LAND AND WATER PROBLEM SOLVING ON THE UPPER RIO GRANDE

Ralph M. Bell[1]/

"All water originates on or passes through watershed lands . . . Thus the condition of watershed lands constitutes an index of the quality of water yield from watersheds."

The author of this observation is lost in antiquity -- however, Dortignac[2]/ stated the watershed condition -- water quality relationship on the Rio Grande in a similar manner as follows:

"On much of the farmland irrigated below Elephant Butte Reservoir, crop yields are reduced 10 to 20 percent by an excess of soluble salts in the soil. Annual crop losses due to this salinity are estimated at more than half a million dollars. These monetary losses are but an index of overall losses caused by salinity. The initial investment in land development as well as both public and private improvements are endangered by loss in land productivity."

"The increase in salt content in going downriver is, no doubt, partially due to the high silt-laden surface runoff waters from woodland-sagebrush and semi-arid zones on soils derived from soft sedimentary rocks, particularly shales, in the New Mexico portion of the basin. The increase in salt content is concomitant with that of sediment. Most of the sediments and salts are contributed by drainages entering the river below Otowi Bridge."

The interrelationships of water supplies, water uses, and water quality with watershed lands are focused and "spot-lighted" by the preceeding comments, and the need for basic data and interpretations of these interrelationships has been the precipitator leading to present and prior studies on the Upper Rio Grande. Both the state of New Mexico and the Department of Agriculture (principally the Forest Service, Economic Research Service, and Soil Conservation Service) have an interest in learning the nature and magnitude of water and related land resource problems on the Upper Rio Grande; and to learn of alternative ways in which programs and activities, within the pervue of USDA, could aid local people and the state in attempting to deal with the problems. These mutual interests resulted in a "type 4" cooperative study on the Rio Grande. The study was initiated by the state in 1965 and was staffed for study by USDA in 1966. This multi-discipline, multi-USDA agency and state study has the following objectives:

1. Identify areas where watershed management efforts might improve the quantity and quality of surface water.

2. Provide a basis for coordinating U. S. Department of Agriculture program activity in watershed protection, flood prevention, and agricultural water management.

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2/ Watershed Resources and Problems of the Upper Rio Grande Basin, E. J. Dortignac, Rocky Mountain Forest and Range Experiment Station

3. Identify opportunities for improving the agricultural economy through small watershed projects under Public Law 566.

4. Appraise opportunities for meeting local water and related land objectives with U. S. Department of Agriculture project-type programs.

5. Appraise development needs that contribute to a plan for coordination, regulation, and management of the water and related land resources.

6. Appraise the potential needs and desires of the human resource and indicate programs, procedures, and assistance possible and necessary to help the local people provide their full contribution to the economy and culture of the basin.

The importance of these objectives increases as one equates them to the tragedy taking place through the "death" of small towns and loss of rural population in parts of the Upper Rio Grande Basin. It is sobering and sad that seventeen of New Mexico's thirty-two counties lost population in the last census -- Catron, Socorro, and Torrance counties of the basin lost population.

As metropolitan areas such as Albuquerque and Santa Fe struggle with the problems and miseries of rapid growth and overcrowding, the proportion of New Mexico population still living in small towns and rural areas continues to decrease. In the basin, two-thirds of incorporated and unincorporated towns and villages of over 1,000 people lost populations. The rural outflow has been going on for a number of years, as the more efficient landowners and operators acquire or lease their neighbors' land, and as residents and young people of small towns and rural areas gravitate to job opportunities in the metropolitan areas. As the rural areas and small town lose population, social amenities diminish and economic survival and self-government becomes difficult for those who remain behind.

Throughout the study, the field party gave consideration to such necessities of life as adequate food, fiber, shelter, and raw materials for industry. The study has considered values such as the quality of life including attractive surroundings, space to live, outdoor recreation, suitable habitat for plants and animals, and aesthetic satisfaction. Also considered were the needs for safe and adequate water, clean air, and productive soil held in place.

The Upper Rio Grande is, indeed, a land of contrasts and presents the student or researcher many gradations of climate, topography, and circumstances from Elephant Butte Reservoir north to the Colorado-New Mexico state line. The variations provide one of the basin's greatest assets -- natural beauty illustrated by such views as the Sandia Mountains at sunset, Mount Taylor, or the Jurassic cliffs near Gallup. The New Mexico Tourist Bureau and Chambers of Commerce call attention to the Indian, Spanish, and Anglo heritage. This heritage is evidenced by such relics as the old abandoned church and abandoned residence at Engle, near T or C, and by the Laguna and Acoma Indian Pueblos west of Albuquerque.

A paramount problem of the basin is pollution -- sediment pollution which causes deterimental effects which can be traced from bare shale slopes and

badlands areas, through the systems of arroyos, to areas of deposition on roads, railroads, in impoundments, or on farmlands. Of course, we find many other forms of pollution such as junk piles, animal waste, mine and mill waste, pollution of air from burning, and phreatophyte infestations where sediment inflows have created high water tables. These high water tables, in turn, allow invasion of phreatophytes or water-loving plants. Solutions are known for nearly all pollution problems. There are opportunities, for example, to curb bank-cutting erosion with rock and wire structures, or to substitute phreatophyte growth with improved irrigated pastures.

As the river basin study progressed, the basic data was developed for four subbasins which have been compiled to cover the entire basin. Results of the study are presented by maps designed to show a graphic story of the resources problems, needs, and possible solutions. Some of the maps provide basic data. Other maps are either complimentary or are interpretative.

Basic Information Maps

The land status map shows geographical distribution of specific land tenure.

The geology map is presented to show the basic geological features in the study area and their relationship to centers of population, stream systems, and transportation routes. It gives the reader an idea of the parent material in which the soils have formed.

The mean annual precipitation (climate) map is presented to show both high and low precipitation areas. This map indicates areas where attention should be focused for watershed management considerations to complement the quantity and quality of surface water.

The vegetation map shows the general kinds of vegetation and broad types of land uses. This map is helpful in locating areas where watershed management might be effective in improving quality and quantity of surface water.

A transportation routes and recreation map shows both present and planned access routes. Existing, planned, and potential recreation facilities may be used to assist in making many interpretations for land, water, and economic improvements.

Interpretative Maps

The land treatment map was developed through study of the geology, mean annual precipitation, soils, land resource area, temperature, present erosion, and vegetative maps. This map exhibits a broad framework of the types of land treatment and management needed in the study area.

A groundwater map shows geographical distribution of available subsurface water and estimated depths to the water-yielding aquifer.

The irrigable and non-irrigable land map presents the location of irrigable and non-irrigable soils in the basin. Irrigable areas shown on the map were determined from soil characteristics including slope, drainage, and extent of present erosion.

The present erosion status map was developed from soils, precipitation, and vegetative maps. When properly interpreted these factors indicate the severity of gross erosion on the land.

The map of areas of potential increased water yield due to land treatment delineates land areas with potential for increased water yield, The precipitation, vegetative, and land treatment maps provided the basic data from which this map was prepared.

A PL 566 projects map shows position and relationship of completed, planned, and potential project areas. The potential project areas are those where the watershed problems can be dealt with through the authorities of the Watershed Protection and Flood Prevention Act (PL 566).

The maps which were mentioned with accompanying tables, interpretations and analyses provide the basis for suggested alternative solutions to the problems. If the old adage holds true, "The proof of the pudding is in the eating" then let's compare one or two of the objectives with the findings and conclusions. Remember the objective "Identify areas where watershed management efforts might improve the quantity and quality of surface water," let's recall the map showing areas where watershed management practices have possibilities. Also, let's look at some statistics which are identified as having potential for development.

The study showed there is a total potential of increasing water harvest and yield by 2.0 million acre-feet in the basin! -- Perhaps only 1.0 million acre-feet of the total potential can be realized. The costs and returns of applying a "water harvest" land treatment and management program are generally as follows:

Land treatment systems applicable	Acres of need and opportunity	Estimated total cost of treatment $	Estimated annual dollar return of treatment* $	Value of additional av. annual employment
Snowpack management	4,000	348,000	25,000	70,000
Spruce-fir mgt.	143,000	5,720,000	1,448,000	172,000
Ponderosa pine mgt.	392,000	11,751,000	2,456,000	352,000
Aspen management	36,000	1,080,000	231,000	32,000
Phreatophyte control	19,000	1,800,000	2,247,000	54,000
Total	594,000	20,700,000	6,407,000	681,000

*Land treatment as applicable includes value of:

Increased water yield	$3,269,000
Sediment damage reduction	28,000
Increased red meat production	1,029,000
Timber and wood increase	2,081,000

The land abuse problems in the basin were determined (acres of land needing treatment). Alternatives were identified (the various land treatment systems) and a qualitative, quantitative, and monetary analysis developed. Actually, one might even note the "negative benefits" value of the obvious alternative of doing nothing or continuing a "status quo". The alternative to the public and private interests not making the $20,700,000 investment would be foregoing the future average annual benefits of $7,087,000. The choice must be the people's!

Remember the objective, "Identify opportunities for improving the agricultural economy through small watershed projects under Public Law 566?"

The field party looked at all watersheds in the Upper Rio Grande Basin. Where damages to cropland, urban areas, roads, or utilities appeared to justify needed measures, a "Watershed Investigation Report" was prepared. Let's look again at the interpretative PL 566 project map. This map shows watersheds where the watershed protection and flood prevention problems could be controlled through authorities of Public Law 566. For these 24 watersheds, there is opportunity to control 2,138 square miles of surface drainage with 132 floodwater retarding structures and 150 miles of floodwater diversions. Average annual costs for these structural measures would be $2,644,000 and average annual benefits would be $3,913,000.

As an "overview" of the nature and significance of the floodwater and sediment damage, the field party noted that three of the watersheds in the Grants area are interrelated in that the city of Grants is a common damage area to the three watersheds and will require a common disposal system. Also, there are many miles of canals and drains within the Middle Rio Grande Conservancy District in which arroyo flood flows are intercepted, and ten watersheds were found to be definitely interrelated with the conservancy district in that floodwater and sediment from any one of the watersheds may cause interruption of irrigation water delivery to substantial areas within the district. These two cases of interrelationships precipitated the field party's recommendation that local people seek basin-wide authorization to most effectively deal with the problems.

The field party first approached the problem of the agricultural economy on an "individual action or practice basis" but soon became mired down in a morass of actions and activities. A second attempt proved effective and usable. This was the "land treatment and management systems" approach. This approach groups applicable practices into an appropriate treatment and management system. In general, investment costs can be determined and economic returns assessed. Thus, in the basin study, a basic remedial program for the land evolved. The remedial program was essentially a qualitative, quantitative, and monetary assessment of land treatment and management needs for the basin. The watershed management aspects have been previously shown, and the following figures show the magnitude of the total land treatment program including watershed management:

Acres needing treatment	12,126,000
Total cost	$108,108,000

This cost when converted to annual equivalent is $10,788,000 as compared with annual returns of $28,667,000. This 1 to 2.65 cost return ratio certainly appears to be a good investment for the private and public dollar.

Applicable USDA project-type programs to the basin include the Watershed Protection and Flood Prevention Act (Public Law 566) with 24 opportunities identified. Other significant programs available include Public Law 46 which authorizes technical assistance to soil and water conservation districts, the Great Plains Conservation Program (Public Law 1021), and REAP (Rural Environmental Assistance Program). These programs provide technical and financial assistance in the installation of the needed land treatment and management systems. It is foreseeable that in the future, counties and cities may enter into joint efforts with landowners to accomplish needed land treatment in some watersheds. Other project-type programs available include the opportunity for water and sewerage developments through Public Law 660 administered by the Farmers Home Administration. In the Upper Rio Grande Basin, community water development is an acute need in 20 of 95 communities. Sewerage systems are needed in 63 of 95 communities. Another USDA project-type program especially well-adapted to accommodate water and related land problems on a project-type basis is the Resource Conservation and Development (RC&D) program. Experience in New Mexico has shown "RC&D" to be especially effective in bringing known sources of assistance to the attention of local decision makers and participants.

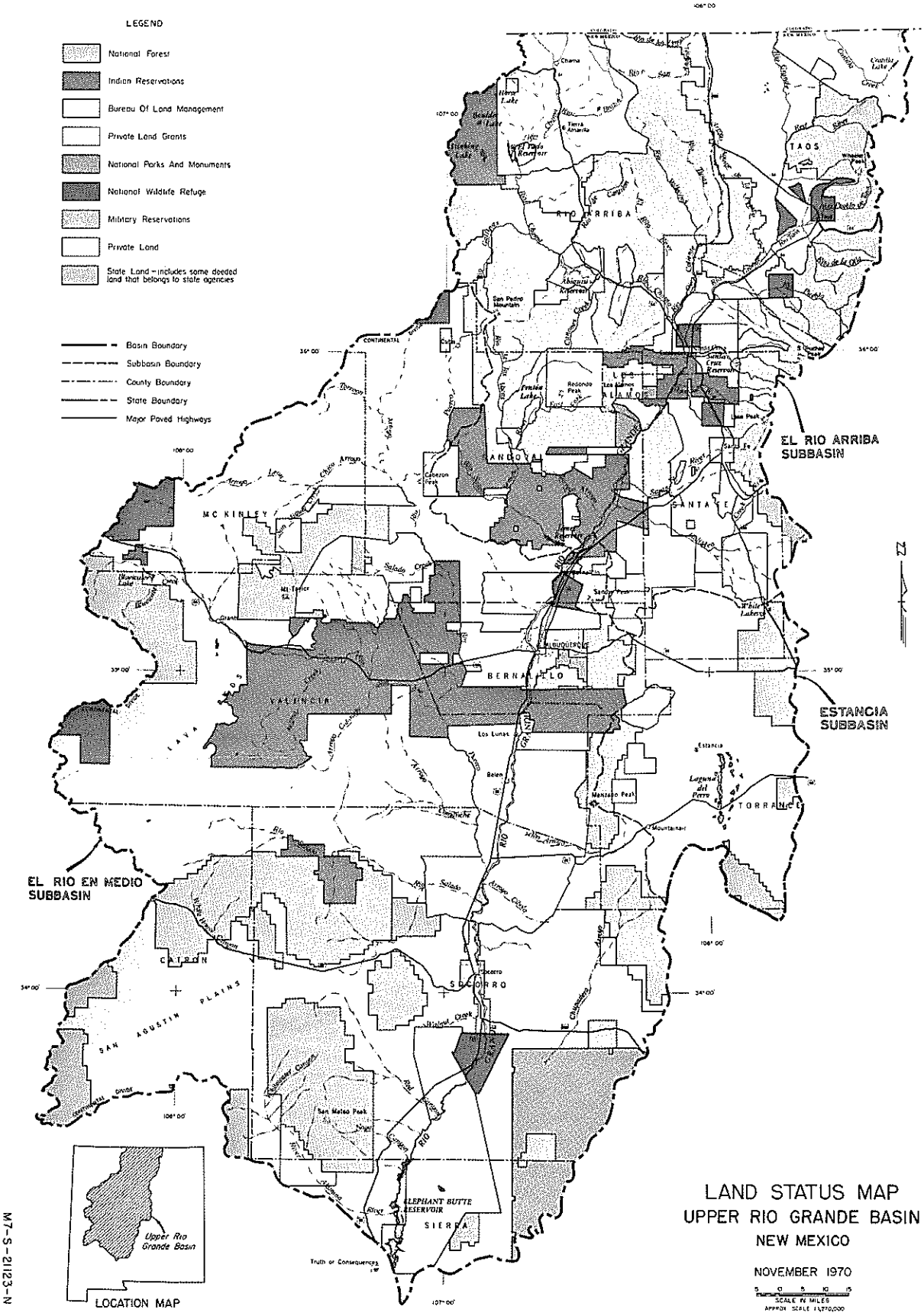
National forests in the basin are significant. The Multiple-Use Sustained Yield Act of 1960 states that national forests are to be administered for recreation, range, timber, watershed, and wildlife purposes. This philosophy of use has endured for 10 years, and the results of multiple uses of forest resources makes significant contributions to the basin economy.

The field party recognized that some legislative changes and enforcement will be required in order for the land and water resources in the basin to be developed and utilized efficiently and properly. Examples of needed changes include:

1. Water rights on Indian land need to be clarified.

2. Land zoning laws must be adopted and enforced. This is evident from the expenditures every year for flood damages and the cost for flood protection. Although millions of dollars have been spent on flood protection and prevention measures, flood damages increase every year. The public should demand that floodplains be marked and zoned. If floodplain areas are developed, they should be flood-proofed to a safe level of protection.

As previously mentioned, I've presented a few of the findings and conclusions of the study. The final basin report will include other suggested ways that local decision makers may deal with their resource development. I wish to close my presentation, however, with the reminder that "planners" per se have no authority to enact alternatives. This is how it should be in a democratic society. I hope it never changes. Action must come from motivated local decision makers who have a definite understanding of their benefits, costs, and responsibilities.


LEGEND
National Forest
Indian Reservations
Bureau Of Land Management
Private Land Grants
National Parks And Monuments
National Wildlife Refuge
Military Reservations
Private Land
State Land – includes some deeded land that belongs to state agencies
Basin Boundary
Subbasin Boundary
County Boundary
State Boundary
Major Paved Highways
EL RIO ARRIBA SUBBASIN
ESTANCIA SUBBASIN
EL RIO EN MEDIO SUBBASIN
RIO ARRIBA
TAOS
MC KINLEY
SANDOVAL
SANTA FE
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SIERRA
LAVA
SAN AGUSTIN PLAINS
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
Upper Rio Grande Basin
LOCATION MAP
LAND STATUS MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
NOVEMBER 1970
SCALE IN MILES
APPROX SCALE 1:1,770,000
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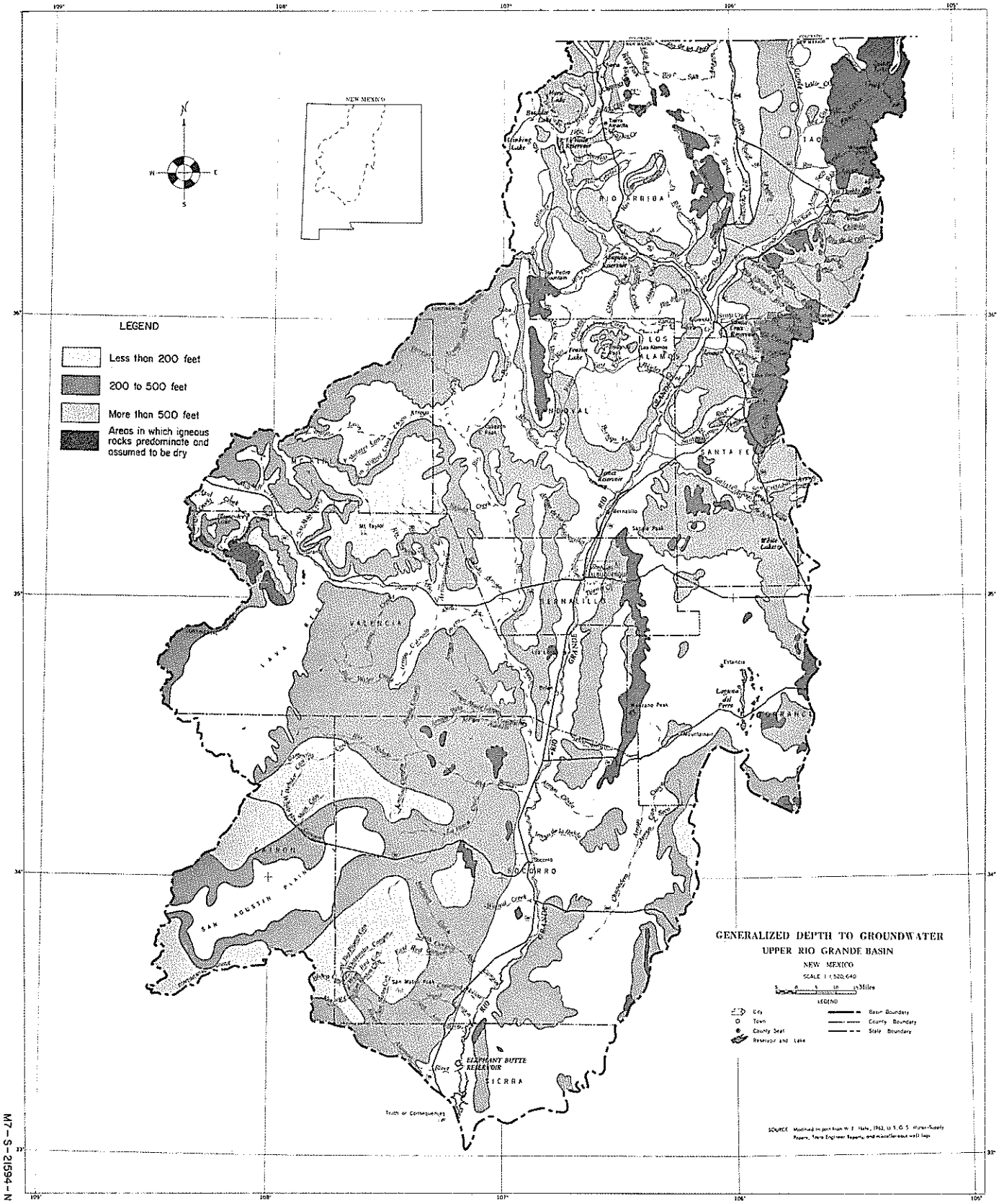
LEGEND
Less than 200 feet
200 to 500 feet
More than 500 feet
Areas in which igneous rocks predominate and assumed to be dry
NEW MEXICO
GENERALIZED DEPTH TO GROUNDWATER
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
0 5 10 15 Miles
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
SOURCE Modified in part from W. J. Hale, 1963, U. S. G. S. Water-Supply Papers, State Engineer Reports, and miscellaneous well logs
RIO ARRIBA
TAOS
SANTA FE
VALENCIA
TORRANCE
SOCORRO
SIERRA
CATRON
LOS ALAMOS
SAN AGUSTIN PLAINS
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
RIO GRANDE
LAVA
109°
108°
107°
106°
105°
36°
35°
34°
33°

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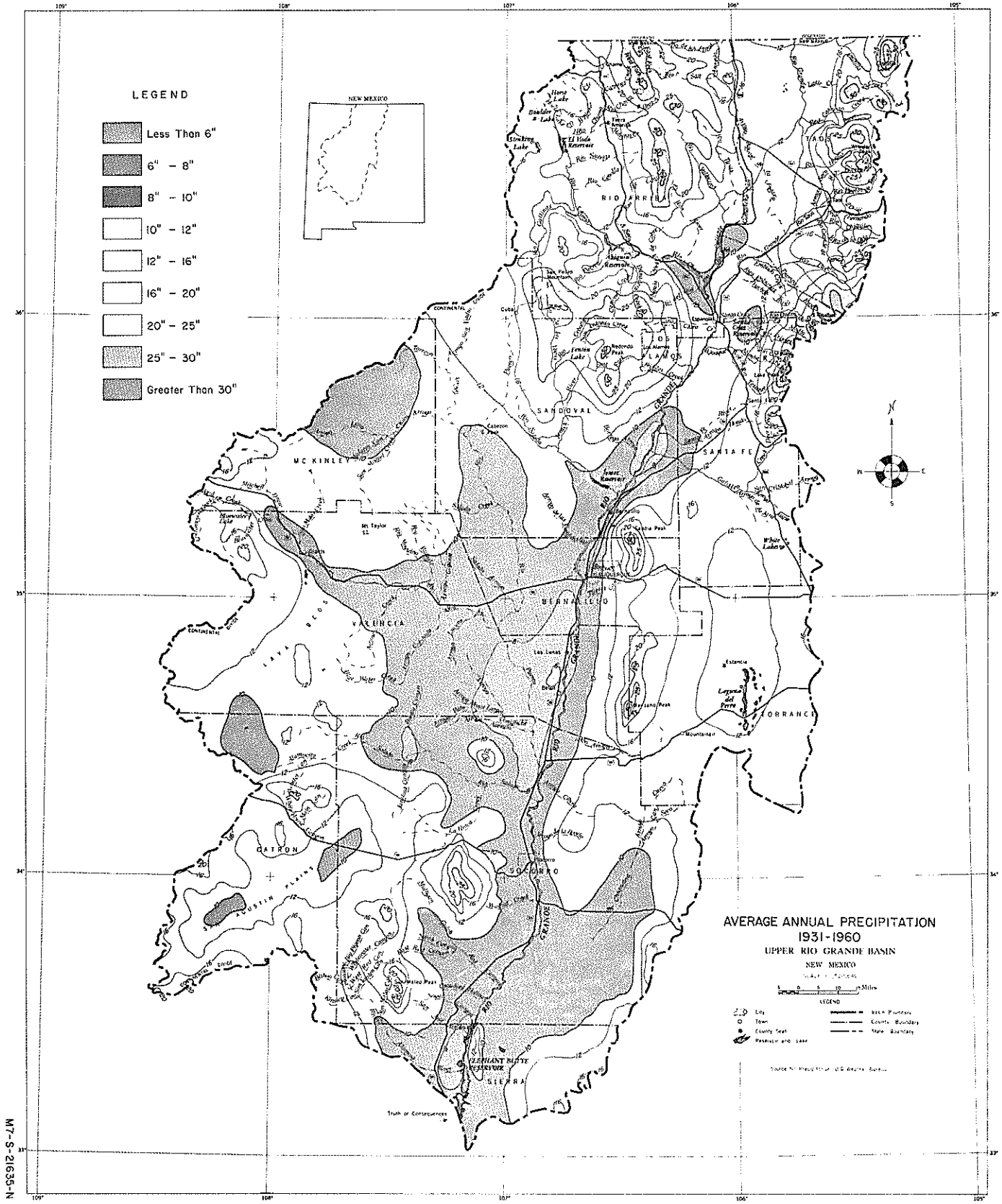
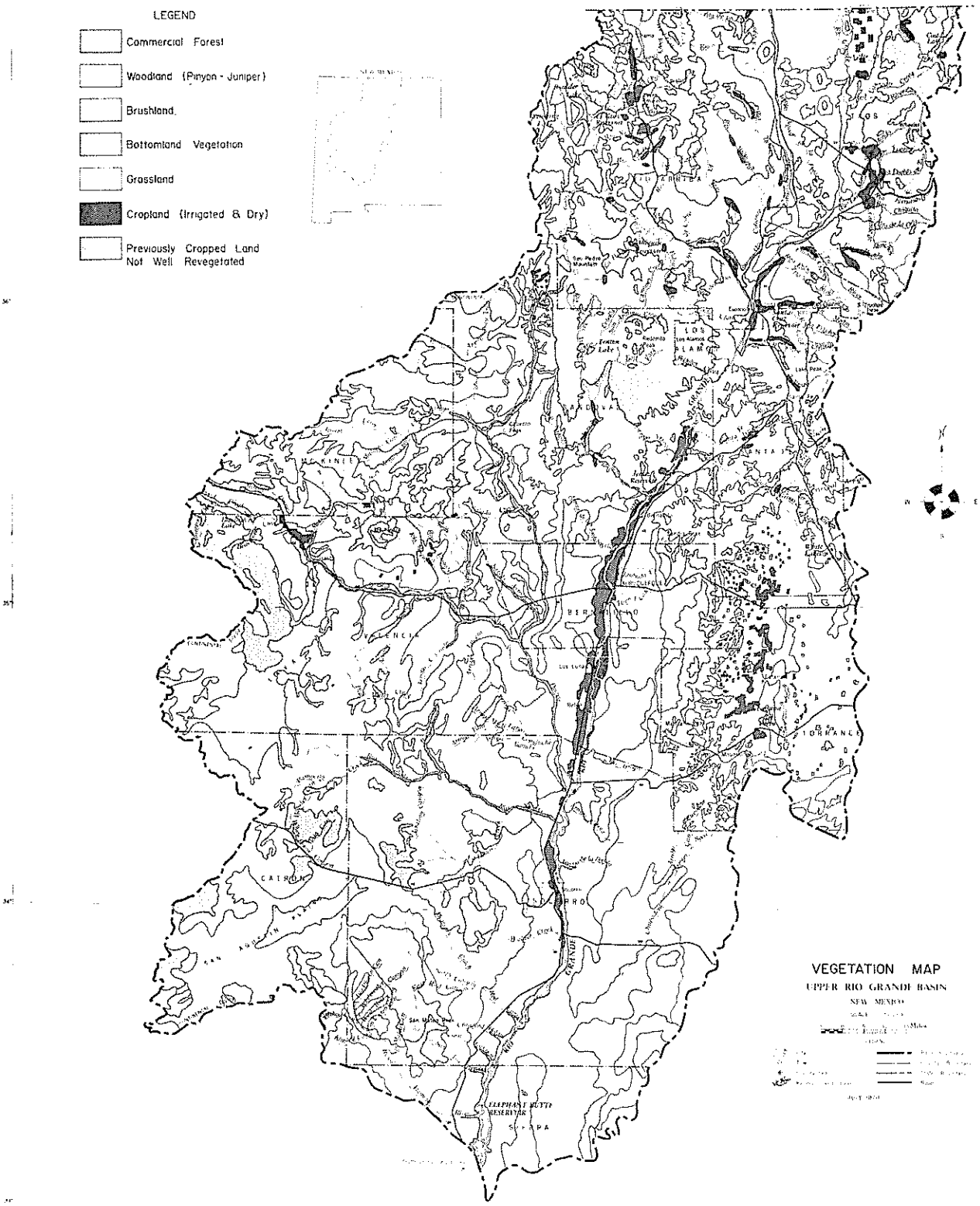
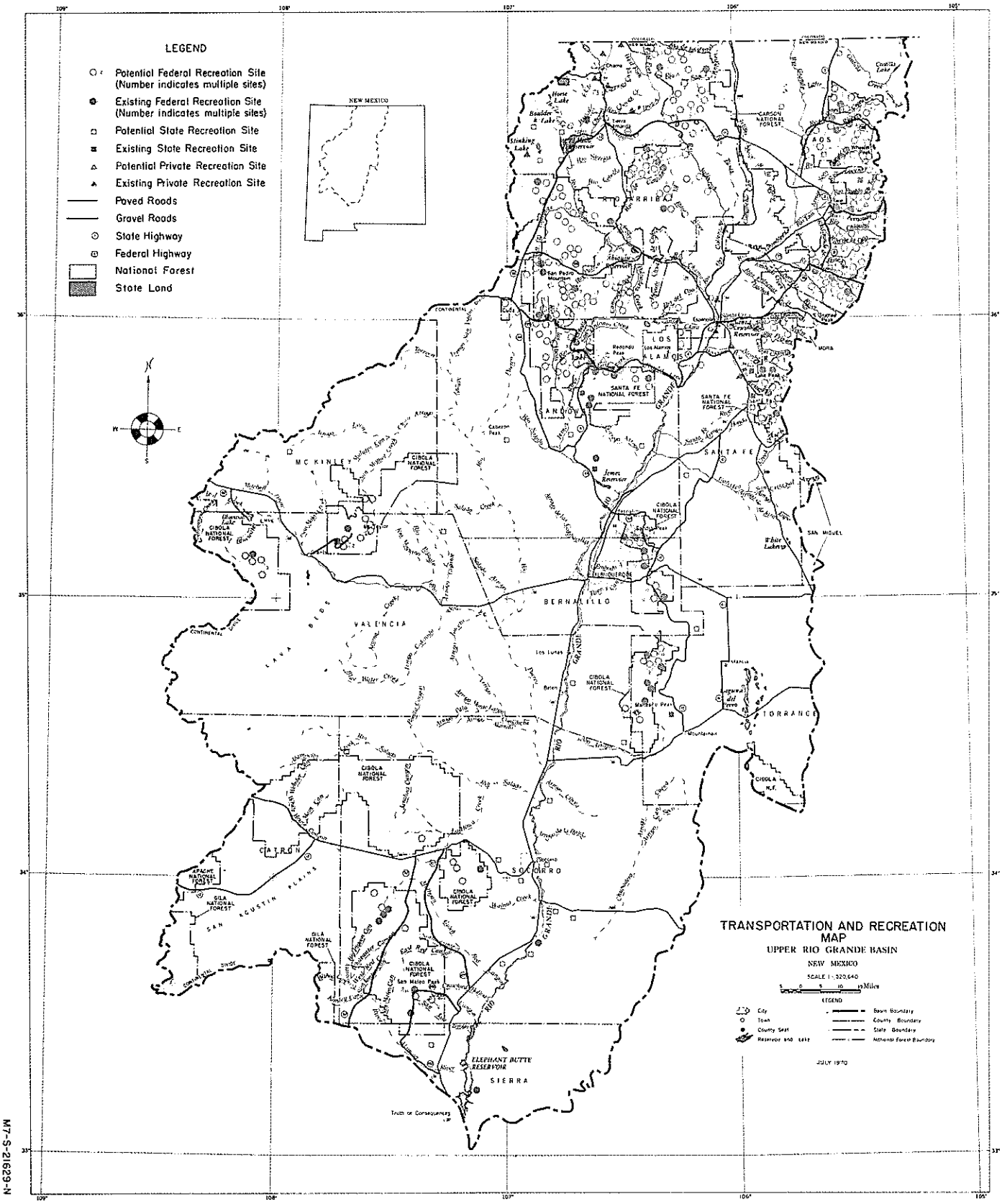

LEGEND
Less Than 6"
6" - 8"
8" - 10"
10" - 12"
12" - 16"
16" - 20"
20" - 25"
25" - 30"
Greater Than 30"
NEW MEXICO
AVERAGE ANNUAL PRECIPITATION
1931-1960
UPPER RIO GRANDE BASIN
NEW MEXICO
RIO ARRIBA
SANDOVAL
SANTA FE
MC KINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
M7-S-21635-N


LEGEND
Commercial Forest
Woodland (Pinyon - Juniper)
Brushland.
Bottomland Vegetation
Grassland
Cropland (Irrigated & Dry)
Previously Cropped Land Not Well Revegetated
VEGETATION MAP
UPPER RIO GRANDE BASIN
NEW MEXICO

NM-S-2613-N


LEGEND
Potential Federal Recreation Site (Number indicates multiple sites)
Existing Federal Recreation Site (Number indicates multiple sites)
Potential State Recreation Site
Existing State Recreation Site
Potential Private Recreation Site
Existing Private Recreation Site
Paved Roads
Gravel Roads
State Highway
Federal Highway
National Forest
State Land
NEW MEXICO
TRANSPORTATION AND RECREATION MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:320,640
JULY 1970
MCKINLEY
SANDOVAL
LOS ALAMOS
SANTA FE
SAN MIGUEL
MORA
TORRANCE
VALENCIA
BERNALILLO
SOCORRO
SIERRA
CATRON
CIBOLA NATIONAL FOREST
SANTA FE NATIONAL FOREST
GILA NATIONAL FOREST
ELEPHANT BUTTE RESERVOIR
LAVA BEDS
SAN AGUSTIN PLAINS
RIO GRANDE

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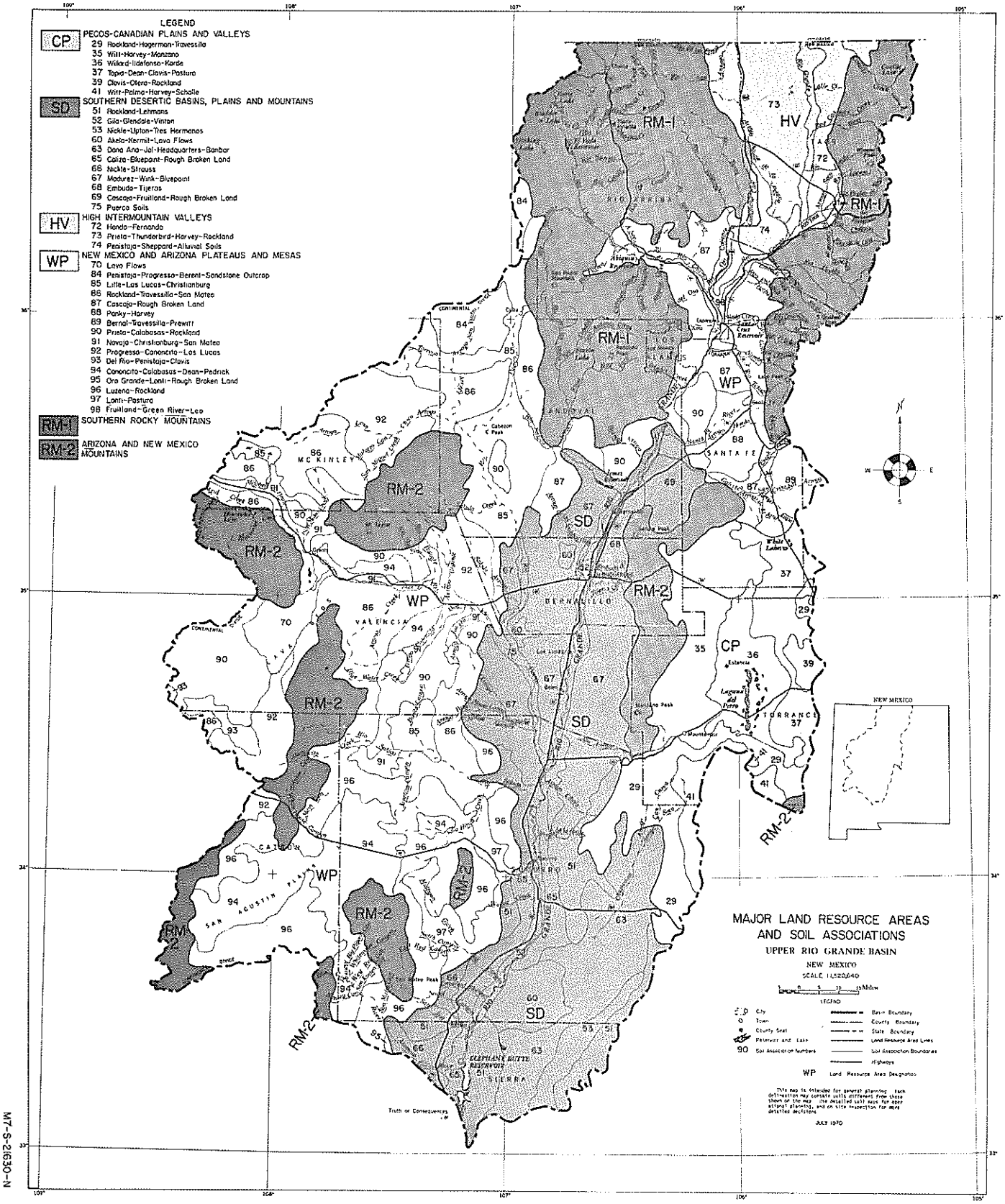
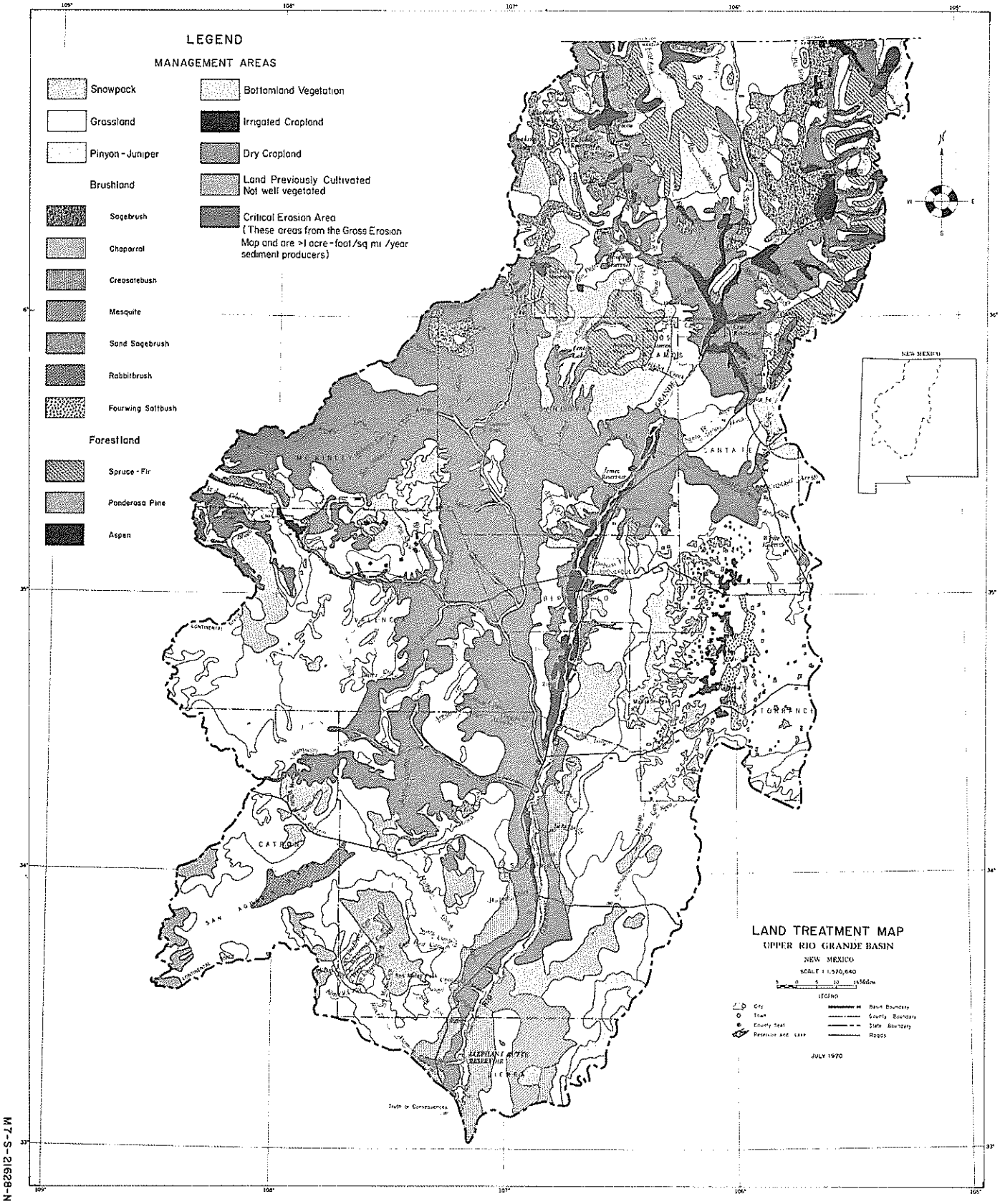

LEGEND
CP PECOS-CANADIAN PLAINS AND VALLEYS
29 Rockland-Hagerman-Travessilla
35 Will-Harvey-Manzano
36 Willard-Idalenna-Karde
37 Topia-Dean-Clovis-Pastura
39 Clovis-Otero-Rockland
41 Witt-Palma-Harvey-Schalle
SD SOUTHERN DESERTIC BASINS, PLAINS AND MOUNTAINS
51 Rockland-Lehmans
52 Gila-Glendale-Vinton
53 Nickle-Upton-Tres Hermanos
60 Akela-Kermit-Lava Flows
63 Dona Ana-Jal-Headquarters-Banbar
65 Caliza-Bluepoint-Rough Broken Land
66 Nickle-Strauss
67 Madurez-Wink-Bluepoint
68 Embudo-Tijeras
69 Cascaja-Fruitland-Rough Broken Land
75 Puerco Soils
HV HIGH INTERMOUNTAIN VALLEYS
72 Hondo-Fernando
73 Prieta-Thunderbird-Harvey-Rockland
74 Penistaja-Sheppard-Alluvial Soils
WP NEW MEXICO AND ARIZONA PLATEAUS AND MESAS
70 Lava Flows
84 Penistaja-Progressa-Berent-Sandstone Outcrop
85 Lille-Las Lucas-Christianburg
86 Rockland-Travessilla-San Matee
87 Cascaja-Rough Broken Land
88 Panky-Harvey
89 Bernal-Travessilla-Prewitt
90 Prieta-Calabasas-Rockland
91 Navaja-Christianburg-San Matee
92 Progressa-Canoncito-Las Lucas
93 Del Rio-Penistaja-Clovis
94 Canoncito-Calabasas-Dean-Pedrick
95 Ora Grande-Lonti-Rough Broken Land
96 Luzena-Rockland
97 Lonti-Pastura
98 Fruitland-Green River-Leo
RM-1 SOUTHERN ROCKY MOUNTAINS
RM-2 ARIZONA AND NEW MEXICO MOUNTAINS
RM-1
RM-2
SD
WP
HV
CP
NEW MEXICO
MAJOR LAND RESOURCE AREAS AND SOIL ASSOCIATIONS
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
LEGEND
City
Town
County Seat
Railroads and Lakes
Soil Association Numbers
Basin Boundary
County Boundary
State Boundary
Land Resource Area Lines
Soil Association Boundaries
Highways
WP Land Resource Area Designation
This map is intended for general planning. Each delineation may contain soils different from those shown on the map. For detailed soil maps for operational planning, and on site inspection for more detailed decisions
JULY 1970
MT-S-21630-N


LEGEND
MANAGEMENT AREAS
Snowpack
Grassland
Pinyon - Juniper
Brushland
Sagebrush
Chaparral
Creosotebush
Mesquite
Sand Sagebrush
Rabbitbrush
Fourwing Saltbush
Forestland
Spruce - Fir
Ponderosa Pine
Aspen
Bottomland Vegetation
Irrigated Cropland
Dry Cropland
Land Previously Cultivated
Not well vegetated
Critical Erosion Area
(These areas from the Gross Erosion
Map and are >1 acre-foot/sq mi /year
sediment producers)
NEW MEXICO
LAND TREATMENT MAP
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY 1970

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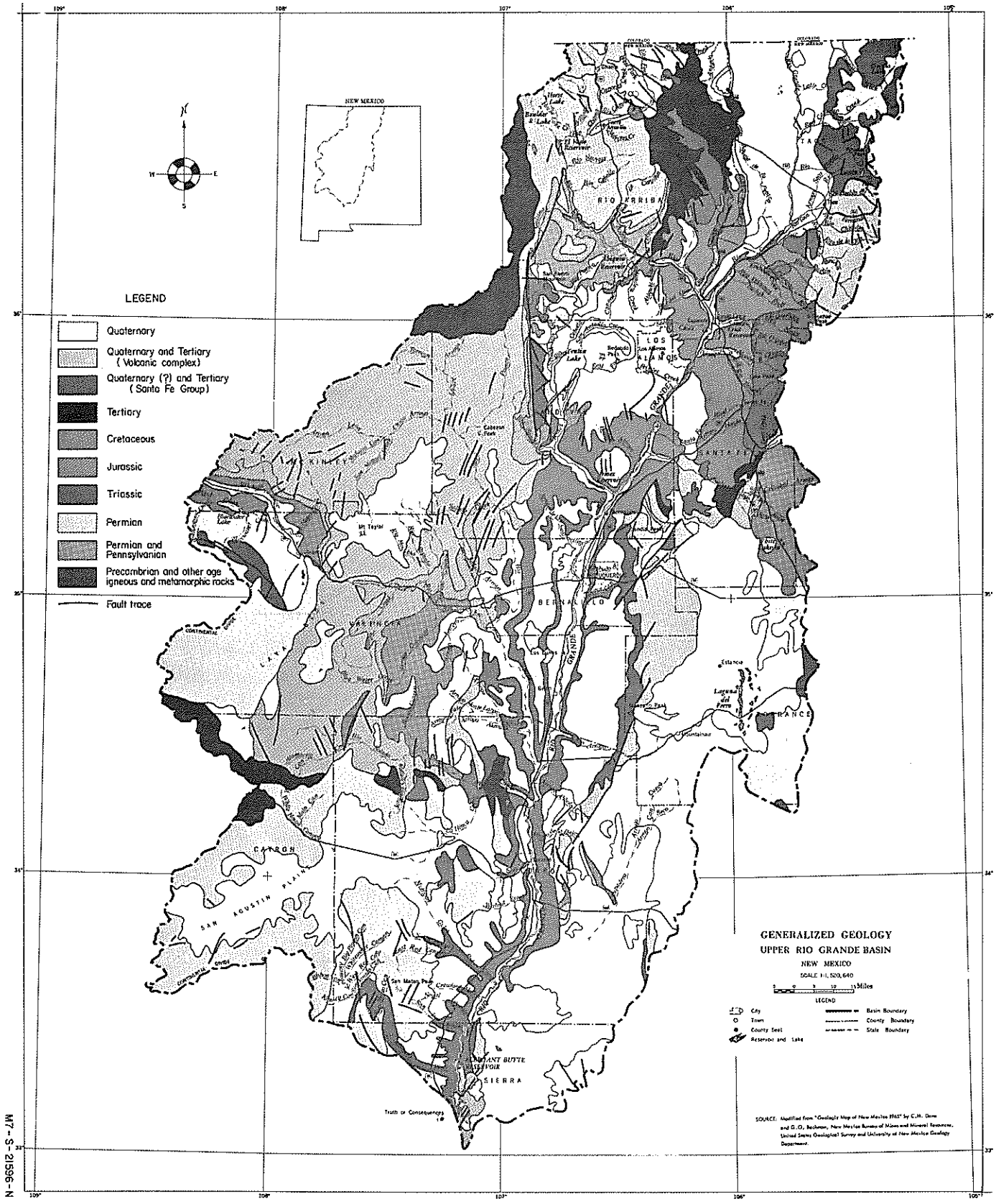
LEGEND
Quaternary
Quaternary and Tertiary (Volcanic complex)
Quaternary (?) and Tertiary (Santa Fe Group)
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Permian and Pennsylvanian
Precambrian and other age igneous and metamorphic rocks
Fault trace
NEW MEXICO
RIO ARRIBA
SANDOVAL
BERNALILLO
VALENCIA
TORRANCE
CATRON
SIERRA
SAN AGUSTIN PLAIN
Truth or Consequences
GENERALIZED GEOLOGY
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
SOURCE: Modified from "Geologic Map of New Mexico 1965" by C.H. Dane and G.O. Bachman, New Mexico Bureau of Mines and Mineral Resources, United States Geological Survey and University of New Mexico Geology Department.

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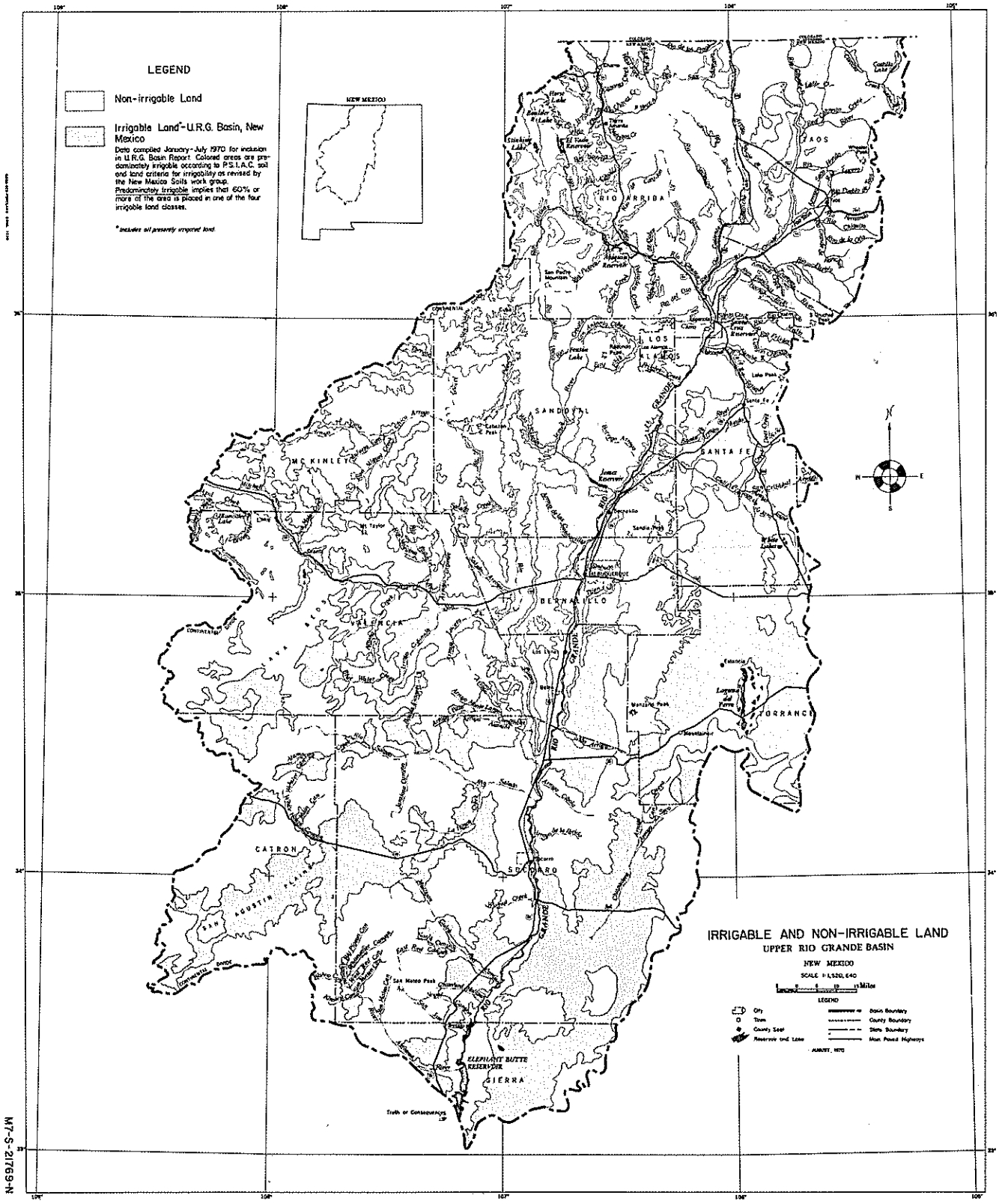
LEGEND
Non-irrigable Land
Irrigable Land*-U.R.G. Basin, New Mexico
Data compiled January-July 1970 for inclusion in U.R.G. Basin Report. Colored areas are predominately irrigable according to P.S.I.A.C. soil and land criteria for irrigability as revised by the New Mexico Soils work group.
Predominately irrigable implies that 60% or more of the area is placed in one of the four irrigable land classes.
* Includes all presently irrigated land.
NEW MEXICO
TAOS
RIO ARRIBA
LOS ALAMOS
SANDOVAL
SANTA FE
MC KINLEY
VALENCIA
BERNALILLO
TORRANCE
CATRON
SOCORRO
SIERRA
ELEPHANT BUTTE RESERVOIR
IRRIGABLE AND NON-IRRIGABLE LAND
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,500,640
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
Main Paved Highways
AUGUST, 1970

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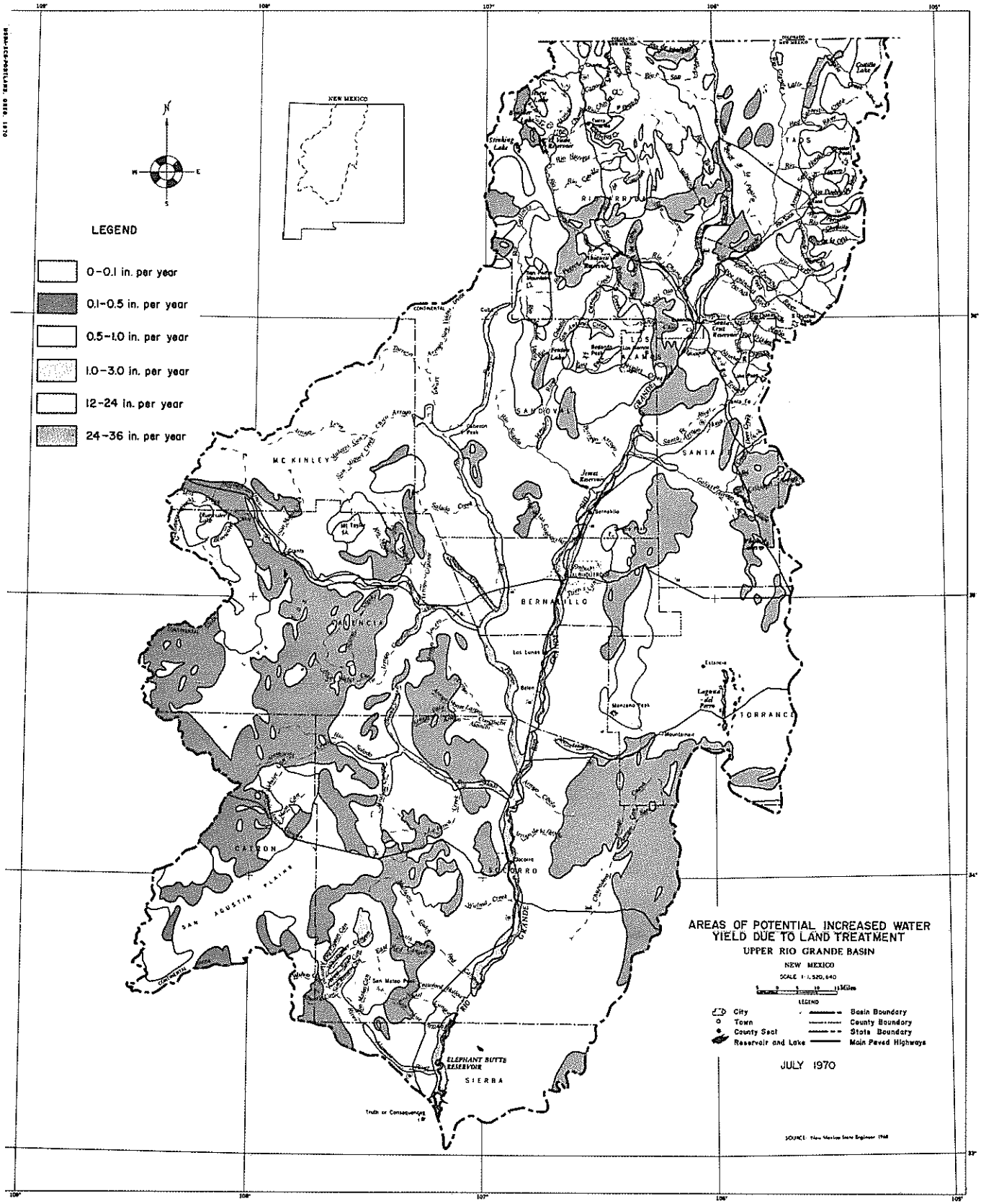
NEW MEXICO
LEGEND
0-0.1 in. per year
0.1-0.5 in. per year
0.5-1.0 in. per year
1.0-3.0 in. per year
12-24 in. per year
24-36 in. per year
TAOS
RIO ARRIBA
SANDOVAL
SANTA FE
MC KINLEY
BERNALILLO
VALENCIA
TORRANCE
CATRON
SOCORRO
SAN AGUSTIN PLAINS
SIERRA
ELEPHANT BUTTE RESERVOIR
Truth or Consequences
AREAS OF POTENTIAL INCREASED WATER YIELD DUE TO LAND TREATMENT
UPPER RIO GRANDE BASIN
NEW MEXICO
SCALE 1:1,520,640
Miles
LEGEND
City
Town
County Seat
Reservoir and Lake
Basin Boundary
County Boundary
State Boundary
Main Paved Highways
JULY 1970

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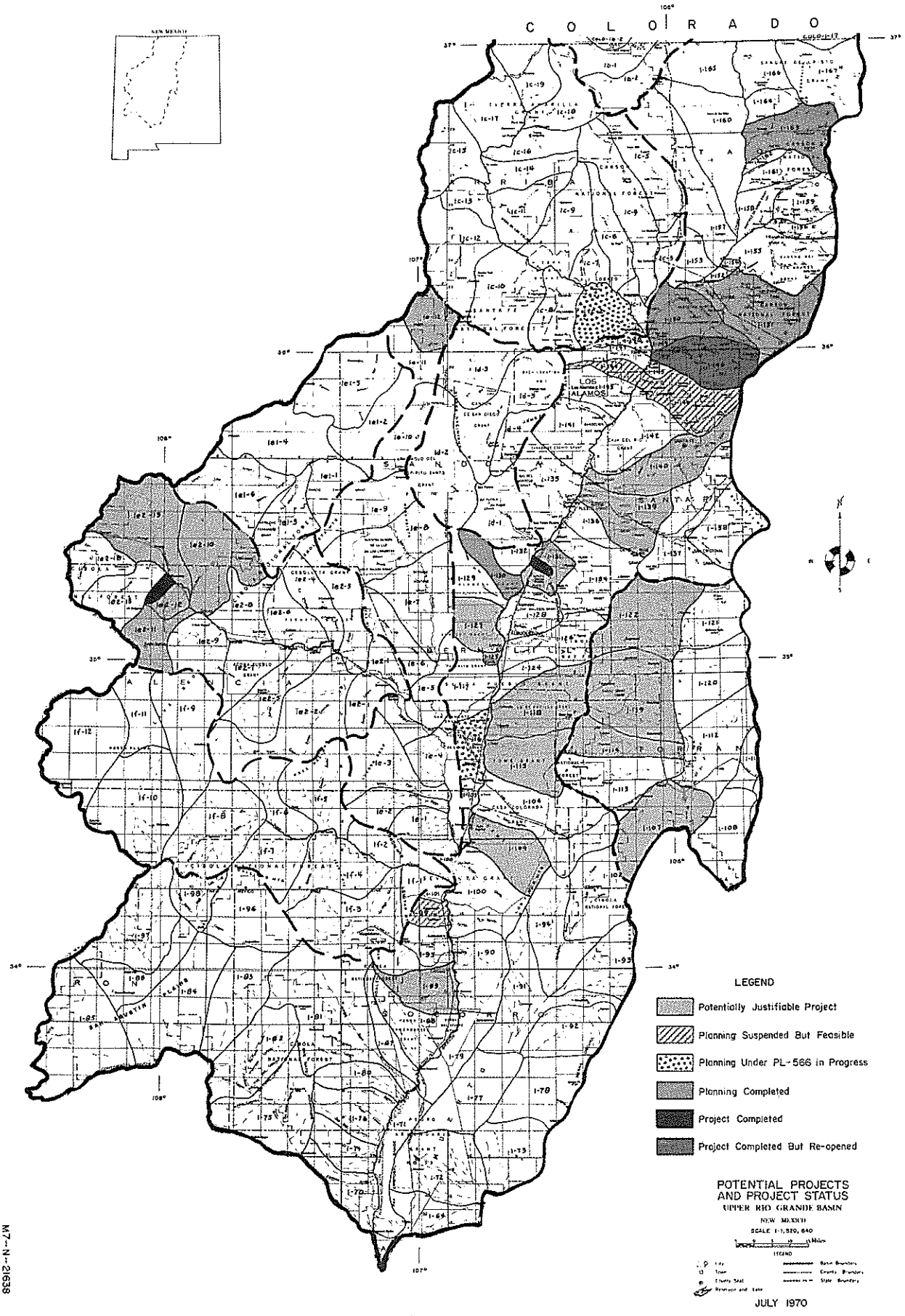
C O L O R A D O
LOS ALAMOS
LEGEND
Potentially Justifiable Project
Planning Suspended But Feasible
Planning Under PL-566 in Progress
Planning Completed
Project Completed
Project Completed But Re-opened
POTENTIAL PROJECTS AND PROJECT STATUS
UPPER RIO GRANDE BASIN
NEW MEXICO
JULY 1970
M7-N-21638