivers

The Wild and Scenic Rivers Act, P.L. 90-542, provides for designation of rivers or sections of rivers as "wild rivers" when their immediate environments possess outstanding, remarkable, scenic, recreation, geologic, fish and wildlife, historic, cultural or other similar values. These rivers shall be preserved in a free-flowing condition and their immediate environment shall be protected for the benefit and enjoyment of present and future generations. Rivers falling in the Wild and Scenic category have three general categories and will be administered in one of these three categories. They are:

1. Wild river areas--Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

2. Scenic river areas--Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

3. Recreational river areas--Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines and that may have undergone some impoundments or diversion in the past.

The remaining areas including archeologic, historic and unique natural areas have been identified in the Recreation Appendix. Reference to that appendix will indicate management direction that will provide for maintaining the unique characteristics of these areas.

More than 1,300 miles of streams in the Lower Colorado Region have been suggested for study for possible inclusion in the Wild and Scenic Rivers System.

Streams recommended for classification as "wild rivers" in the Lower Colorado Region afford a wide variety of "wild river" and "wilderness" experiences. The scenic, geological, climatic, biological, and ecological characteristics range from the rugged canyon and rock formations in the lower Sonoran life zone of the Lower Colorado River Canyon, to the montane and subalpine forests of the Upper Black River in the eastern Gila Subregion.

Military and Related Use

Most lands within the Lower Colorado Region are suitable for military and related uses. Lands adjacent to urban areas, for example, are suitable for ordnance depots, and for military bases and reservations. Other lands remotely located from urban development and other intensive uses are well suited for such uses as training, testing, bombing and gunnery practice. These latter uses require remote, large land areas, and are generally located in areas having limited economic value.

Mineral Production

Vast areas in the Region have a potential for mineral production, including an estimated 20 percent of the federal lands that are covered by mineral claims under the various mineral laws. Land use planning must include provision for developing the mineral resources, both those that are rare and required to meet the needs of the Nation outside of the Region, and those that are required daily to meet local needs.

Mineral deposits may occur under any topographic feature, from streambeds to mountain tops, but they can only be extracted from those locations where nature has placed them in sufficient quantity and quality. Mineral deposits occur over large areas. Mineral extraction from these deposits will occur when demands and technology make it feasible to mine them economically.

Lands administered by the National Park Service and Bureau of Sport Fisheries and Wildlife are generally not available for mineral exploration or development. Other public-owned lands have been withdrawn from mineral production where justified by higher values for recreation, research, watershed and other environmental values, and for administrative and public use. Lands included in wildernesses are available for prospecting until December 31, 1983, for the purpose of gathering information about mineral resources, if such activity is carried on in a manner compatible with the preservation of wilderness environment.

Fish and Wildlife

The criteria for the suitability of land for wildlife are many and varied. The land must provide food, water, and cover for each species. These requirements for some species are simplified in that these animals can derive their water through metabolic processes, thereby requiring no free water. Some desert rodents fall into this

category and require only a burrow to shelter them from the elements, and a few blades of grass and some grass and weed seeds to feed on.

The requirements for most species are not so easily satisfied. Each species must derive its own requirements from the land, and all of these requirements must be available within the range of their travels. If any one of the requirements is not locally adequate, the species will not survive in that locality.

Water Yield Improvement

Research studies have shown that increases in water yield can be obtained from forest land by reducing the water used by on-site vegetation. In many areas water yield can be increased by modifying the practices of timber harvesting and by conversion of chaparral and mountain brush, and the deeper-rooted riparian trees and shrubs to shallow-rooted grasses and forbs. Map 8 shows the extent of the areas suitable for this type of management, and Table 37 presents the potential average annual water yield increase and the cost per acre-foot by vegetative type. The cost per acre-foot of increased water yield is estimated to be as low as 50 cents to as high as $150 including operation, maintenance, and replacement. Increases in water yield costing in excess of $150 per acre-foot have been considered excessive and have not been included in the areas suitable for water yield augmentation programs. Treatment of some areas that result in minimal increases may be justified for enhancement of other resources, including livestock forage, specialized wildlife habitat, timber, and development of farm lands. Potentials for water yield augmentation on the forest lands in the Lower Colorado Region are limited to those that can be achieved through vegetative management programs, and do not include small amounts that might be achieved through snowpack management on the few acres in the alpine zone of the Region.

Precipitation is the most important factor when considering vegetative management for increased water yield from the upland vegetative zones, conifer, woodland, and chaparral. Average annual precipitation of 16 inches is considered as the minimum for possible increased yield, with average winter precipitation of 10 inches to assure a reasonable increase. Water yield increases are dependent upon the nature of the soil mantle and the underlying parent material. Geologic substrata of fractured materials, granites, schists, unconsolidated sediments, etc., are desirable, especially in the chaparral and mountain brush types. The density of the vegetation and crown canopy and steepness of slope are important considerations in determining feasibility for water yield improvement programs. Areas of erosive soils and areas on which the potential for vegetation growth is low due to soil or climatic factors are not considered as treatable.

Table 37
Lower Colorado Region
Potential Average Annual Water Yield Increase and Costs by Vegetative Type and Hydrologic Provinces

Hydrologic Province No.	Name	CHAPARRAL Treatable Area (1000 Ac.)	CHAPARRAL Average Potential Increased Water Yield (1000 Ac-Ft)	CHAPARRAL Average 1/ Cost Per Ac-Ft. ($)	RIPARIAN Treatable Area (1000 Ac.)	RIPARIAN Average Potential Increased Water Yield (1000 Ac-Ft)	RIPARIAN Average 1/ Cost Per Ac-Ft. ($)	CONIFEROUS FOREST Treatable Area (1000 Ac.)	CONIFEROUS FOREST Average Potential Increased Water Yield (1000 Ac-Ft)	CONIFEROUS FOREST Average 2/ Cost Per Ac-Ft. ($)	PINON JUNIPER WOODLAND Treatable Area (1000 Ac.)	PINON JUNIPER WOODLAND Average Potential Increased Water Yield (1000 Ac-Ft)	PINON JUNIPER WOODLAND Average 1/ Cost Per Ac-Ft. ($)	TOTAL Treatable Area (1000 Ac.)	TOTAL Average Potential Increased Water Yield (1000 Ac-Ft)
	Lower Main Stem Subregion														
1	Plateau	-	-	-	-	-	-	330	7.3	5	26	1.2	129	356	8.5
2	Desert	-	-	-	-	-	-	80	4.4	4	-	-	-	80	4.4
5	Utah	-	-	-	-	-	-	15	.2	50	-	-	-	15	.2
6	Great Basin	-	-	-	-	-	-	15	.1	76	-	-	-	15	.1
7	Phreatophyte	-	-	-	141	404	2	-	-	-	-			141	404.0
	Subregion Total	-	-	-	141	404	2	440	12.0	6 3/	26	1.2	129	607	417.2
	Little Colorado Subregion														
1	Plateau	-	-	-	-	-	-	906	32	5	216	1.9	80	1,122	33.9
3	Southern Mts.	-	-	-	-	-	-	495	41	3	5	.2	108	500	41.2
4	Central Mts.	-	-	-	-	-	-	30	5	11	6	.3	140	36	5.3
7	Phreatophyte	-	-	-	20	20	4	-	-	-	-	-	-	20	20.0
	Subregion Total	-	-	-	20	20	4	1,431	78.0	5 3/	227	2.4	90 3/	1,678	100.4
	Gila Subregion														
1	Plateau	-	-	-	-	-	-	124	3	4	-	-	-	124	3.0
2	Desert	1,232	241	18	59	6	20	351	38	3	75	4.5	70	1,717	289.5
3	Southern Mts.	-	-	-	-	-	-	826	92	4	9	.4	100	835	92.4
7	Phreatophyte	-	-	-	100	200	3	-	-	-	-	-	-	100	200.0
	Subregion Total	1,232	241	18	159	206	4 3/	1,301	133.0	4 3/	84	4.9	90 3/	2,776	584.9
	Region Total	1,232	241	-	320	630	-	3, 172	223.0	-	337	8.5	-	5,061	1,103

1/ Costs per acre-feet includes costs of treatment plus costs of maintenance, averaged over projection period.

2/ Costs for treatment of coniferous forests include only additional costs over normal timber harvesting costs. No maintenance costs are included as the areas will become reforested and grow to maturity at the end of the rotation.

3/ Average costs for all vegetative types.

A large part of the Lower Colorado Region, estimated at 5.1 million acres, offers the potential to increase water yields by reducing evapotranspiration through changes in emphasis in vegetation management practice. These opportunities to provide increased runoff are generally found on the watershed lands at the higher elevations where precipitation is high and along the broad flood-plain lands at lower elevations covered with phreatophytic growth.

Since large increases in water yields will result only through substantive changes in management emphasis, it is not likely that the full potential increase would become a feasible or desirable objective.

While a part of the potential can be realized as a spin-off from carefully planned, intensified and improved land management, further increases may be obtained only through trade-offs of the values of other resources and products as viewed by present-day standards. To achieve full potential would adversely affect social, economic and other resource values along with overall environmental quality.

The maximum average-annual potential increase in water yield within the Region through changes in vegetation management is estimated at 1.1 million acre-feet per year from 5.1 million acres. The goals to be established for increased yield will probably be much less than the potentials shown in Table 37 as determined by such considerations as esthetics, outdoor recreation and wildlife habitat requirements, together with other land management objectives for forage and timber production.

These increases in water yield do not include those from lands inside wildernesses, primitive areas, national parks or other lands where land treatment measures are prohibited by law or regulation. Areas where treatment and maintenance costs would exceed $150 per acre-foot have not been considered as land suitable for water yield improvement. Water yields are predicted to increase following prescribed timber harvest, but will decrease as new stands of trees develop and will usually phase out when the stand reaches forty years of age. However, the stands in the 0 to 40 year age classes will show significant increases over uncut mature stands.

The riparian type offers the most promising potential for treatment in the Lower Colorado Region where up to three acre-feet per year of increased water yield may be expected for each acre treated. An estimated 1.25 million acres of chaparral in the desert hydrologic province are considered as suitable for treatment, with an estimated potential of 240,000 acre-feet of additional yield if all suitable chaparral stands were treated. An estimated 3.2 million acres of coniferous forests (commercial timber lands) are suitable for management with increased water yield as one product under designated

silvicultural systems. Less than 1/3 of the total suitable areas could provide an increase in yield of an estimated maximum potential of 223,000 acre-feet annually. Some scattered areas of pinon-juniper and oak woodland may provide limited opportunities for treatment for increased water yield, particularly when other benefits, such as livestock forage and wildlife habitat, are included.

The hydrologic, ecologic, esthetic and economic values associated with the forest and wildland types require intensive inventory, analysis and planning before water yield improvement by vegetation management is initiated.

Transportation and Utilities

The suitability of land factors for transportation and utilities is dependent primarily upon location and availability. Physical characteristics such as slopes, vegetal cover, subsurface conditions, and soil types are of considerable importance too.

Economics, of course, is the most significant criterium in selecting route alignments. The use of lands for transportation and utilities has visual, social, and functional impact on the landscape. All of these factors affect the suitability of the land for transportation and utilities use. Increasing attention is now being focused on the esthetic and social implications of route alignments.

Land suitability for water impoundments is quite restrictive. For hydro-electric dams a canyon or valley must have sufficient fall so power can be generated. The soil and rock formation must be capable of supporting the dam and tight enough to retain the water.

Airports have many social and environmental implications. In choosing a major airport, a few of the factors involved are the noise created by the airplanes, the distance from the center of town (accessibility), the air pollution associated with the airplanes, and the topography of the surrounding area. With big planes in the future, and airport needs to be far enough away from the mountain terrain to enable large aircraft to maneuver safely into low level approach and takeoffs during inclement weather.

Archeological

The archeological resources consist of thousands of sites ranging from ancient stone chipping stations of the Lithic Stage through the architectural remains of the 10th - 13th century Anasazi, Mogollon and Hohokam villages, to the evidences of the historic American Indian period such as Awatovi Ruins and the Seven Cities of Cibola. The sites represent the sum of Man's activities in the Region from most ancient times to most recent history. Yet our knowledge of Man's life-ways over the past 15,000 years is fragmentary and inconclusive when compared to the potential knowledge that remains undisturbed in the unstudied archeological resources of the Region. Techniques of getting more information and different kinds of information about past cultures have increased tremendously over the past 70 years and we are on the threshold of developing even more sophisticated methods of reconstructing the daily life of the people of past societies, and how they interacted with their environment and used the associated natural resource base.

RELATIONSHIP OF LAND AVAILABILITY TO PROJECTED REQUIREMENTS

Table 38 compares land suitability and availability with projected requirements of land for all principal uses. It should be noted that, while there are sufficient suitable lands for each individual land use, there will need to be widespread adoption of the multiple-use principle in order that the requirements for all uses may be fulfilled.

Table 38
Lower Colorado Region
Comparison of Land Suitability and Availability
with Projected Land Requirements
(1,000 acres)

	Lower Main Stem	Little Colorado	Gila	Total Region
Cultivation - irrigated				
Suitable	13,298	7,202	19,260	39,760
Suitable & Available (1965)	2,749	4,812	9,059	16,620
Use in 1965	324	40	1,421	1,785
1980 Requirement	379	44	1,440	1,863
2000 Requirement	382	44	1,456	1,882
2020 Requirement	403	43	1,387	1,833
Cultivation - nonirrigation				
Suitable	181	707	743	1,631
Suitable & Available (1965)	39	67	82	188
Use in 1965	8	23	-	31
1980 Requirement	7	21	-	28
2000 Requirement	6	17	-	23
2020 Requirement	6	13	-	19
Livestock Grazing				
Suitable	35,645	16,654	32,733	85,032
Suitable & Available (1965)	27,970	16,604	31,480	76,054
Use in 1965	27,970	16,604	31,480	76,054
1980 Requirement	26,769	16,429	30,541	73,739
2000 Requirement	24,017	16,263	29,622	69,902
2020 Requirement	20,608	16,057	29,142	65,807

(continued)

Table 38 - continued
Lower Colorado Region
Comparison of Land Suitability and Availability
with Projected Land Requirements
(1,000 acres)

	Lower Main Stem	Little Colorado	Gila	Total Region
Timber Production				
Suitable	1,063	1,510	3,600	6,173
Suitable & Available (1965)	873	1,419	3,166	5,458
Use in 1965	873	1,419	3,166	5,458
1980 Requirement	845	1,396	3,117	5,358
2000 Requirement	838	1,333	2,982	5,153
2020 Requirement	831	1,284	2,929	5,044
Urban and Industrial				
Suitable	N/A 1/	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965	129	19	365	513
1980 Requirement	286	78	499	863
2000 Requirement	460	98	672	1,230
2020 Requirement	530	135	899	1,564
Outdoor Recreation (Designated)				
Suitable	N/A	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965 2/	4,247	203	1,092	5,542
1980 Requirement	4,570	206	1,112	5,888
2000 Requirement	4,609	246	1,157	6,012
2020 Requirement	4,660	262	1,224	6,146
Wilderness (Classified)				
Suitable	2,000	58	1,400	3,458
Suitable & Available (1965)	2,000	58	1,400	3,458
Use in 1965	0	0	861	861
1980 Requirement	0	58	1,400	1,458
2000 Requirement	1,700	58	1,400	3,158
2020 Requirement	2,000	58	1,400	3,458
Military & Related Uses				
Suitable	N/A	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965	3,652	21	453	4,126
1980 Requirement	N/A	N/A	N/A	N/A
2000 Requirement	"	"	"	"
2020 Requirement	"	"	"	"

(continued)

Table 38 - continued
Lower Colorado Region
Comparison of Land Suitability and Availability
with Projected Land Requirements
(1,000 acres)

	Lower Main Stem	Little Colorado	Gila	Total Region
Mineral Production				
Suitable	N/A	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965	5	7	63	75
1980 Requirement	9	28	78	115
2000 Requirement	10	41	105	156
2020 Requirement	11	84	128	223
Fish & Wildlife (Designated)				
Suitable	30,615	14,600	31,210	76,425
Suitable & Available (1965)	1,823	16	19	1,858
Use in 1965	1,823	16	19	1,858
1980 Requirement	3,326	47	173	3,546
2000 Requirement	5,330	226	1,619	7,175
2020 Requirement	12,680	476	1,864	15,020
Water Yield Improvement				
Suitable	607	1,678	2,776	5,061
Suitable & Available (1965)	456	1,229	2,000	3,685
Use in 1965	4	50	60	114
1980 Requirement	49	115	200	364
2000 Requirement	99	245	620	964
2020 Requirement	149	425	840	1,414
Transportation and Utilities				
Suitable	N/A	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965	221	63	376	660
1980 Requirement	266	103	489	858
2000 Requirement	318	130	582	1,030
2020 Requirement	357	136	652	1,145

(continued)

Table 38 - continued
Lower Colorado Region
Comparison of Land Suitability and Availability
with Projected Land Requirements
(1,000 acres)

	Lower Main Stem	Little Colorado	Gila	Total Region
Flood Control 3/				
Suitable	N/A	N/A	N/A	N/A
Suitable & Available (1965)	"	"	"	"
Use in 1965	3	-	74	77
1980 Requirement	36	12	181	229
2000 Requirement	54	17	218	289
2020 Requirement	61	20	255	336

1/ N/A signifies not applicable.

2/ Designated outdoor recreation areas, 1965.

3/ Area required for structures, impoundments, flowage easements, and other necessary rights-of-way.

WATERSHED MANAGEMENT

CHAPTER F - WATERSHED MANAGEMENT

Watershed management is the analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of man.

When emphasis is focused on any one objective, the definition of watershed management is more restrictive. Effective management of an area requires a well-founded knowledge of the interrelationships among climate, plants, soils, geology and other factors. Management objectives may be one or more of the following: increased water yield, improved water quality, control of erosion and sediment yield, and reduced floodwater damage. These objectives may be achieved through variations in management of livestock forage, timber and other vegetative types, wildlife habitat, residential and commercial areas in respect to location (zoning), recreation, crop production, and other resources.

Efficient multiple use requires that watershed management programs be carefully planned and implemented. The watershed problems and needs as of 1965 and projected for 1980, 2000, and 2020 are discussed in this section. Problems and needs were projected under the assumption that development and growth would continue but no additional protection or improvement measures would be installed after 1965. In most cases, problems and needs are discussed in the form of monetary average annual damages, others do not lend themselves to economic evaluation. Damages were projected with prices held constant at the 1965 level. In a later section (Chapter H) the effects of the "going" and "suggested" programs in solving the problems and meeting the needs are described.

WATERSHED PROBLEMS AND NEEDS

Proper management and use of land to improve the quantity and quality of water, to reduce erosion and sediment yields, and to maintain a productive watershed are dependent upon a number of factors. These are: past use of the land, ownership patterns, soils, vegetative type(s), climate, and physiography. Any well balanced watershed management program must consider the use and development of such resources as timber, forage, and wildlife, and such social values as recreation and esthetics. This discussion, however, will focus on water and sediment yields, erosion, and flooding.

Although loss of protective ground cover may result from natural ecological increases of overstory trees and shrubs, attention is more often focused on effects of competitive demands imposed on the land by an increasing population and an expanding economy. More intensive use of the land resources has created a multitude of watershed management problems including: increased soil erosion, accelerated sediment production, reduced productivity, increased flood damage, and degraded water quality. Major land use changes have occurred. The growth of urban populations has resulted in land being shifted from irrigated agricultural production to urban use. Recreation demands have expanded rapidly as has most other uses. Through multiple-use management, attempts are being made to meet these increasing demands.

Land ownership and administration influence watershed management. Because a high percent of the Region (64 percent) is in public ownership, public agencies have the greatest opportunity and responsibility for watershed improvement.

Most of the federal lands are in contiguous ownership. Since the ownership pattern is not as diversified and scattered as most other ownerships, administrators can effectively protect and enhance watershed values as part of the multiple-use program. Some small holdings within the federal lands cause minor problems of continuity and coordination of programs.

On a portion of the federal lands several agencies share the responsibility for administration of the various resources. The purposes for which the agencies manage may not be completely compatible. This situation complicates watershed management and close coordination and cooperation is necessary.

Most of the state ownership resulted from land grants for aid to education. The school land grants were on the basis of a certain number of sections per township. This resulted in state lands being interspersed with other ownerships. Planning and development of effective watershed management programs are very complex where many different ownerships and management policies are involved.

The United States Government holds the title to reservation lands in trust for the Indians. As trustee, the federal government is responsible for the protection and management of the lands. Reservations comprise large blocks of land on which watershed programs can be very effective. The right to use land by individuals, associations, or groups is governed by the Tribal Council. In some areas, because of traditions, there has been improper use which has resulted in damage to the watershed values. A continuing problem has been the lack of funds to implement an effective program.

Past public land laws resulted in transfers of land to private ownership in small parcels causing inefficient intermingled ownership patterns and accessibility problems. Railroad grants of alternate sections, state grants of scattered sections and private homesteads and requisitions have contributed to this situation. Many isolated tracts exist that are too small to form viable management units.

A major complicating factor associated with watershed management on privately-owned lands is that many of the benefits resulting from watershed restoration cannot be realized by the same private owner who makes the investment. Consequently, there is little individual incentive to make watershed investments other than those which will improve production or protection directly.

In order to select effective management and treatment practices, information such as soil depth, texture, origin and the nature of the underlying material must be evaluated. These factors determine the erodibility of the soil and its ability to receive, transmit, and store water.

Proper management must provide for on-site protection or improvement as well as off-site benefits. For example, if management for increased water yields requires vegetative conversion on soils with a surface of unstructured clay or sandy texture, consideration must be given to the length of time needed to re-establish a protective vegetative cover.

The capability of coarse granitic and other open structures soils to receive and store water provides a potential for increased sustained flow. On the other hand, soils of basalt origin are tighter and have less potential for storage and sustained flow. However, these basalt soils do provide opportunities for increased overland flow.

The vegetative types within the Region represent extremes from the true desert and the ephemeral southern desert shrub type near the mouth of the Colorado River to the true alpine type at the summit of the San Francisco Peaks and Mount Baldy on the Colorado Plateau. The sparse overstory of shrubs with no perennial grasses or forbs in the ephemeral southern desert shrub type provides very little protection

to the soil and rapid runoff from torrential rains which occur result in flash floods and localized severe sheet and gully erosion. The perennial southern desert shrub type, on the other hand, supports a fair stand of perennial grasses and forbs which, together with a more dense stand of woody vegetation, provides fair to good protection to the soil mantle. During intense storms the perennial southern desert shrub type, like the ephemeral southern desert shrub, is subject to localized flooding and moderate to severe erosion depending upon the density and condition of the ground cover. The northern desert shrub type under good conditions provides a fair overstory of low shrub and fair to excellent ground cover of grass and forbs; thus providing good to excellent infiltration with a minimum to moderate erosion hazard. Much of the southern perennial and northern desert shrub types are in poor condition and in this area, particularly in the northern desert shrub type, the highest annual sediment yield in the Region occurs.

Grassland types provide excellent ground cover and good to excellent control of runoff with minimum to moderate erosion hazard. Much of the grassland types have been severely overused with the perennial grasses being replaced by sparse stands of annuals. In these areas, infiltration has been reduced and both gully and sheet erosion are occurring in moderate to severe rates.

Dense crown canopy in the chaparral and pinon-juniper vegetative types limits grass and forb ground cover offering little protection to the soil mantle. They offer opportunities for increasing water yield through conversion to perennial grasses on the deeper, better soils, particularly in the chaparral types. When subsurface geology limits storage, conversion of pinon-juniper stands to grass may merely result in making more efficient on-site use of precipitation rather than increasing water yields.

Throughout the coniferous forest type a layer of needles along with grass, forbs and other low vegetation provides excellent protection against erosion and favors rapid infiltration. This type offers good to excellent opportunities to improve the water yield through timber management systems and techniques.

The alpine type is of a very fragile composition. Under good conditions the infiltration rate is good to excellent with little or no erosion. It is subject to severe damage with only a moderate amount of use.

Climate and physiography must also be considered in developing a watershed management program. The interrelationship of all or a combination of some of the following factors contribute to an area's capacity for water yield and sediment production. These factors are:

slope and aspect, rainfall (amount, seasonal distribution, storm intensity, duration and pattern), and amount and character of snowfall.

Short and longwave radiation, barometric pressure, wind, temperature, and relative humidity are important modifiers of snowmelt and evapotranspiration. These factors produce short term variations in snowmelt runoff and sustained water yield. They also determine the opportunity for increased water yields through weather modification.

Water Yield

As established in the Water Resources Appendix, "The Lower Colorado Region faces a shortage of renewable water supply to satisfy the Modified OBE-ERS projected levels of development. The Gila Subregion, even after construction of the Central Arizona Project, shows large water deficiencies." One suggested source for helping offset future shortages was vegetative management to increase water yield.

Average annual runoff varies widely, as to precipitation, temperature, and terrain in the Region. Runoff averages 0.05 inches or less in the desert to as much as 8 inches in the mountainous areas. There is an urgent need to treat these high yielding mountain watershed lands (which now supply more than 90 percent of the Region's surface water supply exclusive of Colorado River supplies) to increase and regulate water yield in order to help fulfill the ever-increasing water requirements. This requires carefully coordinated management practices that will increase water yield, and simultaneously minimize impacts on or enhance other important resource values. Effects on soil stability, timber and forage production, recreation and esthetic values, wildlife habitat, and other environmental values must be incorporated and provided for in all programs for increased water yield.

Sediment Yield

Erosion and sedimentation processes have been active throughout geologic times. Soil erosion causes damages as does sediment, the product of erosion. Sheet erosion results in reduction of soil productivity and reduced income. Streambank and gully erosion may result in severe land damage and land value depreciation. Sediment derived from the transport of eroded materials creates damages such as deposition of sediment on agricultural lands, in reservoirs, and on streets and in buildings.

The normal or geologic erosion of the land surface can be greatly changed by man's activities. The normal rate of erosion can be greatly accelerated by removal of protective vegetation, disturbance of surface soils by activities such as mining and other means. Both

erosion damage and sediment yield can be materially reduced by proper land treatment and management measures. Sixty percent of the area needs land treatment and management for erosion control and sediment yield reduction. Approximately 40 percent of the land does not need treatment because either the measures have been applied, the erosion problem is minor, or it is not feasible to treat. Ten percent of the total has moderate to severe geologic erosion and is within the 40 percent not needing treatment (see Figure 10). Geologic erosion is: (1) normal soil erosion, or the erosion characteristic of the soil type in its natural environment under the native vegetation undisturbed by human activity; and (2) rock erosion, or erosion of rocks consolidated or unconsolidated, on which there is little true soil - as in stream channels, high mountains, or badlands. Examples within the Region are the Salt River channel, the upper portion of Mount Baldy, the steep slopes within the Grand Canyon, and the Painted Desert.

Sediment yield is the volume of sediment carried out of a watershed or to any point of concern within the watershed. It is a function of both the amount of gross erosion in the watershed and the capability of the stream system to transport eroded materials. Sediment yield is not the same as erosion, but is the product of erosion and the efficiency of the stream's transport ability. Factors used in this study in determining sediment yield are geology, soils, climate, runoff, topography, ground cover, land use, sheet erosion, channel erosion, and sediment transport. 1/

The five classes of sediment yield, expressed in acre-feet per square mile per year, are as follows:

Sediment Yield Class 1 - more than 3.0

Sediment Yield Class 2 - 1.0 - 3.0

Sediment Yield Class 3 - 0.5 - 1.0

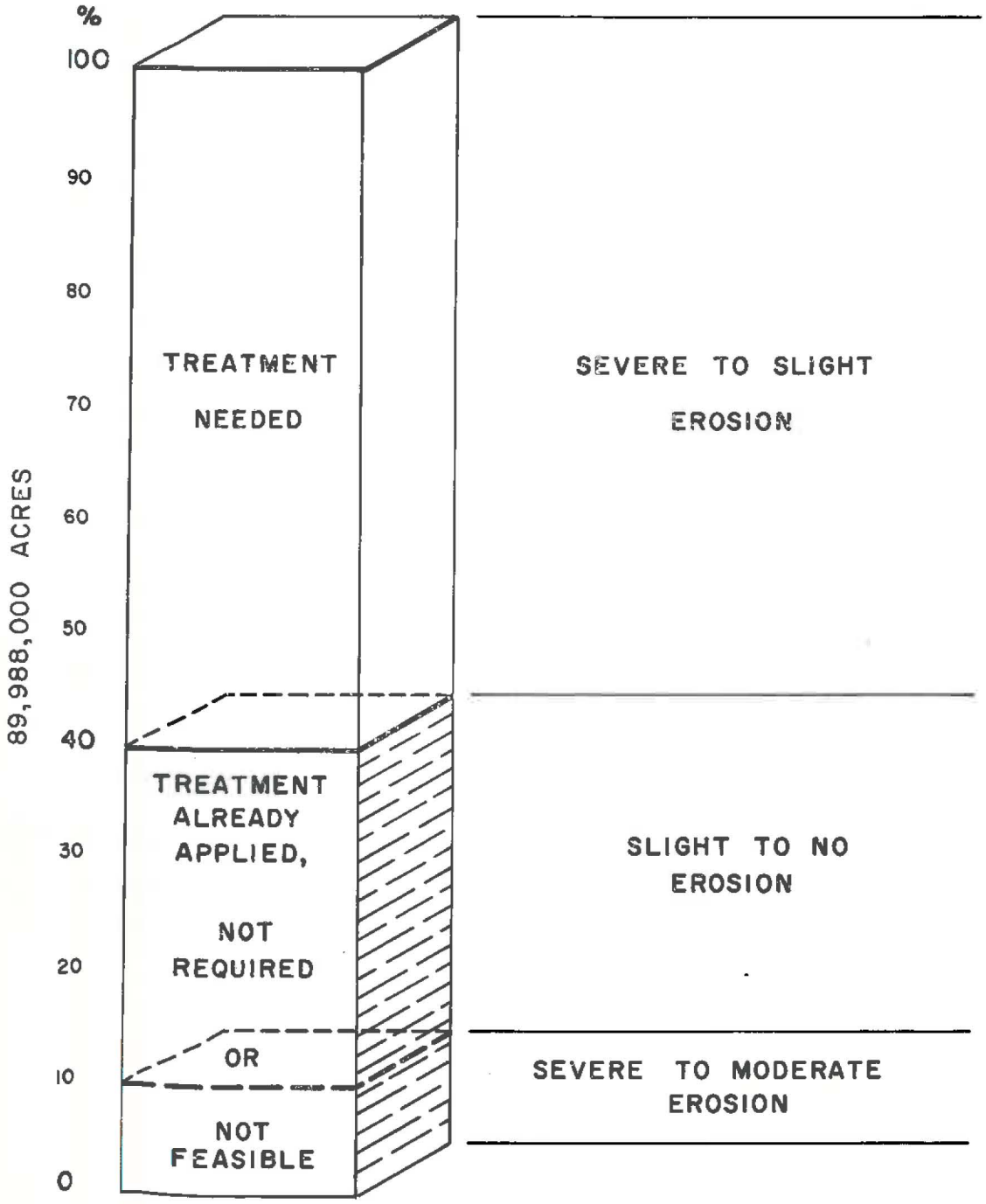
Sediment Yield Class 4 - 0.2 - 0.5

Sediment Yield Class 5 - less than 0.2

1/ The method used in this study is as described in a report of the Water Management Subcommittee of the Pacific Southwest Inter-Agency Committee entitled "Factors Affecting Sediment Yield in the Pacific Southwest Area" dated October 1968.

FIGURE 10

EROSION STATUS
1965
LOWER COLORADO REGION



The Sediment Yield Map (Map 9) shows the general location of the four sediment yield classes (2 through 5) which occur in the Region. This map represents sediment yield unadjusted for cultural activities. For watersheds of 500 to 2,000 square miles the map can be considered adequate for computing the volumes of sediment leaving the basin. Because of variability between areas the map is not considered adequate for areas smaller than 500 square miles. For larger areas, such as the subregions, man's diversion and storage of the streamflow have reduced the stream discharge and, therefore, reduced the streams' sediment transport ability so that the map does not represent actual yields. In other words, man has utilized the streamflow within the subregion so the sediment accompanying the water must remain in the subregion. This sediment is lodged in storage reservoirs, distributed along with the diverted water onto cropland, or deposited in stream channels.

The following figures show the amount and percentage of land in each sediment yield class in the Region, by subregion. It is interesting to note that nearly half the area of the Region is in sediment yield class 4. Also, no sediment yield class 2 was mapped in the Gila Subregion and no sediment yield class 1 was mapped in the Region. While local areas of sediment yield class 1 exist in the Region, their size is so small that it was not feasible to show on the map, or to determine acreages.

Acreage and Percent of Sediment Yield Classes

Subregion	Sediment Yield Classes									
	1		2		3		4		5	
	Ac*	%	Ac*	%	Ac*	%	Ac*	%	Ac*	%
Lower Main Stem	0	0	1,955	2.2	3,321	3.7	17,759	19.7	12,910	14.3
Little Colorado	0	0	3,167	3.5	3,861	4.3	4,866	5.4	5,358	6.0
Gila	0	0	0	0	5,467	6.1	21,517	23.9	9,806	10.9
Total - Region	0	0	5,122	5.7	12,649	14.1	44,142	49.0	28,074	31.2

* Thousands

Most of the area mapped as class 2 has moderate to severe sheet erosion with severe trenching in the alluvial soils in the valleys. Class 2 sediment yields are restricted to those areas adjacent to the Little Colorado and Puerco Rivers in the Little Colorado Subregion, and that area within the Lower Main Stem Subregion where Arizona and Utah share a common boundary. These areas have soil and geologic materials which are very sensitive to erosion.

Photo 42. Land in Sediment Yield Class 2. Note rilling, lack of vegetation and rock cover, and steep topography in background. SCS

Areas of sediment yield class 3 are scattered throughout the Region but generally lie northeast of a line drawn from the southeast corner of Arizona to the junction of the California, Nevada, and Arizona borders. Within the Basin and Range Physiographic Province (Map 3) this sediment yield class is restricted to narrow alluvial valleys. In the Colorado Plateau Province this class is represented by canyons, such as the Grand Canyon, the broad areas of eroded soils and geological materials in the northeastern portion of the Region. This sediment yield class has slight to moderate sheet erosion and moderate to severe gully erosion.

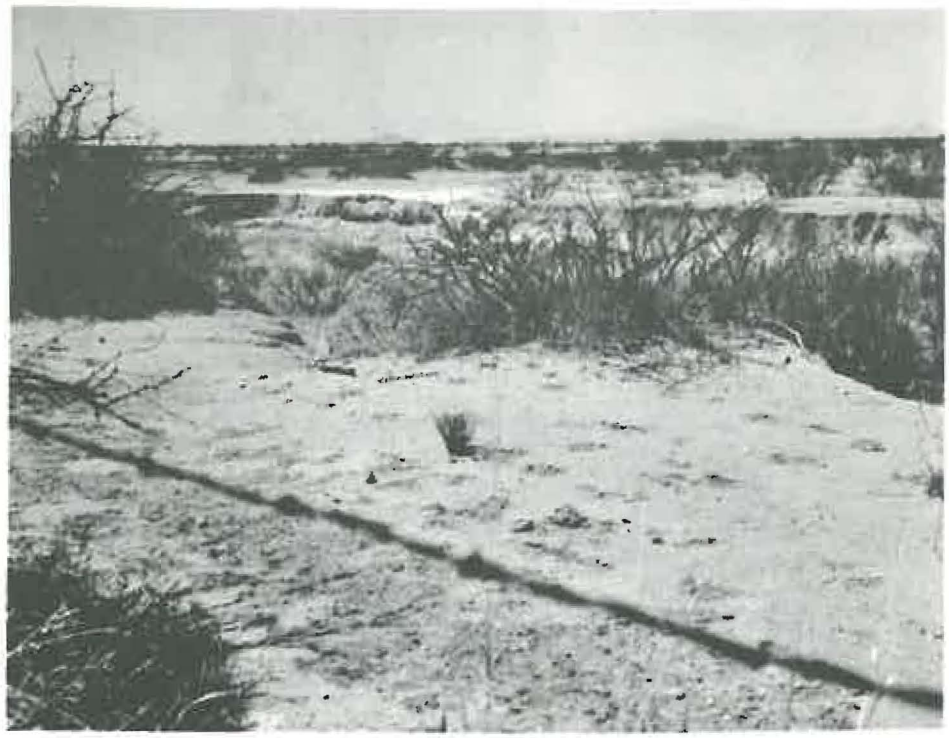


Photo 43. Land in Sediment Yield Class 3. SCS
Note lack of ground cover and gully.

The sediment yield class with the largest acreage is class 4. It is represented in all subregions and is one of the largest classes in each. Forty-nine percent of the Region is in this class.

Both sheet and gully erosion range from slight to moderate in class 4.

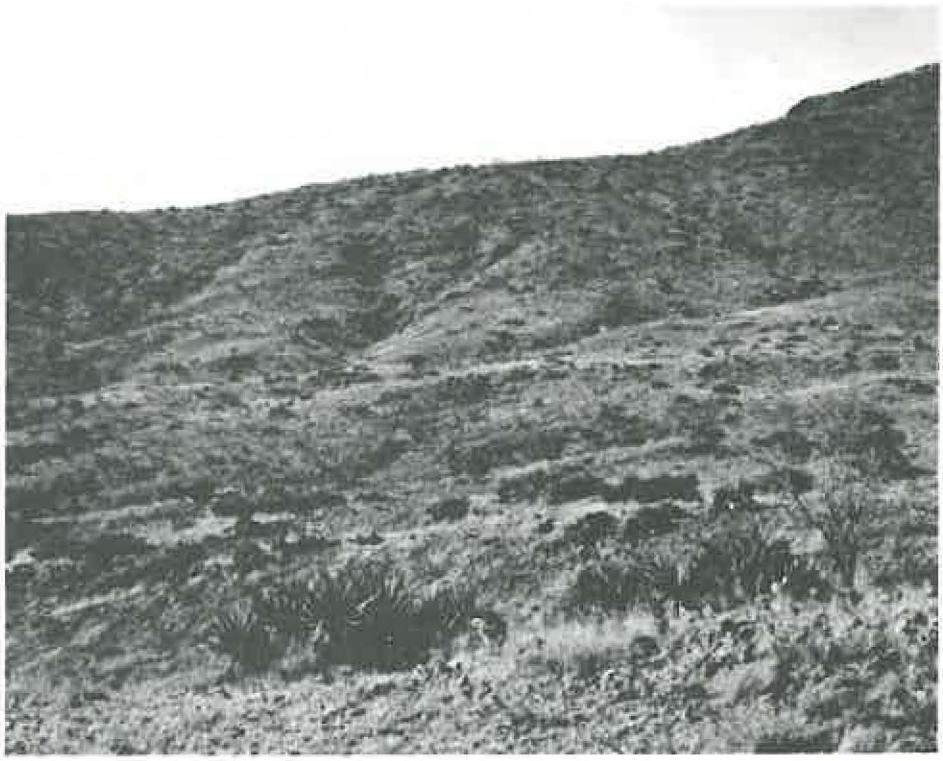


Photo 44. Land in Sediment Yield Class 4. Note steep topography and small gullies on the hillside. SCS

Sediment yield class 5 has the second largest acreage in the Region. The largest areas of this sediment yield class occur in that portion of the Region in Nevada, the area along the boundary between the Lower Colorado and the Gila subregions, and the valley floor between Tucson, Phoenix, and Yuma.

As might be expected of this sediment yield class, sheet and gully erosion is slight and as a whole contributes an insignificant amount of sediment yield.

Photo 45. Land in Sediment Yield Class 5. Note level topography and good ground cover. SCS

Erosion on forest land generally is slight to moderate. In the commercial timber types it is usually the result of soil disturbance resulting from road construction or timber harvesting activities and normally is in the form of gully erosion. At the lower elevations in the woodland and chaparral types, areas of moderate to severe erosion occur either in the form of gully or sheet erosion where the understory of vegetation or duff is insufficient to protect the soil.

Erosion following a fire can be severe with both sheet and gully erosion. This erosion gradually diminishes as the area revegetates. As shown in the following tabulation, most forested lands are within classes 4 and 5.

Sediment Yield Class on Forested Land

	2	3	4	5
Acres *	1,143	4,872	14,144	9,838
Percent	3.8	16.2	47.2	32.8

* Thousand

Erosion on rangeland varies rather widely - from severe to slight although generally it is slight. Areas of severe erosion occur along the Little Colorado and Virgin rivers and areas where the vegetative cover has been depleted by overuse. These are characterized by valley trenching and moderate to severe sheet and wind erosion.

Areas of moderate erosion are the Gila, San Pedro, San Simon, Big Sandy, and Verde river valleys and the Grand Canyon. Most of these areas have slight to moderate sheet erosion and moderate to severe gully erosion. The remainder of rangeland has slight erosion.

Even though sediment yield is generally low on rangeland, most of the highest yields in the Region come from localized areas of this land resource group. As shown on the following tabulation, most rangelands are within yield classes 4 and 5.

Sediment Yield Class on Rangeland

	2	3	4	5
Acres *	3,929	7,636	29,650	16,371
Percent	6.8	13.3	51.5	28.4

* Thousand

Erosion of cultivated and pasture land in the Region is primarily in the form of sheet erosion. Some scour occurs when these lands are flooded. These scoured areas must be filled with soil and releveled in order to maintain proper irrigation grades. Land management practices keep almost all of these lands in sediment yield classes 4 and 5 even though their potential yield may be higher.

Erosion Damage

The 1965 average annual erosion damages by land resource group and subregion are presented in Table 39.

The 1965 average annual erosion damage on forest and rangelands is estimated to be $6,117,000. Of this, $3,118,000 is from loss in land productivity; $102,000 is from land lost from streambank erosion and gullies; $1,044,000 is damage to improvements and equipment; and $1,853,000 is damage to public facilities.

The 1965 average annual losses in cultivated and pasture areas, from erosion, is $527,000. Of this, $402,000 is loss in productivity; $45,000 is loss of land due to streambank and gully erosion; $47,000 is damage to improvements and equipment; and $33,000 is damage to public facilities.

The 1965 average annual erosion damage in urban areas is $63,000. Of this, $37,000 is from land lost from streambank erosion and gullies; $16,000 is damage to improvements and equipment; and $10,000 is damage to public facilities.

The future average annual erosion damages by subregion and time frame are presented in Table 40. These damages are projected to increase from $6.7 million in 1965 to $24.2 million in 2020, based upon 1965 prices and level of protection.

Photo 46. Streambank Erosion SCS

Upstream Floodwater and Sediment Damage

Upstream floodwater and sediment damages are those occurring in watersheds having drainage areas of 250,000 acres or less, and including that portion of damages on common 1/ flood plain lands that result from flows originating in upstream watersheds regardless of the type or magnitude of these damages.

The effects of floodflows, which cause enormous floodwater and sediment damage in the Region, are closely related to the overall management of water and related land resources. The management of the upstream watershed lands can also have a material effect upon downstream floodwater and sediment damages.

1/ Flood plain at the junction of two or more streams, which is subject to flooding by either one or all streams.

Flooding is widespread and often damaging in the Region. An estimated 5.6 million acres of land is subject to periodic flooding in the upstream areas. Of this total, about 4,284,000 acres are forest and range; 1,110,000 acres are in cultivation and pasture; and 164,000 acres are in urban uses.

Flooding of timber and rangeland is not totally detrimental. The resultant increase in soil moisture increases yield provided inundation is not of sufficient duration to harm plants. Diversion and spreading of floodwater is used as a management tool to increase range forage production. In cases where silt is deposited on extremely coarse textured soil, the nutrient supplying ability and the water holding capacity of the soil is enhanced.

Photo 47. Floodwaters spreading over irrigated cropland — SCS

Floodwater losses vary widely depending upon the extent of development, land use, and frequency of flooding.

The 1965 average annual floodwater and sediment damages occurring within upstream watersheds are shown in Table 39.

Damages on forest and rangelands, from floodwater and sediment, are generally of localized nature from small storm cells or rapid snowmelt. The major items of damage are improvements and public buildings, recreation facilities, bridges, and sediment deposition in stream channels, lakes and reservoirs. Damage from floodwater in terms of reduction in grazing capacity or timber production is minor. The "other" category of damage includes such items as reduced recreation opportunities and values, detrimental effects on fish and wildlife habitat because of decreased water quality, etc. This damage category measures the adverse effects of floodwater and sediment on overall environmental quality. Average annual upstream floodwater and sediment damages on forest and rangelands for the Region amount to $5,366,000 for 1965.

When major floods occur in the Lower Colorado Region, floodwater and sediment damages on cultivated lands are extremely high due to the presence of high value crops such as lettuce, melons, cotton, etc.

Photo 48. Floodwater and sediment damage to young citrus grove SCS

Floodwater damage sustained by crops depends upon the damageable value per acre, time of year, depth and duration of inundation, velocity of flow, and sediment and debris content. Farm property and equipment are damaged by floodwater. Cleaning of debris after floodwaters recede is a problem. Weed seeds are deposited by floodwater; reducing yields and increasing production expenses.

Floodwater damage to irrigation canals is a serious and costly problem. Delivery of irrigation water to cropland served by damaged canals is often interrupted causing significant yield reductions.

Sediment deposited by floodflows may cover vegetables, nursery, and other crops, smothering the plants and destroying production.

On-farm irrigation ditches and laterals are often filled with sediment when breached by floodwaters. This causes additional loss of crop yield due to inability to provide proper amounts of irrigation water because of reduced ditch capacities.

Within the Region the 1965 average annual floodwater damages in cultivated areas are estimated to be $12,525,000. Of this, $1,608,000 is loss in productivity; $5,830,000 is to crops, $4,061,000 is to other agricultural properties; and $1,016,000 is to public property such as roads and bridges, and utilities.

Major upstream floods cause extensive damage in residential and business districts of several cities and towns throughout the Region. Peak runoff is higher in urban areas because of the extensive areas of impervious cover such as roofs, parking lots, streets, etc. These floodwaters often constitute a serious threat to human life. Homes are severely damaged by floodwater and sediment. Lawns, fences, paving, walls, water and waste facilities, automobiles, and other property are damaged. The control of disease caused by water contamination and insect infestation after flooding is a serious and expensive health problem. In business and commercial areas similar damages are suffered. In addition, there are high indirect damages due to loss of income during the interruption of business.

Public property and utilities, including highways, roads and railroads are also damaged by floodwaters.

Photo 49. Irrigation canal and road damage SCS

An example of one of many streams that cause extensive urban floodwater damage is Cave Creek. This creek has a drainage area of about 270 square miles and flows through the western part of Phoenix, Arizona before its confluence with the Salt River. Several major floods have resulted from excessive flow along this creek. There are 13,000 acres of developed urban land in the flood plain; yet, there is no trace of the drainage ways which were obliterated during the development of this area.

Photo 50. Flooding of residential homes, Maryvale, Arizona SCS

About one-third of the overflow area of Cave Creek was in residential use in 1963, including about 30,000 homes ranging in value from $8,000 to $40,000. Thirteen percent is in commercial development and includes more than 1,700 establishments. Public property including 36 schools, 7 hospitals, and 81 churches is also subject to flooding. Industrial development includes about 650 separate businesses. Utilities, highways, and streets are also included. Total value of property subject to flooding is estimated to be one billion dollars.

A major flood in the Cave Creek area could cause floodwater damages that exceed $100,000,000. Average annual damage in this watershed is estimated at $3.5 million.

Sediment damage in urban areas consists of deposition on streets, roads, utilities, lawns, and buildings. Sediment also plugs storm sewers and drains. This type of damage presents a formidable clean-up problem. As new urban areas develop, this type of damage will increase.

Photo 51. Sediment damage, Wickenburg, Arizona Double V

Total 1965 average annual urban floodwater damages for the Region are estimated to be $12,537,000, of which $8,941,000 are in upstream areas. Table 39 provides a breakdown of 1965 upstream urban damages.

An additional sediment damage is the depletion of the storage capacity of reservoirs. This additional capacity must be provided for in the design to allow for adequate floodwater storage capacity during the life of the structure. It is estimated that the 1965 average annual damage from this depletion is $2,068,000.

One of the most serious consequences of erosion and the resulting sediment is water pollution. Phosphorous, a major pollutant, is not a mobile element but stays where it is placed, attaches to the soil, and

moves only with the soil. Erosion of that soil, then, causes phosphrous bearing sediment to reach waterways and reservoirs.

The projected 1980, 2000, and 2020 average annual upstream floodwater and sediment damages by subregion and land resource group are shown in Table 40. These damages were projected to increase from $28.9 million in 1965 to $227.7 million in 2020 with only the 1965 level of protection.

Wildfire

Control of wildfire is basic to the development and utilization of nearly all resources, activities and uses of the forest and range lands of the Lower Colorado Region. The agencies and organizations responsible for protection of the forest and range lands from damage by wildfire must continue to expand their technology and methods for prevention and suppression to keep in step with the increasing values of the Region's water and related land resources. Problems and responsibilities for wildfire protection and control in the Lower Colorado Region are multiplying due to the development of small communities, expanding urban, industrial, and public use developments scattered throughout the forest and range land of the Region and increases in recreation uses. This trend is expected to continue through the projection period.

Danger from wildfire on the forest and range lands may be and usually is present some place in the Region during every month of the year. The Region usually has a split fire season. The early season may begin the first of March with fire danger reaching a peak during May and June. The late fire season may build up again in September continuing through November, following the rainy period in July, August, and September. There are exceptions such as the northwestern section of the Region where the fire danger is the highest during the summer months. The length and severity of the fire season varies from year to year, with the wide fluctuation of the precipitation and climatic condition common in the southwest and emphasized in the Lower Colorado Region.

Wildfire usually destroys both plant cover and the litter or duff leaving the soil wholly unprotected and resulting in decreased infiltration, increased overland flows and accelerated erosion. Damages include sediment deposition in reservoirs, streams, and irrigation systems, and floodwater and sediment damage to urban and industrial developments. Wildfires bring about a destruction of the humus within the upper soil mantle, resulting in a lowering of infiltration rates, an acceleration of runoff, and sometimes producing the condition referred to as "nonwettability," with resultant increases in erosion rates and high sedimentation. Damage from floods and sediment

deposition may occur both locally and at considerable distances downstream from the burned area. Damages from forest and range fires can be reduced by emergency land treatment, consisting of site preparation and artificial revegetation.

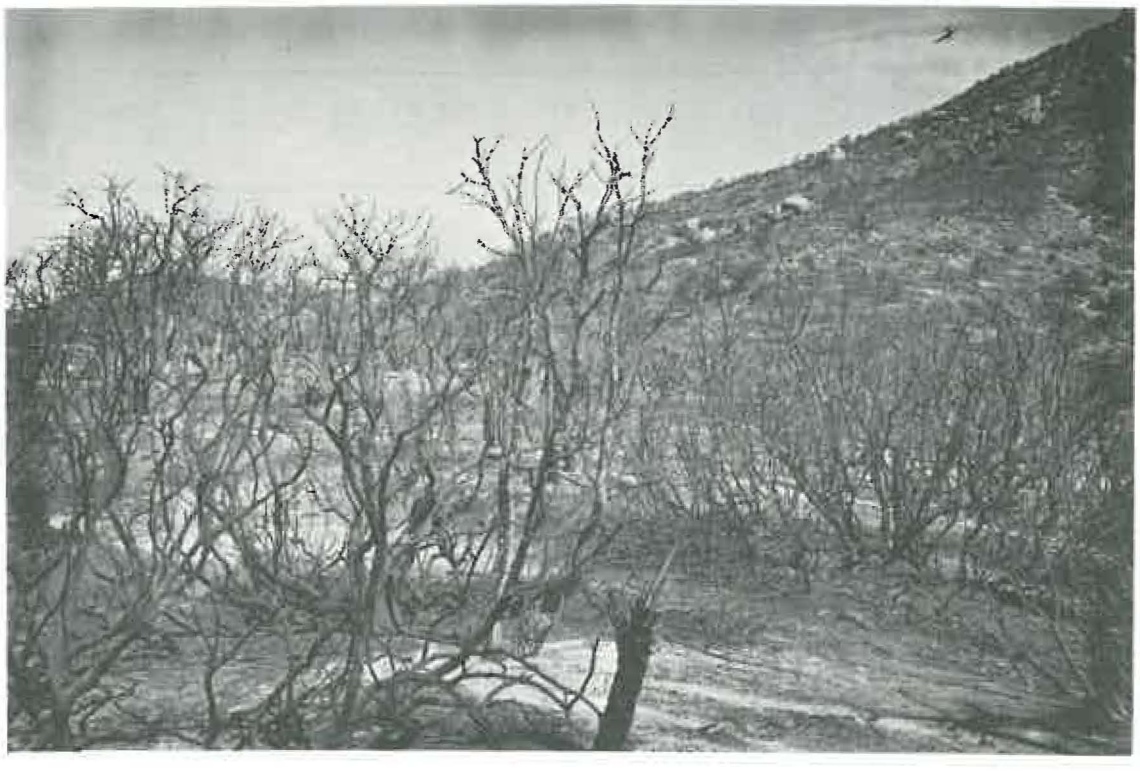


Photo 52. Burned area in chaparral type FS

An average annual burned area from wildfire in the Lower Colorado Region is about 45,000 acres (1965), about equally divided between range and forest land areas. The average total damage (including the resource value lost and improvements) resulting from wildfire is estimated to be about $60 per acre, with rangeland damages being about $50 per acre, and commercial timberlands often sustaining a damage in excess of $1,000 an acre. Suppression and rehabilitation costs of wildfires in the Region average in excess of $75 per burned acre. In 1956, one of the more severe fire years in recent times, more than 87,000 acres of national forest lands burned in the Region with total damages, including suppression costs, in excess of $50 million. The 1965 average annual damage from wildfire for the Region is estimated to be $5,700,000. See Table 39.

Table 39
Lower Main Stem Subregion
Average Annual Damages Resulting from Upstream Watershed Problems 1/
Present Development (1965)

PROBLEM	LAND RESOURCE GROUP	EXISTING PROBLEM AREA (1,000 Acres)	Average Annual Damages (Thousands of dollars)								
			LAND PRODUCTIVITY	LAND	CROPS & LIVESTOCK	IMPROVEMENTS INVENTORY & EQUIPMENT	PUBLIC FACILITIES	DEPLETION OF RESERVOIR CAPACITY	FIRE SUPPR. COSTS & REL. EMERGENCY MEASURES	OTHER	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Erosion	For. & Range	22,956	861	24	-	195	326	-	-	-	1,406
	Cult. & Past.	69	71	20	-	10	8	-	-	-	109
	Urban	9	-	10	-	4	2	-	-	-	16
	Subtotal	23,034	932	54	-	209	336	-	-	-	1,531
Flood & Sediment	For. & Range	1,871	13	-	-	206	413	-	-	756	1,388
	Cult. & Past.	193	334	-	866	681	319	-	-	3	2,203
	Urban	78	-	-	-	1,158	103	-	-	1	1,262
	Other	-	-	-	-	-	-	277	-	-	277
	Subtotal	2,142	347	-	866	2,045	835	277	-	760	5,130
Wildfire	For. & Range	10 2/	-	-	570 3/	30	-	-	660	-	1,260
	Subtotal	10	-	-	570	30	-	-	660	-	1,260
	TOTAL	-	1,279	54	1,436	2,284	1,171	277	660	760	7,921

1/ 1965 Prices and level of protection
2/ Average annual area burned
3/ Includes forage, timber, and wood products

(1 of 4)

Table 39
Little Colorado Subregion
Average Annual Damages Resulting from Upstream Watershed Problems 1/
Present Development (1965)

PROBLEM	LAND RESOURCE GROUP	EXISTING PROBLEM AREA (1,000 Acres)	Average Annual Damages (Thousands of dollars)								
			LAND PRODUCTIVITY	LAND	CROPS & LIVESTOCK	IMPROVEMENTS, INVENTORY & EQUIPMENT	PUBLIC FACILITIES	DEPLETION OF RESERVOIR CAPACITY	FIRE SUPPR. COSTS & REL. EMERGENCY MEASURES	OTHER	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Erosion	For. & Range	11,826	817	54	-	116	169	-	-	-	1,156
	Cult. & Past.	53	32	2	-	6	4	-	-	-	44
	Urban	15	-	1	-	-	-	-	-	-	1
	Subtotal	11,894	849	57	-	122	173	-	-	-	1,201
Flood & Sediment	For. & Range	377	6	-	-	87	174	-	-	613	880
	Cult. & Past.	45	35	-	162	156	71	-	-	3	427
	Urban	14	-	-	-	504	89	-	-	1	594
	Other	-	-	-	-	-	-	429	-	-	429
	Subtotal	436	41	-	162	747	334	429	-	617	2,330
Wildfire	For. & Range	5 2/	-	-	285 3/	15	-	-	330	-	630
	Subtotal	5	-	-	285	15	-	-	330	-	630
	TOTAL	-	890	57	447	884	507	429	330	617	4,161

1/ 1965 Prices and level of protection
2/ Average Annual area burned
3/ Includes forage, timber, and wood products

Table 39
Gila Subregion
Average Annual Damages Resulting from Upstream Watershed Problems 1/
Present Development (1965)

PROBLEM	LAND RESOURCE GROUP	EXISTING PROBLEM AREA (1,000 Acres)	Average Annual Damages (Thousands of Dollars)								
			LAND PRODUCTIVITY	LAND	CROPS & LIVESTOCK	IMPROVEMENTS INVENTORY & EQUIPMENT	PUBLIC FACILITIES	DEPLETION OF RESERVOIR CAPACITY	FIRE SUPPR. COSTS & REL. EMERGENCY MEASURES	OTHER	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Erosion	For. & Range	26,615	1,440	24	-	733	1,358	-	-	-	3,555
	Cult. & Past.	239	299	23	-	31	21	-	-	-	374
	Urban	130	-	26	-	12	8	-	-	-	46
	Subtotal	26,984	1,739	73	-	776	1,387	-	-	-	3,975
Flood & Sediment	For. & Range	2,036	25	-	-	855	1,810	-	-	408	3,098
	Cult. & Past.	872	1,239	-	4,802	3,224	626	-	-	4	9,895
	Urban	72	-	-	-	6,381	702	-	-	2	7,085
	Other	-	-	-	-	-	-	1,362	-	-	1,362
	Subtotal	2,980	1,264	-	4,802	10,460	3,138	1,362	-	414	21,440
Wildfire	For. & Range	30 2/	-	-	1,710 3/	90	-	-	2,010	-	3,810
	Subtotal	30	-	-	1,710	90	-	-	2,010	-	3,810
	TOTAL	-	3,003	73	6,512	11,326	4,525	1,362	2,010	414	29,225

1/ 1965 Prices and level of protection
2/ Average annual area burned
3/ Includes forage, timber, and wood products

Table 39
Lower Colorado Region
Average Annual Damages Resulting from Upstream Watershed Problems 1/
Present Development (1965)

PROBLEM	LAND RESOURCE GROUP	EXISTING PROBLEM AREA (1,000 acres)	Average Annual Damages (Thousands of Dollars)								
			LAND PRODUCTIVITY	LAND	CROPS & LIVESTOCK	IMPROVEMENTS, INVENTORY & EQUIPMENT	PUBLIC FACILITIES	DEPLETION OF RESERVOIR CAPACITY	FIRE SUPPR. COSTS & REL. EMERGENCY MEASURES	OTHER	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Erosion	For. & Range	61,397	3,118	102	-	1,044	1,853	-	-	-	6,117
	Cult. & Past.	361	402	45	-	47	33	-	-	-	527
	Urban	154	-	37	-	16	10	-	-	-	63
	Subtotal	61,912	3,520	184	-	1,107	1,896	-	-	-	6,707
Flood & Sediment	For. & Range	4,284	44	-	-	1,148	2,397	-	-	1,777	5,366
	Cult. & Past.	1,110	1,608	-	5,830	4,061	1,016	-	-	10	12,525
	Urban	164	-	-	-	8,043	894	-	-	4	8,941
	Other	-	-	-	-	-	-	2,068	-	-	2,068
	Subtotal	5,558	1,652	-	5,830	13,252	4,307	2,068	-	1,791	28,900
Wildfire	For. & Range	45 2/	-	-	2,565 3/	135	-	-	3,000	-	5,700
	Subtotal	45	-	-	2,565	135	-	-	3,000	-	5,700
	TOTAL	-	5,172	184	8,395	14,494	6,203	2,068	3,000	1,791	41,307

1/ 1965 Prices and level of protection
2/ Average Annual area burned
3/ Includes forage, timber, and wood products

Environmental Quality Problems

Although environmental quality problems are discussed throughout this section where applicable in relation to watershed problems, a partial list of those directly related to land use and the management of land resources follows:

Water

Sediment as a pollutant
Fertilizer
Pesticides
Animal and human wastes
Competing or conflicting uses on rivers and lakes

Land

Accumulation of pesticides
Septic tanks (poor drainage)
Destruction by removal, burying, etc.
Misuse and/or lack of long-range planning
Competition for the use of the land
Litter and solid wastes

Air

Dust resulting from cultivation, construction activities, mining, and some recreation activities
Dust from wind erosion
Spraying of pesticides
Odors from animal or human wastes
Pollutants from wildfires and burning of crop residues

Natural Beauty

Unnecessary removal of natural vegetation
Marring of the landscape by unsightly construction and by inconsiderate recreationers and others

Environmental problems are best treated at the source. In most cases, treating the symptoms is far more expensive and far less effective.

STATUS OF WATERSHED MANAGEMENT PROGRAMS (1965)

The goal of watershed management in the Region is not only toward minimizing the effects of changes in the ecological balance that man's first activities had disrupted, but also toward modifying it to create greater benefits for man.

Over the past several years, significant advances have been made in watershed management practices and techniques by landowners and public land managers. They strive for improvement of water yield, improvement of water quality, and the reduction of erosion, sedimentation, and flooding. These watershed management programs often result in increased livestock and wildlife forage, improved timber production, recreation, reduced fire hazard, and esthetic values. Management techniques and practices are expected to improve and intensify as a result of continuing research and the continuing demand for increased yield of high quality water.

Public Land

The Soil and Watershed Conservation Program of the Bureau of Land Management is a combination of management, land treatment, and structural practices having a planned pattern in support of multiple-use management. It is designed to regulate floodwater and to control accelerated erosion, to stabilize the soil resource for plant production, to provide for efficient use of water for the improvement of vegetal cover, to rehabilitate areas damaged by wildfires, and to increase the productive capability of the land.

This system is designed to function within the two broad watershed program objectives of conservation and development. The conservation objective is to manage and invest only to the extent necessary to protect the watershed from further deterioration. It includes prevention of erosion, restoration of eroded areas, control of pollution, the related enhancement of the quality of water, and enhancement of social well-being. The development objective is to manage and improve the watershed to the extent that benefits are beyond the conservation objective. These benefits result in increased output of goods and services and reduced flood and sediment damages measured in dollars. These dollar benefits must exceed the cost of development.

Under the 1965 level of land management and capital investment, treatment was limited to projects on critical areas needing immediate attention and those areas needing early correction to reduce need for future treatment. At this level vegetal resources and soil conditions continue to decline on approximately 15 percent of the public lands

administered by the Bureau of Land Management. Lands that are in an advanced state of erosion continue to move into a more serious state of massive erosion.

Improved livestock, recreation and wildlife habitat management programs are being coordinated with the watershed tillage, treatment and structural programs. Emphasis has been placed on livestock management involving adjustment of stocking rates; construction of fences and waters to improve livestock distribution; and vegetation management and reseeding to relieve livestock grazing pressures on critical watershed areas.

There are 4,083,000 acres of land included in the military reservations administered by the Department of Defense. Other uses of the land include limited hunting and fishing and, in some cases, limited grazing by domestic livestock when not in conflict with military use. Where other uses are permitted, management is generally under one of the other land management agencies, either the Bureau of Sport Fisheries and Wildlife or the Bureau of Land Management. Considerable soil movement and erosion are occurring on portions of these national defense lands due to off-road travel with motor vehicles.

The Forest Service administers the national forests for multiple use and sustained yield of the various resources including, but not limited to, outdoor recreation, range, timber, watershed, wilderness, and fish and wildlife. The forest and range experiment stations are carrying on research throughout the Lower Colorado Region to provide information on management of these national forest lands for improved resource management, and to guide in the improvement of watershed values on forest and range lands. The Pacific Southwest Hydrologic Survey, made on the national forest lands in the Pacific Southwest area, provides information to be used in national forest resource management for improvement of watershed management conditions, including increased water yield and reduction of erosion. Pilot and barometer watersheds have been established on the national forests to initiate the findings of the experiment stations and the Hydrologic Survey.

Livestock range management programs, including adjustment in stocking and range improvements, such as water developments and diversion fences, are being developed to maintain and improve the watershed conditions. One hundred thousand acres of pinon-juniper type have been included in a control program whereby the pinon-juniper type was replaced by grass to increase the carrying capacity of the range and reduce erosion. Ten thousand acres of chaparral have been controlled in the watershed improvement program and converted to grass for improvement of watershed conditions and livestock grazing.

Timber management systems in the commercial timber types have been and are being adjusted to provide for maintaining ground cover for prevention of erosion and improvement of the water yield capabilities of these high water producing areas.

Logging practices, road conditions, and other activities and programs on national forest lands provide for holding erosion to a minimum during the development programs and for rehabilitating roads, trails, and other disturbed areas when no longer in use.

The history of efforts to prevent and control wildfires in the Southwest dates back to the mining era in the 1880's. At this time, minimum local efforts were made to prevent and control fires in the timberlands that were the source of wood and timber utilized in the mines and mining camps. The first organized efforts at fire control came with the establishment of the national forests in the early 1900's. Outside of the national forests and national parks little progress was made in fire prevention or control until the 1940's and later. The states provided fire suppression for their timber producing lands either directly or through individual agreement with the federal government. Federal aid to the states has been available through Section 2 of the Clarke-McNary Act since its passage in 1924. 1/

Photo 53. Thorough training is required to control wildfire safely and efficiently BIA

1/ Refer to Legal and Institutional Environments Appendix

Nevada has provided fire protection and fire control for the state and private lands through the act since 1931, Utah since 1941, New Mexico since 1957, and Arizona since 1967. The Bureau of Land Management has provided organized fire prevention, presuppression and suppression for the public domain lands since 1947.

Lands under the administration of the National Park Service include among others national parks, national monuments, and national recreation areas. These areas are classified into three management categories, -- natural, historical and recreational -- and are managed under the applicable classification to protect and preserve the unique feature for which they were set aside. Thus natural areas are preserved, or if necessary restored to as near natural conditions as is possible; historic areas are protected, restored if feasible and maintained in a condition that portrays the scene at the time of the historic or prehistoric event commemorated; and recreational areas are managed to conserve and if required to enhance the natural setting for general outdoor recreation activities. No use which impairs an area's primary function is permitted, and if existing, it is the general policy to seek the elimination of such use.

In certain areas uses such as water development projects are authorized by statute, and in these cases management will consider restoration of the natural values, including useable water and control of accelerated erosion.

While livestock use is permitted in some areas administered by the National Park Service, termination of this use and restoration to natural conditions is sought except where a historic grazing scene is desirable or in recreational areas where the use is not a detriment to the area or its primary function. In any event grazing where present is regulated to maintain and protect the natural conditions.

In the management of parks, monuments, and recreation areas, outdoor recreation is considered as an appropriate use where consistent with the areas' primary classification.

The primary objective of management on the wildlife refuges is for the protection and enhancement of wildlife species. Two types of refuges are common in the Lower Colorado Region, namely the refuges for protection and development of big game habitat, such as the desert bighorn sheep, and the development and protection of habitat for migratory waterfowl. The use by livestock on both the big game habitat areas and the migratory waterfowl areas has been eliminated or controlled to maintain the wildlife habitat and satisfactory ground cover.

The Bureau of Sport Fisheries and Wildlife has developed management plans and improvements, particularly for water supply, on these areas to prevent concentration of animals and resulting erosion. Some trespass by livestock occurs in a few places and cross-country vehicular travel has presented some localized erosion problems.

Watershed problems are minor on the migratory waterfowl refuges along the main stem of the Colorado River. It is necessary to maintain a high water table or wetland condition for satisfactory migratory waterfowl habitat. Channelization of the Colorado River near some of the wetland areas has resulted in deterioration of migratory waterfowl habitat.

There are about 10.6 million acres of state-owned land in the Region. This land is administered by various state agencies. While use of these lands is made by all interests, federal law dictates that the land be used to produce revenue to help operate the various schools and institutions in the state. This then must be the guide to management of state lands.

The timber producing state lands have been put under a sustained yield management plan designed to produce maximum benefits from timber growth and forage production. The methods involved consider enhancement of the intangible resources such as recreation, esthetics, etc. The management of the chaparral areas has been initiated using prescribed burns to reduce the fuels for fire hazard reduction, improved forage production and increased water for livestock and wildlife.

Further studies are planned to fully evaluate the potential for management and development on all state lands.

Privately-Owned Lands

The primary objective of management measures on privately-owned lands (36 percent of the Region) is to protect and/or restore the land and water resources of the immediate area. However, the measures installed for these purposes usually have significant off-site effects in reducing sedimentation, controlling runoff, and improving water quality.

Soil conservation districts have active programs for the improvement of watershed lands. These districts, organized under state law, are governed by local people. The districts utilize technical and financial assistance from various public and quasi-public agencies and organizations. They work directly with individual owners and/or operators and cooperate with agencies administratively responsible for public lands within the district boundaries. Over 90 percent of the Region is within 48 soil conservation districts. Technical leadership

in land and resource management on Indian land is provided by the Bureau of Indian Affairs.

Land management programs on private lands in the Region include land treatment measures related to watershed protection projects carried out by local people with federal and state assistance. These measures are installed in conjunction with structural measures such as floodwater retarding structures, floodways, dikes, irrigation control structures, etc., to reduce sediment production and control runoff. They increase the effectiveness of the structural measures and help to insure that the watershed area will remain productive.

Progress of Practices and Measures

Following are some practices and measures that have been installed on public and private land as of 1965.

Measures that have been applied to reduce channel erosion are as follows: 330 miles of bank and/or channel protection and 2,300 stabilization structures.

Improved grazing management (7,600 sq. mi.) has the following objectives: maintain or improve the quality and quantity of forage, provide soil protection and improve on-site and downstream water values.

Fencing (13,000 miles), stock ponds-earthen (12,000), tanks (5,700), and reseeding (800 sq. mi.) have facilitated proper grazing management objectives while improving the vegetative cover and reducing erosion and sedimentation.

Terraces (1,200 miles) have been installed to control runoff and minimize soil erosion.

Upstream land treatment programs supplement downstream flood control structures and prolong their useful lives by reducing the sediment load of floodwater.

Photo 54. Erosion control structures on forest land FS

An important goal of land treatment and management is to reduce the damages from erosion, flood runoff and sediment. Some of the measures installed as of 1965 to reduce these damages are as follows: Floodwater retarding structures (2,900), which provide temporary storage of floodwater; dikes and levees (1,200 miles); floodwater diversions (500 miles), and floodways (20 miles) have been installed to protect land from overflow.

Two hundred miles of stream channel improvement, which includes clearing of obstructions and realignment, have been installed to provide greater floodwater carrying capacity.

There had been vegetative management on 2,500 sq. miles by 1965. This includes control of chaparral and riparian shrubs and trees and pinon-juniper woodland for improvement of water yields and forage. The treatment involves reducing the density of the existing woody vegetation by mechanical, chemical and biological means and by fire and replacing it with grass.

Photo 55. FS

Photo 56. FS

Two different areas - one before and one after conversion of chaparral vegetative type to grass

Increasing costs of irrigation water have encouraged more efficient use of the water available. Diversion dams, irrigation structures and other water control facilities (245,000) have been installed. Supplemental practices and measures such as water storage facilities (1,000), irrigation ditch and canal lining (7,400 miles), and land leveling and smoothing (1,100 sq. mi.) have also been instrumental in saving and efficiently using the available water.

At the present time there are minor drainage problems in the Lower Colorado Region. Tile drains (150 miles), tile system structures including wells (30), and drainage ditches (40 miles)have been installed to correct high water table problems which have occurred on irrigated land.

Additional information on drainage may be found in Appendix X, Irrigation and Drainage.

Progress in Cooperative Project-Type Programs

There were 17 upstream flood prevention projects constructed by 1965 (see Map 10). These projects include 47 reservoirs which control a total drainage area of 2,306 square miles. The reservoirs, when constructed, provided storage for 95,710 acre-feet of floodwater and 22,660 acre-feet of sediment. Thirty-six miles of flood channel improvements were constructed to safely convey the water from several of these reservoirs. See Table 41 for more details on these projects.

An additional project, primarily for agricultural water management, had been constructed, in Nevada, by 1965.

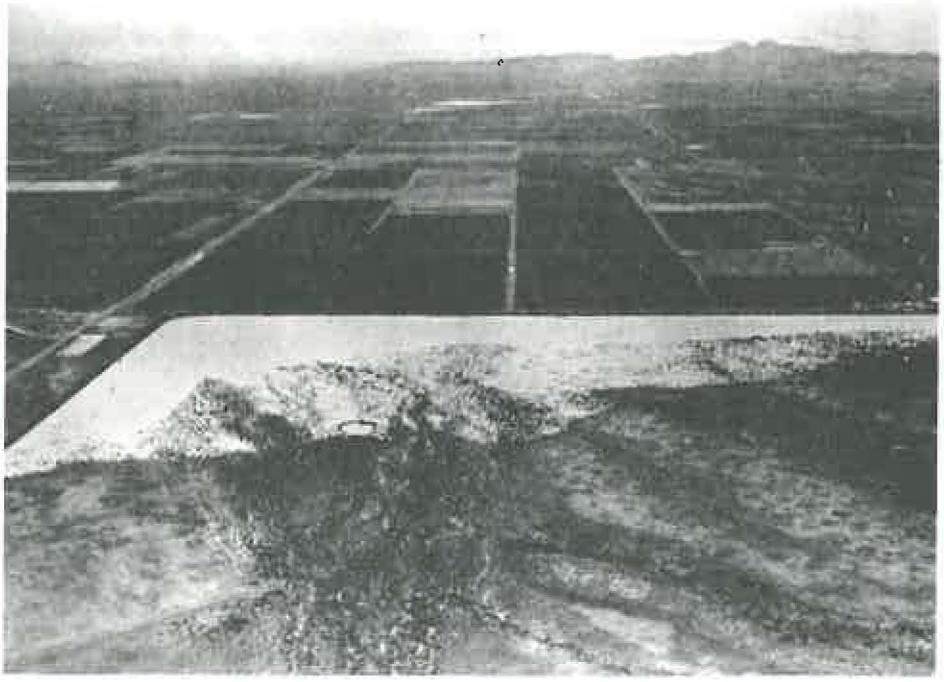
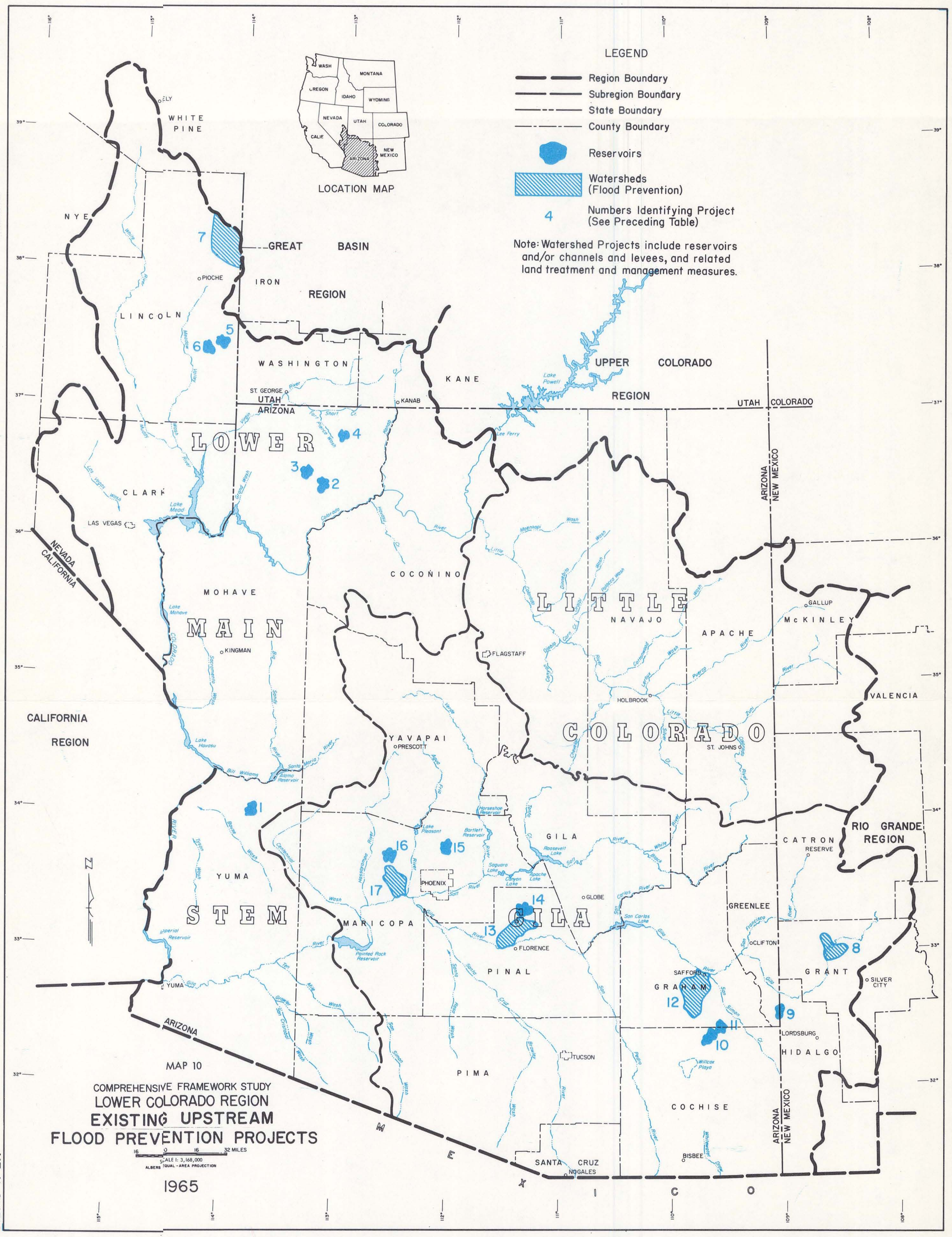


Photo 57. Floodwater retarding structure after September 13,1966 storm. Magma Watershed SCS

There were four upstream flood prevention projects constructed between 1965 and 1970. See Map 11, Chapter G, for general locations. The five reservoirs within these projects control 276 square miles of drainage area and provide storage for 1,370 acre-feet of sediment and 16,080 acre-feet of floodwater. Within these projects, 13.0 miles of


LEGEND
Region Boundary
Subregion Boundary
State Boundary
County Boundary
Reservoirs
Watersheds
(Flood Prevention)
4
Numbers Identifying Project
(See Preceding Table)
Note: Watershed Projects include reservoirs and/or channels and levees, and related land treatment and management measures.
LOCATION MAP
WASH
MONTANA
OREGON
IDAHO
WYOMING
NEVADA
UTAH
COLORADO
CALIF
ARIZONA
NEW MEXICO
116°
115°
114°
113°
112°
111°
110°
109°
108°
39°
38°
37°
36°
35°
34°
33°
32°
GREAT BASIN
IRON
REGION
UPPER COLORADO
REGION
UTAH
COLORADO
ARIZONA
NEW MEXICO
CALIFORNIA
REGION
RIO GRANDE
REGION
NEVADA
CALIFORNIA
LOWER
MAIN
STEM
LITTLE
COLORADO
GILA
WHITE PINE
ELY
NYE
LINCOLN
PIOCHE
CLARK
LAS VEGAS
WASHINGTON
ST. GEORGE
KANE
KANAB
UTAH
ARIZONA
MOHAVE
KINGMAN
COCONINO
FLAGSTAFF
NAVAJO
HOLBROOK
APACHE
ST. JOHNS
McKINLEY
GALLUP
VALENCIA
CATRON
RESERVE
YAVAPAI
PRESCOTT
YUMA
MARICOPA
PHOENIX
GILA
GLOBE
GREENLEE
CLIFTON
GRANT
SILVER CITY
PINAL
FLORENCE
GRAHAM
SAFFORD
PIMA
TUCSON
SANTA CRUZ
NOGALES
COCHISE
BISBEE
HIDALGO
LORDSBURG
Lake Mead
Lake Mohave
Lake Havasu
Lake Powell
Lee Ferry
Alamo Reservoir
Imperial Reservoir
Painted Rock Reservoir
Lake Pleasant
Bartlett Reservoir
Horseshoe Reservoir
Roosevelt Lake
Saguaro Lake
Canyon Lake
Apache Lake
San Carlos Lake
Willcox Playa
ARIZONA
M E X I C O
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
MAP 10
COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
EXISTING UPSTREAM
FLOOD PREVENTION PROJECTS
16 0 16 32 MILES
SCALE 1: 3,168,000
ALBERS EQUAL-AREA PROJECTION
1965

M7-N-21431 I

Table 41
Lower Colorado Region
Existing Upstream Projects
for Flood Prevention - 1965

Subregion Map Iden.	Name of Project or Measure	Agency 1/	Number of Reservoirs	Drainage Area Above Reservoirs Sq. Mi.	Storage Ac. Ft.			Flood Channel Improvement Mi.
					Flood Control	Sediment	Total	
Lower Main Stem								
1	Butler	BLM	1	304	900	100	1,000	-
2	Crosby Tanks	BLM	1	39	800	300	1,100	-
3	Iverson	BLM	1	84	1,300	600	1,900	-
4	Flat Top	BLM	1	370	1,700	400	2,100	-
5	Mathews Canyon	CE	1	34	5,300	1,000	6,300	-
6	Pine Canyon	CE	1	45	6,400	1,400	7,800	-
7	Upper Meadow Valley Wash	SCS	1	200	-	640	640	-
Gila								
8	Arroyos #1	SCS	12	29	1,400	420	1,820	1
9	Railroad Wash	BLM	15	203	2,740	370	3,110	-
10	Creighton	BLM	1	106	1,500	1,300	2,800	-
11	H-X Det.	BLM	1	41	1,100	500	1,600	-
12	Frye Creek Stock	SCS	5	203	7,500	2,800	10,300	14
13	Magma	SCS	1	62	4,850	160	5,010	4
14	Whitlow Ranch	CE	1	143	28,900	7,000	35,900	-
15	Cave Creek	2/	1	162	11,000	3,000	14,000	-
16	McMicken	CE	1	247	16,800	2,500	19,300	6
17	White Tanks	SCS	2	34	3,520	170	3,690	11

1/ Agency: BLM - Bureau of Land Management; CE - Corps of Engineers; SCS - Soil Conservation Service

2/ Constructed by several agencies, including a railroad and oil company, City of Phoenix, and others; maintenance now by the Maricopa Flood Control District.

channel improvements and 5.5 miles of floodwater diversions were constructed. These four projects protect 198 square miles of agricultural and urban areas.

Eleven additional projects had been authorized, but not constructed, by 1970. Many of these projects are located in the Phoenix, Arizona vicinity and will provide protection for a large urban area. See Map 11 for general location of these projects.

The above-mentioned projects had been authorized under several authorities.

Public Law 566 provides for technical and financial assistance by the U. S. Department of Agriculture to states or other qualified local organizations for land treatment, flood prevention, irrigation, drainage, public recreational or fish and wildlife developments, and municipal or industrial water supplies on watersheds up to 250,000 acres in size. It also authorizes coordination with related work of other agencies, including the departments of the Interior and Defense.

Projects under this Act are planned for integrated use and conservation of all water and related resources in a watershed. Structural measures can be of three kinds: (1) flood prevention measures (2) agricultural water-management measures (3) nonagricultural water-management measures.

These small watershed projects are initiated by local organizations having authority to construct, operate, and maintain works of improvement. The federal government supplies technical and financial assistance and can share up to 50 percent of the installation costs for agricultural water management, fish and wildlife, and recreation. Landrights acquisition, operation, and maintenance are the responsibilities of the local sponsors.

Those projects constructed by the Bureau of Land Management were done under authority of the Soil and Watershed Conservation Program as described in an earlier portion of this section (F-2).

The U. S. Corps of Engineers received its initial responsibility for flood control in the 1936 Flood Control Act. This Act, as amended by subsequent acts, established federal policy with regard to flood control. Each flood control project constructed by the Corps of Engineers, except certain small projects under provisions of Section 205 of the 1948 Flood Control Act, must be specifically authorized by Congress. The cost of a flood control project is usually divided between the federal government and local interests directly benefited. The local interests' share of the cost is governed by the requirements in the authorizing act.

Photo 58. Mathews Canyon Reservoir, near Caliente, Nevada CE

Watershed management programs of the Forest Service administered lands are authorized by a number of Acts of Congress. These include the Weeks Law of 1911, the Federal Power Act of 1920, Clarke-McNary Act of 1924, the Bankhead-Jones Act of 1937, the Watershed Protection and Flood Prevention Act of 1954, the Multiple Use Act of 1960, and a number of others. In addition to specialized watershed management programs, watershed management objectives are provided for in other resource and activity programs by maintaining the ground cover necessary to reduce erosion, peak flows and the augmentation of the water supply.

PROGRAM FORMULATION

CHAPTER G - PROGRAM FORMULATION

The program as presented in tables 42, 43, 44, and 47 is based upon the Modified OBE-ERS level of projection. A comparison of the two levels of projection (OBE-ERS and Modified OBE-ERS) is made in Chapter K. Major differences in land requirements and costs of the programs are also discussed in Chapter K for the two levels.

The program was divided into two categories: (1) Land Treatment and Management, including associated minor structural measures and, (2) Upstream Flood Prevention, which includes larger structural measures in upstream areas necessary for flood prevention and other purposes which further the conservation, development, utilization, and disposal of the water resource. In formulation of the land treatment and management part of the program a distinction was made between that portion which is "water related" and that portion which is "associated." The water related portion is that which has significant effects on the water resource. The associated portion is primarily production oriented. The upstream flood prevention program was considered to be totally water related.

LAND TREATMENT AND MANAGEMENT

The total land treatment and management program (water related and associated) is presented in Table 42 by land resource group, subregion, and time frame. The water related portion of the program is broken out in Table 43, and the associated portion is shown in Table 44. The equivalent acreages treated by land resource groups, time frame, and function for the total Region is shown in Table 45.

The land treatment and management portion of the program was formulated based upon the translation of water and related land resources required to satisfy short- and long-term needs within the Region. The economic projections formed a common base for determination of gross demands in terms of goods and services. In the projection of land requirements, assumptions were made that (1) to the extent practicable, land use will be based on sustained or increased production without deterioration of the land and water resources and (2) the maximum application of the principle of multiple use will be employed.

Land treatment and management includes water related practices and measures which improve the quantity, quality, and timing of runoff; reduce erosion and sediment production (the principal water

pollution agent); and improve the efficiency of irrigation water use. The associated practices and measures are needed to meet the requirements for production of food and fiber.

Fire is a useful and valuable tool to the land manager, when properly applied and controlled, to meet the objectives of land management on the forest and range lands of the Region. A vigorous, well-founded program of prescribed burning could materially reduce the extent and severity of wildfires, thus reducing total losses and total costs of fire suppression in the Region. Prescribed fire is a tool used to manage the vegetative cover to improve the total "multiple use" benefits including livestock forage, wildlife habitat, and improve the quantity and quality of water for downstream use. Burning prescriptions should include considerations to minimize smoke and esthetic pollution impacts on air quality.

Two alternates were considered in formulating the land treatment and management portion of the program. These were the "Going Program" and the "Suggested Program." The going program for land treatment and management, using the with and without approach, is the without element; actually without any acceleration in the current annual level of investment. An evaluation of the going program was necessary to provide an understanding of the relative investments required and accomplishments that may be achieved at other alternative levels of development. The suggested program represents a composite level program which reconciles environmental protection, and production objectives. It is necessary to satisfy the projected requirements and insure the improvement of production of all resources and uses from water and related land on a sustained yield basis.

Implementation of the total program would minimize irreversible losses of the land resources and preserve the freedom of choice for future resource users. A carefully designed and widely applied program will enhance rural development opportunities by providing protection of the land resource base, more efficient production and water use, improved water quality, increased recreation opportunities, improved fish and wildlife habitat, increased and stabilized patterns of streamflow, and reduction of sediment yield. In order for people to stay or migrate to rural areas there must be opportunities to realize an adequate return on their labor, management, and capital. The suggested program would be instrumental in helping to achieve this objective. In turn, this would help to relieve population pressures in cities thereby promoting a more healthful urban environment.

As the plan was formulated esthetic values and environmental factors were of primary consideration since, "The well-being of all

the people shall be the overriding determinant in considering the best use of water and related land resources." 1/ Ideally the land treatment and management program should harmonize with all water and related resource development programs required to satisfy present and projected demands within the Region.

The land treatment and management program was formulated by land resource groups. A general explanation of what is included in the program for each land resource group follows:

Cropland

Water Related--This portion of the land treatment and management program for cropland is divided into irrigation water management measures and erosion, sediment, and runoff control measures.

Irrigation water management measures include land leveling, ditch lining, water control structures, and pipelines. These water related measures are for control and more efficient use of irrigation water and/or to reduce costs of irrigation. At the same time these measures, in combination with cultural practices, reduce pollution of the ground water, maintain or improve the productive capacity of the soil and provide opportunity for increased yields through better water distribution and timeliness of operations.

Water related measures such as diversions, levees and dikes, channel improvement, floodways, and streambank protection were considered for erosion, sediment and runoff control on cropland. These measures are primarily for protection of the land and improvements, but also help to maintain and/or improve the productivity of the land, reduce the sedimentation and erosion hazards that would adversely affect the operation and maintenance of structural measures, and help in keeping soil losses within allowable limits. These measures have a beneficial effect on water quality, air quality, and further other environmental quality objectives. Water pollutants such as sediment, plant nutrients, and pesticides which could be carried to the watercourses by floodwaters are retained on the land where they are needed.

Associated--This portion of the program for cropland includes soil surveys and investigations which are necessary for implementation of the irrigation water management, and erosion, sediment and runoff control measures.

1/ Senate Document 97-87th Congress

The program for cropland does not include cultural or management practices that are considered a part of normal farm operations. Neither does it include cost of research and information programs needed for the increase in technology that is projected.

Rangeland

Water Related--This portion of the rangeland program includes those practices and measures necessary for erosion, sediment, and runoff control. These consist of (1) small structural measures, such as diversions, terraces, grade stabilization, gully plugs, etc., (2) vegetative measures, such as grass seeding, and tree and shrub plantings, (3) intensive management, which is the orderly and efficient use of water, land, plants, and other resources and (4) wildfire control.

Associated--Some of the practices and measures included in the water related portion of the program for rangeland are also effective in increasing or maintaining forage production. The cost of such practices and measures were divided on the basis of benefits derived, and that part of the cost for increased livestock and/or forage production was included in the associated portion of the program.

Proper grazing management is necessary for maximum multiple use and production while protecting and improving environmental values. The total program was designed to reduce sediment yield, reduce wildfire damage, improve water quality and/or quantity, and increase the productive ability of the land. Proper land treatment and intensive management of rangeland can benefit recreation, wildlife, esthetics and other resources, uses, and services. Costs for continued research for rangeland improvement are included in the program.

Forest Land

Programs for development and management of forest land and resources are designed to protect, utilize, maintain or improve the total productive capacity of the land, including wood, forage, recreation, wildlife, and water to meet the regional and national needs of the people. Research costs for continued forest land and resources improvement are included in the program.

Water Related--This portion of the program includes measures that control erosion, sediment and runoff and improve water yield. Included are structural; management; and development measures such as proper construction of roads, trails and other structural improvements, reforestation, vegetative management for increasing water yield, reducing erosion and sediment, and wildfire control.

Structural and other management and developing programs are designed to reduce sheet, gully and streambank erosion, control peak runoff, and reduce downstream floods. Roads, trails, and other improvements are designed, constructed, and maintained to minimize erosion and sediment yield and deposition.

Associated--The associated program for forest land consists of development and management to utilize and maintain or improve the total productive capacity of the land. The production oriented portion of the above measures including reforestation, thinning, insect and disease control, vegetative management for forage production, enhancement of recreation resources, including esthetic and environmental values, and improvement of wildlife habitat are considered in the associated portion of the program.

Urban and Other

Water Related--Measures such as diversions, levees and dikes, channel improvement, floodways and vegetative were considered for erosion, floodwater, and sediment control in urban and mined areas, and along roadsides, utility rights-of-way, etc. These measures may be temporary or permanent. The protective vegetative cover of land being developed is usually disturbed by land shaping or heavy equipment. These areas should be provided temporary protection during and immediately after construction. Research costs are not included.

Permanent type measures must be planned and installed during the initial stages of any development to adequately protect the area from future erosion, floodwater, and sediment damages.

The total land treatment and management program is presented in tables 42, 43, and 44. Costs are based on constant 1965 prices. The operation, maintenance and replacement (OM&R) costs are an annual amount and for the last year of the time period.

Outdoor recreation and fish and wildlife habitat program costs are shown only for the "Forest Land" land resource group and are not included in any totals in tables 43 and 44. These costs were not segregated for cropland and rangeland. The total programs for outdoor recreation and fish and wildlife are reported in the respective appendixes, Recreation and Fish and Wildlife.

Table 42
Lower Colorado Region
Suggested Land Treatment and Management Programs
REGIONAL SUMMARY

WATER RELATED AND ASSOCIATED

LAND RESOURCE GROUPS SUBREGIONS	PROGRAM COSTS IN $1,000.															
	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - Total	771	3,182	479	4,414	12,223	47,649	519	7,879	16,335	66,752	530	8,104	15,930	65,257	529	8,052
Lower Main Stem	153	648	87	911	2,908	9,460	127	1,624	3,924	16,245	145	1,804	3,968	16,552	147	1,877
Little Colorado	14	58	10	93	226	898	10	177	307	1,213	11	178	308	1,212	11	178
Gila	604	2,476	382	3,410	9,089	37,291	382	6,078	12,104	49,294	374	6,122	11,654	47,493	371	5,997
RANGELAND - Total	1,123	473	1,453	439	59,782	21,165	4,032	575	78,135	29,304	6,379	707	32,940	24,251	9,224	738
Lower Main Stem	556	51	797	49	16,874	3,414	1,204	72	22,867	4,981	2,065	71	6,308	3,951	2,702	76
Little Colorado	175	147	212	133	6,008	3,369	524	164	8,249	4,719	742	197	4,503	4,115	782	198
Gila	392	275	444	257	36,900	14,382	2,304	339	47,019	19,604	3,572	439	22,129	16,185	5,740	464
FOREST LAND - Total	1,767	689	6,593	758	110,845	22,595	12,185	2,926	293,190	34,825	36,208	13,526	147,480	35,190	54,220	8,814
Lower Main Stem	226	30	1,277	27	15,796	3,045	2,516	110	67,410	5,275	6,506	775	32,100	7,110	10,123	775
Little Colorado	599	67	2,194	628	44,757	6,750	4,277	1,087	104,100	11,900	12,316	5,125	52,680	12,860	18,246	3,302
Gila	942	592	3,122	103	50,292	12,800	5,392	1,729	121,680	17,650	17,386	7,626	62,700	15,220	25,851	4,737
URBAN - Total	50	200	38	337	1,092	4,368	92	829	1,368	5,472	161	1,444	1,692	6,768	245	2,206
Lower Main Stem	14	58	11	97	336	1,344	28	248	474	1,896	51	462	534	2,136	78	702
Little Colorado	4	14	3	24	114	456	8	76	144	576	16	140	168	672	24	216
Gila	32	128	24	216	642	2,568	56	505	750	3,000	94	842	990	3,960	143	1,288
GRAND TOTAL - Region	3,711	4,544	8,563	5,948	183,942	95,777	16,828	12,209	389,028	136,353	43,278	23,781	198,042	131,466	64,218	19,810
Lower Main Stem	949	787	2,172	1,084	35,914	17,263	3,875	2,054	94,675	28,397	8,767	3,112	42,910	29,749	13,050	3,430
Little Colorado	792	286	2,419	878	51,105	11,473	4,819	1,504	112,800	18,408	13,085	5,640	57,659	18,859	19,063	3,894
Gila	1,970	3,471	3,972	3,986	96,923	67,041	8,134	8,651	181,553	89,548	21,426	15,029	97,473	82,858	32,105	12,486

Table 43
Lower Colorado Region
Suggested Land Treatment and Management Programs
REGIONAL SUMMARY

WATER RELATED PORTION

LAND RESOURCE GROUPS / Program Functions	PROGRAM COSTS IN $1,000. Annual Going Program: Installation Fed.	Installation Non-Fed.	Ann. OM&R Fed.	Ann. OM&R Non-Fed.	Suggested Programs 1966-1980: Installation Fed.	Installation Non-Fed.	Ann. OM&R Fed.	Ann. OM&R Non-Fed.	1981-2000: Installation Fed.	Installation Non-Fed.	Ann. OM&R Fed.	Ann. OM&R Non-Fed.	2001-2020: Installation Fed.	Installation Non-Fed.	Ann. OM&R Fed.	Ann. OM&R Non-Fed.
CROPLAND - subtotal	749	3,182	479	4,414	11,853	47,649	519	7,879	15,818	66,752	530	8,104	15,424	65,257	529	8,052
Erosion, Sediment & Runoff Control	59	145	93	228	911	2,236	95	233	1,253	3,070	100	238	1,239	3,035	98	237
Irrigation Water Management	690	3,037	386	4,186	10,942	45,413	424	7,646	14,565	63,682	430	7,866	14,185	62,222	431	7,815
RANGELAND - subtotal	882	292	1,062	261	48,703	16,316	2,617	345	61,612	23,334	4,201	427	26,504	17,179	5,810	462
Erosion, Sediment & Runoff Control	882	292	1,062	261	48,703	16,316	2,617	345	61,612	23,334	4,201	427	26,504	17,179	5,810	462
Structural Measures	(716)	(172)	(655)	(135)	(41,317)	(13,084)	(575)	(163)	(50,596)	(19,353)	(1,344)	(183)	(22,215)	(12,466)	(1,860)	(183)
Vegetative Management	(166)	(120)	(219)	(114)	(7,386)	(3,232)	(766)	(146)	(11,016)	(3,981)	(1,149)	(170)	(4,289)	(4,713)	(1,942)	(156)
Wildfire Prevention & Suppression			(188)	(12)			(1,276)	(36)			(1,708)	(74)			(2,008)	(123)
FOREST LAND - subtotal	1,387	634	5,328	683	86,395	20,070	9,010	2,541	225,290	26,600	29,828	12,886	116,580	32,430	45,355	8,074
Erosion, Sediment & Runoff Control	287	134	4,588	633	72,725	16,070	7,610	2,361	198,390	20,600	13,628	6,736	86,380	27,430	18,975	2,974
Watershed Management	(90)	(100)	(12)	(100)	(65,550)	(14,400)	(545)	(270)	(179,000)	(18,000)	(735)	(4,650)	(73,000)	(27,000)	(660)	(800)
Timber Management	(115)	(4)	(90)	(25)	(5,480)	(1,300)	(140)	(6)	(10,900)	(1,800)	(343)	(11)	(700)	(30)	(415)	(4)
Forage Management	(82)	(30)	(36)	(8)	(1,555)	(370)	(525)	(160)	(8,170)	(800)	(1,100)	(400)	(12,280)	(400)	(2,550)	(320)
Wildfire Prevention & Suppression			(4,450)	(500)	(140)		(6,400)	(1,925)	(320)		(11,450)	(1,675)	(400)		(15,350)	(1,850)
Water Yield Improvement	1,100	500	740	50	13,670	4,000	1,400	180	26,900	6,000	16,200	6,150	30,200	5,000	26,380	5,100
[Outdoor Recreation] 1/	[500]	[250]	[200]	[100]	[40,595]	[12,500]	[10,900]	[3,880]	[87,900]	[37,700]	[31,000]	[10,200]	[110,500]	[55,000]	[49,250]	[20,750]
[Fish & Wildlife Habitat] 1/	[115]	[58]	[116]	[58]	[10,350]	[3,150]	[730]	[130]	[7,300]	[2,250]	[900]	[120]	[11,900]	[3,175]	[1,500]	[280]
URBAN - subtotal	50	200	38	337	1,092	4,368	92	829	1,368	5,472	161	1,444	1,692	6,768	245	2,206
Erosion, Sediment & Runoff Control	50	200	38	337	1,092	4,368	92	829	1,368	5,472	161	1,444	1,692	6,768	245	2,206
SUBTOTAL - Water Related	3,068	4,308	6,907	5,695	148,043	88,403	12,238	11,594	304,088	122,158	34,720	22,861	160,200	121,634	51,939	18,794

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

Table 45

Lower Colorado Region
Suggested Land Treatment and Management Programs
LOWER MAIN STEM SUBREGION

WATER RELATED PORTION

PROGRAM COSTS IN $1,000.

LAND RESOURCE GROUPS / Program Functions	Annual Going Program				Suggested Programs 1966-1980				Suggested Programs 1981-2000				Suggested Programs 2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	149	648	87	911	2,831	9,460	127	1,624	3,800	16,245	145	1,804	3,843	16,552	147	1,877
Erosion, Sediment & Runoff Control	4	10	6	16	68	168	7	17	100	245	8	18	103	252	8	19
Irrigation Water Management	145	638	81	895	2,763	9,292	120	1,607	3,700	16,000	137	1,786	3,740	16,300	139	1,858
RANGELAND - subtotal	483	31	606	29	13,202	2,874	786	41	17,170	4,241	1,273	43	5,448	3,035	1,640	42
Erosion, Sediment & Runoff Control	483	31	606	29	13,202	2,874	786	41	17,170	4,241	1,273	43	5,448	3,035	1,640	42
Structural Measures	(433)	(18)	(429)	(14)	(10,754)	(2,514)	(194)	(16)	(13,372)	(3,747)	(342)	(17)	(4,875)	(2,425)	(456)	(16)
Vegetative Management	(50)	(13)	(114)	(13)	(2,448)	(360)	(256)	(21)	(3,798)	(494)	(447)	(18)	(573)	(610)	(614)	(14)
Wildfire Prevention & Suppression			(63)	(2)			(336)	(4)			(484)	(8)			(570)	(12)
FOREST LAND - subtotal	176	25	977	22	13,421	3,020	1,631	95	61,310	4,750	5,061	735	26,550	7,050	7,943	735
Erosion, Sediment & Runoff Control	56	25	937	22	12,021	3,020	1,481	95	55,910	3,750	2,861	235	21,350	6,550	4,563	185
Watershed Management	(21)	(20)	(2)	(20)	(10,250)	(3,000)	(30)	(45)	(51,000)	(3,250)	(70)	(150)	(18,000)	(6,500)	(160)	(100)
Timber Management	(25)		(15)		(1,540)		(26)		(2,800)	(400)	(91)		(150)		(103)	
Forage Management	(10)	(5)	(10)	(2)	(201)	(20)	(155)	(50)	(2,050)	(100)	(250)	(85)	(3,100)	(50)	(750)	(85)
Wildfire Prevention & Suppression			(910)		(30)		(1,270)		(60)		(2,450)		(100)		(3,550)	
Water Yield Improvement	120		40		1,400		150		5,400	1,000	2,200	500	5,200	500	3,380	550
[Outdoor Recreation] 1/	[100]	[50]	[50]	[10]	[7,525]	[750]	[2,250]	[300]	[20,125]	[5,000]	[7,850]	[2,075]	[25,200]	[10,000]	[10,500]	[5,100]
[Fish & Wildlife Habitat] 1/	[25]	[13]	[34]	[12]	[3,105]	[1,050]	[215]	[30]	[2,400]	[575]	[280]	[30]	[3,650]	[1,075]	[420]	[80]
URBAN - subtotal	14	58	11	97	336	1,344	28	248	474	1,896	51	462	534	2,136	78	702
Erosion, Sediment & Runoff Control	14	58	11	97	336	1,344	28	248	474	1,896	51	462	534	2,136	78	702
SUBTOTAL - Water Related	822	762	1,681	1,059	29,790	16,698	2,572	2,008	82,754	27,132	6,530	3,044	36,375	28,773	9,808	3,356

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

Table 43
Lower Colorado Region
Suggested Land Treatment and Management Programs
LITTLE COLORADO SUBREGION

WATER RELATED PORTION

PROGRAM COSTS IN $1,000.

LAND RESOURCE GROUPS / Program Functions	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	14	58	10	93	220	898	10	177	298	1,213	11	178	298	1,212	11	178
Erosion, Sediment & Runoff Control	2	5	3	8	36	87	3	9	53	131	4	10	53	130	4	10
Irrigation Water Management	12	53	7	85	184	811	7	168	245	1,082	7	168	245	1,082	7	168
RANGELAND - subtotal	124	101	147	87	4,505	2,510	310	110	5,938	3,472	435	130	3,392	2,851	468	137
Erosion, Sediment & Runoff Control	124	101	147	87	4,505	2,510	310	110	5,938	3,472	435	130	3,392	2,851	468	137
Structural	(89)	(70)	(68)	(52)	(3,503)	(1,938)	(55)	(68)	(4,397)	(2,640)	(73)	(77)	(2,652)	(2,009)	(73)	(73)
Vegetative Management	(35)	(31)	(30)	(29)	(1,002)	(572)	(122)	(34)	(1,541)	(832)	(172)	(37)	(740)	(842)	(173)	(36)
Wildfire Prevention & Suppression			(49)	(6)			(133)	(8)			(190)	(16)			(222)	(28)
FOREST LAND - subtotal	434	52	1,774	573	32,532	5,750	3,142	957	67,250	8,300	9,911	4,820	34,530	10,660	15,181	2,957
Erosion, Sediment & Runoff Control	114	52	1,574	553	27,932	4,750	2,617	932	58,750	6,300	4,511	2,770	25,530	9,660	6,781	1,407
Watershed Management	(30)	(40)	(6)	(40)	(25,300)	(4,000)	(115)	(100)	(51,500)	(5,300)	(140)	(1,600)	(21,000)	(9,500)	(200)	(200)
Timber Management	(53)	(2)	(35)	(10)	(1,980)	(600)	(62)	(2)	(4,100)	(700)	(171)	(5)	(325)	(10)	(181)	(2)
Forage Management	(31)	(10)	(13)	(3)	(602)	(150)	(160)	(30)	(3,050)	(300)	(300)	(90)	(4,080)	(150)	(800)	(105)
Wildfire Prevention & Suppression			(1,520)	(500)	(50)		(2,280)	(800)	(100)		(3,900)	(1,075)	(125)		(5,600)	(1,100)
Water Yield Improvement	320		200	20	4,600	1,000	525	25	8,500	2,000	5,400	2,050	9,000	1,000	8,400	1,550
[Outdoor Recreation] 1/	[150]	[75]	[75]	[30]	[13,025]	[5,000]	[3,850]	[2,005]	[32,100]	[12,200]	[8,250]	[3,050]	[40,100]	[20,000]	[20,750]	[7,500]
[Fish & Wildlife Habitat] 1/	[45]	[23]	[36]	[13]	[4,130]	[1,050]	[245]	[50]	[2,900]	[825]	[260]	[40]	[4,600]	[1,050]	[540]	[90]
URBAN - subtotal	4	14	3	24	114	456	8	76	144	576	16	140	168	672	24	216
Erosion, Sediment & Runoff Control	4	14	3	24	114	456	8	76	144	576	16	140	168	672	24	216
SUBTOTAL - Water Related	576	225	1,934	777	37,371	9,614	3,470	1,320	73,630	13,561	10,373	5,268	38,388	15,395	15,684	3,488

Table 43
Lower Colorado Region
Suggested Land Treatment and Management Programs
GILA SUBREGION

WATER RELATED PORTION

PROGRAM COSTS IN $1,000.

LAND RESOURCE GROUPS / Program Functions	Annual Going Program				Suggested Programs 1966-1980				Suggested Programs 1981-2000				Suggested Programs 2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	586	2,476	382	3,410	8,802	37,291	382	6,078	11,720	49,294	374	6,122	11,283	47,493	371	5,997
Erosion, Sediment & Runoff Control	53	130	84	204	807	1,981	85	207	1,100	2,694	88	210	1,083	2,653	86	208
Irrigation Water Management	533	2,346	298	3,206	7,995	35,310	297	5,871	10,620	46,600	286	5,912	10,200	44,840	285	5,789
RANGELAND - subtotal	275	160	309	145	30,996	10,932	1,521	194	38,504	15,621	2,493	254	17,664	11,293	3,702	283
Erosion, Sediment & Runoff Control	275	160	309	145	30,996	10,932	1,521	194	38,504	15,621	2,493	254	17,664	11,293	3,702	283
Structural	(194)	(84)	(158)	(69)	(27,060)	(8,632)	(326)	(79)	(32,827)	(12,966)	(929)	(89)	(14,688)	(8,032)	(1,331)	(94)
Vegetative Management	(81)	(76)	(75)	(72)	(3,936)	(2,300)	(388)	(91)	(5,677)	(2,655)	(530)	(115)	(2,976)	(3,261)	(1,155)	(106)
Wildfire Prevention & Suppression			(76)	(4)			(807)	(24)			(1,034)	(50)			(1,216)	(83)
FOREST LAND - subtotal	777	557	2,577	88	40,442	11,300	4,237	1,489	96,730	13,550	14,856	7,331	55,500	14,720	22,231	4,382
Erosion, Sediment & Runoff Control	117	57	2,077	58	32,772	8,300	3,512	1,334	83,730	10,550	6,256	3,731	39,500	11,220	7,631	1,382
Watershed Management	(39)	(40)	(4)	(40)	(30,000)	(7,400)	(400)	(125)	(76,500)	(9,450)	(525)	(2,900)	(34,000)	(11,000)	(300)	(500)
Timber Management	(37)	(2)	(40)	(15)	(1,960)	(700)	(52)	(4)	(4,000)	(700)	(81)	(6)	(225)	(20)	(131)	(2)
Forage Management	(41)	(15)	(13)	(3)	(752)	(200)	(210)	(80)	(3,070)	(400)	(550)	(225)	(5,100)	(200)	(1,000)	(130)
Wildfire Prevention & Suppression			(2,020)		(60)		(2,850)	(1,125)	(160)		(5,100)	(600)	(175)		(6,200)	(750)
Water Yield Improvement	660	500	500	30	7,670	3,000	725	155	13,000	3,000	8,600	3,600	16,000	3,500	14,600	3,000
[Outdoor Recreation] 1/	[250]	[125]	[75]	[60]	[20,050]	[6,750]	[4,800]	[1,575]	[35,675]	[20,500]	[14,900]	[5,075]	[45,200]	[25,000]	[18,000]	[8,150]
[Fish & Wildlife Habitat] 1/	[45]	[22]	[46]	[33]	[3,115]	[1,050]	[270]	[50]	[2,000]	[850]	[360]	[50]	[3,650]	[1,050]	[540]	[110]
URBAN - subtotal	32	128	24	216	642	2,568	56	505	750	3,000	94	842	990	3,960	143	1,288
Erosion, Sediment & Runoff Control	32	128	24	216	642	2,568	56	505	750	3,000	94	842	990	3,960	143	1,288
SUBTOTAL - Water Related	1,670	3,321	3,292	3,859	80,882	62,091	6,196	8,266	147,704	81,465	17,817	14,549	85,437	77,466	26,447	11,950

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

(sheet 4 of 4)

Table 44
Lower Colorado Region
Suggested Land Treatment and Management Programs
REGIONAL SUMMARY

ASSOCIATED PORTION

LAND RESOURCE GROUPS Program Functions	PROGRAM COSTS IN $1,000.															
	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	22				370				517				506			
Soil Survey & Investigation	22				370				517				506			
RANGELAND - subtotal	241	181	391	178	11,079	4,849	1,415	230	16,523	5,970	2,178	280	6,436	7,072	3,414	276
Forage Production	241	181	332	174	11,079	4,849	1,096	220	16,523	5,970	1,725	260	6,436	7,072	2,912	244
Wildfire Prevention & Suppression			59	4			319	10			453	20			502	32
FOREST LAND - subtotal	380	55	1,265	75	24,450	2,525	3,175	385	67,900	8,225	6,380	640	30,900	2,760	8,865	740
Timber Production	230	15	160	55	21,500	2,200	560	75	51,000	6,600	1,470	50	13,300	2,100	1,390	10
Forage Production	150	40	95	20	2,550	325	215	105	16,300	1,625	760	265	16,800	660	1,775	330
Wildfire Prevention & Suppression			1,010		400		2,400	205	600		4,150	325	800		5,700	400
[Outdoor Recreation] 1/	[400]	[200]	[205]	[70]	[33,600]	[10,750]	[9,100]	[3,800]	[84,400]	[29,000]	[23,600]	[8,100]	[115,400]	[50,000]	[35,250]	[20,130]
[Fish & Wildlife Habitat] 1/	[10]		[125]	[15]	[295]	[40]	[470]	[55]	[655]	[60]	[715]	[85]	[1,125]	[45]	[880]	[90]
SUBTOTAL Associated	643	236	1,656	253	35,899	7,374	4,590	615	84,940	14,195	8,558	920	37,842	9,832	12,279	1,016

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

Table 44
Lower Colorado Region
Suggested Land Treatment and Management Programs
LOWER MAIN STEM SUBREGION

ASSOCIATED PORTION

PROGRAM COSTS IN $1,000.

LAND RESOURCE GROUPS Program Functions	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	4				77				124				125			
Soil Survey & Investigation	4				77				124				125			
RANGELAND - subtotal	73	20	191	20	3,672	540	418	31	5,697	740	792	28	860	916	1,062	34
Forage Production	73	20	173	19	3,672	540	334	30	5,697	740	671	26	860	916	920	30
Wildfire Prevention & Suppression			18	1			84	1			121	2			142	4
FOREST LAND - subtotal	50	5	300	5	2,375	25	885	15	6,100	525	1,445	40	5,550	60	2,180	40
Timber Production	35		25		1,575		105		3,200	400	260		850		305	
Forage Production	15	5	25	5	700	25	55	15	2,750	125	135	40	4,500	60	375	40
Wildfire Prevention & Suppression			250		100		725		150		1,050		200		1,500	
[Outdoor Recreation] 1/	[100]	[50]	[50]	[10]	[7,520]	[750]	[2,030]	[260]	[20,100]	[5,000]	[7,550]	[2,020]	[25,150]	[10,000]	[10,075]	[5,040]
[Fish & Wildlife Habitat] 1/	[5]		[20]		[105]	[20]	[155]	[25]	[225]	[15]	[205]	[30]	[475]	[15]	[310]	[30]
SUBTOTAL Associated	117	25	491	25	6,124	565	1,303	46	11,921	1,265	2,227	68	6,535	976	3,242	74

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

Table 44
Lower Colorado Region
Suggested Land Treatment and Management Programs
LITTLE COLORADO SUBREGION

ASSOCIATED PORTION

LAND RESOURCE GROUPS / Program Functions	PROGRAM COSTS IN $1,000.															
	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal					6				9				10			
Soil Survey & Investigation					6				9				10			
RANGELAND- subtotal	51	46	65	46	1,503	859	214	54	2,311	1,247	307	67	1,111	1,264	314	61
Forage Production	51	46	45	45	1,503	859	181	52	2,311	1,247	259	62	1,111	1,264	259	54
Wildfire Prevention & Suppression			20	1			33	2			48	5			55	7
FOREST LAND - subtotal	165	15	420	55	12,225	1,000	1,135	130	36,850	3,600	2,405	305	18,150	2,200	3,065	345
Timber Production	110	5	90	50	10,975	900	300	5	31,400	3,100	880	30	11,500	2,000	765	5
Forage Production	55	10	25	5	1,100	100	35	20	5,200	500	225	75	6,400	200	550	65
Wildfire Prevention & Suppression			305		150		800	105	250		1,300	200	250		1,750	275
[Outdoor Recreation] 1/	[150]	[75]	[75]	[30]	[13,030]	[5,000]	[3,520]	[1,770]	[32,150]	[12,000]	[8,075]	[3,030]	[40,100]	[20,000]	[12,575]	[7,040]
[Fish & Wildlife Habitat] 1/			[30]	[10]	[50]	[10]	[105]	[10]	[155]	[20]	[205]	[25]	[180]	[20]	[260]	[5]
SUBTOTAL Associated	216	61	485	101	13,728	1,859	1,349	184	39,161	4,847	2,712	102	19,261	3,464	3,379	406

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

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Table 44
Lower Colorado Region
Suggested Land Treatment and Management Programs
GILA SUBREGION

ASSOCIATED PORTION

PROGRAM COSTS IN $1,000.

LAND RESOURCE GROUPS / Program Functions	Annual Going Program				Suggested Programs											
					1966-1980				1981-2000				2001-2020			
	Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R		Installation		Ann. OM&R	
	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.	Fed.	Non-Fed.
CROPLAND - subtotal	18				287				384				371			
Soil Survey & Investigation	18				287				384				371			
RANGELAND - subtotal	117	115	135	112	5,904	3,450	783	145	8,515	3,983	1,079	185	4,465	4,892	2,038	181
Forage Production	117	115	114	110	5,904	3,450	581	138	8,515	3,983	795	172	4,465	4,892	1,733	160
Wildfire Prevention & Suppression			21	2			202	7			284	13			305	21
FOREST LAND - subtotal	165	35	545	15	9,850	1,500	1,155	240	24,950	4,100	2,530	295	7,200	500	3,620	355
Timber Production	85	10	45	5	8,950	1,300	155	70	16,400	3,100	330	20	950	100	320	5
Forage Production	80	25	45	10	750	200	125	70	8,350	1,000	400	150	5,900	400	850	225
Wildfire Prevention & Suppression			455		150		875	100	200		1,800	125	350		2,450	125
[Outdoor Recreation] 1/	[150]	[75]	[80]	[30]	[13,050]	[5,000]	[3,550]	[1,770]	[32,150]	[12,000]	[8,075]	[3,050]	[50,150]	[20,000]	[12,600]	[7,050]
[Fish & Wildlife Habitat] 1/	[5]		[25]	[5]	[140]	[10]	[210]	[20]	[225]	[25]	[305]	[30]	[470]	[10]	[310]	[55]
SUBTOTAL - Associated	300	150	680	127	16,041	4,950	1,938	385	33,849	8,083	3,609	480	12,036	5,392	5,658	536

1/ Outdoor recreation and fish and wildlife habitat costs were segregated for forest land only and are not included in the totals.

The approximate area treated in the suggested land treatment and management program is shown in Table 45, Equivalent Acreage Treated. This table shows area receiving treatment, by function, within water related and associated portions of land resource groups. The acreages are generally not additive since the treatment in one function may be applied to the same land as that in another function. For example, land that is treated to improve water yield may also be treated to control erosion, sediment, or runoff and, in addition, treated for forage or timber production. The acreages also include updating of measures and necessary re-treatment of the land.

Table 45
Lower Colorado Region
SUGGESTED LAND TREATMENT AND MANAGEMENT PROGRAMS
EQUIVALENT ACREAGE TREATED
(1,000 Acres)

	As of 1965	1966-1980	1981-2000	2001-2000
CROPLAND	675	573	801	779
Water Related				
Erosion, Sediment & Runoff Control		153	211	209
Irrigation Water Management		573	801	779
Associated				
Soil Survey & Investigation		344	481	467
RANGELAND	4,184	15,328	21,567	13,219
Water Related				
Erosion, sediment & Runoff Control		15,328	21,567	13,219
Associated				
Production Measures		3,065	4,529	3,173
FOREST LAND	2,000	3,600	4,700	2,850
Water Related				
Erosion, Sediment & Runoff Control		2,700	4,700	2,850
Water Yield Improvement		250	600	450
Associated				
Timber Production		3,600	3,400	1,600
Forage Production		400	1,000	1,600
URBAN	125	182	228	282
Water Related				
Erosion, Sediment & Runoff Control		182	228	282
Equivalent Acreage Treated-Total	6,984	19,683	27,296	17,130

UPSTREAM FLOOD PREVENTION

The total upstream flood prevention program is considered water related and is presented in tables 46 and 47. Table 46 shows the suggested upstream structural measures by time frame, subregion, state, and type of measure. Table 47 presents the total cost by these same breakdowns. Costs are based on constant 1965 prices.

The upstream flood prevention portion of the program includes those larger structural measures required to reduce flood damages occurring within watersheds with drainage areas of 250,000 acres or less. This program for the upstream area is included in the total flood control program as presented in the Flood Control Appendix. The formulation of the upstream flood prevention program was based upon an appraisal of the present and projected upstream flood prevention needs while recognizing the operational effects of existing projects. The projected needs were based upon economic projections and generalized estimates of the tendency and opportunity for future development in upstream flood plain areas while considering the effectiveness of preventive measures which influence flood plain development. In determining the quantity of the program, consideration was given to the projected population, agricultural production requirements, and other land and resource needs. It was recognized that prevention of all upstream floodwater damages would not be physically or economically feasible.

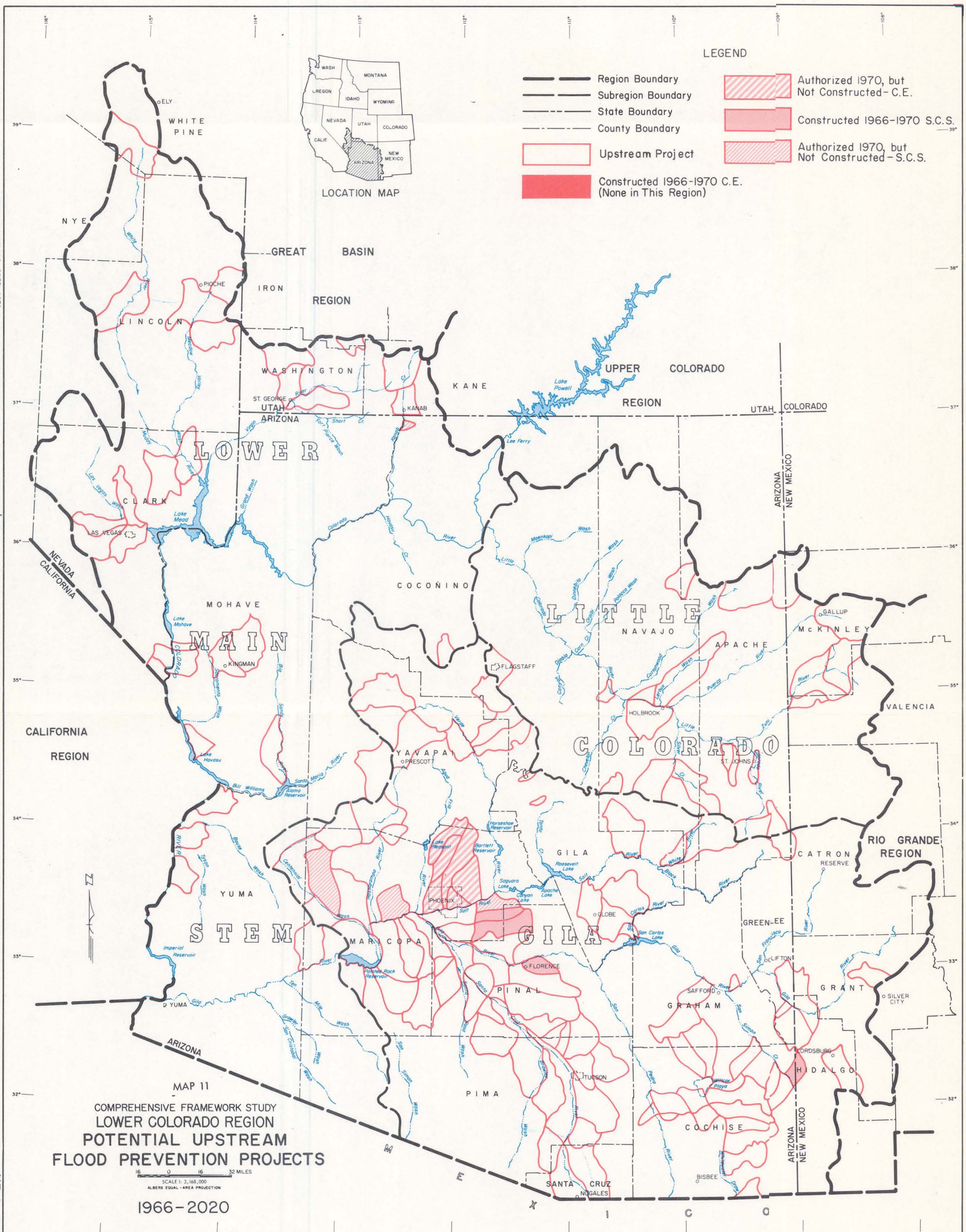
The principal function of upstream corrective measures is to control floodwaters so that the risk of flood damage for any portion of the upstream flood plain is compatible with the use. Environmental quality was one of the primary considerations in the formulation of the upstream flood control program. The program must be fully coordinated with other water and related land resource development within the Region to insure that maximum multiple use is made of water impoundments and other features for fish and wildlife, for outdoor recreation, and other beneficial uses.

The structural measures included in this part of the program consist of floodwater retarding structures for temporary storage of floodwater and sediment, levees, and channel improvement. Flood control structures regulate the flow so that flood damages are kept to a minimum. Flow regulation is accomplished by constructing reservoirs with floodwater storage or levee and channel improvement works separately or in combination. Damages are reduced by either storing the floodwater then later releasing it at nondamaging rates, or by providing sufficient channel capacity.

In development of the structural program consideration was given to the degree of flood damage prevention which could be accomplished

through controlling the use of flood plains by such measures as zoning and ordinances, subdivision or building codes, health regulations, open space regulation, tax adjustments, and flood-warning signs. The purpose of flood plain regulation is not to deny use of the flood plains, but rather, to prescribe land uses that are compatible with nature's need to pass flood water. Also considered was flood forecasting which provides opportunities for the implementation of emergency measures to minimize damages by evacuation of people, livestock, and movable objects from areas expected to be flooded and by the construction of temporary protective structures. Utilization of the nonstructural program is a major requirement in future community planning. Needed land treatment practices and measures are included in the program for flood control. These practices and measures are described in the previous section on "Land Treatment and Management."

Map 11 indicates the general area of the structural measures included in the suggested upstream flood prevention program.



MAP 11

COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
POTENTIAL UPSTREAM
FLOOD PREVENTION PROJECTS

SCALE 1: 3,168,000
ALBERS EQUAL-AREA PROJECTION

1966-2020

USDA-SCS-PORTLAND, OREG. 1971

M7-N-21431-J

Table 46
Lower Colorado Region
Suggested Upstream Structural Measures
for Flood Prevention (1966-1980)

Subregion	Number of Projects	Total Recommended Impoundments	Area Above Impoundments Sq. Mi.	Storage (1,000 Ac. Ft.) Sediment	Flood Control	1/ Other	Total	Flood Channel Improvements Mi.	Levees Mi.
Lower Main Stem									
Arizona	7	14	307	9.4	28.3	--	37.7	22.5	3.0
Nevada	3	4	125	2.8	9.7	--	12.5	12.5	2.2
Utah	3	15	87	3.6	4.7	0.8	9.1	9.3	--
Subregion Total	13	33	519	15.8	42.7	0.8	59.3	44.3	5.2
Little Colorado									
Arizona	11	16	1,112	28.3	82.2	34.0	144.5	16.0	6.0
New Mexico	3	4	326	15.3	26.3	8.0	49.6	4.0	--
Subregion Total	14	20	1,438	43.6	108.5	42.0	194.1	20.0	6.0
Gila									
Arizona	52	66	3,818	91.6	411.9	46.0	549.5	277.6	53.8
New Mexico	2	14	79	2.3	9.6	--	11.9	2.8	--
Subregion Total	54	80	3,897	93.9	421.5	46.0	561.4	280.4	53.8
Region Total	81	133	5,854	153.3	572.7	88.8	814.8	344.7	65.0

1/ Irrigation and Recreation

(1 of 4)

Table 46
Lower Colorado Region
Suggested Upstream Structural Measures
for Flood Prevention (1981-2000)

Subregion	Number of Projects	Total Recommended Impoundments	Area Above Impoundments Sq. Mi.	Storage (1,000 Ac. Ft.)				Flood Channel Improvements Mi.	Levees Mi.
				Sediment	Flood Control	1/ Other	Total		
Lower Main Stem									
Arizona	5	8	193	4.7	26.0	--	30.7	39.0	5.0
Nevada	10	12	822	15.1	54.7	--	69.8	27.5	12.0
Utah	2	1	60	0.6	0.7	11.8	13.1	2.0	--
Subregion Total	17	21	1,075	20.4	81.4	11.8	113.6	68.5	17.0
Little Colorado									
Arizona	6	5	565	14.9	45.0	10.0	69.9	14.1	4.0
New Mexico	1	--	--	--	--	--	--	2.5	--
Subregion Total	7	5	565	14.9	45.0	10.0	69.9	16.6	4.0
Gila									
Arizona	34	35	2,005	63.8	214.0	25.0	302.8	170.0	27.6
New Mexico	--	--	--	--	--	--	--	--	--
Subregion Total	34	35	2,005	63.8	214.0	25.0	302.8	170.0	27.6
Region Total	58	61	3,645	99.1	340.4	46.8	486.3	255.1	48.6

1/ Irrigation and Recreation

(2 of 4)

Table 46
Lower Colorado Region
Suggested Upstream Structural Measures
for Flood Prevention (2001-2020)

Subregion	Number of Projects	Total Recommended Impoundments	Area Above Impoundments Sq. Mi.	Storage (1,000 Ac. Ft.)				Flood Channel Improvements Mi.	Levees Mi.
				Sediment	Flood Control	1/ Other	Total		
Lower Main Stem									
Arizona	2	5	166	3.9	29.0	--	32.9	3.0	--
Nevada	2	2	202	5.7	12.9	--	18.6	8.0	--
Utah	1	2	67	4.7	3.7	--	8.4	--	--
Subregion	5	9	435	14.3	45.6	--	59.9	11.0	--
Little Colorado									
Arizona	4	8	346	10.1	25.9	--	36.0	5.0	--
New Mexico	--	--	--	--	--	--	--	--	--
Subregion Total	4	8	346	10.1	25.9	--	36.0	5.0	--
Gila									
Arizona	14	18	1,029	27.4	118.7	--	146.1	114.0	40.0
New Mexico	1	1	156	5.5	16.6	--	22.1	--	--
Subregion Total	15	19	1,185	32.9	135.3	--	168.2	114.0	40.0
Region Total	24	36	1,966	57.3	206.8	--	264.1	130.0	40.0

1/ Irrigation and Recreation

(3 of 4)

Table 46
Lower Colorado Region
Suggested Upstream Structural Measures
for Flood Prevention (1966-2020)

Subregion	Total Recommended Impoundments	Area Above Impoundments Sq. Mi.	Storage (1,000 Ac. Ft.) Sediment	Flood Control	1/ Other	Total	Flood Channel Improvements Mi.	Levees Mi.
Lower Main Stem								
Arizona	27	666	18.0	83.3	--	101.3	64.5	8.0
Nevada	18	1,149	23.6	77.3	--	100.9	48.0	14.2
Utah	18	214	8.9	9.1	12.6	30.6	11.3	--
Subregion Total	63	2,029	50.5	169.7	12.6	232.8	123.8	22.2
Little Colorado								
Arizona	29	2,023	53.3	153.1	44.0	250.4	35.1	10.0
New Mexico	4	326	15.3	26.3	8.0	49.6	6.5	--
Subregion Total	33	2,349	68.6	179.4	52.0	300.0	41.6	10.0
Gila								
Arizona	119	6,852	182.8	744.6	71.0	998.4	561.6	121.4
New Mexico	15	235	7.8	26.2	--	34.0	2.8	--
Subregion Total	134	7,087	190.6	770.8	71.0	1,032.4	564.4	121.4
Region Total	230	11,465	309.7	1,119.9	135.6	1,565.2	729.8	153.6

1/ Irrigation and Recreation

(4 of 4)

Table 47
Lower Colorado Region
Costs of Suggested Upstream Structural Measures (1966-1980)
for Flood Prevention
(Costs in $1,000)

Subregion/State	Levees & Channels				Flood Control Reservoirs			
	Federal		Non-Federal		Federal		Non-Federal	
	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs
1	2	3	4	5	6	7	8	9
Lower Main Stem								
Arizona	2,648		249	12	6,348		432	27
Nevada	1,046		125	4	2,893		289	13
Utah	652		13	3	2,903		42	12
Subregion Total	4,346	-	387	19	12,144	-	763	52
Little Colorado								
Arizona	3,156		277	15	13,232		177	55
New Mexico	390		5	2	3,927		67	16
Subregion Total	3,546	-	282	17	17,159	-	244	71
Gila								
Arizona	40,557		5,028	114	59,493		4,802	307
New Mexico	202		3	1	3,674		58	15
Subregion Total	40,759	-	5,031	115	63,167	-	4,860	322
Region Total	48,651	-	5,700	151	92,470	-	5,867	445

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Table 47
Lower Colorado Region
Costs of Suggested Upstream Structural Measures (1981-2000)
for Flood Prevention
(Costs in $1,000)

Subregion/State	Levees & Channels				Flood Control Reservoirs			
	Federal		Non-Federal		Federal		Non-Federal	
	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs
1	2	3	4	5	6	7	8	9
Lower Main Stem								
Arizona	2,639		204	11	3,832		560	17
Nevada	14,821		2,537	34	8,758		2,191	40
Utah	78		1	1	3,380		31	14
Subregion Total	17,538	-	2,742	46	15,970	-	2,782	71
Little Colorado								
Arizona	2,010		180	10	6,077		82	25
New Mexico	400		100	5	-		-	-
Subregion Total	2,410	-	280	15	6,077	-	82	25
Gila								
Arizona	70,489		10,231	188	29,270		3,485	173
New Mexico	-		-	-	-		-	-
Subregion Total	70,489	-	10,231	188	29,270	-	3,485	173
Region Total	90,437	-	13,253	249	51,317	-	6,349	269

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Table 47
Lower Colorado Region
Costs of Suggested Upstream Structural Measures (2001-2020)
for Flood Prevention
(Costs in $1,000)

Subregion/State	Levees & Channels				Flood Control Reservoirs			
	Federal		Non-Federal		Federal		Non-Federal	
	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs
1	2	3	4	5	6	7	8	9
Lower Main Stem								
Arizona	195		8	1	3,104		321	13
Nevada	4,335		545	13	1,817		184	8
Utah	-		-	-	2,106		26	9
Subregion Total	4,530	-	553	14	7,027	-	531	30
Little Colorado								
Arizona	343		4	1	4,749		103	20
New Mexico	-		-	-	-		-	-
Subregion Total	343	-	4	1	4,749	-	103	20
Gila								
Arizona	39,703		1,716	173	17,359	100	206	32
New Mexico	-		-	-	1,868	-	47	8
Subregion Total	39,703	-	1,716	173	19,227	100	253	40
Region Total	44,576	-	2,273	188	31,003	100	887	90

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Table 47
Lower Colorado Region
Costs of Suggested Upstream Structural Measures (1966-2020)
for Flood Prevention
(Costs in $1,000)

Subregion/State	Levees & Channels				Flood Control Reservoirs			
	Federal		Non-Federal		Federal		Non-Federal	
	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs	Installation Costs	Annual OM&R Costs
1	2	3	4	5	6	7	8	9
Lower Main Stem								
Arizona	5,482		461	24	13,284		1,313	57
Nevada	20,202		3,207	51	13,468		2,664	61
Utah	730		14	4	8,389		99	35
Subregion Total	26,414	-	3,682	79	35,141	-	4,076	153
Little Colorado								
Arizona	5,509		461	26	24,058		362	100
New Mexico	790		105	7	3,927		67	16
Subregion Total	6,299	-	566	33	27,985	-	429	116
Gila								
Arizona	150,749		16,975	475	106,122	100	8,493	512
New Mexico	202		3	1	5,542	-	105	23
Subregion Total	150,951	-	16,978	476	111,664	100	8,598	535
Region Total	183,664	-	21,226	588	174,790	100	13,103	804

(4 of 4)

OTHER LAND RESOURCE RELATED SUGGESTIONS

Following are additional suggestions regarding land use, administration, and management not specifically included previously in either the land treatment and management or the upstream flood prevention portions of the program. These relate in most instances to land use decisions that are made by county and city planning boards, elected officials, and private landowners. In many cases there are no "installation costs" involved but there may well be need for zoning ordinances, tax incentives, public information programs, and the like.

Cropland

1. Accelerate research and experimentation to develop effective pesticides and herbicides which will not be harmful to humans and domestic animals nor to desirable plants, fish, and wildlife.

2. Encourage private landowners to consider making more cropland available for income-producing recreation.

3. Plant field borders to vegetation which will provide food and protection for wildlife.

4. Improve rural environment by planting windbreaks and by vegetative screening of farmsteads, equipment lots, etc.

5. Use minimum tillage cultivation practices and crop residue use to reduce the quantity of dust which enters the air, decrease soil compaction and maintain soil structure, and reduce costs of crop production.

6. Encourage equitable taxing of cropland. Zoning may be a vehicle to slow "urban sprawl." Land capability should be one of the primary criteria to be considered in zoning.

7. Accelerate research and experimentation to develop strains of crops which require less water and are otherwise well adapted to the Region.

Rangeland

1. The system by which grazing privileges on public-owned lands are tied to private holdings should be reviewed periodically to insure that the system is both equitable and conducive to good management.

2. Take advantage of the unique natural beauty of the Region's rangelands by developing additional dude ranches and other tasteful outdoor income-producing recreation enterprises.

3. Accelerate research and experimentation leading to the introduction of well adapted and productive forage species.

4. Maintain coordinated methods and procedures of land transfer to insure maximum benefit to state, federal, and private interests.

5. Accelerate efforts to direct recreation activities on rangelands in such a way as to reduce damage done to the forage and wildlife resources, the Rancher's property, and to protect to the maximum extent possible, the cacti and other natural flora and fauna.

6. Provide for measures to improve wildlife habitat and maintain water quality when constructing livestock water developments.

7. Encourage flexibility in numbers of grazing animals to permit adjustments in times of drought or of unusually high forage production.

Forest Land

1. Accelerate research on production and marketing of forest products and establish, where feasible, forest related industries in rural areas to provide job opportunities.

2. Accelerate research and experimentation on pesticides and herbicides and alternate control methods which will not be harmful to humans and domestic animals nor to desirable plants, fish, and wildlife.

3. Develop additional tasteful income producing recreation facilities on private forested lands.

4. Review periodically the procedure for land transfers for maximum benefit to federal, state, and private interests.

5. Strengthen multiple-use land management plans and programs to assure equitable consideration for all resources and uses, including recreation and wildlife.

Urban and Other

1. Accelerate land use planning of areas which are expected to be developed for urban use and implement effective and equitable taxing and zoning ordinances in order to direct this development in an orderly and esthetically pleasing fashion.

2. Use flood prone sections of cities and towns for parks and green belt areas.

3. Facilities for efficient use of runoff water from urban areas should be provided. In these areas, because of roof tops and paving, a high percentage of the total rainfall results in runoff.

General

1. Develop adequate and safe facilities for animal and human waste disposal, giving full consideration to soil characteristics, to reduce water and air pollution.

2. Adequate provision should be made to reduce sediment produced during construction of roads, housing developments, pipelines, powerlines, etc., thereby reducing water pollution.

3. To minimize the effect of increases in land use for transportation and utilities in the future, government at all levels should coordinate and perhaps direct the establishment of transportation-utility corridors. Several kinds of utilities should be incorporated, where possible, in the same right-of-way. Locations of rights-of-ways and underground construction should be considered in order to have the least effect on productivity and esthetics.

4. Intensify educational programs to encourage the practical application of land treatment and management practices on the land.

5. Archeological resources are a competing land use and provisions should be made to investigate and evaluate these resources as the basis for deciding which resources should be preserved for future generations, salvaged prior to start of construction activities, or which sites may be allowed to be destroyed.

6. Strengthen coordinated planning on state, private, and federally administered grazing lands to make maximum use of the range resources within the concept of balanced multiple-use management of all the resources and values.

EFFECTS OF THE SUGGESTED PROGRAM

CHAPTER H - EFFECTS OF THE SUGGESTED PROGRAM 1/

The suggested program includes a variety of structural and management measures to maintain and/or increase the productive capacity of the land resource base; increase efficiency of water use; reduce production costs; decrease damaging peak runoff; improve the timing, quality, and quantity of water yield; stabilize streamflow; and decrease sediment production. The program would have varying effects on other land resources, uses, and values, such as recreation, fish and wildlife, and environmental quality.

Projections of the land requirements were based upon the capability of the land resources to satisfy future demands placed upon them. Proper land use, treatment, and management were basic considerations in the determination of land requirements. With the exception of those uses not dependent upon productive capacity, failure to provide and implement an adequate program would substantially increase the land requirements, increase production costs, and adversely affect environmental quality.

The projected outputs from the land for two alternatives of development are shown in Table 48. The "Going Program" is a continuation of the 1965 program level of funding. The "Suggested Program" merges protection and production measures to most nearly satisfy the projected multiple objectives. The suggested program might be an acceleration or deceleration of the going program for any specific phase. Figure 11 graphically illustrates output from these two alternatives plus a third alternative which is "no program." The no program alternative is an estimate of the probable effect on output from land if all programs were discontinued after 1965.

The suggested land treatment and management program for cropland is needed to meet the projected increase in demand for food and fiber production at a reasonable cost, while maintaining or improving the productive capability of the land resource base. The program would provide for reduced costs to the consumer by increasing the efficiency of use of factors of production. The water management measures would provide for control and more efficient use of irrigation water; the flood and erosion control measures will protect the cropland from damage from these sources; and the associated programs are necessary for the implementation of the total cropland program. The program would beneficially affect water quality by reducing sediment yield and by keeping farm chemicals out of the water courses and on the cropland where they are needed. Farming practices such as minimum tillage and crop residue use help control air pollution by reducing dust particles in the air.

1/ Based on Modified OBE-ERS. Chapter K gives a comparison between OBE-ERS and Modified OBE-ERS.

As indicated in the Irrigation and Drainage Appendix, the total diversion requirements for irrigation decreases from about 9.1 million acre-feet in 1965 to 8.4 million acre-feet in 2020. At the same time, the total irrigated area increases from about 1.3 million to 1.6 million acres. The diversion rate per acre would decrease from about 6.9 acre-feet to 5.2 acre-feet. This indicates a substantial increase in irrigation efficiency. The increased efficiency will result from installation of on-farm irrigation practices and measures through the suggested land treatment and management program and installation of improved distribution systems through the suggested irrigation program. As the diversion requirements are theoretical figures based on a full water supply and a portion of the present supply is an overdraft of the ground water, it should not be construed that the decrease in water requirements is a surplus or a water yield change. Therefore, no figures are included in Table 48 to show the increased efficiency resulting from the on-farm program.

With the going program, total value of crop production is expected to increase from about $339 million in 1965 to $899 million in 2020. The recommended program is an acceleration sufficient to meet the projected crop production requirement of approximately $932 million. With no program, crop production by 2020 would be far below the 1965 level.

There will be increased use of the grazing land for recreational and other purposes. This intensified use will create protection and management needs that presently do not exist. At the same time there will be a need for increased forage production from the grazing lands because of the significantly increased livestock production projected for the Region. The suggested program for grazing land is designed to protect the land base while satisfying as much of these demands as possible. It is estimated that, under the going program, total animal unit months of grazing will increase from about 8.5 million to 1965 to 9.5 million in 2020. There will be a further increase to about 10.4 million with the accelerated suggested program by 2020. With no program the total aum's would decrease to less than half the 1965 level by 2020.

The improved and more intensive use and management of forests have the effect of reducing the cost of producing forest resources and will result in more effective multiple use of forest lands. The going and suggested programs provide for effective timber management within the rotation period, including provision for wildlife, recreation, and water production, but such a program will not be completed within the projection period. The projected program will increase timber harvest from about 87 million cubic feet to 140 million cubic feet during the projection period, and will increase the rate of wood production (growth) from 100 million cubic feet to 170 million cubic feet. The suggested program for timber production under the OBE-ERS is approximately the same as under the Modified OBE-ERS for the projection period.

Table 48
Lower Colorado Region
Lower Main Stem Subregion
Projected Output From Land Under Alternative Program Levels

Time Frame PROGRAM LEVEL Land Resource Group	Acres (1000)	Production in Last Year of Time Frame: Crop Production (Million $)	Grazing (1000 AUM)	Timber Harvest (Million CF)	Water Yield Change (AF/yr.) (1000)	Sediment Yield Change (AF/yr.)
1966 to 1980						
GOING PROGRAM						
Cropland	386	133.9	115	-	-	- 1
Rangeland	26,240	-	1,271	-	-	- 300
Forest Land	8,888	-	495	15	+129	- 333
Other Land	681	-	-	-	-	- 15
TOTAL	36,195	133.9	1,881	15	+129	- 649
SUGGESTED PROGRAM						
Cropland	386	140.4 1/	124	-	-	- 2
Rangeland	26,240	-	1,290	-	-	- 364
Forest Land	8,888	-	476	15	+100	- 431
Other Land	681	-	-	-	-	- 27
TOTAL	36,195	140.4	1,890	15	+100	- 824
1981 to 2000						
GOING PROGRAM						
Cropland	390	184.3	135	-	-	- 1
Rangeland	26,004	-	1,280	-	-	- 740
Forest Land	8,804	-	498	17	+ 46	- 566
Other Land	997	-	-	-	-	- 24
TOTAL	36,195	184.3	1,913	17	+ 46	-1,331
SUGGESTED PROGRAM						
Cropland	390	195.1 1/	143	-	-	- 2
Rangeland	26,004	-	1,332	-	-	- 866
Forest Land	8,804	-	521	17	+120	- 856
Other Land	997	-	-	-	-	- 45
TOTAL	36,195	195.1	1,996	17	+120	-1,769
2001 to 2020						
GOING PROGRAM						
Cropland	409	259.6	149	-	-	- 1
Rangeland	25,830	-	1,312	-	-	-1,266
Forest Land	8,761	-	510	20	+ 26	-1,168
Other Land	1,195	-	-	-	-	- 29
TOTAL	36,195	259.6	1,971	20	+ 26	-2,464
SUGGESTED PROGRAM						
Cropland	409	269.1 1/	154	-	-	- 2
Rangeland	25,830	-	1,399	-	-	-1,510
Forest Land	8,761	-	540	20	+ 61	-1,419
Other Land	1,195	-	-	-	-	- 56
TOTAL	36,195	269.1	2,093	20	+ 61	-2,987

1/ Also reduces production costs and increases efficiency of irrigation water use.

Table 48
Lower Colorado Region
Little Colorado Subregion
Projected Output From Land Under Alternative Program Levels

Time Frame PROGRAM LEVEL Land Resource Group	Acres (1000)	Production in Last Year of Time Frame Crop Production (Million $)	Grazing (1000 AUM)	Timber Harvest (Million CF)	Water Yield Change (AF/yr.) (1000)	Sediment Yield Change (AF/yr.)
1966 to 1980						
GOING PROGRAM						
Cropland	65	2.8	38	-	-	- 0
Rangeland	9,765	-	1,242	-	-	- 313
Forest Land	7,267	-	730	40	+ 4	- 211
Other Land	168	-	-	-	-	- 5
TOTAL	17,265	2.8	2,010	40	+ 4	- 529
SUGGESTED PROGRAM						
Cropland	65	2.9 1/	40	-	-	0
Rangeland	9,765	-	1,274	-	-	- 441
Forest Land	7,267	-	738	40	+ 5	- 296
Other Land	168	-	-	-	-	- 14
TOTAL	17,265	2.9	2,052	40	+ 5	- 751
1981 to 2000						
GOING PROGRAM						
Cropland	61	4.1	43	-	-	0
Rangeland	9,715	-	1,262	-	-	- 937
Forest Land	7,240	-	773	63	+ 7	- 535
Other Land	249	-	-	-	-	- 7
TOTAL	17,265	4.1	2,078	63	+ 7	-1,479
SUGGESTED PROGRAM						
Cropland	61	4.3 1/	46	-	-	0
Rangeland	9,715	-	1,338	-	-	-1,452
Forest Land	7,240	-	841	63	+12	- 746
Other Land	249	-	-	-	-	- 22
TOTAL	17,265	4.3	2,225	63	+12	-2,220
2001 to 2020						
GOING PROGRAM						
Cropland	56	5.9	48	-	-	- 1
Rangeland	9,646	-	1,279	-	-	-1,562
Forest Land	7,204	-	818	70	+13	-1,056
Other Land	359	-	-	-	-	- 12
TOTAL	17,265	5.9	2,145	70	+13	-2,631
SUGGESTED PROGRAM						
Cropland	56	6.1 1/	50	-	-	- 2
Rangeland	9,646	-	1,393	-	-	-2,206
Forest Land	7,204	-	887	70	+20	-1,268
Other Land	359	-	-	-	-	- 35
TOTAL	17,265	6.1	2,330	70	+20	-3,511

1/ Also reduces production costs and increases efficiency of irrigation water use.

Table 48
Lower Colorado Region
Gila Subregion
Projected Output From Land Under Alternative Program Levels

Time Frame PROGRAM LEVEL Land Resource Group	Acres (1000)	Production in Last Year of Time Frame Crop Production (Million $)	Grazing (1000 AUM)	Timber Harvest (Million CF)	Water Yield Change (AF/yr.) (1000)	Sediment Yield Change (AF/yr.)
1966 to 1980						
GOING PROGRAM						
Cropland	1,440	340.2	501	-	-	- 4
Rangeland	20,857	-	2,669	-	-	- 342
Forest Land	13,682	-	1,568	55	+139	- 315
Other Land	889	-	-	-	-	- 23
TOTAL	36,868	340.2	4,738	55	+139	- 684
SUGGESTED PROGRAM						
Cropland	1,440	356.6 1/	526	-	-	- 5
Rangeland	20,857	-	2,712	-	-	- 653
Forest Land	13,682	-	1,568	55	+ 85	- 441
Other Land	889	-	-	-	-	- 49
TOTAL	36,868	356.6	4,806	55	+ 85	-1,148
1981 to 2000						
GOING PROGRAM						
Cropland	1,456	476.4	593	-	-	- 8
Rangeland	20,513	-	2,730	-	-	-1,021
Forest Land	13,642	-	1,746	50	+174	- 944
Other Land	1,257	-	-	-	-	- 47
TOTAL	36,868	476.4	5,069	50	+174	-2,020
SUGGESTED PROGRAM						
Cropland	1,456	504.3 1/	627	-	-	- 13
Rangeland	20,513	-	2,904	-	-	-1,805
Forest Land	13,642	-	1,858	50	+120	-1,258
Other Land	1,257	-	-	-	-	- 100
TOTAL	36,868	504.3	5,389	50	+120	-3,176
2001 to 2020						
GOING PROGRAM						
Cropland	1,387	633.4	691	-	-	- 12
Rangeland	20,201	-	2,772	-	-	-1,709
Forest Land	13,589	-	1,926	50	+ 95	-1,573
Other Land	1,691	-	-	-	-	- 68
TOTAL	36,868	633.4	5,389	50	+ 95	-3,362
SUGGESTED PROGRAM						
Cropland	1,387	656.6 1/	716	-	-	- 21
Rangeland	20,201	-	3,065	-	-	-2,512
Forest Land	13,589	-	2,155	50	+ 80	-1,914
Other Land	1,691	-	-	-	-	- 148
TOTAL	36,868	656.6	5,936	50	+ 80	-4,595

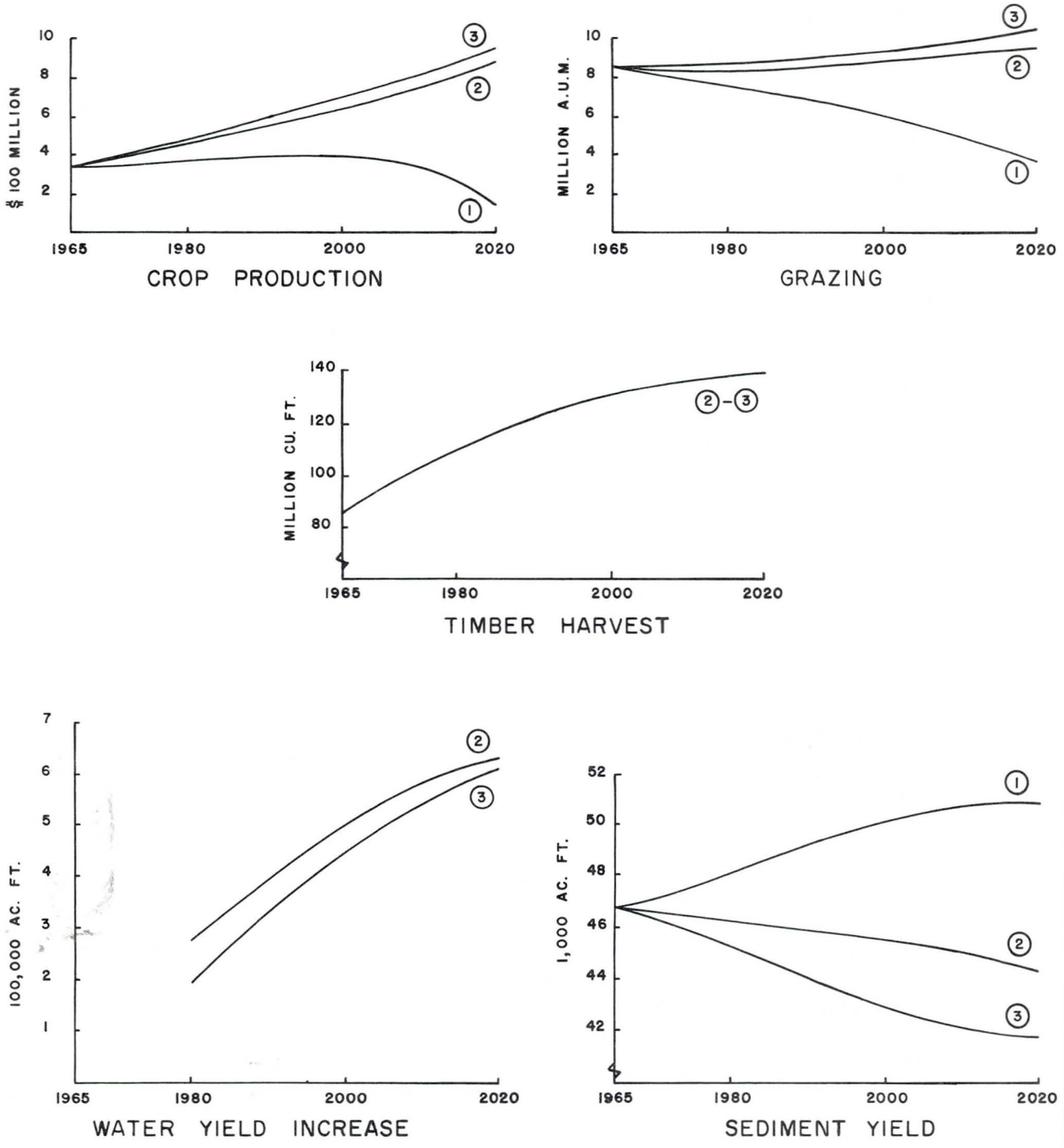
1/ Also reduces production costs and increases efficiency of irrigation water use.

Table 48
Lower Colorado Region
Regional Summary
Projected Output From Land Under Alternative Program Levels

Time Frame PROGRAM LEVEL Land Resource Group	Acres (1000)	Production in Last Year of Time Frame: Crop Production (Million $)	Grazing (1000 AUM)	Timber Harvest (Million CF)	Water Yield Change (AF/yr.) (1000)	Sediment Yield Change (AF/yr.)
1966 to 1980						
GOING PROGRAM						
Cropland	1,891	477	655	-	-	- 5
Rangeland	56,862	-	5,182	-	-	- 955
Forest Land	29,837	-	2,793	110	+272	- 859
Other Land	1,738	-	-	-	-	- 43
TOTAL	90,328	477	8,630	110	+272	- 1,862
SUGGESTED PROGRAM						
Cropland	1,891	500 1/	690	-	-	- 7
Rangeland	56,862	-	5,276	-	-	- 1,458
Forest Land	29,837	-	2,782	110	+190	- 1,168
Other Land	1,738	-	-	-	-	- 90
TOTAL	90,328	500	8,748	110	+190	- 2,723
1981 to 2000						
GOING PROGRAM						
Cropland	1,905	665	771	-	-	- 9
Rangeland	56,234	-	5,272	-	-	- 2,698
Forest Land	29,686	-	3,017	130	+227	- 2,045
Other Land	2,503	-	-	-	-	- 78
TOTAL	90,328	665	9,060	130	+227	- 4,830
SUGGESTED PROGRAM						
Cropland	1,905	704 1/	816	-	-	- 15
Rangeland	56,234	-	5,574	-	-	- 4,123
Forest Land	29,686	-	3,220	130	+252	- 2,860
Other Land	2,503	-	-	-	-	- 167
TOTAL	90,328	704	9,610	130	+252	- 7,165
2001 to 2020						
GOING PROGRAM						
Cropland	1,852	899	888	-	-	- 14
Rangeland	55,677	-	5,363	-	-	- 4,537
Forest Land	29,554	-	3,254	140	+134	- 3,797
Other Land	3,245	-	-	-	-	- 109
TOTAL	90,328	899	9,505	140	+134	- 8,457
SUGGESTED PROGRAM						
Cropland	1,852	932 1/	920	-	-	- 25
Rangeland	55,677	-	5,857	-	-	- 6,228
Forest Land	29,554	-	3,582	140	+161	- 4,601
Other Land	3,245	-	-	-	-	- 239
TOTAL	90,328	932	10,359	140	+161	-11,093

1/ Also reduces production costs and increases efficiency of irrigation water use.

FIGURE II
ALTERNATIVE PROGRAM OUTPUTS



LINE (1) = NO PROGRAM
LINE (2) = CONTINUATION OF "GOING PROGRAM"
LINE (3) = SUGGESTED PROGRAM

The suggested regional program for water yield increase involves only forest land and is a slight deceleration from the going program rate of accomplishment; although, this varies by subregion. The deceleration in the Lower Main Stem and Gila subregions during the projection periods reflect the decrease in rate of conversion of phreatophytes on the lower Colorado and Gila rivers during the 1960-1970 decade. The increased yield expected during an average year by 2020 with the suggested program is about 600,000 acre-feet. With the going program the yield would be about 633,000 acre-feet. The effects of the suggested vegetation management program for increased water yield is shown in more detail in Table 49.

Timber management plans for the mixed conifer types provide for a natural or artificial regeneration to be achieved through clear cutting in small blocks and strips. The Ponderosa pine type will be managed on a seed tree or shelter wood silvicultural system. Approximately 40 percent of the commercial timber producing lands in the Region under the proposed program will be under intensive management by 2020. Should improved timber management techniques become available through research and refined technology, they will be employed. The proposed treatment of the pinon-juniper, chaparral, and riparian types is a conversion to grass and forbs leaving a sufficient percentage of the area in permanent tree and brush cover to provide a favorable wildlife habitat. This treatment for increasing water yield will, if properly planned and carried out, maintain or enhance other resources and uses and give added protection to the soil thereby decreasing sediment production.

The average annual sediment yield for the Region, considering the projected yield with no program, would be reduced by about 8,500 acre-feet with the going program and by about 11,100 acre-feet with the suggested program in 2020 as shown in Table 48 and Figure 11.

The suggested program would significantly decrease downstream damages caused by sediment. These include deposition of sediment on agricultural lands, in reservoirs, and on streets and in buildings. The program would beneficially affect water quality by reducing sediment content, the major pollutant of surface water. This would enhance fish and wildlife habitat, increase recreation values, reduce costs of irrigation and municipal and industrial water treatment, and keep nutrients which are absorbed on soil particles in the fields and out of the water courses, lakes, and reservoirs.

The effects of the alternative program levels in reduction of average annual damages from erosion, floodwater and sediment, and wildfire are presented in Table 50 and Figure 12.

Table 49
Lower Colorado Region
Vegetation Management for Increased
Water Yield for Downstream Uses

Hydrologic Provinces	1966 - 1980		1981 - 2000		2001 - 2020		1966 - 2020	
	Area Treated (1,000 Ac.)	Increased Water Yield 3/ Ac. Ft.	Area Treated (1,000 Ac.)	Increased Water Yield 3/ Ac. Ft.	Area Treated (1,000 Ac.)	Increased Water Yield 3/ Ac. Ft.	Area Treated (1,000 Ac.)	Increased Water Yield Ac. Ft.
				Lower Main Stem				
Phreatophyte 1/	35	100,000	40	120,000	20	60,000	95	280,000
Other 2/	10	200	10	200	30	600	50	1,000
Total	45	100,000	50	120,000	50	61,000	145	281,000
				Little Colorado				
Phreatophyte 1/	-	-	5	5,000	10	10,000	15	15,000
Other 2/	65	4,500	125	7,500	170	10,500	360	22,500
Total	65	5,000	130	12,000	180	20,000	375	27,000
				Gila				
Phreatophyte 1/	30	60,000	20	40,000	20	40,000	70	140,000
Other 2/	110	25,000	400	80,000	200	40,000	710	145,000
Total	140	85,000	420	120,000	220	80,000	780	285,000
				Lower Colorado Region				
Phreatophyte 1/	65	160,000	65	165,000	50	110,000	180	435,000
Other 2/	185	30,000	535	87,000	400	51,000	1,120	168,000
Total	250	190,000	600	252,000	450	161,000	1,300	603,000

1/ Includes management of riparian (phreatophytes) vegetation on flood plains of main rivers and streams. Principal species cottonwood, salt cedar, mesquite and willow.
2/ Includes coniferous and woodland forests and chaparral and mountain brush.
3/ Average annual for the last year of the time frame.

With no additional program after 1965 the erosion damages are projected to increase from $6.7 million in 1965 to $24.1 million in 2020. With the going program the damages in 2020 are estimated to increase to only about $11.5 million. The suggested program will further reduce these damages to $6.3 million.

The program would be effective in reduction of land loss from gully and streambank erosion; give protection to a major portion of lands presently being damaged, through loss in productivity, by sheet scour and rilling; and provide protection to improvements, equipment, and public facilities. Eroded lands often mar the beauty of the landscape and degrade the quality of the environment. The program would substantially reduce this type of damage.

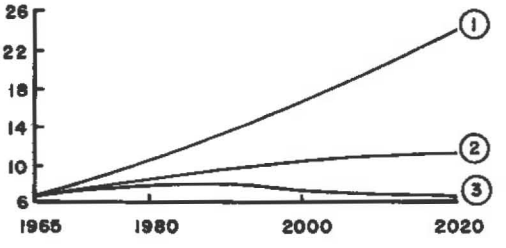
It was readily apparent that total reduction in erosion damages was not physically or economically feasible. The extent to which erosion control structures are considered is only for the most critical areas where either on-site or downstream damages are significant.

The average annual upstream floodwater and sediment damages are projected to increase from $28.9 million in 1965 to about $227.7 million in 2020 with no program. The going program rate of installation of upstream flood projects would reduce this damage to about $170.6 million in 2020. The accelerated suggested program would further reduce the total damage to about $55.2 million. Reductions, by subregion and time frame, are shown in Table 50 and Figure 12.

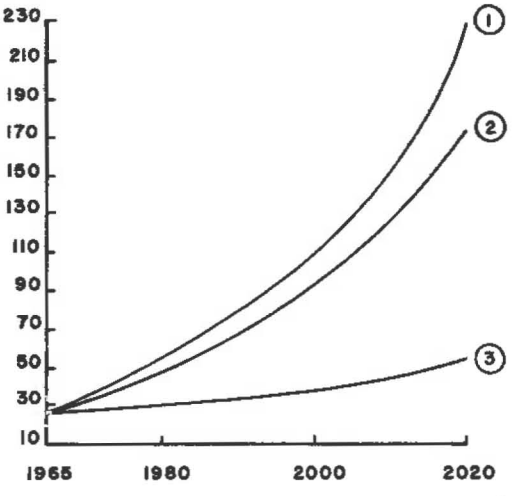
Table 50
Lower Colorado Region
Projected Damage Reduction Under Alternative Program Levels
(Ave. Ann. - $Million - 1965 Prices)

Type of Damage / Program Level	Lower Main Stem			Little Colorado			Gila			Total		
	1980	2000	2020	1980	2000	2020	1980	2000	2020	1980	2000	2020
Erosion												
No Program	2.9	4.9	7.0	1.5	2.1	2.8	6.2	9.6	14.3	10.6	16.6	24.1
Going Program	2.5	3.1	3.5	1.3	1.4	1.4	5.1	5.7	6.6	8.9	10.2	11.5
Suggested Program	2.3	2.2	2.1	1.2	1.0	0.9	4.7	3.8	3.3	8.2	7.0	6.3
Upstream Floodwater & Sediment												
No Program	12.0	26.4	48.7	4.1	7.7	15.6	36.7	76.2	163.4	52.8	110.3	227.7
Going Program	11.5	22.7	37.5	3.9	6.7	12.1	33.8	64.0	120.9	49.2	93.4	170.6
Suggested Program	9.2	10.9	15.4	2.9	3.3	5.1	18.5	22.4	34.6	30.6	36.5	55.2
Wildfire												
No Program	-	-	-	-	-	-	-	-	-	-	-	-
Going Program	1.6	2.2	2.7	0.8	1.1	1.4	6.0	9.6	15.9	8.5	12.9	20.0
Suggested Program	1.6	2.2	2.7	0.8	1.1	1.4	5.0	6.4	7.9	7.4	9.7	12.0

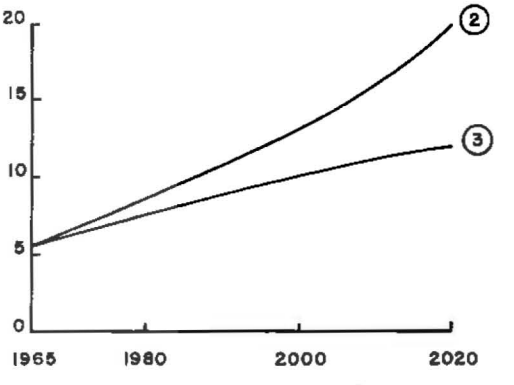
FIGURE - 12
ALTERNATIVE PROGRAM EFFECTS



EROSION DAMAGE ($ MILLION)



FLOODWATER & SEDIMENT DAMAGE ($ MILLION)
(UPSTREAM)



WILDFIRE DAMAGE ($ MILLION)

LINE ① = NO PROGRAM
LINE ② = CONTINUATION OF "GOING PROGRAM"
LINE ③ = SUGGESTED PROGRAM

Upstream flood plain given protection by the suggested program is presented in the following tabulation:

Upstream Flood Plain Receiving Protection (1,000 Acres)

Subregion	1980	2000	2020	Total
Lower Main Stem	60.7	142.5	17.4	220.6
Little Colorado	124.0	39.3	4.1	167.4
Gila	955.7	275.9	113.6	1,345.2
Total	1,140.4	457.7	135.1	1,733.2

The total area provided protection (1.7 million acres) by 2020 represents 30 percent of the total area subject to inundation (5.6 million acres). The 30 percent suggested for protection comprise those areas in high intensity use where damageable values are high (mostly urban and cropland). Most of these areas would be given some degree of flood protection with the suggested program by 2020.

The upstream structural measures would be designed to provide damage reduction benefits primarily in the upstream areas but they would also afford some reductions in damage on the main stems of the larger streams. The sediment storage provided would reduce sedimentation damages, below structures, in the upstream watersheds and also in the downstream reaches by extending the life of downstream reservoirs; decreasing dredging costs; reducing municipal and industrial water treatment costs; decreasing costs of irrigation; and enhancing water quality, recreation values, fish and wildlife habitat and overall environmental quality.

There will be opportunities for multiple use of the structural sites. In instances, where physically and economically feasible, and where prior water rights are not jeopardized or infringed upon permanent storage could be added which would be of benefit to fish and wildlife, recreation, irrigation, municipal and industrial water, and/or other beneficial uses. Storage could afford a valuable increase in low-flow control providing enhanced water quality, recreation values, and fish and wildlife habitat.

In rural areas the program would provide increased income to farmers and ranchers, raise their standard of living; thereby contributing to rural development. The increased production from the agricultural land would foster an increase in business activities associated with transporting, processing, and marketing the additional farm products. This would result in an overall increase in the economic level of the Region.

In urban areas where human life is threatened by floodwater, the suggested program would alleviate a large part of this danger. Also, most of the human suffering associated with evacuation and re-establishment of homes in flooded areas would be prevented.

Wildfire damages are projected to increase from $5.7 million in 1965 to about $20.0 million in 2020 with only the going program. The accelerated suggested program would reduce these damages to about $12.0 million.

Within the suggested program is provision to give protection to the expanding development of small communities, industrial, public use, and other developments scattered throughout the forest and rangelands of the Region. The program includes provisions to provide protection to the various resources, timber, livestock forage, wildlife and fish habitat, recreation, and esthetics. The program would have beneficial effects in reduction of damaging runoff and sediment yield. The average burned area, with the going program, would be about 45,000 acres. The recommended program would reduce this to about 30,000 acres by 2020.

The overall consequence of these effects is to make the countryside more desirable and productive thus providing more opportunities for people in rural areas. This might tend to decrease, at the same time, the pressures and resulting social problems in the cities.

OPPORTUNITIES AVAILABLE FOR IMPLEMENTING THE SUGGESTED PROGRAM

CHAPTER I - OPPORTUNITIES AVAILABLE FOR IMPLEMENTING THE SUGGESTED PROGRAM

Existing programs have been changing to meet the demands as new pressures and research have indicated. These same activities, if expanded and accelerated and new activities added, are essential to implement the suggested program.

A discussion of authorities and programs under which the agencies operate are discussed in the Legal and Institutional Appendix.

PRIVATE AND CORPORATE EFFORTS

Private landowners, including Indians, using their own initiative and resources, will continue to apply land treatment and management to lands they own and operate. They will become even more effective in getting these practices and measures on the land as their technical and financial abilities continue to improve. Projects benefiting more than one owner or operator usually require group action, and assistance from public agencies and organizations.

The Farmers Home Administration provides soil and water conservation loans to rural landowners. These loans are authorized to make available adequate financing for soil conservation; water development; water conservation and use; watershed protection; forestation; drainage; establishing and improving permanent pasture; development of public recreation; fishing and wildlife areas; and other related purposes.

Research in soil, plant and water technology is conducted by the Agricultural Research Service and state experiment stations, either individually or through cooperative arrangements. Educational work of soil and water conservation is carried on through the Extension Service.

The Soil Conservation Service performs a broad technical and financial program to assist in the use and protection of soil and water resources. Upon request, the Service assists other agencies and organizations as well as private landowners with the conservation of soil and water.

Among the major Soil Conservation Service activities are the development of overall conservation plans and direct assistance to land owners and operators in the application of conservation practices on the land. The federal portion of the National Cooperative Soil Survey and the Cooperative Snow Survey and Water Supply Forecasting are

direct responsibilities. The Service administers the Watershed Protection and Flood Prevention Program under Public Law 566, has USDA leadership in the National Inventory of Soil and Water Conservation Needs, is designated by USDA as the administrator of Resource Conservation and Development Projects, acts as liaison with agricultural research programs and cooperates with programs such as the Federal National Flood Insurance, loan programs of the Farmers Home Administration, regional planning activities and other related programs.

Private landowners may receive financial assistance from the Agricultural Stabilization and Conservation Service for installation of land treatment and structural measures. Technical assistance to private landowners is provided by the Soil Conservation Service through this program. This assistance includes determination of need and feasibility, design and layout, supervision of installation, and field checking prior to certification of compliance with technical standards of land treatment measures. The Soil Conservation Service under Public Law 46, provides this service through locally organized soil conservation districts. The affairs of these districts are directed by unsalaried local boards elected by the people within the district boundaries. These districts are legal subdivisions of, and their activities are coordinated by, state governments.

Water users' organizations through cooperation with Forest Service, Bureau of Indian Affairs, and private landowners, carry on watershed management research and develop watershed management programs and projects for improving the quantity and quality of water for downstream use. Livestock associations and organizations through cooperation with the public land managing agencies, universities, and private landowners, carry on research and develop programs and projects for increasing livestock forage and the productive capacity of range livestock. Private forest industries through the universities, Forest Service, Forest and Range Experiment Stations, and private and public forest land managers, cooperate in research for timber growth and harvesting and marketing of various timber products.

State forestry agencies provide fire protection for much of the private forest and range lands. This may be accomplished through direct protection by the States or in some cases they work with local groups in organization, training and by providing fire fighting equipment. State forestry departments also provide technical assistance in forest management on private lands.

PROGRAMS OF LAND-ADMINISTERING AGENCIES

The Bureau of Land Management Watershed Conservation and Development Program provides for the protection, enhancement, and maintenance of environmental quality through conservation and development of the soil and water resource base. The program employs general principles which serve to conserve the land resource base for present and future uses, protect public values, help stabilize dependent uses and industries, assist in meeting regional and national needs for land resource products and services, and contribute to the beneficial growth and stability of communities.

The major functions of the program are to apply land treatment and watershed management practices (including related emergency activities such as Fire Rehabilitation) that will:

Control or prevent soil erosion to the extent practicable, through stabilization of depleted lands; control of runoff, etc.

Restore soil productivity to enhance on-site resource use values, including fish and wildlife development, livestock forage, timber production, outdoor recreation, industrial development, mineral production, and esthetic values.

Enhance off-site values, including improvements of water quality, improved timing and yield of streamflow, renewal of ground-water supplies, control of flood and sedimentation, protection of public health, and stabilization of local economies.

This program is accomplished under the following activities:

Soil and Water Conservation

The Soil and Watershed Conservation Activity is the primary activity with the responsibility of protection, enhancement, and maintenance of environmental quality. This activity is directed toward the protection, use, improvement, development, and maintenance of the soil and water resources and associated ecological systems within the jurisdiction of Bureau of Land Management.

Functions include resource inventories and interpretations; research and studies; analysis and plans; purchase of easements and water rights; water management and development; land treatment practices; resource use and protection facilities; weed control and pest control.

Range Improvement

The range improvement program is that portion of the broad program authorized by the Taylor Grazing Act which contributes toward effective and efficient grazing administration through the establishment and maintenance of facilities for promoting orderly grazing use and the improvement of forage and water resources on the public lands and Farm Tenant Act lands. Range improvement funds are limited each fiscal year to the total receipts collected the previous fiscal year as range improvement fees. Detailed watershed project plans prepared under the Watershed Conservation and Development Program include project practices financed under this program to assure coordination. All types of practices designed to contribute toward better management, rehabilitation and perpetuation of the public land and its resource may be conducted under this program.

Fire Rehabilitation

The basic objective of the Fire Rehabilitation Program is the timely mitigation, in the most economic and expeditious manner possible, of the adverse effects of fire on the vegetation-soil complex, inherent renewable resources of the watershed, and other damages.

Means for restoration of the damaged area includes one or any combination of the following: Management (all types--livestock, people, wildlife, etc.), Vegetation Establishment (seeding, planting), Watershed Tillage (furrowing and trenching, ripping, etc.), Water Control (detention dams, dikes, diversions, etc.), or Restricted Use (curtailment or elimination of all uses).

Special Projects

Special projects generally consist of identified areas scheduled to receive particular emphasis in management, development, protection and use.

Cooperative

These activities are conducted jointly with other federal agencies, soil conservation districts, state agencies, and private parties.

Public Law 566 authorizes the Secretary of Agriculture to cooperate with the Department of Interior as well as local organizations in planning and carrying out works of improvement for flood prevention or for the conservation, development, use and disposal of water in watersheds. Provision is made for close cooperation between the Bureau of Land Management and Soil Conservation Service. The program provides for federal technical and financial assistance to local organizations for solving or alleviating existing watershed problems which cannot be solved adequately or timely by other means.

The Agricultural Conservation Program under Public Law 264 provides for those conservation practices carried out on federally-owned noncroplands which directly conserve or benefit nearby or contiguous nonfederally-owned lands. The Bureau of Land Management provides limited technical assistance and cooperates with the program.

Under the Private Range Improvement Program range user privately-owned improvements on public domain lands may be covered by permit (not classified as trespass) if such improvements comply with the program requirements. The entire cost of constructing projects under this program must be financed by the applicant; however, Bureau of Land Management may furnish technical assistance in the development of projects.

Watershed treatment involves management practices along with a treatment program and/or installation of structures. In some cases, sound management alone will suffice, i.e. changes in season-of-use of livestock, adjusting other uses of the land, etc. How the land is being used and the extent of deterioration of the resource are the criteria that determine the degree and intensity of watershed treatment.

Forest Service management of lands, historically based on a conservation ethic, has recognized the dual responsibility of providing for both protection and the wise use of natural resources. Guided by this ethic, principles of sustained yield and multiple use have become the hallmarks of good forest and range land management.

On the face of growing demands the husbandry of land under the multiple-use, sustained-yield concept has maintained resources in an ecologically healthy state while providing forest and forage land uses to satisfy the social, environmental, and material needs of the people. Forest Service activities include concern for the less tangible values such as scenery, pure air, quality water, recreation, open space, environmental quality, economic strength and social well-being. The ability of forest and related lands to provide enough products and services to meet the needs of the people of the Lower Colorado Region depends upon applying the right input combinations of capital, manpower, and resources.

Recreation programs provide for development of intensively used areas (such as picnicking, camping, and winter sports); management of unique natural values, wilderness and primitive experiences; and management (access, protection of esthetics, etc.) on lands providing recreation experiences in a natural environment in conjunction with other resource uses.

Wildlife management programs protect and enhance all forms of wildlife, game species and nongame species. The latter, nongame species, and their habitat are becoming more important for public study and recreation and may exceed game species in importance in the future. Programs to provide habitat inventory and management for the restoration of rare and endangered species are provided.

Based on hydrologic knowledge and surveys, watershed management is programmed to increase water yield, maintain or improve water quality, reduce water pollution, control soil erosion and sedimentation, control runoff and downstream flooding, and provide for downstream municipal water supply.

Timber management programs provide a continuous supply of forest products through improved silvicultural systems of harvesting, more efficient utilization, timber stand improvement, and reforestation. To maintain forests, programs for insect and disease control by use of chemicals and biological agents, sanitation logging, and disposing of forest debris are included.

Livestock forage production programs on forest and related lands include surveys, improved livestock management systems, water developments, management of vegetation for increased forage production and other grazing land improvements.

The fire control program provides for intensive prevention and presuppression plans, prescribed burning for improved forest management, improved wildfire suppression, training techniques, and rehabilitation of burned areas.

Mineral developments are planned to minimize adverse effects on other resources through cooperation of federal, state, and private organizations in leasing, exploring, and extracting operations.

Through land exchange and acquisition programs, national forest lands are consolidated for more efficient administration and resource management, provide for transferring national forest lands to private ownership where needed for expansion of urban areas, and acquiring private lands having outstanding values for environmental enhancement, outdoor recreation, and wilderness enjoyment.

Engineering programs provide for expanding and improving the forest road and trail systems, transmission facilities, buildings, and other structures to protect and enhance forest and related land values. Programs provide for updating forest maps, aerial photography and for developing systems of obtaining forest information from data banks, using information provided by aerial photography, remote sensing and other sources.

The information and education program provides for keeping the public informed about Forest Service activities and plans, assisting in conservation education through various educational institutions, youth conservation programs, and numerous in-service training activities.

The National Park Service, the Bureau of Sport Fisheries and Wildlife and other agencies who administer land carry out their specific land management and treatment programs for their particular objectives. These activities also assist in controlling erosion, sediment yield, and generally protect and encourage growth of vegetation.

Agencies of the states have responsibilities and some programs to carry out soil conservation and watershed treatment on state-owned land. On these lands, where appropriate, they develop and apply land treatment and management programs, such as multiple-use plans on forest land. Their activities would assist in implementing the suggested program in this appendix.

FEDERAL AND NONFEDERAL ASSISTANCE PROGRAMS

Programs covering large areas, serving many people, and dealing with mutual problems are most effective when coordination of program objectives and functions are accomplished through cooperation between agencies, organizations, and the public. These programs that include all aspects of environmental problems are necessary to implement the suggested program in this appendix.

A Resource Conservation and Development project is a locally initiated and sponsored activity to expand the economic opportunities for the people of an area by developing and carrying out a plan of action for the orderly conservation, improvement, development and wise use of their natural resources.

Public Law 87-703 authorizes the Secretary of Agriculture "to cooperate with federal, state, territorial, and other public agencies in developing and assist in carrying out these plans."

Project measures proposed by local interest groups or individuals include structural measures, land treatment, associated measures, and supporting measures. Funds are made available from Resource Conservation and Development appropriations to defray that portion (cost-share) of total costs for authorized purposes with group or community benefits.

The Watershed Protection and Flood Prevention Act, (Public Law 566) as amended authorizes the Secretary of Agriculture to cooperate with states and local agencies in the planning and carrying out of works of improvement for soil conservation, and for other purposes. Works of improvement are undertakings for flood prevention (including structural and land treatment measures) and the conservation, development, utilization, and disposal of water in watershed areas with drainage areas of less than 250,000 acres.

All resource planning by the Bureau of Indian Affairs is developed in conjunction with the Indian tribe concerned and individual Indian owner where allotted lands are involved. Such plans are developed progressively, coordinated with the river basin activities, but go only as far as Indians are willing to make the necessary divisions. The plan encompasses a study of social, economic and natural physical resources; an exploratory investigation of the ways and means of obtaining desired goals and objectives; and a specific statement of programs to accomplish them. Tribal governing organizations generally participate financially in conservation programs to the extent that circumstances permit. This may be accomplished by providing cost-sharing funds required for their participation in federal programs, implementing tribal public work projects, conducting tribally-financed resource programs, and funding a limited number of positions in on-going government programs.

The Bureau of Indian Affairs cooperates fully with soil conservation districts and recommends the inclusion of Indian lands in the formation of new districts, and encourages the enlargement of established districts to include Indian lands.

Indian soil and moisture conservation associations may be formed on reservations to assist the Indian people to participate in natural resource conservation programs. Equipment procured with Bureau of Indian Affairs funds may be granted or loaned to such organizations who in turn can utilize it in the application of conservation practices to the land.

The main function of the Bureau of Indian Affairs with respect to watershed management programs is to act as trustees for land held in trust by the United States Government and to assist the owners in making the most effective use of these lands and associated resources. This entails the primary duty of providing technical services in matters of resource management.

These services include programs for protection of the land against erosion and soil deterioration, the restoration of eroded and depleted areas, the improvement of production with respect to cropland, forest, pasture, and range, and the retention of water for farm, ranch, and recreational purposes. A multi-purpose land management use of resources is encouraged to provide for maximum beneficial return from the land.

In addition to technical services, funds are sometimes provided on a limited basis for the installation of physical structures. Funds for special projects such as construction of water delivery and power distribution systems on the San Carlos Irrigation Project are acquired from Congress and administered by the Bureau of Indian Affairs. These funds are reimbursable and must be repaid.

The Bureau of Sport Fisheries and Wildlife and the National Park Service provide technical services under memorandums of understanding with the Bureau of Indian Affairs for individual tribal governing organizations. The Soil Conservation Service provides assistance in determining compliance with the Agricultural Conservation Program on Indian lands and renders specialized technical assistance upon request. The Bureau of Reclamation also undertakes studies and supervises the construction of projects within Indian reservations on a specific request basis. The coordination of their project planning with that of the Bureau of Indian Affairs is vital to the development of Indian lands.

The United States Geological Survey maintains stream gaging stations which provide runoff and silt-load data essential to Bureau of Indian Affairs planning. Information supplied on water yields and water-bearing strata is essential in locating wells and earthen tanks.

ADDITIONAL STUDIES REQUIRED

CHAPTER J - ADDITIONAL STUDIES REQUIRED

MORE DETAILED RIVER BASIN STUDIES

Data relating to water and related land management in the Lower Colorado Region are, in many areas, on a reconnaissance level and will need to be in more detail to permit effective planning. Studies to refine the information on the current watershed conditions, soil types, erosion susceptibility, sediment yield rates, and contribution to salinity in streams are essential to effective planning and management.

There appear to be many opportunities for upstream watershed development for purposes of watershed protection and flood prevention, water yield improvement, increased range forage and timber production, fire protection, wildlife habitat improvement, and recreation development. However, more detailed river basin studies of Type 2, 3, and 4 intensities would be needed to identify and evaluate individual projects. Studies are needed in areas such as the Santa Cruz-San Pedro river basins, Whitewater Draw, and Willcox Playa in order to determine priorities for upstream flood prevention projects and other water and related land resource developments. Studies are also needed in the Salt-Verde, Gila, and Agua Fria drainage areas and along those major river flood plains with riparian vegetation to determine impact of and potential for a vegetative management program for increased water yield.

RESEARCH

Research is essential to provide direction for installation of a complete watershed and land resource management program which will assure maximized benefits to individuals, the communities, the Region, and the Nation. Development of new or improved techology and increased application of the present technology are important opportunities. Problems on natural resource management and enhancement of the environmental quality are complex. In the future much of the research will need to be multifunctional, that is, concerned with two or more land use commodities which must work together closely in order to provide the information needed for the management of forest land, rangelands, croplands, and urban areas of the Southwest.

Examples of research needs are:

(1) Determine the amounts of water yield increases which can be expected from specific patterns and intensities of vegetative management within specific vegetative types. Evaluate the

effects of these treatments on soil stability, water quality, esthetics, archeaological sites, and public opinion. Also determine the effects of these water yield treatments on other multiple-use values, i.e., timber, forage, wildlife, recreation, and esthetics.

(2) Determine the effects on surface supply and ground-water recharge of runoff control and floodwater retarding measures.

(3) Develop snow management guidelines by better defining the parameters and the interrelationships which affect snowmelt and runoff, and improving snow data collection techniques and runoff prediction formulas.

(4) Determine the effect of amount and type of precipitation on runoff from watersheds characterized by the various vegetative and soil types.

(5) Develop economical water harvesting techniques.

(6) Accelerate research to develop more effective pesticides and herbicides and further define the use limitations of presently used chemicals. Alternate management tools (such as mechanical, biological, and fire) need additional investigation.

(7) Determine how man's activities and land management affect the habitat requirements of the associated game and nongame species of fish and wildlife, including rare and endangered species.

(8) Develop census techniques and determine opportunities for habitat management to obtain optimum populations for game and nongame species of fish and wildlife.

(9) Develop improved timber management systems and superior genetic strains of timber species to increase timber yields and reduce insect and disease damage.

(10) Develop new methods and more efficient methods of utilizing forest products.

(11) Perfect methods to reduce erosion and sediment yields, improve infiltration, and establish protective vegetative cover which is suitable for domestic livestock and wildlife use on disturbed areas.

(12) Continue development of improved strains of vegetation for food, feed, oil, and fiber.

(13) Investigate effects of meteorological conditions on wildfires, control burning, and opportunities for precipitation inducement.

(14) Improve techniques for inventorying resources, measuring resource conditions, and organizing resource data for more meaningful interpretation and utilization in management decisions. An example is remote sensing from aircraft and satellites.

Research is needed not only for investigations into the specific factors affecting management of each individual resource, but also needs to be aimed at the various combinations of products and values to determine their interactions before and after management treatments. Because optimum use of a resource may conflict with the optimum use of other resources, a systems analysis approach is needed to determine the trade-off values among resources such as wood, water, wildlife, and forage products in relationship to each other and to other values such as recreation, esthetics and environmental quality. Knowledge of these resource interrelationships and trade offs will present the resource manager with the tool for improved management judgments.

NEW PROGRAMS

Although existing programs are designed to handle many of the situations or problems there are areas where new programs may be required.

Broadening the scope by amendments to present laws may fulfill the need in some cases.

Areas of need include the following:

1. Additional federal and state financing and assistance for installation of land treatment measures.

2. Additional federal and state financing for all watershed management practices to meet the objectives for improvement of the quantity, quality, and timing of water yields.

3. Authority for local sponsoring organizations to use funds under federal programs, where appropriate, for acquiring land, easements, and rights-of-way for small watershed program purposes.

4. Increased state participation in the management of watershed areas where state ownership is intermixed with other public and private lands.

5. Federal cost-sharing for additional water storage in flood-water retarding structures to provide low-flow augmentation to reduce water pollution.

6. Additional federal and state financing for the investigation and salvage of archaeological resources that are endangered by program activities.

COMPARISON OF ALTERNATE PROJECTIONS

CHAPTER K - COMPARISON OF ALTERNATE PROJECTIONS

Two sets of projections were developed in some detail in the Type I study. One set is referred to as the OBE-ERS projections since they were made by the Office of Business Economics, U. S. Department of Commerce, and the Economic Research Service, U. S. Department of Agriculture. They comprise a part of a coordinated set of national and regional projections made at the national level for the Water Resources Council and are considered the baseline projections to which other projections are related.

The second set of projections is referred to as the modified OBE-ERS projections. The modified OBE-ERS projections are modifications of the OBE-ERS projections of population and irrigated land made by the States of Arizona, Nevada, New Mexico, and Utah, together with modifications of the economy emanating from these revisions. A few additional modifications were made by the Economics Work Group with a view to making the OBE-ERS projections more consistent with historical trends.

The following tabulation reflects the difference by subregion and state between the OBE-ERS and modified OBE-ERS population projections.

Population Projections
Modified OBE-ERS Compared to OBE-ERS

Subregion State	1980	2000	2020
	-------	Percent	-------
Lower Main Stem			
Arizona	100	100	100
Nevada	164	161	118
Utah	111	113	133
Subregion	151	153	116
Little Colorado			
Arizona	100	100	100
New Mexico	113	148	207
Subregion	103	110	122
Gila			
Arizona	100	100	100
New Mexico	113	141	150
Subregion	100	100	100
Total Region	110	113	105

For the State of Arizona the population projections are the same. The modified OBE-ERS projections for the other three states are higher. The greatest increase was in Nevada; the increases in New Mexico and Utah were smaller and more gradual through the projection period.

Most of the demands for related land resource uses are based on a translation of the population projections. One exception is irrigated cropland. The projected increase in irrigated crop production was adjusted to more nearly reflect local historical and anticipated trends. The total acreage of irrigated cropland in 2020 for the Region is about seven percent higher for modified OBE-ERS. There were significant differences in the acreages of crops produced. For modified OBE-ERS the acreage of vegetables and citrus was increased substantially; the Region is especially well-suited to production of these crops.

The land requirements by specific use are given in the following tabulation for OBE-ERS projections:

Land Requirements for OBE-ERS Level of Projection

Land Use / Year	Lower Main Stem		Little Colorado		Gila		Total	
	Acres	Percent 1/	Acres	Percent 1/	Acres	Percent 1/	Acres	Percent 1/
Cultivation-Irrigated								
1980	323	117	40	110	1,417	102	1,780	105
2000	317	121	39	113	1,390	105	1,746	108
2020	310	130	38	113	1,358	102	1,707	110
Cultivation-Nonirrigated	(Same as Modified OBE-ERS)							
Livestock Grazing								
1980	26,929	99	16,450	100	30,565	100	73,944	100
2000	24,253	99	16,304	100	29,699	100	70,256	99
2020	20,782	99	16,162	99	29,194	100	66,138	99
Timber Production	(Same as Modified OBE-ERS)							

(continued)

Land Requirements for OBE-ERS Level
of Projection (continued)

Land Use / Year	Lower Main Stem		Little Colorado		Gila		Total	
	Acres	1/ Percent	Acres	1/ Percent	Acres	1/ Percent	Acres	1/ Percent
Urban & Industrial								
1980	189	151	76	103	498	100	763	113
2000	299	154	89	110	671	100	1,059	116
2020	456	116	111	122	897	100	1,464	107
Outdoor Recreation								
1980	4,566	100	206	100	1,112	100	5,884	100
2000	4,601	100	245	100	1,156	100	6,002	100
2020	4,655	100	260	101	1,224	100	6,139	100
Wilderness	(Same as Modified OBE-ERS)							
Military & Related	(Same as Modified OBE-ERS)							
Mineral Production								
1980	6	150	13	215	78	100	97	119
2000	8	125	15	273	96	109	119	131
2020	9	122	10	840	107	120	126	177
Fish & Wildlife	(Same as Modified OBE-ERS)							
Transportation & Utilities	(Same as Modified OBE-ERS)							
Flood Control	(Same as Modified OBE-ERS)							

1/ Modified OBE-ERS land requirements (as shown in Table 38) compared to land required for OBE-ERS.

The different pattern of land use projected for OBE-ERS, compared to modified OBE-ERS, would affect to some extent the related land resource problems and could affect the general approaches that appear appropriate for their solution. The magnitude and nature of projected problems and needs related to land resource development and use would be significantly different only for the irrigated cropland and urban areas.

The major difference in the suggested program for irrigated cropland would be in the Lower Main Stem Subregion. For this subregion OBE-ERS irrigated acreage is 15 percent less than modified OBE-ERS in 1980, 17 percent less in 2000, and 23 percent less in 2020. The Lower Main Stem Subregion also has the major difference in urban land requirements. In 1980 urban land requirements for this subregion were projected to be 34 percent less for OBE-ERS, in 2000 about 35 percent less, and in 2020 only 14 percent less. The acreage projected for livestock grazing is the only use which increases using the OBE-ERS projections, and this increase is very insignificant. The remainder of the uses either remain the same or increase slightly with modified OBE-ERS. The change in the suggested program because of these differences would be insignificant.

In all cases the suggested program outlined in Chapter G would be adequate to meet OBE-ERS projection requirements.

Using acreage as a basis of estimation, there would be very little difference in cost of the suggested program as outlined in Chapter G for forest land and rangeland. For the Region the total cost of the program for cropland would be about four percent less in the 1965-1980 time frame under the OBE-ERS level of development, and about seven percent less in the last two time frames. The program cost for urban land would be about 12 percent less in the 1965-1980 time frame, 14 percent less in the 1981-2000 time frame, and only about 6 percent less during the last time frame.