WATER and RELATED LAND RESOURCES
ESTANCIA SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

Typical Landscape, Estancia Valley, New Mexico. RIVER BASIN FIELD PARTY PHOTO

PRELIMINARY
EARLY ACTION OPPORTUNITIES

A Report Based on a Cooperative Study by
THE UNITED STATES DEPARTMENT OF AGRICULTURE
and the
NEW MEXICO STATE ENGINEER

PREPARED BY
SOIL CONSERVATION SERVICE - ECONOMIC RESEARCH SERVICE - FOREST SERVICE
ALBUQUERQUE, NEW MEXICO 1971

USDA-SCS-PORTLAND, OREG. 1971

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Agriculture

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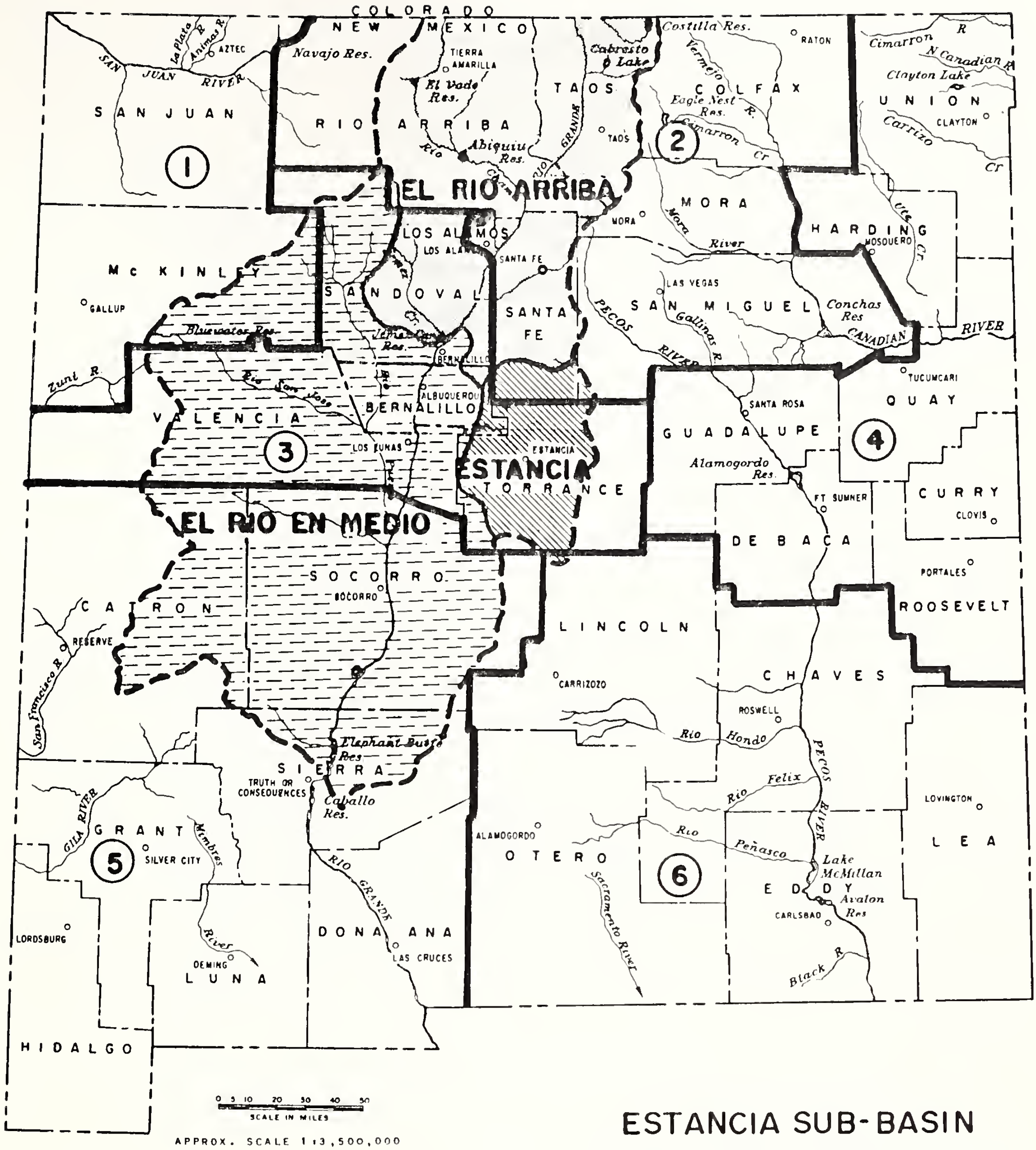

ESTANCIA SUB-BASIN
UPPER RIO GRAND BASIN
STATE OF NEW MEXICO
PLANNING AND DEVELOPMENT DISTRICTS

LEGEND

- STATE LINE
- COUNTY LINE
- UPPER RIO GRANDE BASIN
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UPPER RIO GRANDE BASIN
NEW MEXICO

PREFACE

This report is the last of four preliminary reports about the Upper Rio Grande Basin. It deals with water and related land resource problems and project opportunities in the Estancia Subbasin and suggests available United States Department of Agriculture programs that can be initiated to help alleviate some of the problems. These are project opportunities that should be initiated in the next 15 years.

The four preliminary reports contain early action recommendations for (1) the Chama-Otowi Subbasin, (2) El Rio Arriba Subbasin (the Upper River area), (3) El Rio en Medio Subbasin (the Middle River area), and (4) this, the Estancia Subbasin.

The final basin report will include early action recommendations compiled from an assessment of the project opportunities and appraisal of needs to support requests for basin-wide project authorization needed in the next 15 years.

I. INTRODUCTION AND SUMMARY

Purpose, Objectives, Authority, and Scope of Study

The purpose of this report is to summarize the problems, needs, and development opportunities of water and related land resources that need immediate attention in the Estancia Subbasin of the Upper Rio Grande Basin, New Mexico. 1/ Problems concerning the conservation and use of land and water are identified and recommendations are made for solving some of these problems through programs of the United States Department of Agriculture and other federal and state agencies.

Emphasis is placed on opportunities for project-type developments through initiative of local sponsors. Developments under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566, as amended) is an example. Other opportunities exist for individual and group developments. Farm and ranch planning and development measures are examples.

Purposes considered eligible for United States Department of Agriculture technical and financial assistance are: community resource conservation and development, land use and treatment, flood prevention, agricultural water management, municipal and industrial water supply, recreation, fish and wildlife, and improving water quality through sediment drainage reduction which adversely affects water quality.

The New Mexico State Engineer requested the United States Department of Agriculture to conduct a study in the Upper Rio Grande Basin. This study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83d Congress (Public Law 566, as amended) which authorizes the Secretary of Agriculture to cooperate with other federal, state, and local agencies to develop coordinated programs. The compilation of this report is the result of decisions by a field advisory committee for the study. The field advisory committee is composed of representatives of the Soil Conservation Service, Forest Service, and Economic Research Service.

1/ The term "related land" as used here refers to land that is associated with water resource developments either through the effects of the land on the water resources, or the effects of the water resources and their developments on the land. All land in the subbasin is considered related land.

It is recognized that social, institutional, legislative, and economic considerations may impede some recommended developments and increase the interest in others. These factors may establish the need for studies beyond the scope of this study. These possible developments are treated only to the extent of discussing impacts, both adverse and beneficial, of recommended developments and their capability of meeting projected demands.

The potential development program recognized as being needed to meet total demands by the year 2020 has been examined to extract that part which can reasonably be expected to be initiated during the next 15 years. The study will provide local people, the state of New Mexico, and federal agencies with possible courses of action (1) for the development, conservation, and use of the natural resources, and (2) to improve the economic and social opportunities for the people. Alternative solutions proposed should be applicable for the next 15 years.

This study has the following five principal objectives:

1. To identify broad areas which are feasible for land treatment[1/] to improve water yield, control erosion on critical areas, and reduce sedimentation of water ways; and to appraise the economic effects of such treatment.

2. To provide a technical basis for more effective coordination of United States Department of Agriculture programs for resource development and management with similar activities of local, state, and other federal agencies.

3. To identify and describe the opportunities of water and related land resource development to assist in the full development and utilization of the human resources to improve the economic and cultural status of the people.

4. To appraise opportunities of meeting local objectives through existing Department of Agriculture programs.

5. To appraise the needs of the area to improve the general welfare of the local people by developing a plan for orderly control or regulation, management, and use of water and related land resources.

1/ The quantitative, qualitative, and monetary impacts of land treatment on water yield will receive full treatment in the Upper Rio Grande Basin report.

The project measures proposed can be developed under programs of the United States Department of Agriculture or programs of other agencies in which USDA agencies can participate. The opportunities include:

1. Items on which project-type action is the best means of accomplishing the objectives.

2. Programs to be carried out entirely by an agency of the U. S. Department of Agriculture.

3. Treatment measures to be carried out by land administering agencies and by private landowners.

All of the measures could come under authorities of the Resource Conservation and Development Act, Public Law 87-703. The projects and measures, where noted, are interrelated with project developments proposed by other agencies.

Problems Needing Early Action

Problems needing study and project action in the next 15 years can be grouped into six general categories:

1. Water management includes problems of irrigation water management and reduction of sediment in streams. Eventually problems of water quantity and quality may arise.

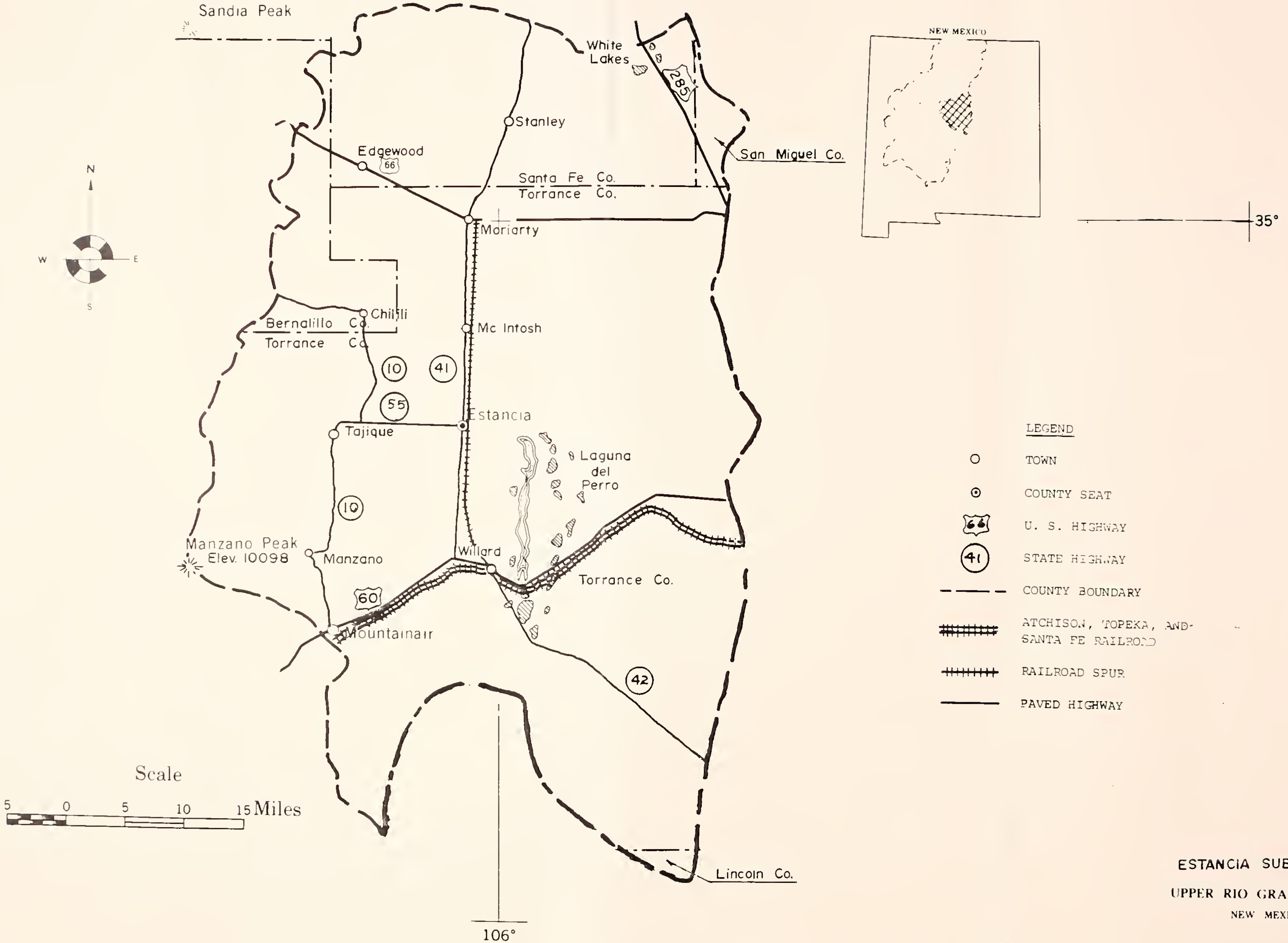
2. Floodwater, erosion, and sediment damage.

3. Agricultural problems include those of range management, utilization of private forest land and timber resources, and inadequate, or non-existing agricultural marketing and processing facilities.

4. Lack of adequate water-based recreational facilities.

5. Lack of adequate community facilities (i.e., community water, community sewage, garbage, and solid waste systems, and adequate housing).

6. Lack of economic opportunities and the associated social problems of the small rural communities.



ESTANCIA SUB-BASIN

UPPER RIO GRANDE BASIN

NEW MEXICO

Findings and Conclusions

Attention in this report is given to programs and measures which are applicable now and during the next 15 years. These programs and measures are considered feasible and needed to help solve some of the problems of the area:

1. Four watersheds in the area have potential for development. Average annual costs for the watershed developments would be $612,000 for nine floodwater retarding structures which would include the cost of facilities for groundwater recharge. Average annual benefits are estimated to be $747,400 resulting in an overall benefit-cost ratio of 1.2 to 1 for the four watersheds. The proposed structures would control 542 square miles (346,900 acres).

2. Community water systems are in service in all six of the communities in the subbasin of over 100 population. Community sewage systems are needed in three of the six communities. For the early action period, the costs for water and sewerage development needs are estimated to be $14,509,800. Analysis of apparent groundwater resources shows an adequate quantity of groundwater underlying five of the six communities. A detailed study of water supply for Mountainair may be needed. Tajique and Torreon had municipal water wells in 1963 which will probably not be adequate for 1985 population.

3. Increase in population will have a corresponding increase in water use present time to 1980.

	Status - 1980 ac.ft./day	Increase in % 1970 to 1980
Municipal water demand	2.287	11.2
Municipal water consumptive use	1.384	15.3
Rural water demand	.227	28.6
Rural water consumptive use	.151	23.8
Industrial water demand	5.230	23.9
Industrial water consumptive use	.761	8.8
Power water demand	13.473	51.8
Power water consumptive use	.272	47.9

4. Land treatment needs include:

Good range management	430,800 acres
Critical area erosion management	2,600 acres
Formerly cropped land treatment	100,000 acres
Pinyon-juniper treatment	182,100 acres
Sagebrush treatment	1,800 acres
Yucca treatment	3,200 acres
Chaparral treatment	10,400 acres
Cholla treatment	500 acres
Commercial timberland treatment	21,700 acres
Irrigated land treatment	28,500 acres
Dry cropland treatment	2,700 acres

The proposed land treatment will reduce sediment reaching damage area by 17 percent per year ($31,000 average annual damage) and will reduce loss of nutrients in the soil due to erosion by $214,500 per year. The total estimated cost for land treatment is $4,615,200. This cost, converted to an annual equivalent, plus the operation and maintenance cost is $662,700 and produces average annual returns of $1,590,900. This land treatment will create an additional 510 man-years of employment for the area over a 15-year period, or 34 average annual man-years of employment.

5. Present and planned National Forest recreational developments will more than accommodate the uses projected for the next 15 years. It is anticipated that increased use of developments will come from the Albuquerque area.

6. The Cibola National Forest is significant in the subbasin. While contributing only about 6 percent to the total area, it furnishes about 98 percent of the recreational development and 59 percent of the commercial timber. The project work inventory identifies six distinct types of resource conservation and development needs. The total estimated investment for the project work inventory, which includes the above, is in excess of $4,300,000.

7. There is a possibility of increasing water yields in the higher elevations through soil and cover management.

8. Groundwater recharge is physically feasible and these incidental benefits were used in the economic justification of all four watersheds. Average annual groundwater recharge is estimated to be about 7,300 acre-feet. The estimated value of this additional water which would be added to the underground basin is about $234,100 annually.

Description of Study Area

The Estancia Subbasin of the Rio Grande Basin is located in central New Mexico. "Estancia" is the Spanish expression for "stations" or "way station". The area includes portions of Torrance, Bernalillo, Santa Fe, and Lincoln Counties. The study area is bounded on the north and east by Rowe Mesa and on the west by the San Pedro and Manzano Mountains. Although, it is a topographically closed basin, it is included in the Upper Rio Grande Basin for economic and sociological reasons.

Drainage of the basin is to its center into a series of usually dry salt lakes (i.e., "Laguna del Perro"). Sea level elevations range from 6085 feet at the salt lakes to 10,098 feet at Manzano peak of the western rim. The study area is about 72 miles long north to south, and 31 miles wide east to west. There are about 1,420,800 acres (2,220 square miles) in the study area.

Arroyos with significant drainages include: Tabet Draw, Arroyo del Manzano, Arroyo del Cuervo, Arroyo de Tajique, Melbourn Draw, Arroyo de Chilili, and Canyon Juan Thomas (Bachelor Draw), Hyer Draw, and King Draw.

Approximately 76 percent of the land is privately owned, 18 percent is state land, less than 1 percent is Indian land, and 6 percent is federal land (National Forest). The subbasin includes the small communities of Estancia, Mountainair, Chilili, Manzano, Punta de Agua, Stanley, Tajique, Torreon, Willard, and Moriarty. Albuquerque, 31 miles to the west of Moriarty and out of the subbasin, is the main trading center of the area.

The subbasin is traversed by Interstate Highway 40 and U. S. Highways 60 and 285 which are the main arteries of travel. Access west to the Rio Grande Basin leads through Abo Pass on the south or Tijeras Canyon on the north. State and county highways provide access to most of the study area. The Atchison, Topeka, and Santa Fe Railroad follows U. S. Highway 60 and crosses the subbasin east to west. A spur line runs north from Mountainair to Moriarty.

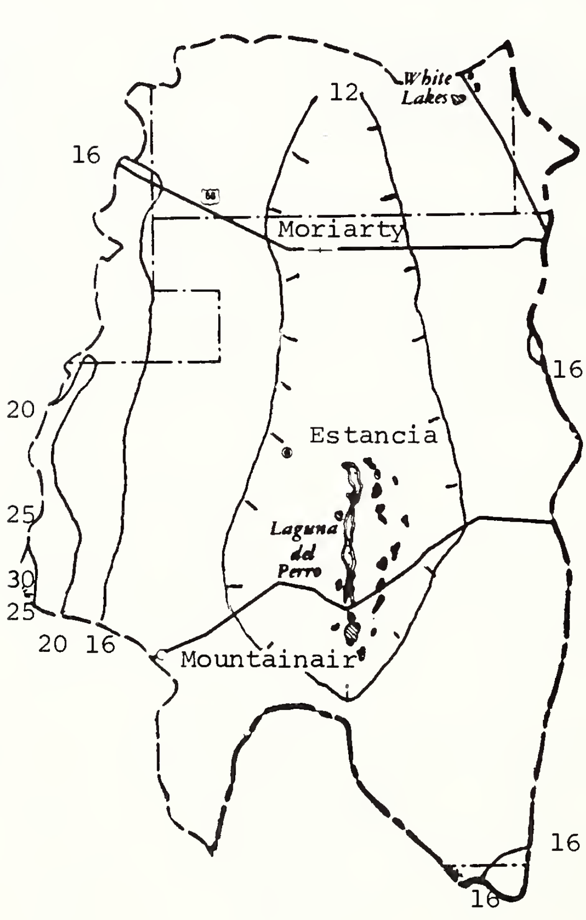
This area is among the oldest continuously occupied area in United States with signs of ancient civilizations evidenced by ruins of the Abo, Chilili, Quirai, and Tajique Pueblos. Some of the first Spanish missions in New Mexico were located at these pueblos. The area was explored by Coronado in 1540. The land grants of Tajique, Torreon, and Manzano were awarded in 1834, 1841, and 1829.

At the present time, there are three ethnic groups in the area: (1) the native Indian, (2) descendants of Spanish settlers, and (3) people of Anglo extraction.

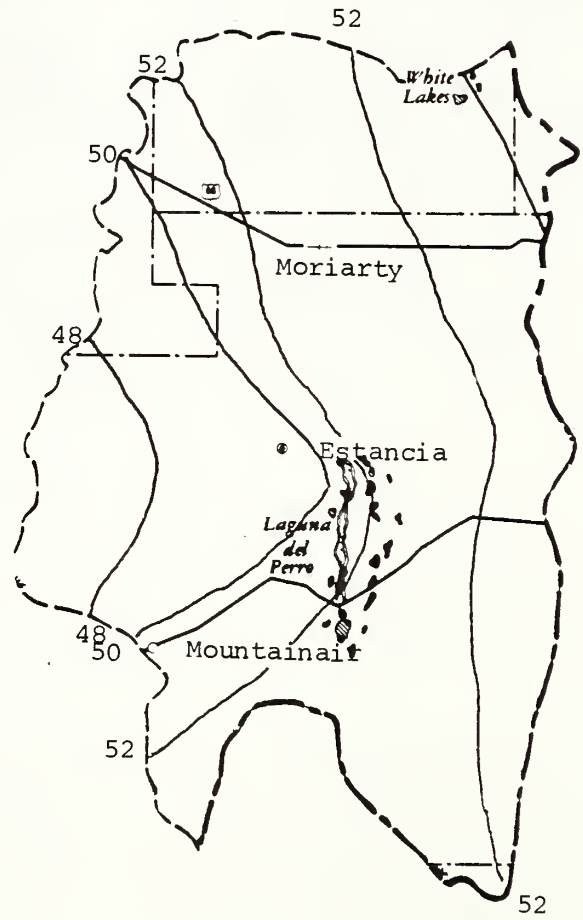
Most of the subbasin lies in State Planning District No. 3, and Torrance and Santa Fe Counties have been declared economically depressed. The entire subbasin is within the Four-Corners Economic Development Region. The 1970 population within this area is about 4,800.

The climate varies from severe winter weather with snowfall in the high mountains to a temperate climate in the lower elevations of the basin. Recorded temperature extremes range from a high of 106° F. to a low of minus 33° F.

CLIMATOLOGICAL MAPS



Average annual precipitation in inches



Average annual temperature in °F.

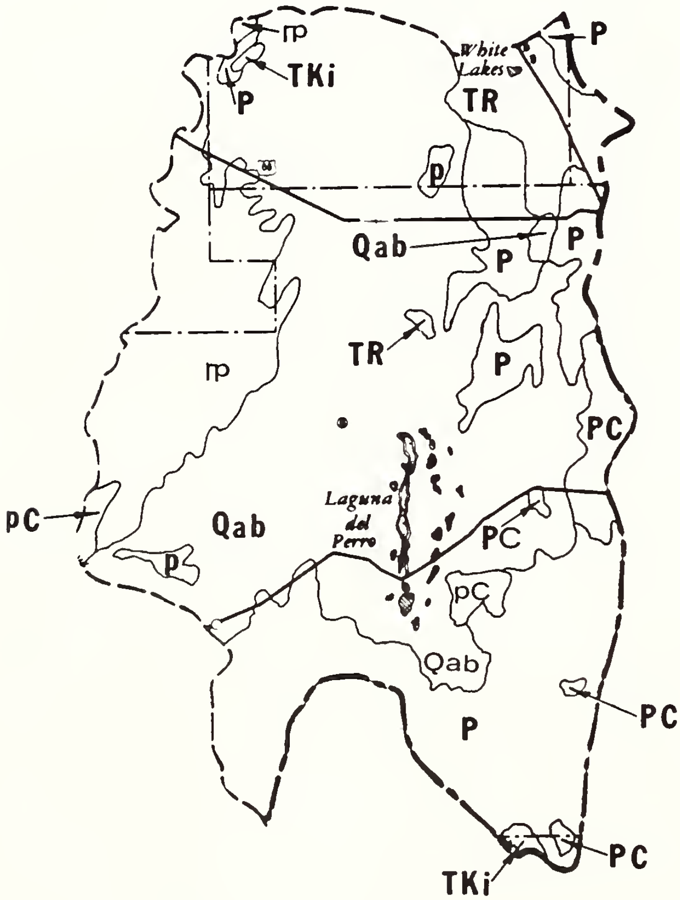
Table 1, Typical climatic conditions by land resource area, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Data for the vicinity of	Elevation	Mean annual precip.	Oct.-March precip.	Winter precip.	Mean annual temp.	Max. temp.	Min. temp.	Average frost-free period
	(feet)	(inches)	(inches)	(percent)	(°F.)	(°F.)	(°F.)	(days)
ARIZONA-NEW MEXICO MOUNTAINS LRA								
Tajique	7100	18.62	7.05	37.9	47.7	96	-21	136
Average frost-free period at Tajique: May 20 - Oct. 3								
CANADIAN PLAINS AND VALLEYS LRA								
McIntosh	6250	12.45	3.45	27.7	50.1	98	-26	149
Estancia	6107	9.62	3.58	37.2	50.3	102	-33	138
Mountainair	6500	15.05	5.24	34.8	50.8	99	-24	155
								CIR 1.137
Average frost-free period at McIntosh: May 17 - Oct. 13								
" " " " " Estancia: May 17 - Oct. 2								
" " " " " Mountainair: May 7 - Oct. 9								

All amounts for length of records.
"CIR" is consumptive irrigation requirement = U - R (acre-feet per acre)
"U" = seasonal crop consumptive use.
"R" = Sum of monthly effective rainfall for the growing period.

The average annual precipitation above the 8,500 foot elevation is about 25 inches, of which about half is in the form of snowfall, and the other half is summer rainfall. At the lower elevations, the annual precipitation is low occurring mostly as summer thunderstorms. Precipitation in the lower portion is about 10 to 12 inches annually. (See table 1).

Generalized Geology



LEGEND

Qab	Alluvium and bolsom deposits
TKi	Intrusive rocks of various ages
TR	Triassic rocks, undivided
P	Permian rocks
IP	Pennsylvanian rocks
PC	Precambrian rocks

Source: Modified from "Geologic Map of New Mexico, 1965" by C. H. Dane and G. O. Bachman

Geology

Quaternary lake deposits are located in the central part of the subbasin and dune sand is found on the east side of Playas. Pliocene to Recent valley fill covers much of the central and northern part of the subbasin. Triassic age gray and tan conglomeratic sandstone, red shale, and some limestone conglomerate of the Dockum Group crops out in the northeast corner of the subbasin. Cropping out below the Triassic age rock are the Permian age San Andres Formation, Yeso Formation, and Abo Formation which contain sandstones, shales, and limestone. These rocks are exposed in the southern and eastern parts of the subbasin.

The arkosic member of the Madera Limestone, which is Pennsylvanian in age, crops out along the west side of the basin. Precambrian igneous and metamorphic rocks appear along the east side of the subbasin and one area on the west side.

Groundwater[1/]

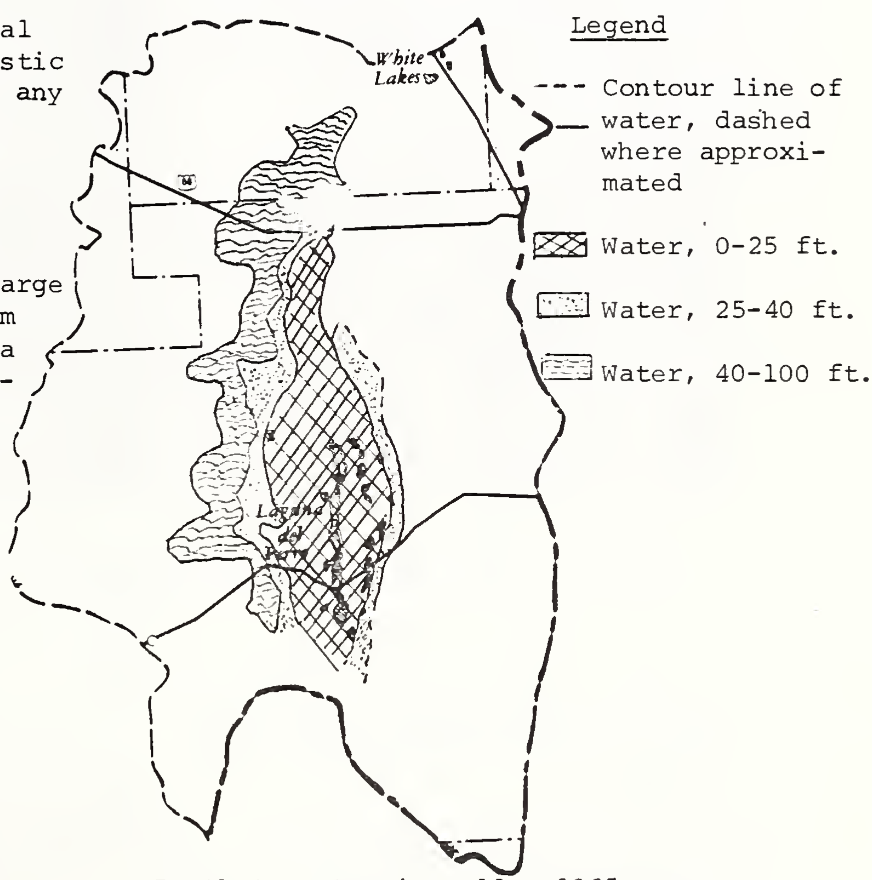
The groundwater levels are declining in the pumped area of the Estancia Subbasin. A maximum decline of 40 feet occurred just west of a line between Moriarty and Estancia during the 1948-1965 period.

In general, three aquifers in the Estancia Valley supply water for irrigation. The principal aquifer in the valley is the Tertiary and Quaternary valley fill which is in the central valley and is up to 400 feet in thickness and contains up to 350 feet of saturated thickness. The second aquifer is the arkosic limestone member of the Madera Limestone along the western margin of the groundwater basin. In the northeastern area of the valley, the Glorieta sandstone member of the San Andres Formation is an aquifer. In general water for stock and domestic use can be obtained from any formation in the valley.

Recharge to Groundwater

According to Smith[1/] a large part of the recharge to valley fill comes from groundwater in the Madera limestone, derived originally from precipitation and in summer flood runoff on the east slope of the Manzano Mountains A small amount of recharge can be expected from runoff on the west slopes of the Pedernal Hills and from groundwater moving westward through the Yeso Formation and the Glorieta Sandstone member of the San Andres Formation.

According to Smith[1/] data indicate that "the

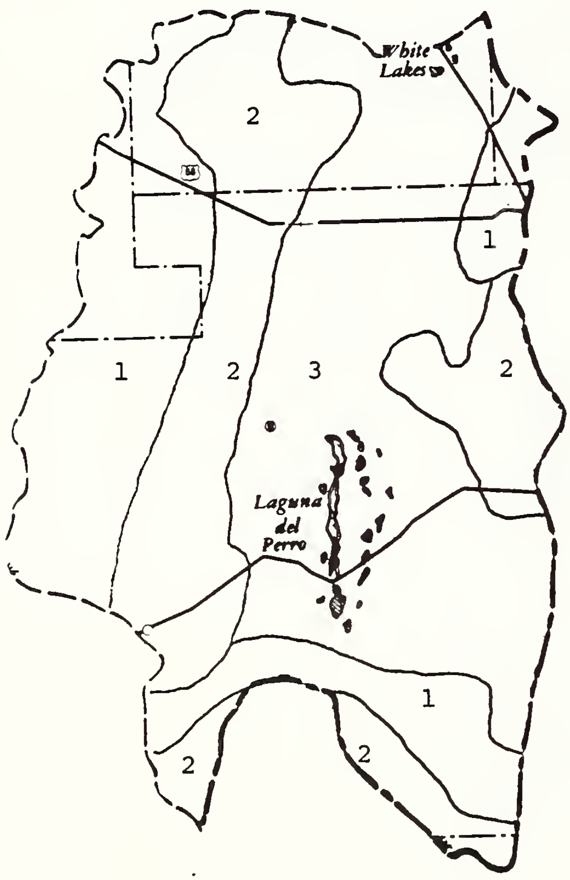


Depth to water in wells, 1965
SOURCE: New Mexico State Engineer

1/ Smith, R. E., 1957, Geology and Groundwater Resources of Torrance County, New Mexico: State Bur. Mines and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico playas are the area of natural discharge for the groundwater in Estancia Valley."

An area suited for possible consideration and study relative to recharge potential is the outcrop area of the arkosic limestone member of the Madera Limestone located along the western side of the subbasin. John G. Koogler[1/] indicates an area of approximately 7,000 acres in this area which was considered physically feasible for water spreading.

Soils



1. Steep mountain and rockland soils forming over limestone and sandstone.

2. Sloping to nearly level soils forming in valley fill alluvium.

3. Nearly level soils forming over lake sediments or caliche.

The Estancia Subbasin is topographically closed. The Laguna del Perro is the center of an ancient lake bed.

The soils in the basin developed in, or were derived from, several kinds of parent material: bedrock, valley fill sediments, and lacustrine sediments. Soils from bedrock occur mainly in the mountains and foothills in the west and in the sandstone breaks in the east and south. Valley fill sediments occur on the piedmont fans west of Highway 41 and east of Laguna del Perro. Lacustrine sediments are near the center of the basin at the lower elevations. The deeper, nearly level, soils are generally fertile and irrigable. Attempts at dry farming these soils have resulted in widespread wind and water erosion damage. A detailed soil survey dated January 1970 is available for Torrance County.

The total erosion in the subbasin amounts to approximately 638 acre-feet per year. Gross erosion rates range from 0.05 to 0.67 acre-feet per square mile per year. Sparse vegetation cover caused by a combination of unwise land use and

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1/ Koogler, John G., 1936, Soil Conservation Service file report and map.

semi-arid climate contributed to erosion and sediment problems in the study area.

Land Use

There are about 30,000 acres of irrigated farmland; 11,000 acres fallow, irrigated land; 165,000 acres of formerly cropped land; 48,000 acres of commercial timber; and 192,000 acres of woodland; 818,000 acres of grassland; 67,000 acres of brushland; 50,000 acres of dry cropland; and 40,000 acres of miscellaneous land (lake surfaces, roads, municipalities, etc.).

Bliss certified potato crop on farm 7 miles north and east of Moriarty, New Mexico, on Highway 41. Yield is 275 sacks per acre.

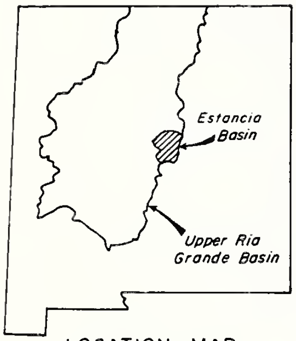
RIVER BASIN FIELD PARTY PHOTO

Land Resource Areas (LRA) are geographic areas characterized by particular soils and soil patterns (including slope and erosion), climate, elevation, water resources, land use, and type of agriculture. There are two land resource areas represented in this subbasin as follows:

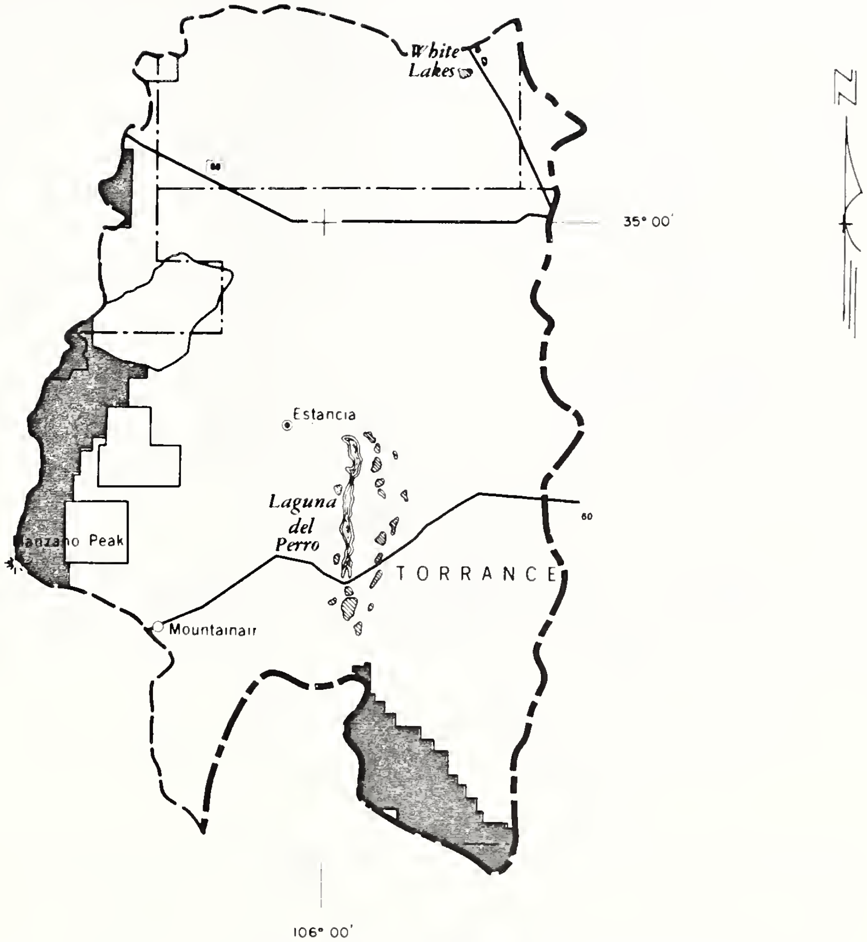
Arizona and New Mexico Mountains (RM2) - This mountainous LRA occurs along the west side and on the southern tip of the subbasin. Elevations range from 6500 to about 10,000 feet. The area is characterized by steep mountains dissected by narrow stream valleys. The higher elevations are in forests of ponderosa pine while the lower elevations have pinyon and juniper trees, chaparral, and mixed grass vegetation. Some of this LRA is rough and steep and has little economic use. Most of the area is used for range and recreation. Many of the valleys were used for dryland farming in the 1950's but most have been reestablished to grass.

This photograph is typical of Arizona and New Mexico Mountains LRA
SCS PHOTO 12-P954-1

Typical view of Pecos-Canadian Plains and Valleys LRA SCS PHOTO 12-P954-16



LOCATION MAP



LEGEND

(shaded)	National Forest
(shaded)	Indian Reservations
(blank)	Private Land Grants
(blank)	Private Land

LAND STATUS MAP

ESTANCIA BASIN

UPPER RIO GRANDE BASIN, NEW MEXICO

APRIL 1969

5 0 5 10 15

SCALE IN MILES

APPROX SCALE 1:1,000,000

US DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA SCS PORTLAND OREG 1969

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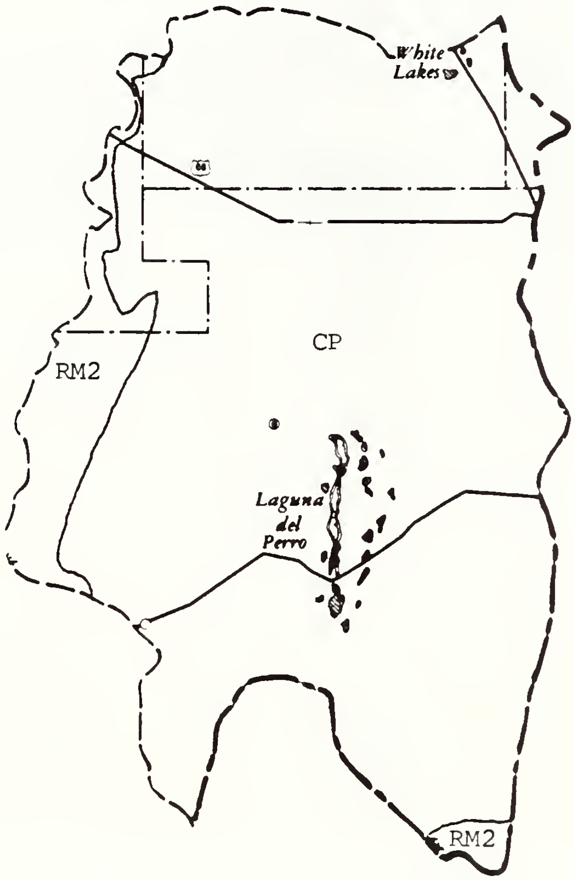
Pecos-Canadian Plains and Valleys (CP) - Most of the subbasin is included in this land resource area. Elevations range from about 6000 to 6500 feet. Most of the slopes of this dissected high plains are gentle or rolling, but bands of steep slopes and rough broken land border the stream valleys. This LRA consists primarily of grassland vegetation with scattered woodland. Its principal use is range.



Uses of the Report

This preliminary report is designed to present information about problems and possible solutions to local people at an early date. It will inform local people of United States Department of Agriculture programs of assistance to help solve some of their water and related land resource problems. Possible uses of the report are:

1. To help soil and water conservation district boards of supervisors in revising and updating their long-range programs of work.

2. To inform landowners and operators of resource problems, of possible courses of action for solving these problems, and of the probable results of such action.

3. To indicate to business and community leaders how locally sponsored action programs designed to utilize natural resources can support new industry, expand business activity, and encourage growth in the agricultural and non-agricultural economy.

4. To help county commissioners evaluate development trends which may serve as a basis for projecting current and future highway and other county needs.

5. To assist state and local action groups to identify rural problems and suggest ways to develop more completely the natural, human, economic, and social resources.

6. To identify for state and federal agencies, opportunities for coordination of effort to maximize the development, conservation, and use of natural resources.

7. To provide regional organizations (Economic Development Districts, Four-Corners Regional Development Commission, Councils of Governments, etc.) with factual data which should be considered for program action by these organizations.

8. To provide land use planning and zoning entities with factual data to guide their planning and decision-making activities.

Participating Agencies

United States Department of Agriculture agencies participating in the study are the Soil Conservation Service, the Forest Service, and the Economic Research Service. The study is in accordance with the memorandum of understanding, dated April 15, 1968, between the Administrator of the Soil Conservation Service, the Chief of the Forest Service, and the Administrator of the Economic Research Service. Representatives of these agencies constitute a field advisory committee to oversee the conduct of the survey.

Acknowledgment to Others

Many state and federal agencies, in addition to the Department of Agriculture and the State Engineer of New Mexico, have provided data and assistance for this report. Significant contributions have been received from private individuals, business firms, the state's universities, and retired professional people.

Existing Water and Related Land Resource Projects and Available Programs

Agencies of the Department of Agriculture and the State of New Mexico have existing projects and programs designed to meet some of the needs for conservation and utilization of the Estancia Subbasin's water and land resources.

Soil Conservation Service

The Soil Conservation Service is considered the "technical arm" of the United States Department of Agriculture. As such, the "Service" provides technical and scientific assistance to all users of water and related land resources in New Mexico. Specifically the assistance is within the framework of legislation as follows:

Public Law 46 - The 74th Congress enacted Public Law 46 which established a national soil and water conservation policy creating the Soil Conservation Service. It directed the Soil Conservation Service to develop an effective program to prevent soil and water wastage and to reduce flooding and sediment hazards. To effectively carry out this responsibility, technical services are available to land owners in locally organized soil and water conservation districts to assist in planning, designing, and applying conservation practices. In Torrance County, of which the Estancia Subbasin is a major part, a standard soil survey with appropriate interpretations has been developed. This survey will provide soil information to help guide the growth and development of the subbasin.

Public Law 566 - Opportunities for dealing with watershed protection and flood prevention problems are discussed in the section on watershed investigation reports.

Public Law 1021, Great Plains Conservation Program - The purpose of this program is to expedite needed changes in land use and accelerate the application of necessary conservation treatment to land. The legislation authorizes cost sharing to facilitate such changes and is applicable in the Estancia Subbasin.

Resource Conservation and Development - This authority of USDA (Public Law 87-703) is available to local sponsorship that is willing to combine local determination with local leadership and self government toward the objective of effecting conservation and economic opportunity through accelerating development of their area's natural resources.

Other Department of Agriculture Programs

Rural Environmental Assistance Program administered by the Agricultural Stabilization Service, is the program through which the United States Department of Agriculture provides a cost share for landowners and operators to install environmental conservation practices that are difficult and expensive but which have enduring benefits to the local economy and which probably would not be installed if cost-sharing were unavailable.

Farmers Home Administration is a lending agency of the United States Department of Agriculture for providing credit and management aid to people in rural areas. Loan programs available to farmers who are unable to obtain loans from private sources are: (1) farm ownership loans, (2) farm operating loans, (3) housing loans, (4) under Title III, Economic Opportunity Act of 1964, FHA provides assistance loans up to $2500 for establishing profit-making enterprises, (5) soil and water development loans. Under this program, groups of farmers or urban dwellers may form an association and obtain loans for development of water and sewer facilities, (6) recreation development loans and loans to grazing associations, (7) loans to local organizations to finance the local share of costs of carrying out Public Law 566 works of improvement.

Community water tower at Moriarty, New Mexico SCS PHOTO 12-P954-12

Economic Research Service and Statistical Reporting Service - These agencies do not have action resource programs but do provide historical and projected data and analysis related to natural resource problems.

Cooperative State-Federal Forestry Programs - The U. S. Forest Service and the New Mexico State Forestry Department are involved in three state-federal cooperative forestry programs: (1) fire control, (2) forest management, and (3) tree planting. The New Mexico State Forestry Department is providing fire protection on state and private lands. The U. S. Forest Service provides fire protection for state and private lands inside and immediately adjacent to the National Forest under contractual arrangements with the State Forestry Department.

National Forest Development and Multiple-Use Program - National Forests are managed under principles of multiple use to produce a sustained yield of products and services as authorized and directed by the Multiple Use Acts of June 12, 1960, and September 19, 1964. These principles provide for the management of forest resources so that they are utilized to best meet the needs of American people. These forest resources are water, timber, range, recreation, and wildlife habitat.

Water Resources - As regulators of water flows, National Forest watersheds are managed in accordance with two principal objectives: (a) protection of the watershed to preserve and improve water quality, (b) management of the watershed to increase water yield in harmony with other resources and uses.

Timber Resources - The goal for the National Forest system is annual harvest on a sustained yield basis to meet the projected need for timber which the National Forests will be expected to supply. Management objectives designed to meet this goal are: (a) the protection, development, and utilization of the timber resource so it can contribute maximum social and economic benefits on a sustained yield basis in harmony with the protection, development and utilization of other National Forest system resources and activities, (b) improvement of stands, (c) reforestation of non-stocked or poorly-stocked lands, (d) maintenance of proper stocking and growing conditions in young stands through timely timber stand improvement measures, and (e) the reduction of fire, wind, insect, and disease losses through proper harvesting, and direct control.

Range Resources - An estimated 70 percent of National Forest system lands are suitable for the grazing of livestock. Objectives for managing the range resources are (1) produce the maximum amount of forage on a sustained yield basis consistent with other uses and demands, and (2) maintain a healthy livestock industry by (a) restoring depleted ranges to full production, (b) managing in accordance with proven methods and techniques, and (c) encouraging improvement and proper use of adjacent and intermingled rangelands.

Recreation Resources - The recreational potential of the National Forest land is relatively unlimited. Presently, with few exceptions, the entire National Forest area is open to hunting, fishing, riding, and hiking. Projected population growth will add to the present intense use of National Forest recreation facilities. It is the policy of the Forest Service to provide facilities for visitors to the National Forests. The National Forest recreational survey provides data useful in planning and constructing facilities to meet public demands. The survey designates sites as having potential for development. These sites will be developed dependent on demands and availability of funds. If recreation demands develop beyond those projected, site selection criteria might be altered to make additional area available.

Wildlife Resources - The long range objective of wildlife management is to provide and maintain an environment conducive to maximum production of fish and wildlife in harmony with the uses and management of other resources. Vegetative-type conversion may change the environment. Such projects will be designed and executed giving full recognition to wildlife needs. Extensive type conversion projects financing will include provisions for inventories prior to beginning of operations. Important wildlife areas will be given special consideration for protection and enhancement. Forest Service policy and guidelines will govern allowances for wildlife cover, forage, and protection on all type conversion projects on National Forest lands.

Fire Control - Control of wildfire is basic to the protection of nearly all resources. Fire protection planning must anticipate greater risks as the forests annually accommodate more users. Fire damage is frequently followed by disastrous insect and disease invasion on forested areas. It usually results in erosion, increased sediment and floodwater production, sediment deposition, and destruction of forage required by both livestock and wildlife. Serious economic losses are incurred by forest industries, forest-dependent communities, and range operators. Prevention, or prompt suppression, of potentially disastrous range or timber fires is now, and will continue to be, an important aspect of resource and watershed management. Prescribed burning is coming to be recognized as a management tool in certain cover types and may be used more extensively as methods and procedures are better understood. Users of prescribed burning must abide by state air quality standards.

Other Programs and Organizations

Bureau of Land Management (BLM) - Erosion control structures and livestock water facilities have been planned by the Bureau of Land Management for construction over a ten-year period. Since 1962, about one-half of these planned units have been completed. An active program of proper range management is being carried out on lands administered by BLM.

Bureau of Indian Affairs (BIA) - A program of timber management and recreation development is planned for the Isleta Pueblo land within the basin.

Soil and Water Conservation Districts are groups of local landowners organized under state law to identify and combat problems involving soil and water. These districts, using the programs of the Soil Conservation Service and other federal and state agencies are an effective force in fighting water and soil waste. Districts in the Estancia Subbasin area include: East Torrance, Claunch-Pinto, Edgewood, and the Upper Pecos.

State Developments for Fish and Wildlife and Recreation - There are no developments by the Park and Recreation Commission in the area and recreational developments by towns in the subbasin are minimal. Public lands along the eastern slopes of the Manzano and Sandia Mountains, however, are extensively used by the people of the subbasin and nearby centers of population for various recreational activities.

There are approximately 190,000 acres of state trust lands in the subbasin leased by the New Mexico Game and Fish Commission for hunting of big game. In addition, the department manages some of the area for special game purposes.

Public Assistance Programs - Public welfare programs exist to aid in training welfare recipients in some areas. Two federal programs designed to combat "hard core" unemployment are the Area Redevelopment Act (ARA) and the Manpower Development and Training Act (MDTA). Both gave the New Mexico Employment Service the responsibility of identifying occupational training needs and the selection of trainees. The choice of training sites and the actual training are functions of the State Department of Education.

New Mexico counties that are economically depressed and all Indian reservations and Pueblos have been designated as eligible for assistance under ARA.

The Four-Corners Economic Development Region - A Four-Corners Economic Development Commission was established in 1966 under Title V of the Public Works and Economic Development Act of 1965. All counties of the subbasin are within the New Mexico portion of this region.

Council of Governments - The portions of Bernalillo and Torrance Counties within the subbasin are also within a Council of Governments area which coincides with State Planning and Development District No. 3. The Council of Governments, operating under Federal Authority of Bureau of the Budget Circular A-95, the State Regional Planning Act, and local articles of agreement, provides sponsors of projects or practices unified, comprehensive, and balanced cooperation among local governments.

Through Councils of Governments, local prerogative and local autonomy is maintained in areas which have been traditionally under local jurisdiction. Local identity assumes real meaning as it becomes an integral part of the metropolitan area.

Population and Employment Trends

The Estancia Subbasin has experienced a substantial drop in population and employment over the past three decades. This is largely because the area is almost entirely dependent on an agricultural economy which has declined sharply. The number of farms and farmers and the acres of land farmed have declined since 1945. As farmers leave, they cause other businesses to leave also. These changes typify the national farm to city migration trend over past years. In contrast to the expected growth in state and basin employment and population, Estancia Subbasin population is expected to continue decreasing, but at a slower rate. Employment is expected to remain roughly at its present level. (Tables 2 and 3).

Table 2, Population, Estancia Subbasin 1930-1980 (thousands)

	Historical	Projections		percent change			
Year	trend	OBERS	BBR	Trend	OBERS	BBR	Upper Rio Grande Basin
1930	9.2						
1940	11.0			+ 19			+ 37
1950	8.0			- 27			+ 44
1960	6.5			- 19			+ 49
1970		5.4	6.0		- 17	- 8	+ 32 1/
1980		5.2	6.5		- 4	- 8	+ 39 1/

1/ Based on BBR projections

Source: Bureau of the Census: Preliminary Report on Economic Projections for Selected Geographic Areas 1929-2020, Vol. 1, U. S. Water Resources Council, Washington, D. C., March 1968; Projections of the Population of New Mexico and its Counties to the year 2070, by Ralph Edgel, Associate Director, the Bureau of Business Research, the University of New Mexico.

Two projections of Estancia Subbasin population and employment are shown. The OBERS projections are based on the continuation of New Mexico's shares of national population and production. The BBR projections are based on the expected employment opportunities in New Mexico.

Employment in agriculture will probably continue to decrease and may be offset by increase in services and public administration.

Table 3, Employment - Estancia Subbasin 1940-1980 (thousands)

Year	Historical trend	Projections OBERS	Projections BBR	Percent change Trend	Percent change OBERS	Percent change BBR	Percent change Upper Rio Grande Basin
1940	2.7						
1950	2.0			- 26			+ 93
1960	1.8			- 10			+ 52
1970		1.8	1.8		0	0	+ 43 1/
1980		1.8	1.9		0	+5	+ 39 1/

1/ Based on BBR projections

Source: Preliminary Report on Economic Projections for Selected Geographic Areas 1929 to 2020, Vol. 1, U. S. Water Resources Council, Washington, D. C., March 1968; Projections of the Population of New Mexico and its Counties to the year 2070 by Ralph Edgel, Associate Director, The Bureau of Business Research, University of New Mexico; Growth Patterns in Employment by County 1940-1950 and 1950-1960, Vol. 6, Southwest U. S. Dept. of Commerce, Office of Business Economics, U. S. Govt. Printing Office.

Water Rights Administration 1/

New Mexico law provides that the surface and underground waters of the state belong to the public and are subject to appropriation for beneficial use. Use is the basis, the measure, and the limit to the

1/ This statement was prepared by the office of the New Mexico State Engineer.

right to use of water, and priority in time gives the better right. The underlying principle is known as the appropriative doctrine of water rights. Where it applies, the mere physical presence of water upon, within, or adjacent to land does not confer upon the owner of the land, ownership of the water or a right to its use.

Water rights in New Mexico are administered by the State Engineer in accordance with provisions of the constitution and the statutes, the adjudication of the courts, the terms of interstate water compacts, and the rules and regulations of the State Engineer. Seven interstate compacts to which the state is signatory affect development and use of water in New Mexico. Situations in which there is intimate relationship between occurrence of groundwater and the flow of surface streams require coordinated administration of diversions by wells and by surface works in order to insure that valid water rights are served and the state's ability to meet interstate water delivery obligations is preserved.

Estancia Subbasin is closed topographically and hydrologically. All waters within the subbasin are depleted within its boundaries; consequently, waters of the subbasin are not subject to provisions of interstate compacts.

At the present time, in some areas of the declared underground water basin in this subbasin, water is available for appropriation and use. About 1,498 square miles (67.5 percent of the subbasin area) is within the declared underground water basin. However, any new depletion of water in the subbasin resulting from new appropriations must comply with the state statutes and the rules and regulations of the State Engineer for the appropriation and use of public waters.

II. WATERSHED INVESTIGATION

REPORT SUMMARIES

This section contains summaries of pertinent information from four watershed investigation reports. The complete watershed investigation reports are contained in the appendix to this report. These watersheds were selected for investigation because they have Public Law 566 potential for solving water and related land resource problems. The proposed projects appear to be physically and economically feasible and should be initiated within the next early action years.

The major problems in each watershed are floodwater and sediment damage and protection of land from wind and water erosion. The primary benefits would stem from reduction of flood and sediment damage and groundwater recharge. However, in the event diversion works are required for spreading of water to accomplish the desired recharge, a water right to appropriate and use surface water will be required.

Benefits accruing to the general public include flood damage reduction to the town of Estancia and to roads, bridges, streets, culverts, and public utilities. There will be incidental benefits through increasing recharge to the underground basin from flood flows. Land treatment benefits will include reduced wind and water erosion and reduction in sediment damage, and increased economic activity.

The proposed treatment on each watershed includes needed land treatment and structural measures. Watershed locations within the subbasin are shown on the watershed map.

Rock Lake Watershed

(Watershed No. 1-107)

The watershed is located in Torrance County near Willard, New Mexico. The upper part of the watershed heads in the Manzano Mountains.

The watershed covers approximately 156,000 acres, of which 76,000 acres are rangeland, 36,000 acres are woodland, 31,000 acres farmland, and 13,000 acres brushland. About 3,700 acres of the farmland is irrigated.

Irrigation wells developed on individual farms are the source of irrigation water. The principal crops grown in the watershed are alfalfa, corn, small grains, and potatoes.

The principal problems associated with water and related land resources are flood damage to irrigated land and improvements, damage to roads and railroads, and erosion to land by wind and water. A decline in the underground water table and a lack of water-based recreation are additional problems.

The watershed problems can be greatly reduced by the application of needed land treatment for protection and improvement of the watershed land along with feasible flood prevention structural measures. Land treatment needs include systems designed to stabilize the land against wind and water erosion and improve the vegetation cover in the watershed. One thousand acres of critically eroded areas need gully plugs, contour furrows, diversions, and grass seeding and proper use of the grazing land. Revegetation of areas previously farmed is needed on about 26,000 acres and grazing management is needed on all of the rangeland. The estimated cost of applying the needed land treatment is $418,000. This cost converted to average annual cost is $77,200 which will give average annual returns of $152,000.

Structural measures needed for flood prevention include two floodwater retarding structures and associated channels on Round Top and Tabot Draws. These structures would protect about 3,700 acres of irrigated land and benefit six landowners. In addition, the structural measures will provide public benefits by increasing the amount of water recharge into the groundwater basin from flood runoff.

The average annual cost of structural works of improvement is estimated to be $142,000, and the evaluated average annual benefits are estimated to be $167,100. The benefit-cost ratio is 1.2 to 1.

Tajique Draw Watershed

(Watershed No. 1-114)

The watershed is located in the western part of Torrance County about ten miles north of Willard, New Mexico. The upper portion of the watershed heads in the Manzano Mountains.

The watershed covers approximately 98,600 acres. About 29,600 acres are grassland, 16,000 acres brushland, 11,000 acres woodland, 20,000 acres commercial timber, and 22,000 acres are farmland. About 5,000 acres of the farmland are irrigated. Irrigation water is pumped from wells and the principal irrigated crops are alfalfa, beans, corn, grain sorghum, and small grains. Dry cropland farms account for 500 acres, and 16,000 acres are formerly-cropped fields that are poorly vegetated.

Highway and crop damage from floodwater from Tajique and Torreon Draws.

SCS PHOTO 12-P573-5

Watershed problems identified in the investigation are (1) flood damage to irrigated farms, state, county, and private roads, and the railroad; (2) loss of flood runoff to natural lakes or basins which prevent beneficial use of the floodwater, and (3) erosion and sediment damage from poorly vegetated areas in the upper watershed.

The watershed problems can be alleviated or significantly reduced by the installation of land treatment and structural measures for flood prevention.

The land treatment needed includes improved grazing management on 25,000 acres of grassland, treatment of 1,500 acres with critical erosion problems. Treatment includes small gully plugs, contour furrows and diversions, grass seeding, and revegetating about 14,100 acres of land previously dry-farmed and not well vegetated. The estimated average annual cost of applying the needed land treatment is $74,500 and the average annual returns amount to $208,000. The estimated cost of applying land treatment needed in the watershed is $592,000.

Structural measures needed for flood prevention include one floodwater retarding dam located on Torreon Draw and Arroyo del Cuervo. Incidental groundwater recharge benefits would accrue to the general public in the Estancia Valley from the structure. Approximately 15 landowners on 3,000 acres of irrigated land would directly benefit from the installation of the structure.

The average annual cost of the structure is $80,500 which would produce estimated average annual benefits of $83,400 and yield a benefit-cost ratio of 1 to 1.

Buffalo Springs Watershed

(Watershed No. 1-119)

The watershed is located in Torrance County and includes the towns of Estancia and Moriarty as well as the community of Chilili. The west end of the watershed extends into the Manzano Mountains.

The watershed covers approximately 238,000 acres of which 100,000 acres are grassland, 50,000 acres woodland, about 50,000 acres of farmland, 23,000 acres timberland, and 15,000 acres are brushland. The farmland acreage includes about 13,500 acres of irrigated land, 1,300 acres of dry cropland, and 35,200 acres of formerly-cropped land that is not well vegetated.

Irrigation water is pumped from wells developed by individual farm owners. The principal crops grown are alfalfa, corn, grain sorghums, potatoes, beans, and small grains.

Main street of Estancia, New Mexico under floodwaters from Milbourne and Compton Draws

SCS PHOTO 12-P514-7

The principal watershed problems are flood damage to irrigated land and associated improvements, urban damage in Estancia, and damage to highways, roads, and the railroad. Other significant problems are erosion by wind and water to unprotected upland areas of the watershed particularly the formerly cropped fields.

Feasible land treatment measures necessary to improve and enhance the water and related land resources in the watershed include improved grassland management on about 21,000 acres, pinyon-juniper control on 25,000 acres, timber stand improvement on 11,600 acres and revegetation of 32,000 acres of land previously dry farmed. The estimated cost of applying the needed land treatment is $1,239,000. This cost converted to an average annual cost is $165,000 and the estimated average annual returns amount to $475,000.

Structural measures needed for flood prevention include four floodwater retarding structures. The four structures would reduce damages received from floodwater originating in Estancia Draw, Milbourne Draw, and Arroyo Chinchante; Compton Draw, and Cienega Draw. These measures would provide significant flood damage reduction benefits to approximately 1,200 residences in Estancia, 30 owners of irrigated cropland, and to the general public by damage reduction to highways, roads, and the railroad. In addition supplemental benefits would accrue from groundwater recharge.

The estimated average annual cost of the structural measures is $167,400, and the estimated total average annual benefits are $192,900. The benefit-cost ratio is 1.2 to 1.

Hyer Draw Watershed

(Watershed No. 1-122)

The watershed is located in Torrance County and is north and west of Moriarty. The western part of the watershed heads in the San Pedro and the South Mountains.

The watershed covers approximately 198,400 acres of which 125,900 acres are grassland, 19,000 acres woodland, 4,000 acres timberland 500 acres brushland, and 49,000 acres are farmland. Included in the farmland acreage are 11,000 acres of irrigated cropland, 2,200 acres of dry cropland, and 36,000 acres of formerly-cropped land not well vegetated.

Water for irrigation is pumped from wells developed by individual landowners. The principal crops now grown in the watershed include alfalfa, corn, grain sorghums, small grains, and potatoes.

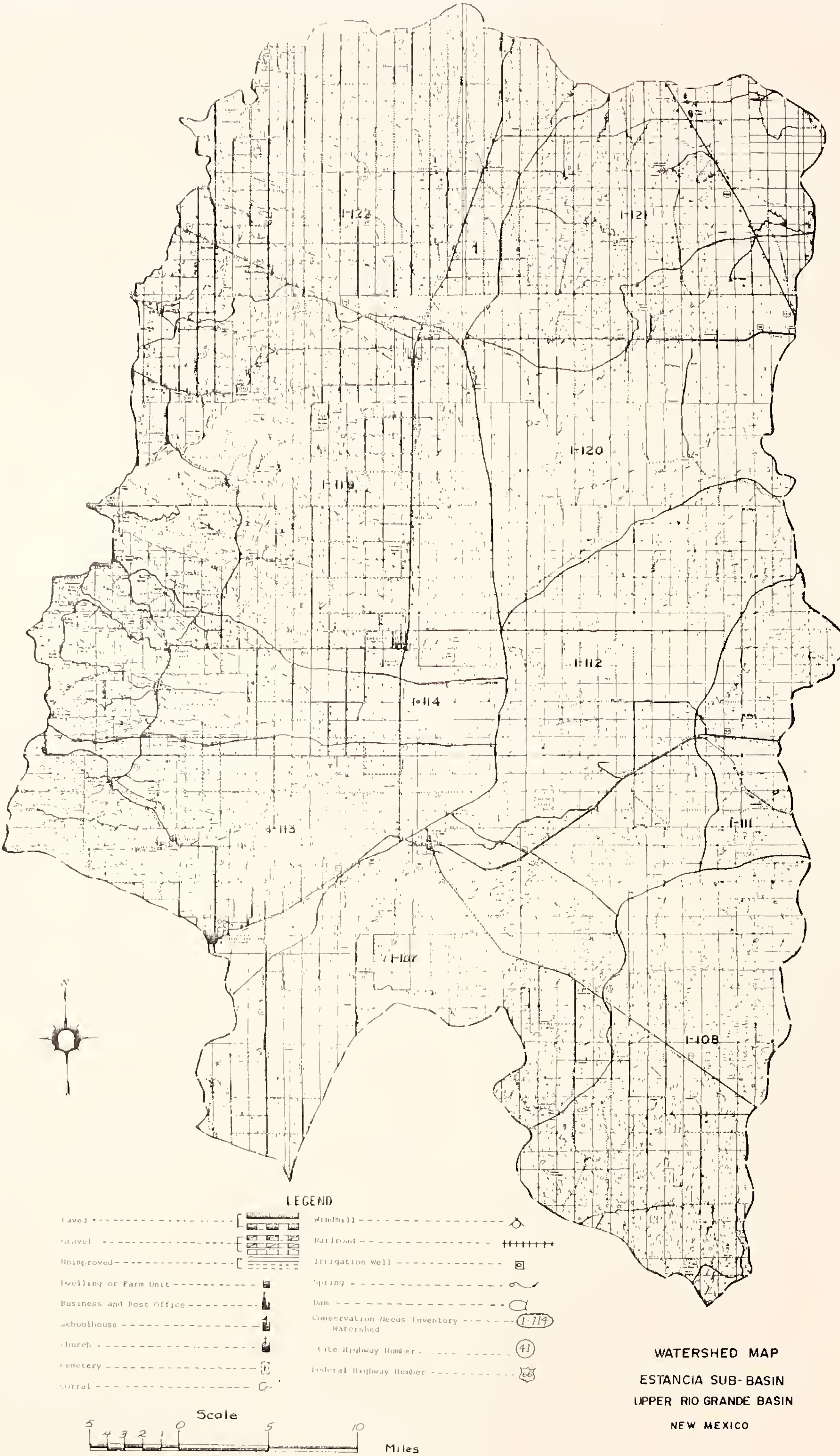
The principal watershed problems associated with the water and related land resources are flood damage to irrigated land and associated farm improvements, roads, and highways; wind and water erosion on formerly dry-farmed land; and the loss of flood runoff to non-beneficial use.

Feasible systems of land treatment for improving and enhancing watershed lands and structural measures for flood prevention will greatly reduce the watershed problems identified in the investigation. In addition, incidental public benefits from groundwater recharge will accrue from the installation of potential floodwater retarding structures.

Land treatment systems effective in alleviating watershed problems include improved management on 62,000 acres of grassland, pinyon-juniper control on 2,500 acres, critical erosion control on about 1,100 acres of formerly dry-farmed land, and the improvement of irrigation systems on about 7,000 acres of irrigated land. The estimated cost of applying land treatment needed in the watershed is $545,000. This cost converted to average annual equivalents amounts to $96,000 and will result in average annual returns of $181,000.

The structural measures needed for flood prevention are two floodwater retarding structures. One structure would be in Bachelor Draw, and one would be on Hyer-King Draws. The structures will provide direct flood damage reduction benefits to 20 landowners covering about 4,000 acres of irrigated land. In addition, benefits to the general public and watershed community will be realized from reduction of flood damage to highways and roads and from incidental groundwater recharge.

The estimated average annual costs of the two floodwater retarding structures are $222,100, and the estimated average annual benefits are $304,000. The benefit-cost ratio is 1.4 to 1.



WATERSHED MAP
ESTANCIA SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

III. OTHER EARLY ACTION NEEDS

National Forest Development Program and Project Work Inventory

The development program for the National Forests includes resource management and development work needed on the National Forests to assure these public lands will contribute their full share of present and future public needs.

The program includes renewable resources of the National Forest system - water, timber, forage, recreation, and wildlife habitat. It provides for continued orderly use and development of renewable resources of the National Forests in accordance with basic conservation principles under the Multiple-Use-Sustained Yield Act of June 12, 1960.

The project work inventory for 1967 lists non-recurrent work which should be initiated on the National Forests to meet estimated public needs. The determination of these needs was based on (1) approved management and development plans and (2) knowledge, vision, and judgment of resource managers in the field.

Total basin needs as indicated by the project work inventory (PWI) and the estimated early action programs for Estancia Subbasin are as follows:

	PWI		Early Action	
Revegetation	4,700 ac.	$ 32,000	4,700 ac.	$ 32,000
Erosion Control	5,400 ac.	181,000	1,350 ac.	33,500
Timber Stand Improvement	6,600 ac.	132,000	6,600 ac.	132,000
Hazard Reduction	6,500 ac.	260,600	4,000 ac.	160,000
Recreation Development	110 ac.	678,000	25 ac.	154,100
Fences (Range Mgt.)	23 mi.	27,600	23 mi.	27,600
Stock and Wildlife Water Development	16 ca.	7,500	16 ca.	7,500
Construction and Betterment (roads)	150 mi.	3,040,000	25 mi.	516,700
Totals		$4,358,700		$1,063,400

The overall program accomplishments will be regulated by the priorities and availability of funds for the projects.

Recreation on National Forest Land - The recreational potential of the National Forest in the subbasin is limited only by area. With few exceptions, the forest lands are open to some form of recreation.

Presently there are six developed sites with 96 family units having a capacity of 480 people at one time and a total area of 55 acres. There are 46 miles of trail and 6 miles of stream available for recreational use also.

Existing developments and the planned development of eight new sites will be adequate to satisfy the estimated recreational demands on the National Forest of the subbasin for the year 1980.

Table 4 is a listing of the recreational use on the National Forest of the subbasin in 1968 and the use projected to 1980.

Big game population on the National Forest within the subbasin is estimated to be 9 elk, 2,400 deer, 7 bear, 8 bighorn sheep, and 100 turkeys.

Table 4, Recreation use, Cibola National Forest, Estancia Subbasin (visitor days 1,000's)

Activity	1968	1980*
Developed sites		
Observation	.108	.151
Playgrounds, sports	.054	.076
Swimming	-	-
Campgrounds	7.015	9.821
Picnic Grounds	6.622	9.271
Rec. Res. Sites	.400	.560
Winter Sports	.378	.529
Subtotal	14.577	20.408
Dispersed areas		
Roads (rec.)	7.568	10.595
Trails (rec.)	1.429	2.001
General undeveloped	12.401	17.361
Subtotal	21.398	29.957
Grand total	35.975	50.365

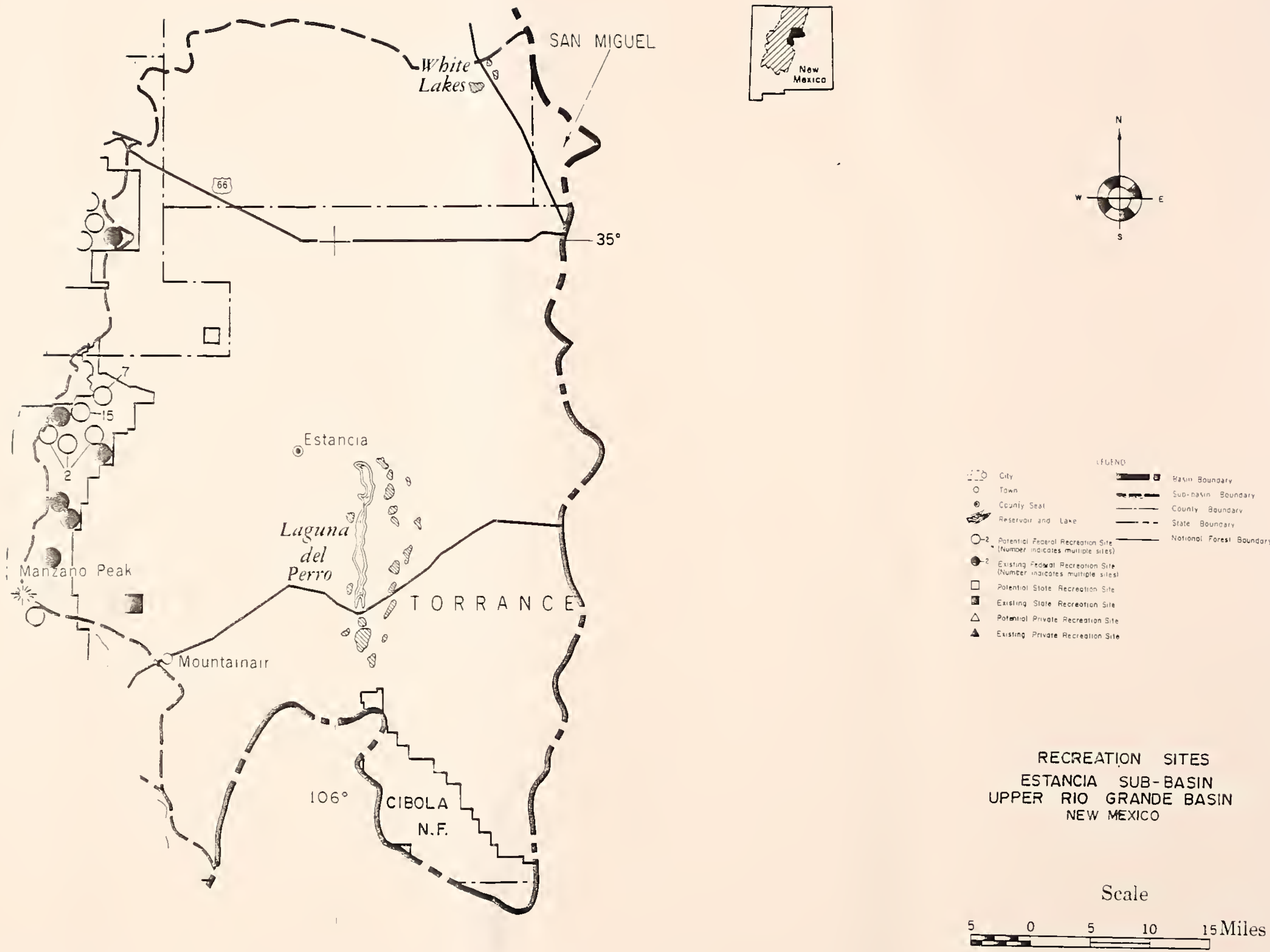
*Projections made by Recreation Section of Division of Recreation and Lands Division, U. S. Forest Service

Typical National Forest modern camp and picnic facilities

SCS PHOTO 12-P496-15

Deer on National Forest land in Estancia Subbasin - New Mexico Dept. of Game and Fish photograph

NEW MEXICO DEPT. OF GAME & FISH PHOTO



RECREATION SITES
ESTANCIA SUB-BASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

Land Treatment

Good management, soil and cover management, and mechanical land treatment practices are methods by which the land can contribute more to the subbasin economy. Land treatment can be planned and applied so the study area will produce more forage, timber, water, recreation, and food. The same land treatment systems can reduce the amount of damaging sediment and provide additional employment to local people. Table 5 estimates land treatment needs on lands subject to United States Department of Agriculture programs. The land treatment map shows the land treatment and vegetation areas in the subbasin.

The most critical land treatment problem is the 100,000 acres of formerly-cropped land that is now poorly-vegetated. Most of this land was planted to dryland crops prior to 1956. The drought of the mid-1950's and unfavorable agricultural prices put many dryland farmers out of business. Participation in the Conservation Reserve Program administered by the Agricultural Stabilization and Conservation Service was unusually high among farmers in the basin. This program provided lease payments to farmers for withholding land from crop production. A program requirement was planting a vegetative cover to control erosion. Because of extremely dry weather and the selection of short-lived grasses, much of the area was not established to desirable range grasses. As a result weeds and annual grasses are the predominant cover on many of these fields, and they are producing only ten to fifteen percent of their potential forage yield.

Another 2,600 acres of land is classified as critically eroded. This land is generally near villages or farmsteads and along roads and trails.

These two areas of critical erosion need a system of land treatment that includes the proper combination of the following practices: planting desirable grass varieties, livestock exclusion or limited use by livestock, gully control, water-spreading or erosion-control devices, grazing land mechanical treatment, fencing, and relocation or additional water points. Proposed land treatment systems will reduce sediment reaching the damage area by approximately 17 percent.

Of the 182,000 acres of pinyon-juniper woodlands needing treatment 80,000 acres have moderately deep soils and moderate slopes where a woodland improvement program can be developed. The other 102,000 acres need good range management supplemented by selective thinning and spot clearing.

About 1,850 acres of sagebrush, 3,200 acres of yucca, 500 acres of cholla, and significant but undetermined acreage of "dog cactus" needs to be evaluated for control and revegetation. The rest of the brushland needs intensive management techniques including deferred grazing, rotation deferred grazing, and better livestock distribution through use of fences, water locations, and salting.

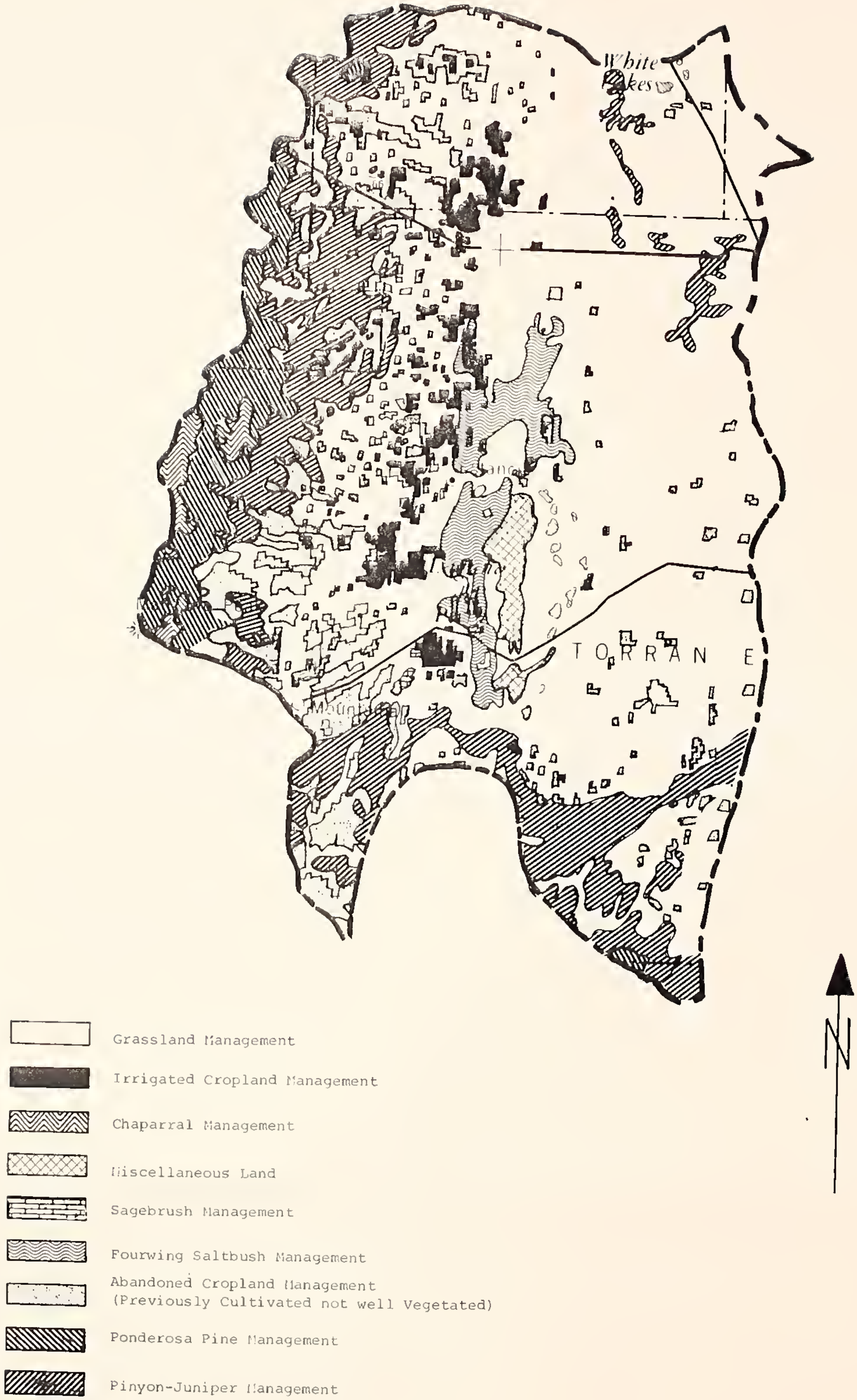
There are 21,700 acres of ponderosa pine timberland in the subbasin that need treatment. Management and treatment practices include: selective cutting, thinning, tree planting, fire protection, grass seeding, erosion control on trails and roads, proper grazing use, and wildlife habitat improvement.

About one-half of the 860,000 acres of grassland need the improvement provided by good range management. Treatment systems should include the proper combination of deferred grazing, rotation deferred grazing, proper grazing use, salting, and better livestock distribution which might be accomplished by fencing and installing additional watering locations or relocating fences and water facilities already in existence.

There are about 28,000 acres of irrigated cropland and 2,700 acres of dry cropland that need treatment. The irrigated land needs improved irrigation systems that include combinations of land leveling, sprinkler systems, pipelines, ditch lining, and realigning field ditches. The dry cropland treatment needs include the proper combination of the following practices: conservation cropping systems, contour farming, diversion, terraces, and proper residue management.

"Noxious plant pollution." Good grassland invaded by "dog cactus"

SCS PHOTO 12-P954-7



LAND TREATMENT MAP

ESTANCIA SUB-BASIN

UPPER RIO GRANDE BASIN

NEW MEXICO

JULY 1970

Table 5, Land treatment needs for watershed protection, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Land treatment systems	Total treatment needs (acres)	Total treatment cost $	AVERAGE ANNUAL RETURNS: Water harvest $	Sediment reduction $	Soil nutrient loss reduction $	Red meat increase $	Timber wood increase $	Cultivated land increase $	Additional employment $	Total average annual returns $
1. Grassland										
1c-Good range management	430,800	215,400		17,400	122,100	96,900			19,800	256,200
2. Grazable woodland										
2a-Pinyon-Juniper control	80,000	1,200,000		3,200	22,700	75,600			25,800	127,300
2b-Pinyon-Juniper mgt.	102,100	306,300		4,100	29,000	62,000			17,000	112,100
3. Brushland										
3a1-Sagebrush control	1,800	14,400		100	500	3,000			300	3,900
3b3-Chaparral management	10,400	20,800		400	3,000	11,700			1,200	16,300
3a4-Yucca control	3,200	12,800		100	900	3,600			300	4,900
3a5-Cholla control	500	2,000			100	1,100				1,200
4. Commercial timber										
4b-Ponderosa pine mgt.	21,700	651,000	19,900	900	6,200	24,400	83,600		23,600	158,600
6. Crop, pasture, hayland										
6a-Irrigated land										
6a2-Improved irrigation	28,500	1,140,000						570,000	45,600	615,600
6b-Dryland	2,700	13,500		100	800			9,600	400	10,900
6c-Abandoned cropland	100,000	1,000,000		4,100	28,500	172,500			69,600	274,700
8. Critical erosion areas	2,600	39,000		600	700	5,900			2,000	9,200
Total		4,611,200	19,900	31,000	214,500	456,700	83,600	579,600	205,600	1,590,900

Pinyon-juniper control on rangeland SCS PHOTO 12-225-10

Agricultural Water Management

Irrigation of agricultural crops has been practiced in New Mexico for many years. Some areas on the west side of the basin were being irrigated prior to the coming of the Spanish explorers and settlers to the area. Initially all irrigation in the subbasin was from surface flow of water. In recent years, groundwater from wells has been developed for this purpose. Most of the irrigated area considered in this report is irrigated with groundwater from wells.

Mean annual runoff of contribution to streamflow from the area considered in this report is relatively insignificant. Mean annual runoff is less than 0.1 inch over most of the area to about 2 inches in the Manzano Mountains.[1/]

The expansion of irrigation farming to a large part of the subbasin is limited only because of the availability of irrigation water. There are 41,000 acres of land under irrigation systems. About 29,750 acres were irrigated in 1968. There is some surface water use around some of the mountain villages. The groundwater supply is from the alluvium of the Estancia subbasin. Chemical quality of the water is highly variable. Chloride is usually the dominant anion found in water of the shallower part of the lacustrine sediments.[2/]

The Estancia Subbasin is closed hydrologically as well as topographically. The depth of water varies from surface to 500 feet. Water level changes have been of interest to the state and have been studied since about 1948. The water level has declined in the areas of pump irrigation farming. The amount of decline depends upon the location in respect to the intensity of irrigation. On the outer edges of irrigation, the water depth increased from 1948 to 1960 by about 5 feet and toward the center of irrigation well intensity the increase was as much as 25 feet. In 1965, the latter had increased to 40 feet.

Significant groundwater development was started in the Estancia Valley in about 1940. In 1950, the State Engineer established the Estancia underground water basin in order to protect and conserve the relatively fixed water supply. The State Engineer has taken the position that it is not practical to operate an aquifer on a sustained yield basis when the amount of water in storage is very large compared with the annual recharge; therefore, the greatest value of the large amount of water in storage can be realized only through mining. To allow rational mining of the Estancia underground water basin, the

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1/Characteristics of the Water Supply in New Mexico. New Mexico State Engineer Tech. Report 31 (1965)

2/Water Resources of New Mexico - New Mexico State Planning Office (1965).

amount of water in storage was inventoried by the State Engineer in 1965 and 1967, and a plan was developed to permit withdrawals distributed over the basin in such a way that withdrawals permitted could be continued economically for a period of 40 years or more.

Because of the economy of the area, groundwater withdrawals have not significantly increased over the last two decades and, if this trend continues, groundwater in the major portion of the basin should permit economic withdrawals for many decades. If something should develop that would change the economy of the area in such a manner as to increase the demand for water, or if demands are made to export water ouside the major water-bearing aquifer or to points outside the subbasin, then the 40-year life becomes more realistic.

As water levels continue to decline, there is a possibility that saline water will move toward the heavily pumped areas; however, studies made by the State Engineer in 1967 did not indicate encroachment at that time.

When shortage of water or excessive pumping costs do develop, then our expanding technology should be at the point where the abundant saline and brackish waters can be treated economically, or importation of water should be feasible.

There are estimated 50,000 acre-feet of water lost annually from evaporation from the salt lakes southeast of Estancia; and, in addition, about 36,600 acre-feet is used in crop production.

Rural and Municipal Domestic Water

Water Quality

There are six communities in the Estancia Subbasin with populations in excess of one hundred people. Water supplies of these communities are generally very hard. The ratings are as follows:

Very hard	5 communities out of 6
Hard	1 community out of 6

Water supplies for Moriarty and Willard have sulfate mineralization which exceeds New Mexico State Health Department standards.

Water Quantity

Municipal and rural domestic water needs and consumptive use for the area are projected as follows:

Water Needs (Diversion) in acre-feet/day

Year	Communities with population over 100	Communities with population less than 100 and rural	Total
1970	2.057	0.192	2.249
1980	2.287	0.227	2.514

Water Consumptive Use (Depletion)

Year	Communities with population over 100	Communities with population less than 100 and rural	Total
1970	1.201	0.122	1.323
1980	1.384	0.151	1.535

Water and Sewerage Development Needs

In 1970, the water and sewerage needs of the six communities were analyzed as follows:

(a) There were community water systems in service in six communities with populations above 100 persons. The villages of Torreon, Mascero, and Tajique need their water systems overhauled. The village of Punta del Agua needs a new well.

(b) Community sewerage systems are needed in three of the six communities.

Projected increase in population and the corresponding increase in water needs reveal the nature and magnitude of the water and sewerage needs. To bring all communities up to an 80 percent "hook up" level for residents and keep pace with the expanding population, will require an expenditure of $267,000 during the early action period.

Projected water and sewerage development needs are as follows:

Year	Total cost of water and sewerage facilities
1970	$128,800
1980	138,100

In addition to Public Law 660 and under certain conditions, local sponsors can obtain loans and grants up to 50 percent of the development cost of water or waste disposal systems under USDA's Public Law 87-128 (amended by PL 89-210) and Public Law 87-703. These laws are administered by the Farmers Home Administration.

Other sources of assistance are available as follows:

A. Water and sewerage facilities grants from the U. S. Department of Housing and Urban Development (Public Law 87-117). Their program provides grants of up to 50 percent of costs of land and construction of new water and sewerage facilities.

B. Programs of grants up to 50 percent and loans which may run as long as 50 years with Economic Development Administration. (Public Law 89-136).

C. Loans up to 40 years for 100 percent of cost under Department of Housing and Urban Development (Public Law 84-345).

D. Grants ranging from 30 to 60 percent of costs for water treatment works through Water Pollution Control Administration.

Groundwater supplies underlying 5 of the 6 communities appear adequate to meet community needs for the next fifteen years. The community of Mountainair, located on the western edge of the declared groundwater basin, may not have an adequate water supply to meet needs of the projected population growth. Future water supplies for Mountainair will, no doubt, come from the declared groundwater basin. Tajique and Torreon had municipal water wells in 1963 which will probably not be adequate for projected 1980 population.1/ Groundwater resources at Moriarty, Willard, and Estancia are adequate for projected population growth. (Acknowledging that Moriarty and Willard need treatment for sulfates). These communities are in the declared underground water basin.

Since there is groundwater available for appropriation in some areas of the subbasin, community water needs may be met either by new appropriations in these areas, or by retirement of existing water rights. An alternate source of supply might be desalting groundwater available near the salt lakes. A study to determine the feasibility of using this water for Moriarty is now underway. This is in conformance with state water laws pertaining to development and use of water for municipal use.

Industrial Water

Demands for industrial water will vary in types of industries to be attracted to the area, relationship of industry to transportation systems, labor supplies, local initiative, and other factors. Thus, it would be impossible to pin-point locations to any exact degree. Projections for demands and consumptive use of industrial water are, thus, based on relationship of industrial water to municipal waters. Projections are as follows:

1/ Dinwiddie, G. A., Municipal Water Supply and Uses Southeastern New Mexico: Tech. Report 29A, New Mexico State Engineer, Santa Fe, New Mexico, 1963.

Year	Demand	Consumptive Use
1970	4.220 ac.ft./day	0.700 ac.ft./day
1980	5.230 ac.ft./day	0.761 ac.ft./day

Water for Power

Demands for water used in power generation follow the projected population increase. The projections developed reflect water demands for power whether generation is within or without the area. Projections are as follows:

Year	Demand	Consumptive Use
1970	8.876 ac.ft./day	0.184 ac.ft./day
1980	13.473 ac.ft./day	0.272 ac.ft./day

Sources of data: "The Nation's Water Resources Summary Report", United States Water Resources Council, 1968.

Public Law 87-703

Resource Conservation and Development Program

A basic objective of the Resource Conservation and Development (RC&D) Program is the orderly development, improvement, conservation, and utilization of natural resources of the project area thereby providing employment and other economic opportunities to the people of the area. The RC&D Program is applicable where the acceleration of current conservation activities plus the use of other authorities will provide additional opportunities to local people.

The area included in this report is not an authorized RC&D Program area, at present, but many of the projects proposed in the preceding pages of this report could be accomplished, or assisted, under Public Law 87-703.

Additional measures which could be considered for inclusion as potential RC&D project proposals in the early action program and/or additional study may include:

(1) Accelerated conservation planning on those lands proposed for intensive land treatment.

(2) Christmas tree plantations which would hire people full time in the summer and provide additional employment during the winter.

(3) Livestock improvement associations with artificial insemination and pregnancy testing of stock included.

(4) Development of small industries such as a potato chip plant utilizing basin-grown produce.

(5) Range development - access roads or trails and watering facilities.

(6) Farm and ranch skill training.

(7) Scenic road along the Manzano Mountain ridge.

(8) Fishing ponds.

Land Use Planning and Zoning

Significant areas within the boundaries of this subbasin are feeling the impact of commercial and residential development by private land developers. It is possible that the impact soon will be greater. The potential problems relative to land and water use indicate an immediate need for comprehensive land use planning throughout the subbasin. Land use planning needs to be developed to cope with future population and economic expansion. Responsibility for this type project lies with county and municipal commissioners and state and federal planners. It is desirable that subsequent local zoning laws complement future plans of state and federal agencies. Zoning boards should include county commissioners and representatives of municipalities, the State Planning Office, U. S. Forest Service, Soil Conservation Service, Bureau of Land Management, Bureau of Indian Affairs, and other organizations interested in total resource development of the subbasin.

Items that should be considered are:

1. Locations for industrial growth

2. Areas for home sites

3. Restrictions on future use of flood plains to limit loss of lives and property from floods.

4. Location of garbage and refuse disposal areas.

5. Areas for agricultural expansion.

6. Locations for future highways and other transportation facilities.

7. Sources of water and sewage disposal facilities.

8. Location of school sites and other municipal, county, and state management facilities.

9. Regulation of roadside advertising.

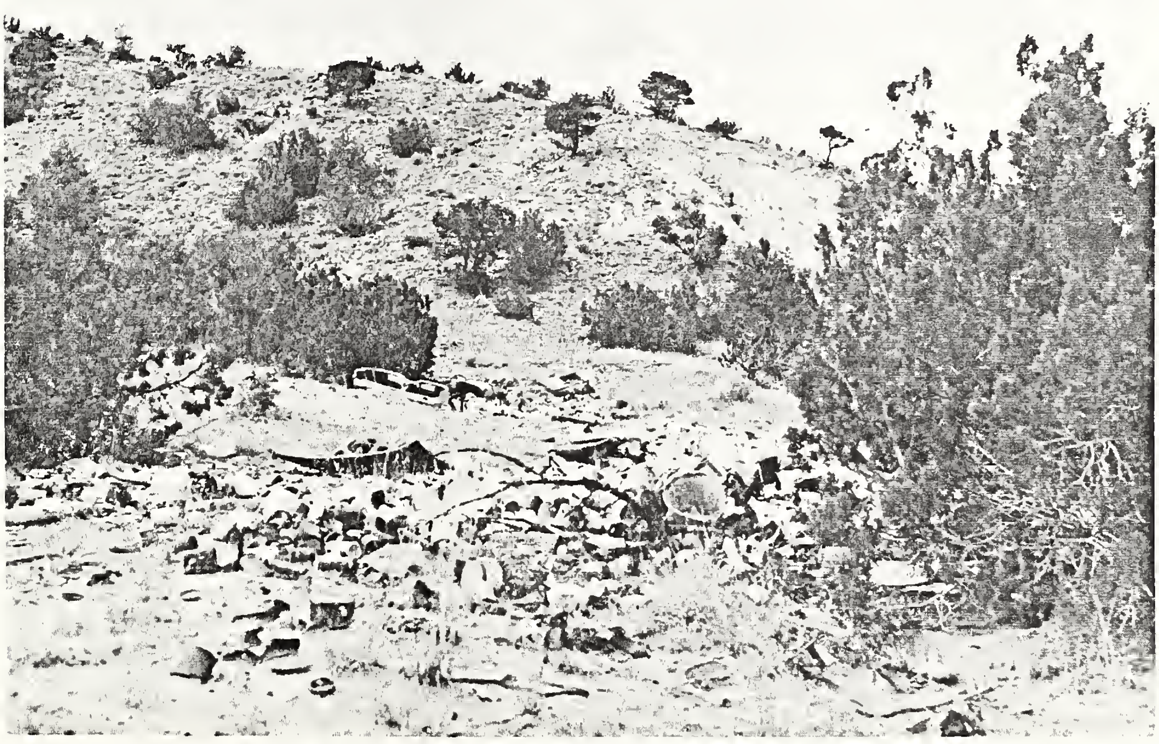
10. Preservation of good agricultural land for agricultural purposes.

11. Preservation of natural beauty spots and recreational sites,

12. Game management areas.

The Estancia Subbasin, because of its proximity to metropolitan Albuquerque, will be a logical area for home sites. Small acreage subdivision of farm and rangeland has begun. Developers and county commissioners should take early action to plan and zone for suburbanization. The land should be kept as open as possible. Residential development should be permitted only at very low densities, and should be given ecological and visual considerations.

The problems of unregulated development without the protection of a good plan is very hard to correct once established and brings social and political problems, devaluated land prices, unsightly unsanitary conditions, and conflicts of neighboring land functions.



Proper land use regulation would prevent unsightly scenes as this

SCS PHOTO 12-P351-10

IV. SUMMARY OF IMPACTS

Some of the ideas and alternatives proposed in this report can be analyzed through a study of the monetary impact they will have in the subbasin. In the following table (table 6) the estimated average annual cost, benefits and returns are listed for a few programs in which the United States Department of Agriculture can participate.

Table 6, Economic impacts of programs under United States Department of Agriculture in the Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Area	Early Action Opportunities - Next 15 Years				Average annual man-years of employment
	Land treatment systems		Structural measures		
	Average annual cost	Average annual return	Average annual cost	Average annual benefits	
	$	$	$	$	
Potential PL 566 Projects					
1. Rock Lake Watershed	77,200	152,000	142,000	167,100	11
2. Tajique Draw Watershed	74,500	208,000	80,500	83,400	8
3. Buffalo Springs Watershed	165,000	475,000	167,400	192,900	17
4. Hyer Draw Watershed	96,000	181,000	222,100	304,000	11
Remaining Subbasin	250,000	574,900	-	-	17
Total	662,700	1,590,900	612,000	747,400	64

APPENDIX

PRELIMINARY REPORT
ESTANCIA SUBBASIN
UPPER RIO GRANDE BASIN
NEW MEXICO

ALBUQUERQUE, NEW MEXICO
1971

Prepared by:

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Economic Research Service
Forest Service

and the

NEW MEXICO STATE ENGINEER

TABLE OF CONTENTS

APPENDIX

PRELIMINARY REPORT

ESTANCIA SUBBASIN

This appendix contains four watershed investigation reports. These watersheds were selected because they have Public Law 566 potential for solving water and related land resource problems. The proposed projects appear to be physically and economically feasible and should be initiated as soon as possible.

WATERSHED INVESTIGATION REPORT

ROCK LAKE WATERSHED
Torrance County, New Mexico
(Watershed No. 1-107)

The Watershed in Brief

The watershed is located in Torrance County in central New Mexico. Willard, New Mexico, located 26 miles south of Moriarty and 10 miles south of Estancia, is in the watershed. This watershed drains in a northeasterly direction and is irregularly shaped. The north boundary of the watershed is one-half mile north of Willard and extends to the southwest about 23 miles to the divide between the Estancia and Rio Grande basins. The south boundary is about 11 miles south of Willard.

The watershed varies from about 12 miles wide in the middle to about 20 miles wide on the west side in the north-south direction by about 24 miles long in the east-west direction. The total area of the watershed is about 156,000 acres or 242 square miles. There are 76,000 acres of grassland, 13,000 acres of brushland, 36,000 acres of woodland, and 31,000 acres of farmland of which about 3,700 acres are irrigated.

The ownership of the watershed area is as follows: 19,000 acres administered by the federal government, 124,000 acres of private land, and 13,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies. The Bureau of Land Management administers 6,000 acres. The Forest Service administers 13,000 acres as part of the Cibola National Forest, of which approximately 600 acres are classed as commercial forest, 7,800 acres as non-commercial, and 5,600 acres as grassland.

The Forest Service project work inventory lists needs for work to enhance range conditions and wildlife habitat, control erosion, improve timber stands, and recreation needs. These needs should be included in work plan preparation.

Three highways traverse the watershed. U. S. Highway 60 is located in the northern tip. New Mexico Highway 41 extends north to south in the center, and New Mexico Highway 42 begins at Willard and extends southeast.

The Atchison, Topeka, and Santa Fe Railroad passes through the watershed. There are several county roads which make all portions of the watershed easily accessible.

Sea level elevations range from about 7600 feet in the mesas west of Willard to about 6100 feet in the valley. Topography in the watershed ranges from steep, rough mesa breaks to rolling plains and is nearly level on the valley floor. The watershed is included in the Basin and Range Physiographic Province.

Climate in the valley is favorable to agriculture. The average annual temperature in the valley is about 50° F. with a high of a little over 100° F. and a low of around -33° F. Average annual precipitation ranges from as high as 30 inches in the mountains to about 10 inches in the valley. The average frost-free period is about 140 days from the middle of May to October. Average annual lake evaporation is about 60 inches.

Soils in the higher elevations are developing on nearly level to steep slopes in sandstone materials and mixed aeolian and alluvial materials on piedmont slopes. Soils range from shallow to deep and are represented by Steep Rocklands and Penistaja, Witt, Harvey, and Manzano soil series.

Soils in the vicinity of Willard are developing on level to gently sloping topography in terrace lake sediments and wind-deposited materials. They are generally of moderate depth and are represented by Willard, Ildefonso, and Karde soil series.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains and (2) Pecos-Canadian Plains and Valleys. The latter is very adaptable to irrigated crop production.

There are no perennial surface water streams. Groundwater is fairly accessible for irrigation developments.

Drainages flowing from southwest to northeast cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, highways, and railroads. Floods in these draws are caused by high-intensity, short-duration rainstorms between May and October.

High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

Watershed Problems and Needs

Floodwater from the draws cause damage to high-developed irrigated cropland, irrigation wells, county roads, U. S. Highway 60, State Highway 41, and the Atchison, Topeka, and Santa Fe Railroad, farm equipment, and farm homes.

Floods are caused by high-intensity, short-duration summer thunderstorms. Flood history obtained from the local people indicated that substantial damages are received about every two or three years. In 1967, a storm occurred over a portion of the watershed resulting in floodwater damage estimated at $40,000. The 1967 storm is estimated to be of the size which will occur on the average once every 5 years. The 100-year frequency storm would cause an estimated $400,000 damage in the watershed.

The estimated average annual flood damage under future development without flood prevention measures installed is $95,500. The average annual damage to crop and pasture is estimated to be $68,000, and other agricultural damage is estimated to be $27,500. Other agricultural

Typical floods in Estancia Subbasin. Corn damaged by floods.

SCS PHOTO 12-PS73-3

damage includes farm irrigation systems consisting of wells, pumps, and distribution systems; farm improvements; farm roads, and farm equipment. Damage to crops and pastures consists of actual loss, deterioration in quality and the added expenses of harvesting and cleaning up of debris.

The Estancia Valley groundwater table has lowered. From 1948 through 1965 the water table declined about 5 feet.

The needs include flood protection, water-based recreation, groundwater recharge, grazing land management, and an improvement in the vegetative cover.

Additional studies will be needed to determine the effects of artificial recharge on water quality.

Physical Potential for Meeting the Needs

The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Except for some incidental recreational benefits realized as the flood pool is drawing down, water-based recreation needs will have to be satisfied elsewhere.

Land treatment measures could be installed which would tend to increase cover, decrease runoff and sediment production, and increase groundwater recharge.

The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment; however, due to the high-intensity rainfall and subsequent high runoff, the land treatment alone will not control floodwater.

Along with the land treatment program, a flood protection project would be installed to control the floodwater. Potential floodwater retarding structure sites have been tentatively located. The topography does not lend itself well to retarding structures.

Available geologic information indicates floodwater retarding structures could be installed without exceptionally high structure cost on valley fill material of sand, clay, and gravel of Pliocene to Recent age. Abutment materials at all potential structure sites are erodable. Good material for construction of the earthfills is available. Soil material at potential structure sites are SM, SP, and SC. Gross erosion rates in the watershed range from 0.09 to 0.31 acre feet/square mile/year and yield to reservoirs is 0.08 acre feet/square mile/year.

Permeability at the potential structure sites and down the channels below the sites indicates the possibility of disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels all the way to the salt lakes. It is assumed from available information that this is the most logical way to take care of the principal spillway discharge from the potential retarding structures.

Local Interest in Project Development

The local people are aware of the existing flood hazard and are somewhat anxious to take measures to reduce or prevent this damage.

It is recommended that the local people obtain information necessary to form a legal sponsoring organization and pursue assistance from all available state and federal programs.

Works of Improvement for Potential Development

Land Treatment - The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum.

Systems include:

(a) Protection from critical erosion on 1,000 acres. These areas are generally on steep, poorly vegetated, unstable soils, and along roads and trails. These severely eroded areas can benefit from the use of small gully plugs, net wire fences, contour furrows, and diversion designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

(b) Grazing management - good range management is essential on 6,000 acres of grassland. On all rangeland effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.

(c) Brush control on 1,000 acres of sagebrush and 3,000 acres of yucca.

(d) Pinyon-juniper control on 18,000 acres of woodland growing on soil and slope conditions adaptable to control.

(e) Improved irrigation systems on 2,000 acres of irrigated land.

(f) Dry cropland treatment on 1,000 acres.

(g) Revegetation of 9,000 acres of poorly vegetated, formerly cropped fields. Many old dry cropland fields reseeded under the Conservation Reserve Program failed to respond with adequate stands of desirable grasses to provide protection from wind and water erosion.

Structural Measures - Potential structural measures within the watershed are floodwater retarding structures on Round Top and Tabet Draws. The principal spillway discharges from these potential structures could be spread on the rangeland until absorbed, thereby serving as groundwater recharge. This can be done at very little cost, and is the most economical and logical method of disposing of the principal spillway flow. However, in the event diversion works are needed to accomplish the desired recharge, a water right to appropriate and use surface water will be required.

The potential structures are single-purpose flood prevention measures with incidental agricultural water management benefits from the groundwater recharge. The potential structures are all classed as "c" high-hazard sites and concrete-chute emergency spillways are assumed necessary. (See tables 1 and 2 for structural details, and figure 1 for structure locations).

Nature and Estimate of Costs of Improvements

Potential structures were located on United States Geological Survey 15-minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A centerline profile was taken off of the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. With this information, estimated cubic yards of earthfill for a proposed dam was developed.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on New Mexico's latest Public Law 566 contract. Cost for concrete chute emergency spillway was based on estimates made for similar dam heights and drainage areas in planning. A 20 percent contingency figure was added to construction cost estimates to offset unforeseen costs of the structural measures. Other costs were estimated by using cost data from other watersheds with similar conditions.

Effects and Feasibility of Potential Development

The estimated average annual flood damage in the watershed after the potential project is installed is $9,500. This is a reduction of approximately $86,000 or 90 percent by the installation of the project.

Redevelopment benefits from the installation of the project and operation and maintenance of project facilities would accrue. Local labor, not presently employed or not employed fulltime, could be employed in the installation and maintenance of project measures. The average annual value of redevelopment benefits is estimated to be $35,300.

Groundwater recharge will occur as a result of the potential floodwater retarding structures and associated works of improvement. The monetary value of increasing the recharge to the underground basin is estimated to be $34,600 when converted to an average annual value.

Secondary benefits resulting from the project will include increased net income to producers, handlers, and processors of increased agricultural production in the watershed. The estimated average annual secondary benefits are $11,200.

Total average annual benefits are estimated to be $167,100 (table 6). The estimated average annual cost of the structural measures is $142,000. This results in a benefit-cost ratio of 1.2 to 1 (table 6).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $77,200. The average annual returns are estimated to be $152,000.

Alternative or Additional Possibilities

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structure sites have been located.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated and it appeared to be the most expensive method of disposal. (2) Artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment would need to be made since the injected water would have to meet State Health Department requirements.

Table 1, Structure data, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site No.	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway: Type	Principal spillway: Release rate	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surface area @ emerg. spwy. level	Struc. class hazard
	(sq.mi.)	(feet)	(cu.yds.)		(csm)			(acres)	
1	14.0	43	510,000	R/C conduit	8	R/C chute	one	130	c
2	79.6	74	1,100,000	R/C conduit	8	R/C chute	one	500	c

Table 2, Reservoir storage capacity, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site no.	Drainage area	Planned storage capacity: Sediment	Planned storage capacity: Detention	Total flood prevention storage
	(sq.mi.)	(ac.ft.)	(ac.ft.)	(ac.ft.)
1	14.0	105	1,480	1,585
2	76.6	565	7,000	7,565

Table 3, Distribution of structural cost-potential development, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation costs				
	Construction	Installation services	Land, easements & rights-of-way	Administration of contracts	Installation cost
Site 1	660,600	99,100	11,000	300	771,000
Site 2	1,504,800	180,600	25,000	600	1,711,000
Total	2,165,400	279,700	36,000	900	2,482,000

1/ Price base 1969

Table 4, Estimated average annual flood damage reduction benefits, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Crop and pasture	68,000	6,800	61,200
Other agricultural	27,500	2,700	24,800
Total	95,500	9,500	86,000

1/ Based on adjusted normalized prices

Table 5, Annual cost, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

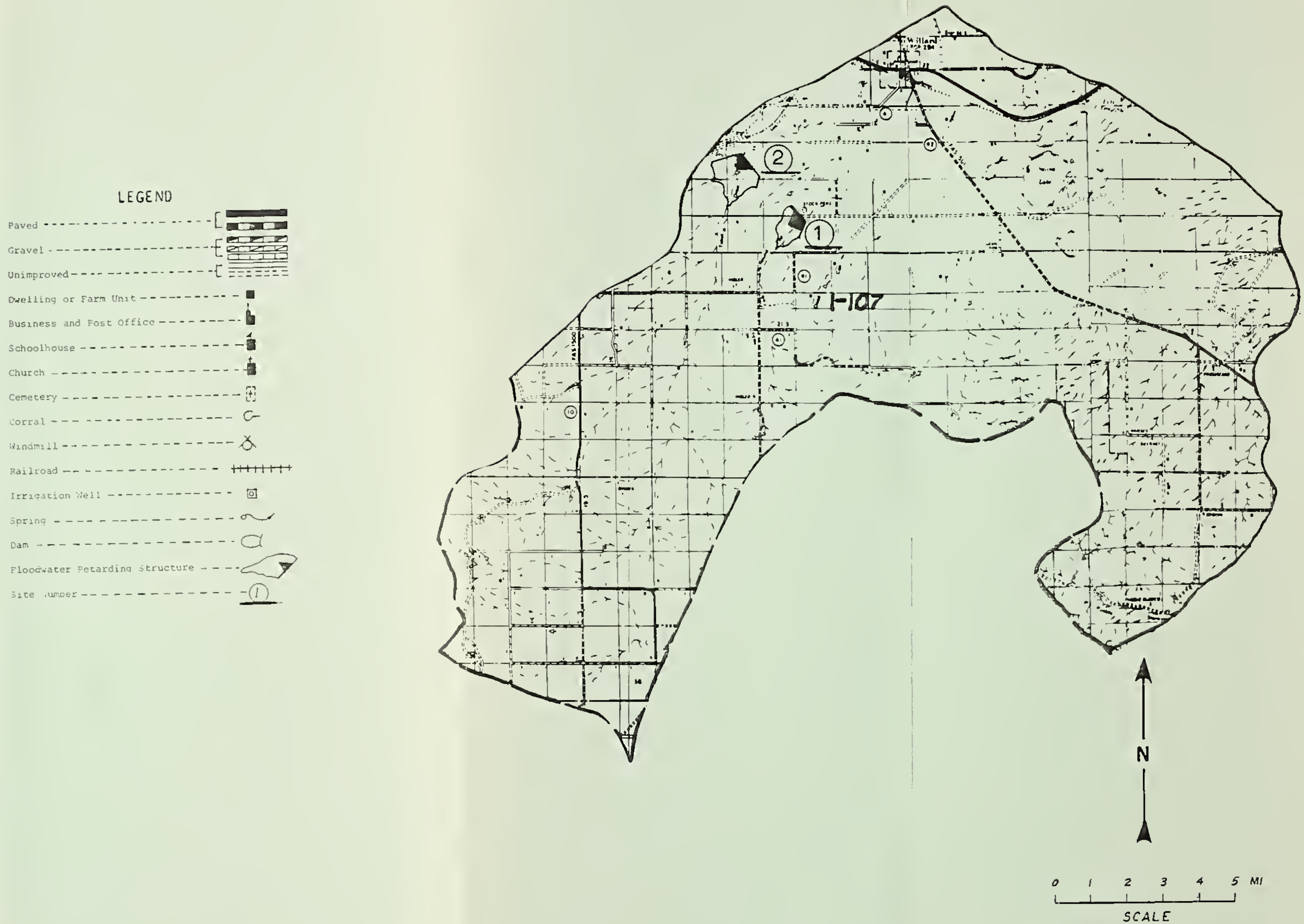
Evaluation unit	Amortization of installation cost (dollars) 1/	Operation and maintenance cost (dollars) 2/	Total annual cost
All structural measures	128,000	14,000	142,000

1/ Amortized for 100 years at 5 1/8 percent interest
2/ Adjusted normalized prices

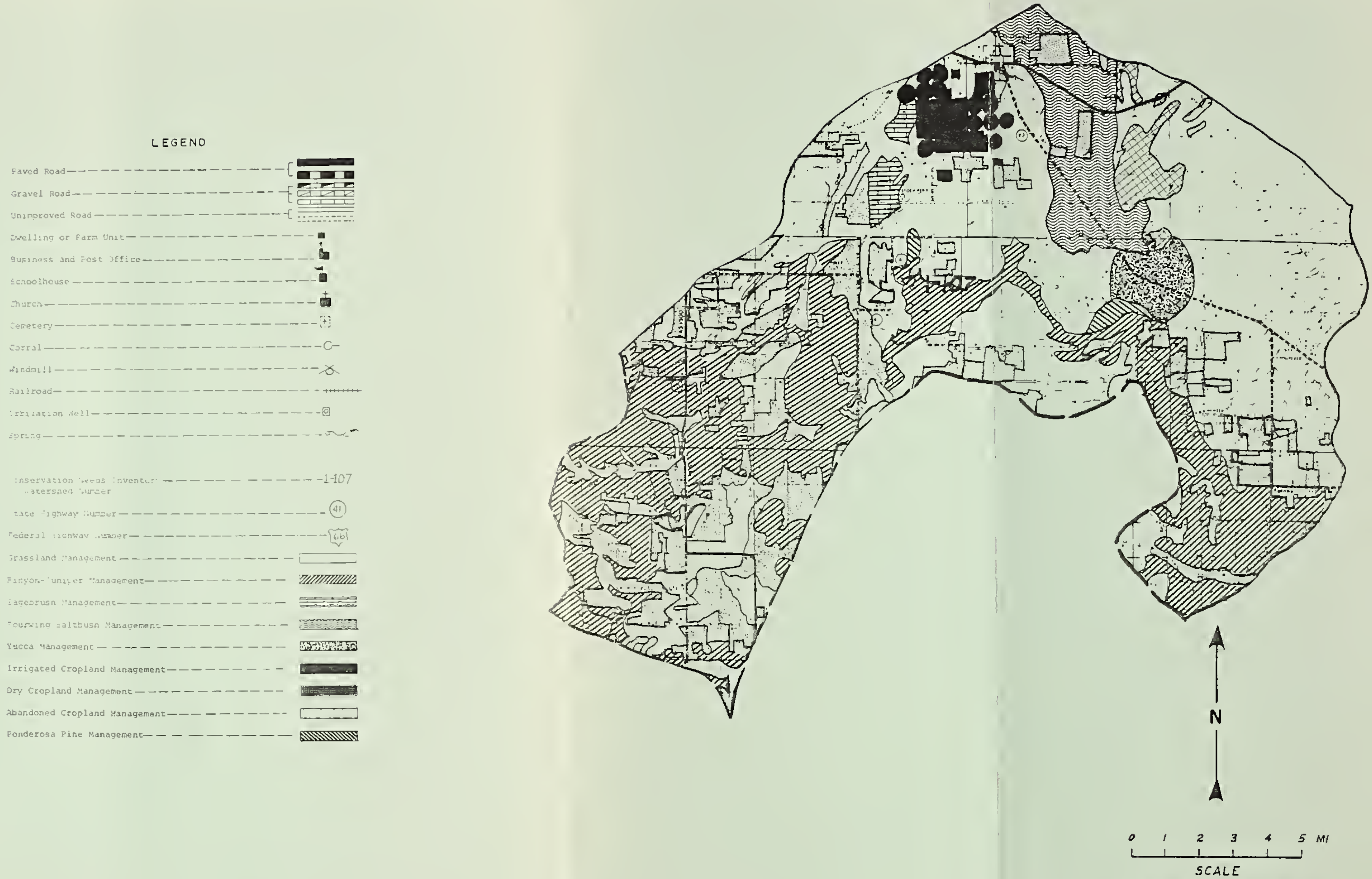
Table 6, Comparison of benefits and costs for structural measures, Rock Lake Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Average annual benefits 1/ (dollars)					Ave. annual cost 2/	B/C ratio
	Flood prev. damage red.	Groundwater recharge	Redevelopment	Secondary	Total		
All structural measures	86,000	34,600	35,300	11,200	167,100	142,000	1.2:1

1/ Adjusted normalized prices
2/ From table 5



STRUCTURE LOCATION
ROCK LAKE WATERSHED
UPPER RIO GRANDE BASIN



LAND TREATMENT
ROCK LAKE WATERSHED
UPPER RIO GRANDE BASIN

Flood damage to roads and crops SCS PHOTO 12-P573-5

The estimated average annual flood damage under future conditions without flood prevention measures is $30,400. The estimated average annual flood damage is distributed as follows:

Crop and pasture	$22,400
Other agricultural	4,000
Highway and railroad	4,000

In most areas in the Estancia Valley, the groundwater table is on the decline. From 1948 through 1965, the water table declined as much as 20 feet. Continued decline of the water table will, in time, present a problem of water quality.

There is need for flood protection, water-based recreation, groundwater recharge, grazing land management, increase in vegetative groundcover and better vegetation conditions. Additional studies will be needed to determine the effects of artificial recharge on water quality.

Physical Potential for Meeting the Needs

The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water-storage pools. Full time facilities to meet water-based recreation needs cannot be provided by Public Law 566 projects here. Incidental recreational benefits as the flood pools recede are a possibility.

Land treatment measures can be instigated which will tend to increase cover, decrease runoff and sediment production, and aid in recharging groundwater aquifers. The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. However, due to the high-intensity rainfall and subsequent high runoff, land treatment alone will not control floodwater.

In addition to the land treatment program, a flood protection project could be installed to control floodwater. Potential floodwater retarding structure sites have been tentatively located. The topography does not lend itself well to building high retarding structures, but the structures can be built long enough so the necessary storage can be obtained.

Available geologic information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of clay, sand, and gravel of Pliocene to Recent age. Abutment materials at all structures are erodable. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are ML-CL and CL.

Permeability at the potential structure sites and down the channels below the sites indicates the possibility of disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. It is assumed from information available that this is the most logical and economical way to take care of the principal spillway flow from the potential retarding structures.

Local Interest in Project Development

Since the flood of 1967, the interest of local people has increased. The local people are aware of the flood hazard, and are interested in trying to eliminate the problems. It is recommended that the people form a legal sponsoring organization to guide their search for the best programs available to alleviate their problems.

Works of Improvement for Potential Development

Land Treatment - The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Protection from critical erosion on 1,500 acres. These small, scattered areas are generally located on steep, poorly vegetated, unstable soils, and in areas of heavy use near farmsteads and along roads and trails. Land subject to critical erosion can benefit from small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils so grass seeding will result in protective stands of vegetation.

(b) Good range management on 13,000 acres of grassland. Grazing management is essential to all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.

(c) Brush control on 100 acres of chaparral growing in the upper elevations of the watershed.

(d) Pinyon-juniper control on 6,000 acres of woodlands growing on soils and slope conditions adaptable to control.

(e) Ponderosa pine management on 10,000 acres. Treatment includes timber stand improvement, establishment, and reinforcement.

(f) Improved irrigation systems on 4,000 acres of irrigated land.

(g) Dry cropland treatment on 480 acres.

(h) Revegetation of 14,000 acres of poorly vegetated, formerly cropped fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to provide protection to the land from wind and water erosion. This formerly cropped land poses a threat to the effectiveness of structural measures that may be installed.

(i) Develop ponds for water-based recreation.

Structural Measures - The one potential structural measure is a floodwater retarding structure on Torreon Draw and Arroyo del Cuervo. The principal spillway discharge from this structure could be spread on the rangeland until absorbed thereby serving as groundwater recharge. This can be done at very little cost, and is the most economical and logical method of disposing the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structure is single-purpose flood prevention with incidental agricultural water management benefits from the groundwater recharge. The potential structure is classed as "c" high-hazard site and a concrete chute emergency spillway is assumed necessary. (see tables 1 and 2 for structural details, and figure 1 for structure location).

Nature and Estimate of Costs of Improvements

Potential structures were located on United States Geological Survey 15-minute quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure.

A centerline profile was taken from the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. Using the above information, an estimate was made of the cubic yards of earthfill needed.

Cost estimates on the potential floodwater retarding structure were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest bid for structural measures. Cost for the concrete chute emergency spillway was based on estimates made for similar dam heights in watershed planning. A 20 percent contingency figure was added to the construction cost estimates to offset unforeseen costs of the structural measures.

Other costs were estimated by using cost data from other watersheds with similar conditions.

Effects and Feasibility of Potential Development

With the project installed, the estimated average annual flood damage would be $8,700, or a reduction in average annual damage of approximately 71 percent. Average annual damage reduction benefits from the installation of structural measures are estimated to be $21,700 (table 4).

Other benefits which would result from the structural measures found feasible in the watershed include the following average annual estimates:

Groundwater recharge	$35,900
Redevelopment	20,300
Secondary	5,500

Total average annual benefits to the structural measures are estimated to be $83,400 (table 6). The average annual cost of structural measures is estimated to be $80,500 (table 5). The benefit-cost ratio is 1 to 1 (table 6).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $74,500. The average annual returns are estimated to be $208,000.

Alternate or Additional Possibilities

There are many other potential structure site locations within this watershed. Such locations exist on the draws on which the structure site has been located.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated, and it appeared to be the most expensive method of disposal. (2) Artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment necessary would need to be made since the injected water would have to meet State Health Department requirements.

Table 1, Structure data, Tajique Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site No.	Drainage area	Est. height of dam	Est. vol. of fill	Principal spillway		Emergency spillway		Max. surf. area @ emerg. spwy. level	Struc. class hazard
				Type	Release rate	Type	% chance of use		
	(sq.mi.)	(feet)	(cu.yds.)		(csm)			(acres)	
1	111.5	42	689,000	R/C conduit	12	R/C chute	one	1,000	c

Table 2, Reservoir storage capacity, Tajique Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site No.	Drainage area	Planned storage capacity		Total flood prevention storage
		Sediment	Floodwater detention	
	(sq.mi.)	(acre-feet)	(acre-feet)	(acre-feet)
1	111.5	810	11,600	12,410

Table 3, Distribution of structural cost - potential development, Tajique Watershed, Estancia Subbasin Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measure	Installation costs				
	Construction	Installation services	Land, easements & rights-of-way	Administration of contracts	Installation cost
1	1,107,600	132,900	125,000	500	1,366,000

1/ Price base 1969

Table 4, Estimated average annual flood damage reduction benefits, Tajique Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Crop and pasture	22,400	6,700	15,700
Other agricultural	4,000	1,000	3,000
Highway and railroad	4,000	1,000	3,000
Total	30,400	8,700	21,700

1/ Based on adjusted normalized prices

Table 5, Annual cost, Tajique Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

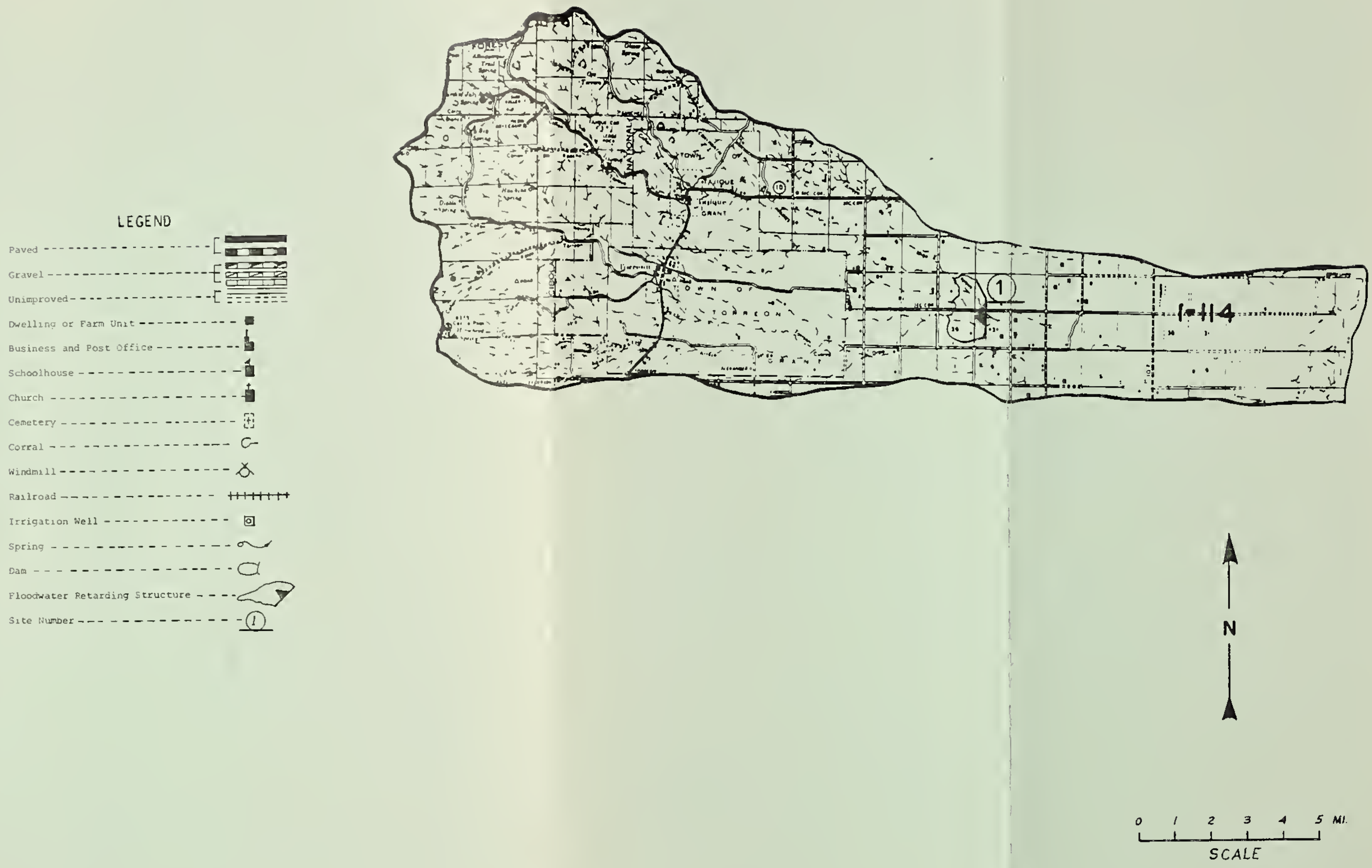
Evaluation unit	Amortization of installation cost (dollars) 1/	Operation and maintenance cost (dollars) 2/	Total annual cost
All structural measures	70,500	10,000	80,500

1/ 1969 costs amortized at 5 1/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Tajique Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Average annual benefits 1/: Flood prev. damage red.	Groundwater recharge	Redevelop-ment	Secondary	Total	Ave. annual cost 2/	B/C ratio
All structural measures	21,700	35,900	20,300	5,500	83,400	80,500	1:1

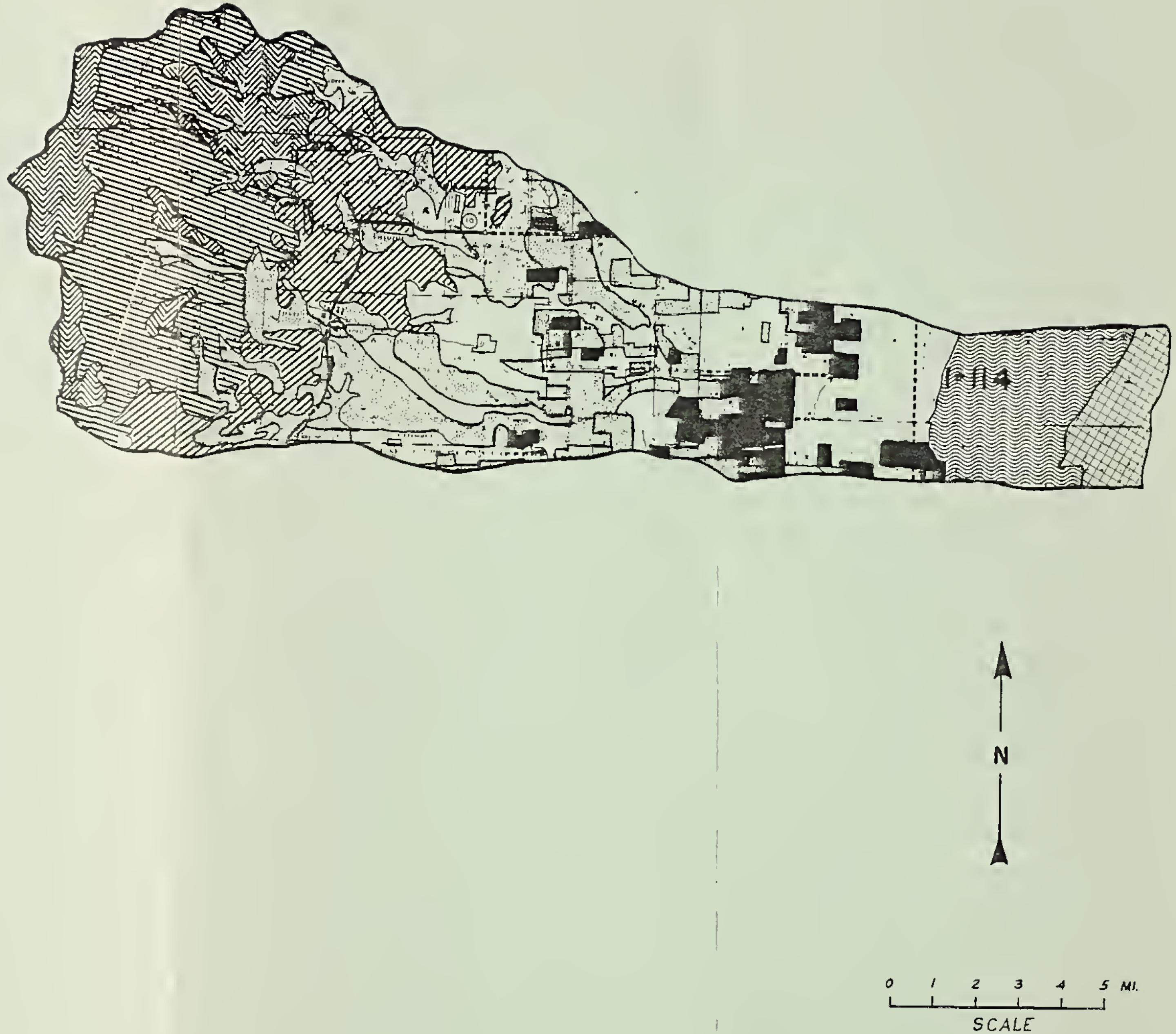
1/ Adjusted normalized prices
2/ From Table 5



STRUCTURE LOCATION
TAJIQUE WATERSHED
UPPER RIO GRANDE BASIN

LEGEND

- Paved Road
- Gravel Road
- Unimproved Road
- Dwelling or Farm Unit
- Business and Post Office
- Schoolhouse
- Church
- Cemetery
- Corral
- Windmill
- Railroad
- Irrigation Well
- Spring
- Conservation Needs Inventory Watershed Number — 1-114
- State Highway Number — 41
- Federal Highway Number — 66
- Grassland Management
- Pinyon-Juniper Management
- Fourwing Saltbush Management
- Chaparral Management
- Ponderosa Pine Management
- Irrigated Cropland Management
- Dry Cropland Management
- Abandoned Cropland Management
- Miscellaneous Land



LAND TREATMENT
TAJIQUE WATERSHED
UPPER RIO GRANDE BASIN

WATERSHED INVESTIGATION REPORT

BUFFALO SPRINGS WATERSHED
Torrance County, New Mexico
(Watershed No. 1-119)

The Watershed in Brief

The watershed is located in Torrance County in central New Mexico. It drains part of the east side of the Manzano Mountains, and the drainage pattern is in an easterly direction. The north boundary of the watershed is just north of Moriarty and extends to the west into the Manzano Mountains which form the western boundary of the watershed. The south boundary of the watershed is 2 miles south of Estancia and the east boundary extends parallel with and about 4 1/2 miles east of State Highway 41.

The watershed is about 21 miles from north to south, by about 20 miles east to west. The total area of the watershed is 238,000 acres, or 372 square miles, of which 100,000 acres are grassland, 15,000 acres are brushland, 50,000 acres are woodland, 23,000 acres are timberland, and 50,000 acres are farmland. There are 13,500 acres of the farmland irrigated.

The ownership of the watershed area is as follows: 8,400 acres administered by the federal government, 216,600 acres of private land, and 13,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies. The Bureau of Land Management administers 1,400 acres. About 7,000 acres is National Forest land administered by the Forest Service through the Cibola National Forest, Mountainair and Sandia Ranger Districts. The area consists of approximately 1,200 acres of commercial timber, 5,600 acres of non-commercial timber, and 200 acres of grassland.

The project work inventory lists needs for land treatment, vegetative manipulation, and timber stand improvement on the National Forest, all of which should be included in the work plan for this watershed.

The towns of Moriarty and Estancia are located within the watershed. Moriarty is located about 30 miles east of Albuquerque on U. S. Highway 66. Estancia is located 16 miles south of Moriarty. State Highway 41 runs north and south through the watershed and intersects U. S. Highway 60 about 11 miles south of Estancia.

There is a spur line from the Atchison, Topeka, and Santa Fe Railroad which extends south to Willard where it intersects the main line. Several county roads traverse the area and make all parts of the watershed easily accessible.

Sea level elevations range from about 10,098 feet in the Manzano Mountains to 6100 feet in the valley. Topography in the watershed ranges from steep, rough mountains to rolling plains and is essentially flat in the valley floor. The watershed is included in the Basin and Range Physiographic Province.

Climate in the valley is favorable to agriculture. The average annual temperature at Estancia is 50° F. with a high of about 102° F. and a low of about -33° F. Average annual precipitation is about 9.6 inches at Estancia. The average frost-free period is about 138 days, from May 17 to October 13.

Soils in the mountains and foothills are developing on gently sloping to very steep slopes in limestone, sandstone, and shale materials. Depths range from shallow to deep. Wilcoxson, Supervisor, Pino, and Turkey Springs soil series are representative. Soils below the foothills on valley-fill slopes and piedmont fans are developing on nearly level to strongly sloping topography in mixed alluvial deposits. They are moderately deep to deep and are represented by Witt, Harvey, and Manzano soil series. Soils in the vicinity of McIntosh and Estancia are developing on level to gently sloping topography in terrace lake sediments and wind-deposited soil materials. They are moderately deep and are represented by Willard, Ildefonso, and Karde soil series.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains and (2) Pecos-Canadian Plains and Valleys. Much of the latter is adapted to irrigation crop production.

There are no perennial surface water streams; however, groundwater is fairly accessible. It is necessary to rely upon groundwater for any developments entailing large quantities of water.

Draws which flow from west to east cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, highways, railroads, and residential and commercial property in Estancia. Floods are caused by high-intensity, short-duration rainstorms occurring for the most part from May through October.

High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

Watershed Problems and Needs

Floodwaters from the draws cause damage to highly-developed irrigated cropland, irrigation wells, county roads, state highway 41, and the Atchison, Topeka, and Santa Fe Railroad spur, farm equipment, farm homes, and residences and businesses in the town of Estancia.

Flood history obtained from the local people indicates that substantial damages are received about every two or three years.

Irrigated land damage. Note high-water mark on fence SCS PHOTO 12-PS14-1

Main street of Estancia under floodwater from August 1967 flood from Milbourne and Compton Draws. SCS PHOTO 12-PS14-12

Investigation of flood damage in the watershed was made. The most recent flood resulting in major damage occurred in 1967. Other floods caused major damage in the watershed in 1927, 1935, 1942, 1952, and 1904.

In 1967, a storm occurred over a portion of the watershed, and resulting floodwaters caused damages estimated at $75,000. The 1967 storm is estimated to be of the size which will occur on the average once every 10 years. The 100-year frequency storm would cause an estimated $450,000 damage in the watershed.

The estimated average annual flood damage under future conditions, without flood prevention measures, is $105,500. Average annual damage to agricultural property amounts to $52,200 and to non-agricultural property including highway, railroad, and urban property in Estancia accounts for the remaining $53,300.

In most areas, the Estancia Valley groundwater table is on the decline. From 1948 through 1965, the water table dropped as much as 40 feet.

There is need for flood protection, water-based recreation, groundwater recharge, irrigation water management, increased vegetative cover, and better vegetation condition. Additional studies will be needed to determine the effects of artificial recharge on groundwater quality.

Local Interest in Project Development

Since the flood of 1967, the interest of the local people has increased. Residents of the town of Estancia are aware of the flood hazard to their community, and are interested in trying to eliminate the problem. It is recommended that the people form a legal sponsoring organization and submit their problems to the New Mexico State Engineer and others for consideration for technical and monetary assistance.

Physical Potential for Meeting the Needs

Average annual precipitation is about 18 inches at Tajique and about 9.6 inches at Estancia. Average annual lake evaporation is about 55 inches. The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Full time facilities to meet water-based recreation needs cannot be provided by Public Law 566 projects here. These needs will have to be met in adjoining subbasins. Incidental recreational benefits as the flood pools recede are a possibility.

The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. Due to the high-intensity rainstorms and subsequent high runoff, land treatment alone will not control floodwater.

In addition to a land treatment program, a flood protection project is needed. The flood protection project would consist of floodwater retarding structures and outlet channels to be installed so as to enhance groundwater recharge.

Potential floodwater retarding structures have been tentatively located. The topography does not lend itself well to retarding structures; however, long structures can be constructed.

Available geologic information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of sand, gravel, and clay which is Pliocene to Recent in age. Abutments at all structures are erodible. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are ML-CL and CL.

Permeability at the potential structure sites and down the channels below the sites makes possible the disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. Partial cutoff in foundation will control velocity of subsurface flow to a safe level without excessive cost. It is assumed from available information that this is the most logical way to take care of the principal spillway discharge from the potential retarding structures.

Gross erosion rates range from 0.26 to 0.38 acre-feet/square mile/year and yield of sediment to reservoirs is approximately 0.1 acre-feet/square mile/year.

Works of Improvement for Potential Development

Land Treatment - The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Protection from critical erosion on 1,000 acres. These areas are generally on steep, poorly vegetated, unstable soils, and in areas of heavy use near farmsteads and urban areas. Land subject to criticial erosion can benefit from small gully plugs, net wire fences, contour furrows and diversions designed to stabilize the soils in order for grass seeding to produce protective stands of vegetation.

(b) Good range management on 21,000 acres of grassland. Grazing management is essential on all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through use of additional fences and livestock watering facilities.

(c) Pinyon-juniper control on 25,000 acres.

(d) Chaparral control on about 20 acres.

(e) Timberland improvement - establishment or reinforcement on 11,600 acres of ponderosa pine forest land.

(f) Improved irrigation systems on 10,000 acres of irrigated land.

(g) Dry cropland treatment on 640 acres.

(h) Revegetation of 32,000 acres of poorly vegetated, formerly cropped fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to protect the land from erosion. This formerly cropped land poses a serious threat to the effectiveness of structures that may be installed.

Structural Measures - Potential structural measures proposed are floodwater retarding structures on Estancia Draw just west of Estancia, Melbourne, and Chincante Draws, Compton Draw and Cienega Draw. The principal spillway discharges from these structures could be spread on the rangeland until absorbed thereby enhancing groundwater recharge. This is the most economical and logical way of disposing of the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structures would be single-purpose flood prevention measures with incidental agricultural water management benefits resulting from the groundwater recharge. The potential structures are all classed as "c" high-hazard sites and concrete emergency spillways are assumed necessary. (See tables 1 and 2 for structural details and figure 1 for structure location).

Nature and Estimate of Costs of Improvements

Potential structures were located on United States Geological Survey (15-minute) quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A centerline profile was taken from the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield, and the runoff produced by the 100-year frequency storm routed through the structure. With this information an estimated earthfill in cubic yards was made.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest projects for which bids were received. Costs for concrete chute emergency spillways were based on estimates made for similar planned Public Law 566 projects. A 20 percent contingency figure was added to the construction cost estimates in order to offset unforeseen costs of the structural measures.

Other costs were estimated by using cost data from planned Public Law 566 watersheds having similar conditions.

Effects and Feasibility of Potential Development

The installation of the structural measures would reduce flood damages by an estimated 87 percent and give average annual benefits of $91,800 (table 4). Remaining average annual damages after project installation would amount to about $13,700.

Installation of the project would provide secondary benefits in the watershed and general trade area. These benefits would accrue as increased net income to both producers and processors of agricultural products and services. The estimated average annual secondary benefits which would accrue with the installation of the project are $13,700.

Redevelopment benefits resulting from the installation and maintenance of project works of improvement are estimated to be $44,700 when averaged annually over the project life of 100 years. These benefits would result from the employment of local labor now unemployed or not employed full time. These benefits would accrue to the watershed community during construction of the project and by the employment of local labor necessary to operate and maintain project works of improvement for several years.

Groundwater recharge resulting from the flood prevention structural measures would afford some increase in beneficial use of flood runoff. The estimated average annual benefits from groundwater recharge are $42,700.

Average annual benefits accruing to structural works of improvement amount to $192,900. The estimated average annual costs for the structural works required to provide the evaluated benefits are $167,400. The benefit-cost ratio is 1.2 to 1 (table 6).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development, and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $165,000. The average annual returns are estimated to be $475,000.

Alternative or Additional Possibilities

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structures have been located. There is a possibility structures could be justified on some of the other draws also.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was investigated, and it appeared to be the most expensive method of disposal, (2) artificial recharge wells were investigated to obtain a rough cost estimate and proved physically possible. A thorough investigation of the water treatment necessary would need to be made since injected water would have to meet State Health Department requirements.

Table 1, Structure data, Buffalo Springs Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site No.	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. vol. of fill (cu.yds.)	Principal spillway: Type	Principal spillway: release rate (csm)	Emergency Spillway: Type	Emergency Spillway: % chance of use	Max. surface area @ emerg. spwy. level (acres)	Struc. class hazard
1	12.0	19	67,000	R/C conduit	8	concrete	one	240	c
2	55.7	48	818,000	R/C conduit	8	concrete	one	540	c
3	20.8	35	849,000	R/C conduit	8	concrete	one	170	c
4	11.8	26	30,000	R/C conduit	8	concrete	one	100	c

Table 2, Reservoir storage capacity, Buffalo Springs Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site no.	Drainage area	Planned storage capacity (acre-feet)		
		Sediment	Detention	Total flood prevention storage
	(sq.mi.)	(ac.ft.)	(ac.ft.)	(ac.ft.)
1	12.0	135	1,300	1,435
2	55.7	515	5,900	6,415
3	20.8	200	2,200	2,400
4	11.8	130	1,250	1,380

Table 3, Distribution of structural cost of potential development, Buffalo Springs Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation costs				
	Construction	Installation services	Land, easements & rights-of-way	Administration of contracts	Installation cost
Site 1 (Estancia)	191,600	40,300	7,500	300	239,700
Site 2 (Milbourne)	1,072,700	128,700	25,000	500	1,226,900
Site 3 (Compton Draw)	1,129,200	135,500	10,000	500	1,275,200
Site 4 (Cienega Draw)	138,600	29,100	25,000	300	193,000
Total	2,532,100	333,600	67,500	1,600	2,934,800

1/ Price base 1969

Table 4, Estimated average annual flood damage reduction benefits, Buffalo Springs Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Crop and pasture	46,200	11,500	34,700
Other agricultural	6,000	1,000	5,000
Subtotal, agricultural	52,200	12,500	39,700
Residential	31,600	600	31,000
Commercial	19,200	400	18,800
Highway-Railroad	2,500	200	2,300
Subtotal, non-agricul.	53,300	1,200	52,100
Total	105,500	13,700	91,800

1/ Based on adjusted normalized prices

Table 5, Annual cost, Buffalo Springs Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Amortization of installation cost 1/	Operation & maintenance cost 2/	Total annual cost
All structural measures	151,400	16,000	167,400

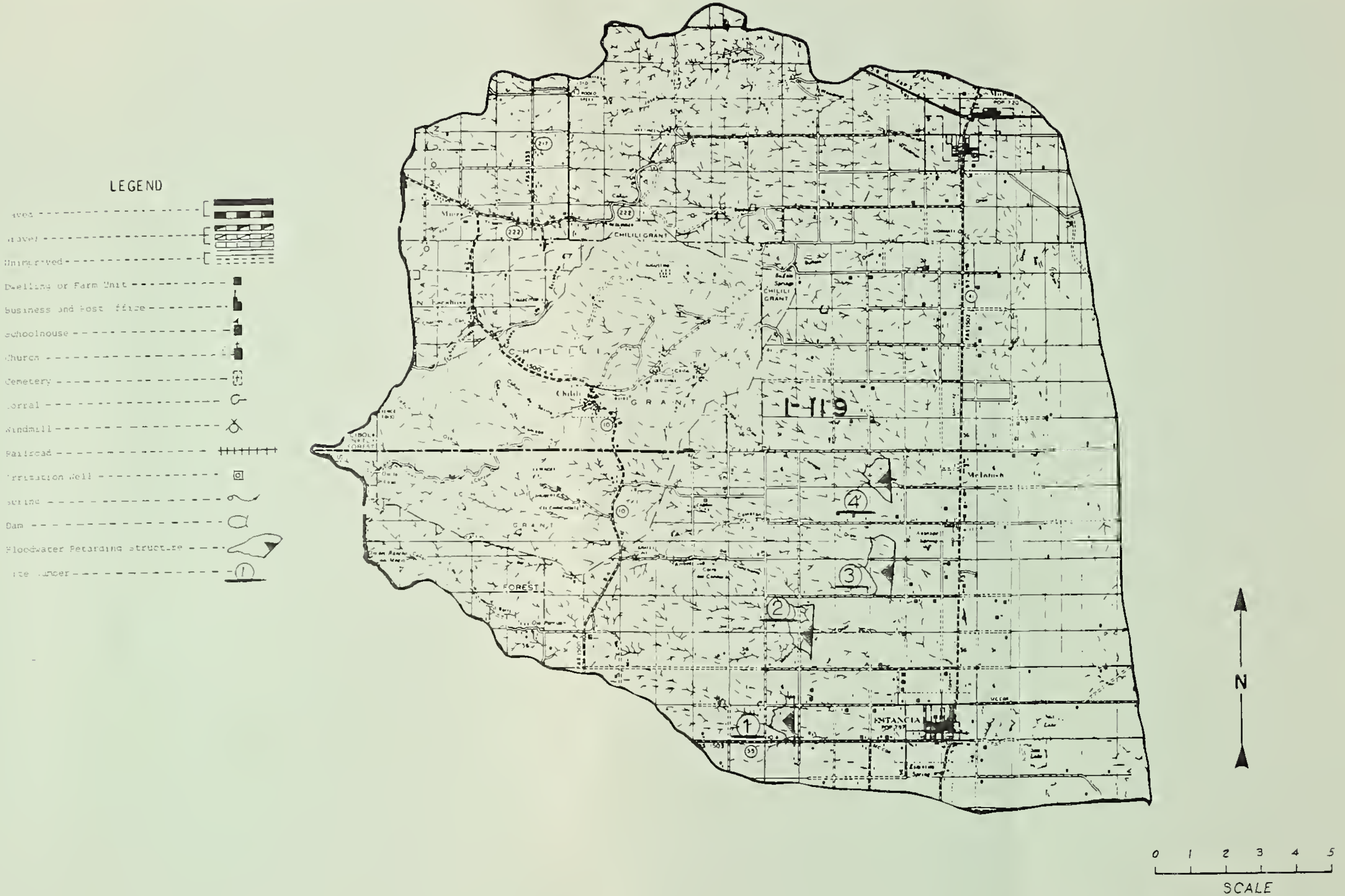
1/ 1969 cost amortized at 5 1/8 percent interest for 100 years
2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Buffalo Springs Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Evaluation unit	Average annual benefits 1/					Average annual cost 2/	Benefit-cost ratio
	Flood prev. damage red.	Groundwater recharge	Re-development	Secondary	Total		
All structures	91,800	42,700	44,700	13,700	192,900	167,400	1.2:1

1/ Adjusted normalized prices

2/ From table 5

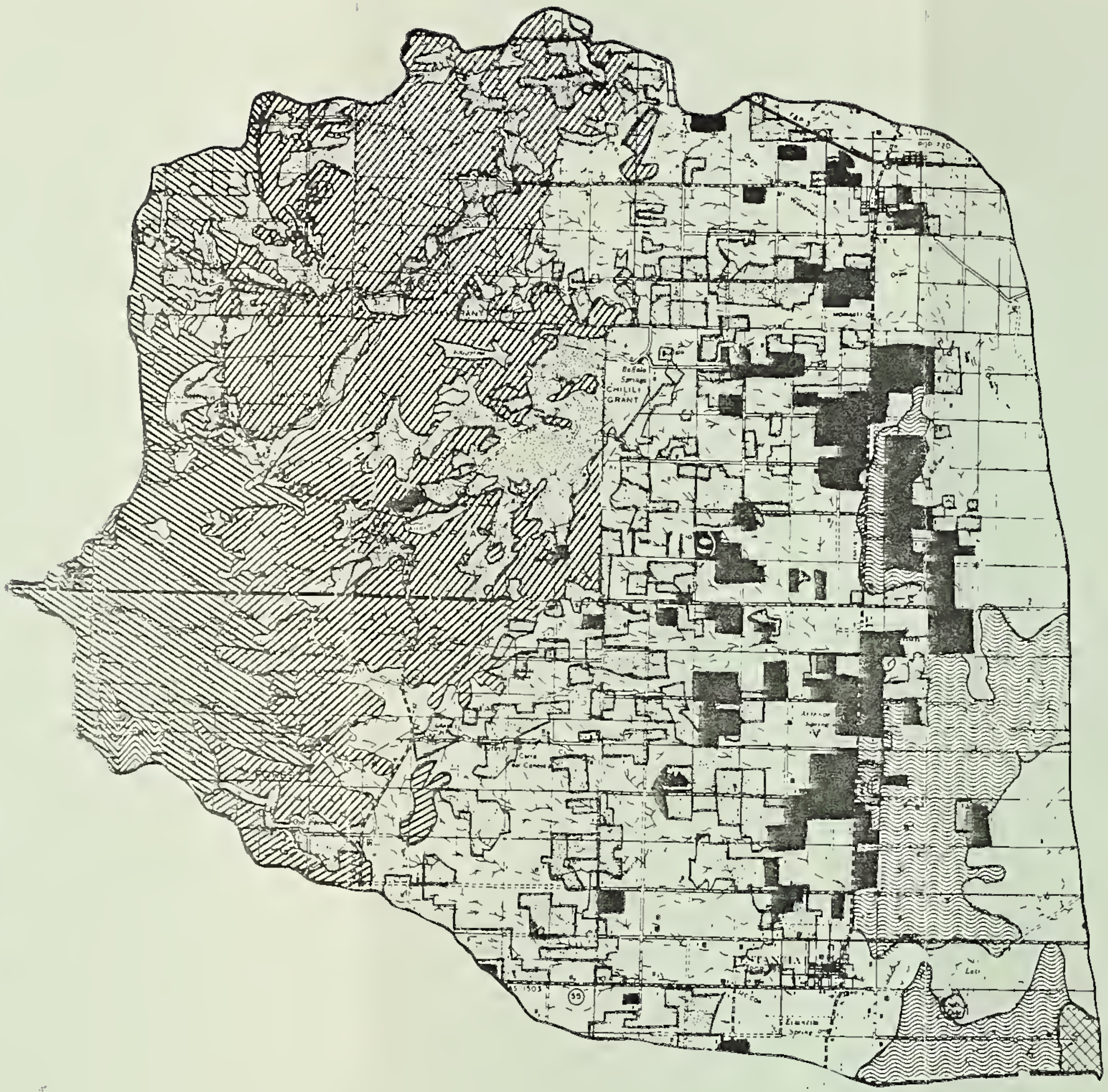


STRUCTURE LOCATION
BUFFALO SPRINGS WATERSHED
UPPER RIO GRANDE BASIN

LEGEND

Paved Road
Gravel Road
Unimproved Road
Dwelling or Farm Unit
Business and Post Office
Schoolhouse
Church
Cemetery
Corral
Windmill
Railroad
Irrigation Well
Spring

Conservation Needs Inventory Watershed Number — 1 119
State Highway Number
Federal Highway Number
Grassland Management
Pinyon-Juniper Management
Fourwing Saltbush Management
Chaparral Management
Ponderosa Pine Management
Irrigated Cropland Management
Dry Cropland Management
Abandoned Cropland Management (previously cultivated not well vegetated)
Miscellaneous Land



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LAND TREATMENT
BUFFALO SPRINGS WATERSHED
UPPER RIO GRANDE BASIN

WATERSHED INVESTIGATION REPORT

HYER DRAW WATERSHED
Torrance, Santa Fe, and Bernalillo Counties
(Watershed No. 1-122)

The Watershed in Brief

The watershed is located in Torrance, Santa Fe, and Bernalillo Counties in central New Mexico. The draws in the watershed drain the east side of the San Pedro Mountains in an easterly direction and to the south from the Galisteo Divide. The watershed is fan-shaped with the fan sides coming together about 5 miles east of Moriarty. The east boundary extends north to the Galisteo Divide, which forms the northern boundary of the watershed. The west boundary is formed by the San Pedro Mountains. The confluence of the drainages in this watershed is about 1 1/2 miles east of Moriarty.

The watershed is about 16 miles wide, north to south, about 18 miles long, east to west. The total area of the watershed is 198,400 acres or 310 square miles, of which 125,900 acres are grassland, 500 acres are brushland, 19,000 acres are woodland, 4,000 acres are timberland, and 49,000 acres are farmland. There are 11,000 acres of irrigated farmland.

The ownership of the watershed area is as follows: 5,300 acres administered by the federal government, 159,100 acres of private land, and 34,000 acres of land administered by the state.

Land administered by the federal government is under two separate agencies: the Forest Service (3,400 acres) and the Bureau of Land Management (1,900 acres). Of the 3,400 acres of the Cibola National Forest, which includes Sandia Ranger District, approximately 400 acres are classified as commercial and 2,600 acres as non-commercial forest.

The villages of Stanley and Edgewood are within the watershed. The town of Moriarty which is about 30 miles east of Albuquerque on U. S. Highway 66 is located about one mile south of the watershed boundary at the intersection of U. S. Highway 66 and State Highway 41 which runs north and south through the watershed intersecting U. S. Highway 60 about 26 miles south of Moriarty.

There is a spur line from the Atchison, Topeka, and Santa Fe Railroad which extends to Moriarty. There are several state and county roads which make all portions of the watershed easily accessible.

Sea level elevations range from about 8240 feet in the San Pedro Mountains to 6200 feet in the valley. Topography in the watershed ranges from steep, rough mountains to rolling plains, and is nearly level on the valley floor. It is included in the Basin and Range Physiographic Province.

Climate in the valley is mild and favorable to agriculture. The average annual temperature is about 50° F. with a high of about 102° F. Average annual precipitation is about 12 inches at McIntosh located about 6 miles south of Moriarty. The average frost-free period at McIntosh is about 149 days from May 17 to October 13.

Soils in the higher elevations are shallow to deep and moderately permeable, developing on steep to very steep slopes in weathered granite, gneiss, schist, and mixed alluvium. Soil series representative of the area are Chimayo, Mirabal, Loma, and Hubert. Sixty percent of the watershed's soils are deep and moderately permeable, developing on broad, nearly level, to strongly sloping uplands in ancient mixed alluvium. Witt, Harvey, and Clovis soils are representative. The northeastern part of the watershed has shallow to moderately deep, loamy soils developing on gently sloping to moderately steep slopes in mixed alluvium containing caliche horizons. Dean, Harvey, and Tapia are soil series representative of the area.

There are two major land resource areas included in the watershed: (1) Arizona and New Mexico Mountains, and (2) Pecos-Canadian Plains and Valleys. The latter is very adaptable to irrigated crop production.

There are no perennial surface water streams. Any developments requiring water must depend on use of groundwater which is fairly accessible.

Floods in draws which flow from west to east cause substantial amounts of damage to land developed for irrigated crop production, farmsteads, fences, and highways. Floods in these draws are caused by high-intensity, short-duration rainstorms between May and October. High-value crops such as lettuce, potatoes, and onions are well adapted to the area.

Watershed Problems and Needs

Floodwater from draws causes damage to highly developed irrigated cropland, irrigation wells, county roads, state highways 41, 344, and 472, farm equipment, and farm homes.

Floods in these draws are caused by high-intensity, short-duration summer thunderstorms. Flood history obtained from the local people indicates that substantial damages are received about every two or three years. In 1967, a storm occurred over a portion of the watershed and resulting floodwater caused damages estimated at $40,000. This storm is estimated to be of the size which will occur once every 5 years. The 100-year frequency storm would cause an estimated $300,000 damage in the watershed. Preliminary estimates indicate that about 1,500 acres are flooded to an average depth of about one foot once each three years. On the average, annual damages occur to about 600 acres with flooding up to six inches. It is estimated that the one percent chance storm would flood about 2,800 acres with depths up to three feet.

The estimated average annual crop and pasture damage without flood prevention measures is estimated to be $129,100.

In most areas in the Estancia Valley, the groundwater table is on the decline. From 1948 to 1965, the water table dropped as much as 40 feet.

There is need for flood protection, water-based recreation, ground-water recharge, grazing land management, irrigation water management, increase in vegetative ground cover and better vegetative condition on grazing land. Additional studies will be needed to determine the effects of artificial recharge on water quality.

Minor areas in the National Forest are in need of timber stand improvement and erosion control.

Lettuce crop destroyed by floodwater from 1967 storm. Irrigated crops are damaged frequently by floods. SCS PHOTO 12-P573-8

Physical Potential for Meeting the Needs

Average annual precipitation is about 18 inches at Tajique and about 12 inches at McIntosh. Average annual lake evaporation is about 60 inches in the valley. The topography, soils, and foundation conditions at the potential structure site locations do not lend themselves to large permanent water storage pools. Except for some incidental recreational benefits realized as the flood pool is drawing down, it is felt water-based recreation needs cannot be satisfied in the subbasin. These needs will have to be met in adjoining subbasins.

The average annual rainfall, soils, topography, and climate in this area make it possible to attain a high degree of sediment control with land treatment. However, due to the high-intensity rainfall and subsequent high runoff, land treatment alone will not control the floodwater.

Along with the land treatment program, a flood protection project is essential. The flood protection project would consist of necessary floodwater retarding structures and outlet channels with installation along the channel to enhance groundwater recharge.

Potential floodwater retarding structures have been tentatively located. The topography does not lend itself very well to retarding structures, but structures that are long enough can be built with the ends turned upstream in order to obtain the necessary storage.

Available geologic information indicates floodwater retarding structures can be installed without exceptionally high structure cost on valley fill material of clay and sand, and materials in the abutments at all structures are erodable. Good material for construction of the earthfills is available. Prevailing materials at potential structure sites are gravel of Pliocene to Recent Age, ML-CL and CL.

Permeability at the potential structure sites and down the channels below the sites makes possible the disposal of floodwater by recharging the groundwater aquifer instead of providing stable channels to the salt lakes. It is assumed from available information that this is the most logical way to take care of the principal spillway flow from the potential retarding structures. A partial cutoff in the foundation will control velocity of subsurface flow to a safe level without excessive cost. Gross erosion rates range from 0.15 to 0.50 acre-feet per square mile per year and yield to reservoir averages about 0.1 acre-feet per square mile per year.

Local Interest in Project Development

The local people are aware of the flood damage received, but much of the flooding is looked upon as merely a normal annual occurrence which is only detrimental in the event of a large storm. The people interviewed were interested in trying to do something to eliminate, or at least reduce, floodwater damages. It is recommended that the people form a legal sponsoring organization to obtain guidance and financial support for a project that will alleviate the watershed problems.

Works of Improvement for Potential Development

Land Treatment - The land treatment systems mentioned here are important tools in the management of this watershed. Each system includes a variety of land treatment practices designed to achieve maximum landscape stability by keeping erosion and runoff above the potential structure sites at a minimum. Systems include:

(a) Good range management on 62,000 acres of grassland. Grazing management is essential for all rangeland. Effective grazing systems include deferred grazing, rotation-deferred grazing, and better livestock distribution through the use of additional fences and livestock watering facilities.

(b) Pinyon-juniper control on 2,000 acres.

(c) Cholla control on 375 acres.

(d) Improved irrigation facilities on 7,000 acres of irrigated land.

(e) Dry cropland treatment on 900 acres.

(f) Revegetation of 14,000 acres of poorly vegetated, formerly cropped dryland fields. Many fields reseeded under the Conservation Reserve Program failed to respond with stands of desirable grasses adequate to provide protection to the land from wind and water erosion. This formerly-cropped land poses the most important threat to the effectiveness of proposed structural measures.

Structural Measures - Potential structural measures include one floodwater retarding structure on Bachelor Draw and one on King-Hyer Draw. Principal spillway discharges from these structures could be spread over the rangeland until absorbed thereby serving as groundwater recharge. This can be done at very little cost and is the most economical and logical method of disposing of the principal spillway flow. However, in the event diversion works are needed for spreading water to accomplish the desired recharge, a water right to appropriate and use surface water will be required. The potential structures would be single-purpose flood prevention measures with incidental agricultural water management benefits from the groundwater recharge. The potential structures are classed as "c" high-hazard sites, and concrete chute emergency spillways are assumed necessary. (See tables 1 and 2 for structural details and figure 1 for structure location).

Nature and Estimate of Costs of Improvements

Potential structures were located on United States Geological Survey (15-minute) quadrangle sheets. A stage storage curve was developed for each potential floodwater retarding structure to obtain an estimated height of structure. A center line profile was taken off of the quadrangle sheet by interpolation between contour lines (20-foot contours). The required storage is based on the estimated 100-year sediment yield and the runoff produced by the 100-year frequency storm routed through the structure. With this information, an estimated earthfill in cubic yards was made.

Cost estimates on the potential floodwater retarding structures were based on a cost per cubic yard of earthfill as determined by the lowest five bids on the latest Public Law 566 contract. Cost for concrete chute emergency spillway was based on estimates made for similar dam heights and drainage areas in watershed planning. A 20 percent contingency figure was added to the construction cost estimates to offset unforeseen costs of the structural measures.

Other costs were estimated by using cost data from other watersheds with similar conditions.

Effects and Feasibility of Potential Development

With the potential project installed, average annual damages are estimated to be $25,800, a reduction of about 80 percent, which gives average annual damage reduction benefits of $103,300 (table 4). The average annual crop and pasture damage reduction benefits are estimated to be $87,700.

Other benefits which the structural measures would bring about are as follows:

Benefit	Average Annual
Groundwater recharge	$120,900
Redevelopment	58,500
Secondary	21,300

Total evaluated average annual benefits amount to $304,000. The average annual cost of the structural measures is $219,300. The benefit-cost ratio is 1.4 to 1 (table 6).

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

An added and important associated effect of these systems is the ultimate decrease in downstream damages and the reduction in capacity requirements of structures for flood control. Quality of runoff water will be improved. The systems will contribute to the improvement, development and preservation of all watershed resources and their optimum utilization.

Total average annual costs for the land treatment systems are estimated to be $96,000. The average annual returns are estimated to be $181,000.

Alternative or Additional Possibilities

There are other potential structure site locations within this watershed. Such locations exist on the draws on which structures have been located and structures possibly could be justified on some of the other draws on which structures have not been shown in this report.

There are other methods of handling the principal spillway discharge from the structures: (1) concrete-lined channel to deliver the flow below the railroad and highway. This alternative was superficially investigated and it appeared to be the most expensive method of disposal. (2) Artificial recharge wells might be a possibility. This was investigated to obtain a rough cost estimate and would be possible if necessary. A thorough investigation of the water treatment would need to be made since the injected water would have to meet State Health Department requirements. This may not be economically possible. If research develops a feasible method of controlling surface evaporation, then surface storage may be feasible.

Table 1, Structure data, Hyer Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Site No.	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. vol. of fill (cu.yds.)	Principal spillway: Type	Principal spillway: Release rate (csm)	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surface area @ emerg. spwy. level (acres)	Struc. class hazard
1	98.4	38	1,100,000	R/C conduit	8	R/C chute	one	410	c
2	144.9	34	1,105,000	R/C conduit	14	R/C chute	one	1400	c

Table 2, Reservoir storage capacity, Hyer Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin,

Site no.	Drainage area (sq.mi.)	Planned storage capacity (acre-feet): Sediment	Floodwater Detention	Total floodwater detention
1	98.4	800	10,500	11,300
2	144.9	995	12,500	13,495

Table 3, Distribution of structural cost - potential development, Hyer Draw, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation costs: Construction	Installation services	Land, easements & rights-of-way	Administration of contracts	Installation cost
1	1,444,800	173,400	75,000	600	1,693,800
2	1,782,400	213,900	90,000	600	2,086,900
Total	3,227,200	387,300	165,000	1,200	3,780,700

1/ Price base 1969

Table 4, Estimated average annual flood damage reduction benefits, Hyer Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage		Damage reduction benefits
	Without project	With project	
Site 1 - Bachelor Draw			
Crop and pasture	44,600	8,900	35,700
Other agricultural	5,000	1,000	4,000
Roads & misc.	3,000	600	2,400
Subtotal	52,600	10,500	42,100
Site 2 - King Draw			
Crop and pasture	65,000	13,000	52,000
Other agriculture	7,500	1,500	6,000
Roads & misc.	4,000	800	3,200
Subtotal	76,500	15,300	61,200
Total	129,100	25,800	103,300

1/ Based on adjusted normalized prices

Table 5, Annual cost, Hyer Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost	Operation and maintenance cost	Total annual cost
	(dollars) 1/	(dollars) 2/	
Site 1, Bachelor Draw	87,400	10,000	97,400
Site 2, King Draw	107,700	17,000	124,700
Total	195,100	27,000	222,100

1/ 1969 cost amortized for 100 years at 5 1/8 percent interest
2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Hyer Draw Watershed, Estancia Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Average annual benefits 1/					Average annual cost 2/	Benefit-cost ratio
	Flood prev. damage red.	Groundwater recharge	Redevelopment	Secondary	Total		
Site 1, Bachelor Draw	42,100	59,200	25,700	9,700	136,700	97,400	1.4:1
Site 2, King Draw	61,200	61,700	32,800	11,600	167,300	124,700	1.3:1
Total	103,300	120,900	58,500	21,300	304,000	222,100	1.4:1

1/ Adjusted normalized prices
2/ From table 5

The land treatment systems suggested for this watershed are groups of interdependent measures designed primarily to correct the dominant on-site problems of critical flood and sediment source areas.

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STRUCTURE LOCATION
HYER DRAW WATERSHED
UPPER RIO GRANDE BASIN

LAND TREATMENT
HYER DRAW WATERSHED
UPPER RIO GRANDE BASIN

DEFINITIONS
LAND TREATMENT SYSTEMS

1. Grassland Management Area - (potential benefits include increased forage production, reduction in sediment yield and increased water yield).

   1b-Snowpack Management - This treatment system applies to open grasslands at elevations above 10,000 feet. Snowfall is managed by constructing barriers (vertical slat snow fence) of appropriate height and spacing to create drifts, thus reducing evaporation caused by wind action. Bush-type vegetation can be planted to eventually replace the barriers.

   1c-Good Range Management - This treatment system includes the remainder of the open grassland not in 1b or 8. Benefits can be expected by using better than average range management. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, and better livestock distribution through use of fencing and water locations.

2. Grazable Woodland Management Area - (potential benefits include increased forage production for livestock and big game, limited wood products, and reduction in sediment yields).

   2a-Pinyon-Juniper Control - This treatment system applies to grazable woodland areas with moderately deep and deep soils on moderate slopes. Treatment includes tree and brush removal and the proper combination of practices as shown in 1c or 8 based on the need for either critical area management or good range management and wildlife habitat protection or improvement.

   2b-Ponderosa Pine-Pinyon-Juniper Management - This treatment system applies to the non-commercial ponderosa pine (under 45 site index) and the remaining pinyon-juniper areas. Treatment includes selective thinning and spot clearing of woody vegetation, needed good range management practices as shown in 1c, and wildlife habitat protection or improvement.

3. Brushland Management Area - (Potential benefits include increased forage production for livestock and big game and a reduction in sediment yield. An increased water yield may be expected on brush land at high elevations.)

   3a1, 3a4, 3a5 - Brush control - These treatment systems apply to all sage, yucca, and cholla brush covered land on topography and soils suited to brush clearing methods. Depending upon type of brush, treatment may include plowing and seeding, burning and seeding, shredding and spraying, grubbing and stacking of brush followed by the proper combination of practices as shown in 1c or 8 based on the need for critical area management or good range management and wildlife habitat protection or improvement.

3b2-Chaparral brush area management - This treatment system applies to all chaparral brush land on which brush control is unnecessary or undesirable. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, better livestock distribution through use of fencing and water locations, and wildlife habitat protection or improvement.

4. Commercial Timber Management Area - (Potential benefits include increased water yield, timber harvest, and forage production for livestock and big game).

4a-Spruce-Fir Management - Treatment system applies to all spruce-fir and mixed conifer stands suitable for treatment. Treatment includes the proper combination of the following practices: block and strip cutting for spruce-fir and selective cutting for mixed conifer, thinning, tree planting, fire protection, proper grazing use, and wildlife habitat.

4b-Ponderosa Pine Management - Treatment system applies to all commercial ponderosa pine (over 45 site index) stands suitable for treatment. Treatment includes the proper combination of the following practices: harvest cutting, thinning, pruning, tree planting, seeding grass, proper grazing use, fire protection, and wildlife habitat protection or improvement.

4c-Aspen Management - Treatment system applies to all aspen stands suited to management for regrowth of aspen. Treatment includes the proper combination of practices necessary to provide for proper grazing use and wildlife habitat protection or improvement.

5. Bottomland Vegetation Management Area - (Potential benefits include increased water yield and forage production).

5a-Phreatophyte Control - Treatment system applies to all areas invaded by undesirable woody vegetation. Treatment includes the proper combination of the following practices: clearing, thinning, shredding, spraying, reseeding to adapted grasses, and proper grazing management.

5b-Bottomland Management - Areas on which it is desirable to maintain some woody vegetation cover for recreation, wildlife habitat and aesthetic purposes.

6. Crop, Pasture, and Hayland Management Area - (Potential benefits include savings of water, reduction in sediments, and increased crop and forage yields).

6a-Irrigated Land Management - Treatment system applies to all irrigated land. Treatment includes the proper combination of the following practices: conservation cropping systems, pasture and hayland management, timely tillage, irrigation water management, and the following:

6a1-Drainage - Practice involves reclamation of land subject to a crop-inhibiting water table.

6a2-Improved Farm Irrigation Systems - Practices include realigning irrigation canals, laterals, and field ditches, ditch lining, irrigation pipelines, sprinkler systems, land leveling, and tail water recovery facilities.

6b-Dryland Management - Treatment system applies to all dry crop, pasture, and hayland. Treatment includes the proper combination of the following practices: conservation cropping system, contour farming, diversion terraces, proper residue management, pasture and hayland management.

6c-Abandoned Cropland Management - Treatment system applies to all permanently idle land that was previously cropped. Treatment includes the proper combination of the following practices: reseeding with adapted grasses, trees or shrubs, small gully control, water-spreading devices, grazing land mechanical treatment, and the needed good range management practices listed in 1c.

7. Miscellaneous Land - Land from which few, if any, economic returns can be expected from land treatment. Included are inaccessible areas (very steep land) and non-productive land (rockland, riverwash, water areas, badlands, cities, towns, roads, airports, farm sites, and other cultural areas).

8. Critical Erosion Areas - (Potential benefits include - sediment and wind damage reduction and increased forage yields.) This treatment system applies any place where special methods are needed to reduce erosion and to restore the area to productive use. Treatment includes the proper combination of the following practices: livestock exclusion or limited livestock use, small gully control, water-spreading devices, grazing land mechanical treatment, fencing, intensive vegetation management and critical area seeding.