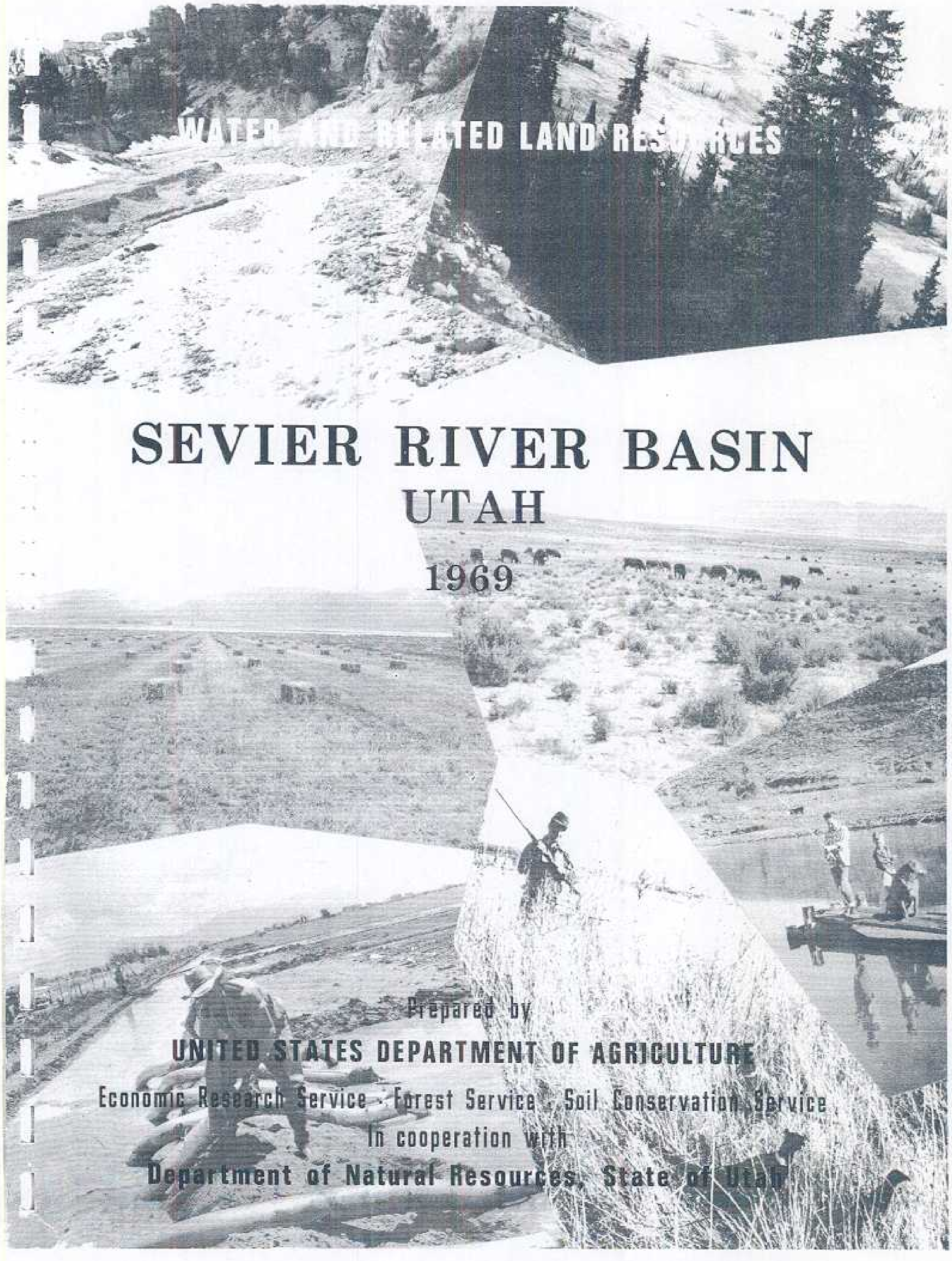

WATER AND RELATED LAND RESOURCES

SEVIER RIVER BASIN
UTAH

1969

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

Economic Research Service · Forest Service · Soil Conservation Service

In cooperation with

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CONTENTS

TABLES

Number		Page
1	Soil Association Zone Areas	26
2	Land status, 1965	43
3	Land use by water-budget area, sub-basin and Sevier River Basin	44
4	Relationship of precipitation, consumptive use, and water yield	49
5	Average water supply to water-budget areas	51
6	Major springs in the Sevier River Basin	59
7	Average water use, water-budget areas	68
8	Major reservoirs and lakes in the Sevier River Basin	70
9	Discharge from wells by sub-basin	71
10	Trend in pumped well and flowing well discharge for selected years in Pavant Valley, 1946-65	72
11	Physical and biological data for selected lakes and reservoirs, Sevier River Basin, 1958	79
12	Classification of selected streams for fish habitat, Sevier River Basin, 1958	80
13	Recreation visits on National Forest lands, Sevier River Basin, 1960 and 1965	83
14	Population of the Sevier River Basin and State of Utah, 1890-1960	86
15	Selected attributes of the population, Sevier River Basin and State of Utah, 1960	88
16	Projected population for Sevier River Basin and State of Utah, 1965-2020	90
17	Personal income by source of income, Sevier River Basin, 1958-1962	91
18	Average annual work force, unemployment, and type of employment, Sevier River Basin, 1958-1966	92
19	Cropland harvested in six-county area, 1924-1964	94
20	Average size of farm in six-county area, 1924-1964	95
21	Acreages harvested of major crops in six-county area, 1944-1964	95
22	Average yields of major crops grown in six-county area, 1944-1959	97
23	Alfalfa acreage, production, and sales in six-county area, 1954-1964	99
24	Livestock on farms in the six-county area, 1944-1964	99
25	Amount of livestock and livestock products sold from farms in six-county area, 1944-1964	100
26	Value of farm products sold by source, six-county area, 1954-1964	101
27	Classification of farms by farm type and economic area, 1962	105
28	Total land, cropland and noncropland, in farms by economic area, 1962	106
29	General information about farmers and farm families by economic area, 1962	107
30	Agricultural land use on study farms, Sevier River Basin, 1962	108
31	Agricultural land use on study farms, Economic Area I, 1962	109
32	Agricultural land use on study farms, Economic Area II, 1962	110
33	Agricultural land use on study farms, Economic Area III, 1962	111
34	Agricultural land use on study farms, Economic Area IV, 1962	112
35	Distribution of crops by economic areas, 1962	113
36	Crop yields per harvested acre on study farms by economic area, 1962	114
37	Estimated market value per acre of land and water without buildings and rental arrangements, economic areas, 1962	116
38	Use of public grazing land by farm operators with base property within the Sevier River Basin, 1962	117
39	Acreage and animal unit months of forage provided by private and State lands, 1962	119
40	Projected normalized prices received and selected prices paid, 1965	122
41	Crop yields used in estimating farm incomes by economic areas, 1962	123
42	Agricultural incomes and organizational items for selected farm types and sizes, Economic Area I	124
43	Agricultural incomes and organizational items for selected farm types and sizes, Economic Area II	125
44	Agricultural incomes and organizational items for selected farm types and sizes, Economic Area III	126
45	Agricultural incomes and organizational items for selected farm types and sizes, Economic Area IV	127
46	Present level of development and recommended levels of improvement practices for full development of on-farm resources and estimated costs by areas	129

Number		Page
47	Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present systems and full water supply for all irrigated lands, Economic Area I	131
48	Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present systems and full water supply for all irrigated lands, Economic Area II	132
49	Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present systems and full water supply for all irrigated lands, Economic Area III	134
50	Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present systems and full water supply for all irrigated lands, Economic Area IV	136
51	Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present systems and full water supply for all irrigated lands, Sevier River Basin	137
52	Acreage and volume of commercial timber on National Forest lands, 1965	138
53	Commercial forest area of lands not in National Forest, 1961	139
54	Erosion condition classification	145
55	Estimated annual sediment damage for selected watersheds	150
56	Sedimentation in Otter Creek, Piute and Sevier Bridge Reservoirs, 1963	151
57	Average sediment yield from selected drainages	152
58	Annual gross sediment production based on hydrological condition of National Forest and other forested lands, 1968	153
59	Reported floods in the Sevier River Basin, 1890-1968	156
60	Crop and pasture lands influenced by water tables	157
61	Average annual consumptive-use deficits, 1931-60	159
62	Irrigation distribution system condition	160
63	Bacteriological contamination at selected sites, 1964	165
64	Leaching requirements in the Delta area	171
65	Present and potential irrigation water needs	172
66	Projected municipal, rural domestic, and industrial water diversion demands	173
67	Present and projected visitor days of recreation demand, 1963-2020	175
68	Status of public water systems	181
69	Land leveling, on-farm ditch lining, and canal lining completed	185
70	Conservation practice cost sharing, 1966	187
71	FHA loan status, by county, 1966	188
72	Cooperative fire protection by county, 1965	189
73	Watershed improvement work completed on National Forest lands prior to 1965	192
74	Additional irrigable land available for potential development	197
75	Potential annual water salvage from wetlands by sub-basin	199
76	Management potential of underground reservoirs	200
77	Unused storage capacity in three major reservoirs	201
78	Potential reservoir sites and enlargements	203
79	PL-566 project cost and benefit-cost ratios	215
80	Opportunities for selected structural measures, project feasibility, and PL-566 planning status in watersheds	216
81	On-farm land treatment opportunities	223
82	Benefit-cost relationship of cooperative State-Federal fire protection of State and private lands	225
83	Range improvement development opportunities on National Forest and other forested lands	228
84	Erosion control development opportunities on National Forest and other forested lands	229
85	Benefit and cost evaluation of watershed and range improvement programs	230
86	Employment opportunities in watershed and range improvement projects	232
87	Benefit-cost relationship of recreation development on National Forests to accommodate projected demand	233
88	Reduction in outflow with potential development of present water resources, by sub-basin	241

FIGURES

MAPS

CHAPTER I

SUMMARY

OBJECTIVE AND SCOPE OF STUDY

The purpose of this report is to present information on water and related land resources in the Sevier River Basin, Utah. The Basin contains 5,200,000 acres encompassing the Sevier River drainage in south-central Utah. It is 170 miles long, north to south, and 100 miles wide, east to west. The drainage, a closed basin within the Great Basin, terminates at Sevier Lake. Most of the area lies within the High Plateaus, except the northwest portion, which is in the Basin and Range province.

The report identifies and recommends solutions for problems concerning the conservation and use of water and land within the Basin, and emphasizes opportunities for the development of these resources through the initiative of local sponsors. It also provides information to plan programs of the U. S. Department of Agriculture, other Federal agencies, and the State of Utah, and provides a basis for more effective coordination between these agencies.

Although land resources were studied, they were examined primarily as they relate to water, and this study focuses on water resources and analyzes their importance to the economic development of the Sevier River Basin. Available secondary data supplemented by field surveys were used in the study and findings suggest that many opportunities for individual and group improvement practices exist which will contribute to the overall development of the water and related land resources. However, additional investigations of practices and projects suggested by the study will be required for detailed planning in the future.

It is recognized that social, institutional, legislative, and economic considerations may impede some recommended developments, strengthen the interest of others, or establish the need for additional studies beyond the scope of this report. These considerations are treated only to the extent of reasonably evaluating the impact of the recommendations and their capability of meeting demands.

Although investigations were carried out within the framework of existing water rights and developments, some projects investigated either contemplate or will definitely require exchange and purchase agreements to make them feasible.

PROBLEMS AND NEEDS

The development of new projects and the acceleration of existing programs are needed to make more efficient use of resources. This will require financial and technical help from many sources. Range and cropland management, floodwater and sediment control, soil stabilization, and more efficient use of water and land resources are all needed to solve primary and interrelated problems within the Sevier River Basin.

Heavy to excessive erosion is found on 20 percent (1,040,000 acres) of the area. Annual sediment yields are 1.0 acre-foot per square mile in several small problem areas and over 2.0 acre-feet per square mile in some other areas. General sediment yield is less than 1.0 acre-foot per square mile.

There are root-zone water shortages of 77,830 acre-feet, reflecting irrigation needs of 240,780 acre-feet at the point of diversion at present efficiencies. Nearly 18,000 acres of rotated cropland need drainage facilities. There are 1,480 total miles of irrigation canals of which 380 miles or over one-fourth are in poor condition (losses over 6 percent per mile). Water quality is a serious problem in the lower reaches of the river.

Low per capita income and an increase in the average age of the work force indicate a declining economy. Stabilization and enhancement of the agricultural economy is a primary economic need. Economic expansion should be encouraged to provide employment for the younger generation.

Development of recreation facilities, both public and private, is urgently needed. Present demands even now exceed the supply in many areas.

FINDINGS AND CONCLUSIONS

DEVELOPMENT POTENTIAL

Acceleration of current programs of the U. S. Department of Agriculture potentially could solve many of the water and related land resource problems within the Sevier River Basin. Development potential on National Forest and other forested lands include land treatment measures on 285,600 acres and range improvement on 225,175 acres. Watershed improvement will help alleviate erosion, floodwater, and sedimentation problems. Development of recreation facilities and improved grazing resources will stimulate the local economy. Although recreation is expected to increase 8 times by the year 2020, there is sufficient potential to meet this demand.

Land leveling or sprinkling on 172,000 acres of cropland, ditch lining on 156,000 acres, and regulating reservoirs to serve 15,300 acres are needed to solve on-farm water management problems. The installation of recommended on-farm improvement practices would increase the average on-farm irrigation efficiency by 6 percent and the overall water-use efficiency by 4 percent. Diversion requirement for presently irrigated lands would be reduced by 25,100 acre-feet.

With the development of both on-farm and off-farm improvement practices, an additional 70,000 acres of irrigable lands under the present irrigation systems could be provided with a full water supply in addition to presently irrigated lands. Water salvage projects on wet areas could provide 215,000 acre-feet of additional irrigation water. A 10 percent increase in the irrigation distribution system efficiencies would eliminate the existing irrigation water deficit.

There are about 5,470,000 acre-feet of water stored in the upper 200 feet of alluvium in 9 major underground reservoirs. Potentially, this is one of the best water management tools available. In addition, feasible sites exist for 79,000 acre-feet of surface storage for better water management.

SOLUTIONS

Agencies of the U. S. Department of Agriculture, other Federal agencies, and private land owners are helping to alleviate many problems related to the conservation and best use of water and land resources. There are many opportunities to accelerate these programs in solving Basin problems.

Findings suggest that 12 potential PL-566 watershed projects will be feasible within the next 10-15 years. An additional 10 will be feasible in the more distant future. These projects will help solve water management and soil stabilization problems, reduce flood damages, and improve related management facilities. They will provide better watershed conditions, create additional recreation facilities, and increase available irrigation water supplies.

Many problems can be solved through individual and group action, but the best use of all resources will require development of the Basin as a unit under a coordinated and cooperative program.

IMPACTS

The impact of the proposed programs and projects will be felt in every phase of activity throughout the Sevier River Basin. Grazing management and allotments will be altered. Vegetative manipulation and cropping pattern changes will increase the water available for irrigation or other uses and permit exchange and transfer of water rights. Although more efficient use of water will likely reduce downstream-flow patterns, these effects could be offset by water-saving projects. Land resources will be conserved through floodwater and sediment control and soil stabilization.

The development of on-farm improvement practices on presently irrigated lands would result in annual direct agricultural benefits of $1,588,000 with amortized annual costs of $1,106,000. Income available to farm operators would be increased by $482,000 annually. In addition, considerable secondary benefits would also accrue to the local people.

With the development of all on-farm and off-farm resources and the irrigation of irrigable lands under the present irrigation systems, there will be $4,924,000 in direct agricultural benefits with $1,573,000 amortized annual on-farm costs. Farmers would have available $3,351,600 additional income to offset the off-farm development costs to obtain the additional irrigation water necessary to provide a full water supply.

Development programs on National Forest and other forested lands will reduce sediment, floodflows and provide increased grazing capacity valued at $444,700 annually. In addition, recreation developments will accommodate 6,343,000 visitor days annually--over 8 times present day use.

CHAPTER II

INTRODUCTION

DESCRIPTION OF STUDY AREA

The Sevier River Basin is a major landlocked drainage of the Great Basin located in south-central Utah (Map 1). It is bounded on the east and south by the Colorado River Basin, on the west by the Beaver River Basin, and on the north by the Great Salt Lake Basin. The Sevier River once terminated in prehistoric Lake Bonneville near the town of Gunnison and more recently discharged perennially into Sevier Lake. Irrigation developments since the turn of the century have depleted the river until the only water now reaching Sevier Lake is occasional flood flows, drainage effluent, and groundwater. Sevier Lake has now become an ephemeral playa of sparse salt-tolerant vegetation and evaporation basins which consume the remains of the River system.

The Basin contains 5,200,000 acres and includes portions of Garfield, Iron, Juab, Kane, Millard, Piute, Sanpete, Sevier, and Tooele Counties. Fifty percent of the area is mountainous and yields most of the water for irrigation. The irrigated crop and wetland areas represent about 10 percent. On the remaining valley and desert rangeland, precipitation either evaporates or is consumptively used by vegetation.

Mountain ranges trend in a southwesterly-northeasterly direction. Most of these are plateaus, but there are some basin and range types in the northwest portion. Valleys are relatively long and narrow except where the river breaks into the Sevier Desert. Elevations range from 4,550 feet to 12,173 feet.

The climate is semiarid with precipitation ranging from 6.4 to 13.0 inches in the valleys to over 40 inches in the highest mountains. Cold winters and generally mild summers result in growing seasons which vary from 98 days to 178 days.

The population in 1960 was 31,085. The inhabitants reside mostly in small farming communities of which Richfield, with a population of nearly 4,500, is largest. The Basin is primarily an agricultural area with few mining or manufacturing interests. Recreation, however, is becoming increasingly important and will continue to influence the area's economy in the years to come.

Map 1
Location Map
Sevier River Basin
Utah

NEED FOR THE STUDY

During the last 25 years, the Sevier River has experienced a reduction in runoff similar to most streams in the Pacific Southwest. This has been caused largely by changing precipitation patterns. As a result, many irrigation companies have proposed improvement programs in order to conserve their irrigation water supplies. Some of these water and related land resource improvement projects have been completed; however, there remains a large resource potential. The failure to complete more projects is not because the people lack desire or do not need the water, since they are short of irrigation water, but because of the peculiar situation where further development has, or is feared to have, an impact on other established irrigation water rights. Lacking information about the effects of the proposed developments, downstream water users resist these changes in order to protect their water supply. Their efforts often are carried into courts of law.

Low economic returns, along with a declining population, have made the people aware of the need to overcome water related problems through coordinated resource development. This indicated the need for a study that would investigate all aspects of these resource problems and recommend solutions to them.

AUTHORITY AND ORGANIZATION

In 1956, water users and representatives of Federal, State and local agencies began a comprehensive review of water and related land resource problems. After many meetings and after several somewhat unrelated but important work programs had been started, the Sevier River Study Group requested that a "framework plan" be formulated for the coordinated development of water and related land resources. The Governor of Utah, in response, made a formal request for assistance from the United States Department of Agriculture.

Participation by the U. S. Department of Agriculture was authorized under provisions of Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Statute 666 as amended). This Act authorized the Department of Agriculture to cooperate with other Federal, State, and local agencies in making investigations and surveys of river basins as a basis for the development of coordinated programs.

The State of Utah assigned the State Engineer to carry out the State's responsibilities both for assisting in the study and for aiding coordination between other Federal and State agencies.

Work was coordinated by a Field Advisory Committee representing the Soil Conservation Service, the Forest Service, and the Economic Research Service. The study was accomplished by a Field Party composed of technicians from these parent agencies.

Federal, State, and local organizations have contributed to the study by providing counsel, donating information, and participating in public meetings. Their cooperation and help is gratefully acknowledged. Significant contributions were made by the following:

Local

Counties
Irrigation Companies and Associations
Municipalities
Sevier Water Users Association, Inc.
Soil Conservation Districts
Water Conservancy Districts

State

State of Utah Forestry and Fire Control
University of Utah
Utah Department of Natural Resources
- Division of Fish and Game
- Division of Parks and Recreation
- Division of State Lands
- Division of Water Resources
- Division of Water Rights

Utah Division of Health
Utah Division of Travel Development
Utah Geological and Mineralogical Survey
Utah State Department of Agriculture
Utah State Department of Highways
Utah State University
- Agricultural Experiment Station
- Engineering Experiment Station
- Extension Services
- Utah Water Research Laboratory

Utah State Soil Conservation Committee

Federal

U. S. Department of Agriculture
- Agricultural Research Service

Agricultural Stabilization and Conservation Service
Economic Research Service
Farmers Home Administration
Federal Extension Service
Forest Service
Rural Electrification Administration
Soil Conservation Service

U. S. Department of the Army
Corps of Engineers

U. S. Department of Commerce
Census Bureau
Environmental Sciences Service Adminstration
Environmental Data Service
Weather Bureau

U. S. Department of Interior
Bureau of Land Management
Bureau of Reclamation
Bureau of Sport Fisheries and Wildlife
Geological Survey

U. S. Department of Transportation
Bureau of Public Roads

OBJECTIVES OF THE STUDY

The objectives of the study were to inventory water and related land resources within the Sevier River Basin, to define the problems and needs confronting this area, and to determine what opportunities exist to develop the Basin's full potential.

Problems are defined as inadequacies in the use and preservation of water and related land resources. Both physical and monetary values were used to identify the problems which represent present instead of future conditions. The problems are identified by describing their causes, by analyzing their extent and frequency, and by estimating their economic and social consequences. It is recognized that there is competition between users for available resources and problems in which a conflict of interests exist are identified.

Needs are defined as conditions requiring relief or as something desirable or useful. Needs may be present or projected and are based on problems and projected economic activity and its effect on resource use and quality. Resource needs are identified regardless of competing or conflicting uses.

Opportunities are defined as the capability to manage or develop resources to alleviate the needs and problems associated with water and related land use. Multiple-use programs and value judgments between alternative uses are reflected in development opportunities. Both present resource conditions and projected demand are considered.

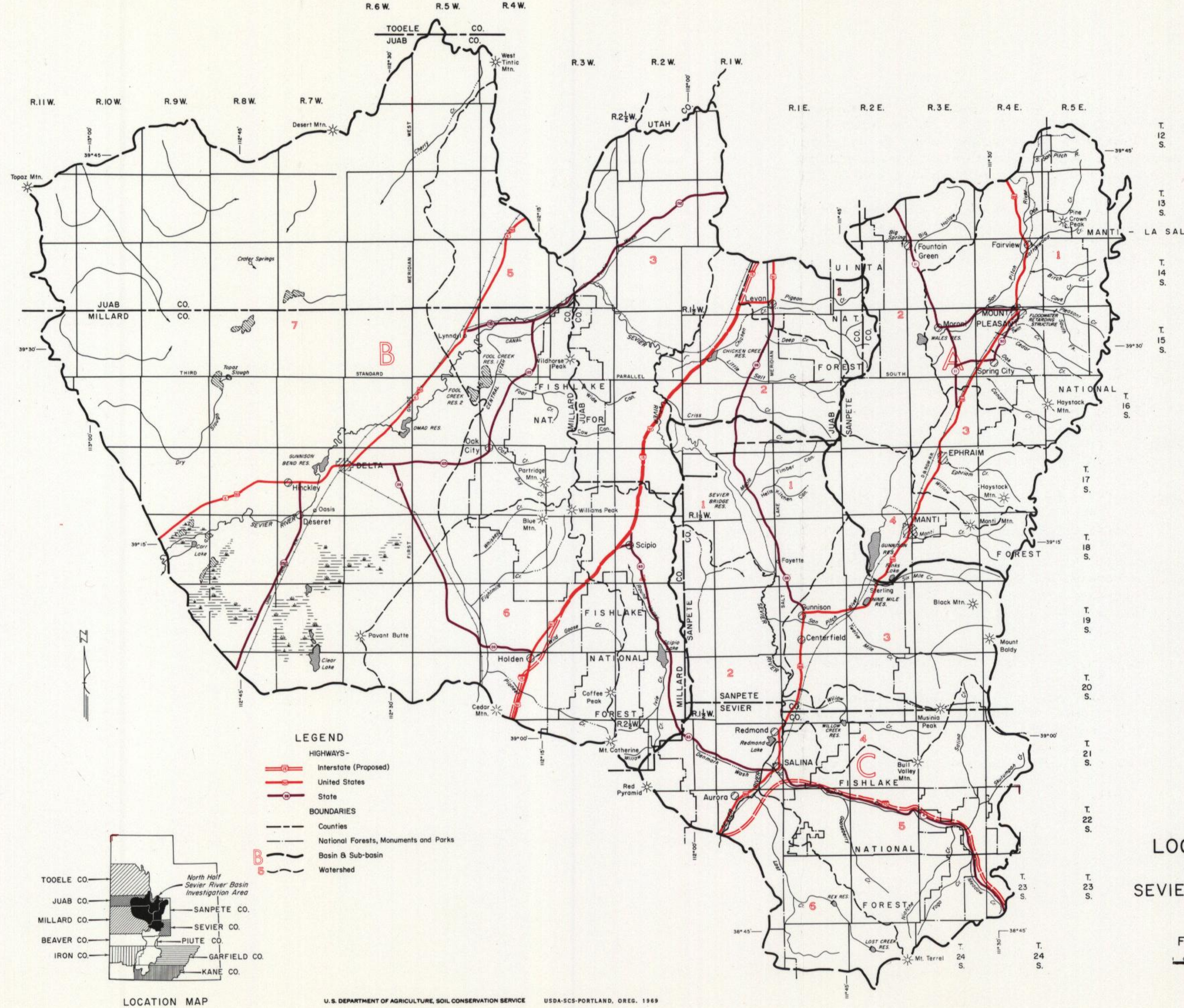
Programs of the U. S. Department of Agriculture and the State of Utah were emphasized in meeting objective. Emphasis was placed on watershed investigations to determine where PL-566 projects were feasible and what their inter-watershed effects would be.

NATURE OF STUDY

The study was a reconnaissance investigation of the water resources, including source, distribution, and use; land resources, including data on soils and vegetation; and economic resources, including interaction among all resources available for development. Water was recognized as the limiting resource, and its availability was considered in identifying and evaluating improvement opportunities.

The Basin was divided into 35 watersheds which were grouped into 6 hydrologic sub-basins (Map 2). Four economic areas were delineated using both watershed and county boundary lines. Map 12 showing the location of the economic areas is shown on page 102. Most data collected were processed and tabulated for each watershed and then assembled by sub-basins or economic areas for analysis. Sub-basins were generally the smallest areas where hydrologic date were available to balance inflow-use-outflow studies. Economic Areas represented the different agricultural situations.

The study consisted mostly of an accumulation and evaluation of previously recorded data, both published and unpublished, much of which was furnished by other cooperating agencies. Unless otherwise indicated in the report, all data is based on the 1931-60 average. Other information was obtained through consultation with local, public, and private officials and reconnaissance surveys by Economic Research Service, Forest Service, and Soil Conservation Service specialists. Limited studies were made to hather basic information that was not otherwise available. Most basic data will be published in appendices.



MAP 2
LOCATION MAP
NORTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE   USDA-SCS-PORTLAND, OREG. 1969

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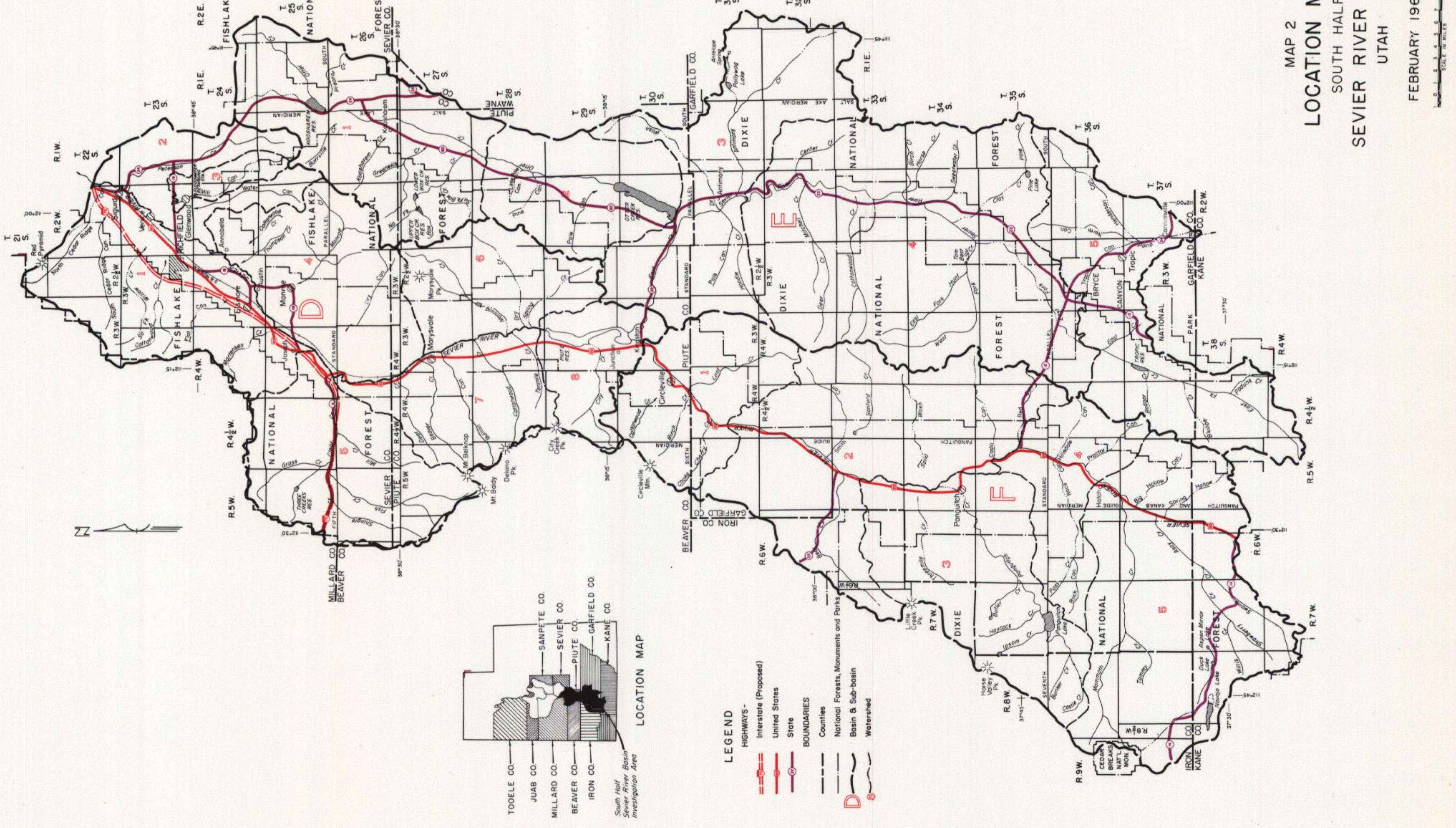

MAP 2
LOCATION MAP
SOUTH HALF
SEVIER RIVER BASIN
UTAH
FEBRUARY 1969
LEGEND
HIGHWAYS-
Interstate (Proposed)
United States
State
BOUNDARIES
Counties
National Forests, Monuments and Parks
Basin & Sub-basin
Watershed
LOCATION MAP
TOOELE CO.
JUAB CO.
MILLARD CO.
BEAVER CO.
IRON CO.
SANPETE CO.
SEVIER CO.
PIUTE CO.
GARFIELD CO.
KANE CO.
South Half Sevier River Basin Investigation Area

U S E O F T H E R E P O R T

This report can be used as a guide to the coordinated development of the Sevier River Basin resources. It will provide knowledge of areas where efforts should be concentrated, where priorities should be established, and where the best potential resource development lies.

This report identifies potential Watershed Protection and Flood Prevention projects. It explains the possibilities of a Basin-wide coordinated development program. The information presented will help establish priorities and will accelerate operational programs of the U. S. Department of Agriculture and the State of Utah and will stimulate development of Soil Conservation District programs. It will provide valuable information on water and related land resources to managers of Federal, State, and private lands, and to the general public.

CHAPTER III

NATURAL RESOURCES OF THE BASIN

In this section, the natural resources of the Sevier River Basin are described in both qualitative and quantitative terms. Those features which are most important to the water and related land resource development of the Basin are stressed. Specifically included in the discussion are climate; land resources, including physiography, geology, soils, vegetation, and land status and use; water resources, including surface and groundwater use and management; wildlife; and recreation.

C L I M A T E

Within the Sevier River Basin, average monthly valley precipitation (Map 3) is distributed nearly equal during the year although precipitation during the winter is greater in the northern part of the Basin while during the summer it is greater in the southern. Precipitation ranges up to a maximum of 40 inches annually at the highest elevations with the major portion falling in winter. The effect of northern winter storm paths is shown by a 6-inch greater annual precipitation in the northern portion. The snow course information plotted in Figure 1 indicates, however, a declining trend in winter precipitation. Since 1939, the 5-year trend average precipitation on 21 courses within or near the Basin has dropped from over 16 inches to less than 11 inches.

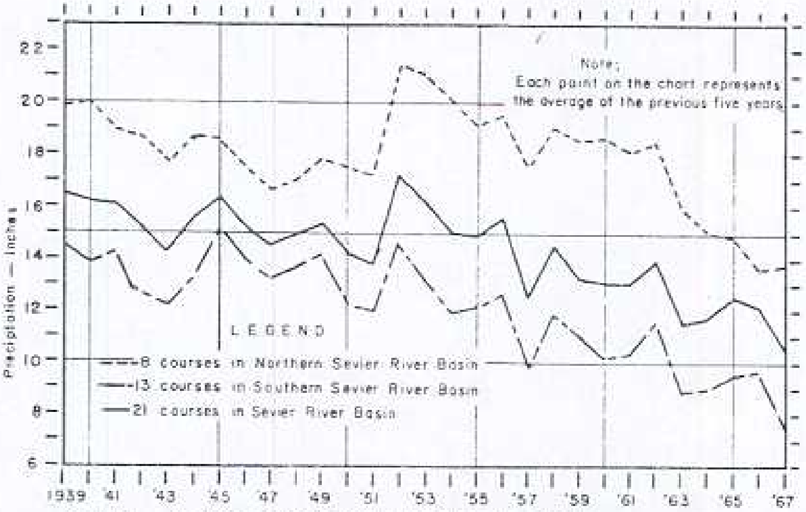


Figure 1: 5—Year average precipitation for 21 selected snow courses.

April 1 reading for years 1939 thru 1967
Sevier River Basin
Utah

The climate of the cropland area varies from semiarid to arid. Average annual precipitation on irrigated land varies from 13.0 inches at Levan and Tropic to 6.4 inches at Delta. Annual extremes at Levan were 7.20 inches during 1931 and 26.22 inches during 1895, and at Deseret were 3.08 inches during 1956 and 11.33 inches during 1915. The uncertainty of precipitation is further illustrated by the monthly extremes. Both Levan and Deseret have experienced several months without precipitation and maximums of 7.18 inches during May 1895, at Levan and 3.99 inches during October 1946, at Deseret.

Mean annual temperatures vary from 42.3° F at Hatch to 52.4° F at Oak City. Hatch has the coldest winters with a January mean of 21.6° F while Holden is the warmest in summer with a July mean of 77.9° F. The hottest temperature recorded at a valley weather station was 111° F at Mount Pleasant while the coldest was -40° F at Scipio. Frost-free periods vary from 98 days (June 8 to September 14) at Panguitch to 178 days (April 26 to October 21) at Oak City.

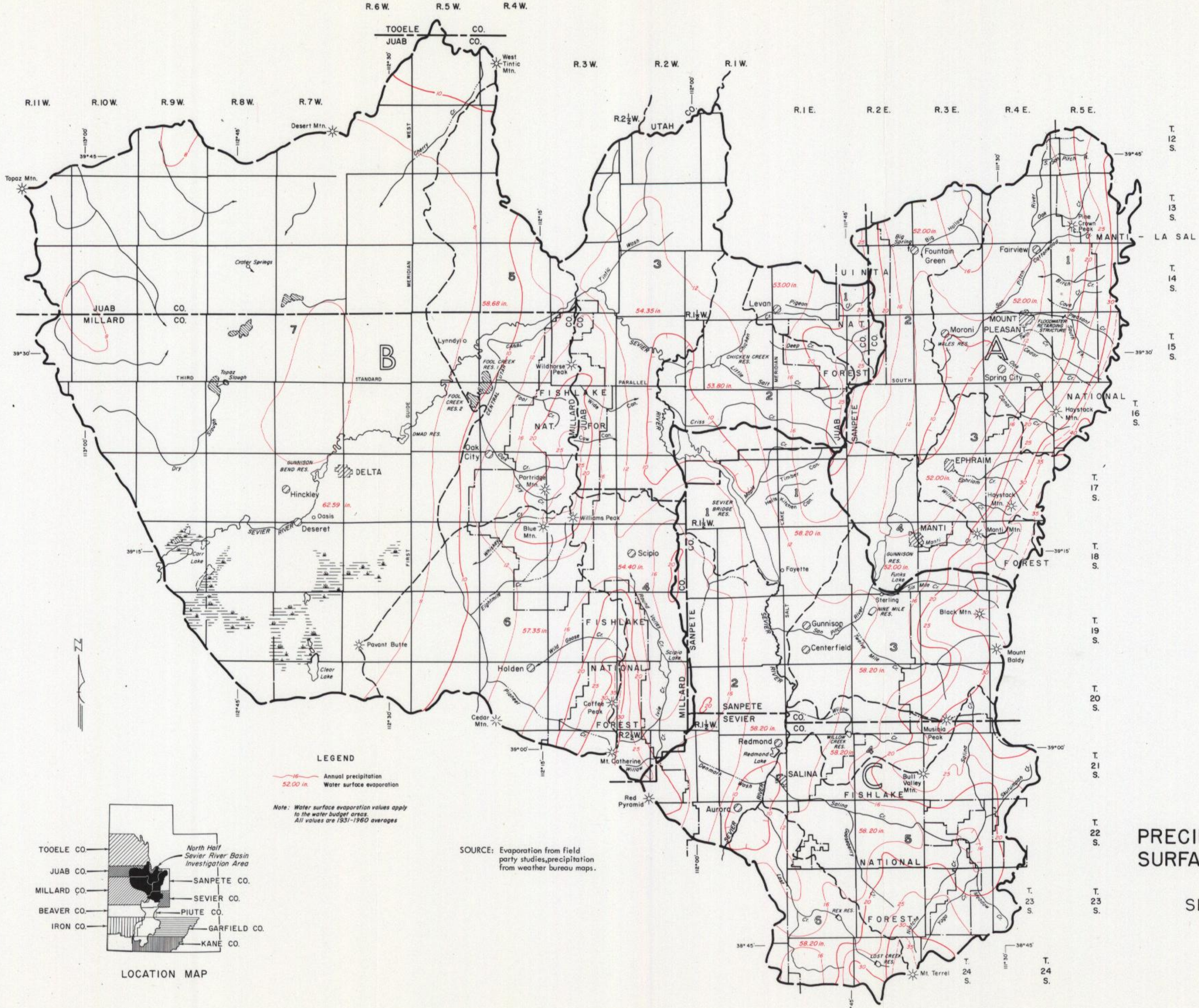
Annual water surface evaporation in the irrigated areas varies from 62 inches in Watershed B-7 (Delta) to 49 inches in Sub-basins E and F. The average rate is 54 inches per year (Map 3).

Prevailing winds are from the southwest. Average wind movement is greatest during May at 80 miles per day in all areas except for the Delta area where it is 120 miles per day. Values drop to half these amounts during midwinter.

LAND RESOURCES

GEOLOGY AND PHYSIOGRAPHY

The Sevier River Basin has been covered seven times by marine seas and once by a great system of freshwater lakes. It has been an enormous and probably majestic highland, as well as a humid, subtropical area dotted with swamps, and once it was a vast desert covered by sand dunes. The Basin now contains some of the outstanding physiographic and geologic features in Utah. The panoramic scenery extends from the broad expanse and sheer cliffs of the Markagunt and Paunsaugunt Plateaus, along the lofty Tushar Mountains, through the high mountain valleys of the Sevier, and past the Wasatch monocline to the Sevier Desert and her serrated mountain ranges. The "backbone" or Wasatch Line, a portion of which runs northeasterly from the Markagunt Plateau to Mt. Nebo, roughly divides the area into the High Plateaus (highest in North America) on the east, and the Basin and Range Province on the west.



MAP 3

PRECIPITATION AND WATER SURFACE EVAPORATION MAP

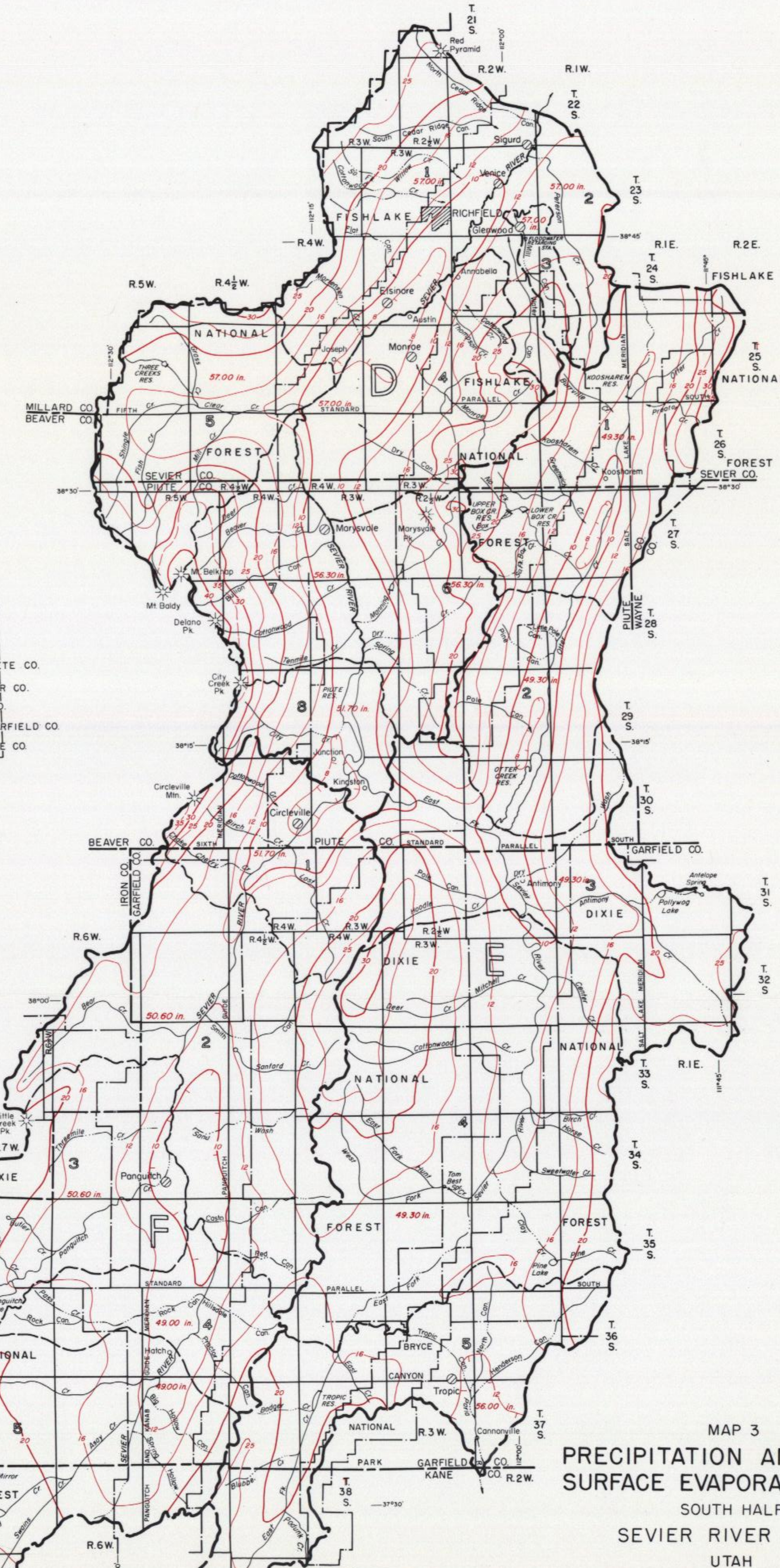
NORTH HALF

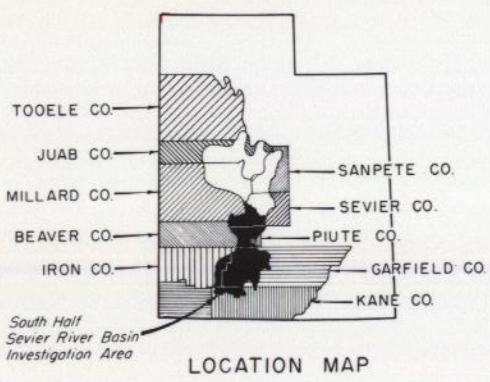
SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SCALE IN MILES





LOCATION MAP

LEGEND

10 — Annual precipitation

56.00 in. — Water surface evaporation

Note: Water surface evaporation values apply to the water budget areas. All values are 1931-1960 averages

SOURCE: Evaporation from field party studies, precipitation from weather bureau maps.

MAP 3

PRECIPITATION AND WATER SURFACE EVAPORATION MAP

SOUTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SCALE IN MILES

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Irrigated mountain valleys lie between 5,000 and 7,500 feet above sea level while most of the Sevier Desert area is between 4,550 and 5,000 feet high. The old riverbed leading from the Sevier Desert to the Great Salt Lake is 4,630 feet. The highest point is Delano Peak in the Tushar Mountains at 12,173 feet. There are 12 other peaks above 11,000 feet.

The fall of the Sevier River is 2,450 feet from its confluence with Asay Creek to the Basin boundary, a distance of 230 miles. Average fall is 11 feet per mile, varying from 3 feet per mile near Delta to 23.4 feet per mile through Marysvale Canyon.

Headwaters of the Sevier River rise in the Markagunt and Paunsaugunt Plateaus which form the south boundary. The Awapa, Sevier, Fish Lake, Wasatch and Gunnison Plateaus are important landmarks. The Tushars, described by Dutton as "a composite structure, its northern half being a wild bristling cordillera of grand dimensions and altitudes, crowned with snow peaks, while the south half is conspicuously tabular," (7) the lower Valley Mountains, Sheeprock Range, Canyon Range and Pavant Range, "a curious admixture of plateau and sierra" (7) complete the majestic array of the sentinels of the Sevier.

Each plateau and mountain range has its own character, influencing the hydrologic history. Throughout the length of the Sevier River, evidence of past erosion and deposition cycles is left in the form of piedmont benches and terraces. Erosion has produced the spectacle of Bryce Canyon National Park and Cedar Breaks National Monument. Where the Sevier River emerges into the Sevier Desert, a vast delta has been molded under the influence of ancient Lake Bonneville where lake-bottom features and wave-cut benches and terraces along high waterlines are evident.

Prior to Lake Bonneville, geologic blocks across the drainage of the Sevier River formed Panguitch Valley, Circle Valley, Sevier Valley, and Mills Valley. Several hundred feet of alluvium was deposited in these valleys providing large underground reservoirs.

All eras of geologic time are represented (Map 4), but most of the area is covered by either Tertiary volcanics or Jurassic, Cretaceous, Tertiary, or Quaternary sediments. Tertiary rocks are the dominant strata of the consolidated sediments. It was not until the volcanism and faulting of the Tertiary that the present landscape started to form. The Tertiary volcanics are extrusive rocks which occupy the boundary between the Colorado Plateau and the Basin and Range Provinces. They extend from near Panguitch Lake on the south to the Sevier and Fish Lake Plateaus on the north. Three distinct periods are represented with an aggregate thickness of about 9,000 feet.

Uplifting of the plateaus with subsequent erosion has carved these blocks to their present profiles and has created the erosional escarpments now in evidence. Quaternary basalts, some probably only one-thousand years old, are found on the Markagunt and Paunsaugunt Plateaus and in the Sevier Desert.

The bedrock of the interior valleys of western Utah have been buried by sediments over a mile deep in places. Glaciers and Pliocene Lake Bonneville have left their marks, but have only slightly altered the overall landscape. Even the volcanic eruptions and faulting of the last few thousand years, although enormous and earth rending locally, have not made widespread changes.

The Wasatch monocline, with a maximum displacement of more than 8,500 feet, is the one major fold. Two major normal faults, the Sevier and the Paunsaugunt, trend northeasterly. The Sevier fault extends from Arizona through Sevier Valley and probably into Sanpete Valley, and the Paunsaugunt fault runs from northern Arizona, past Bryce Canyon, and through Grass Valley. Maximum displacement of these faults, downthrown on the west, is about 2,000 feet, although there is considerable variation within short distances. Major thrust faults are located in the Pavant and Gunnison Plateaus and the Canyon Range.

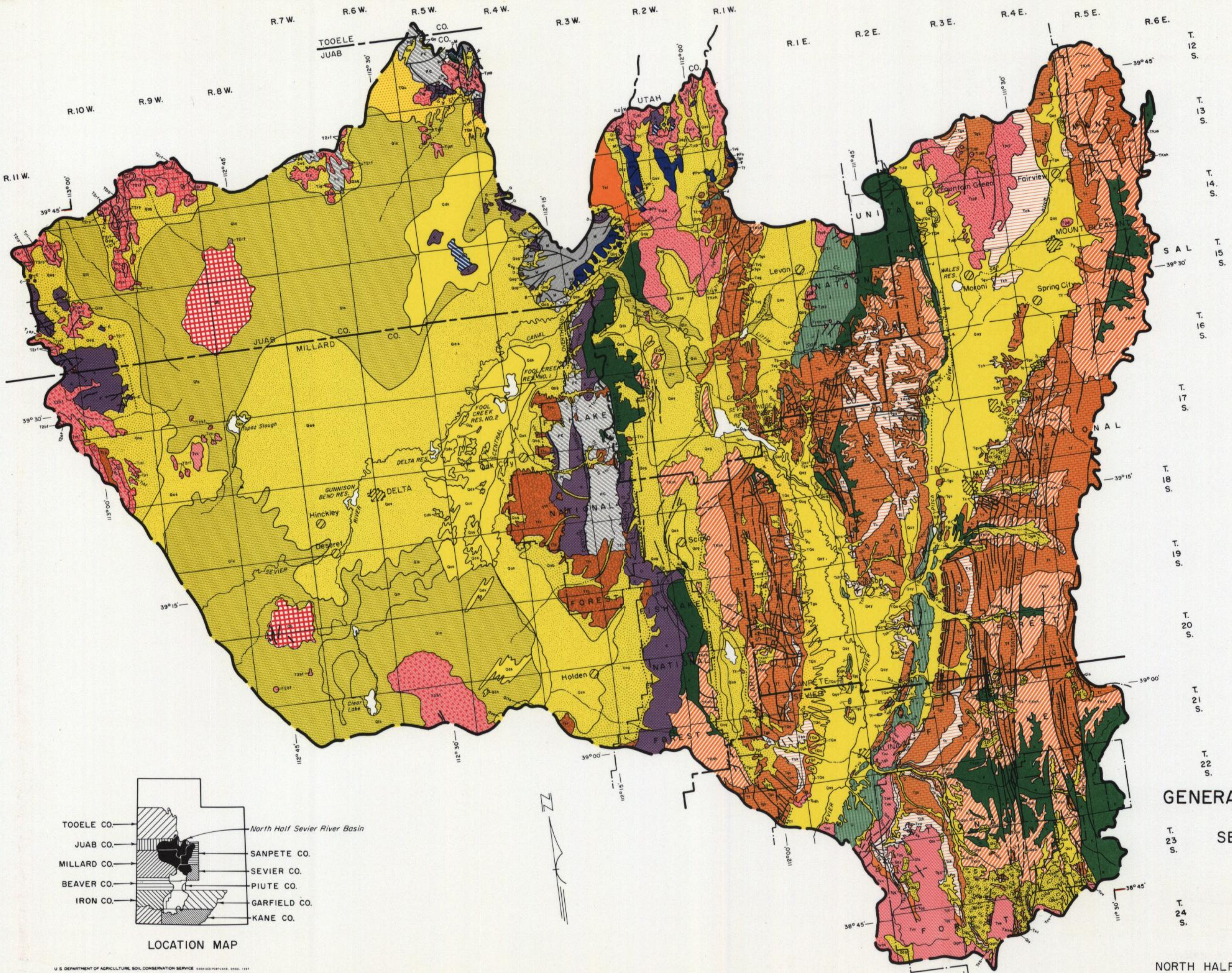
MINERALS

Minerals include numerous deposits of hydrocarbons, metallic and nonmetallic minerals, and other associated materials. Most of the deposits are noncommercial at present. The first settlers developed those materials that were accessible and necessary to their subsistence. Later they turned to mining some of the more marketable deposits. Metallic minerals include antimony, beryllium, copper, gold, iron, lead, manganese, molybdenum, mercury, silver, thorium, uranium, vanadium, and zinc.

Nonmetallic minerals and materials include alunite, barite, building stone, clays, diatomacious earth, fluorite, gems, gypsum, limestone, salt, sand and gravel, silica and volcanic cinders.

Mineral fuels include coal, oil, and gas. These are generally located in the more recent depositions, but exploration has not completely defined these fields.

The Wah Wah-Tushar mineral belt and Deep Creek-Tintic mineral belt cross through the south-central and northern areas, respectively. These zones of weakness include most of the ore producing areas.



MAP 4

GENERALIZED GEOLOGIC MAP

NORTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SCALE IN MILES

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

LEGEND

SEDIMENTARY ROCKS

QUATERNARY SEDIMENTARY ROCKS

Symbol	Description
Qay Qco Qdo Qds Qdg	Qay-YOUNGER ALLUVIAL DEPOSITS, CHIEFLY ALONG ACTIVE STREAMS. Qco-MISCELLANEOUS, COVERING DEPOSITS; INCLUDING WIND BLOWN MATERIAL, THIN SOIL AND ALLUVIUM. Qdo-DUNES, OOLITIC; Qds, SILICEOUS; Qdg, GYPSIFEROUS.
Qao Qa Qas	Qao-OLDER ALLUVIAL DEPOSITS, ON TERRACES ABOVE ACTIVE STREAMS. Qa AND Qas-ALLUVIAL SURFACES; MOSTLY SLOPING AND WELL DRAINED WITH SOIL PROFILE SUITABLE FOR CROPS. MOSTLY NOT STONY.
Qag Qgs Qgm Qlts	Qag-COLLUVIUM AND ALLUVIUM; MOSTLY STONY AND UNFIT FOR AGRICULTURAL CROPS. Qgs - GRAVEL SURFACES; MAINLY TERRACES AND PEDIMENTS UNDERGOING EROSION; MAY NOT BE ASSOCIATED WITH ACTIVE STREAMS. Qgm-GLACIATED GROUND AND MORAINES UNDIFFERENTIATED; INCLUDES BARE ROCK AS WELL AS MORAINES OF ALL TYPES. Qlts-CONSTRUCTIONAL LAKE SHORE FEATURES (TERRACES, SPITS, AND BARS), SANDY.
Qls	LANDSLIDES AND OTHER SURFICIAL MASSES DISPLACED BY GRAVITY.
Qlc Qm	Qlc-LAKE BED SEDIMENTS, MOSTLY DRY CLAY OR DUST, POORLY DRAINED AND WITH ENOUGH SALT TO PROHIBIT AGRICULTURE. Qm-MARSHLAND, MOSTLY FRESH WATER BUT SOME SALTY OR BRACKISH.

TERTIARY SEDIMENTARY ROCKS

Symbol	Description
TQu TQa	TQu-TERTIARY AND QUATERNARY DEPOSITS AND SURFACES OF UNCERTAIN AGE GENERALLY BROWNISH AND CONGLOMERATIC. TQa-AXTEL FORMATION, CONGLOMERATE OF PEBBLES TO BOULDERS, LOCAL IN SEVIER VALLEY.
Tcg	TERTIARY CONGLOMERATE, EXACT AGE UNCERTAIN.
Tb	TERTIARY BRECCIA, EXACT AGE UNCERTAIN.
Tsl Tu	Tsl-SALT LAKE FORMATION OR GROUP. CONTINENTAL SANDSTONE, SHALE, MARLSTONE, SILT AND PYROCLASTIC ROCKS, GENERALLY VERY LIGHT COLORED, RANGE FROM OLIGOCENE TO PLIOCENE, COULD BE SUBDIVIDED.
Tsr Tfc	Tsr-SEVIER RIVER FORMATION. GRAY PARTLY CONSOLIDATED COARSE CONGLOMERATE WITH VOLCANIC DEBRIS PLIOCENE? Tfc-FOOL CREEK CONGLOMERATE. PEBBLE, COBBLE AND BOULDER BEDS NEAR CANYON RANGE. PLIOCENE?
Tgg	GRAY GULCH FORMATION. COMPLEX AGGREGATION OF PYROCLASTIC ROCKS WITH COLORED SANDSTONE, LIMESTONE, AND SHALE, SEVIER VALLEY ONLY. OLIGOCENE?
Tbk Tch	Tbk-BALD KNOLL FORMATION. LIGHT GRAY SILTSTONE, LOCAL IN SEVIER VALLEY. LATE EOCENE? Tch-CRAZY HOLLOW FORMATION. RED TO WHITE SANDSTONE AND SILTSTONE, LOCAL CONGLOMERATES. LATE EOCENE?
Tvg	GOLDENS RANCH FORMATION. CHIEFLY VOLCANIC CONGLOMERATE WITH MINOR FLOWS AND LIMESTONE WITH EOCENE FOSSIL PLANTS.
Tgu	GREEN RIVER FORMATION. FRESH WATER LIMESTONE WITH MINOR SANDSTONE AND CONGLOMERATE. MIDDLE EOCENE.
Tc Tw	Tc-COLTON FORMATION. FLUVIAL RED BEDS WITH CHANNEL SANDSTONE LENSES. PALEOCENE. Tw-WASATCH FORMATION OR GROUP. VARIEGATED CONTINENTAL SEDIMENTS RANGING FROM LIMESTONE TO COARSE CONGLOMERATE. PALEOCENE AND EOCENE.
Tf	FLAGSTAFF LIMESTONE. GRAY TO BLUE-GRAY FOSSILIFEROUS, FRESH WATER LIMESTONE. PALEOCENE
TKnh	NORTH HORN FORMATION. VARIEGATED CONTINENTAL BEDS; DINOSAURS IN LOWER PART, PALEOCENE MAMMALS ABOVE.

MESOZOIC SEDIMENTARY ROCKS

Symbol	Description
K	CRETACEOUS; INCLUDES CONGLOMERATE, SANDSTONE, COAL, SILTSTONE, SHALE, SANDY SHALE, LIGHT BROWN, GRAY, SOME RED.
J	JURASSIC; INCLUDES VARIEGATED SILTSTONE, SANDSTONE, LIMESTONE, SALT, GYPSUM, EOLIAN SANDSTONE RED, PINK, ORANGE AND GRAY.
℞	TRIASSIC; INCLUDES SANDSTONE, SILTSTONE AND SHALE, CHIEFLY RED.

PALEOZOIC SEDIMENTARY ROCKS

Symbol	Description
Pz	PALEOZOIC ROCKS, SPECIFIC AGE UNCERTAIN.
P ℙPo	PERMIAN; INCLUDES LIGHT COLORED CHERTY LIMESTONE, DOLOMITE, EVAPORITES, SILTSTONE, SILICEOUS SHALE, PHOSPHORITE, CROSS-BEDDED SANDSTONE, CHIEFLY LIGHT COLORED, GRAY, BUT SOME RED. ℙPo-PERMIAN-PENNSYLVANIAN; INCLUDES QUARTZITE, LIMESTONE DOLOMITE, SANDSTONE AND SHALE.
M	MISSISSIPPIAN; INCLUDES LIMESTONE, QUARTZITIC SANDSTONE, DOLOMITE, CHERT, LIMY SILTSTONE.
D S O Є	DEVONIAN; INCLUDES QUARTZITE, CONGLOMERATE, SANDSTONE, SILTY LIMESTONE, DOLOMITE. SILURIAN; INCLUDES MASSIVE DOLOMITE BEDS. ORDOVICIAN; INCLUDES DOLOMITE, QUARTZITE, HARD SANDSTONE, LIMESTONE, SILTY LIMESTONE, OLIVE SHALE AND CONGLOMERATE. CAMBRIAN; INCLUDES CHIEFLY LIMESTONE, SOME SHALE, DOLOMITE, QUARTZITE, SANDSTONE, CONGLOMERATE AND SOME PHYLLITE.

PRECAMBRIAN SEDIMENTARY ROCKS

Symbol	Description
PЄ	PRECAMBRIAN; INCLUDES ARGILLITE, TILLITE, META CONGLOMERATE, QUARTZITE AND PURPLE QUARTZITE.

IGNEOUS ROCKS

EXTRUSIVE ROCKS

Symbol	Description
Qb	QUATERNARY BASALT.
Tvu	TERTIARY VOLCANIC ROCKS UNDIFFERENTIATED.
T2bf T2af T2rf	T2bf-LATE TERTIARY BASALT AND BASALTIC ANDESITE FLOWS. T2af-LATE TERTIARY ANDESITE-TRACHYTE-LATITE FLOWS. T2rf-LATE TERTIARY RHYOLITE-DACITE-QUARTZ LATITE FLOWS.
T2rp	LATE TERTIARY RHYOLITE-DACITE-QUARTZ LATITE PYROCLASTICS.
T1af T1bf	T1af-EARLY TERTIARY ANDESITE-TRACHYTE-LATITE FLOWS. T1bf-EARLY TERTIARY BASALT AND BASALTIC ANDESITE FLOWS.
T1ap	EARLY TERTIARY ANDESITE-TRACHYTE-LATITE PYROCLASTICS.
T1ai	EARLY TERTIARY ANDESITE-TRACHYTE-LATITE IGNIMBRITES (WELDED TUFFS)
T1rf	EARLY TERTIARY RHYOLITE-DACITE-QUARTZ LATITE FLOWS.
T1ri	EARLY TERTIARY RHYOLITE-DACITE-QUARTZ LATITE IGNIMBRITES (WELDED TUFFS)

MARYSVALE AREA

Symbol	Description
Tvjl Tvmb	PLIOCENE, Tvjl-JOE LOTT TUFF, A WELDED RHYOLITE TUFF. Tvmb-MOUNT BELKNAP RHYOLITE, A GROUP OF RHYOLITIC EFFUSIVES THAT ARE MOSTLY WELDED TUFFS.
Tvdh	PLIOCENE, DRY HOLLOW LATITE, WIDESPREAD LATITE FLOWS INTERLAYERED WITH TUFF AND BASALTIC ANDESITE FLOWS.
Tvrp	PLIOCENE, ROGER PARK BRECCIA, COMPOSED OF FRAGMENTS AND MATRIX OF BASALTIC ANDESITE. MATRIX LIGHTER COLORED THAN FRAGMENTS BUT HAS SAME COMPOSITION.
Tvbc	OLIGOCENE, BULLION CANYON VOLCANICS, PYROCLASTICS ARE VERY THICK IN LOWER PART AND FLOWS MAKE UP MOST OF UPPER PART.

SOUTHWESTERN UTAH

Symbol	Description
Tvbh	PROBABLY EOCENE, BRIAN HEAD FORMATION, MOSTLY LATITIC IGNIMBRITES (WELDED TUFFS).

INTRUSIVE ROCKS

Symbol	Description
Tig Tip	Tig-TERTIARY GRANITOID ROCKS. Tip-TERTIARY PORPHYRITIC INTRUSIVE ROCKS.

FAULT SYMBOL

- FAULT TRACE WELL EXPOSED
- FAULT INFERRED
- FAULT CONCEALED BY ALLUVIUM
- THRUST FAULT, BARBS ON SIDE OF THRUST SHEET
- VOLCANIC CONE

SOURCE: Geologic maps of Utah compiled by Lehi Hentze.

MAP 4

GENERALIZED GEOLOGIC MAP

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1967

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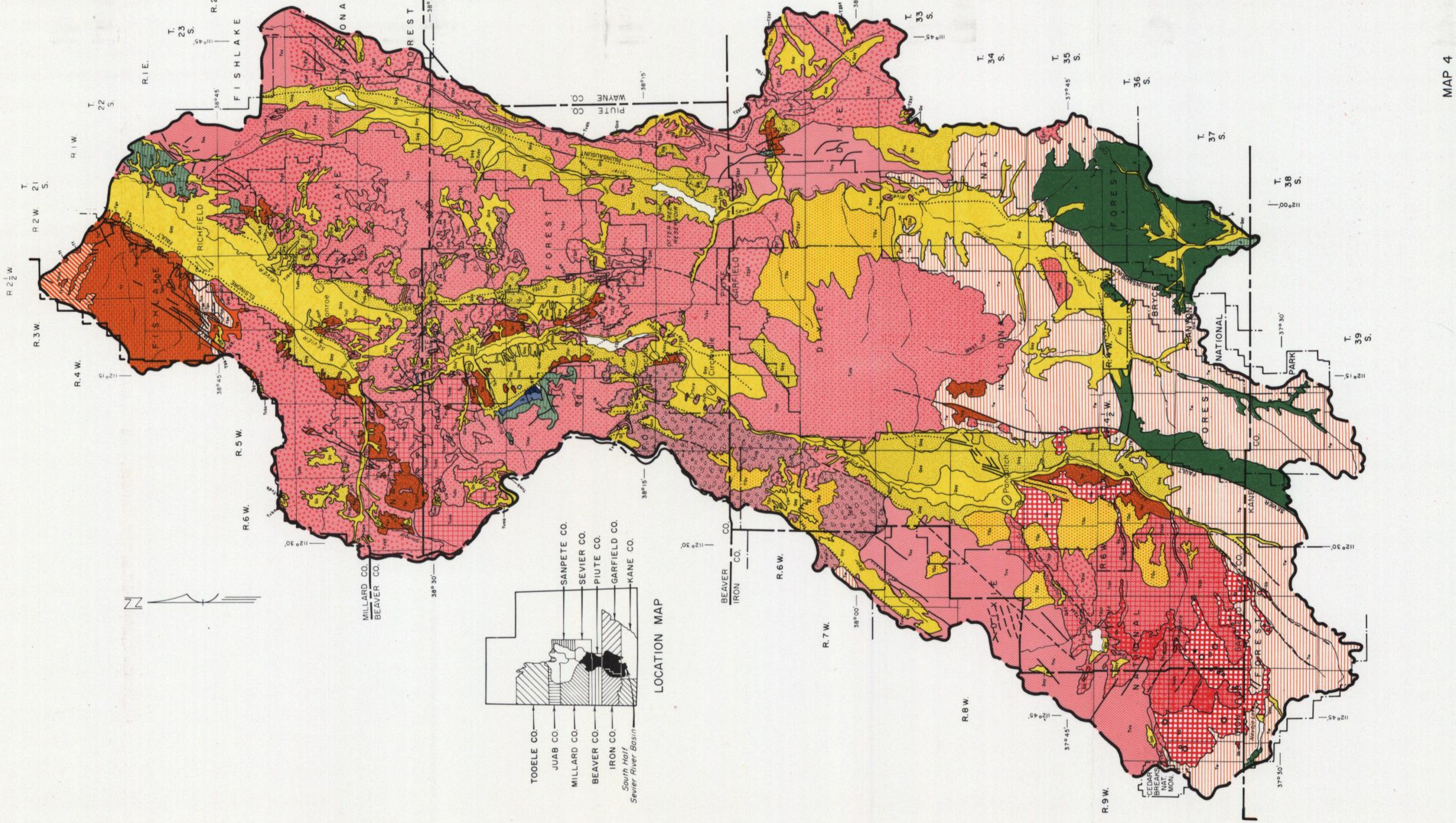
MAP 4
GENERALIZED GEOLOGIC MAP
SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969



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SOUTH HALF, SHEET 2 OF 2, M7-E-18518-N

NATURAL FEATURES

Extreme changes in elevation, brilliantly colored rock formations, and climatic variations from semideserts to alpine forests, are all natural features which make the Sevier River Basin a pleasant area in which to live or visit.

Skyline Drive, which follows the divide between the Colorado and San Pitch Rivers, affords travelers a scenic vista of aspen groves, meadows, and pines. There are natural high-mountain lakes, which although generally small, attract many fishermen, campers and sightseers. In the valleys, the diversion of irrigation water has created green, cultivated cropland which contrasts beautifully with the wild, arid surroundings.

The bold tabular relief throughout most of the area is modified occasionally by volcanic flows. Dominant features are the cliffs and canyons carved through the ages by vast upheavals of the earth's crust and tumultuous streams carving their way to their rest.

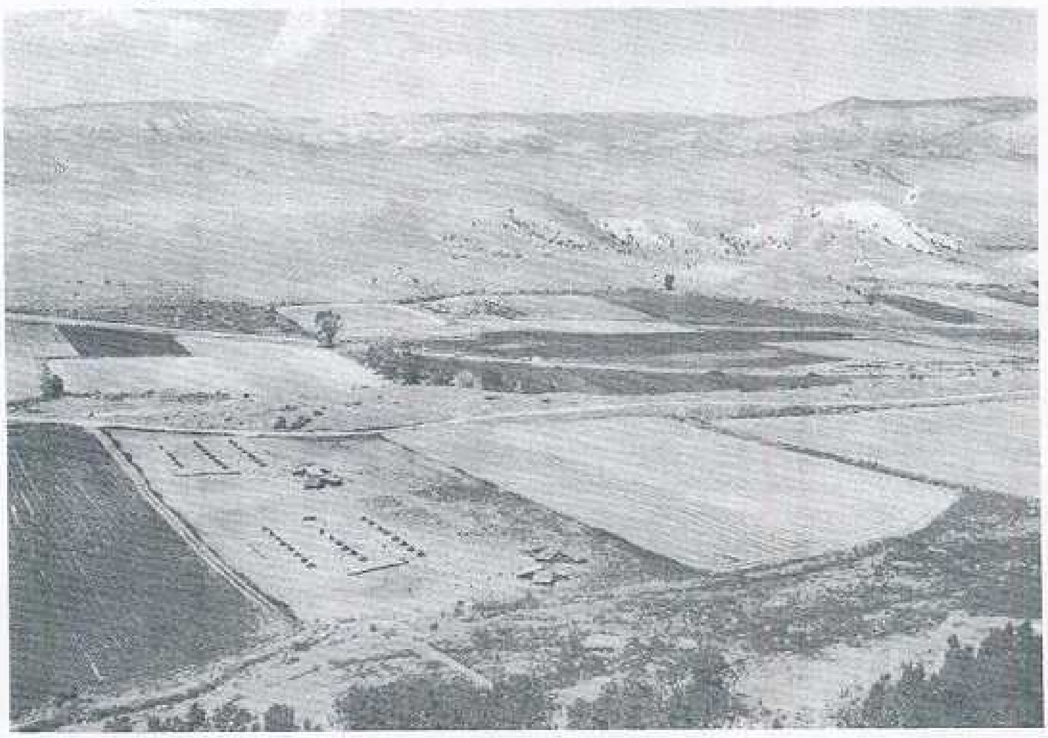
The pink Tertiary cliffs of the Markagunt and Paunsaugunt Plateaus are described by Dutton:

> Even to the mere tourist there are few panoramas so broad and grand; but to the geologist there comes with all the visible grandeur a deep significance. The radius of vision is 80 to 100 miles. We stand upon the great cliffs of Tertiary beds which meanders to the eastward till lost in the distance, sculptered into strange and even startling forms, and lit up with colors so rich and glowing that they awaken enthusiasm in the most apathetic . . . . To the southwest the Basin Ranges toss up their angry waves in characteristic confusion, sierra behind sierra, till the hazy distance hides them as with a veil. (7)

From these colorful borders, one is led down the gentle slopes of the plateaus with their ponds and lakes fed by cool mountain springs, through forests of pine and aspen to the river valleys below and onto the vast delta built by the Sevier River and then into the simmering desert with its barren mountains and vast expanse; here the river dissipates into nothing.

U. S. FOREST SERVICE PHOTO 5881 - 24

High mountain lands and valley farms provide cooperative agricultural benefits.



SOIL CONSERVATION SERVICE PHOTO 6-125-3

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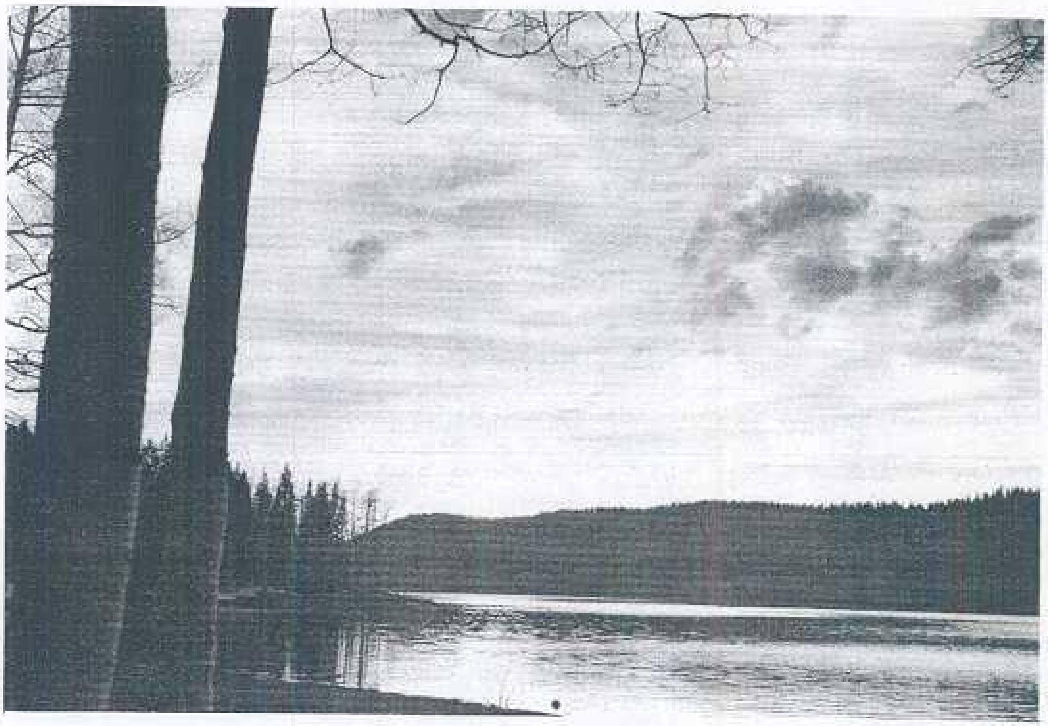


Natural resources and recreation go hand in hand.

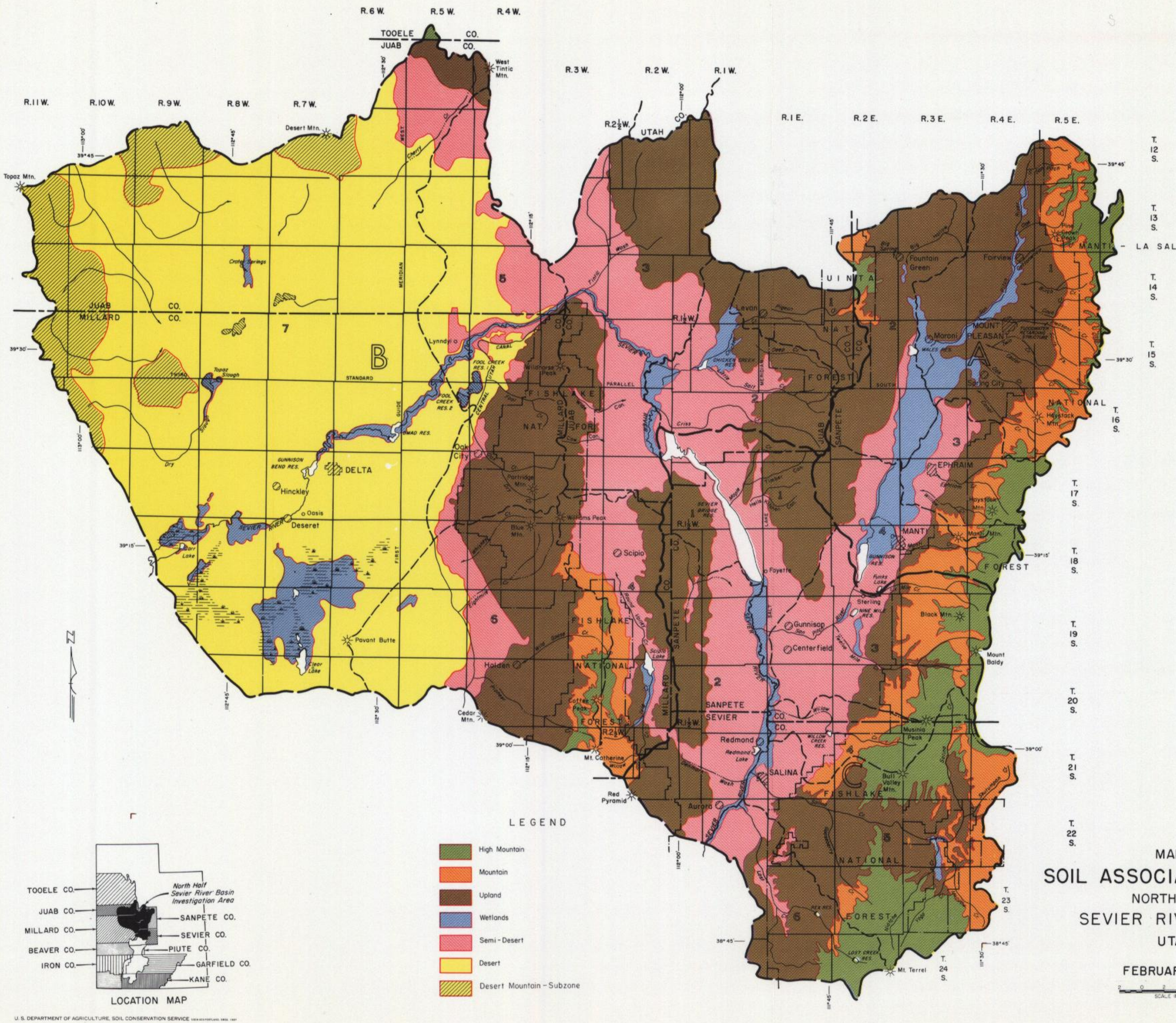
UTAH STATE DIVISION OF FISH & GAME PHOTO SR01 - 26

SOILS

The soils were mapped into 194 associations on the basis of parent material, capability, stability, slope, aspect, climate, texture, water-holding ability, present vegetative cover and potential usefulness. These Associations were grouped into six Soil Association Zones, which are shown in Table 1 along with major water surfaces and on Map 5. (27)

TABLE 1.--Soil Association Zone areas, Sevier River Basin

Sub-basin	Major water surfaces	Desert	Semi-desert	Wet-lands	Upland	Mountain	High Mountain
	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A	350		43,650	56,050	211,220	80,340	53,610
B	4,700	989,760	290,600	79,600	405,830	39,800	11,810
C	12,380		237,060	20,310	241,230	81,920	114,880
D	2,600		212,820	24,120	174,710	109,460	120,490
E	3,340		128,110	11,650	342,970	188,140	185,490
F	1,960		134,890	18,050	289,700	142,150	134,250
Total	25,330	989,760	1,047,130	209,780	1,665,660	641,810	620,530



MAP 5

SOIL ASSOCIATION ZONES

NORTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

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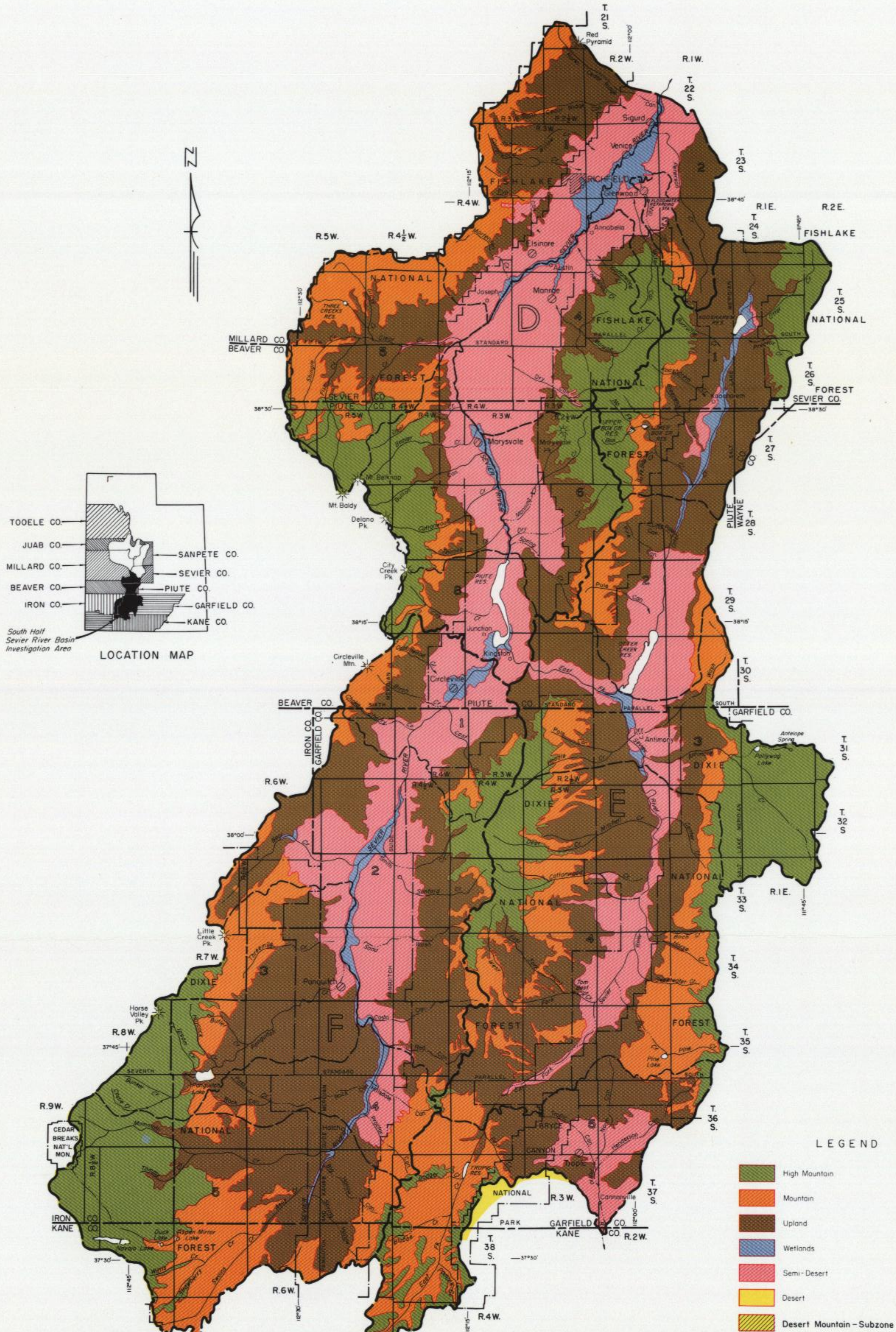


MAP 5

SOIL ASSOCIATION ZONES

SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

M7-R-17965A-2-N

DESERT ZONE

The Desert Zone soils are located within the lowest precipitation and elevation zones. Mean annual precipitation ranges from 6 to 10 inches and elevations vary from 4,550 to 5,800 feet. Slopes are dominantly 0 to 2 percent, but range to 50 percent in hilly areas. This region includes a wide range of soils occurring on lake terraces, lake bottoms, alluvial fans, and flood plains. It also includes desert mountain ranges and a few small, hilly basalt areas. Most of the soils are derived from mixed alluvium and there are large areas of deep Torripsamments with wind-formed sand dunes up to 15 feet in height.

Deep Natrargids are common with thin, light colored, medium textured A2 horizons and moderately fine to fine textured B horizons. The C horizons range from moderately coarse to moderately fine with some local areas underlain by gravel. They are strongly calcareous and strongly to very strongly saline-alkali.

The Haplaquepts show poor drainage characteristics. Some have been drained, but there are many large areas of declining water supply where the water tables have dropped below 6 feet at present. The Haplaquepts and Torrifluvents range in texture with fine and moderately fine textured soils being most common. They are strongly calcareous and moderately to strongly alkaline. Irrigated soils are moderately saline and nonirrigated areas are strongly saline.

Calciorthids occur on the older alluvial fans. They are moderately fine to moderately coarse textured, with strong lime horizons at 8 to 15 inches. Some areas have a water table within 60 inches while others are well drained.

SEMIDESERT ZONE

The Semidesert Zone has elevations which vary from 5,000 to 7,500 feet and mean annual precipitation which ranges from 8 to 12 inches. Within this zone there are three broad groups of soils: Those that occur in valleys, on alluvial fans, or in hilly areas. In the hilly areas both shallow and gravelly soils are present. Parent material consists of sandstone, limestone, shale, and basic and intermediate igneous rocks.

Torrifluvents are the dominant soils in the valleys. These soils are deep and are dominantly moderately fine and medium textured. Slopes are 1 to 3 percent, but range to 6 percent.

Calciorthids and Torrifluvents are dominant on the alluvial fans. They are medium to moderately coarse and are underlain by a gravelly or cobbly soil matrix, usually between 10 and 30 inches thick. Gravel and cobbles occur on the surface at some locations. Calciorthids are prevalent with strong lime horizons at 10 to 20 inches. Slopes are 2 to 10 percent, but range to 15 percent at some locations.

Hilly areas have Lithic Torriorthents, Calciorthids, Torrifluvents, and rock outcrops. Lithic Torriorthents have 5 to 20 inches of moderately coarse to moderately fine textured soil over bedrock. Slopes are 5 to 60 percent. Calciorthids and Torrifluvents are similar to the fan soils except they occur on rolling hills on slopes of 10 to 40 percent. Rock outcrops are common.

WETLAND ZONE

The Wetland Zone consists of deep, poorly drained soils. Elevations range from 4,600 to 8,000 feet. These soils are found in alluvium from a wide range of parent material and occur in valley bottoms and on river flood plains. Mean annual precipitation is from 6 to 12 inches.

Wetlands contain Haplaquept, Calciaquoll, and Haplaquoll soil groups. Soils range from moderately coarse to fine textured. They are mottled or gleyed and generally have a high water table between the surface and 40 inches.

UPLAND ZONE

The Upland Zone includes Argiustolls, Argixerolls, Haploustolls, Haploxerolls, Calciustolls, Calcixerolls, Lithic Haploustolls, and Lithic Haploxerolls. Parent materials are sandstone, limestone, shale, and basic and intermediate igneous rocks.

Elevations range from 5,000 to 8,000 feet. Slopes are dominantly from 3 to 30 percent, but range up to 70 percent. Precipitation is 12 to 18 inches. The soils are usually moist, but are dry for 90 cumulative days or more in most years in some sub-horizons between 7 and 20 inches.

Argiustolls and Argixerolls are most common. They are deep, have medium textured A horizons, moderately fine to fine textured B horizons and moderately coarse to moderately fine C horizons. Strong lime horizons are usually between 15 and 30 inches. More than 50 percent of these soils have coarse fragments in the profile. They occur on alluvial fans and mountain slopes.

The Haploxerolls usually occur on the lower fans and in the alluvial valleys. They are deep and range from moderately coarse to moderately fine textured. Some soils have gravels or cobbles in the profile.

The Calciorthids are medium or moderately fine textured and are usually gravelly or cobbly. Stony lime horizons occur at 12 to 24 inches. They are on the higher fans, ridge tops and in the hilly areas.

The Lithic Torriorthents occur on the ridge tops and in the rough broken areas with 5 to 20 inches of soil over bedrock and are associated with rock outcrops.

MOUNTAIN ZONE

Argic Cryoborolls are dominant in the Mountain Zone with some transitional areas having Cryoboralfs at the higher elevations and Argixerolls at the lower elevations. Areas of minor extent consist of Lithic Cryoborolls, Typic Cryoborolls, Cryoboralfs and rock.

The Argic Cryoborolls are dominantly moderately deep to deep, cobbly or stony, medium to moderately fine textured, and are slightly acid to neutral. The Argiustolls are moderately deep to deep, gravelly or cobbly, moderately coarse to medium textured, and are neutral to moderately alkaline. Torripsamments and Haploxerolls are generally cobbly or stony and are usually neutral to moderately alkaline.

Parent materials include calcareous sandstone, calcareous shale, limestone, basalt, intermediate igneous rocks, conglomerates, and quartzites.

Landscapes are moderately sloping to steep mountain slopes with deep, incised drainageways. Included are gently sloping to moderately steep plateaus and bench-like areas. Elevations vary from 7,000 to 9,000 feet. Annual precipitation is 16 to 25 inches, most of which falls as snow.

HIGH MOUNTAIN ZONE

The dominant soils in the High Mountain Zone are deep to moderately deep, gravelly, cobbly or stony, well-drained, slightly to strongly acid Cryoboralfs and Argic Cryoborolls. The landscape is typically steep mountain slopes with deeply incised drainages and undulating high elevation plateaus. Elevations are 8,500 to 12,000 feet. Annual precipitation is 20 to 40 inches, most of which falls as snow.

Cryoboralfs have a dark-brown, sandy loam A horizon overlying sandy, leached, medium acid A2 horizons with a medium to moderately fine textured and medium to strongly acid B2 horizon.

Argic Cryoborolls have thick, dark-brown, loam to sandy loam A horizons overlying medium to moderately fine textured B2t horizons.

Soils of lesser extent include Lithic Cryoborolls and Typic Cryoborolls. Typic Cryoborolls are usually deep, very cobbly or stony, and are well drained with sandy loam A horizons overlying sandy loam to loamy C horizons.

Lithic Cryoborolls are shallow, extremely stony or cobbly, with thin, medium textured A horizons over extremely stony, medium to coarse textured C horizons.

The soils are formed from colluvium and alluvium derived from basic and intermediate igneous rock types, thin bedded to massive sandstones, calcareous sandstones, conglomerates, limestones, and a variety of shales. Minor areas have soils derived from glacial till.

VEGETATION

Land-use surveys classified the farm lands into rotation and nonrotation cropland. Rotation cropland contains irrigated land managed in a crop rotation system and dryland as a special category. Nonrotation cropland consists mainly of wetlands, some of which are irrigated and some nonirrigated.

Above and surrounding intensively managed farm lands, native vegetation predominates. These vegetative zones are described on the map as Shadscale-Greasewood, Sagebrush, Pinyon-juniper, Oak brush, and Aspen-Conifer.

The land-use classifications are described below and shown on Map 6.

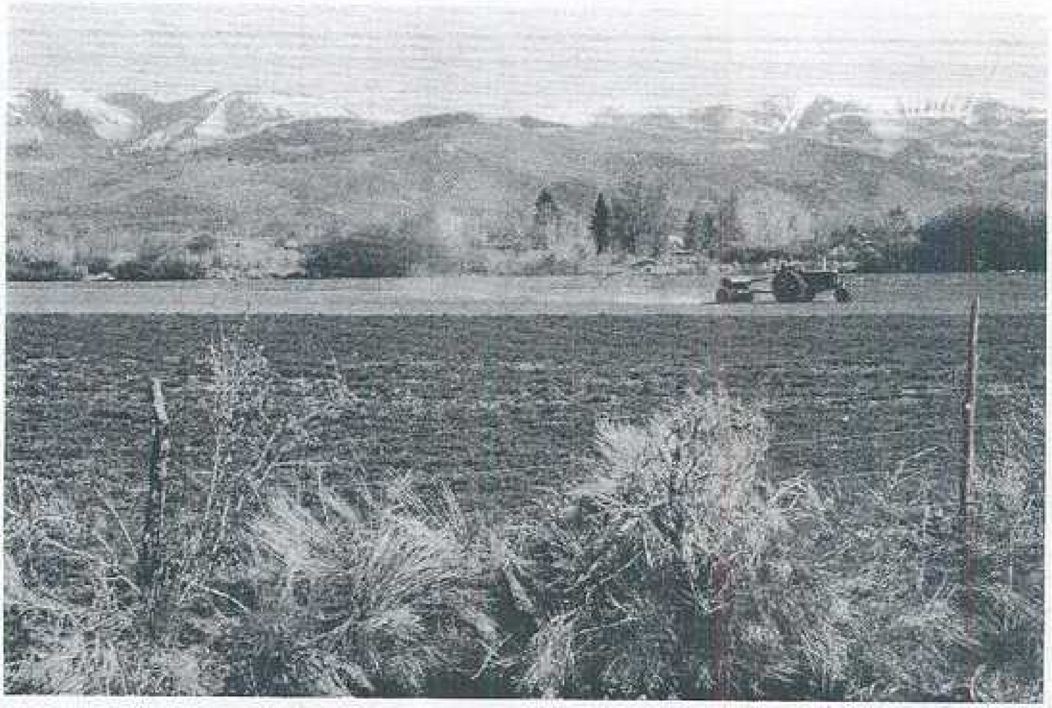
ROTATION CROPLAND

Commonly produced crops on the irrigated rotation cropland are alfalfa, alfalfa seed, pasture, wheat, barley, sugar beets, and silage corn. Wheat or barley are grown on dryland areas with a crop produced every second year.

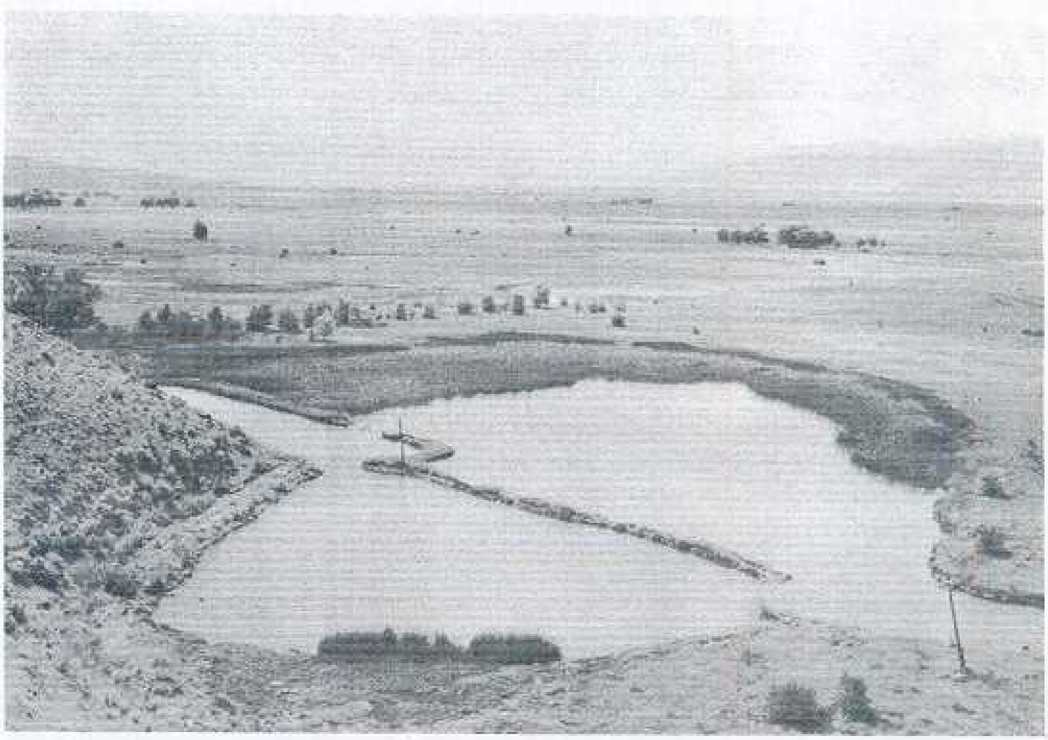
WETLANDS AND NONROTATION CROPLAND

Wetlands and nonrotation cropland have a grassland aspect with the following species predominating: Carex (Carex spp.), bulrush (Scirpus spp.), saltgrass (Distichlis stricta), spikerushes (Eleocharis spp.), redtop (Agrostis spp.), and meadow foxtail (Alopecurus pratensis).

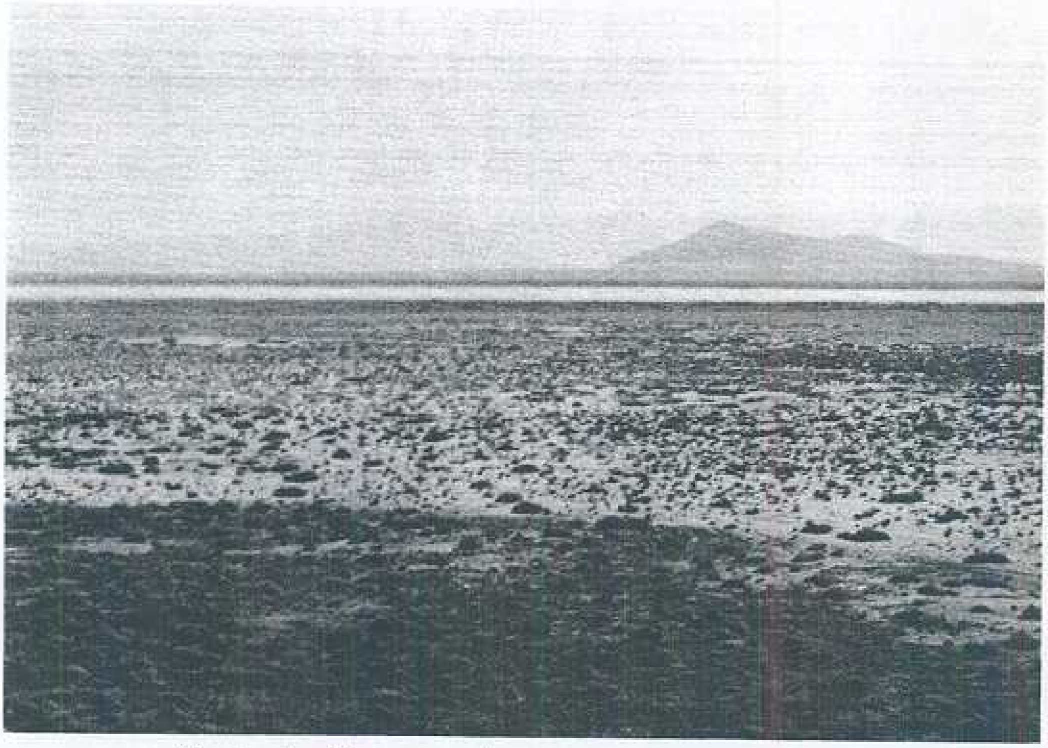
VEGETATIVE ZONES



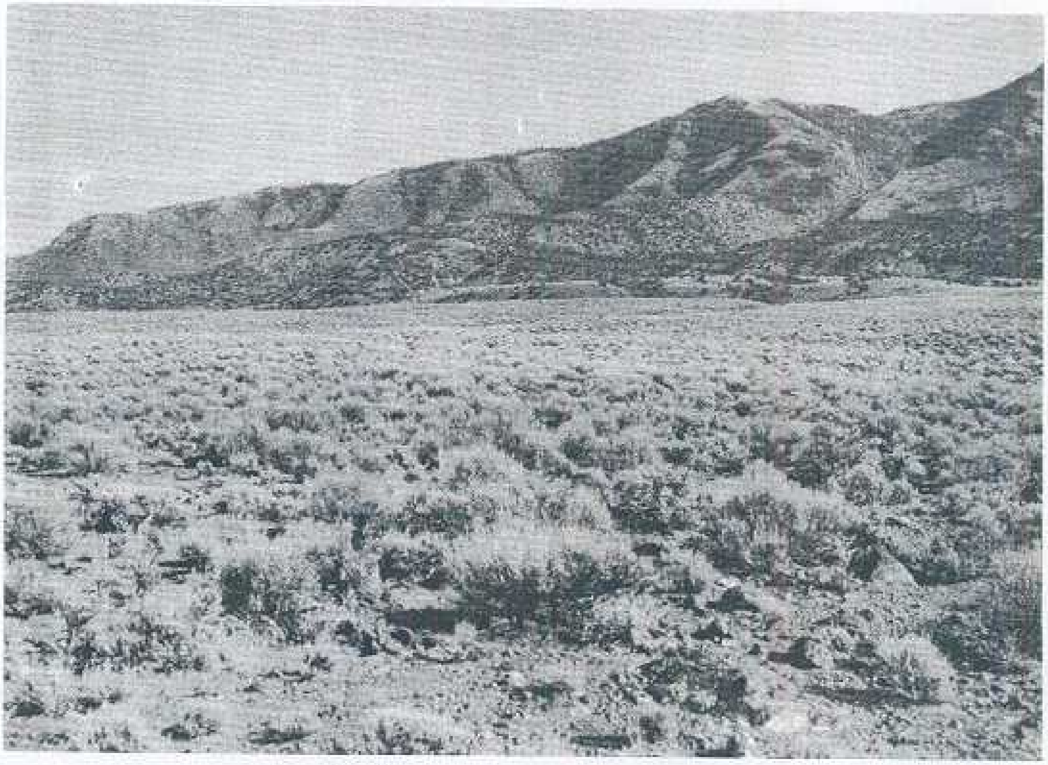
Irrigated Lands SOIL CONSERVATION SERVICE PHOTO 8-682-4



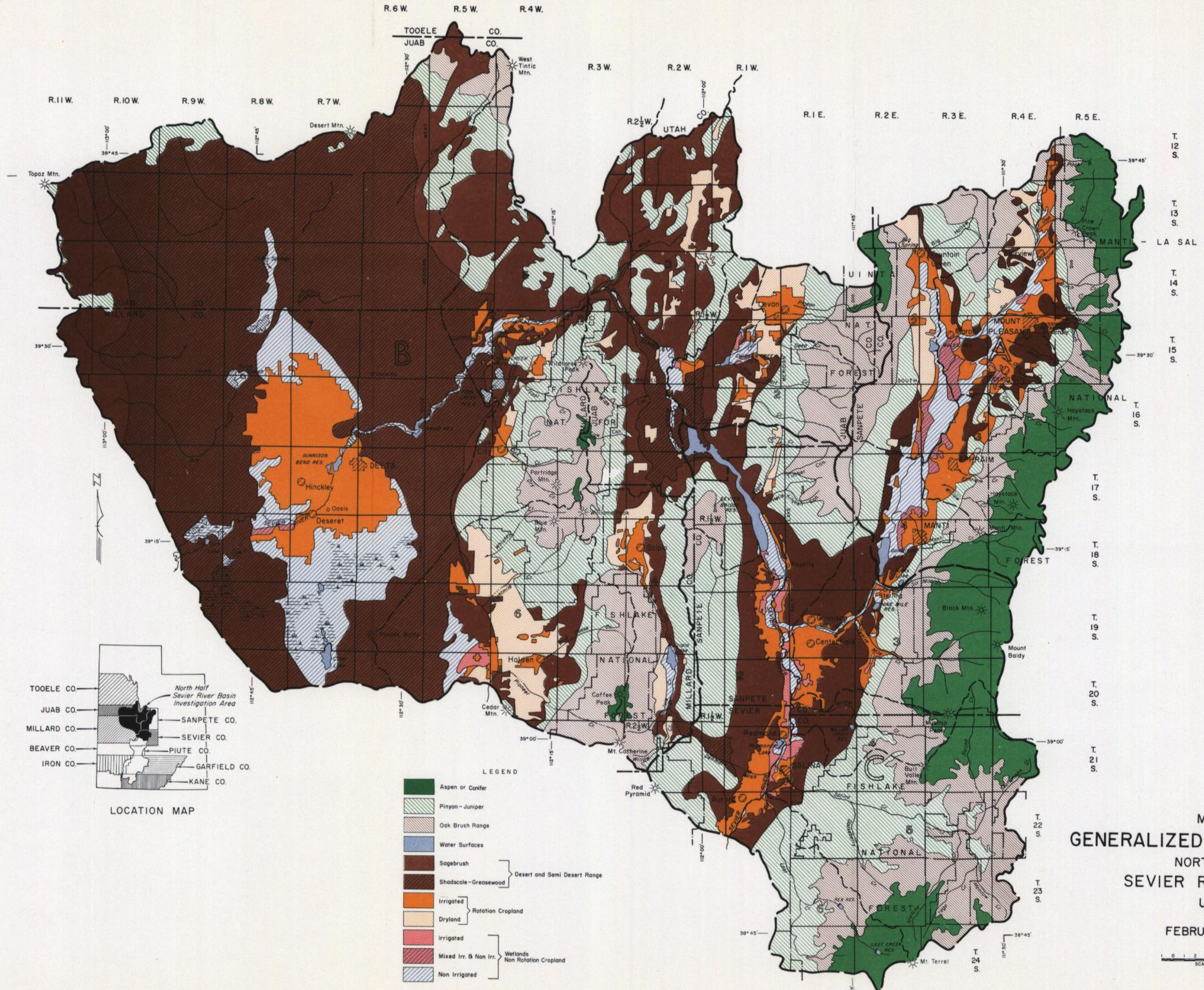
Wetlands FIELD PARTY PHOTO 8-1402-5



Shadscale-Greasewood FIELD PARTY PHOTO S881-21



Sagebrush FIELD PARTY PHOTO S-1283-16



MAP 6

GENERALIZED LAND USE MAP

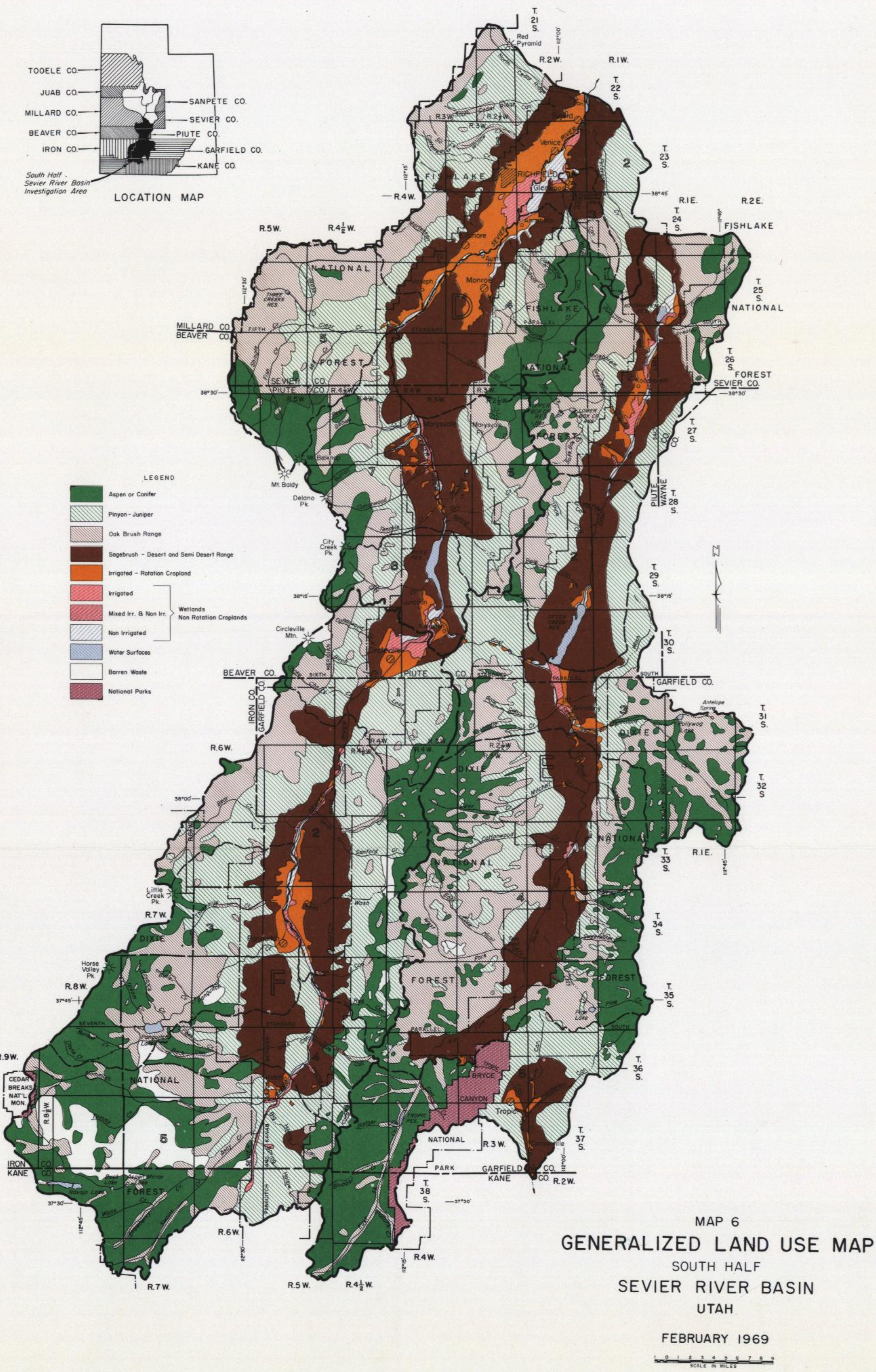
NORTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

NORTH HALF M7-R-18570-N



MAP 6

GENERALIZED LAND USE MAP

SOUTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SCALE IN MILES

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

SHADSCALE-GREASEWOOD

Shadscale-greasewood is utilized as desert and semidesert rangeland, furnishing winter grazing for sheep and some spring and summer forage for cattle. The climate is arid with precipitation from 6 to 9 inches and uses except for grazing by livestock and wildlife are limited.

Vegetative communities have a browse aspect of greasewood (Sarcobatus vermiculatus), shadscale (Atriplex confertifolia), saltbrush (Atriplex canescens), winterfat (Eurotia lanata), or low sagebrush (Artemisia arbuscula). Principal grasses are squirreltail (Sitanion hystrix), Indian ricegrass (Oryzopsis hymenoides), galleta (Hilaria jamesii), saltgrass (Distichlis stricta), sand dropseed (Sporobolus cryptandrus), alkali sacaton (Sporobolus airoides), needle-and-thread grass (Stipa comata), and annual bromegrass (Bromus spp.). Forbs include globemallow (Sphaeralcea coccinea), smotherweed (Kochia americana) and other xeric plants.

SAGEBRUSH

Sagebrush furnishes spring-fall range at lower elevations and summer range for both sheep and cattle as well as wildlife habitat at higher elevations where snow cover is heavier.

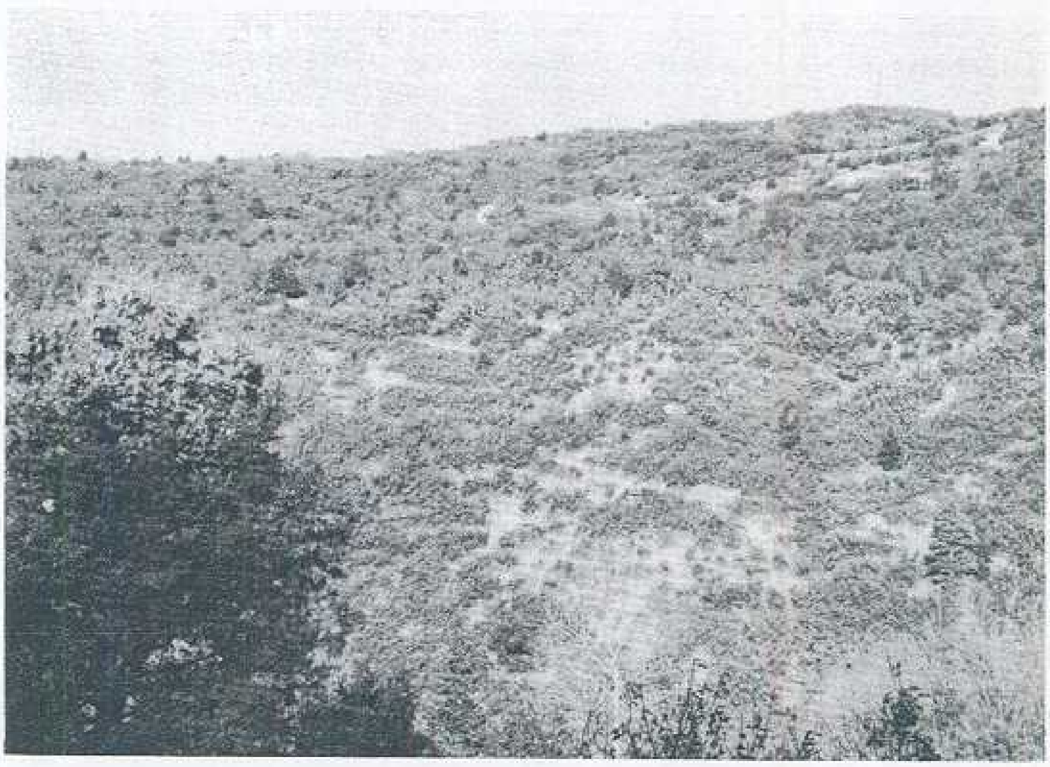
Big sagebrush (Artemisia tridentata) is the dominant species. A wide variety of browse, grasses, and forbs are found. Browse includes rabbitbrush (Chrysothamnus spp.), bitterbrush (Purshia tridentata), serviceberry (Amelanchier alnifolia), cliffrose (Cowania stansburiana), and winterfat (Eurotia lanata). The grasses include bluebunch wheatgrass (Agropyron spicatum), Kentucky bluegrass (Poa pratensis), Sandberg bluegrass (Poa secunda), junegrass (Koeleria cristata), needle-and-thread grass (Stipa comata), western wheatgrass (Agropyron smithii), dryland sedge (Carex spp.), Indian ricegrass (Oryzopsis hymenoides), squirreltail (Sitanion hystrix), and cheatgrass (Bromus tectorum).

PINYON-JUNIPER

Pinyon-juniper trees lend a pigmy forest aspect to the foothills. This vegetative zone has nearly the same elevational range as sagebrush and often occupies the shallow hillside soils. This area provides grazing for livestock and big game, and materials for fence posts, firewood, and Christmas trees. Many people gather pinyon pine nuts for food and recreation.

Pinyon pine (Pinus edulis) and Utah juniper (Juniperus osteosperma) are the dominant vegetation. Associated species are similar to the sagebrush type.

Pinyon-Juniper FIELD PARTY PHOTO 8-1283-14



Oak brush FIELD PARTY PHOTO 5801-22

Aspen–Conifer

OAK BRUSH

Oak brush occupies a well-defined elevational zone from 6,500 to 8,000 feet. Principal uses are wildlife habitat and grazing, along with recreation. In places, the oak becomes so thick it is almost impenetrable. Associated with the dominant oak species (Quercus gambellii) are the following browse plants: Mountain maple (Acer glabrum), bitterbrush (Purshia tridentata), snowberry (Symphoricarpos spp.), chokecherry (Prunus virginiana), and serviceberry (Amalanchier alnifolia). Grass and forb species are similar to the adjacent vegetative zones.

ASPEN-CONIFER

Aspen and conifer occupy the higher elevations from 8,000 to 12,000 feet. This area produces most of the streamflow, all of the commercial timber, and a wide variety of wildlife habitat. Ponderosa pine and Douglas fir are found in the lower areas with spruce-fir at the higher elevations.

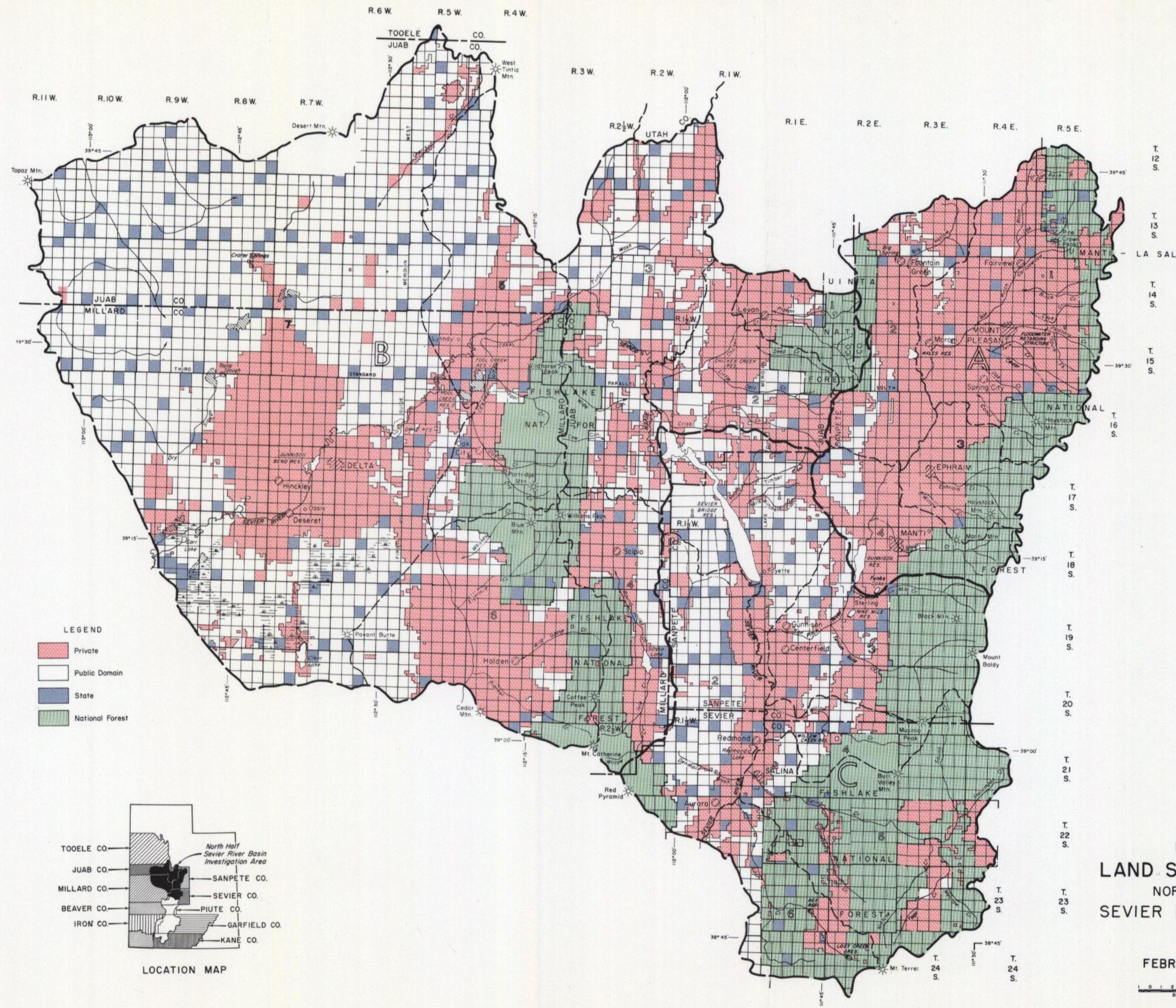
Trees include: Ponderosa pine (Pinus ponderosa), aspen (Populus tremuloides), Douglas fir (Pseudotsuga menziesii), white fir (Abies concolor), Engleman spruce (Picea engelmanni), blue spruce (Picea pungens), and alpine fir (Abies lasiocarpa).

A wide range of shrub, grass and forb species are associated with aspen and conifer.

LAND STATUS

Private lands are adjacent to and intermingled with the public lands. The two largest contiguous blocks of private lands are in Sanpete Valley and in the Lyndyll, Holden, Oak City area. The central Sevier Valley also contains a large block of private land.

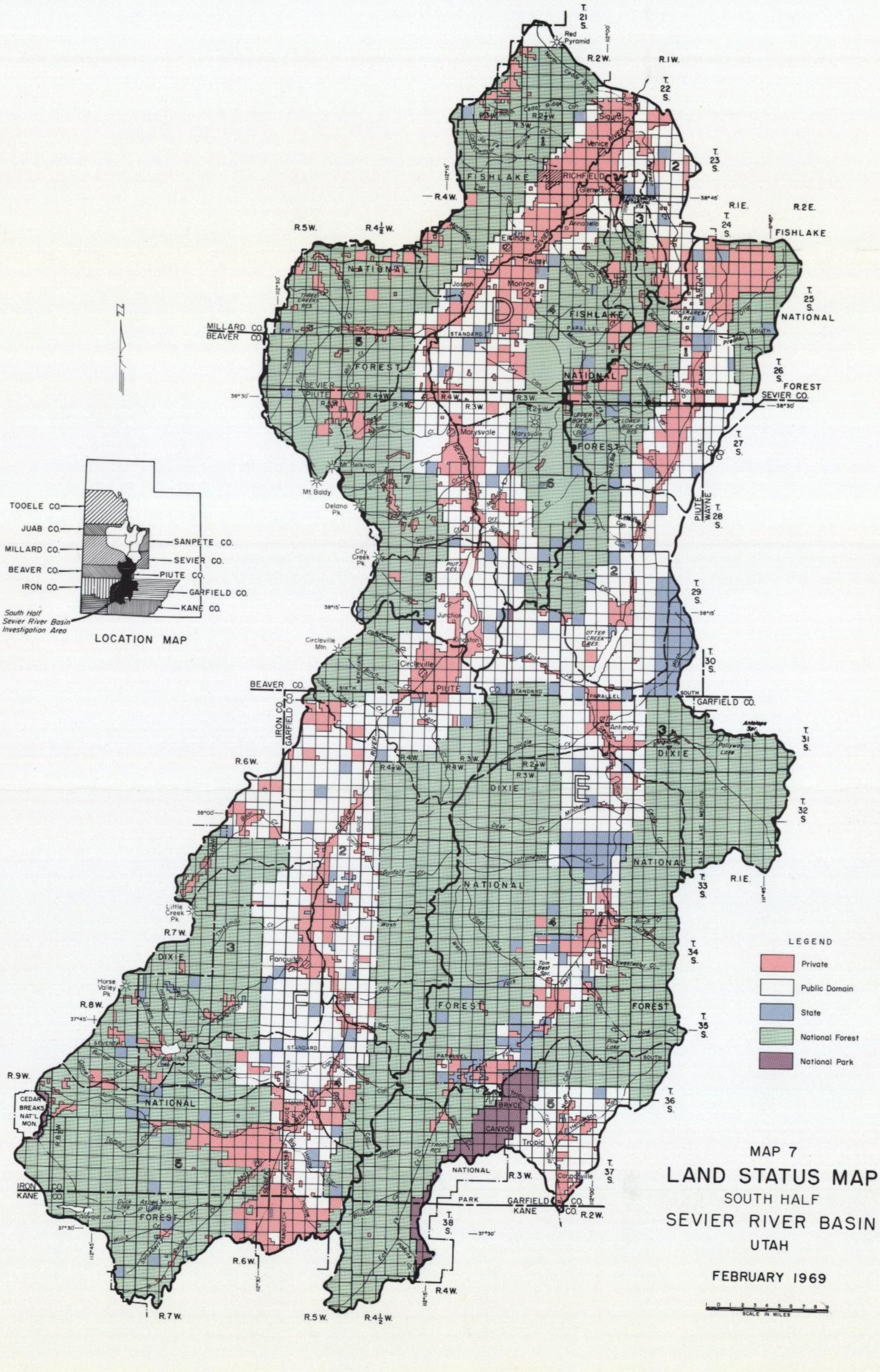
More than three-fourths of the land area is in public ownership and is managed by government agencies. State lands are in scattered tracts throughout, generally four sections in each township except where they have been exchanged or sold. Lands administered by the Bureau of Land Management and Forest Service are almost equal. However, Public Domain lands predominate in the northwest portion of the Basin while National Forests cover a majority of the area in the southern half and eastern margin. Land ownership is shown in Figure 2 and Table 2. The distribution pattern is shown on Map 7.



MAP 7
LAND STATUS MAP
NORTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE



MAP 7
LAND STATUS MAP
SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

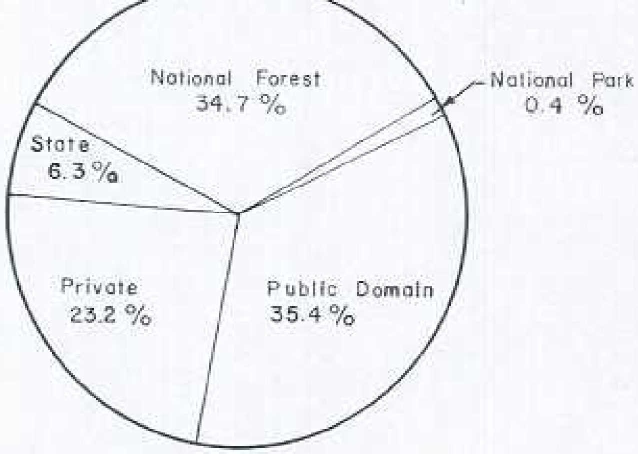


Figure 2: Land Status
1965
Sevier River Basin
Utah

TABLE 2.--Land status, Sevier River Basin, 1965

Sub-basin	Private	State	National Forest[a]	National Park	Public Domain	Total
	Acres	Acres	Acres	Acres	Acres	Acres
A	256,360	40,000	117,890		32,250	446,500
B	487,840	151,760	209,480		973,020	1,822,100
C	185,030	41,750	283,670		196,050	706,500
D	121,040	21,380	301,360		200,420	644,200
E	80,330	46,900	499,150	21,020	212,300	859,700
F	74,970	27,220	389,760	940	228,110	721,000
Total	1,205,570	329,010	1,801,310	21,960	1,842,150	5,200,000

[a]Source: National Forest land status records adjusted to sub-basin boundaries.

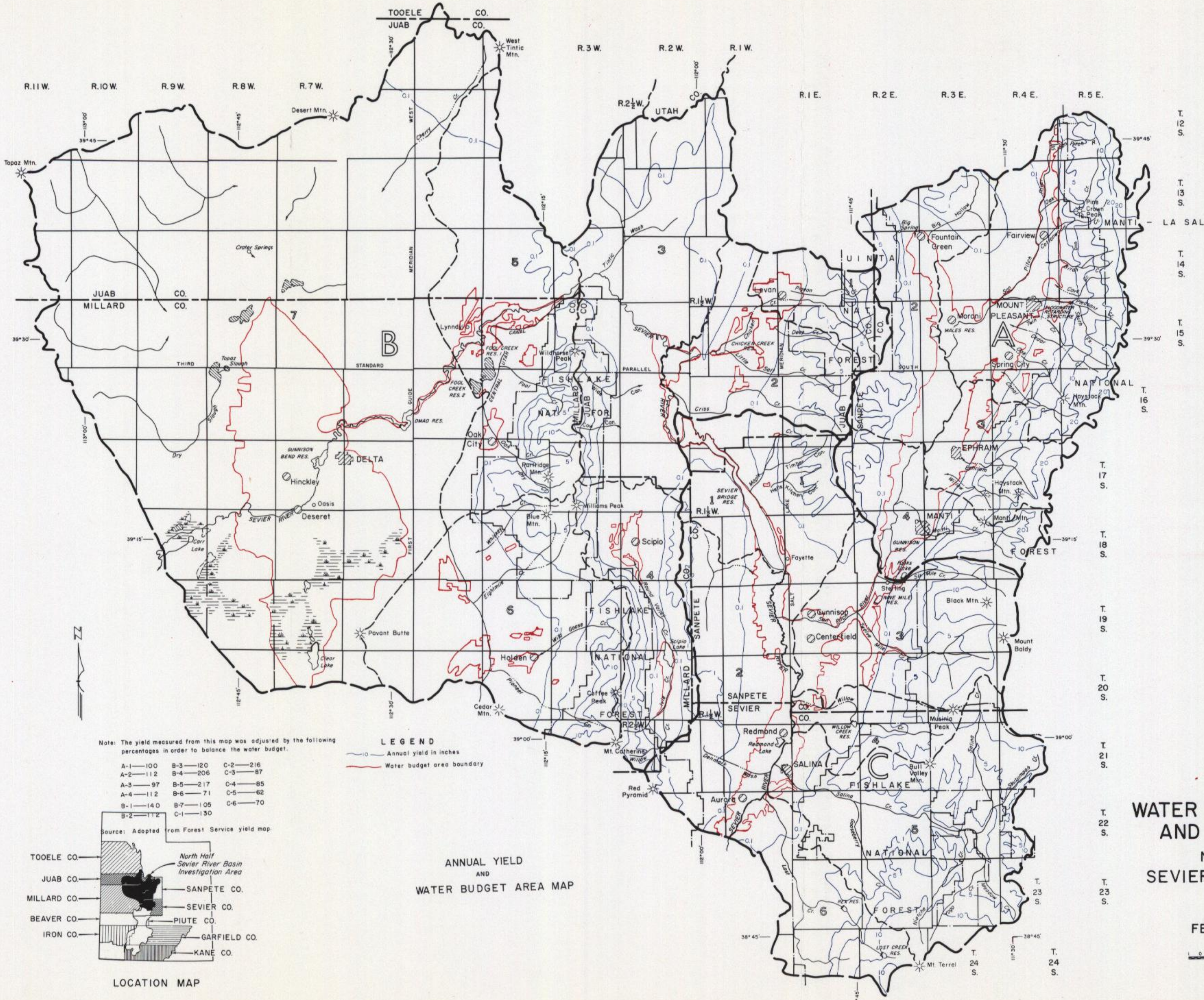
LAND USE

FARMLAND USE & MANAGEMENT

Principal use of the Basin lands is for agriculture. Along the river and major tributary stream valleys, the primary use is for crop production. These valley lands, together with the associated wetlands and water surfaces, comprise the areas for which water budgets were formulated in evaluating the water supply and use. These "water-budget areas," as referred to in this report and shown on Map 8, include all the lands of the watersheds under the highest irrigation canal systems that use more water than the precipitation falling directly on them. Table 3 lists the land use by acreage for each watershed and summaries are shown in Figure 3.

TABLE 3.--Land use by water-budget area, sub-basin and Sevier River Basin

Water-budget area	Irrigated cropland		Nonirrigated lands			Miscellaneous areas			Total
	Rotated	Nonrotated	Wet meadows	Dryland	Phreatophytes	Bare ground	Water surfaces	Major reservoirs	
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
A-1	24,770		14,070		1,320	2,270	650		43,080
A-2	7,940		10,120		1,920	820	400		21,200
A-3	10,350		3,530		570	700	200		15,350
A-4	6,580		9,940		3,110	860	420		20,910
Total	49,640		37,660		6,920	4,650	1,670		100,540
B-1	3,910			1,310		320	60		5,600
B-2	2,750	1,120	1,360	610	2,040	210	130	510	8,730
B-3			1,420		1,860	70	120		3,470
B-4	3,730		1,480	2,110	420	280	50	1,190	9,260
B-5	6,900		1,540		2,360	1,310	330	640	13,080
B-6	5,630		2,150		5,620	2,320	160		15,880
B-7	57,930		37,120		81,250	21,150	650	1,990	200,090
Total	80,850	1,120	45,070	4,030	93,550	25,660	1,500	4,330	256,110
C-1	2,440	2,650	4,050		640	290	250	6,240	16,560
C-2	15,490	2,610	2,600		1,740	700	490		23,630
C-3	15,160	1,400	1,310		540	820	200	1,360	20,790
C-4	1,260	60			410	40	30		1,800
C-5	1,990	1,440	480		590	310	90		4,900
C-6	2,020	50	90		210	40	30		2,440
Total	38,360	8,210	8,530		4,130	2,200	1,090	7,600	70,120
D-1	19,880	3,340	1,020		390	1,370	560		26,560
D-2	1,320	610	3,980		260	140	140		6,450
D-3	270	80	240			80			670
D-4	10,960	380	220		1,310	710	130		13,710
D-5	750				190	20	10		970
D-6	410	640	400		60	10	20		1,540
D-7	2,470	690	980		660	110	70		4,980
D-8	2,260	300	430		340	120	30	1,940	5,420
Total	38,320	6,040	7,270		3,210	2,560	960	1,940	60,300
E-1	5,220	2,840	2,830		210	170	80	400	11,750
E-2	830		190		170	20	20	2,200	3,430
E-3	2,550	1,190	420		650	50	100		4,960
E-4	1,250	550	120		220	10	110		2,260
E-5	2,870	260	30		280	70	60	170	3,740
Total	12,720	4,840	3,590		1,530	320	370	2,770	26,140
F-1	4,580	1,680	1,160		510	190	80		8,200
F-2	5,460	740	1,900		270	50	200		8,620
F-3	4,470	480	570		100	380	90		6,090
F-4	730	230	140		290		80		1,470
F-5	1,400	860	200		200	50	60		2,770
Total	16,640	3,990	3,970		1,370	670	510		27,150
GRAND TOTAL	236,530	24,200	106,090	4,030	110,710	36,060	6,100	16,640	540,360



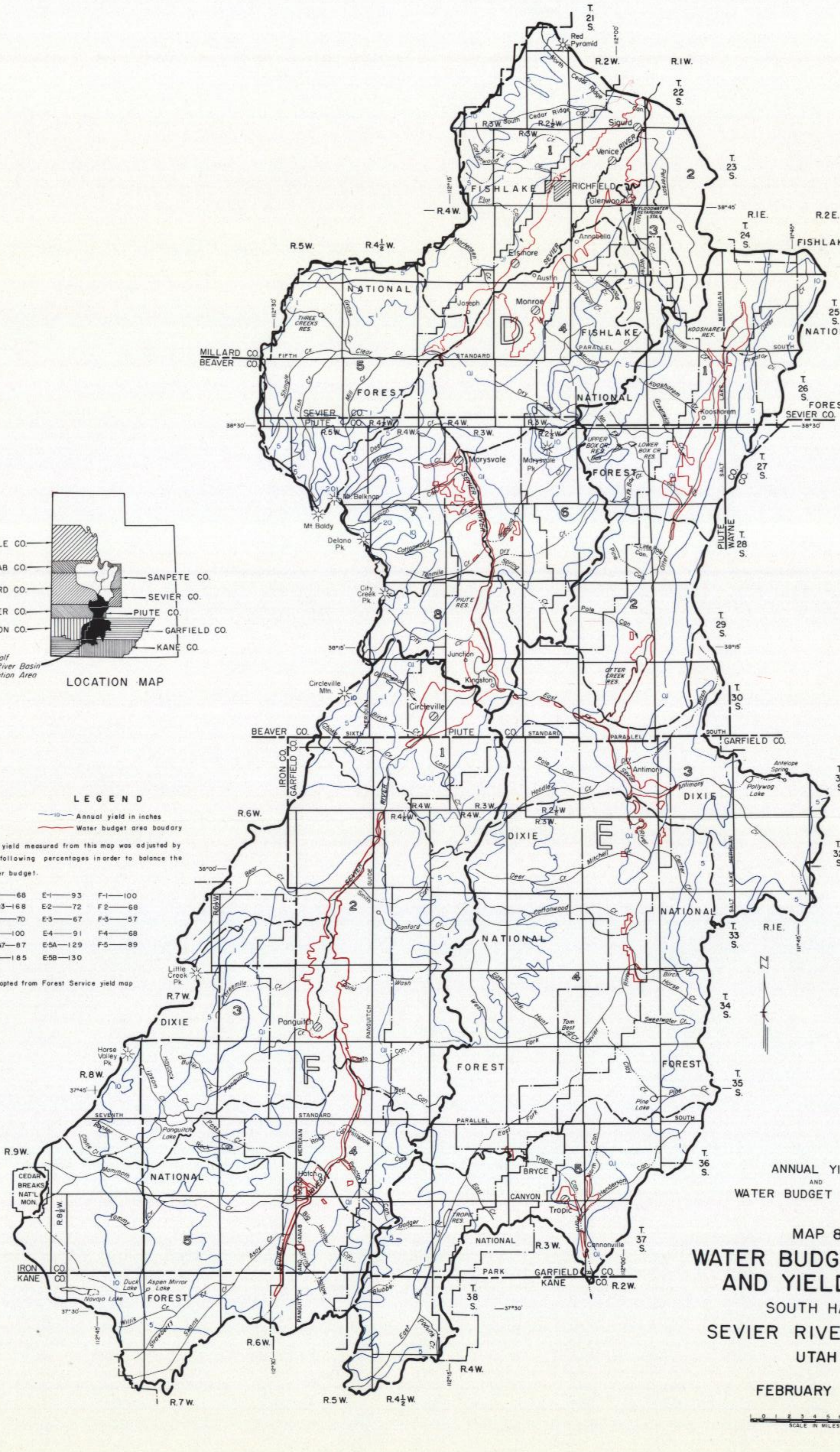
MAP 8

WATER BUDGET AREA AND YIELD MAP

NORTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1969



LOCATION MAP

LEGEND

—10— Annual yield in inches

—— Water budget area boudary

Note: The yield measured from this map was adjusted by the following percentages in order to balance the water budget.

D-1 — 68	E-1 — 93	F-1 — 100
D2&3 — 168	E-2 — 72	F2 — 68
D-4 — 70	E-3 — 67	F-3 — 57
D-5 — 100	E-4 — 91	F4 — 68
D6&7 — 87	E-5A — 129	F-5 — 89
D8 — 185	E-5B — 130	

Source: Adopted from Forest Service yield map

ANNUAL YIELD AND WATER BUDGET AREA MAP

MAP 8
WATER BUDGET AREA AND YIELD MAP

SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES

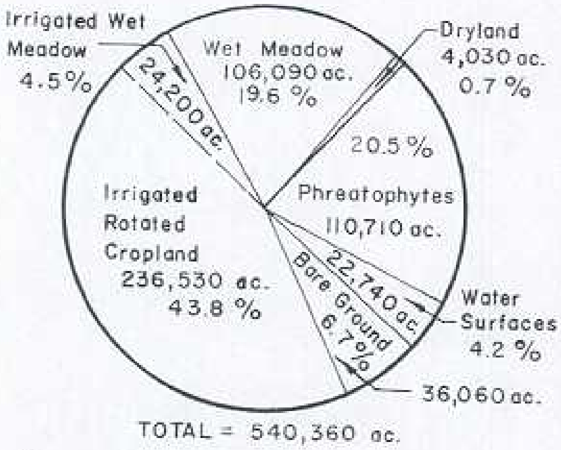


Figure 3: Water budget area land use summary.

Sevier River Basin
Utah

About 48 percent of the total water-budget areas are irrigated, 20 percent are wetlands, 20 percent are other less beneficial phreatophytes, and 12 percent are water surfaces, bare ground and dry cropland. The dry cropland acreage listed here includes only the small areas under existing irrigation systems. Large dryland areas located in Subbasins A and B are not included.

Cropping practices throughout most of the Basin are livestock oriented. There are 155,000 acres of alfalfa, 24,200 acres of irrigated wet meadows, and 106,090 acres of wetlands supporting this industry which make up over half of the 540,360 acres in the water-budget areas.

Generally, rotated crops are planted and land treatment practices applied on the more productive lands under the irrigation distribution systems where greater economic benefits are realized. Irrigated nonrotated lands are principally the better native meadows where water tables are between 2 and 5 feet below the ground surface. With surface irrigation, fertilization, and other improvement practices, these lands will produce increased yields.

The phreatophytes included in the water-budget acreage were generally those growing on the lowland immediately adjacent to the river and major tributaries where the water table is within ten feet of the ground surface. Generally this land is bounded by the higher ground where rotated crops are grown. It is significant to note that of the 110,170 acres of phreatophytes, 81,250 acres or 73 percent are located in Watershed B-7 (Delta). Here, most of the wetlands are located on the lower land around the periphery of the cropland as shown on Map 6, pages 33 and 34.

FOREST AND RANGE USE AND MANAGEMENT

Less intensively developed areas surround the farm lands. These lands comprise a vast expanse of 4,659,810 acres or 90 percent of the Basin area (Figure 4). These lands produce forage for livestock and wildlife. Commercial timber covers 518,800 acres. Water in excess of that utilized on site becomes available for irrigation, domestic, industrial, and other uses. People seeking recreation utilize these lands in a wide variety of pursuits ranging from rockhounding and sightseeing to hunting big game. Transportation routes, communication facilities, power lines, water-transmission lines, as well as many other structures occupy this area. In addition, these lands contain mineral resources. Grazing, timber production, wildlife and recreation uses are covered in detail in other portions of the report.

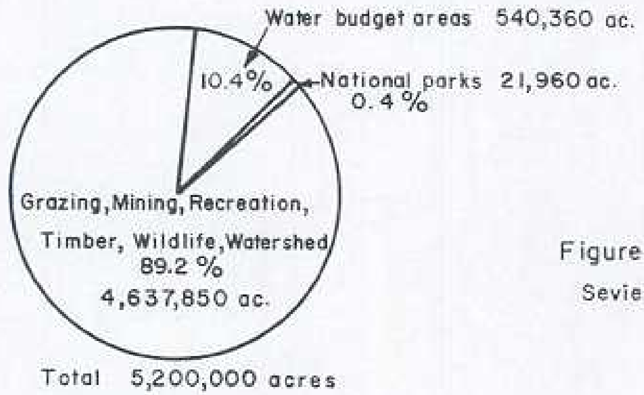


Figure 4: Land Use
Sevier River Basin
Utah

Public lands administered by the U. S. Forest Service and Bureau of Land Management are managed under principles of multiple use that will best meet the needs of our growing nation. The U. S. Park Service administers national park and monument lands for recreational and aesthetic values only.

State and private lands are often managed to provide public benefits, but they must also provide favorable economic return to their owner. Consequently, multiple-use principles are not emphasized to the extent that they are on public lands.

WATER RESOURCES

Water is the most important single resource affecting the development and economy of the Sevier River Basin. With few exceptions, the availability of water is the limiting factor in the expansion of agriculture enterprises.

The total water resource expressed as total precipitation for the Basin is 6.5 million acre-feet (30 year annual average). Of that amount, 398,400 acre-feet falls on the water-budget areas. Of the remaining 6.1 million acre-feet which falls on range and forested areas, 88 percent is consumptively used by on-site vegetation and 12 percent reaches the water-budget areas as tributary inflow.

It is important to understand the relationship between precipitation, consumptive use on the watersheds, and water yield to the irrigated areas. The annual on-site consumptive use, consisting of transpiration by vegetation and evaporation from soil and snow surfaces, is relatively constant and does not respond immediately to precipitation variations. This causes water yields to be sensitive to changes in precipitation as shown in Table 4. In this example a 5 percent change in precipitation will cause a 50 percent change in water yield. This relationship is generally typical of semiarid areas.

TABLE 4.--Relationship of precipitation, consumptive use, and water yield, Sevier River Basin

Condition	Precipitation	Consumptive use	Water yield	Percent change from normal
	Inches	Inches	Inches	Percent
Normal	20	18	2	0
5% decrease in precipitation	19	18	1	-50
5% increase in precipitation	21	18	3	+50

SURFACE WATER

Surface water volume is the primary supply available for beneficial use in the water-budget areas. There are three sources of surface water to a given area: Tributary inflow, transmountain diversions, and river inflow.

TRIBUTARY INFLOW

Average tributary surface water inflow provides 566,030 acre-feet annually or about 49 percent of the water available for crop production (Figure 5). Tributary inflows from the mountain watersheds available to the valley areas for diversion are shown in Table 5. Sub-basins A and F with extensive mountain areas above 9,500 feet elevation are the highest yielding areas (Map 8, p.   ). Watersheds A-1 and F-5 yield 91,000 and 93,270 acre-feet, respectively, or nearly one-fourth the total tributary inflow. Of the 93,270 acre-feet of water yield in Watershed F-5, 14,620 acre-feet flows underground directly to the Virgin River drainage leaving 78,650 acre-feet available for use within the Sevier River Basin. In Watershed E-5, 6,750 acre-feet of the 23,960 acre-feet total yield flows underground directly to the Colorado River drainage.

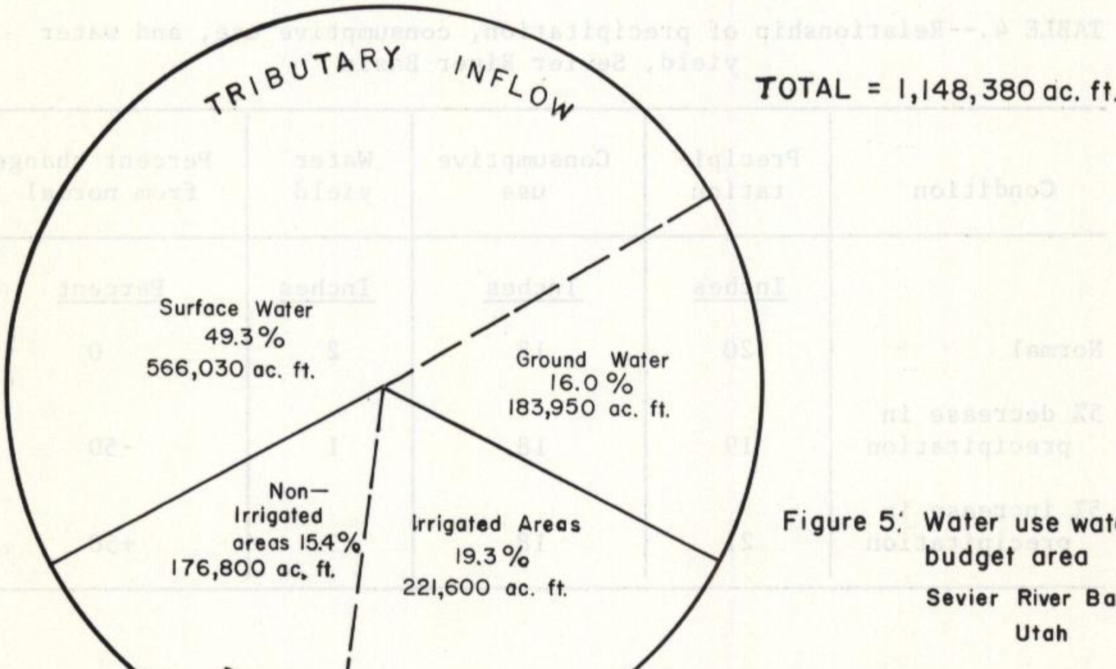


Figure 5: Water use water budget area
Sevier River Basin
Utah

TABLE 5.--Average water supply to water-budget areas, Sevier River Basin, 1931-60

Water-budget area	Tributary inflow: Surface water	Tributary inflow: Groundwater	Tributary inflow: Total	Precipitation: Irrigated areas	Precipitation: Nonirrigated areas
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
A-1	91,000[a]		91,000	24,860	
A-2	2,500	16,000	18,500	8,280	
A-3	31,000[a]		31,000	9,930	
A-4	29,180[a]		29,180	7,170	
Total	153,680	16,000	169,680	50,240	40,640
B-1	8,130	2,710	10,840	6,080	
B-2	5,220	3,480	8,700	4,590	
B-3	5,370[a]		5,370		
B-4	14,020	12,620	26,640	6,080	
B-5	12,780	15,040	27,820	6,760	
B-6	10,490	11,750	22,240	5,340	
B-7	15,230	1,740	16,970	33,850	
Total	71,240	47,340	118,580	62,700	95,430
C-1	3,510	3,540	7,050	4,750	
C-2	4,980	5,790	10,770	17,570	
C-3	32,330	9,520	41,850	16,350	
C-4	5,180	1,720	6,900	1,300	
C-5	39,130		39,130	3,340	
C-6	7,930	1,500	9,430	1,830	
Total	93,060	22,070	115,130	45,140	18,790
D-1	5,160	9,640	14,800	16,680	
D-2 & 3	970	7,510	8,480	2,310	
D-4	9,780	2,680	12,460	7,630	
D-5	25,350		25,350	520	
D-6	4,420	1,470	5,690	810	
D-7	19,920	6,640	26,560	2,450	
D-8	10,000	3,330	13,330	1,840	
Total	75,600	31,270	106,870	32,240	9,050
E-1	21,080	7,030	28,110	6,710	
E-2	1,410	1,340	2,750	660	
E-3	15,780	1,960	17,740	3,170	
E-4	8,790	20,520	29,310	1,760	
E-5	16,800	7,160	23,960[b]	2,780	
Total	63,860	38,010	101,870	15,080	8,220
F-1		10,000	10,000	4,020	
F-2	6,150	2,050	8,200	4,900	
F-3	21,440	1,740	23,180	4,170	
F-4	1,880	1,320	3,200	800	
F-5	79,120	14,150	93,270[c]	2,310	
Total	108,590	29,260	137,850	16,200	4,670
GRAND TOTAL	566,030	183,950	749,980	221,600	176,800

[a]Lack of flow measurements prevented distribution between surface and ground.

[b]Includes 6,750 acre-feet groundwater outflow to Colorado River.

[c]Includes 14,620 acre-feet groundwater outflow to Virgin River.

The time distribution of the tributary inflow is typical of snow-melt fed, unregulated streams with peak flows in May and minimum flows during the winter months. A typical example of total and base-flow hydrographs is shown in Figure 6. The hydrograph at Hatch gage is typical of unregulated streams contrasted with regulated flows shown by the hydrograph of the Sevier gage. High flows are extended into the heavy-use months of June, July, and August with minimum flows still occurring during the winter months.

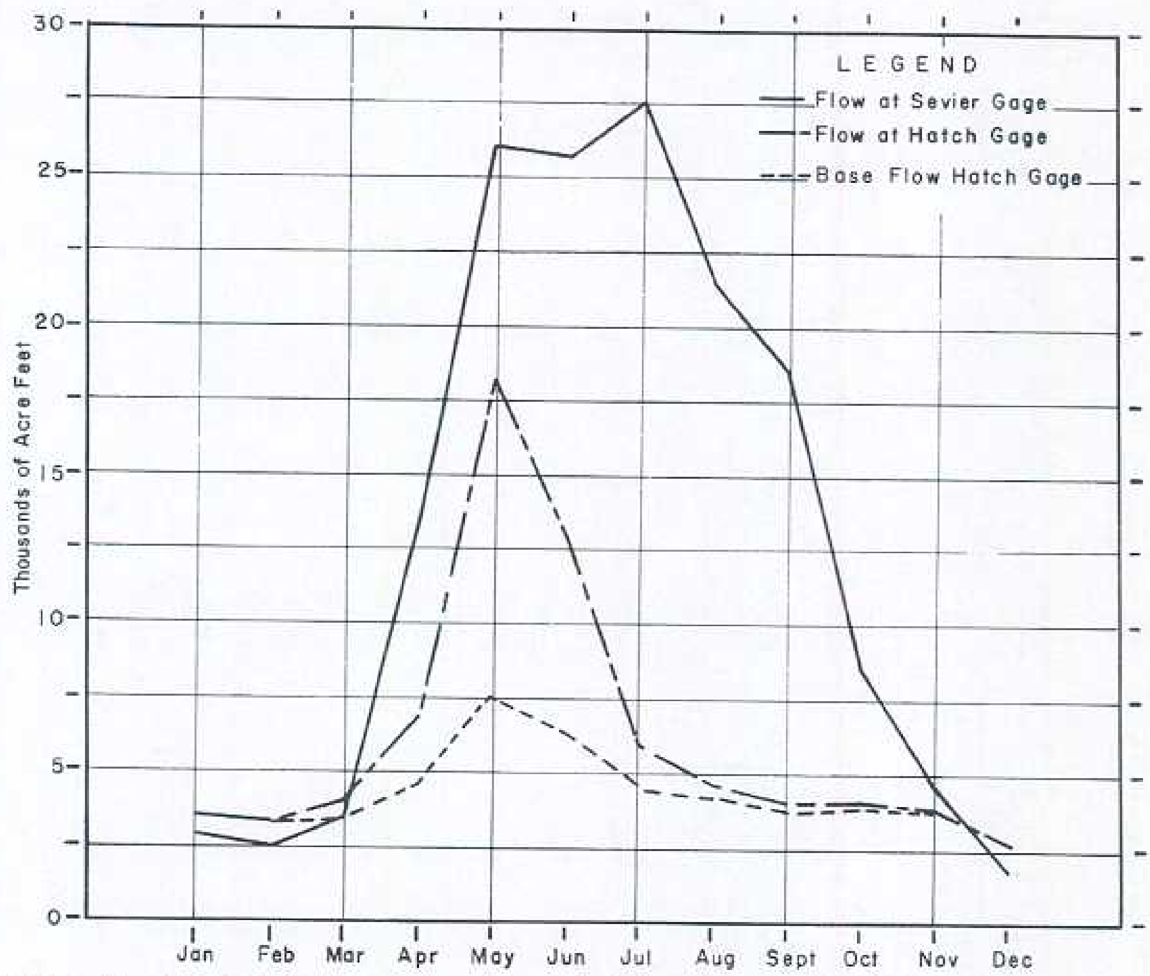
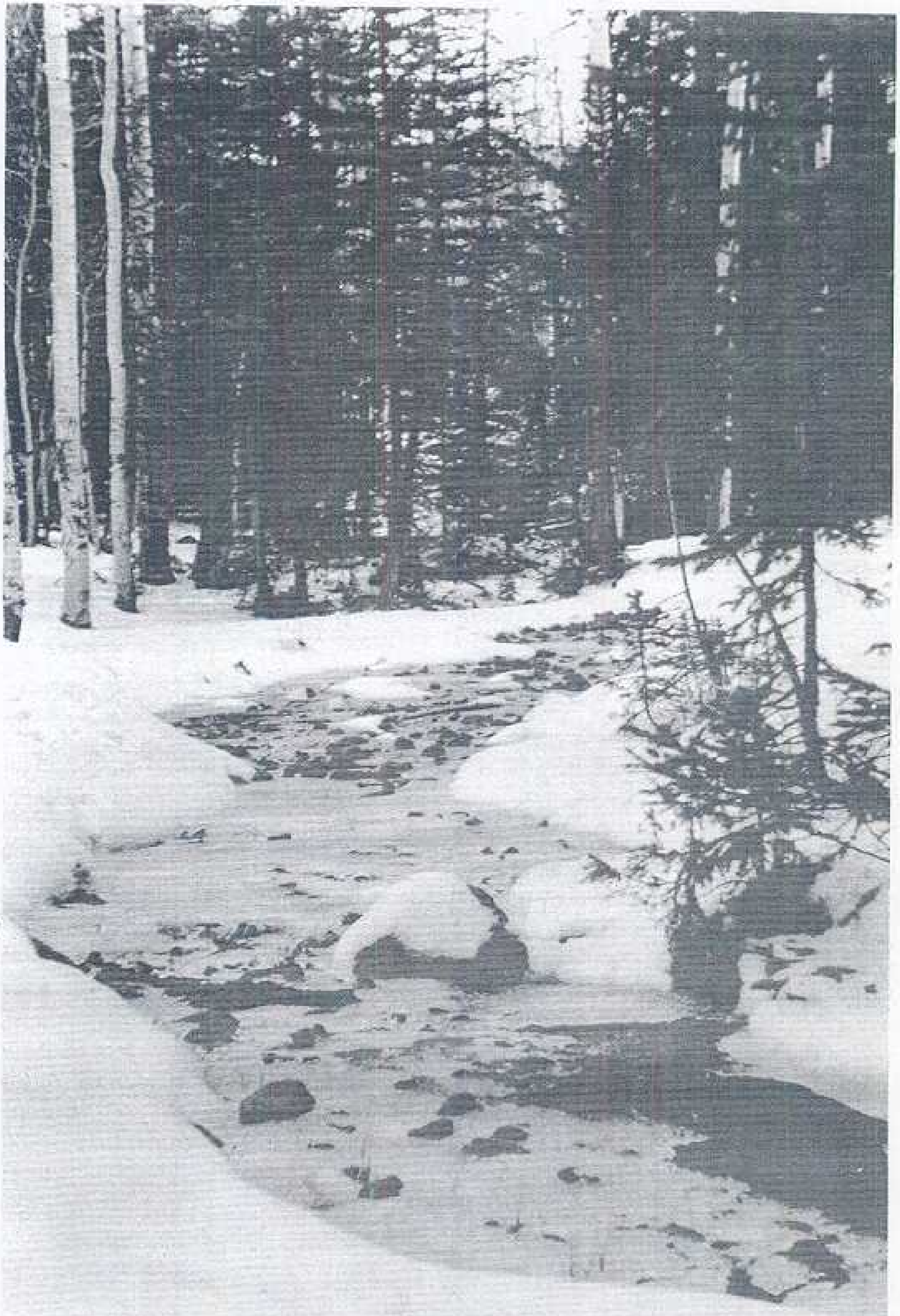
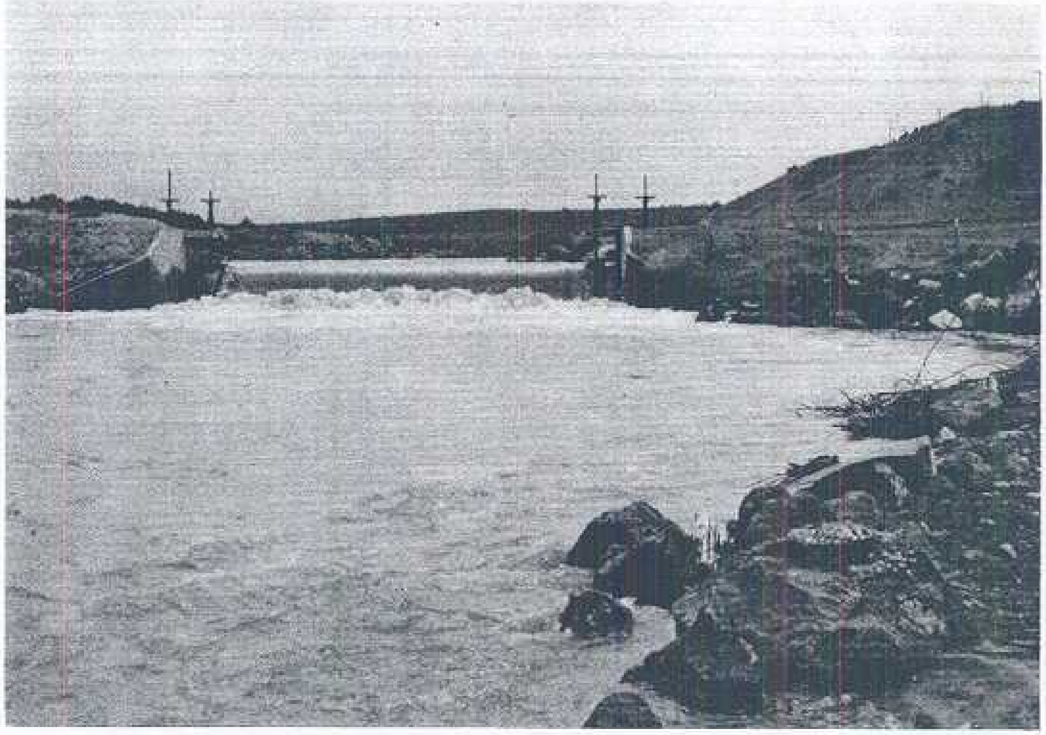


Figure 6: Typical hydrographs of regulated and unregulated river flow, Sevier and Hatch gages. 1931—1960
Sevier River Basin
Utah

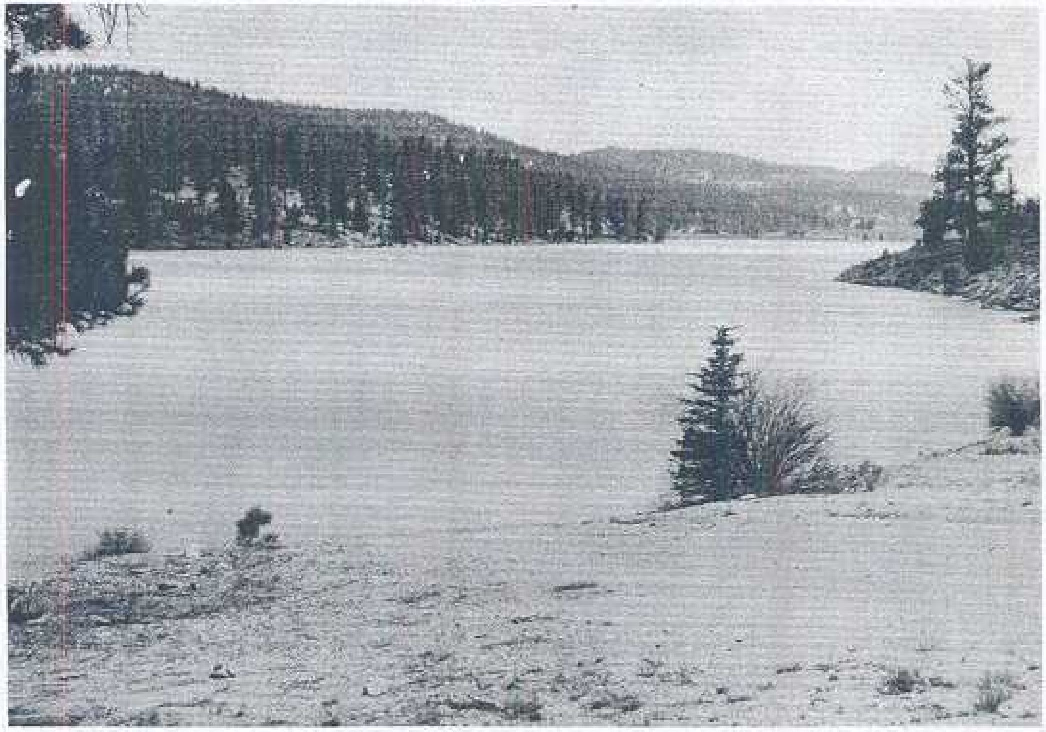


Jackass Creek is a typical tributary to the Sevier River.

FIELD PARTY PHOTO 5881-20



Water is the lifeblood of the Sevier River Basin.



Several studies of the changing relationship between tributary yield and precipitation have been made by various individuals and agencies. Primarily these studies have been concerned with that portion of the Markagunt Plateau tributary to the Sevier River above Hatch gage. This is the only long-term record not influenced by regulation or diversion of consequence. The authors of these studies conclude that the change in runoff is a result of one or a combination of: Changing vegetative types, changing precipitation patterns, or decreasing precipitation. They all agree, however, that there is less water flowing past the Hatch gage now than in the past.

Field party studies indicate the trend in base flow has dropped from 100 c.f.s. in 1923 and 35 c.f.s. in 1960 and indicates a declining groundwater supply on the Markagunt Plateau. The average flow volume during the period 1912-30 was 117,500 acre-feet annually, and from 1931-60 the average was 74,750 acre-feet annually. An increase in precipitation since 1960 has halted or may have reversed this trend.

The Field Party made a study of this situation with a different approach to the variables and limited to the period 1940-62 where more accurate data of greater variety was available. Runoff at Hatch gage was separated into base flow and direct runoff by extending recession curves. Direct runoff and subsequent recession flows were used to represent runoff generated by a given year's precipitation. Average precipitation on the watershed was represented by data from storage precipitation gages and snow courses located on the watershed. The weight given each station was determined by rank correlation procedures.

A highly significant correlation resulted with 95 percent of the runoff fluctuations accounted for by variations in watershed precipitation. There were likely other factors that caused changes in runoff, but they could not be isolated. It was concluded that the change in runoff volume and timing is primarily due to changes in precipitation. (26)

TRANSMOUNTAIN DIVERSIONS

Transmountain diversions are not large sources of water in terms of total supply. They are important locally in Sub-basin A and are the major source of water for Bryce Valley in Watershed E-5. In Watersheds A-1 and A-3, 4,940 and 6,170 acre-feet, respectively, are imported annually from the Colorado River drainage. Annual exports of 3,420 acre-feet are made from the East Fork of the Sevier River into Bryce Valley.

RIVER FLOW

The Sevier River system above Clear Creek consistently yields more water than is consumptively used while that portion of the system below this point uses more water than it yields. Many of the diversions below and including the Vermillion Dam diversion, depend on return flow to the river for their supply.

Of the total yield of 264,130 acre-feet above the gage on the Sevier River above Clear Creek, the average annual flow past this point is 157,790 acre-feet. This is the largest flow at any point on the river system (Map 9). This flow is depleted to 57,500 acre-feet annually at Sigurd, 30 miles downstream, about half of which is return flow from the irrigated areas between Sevier and Sigurd.

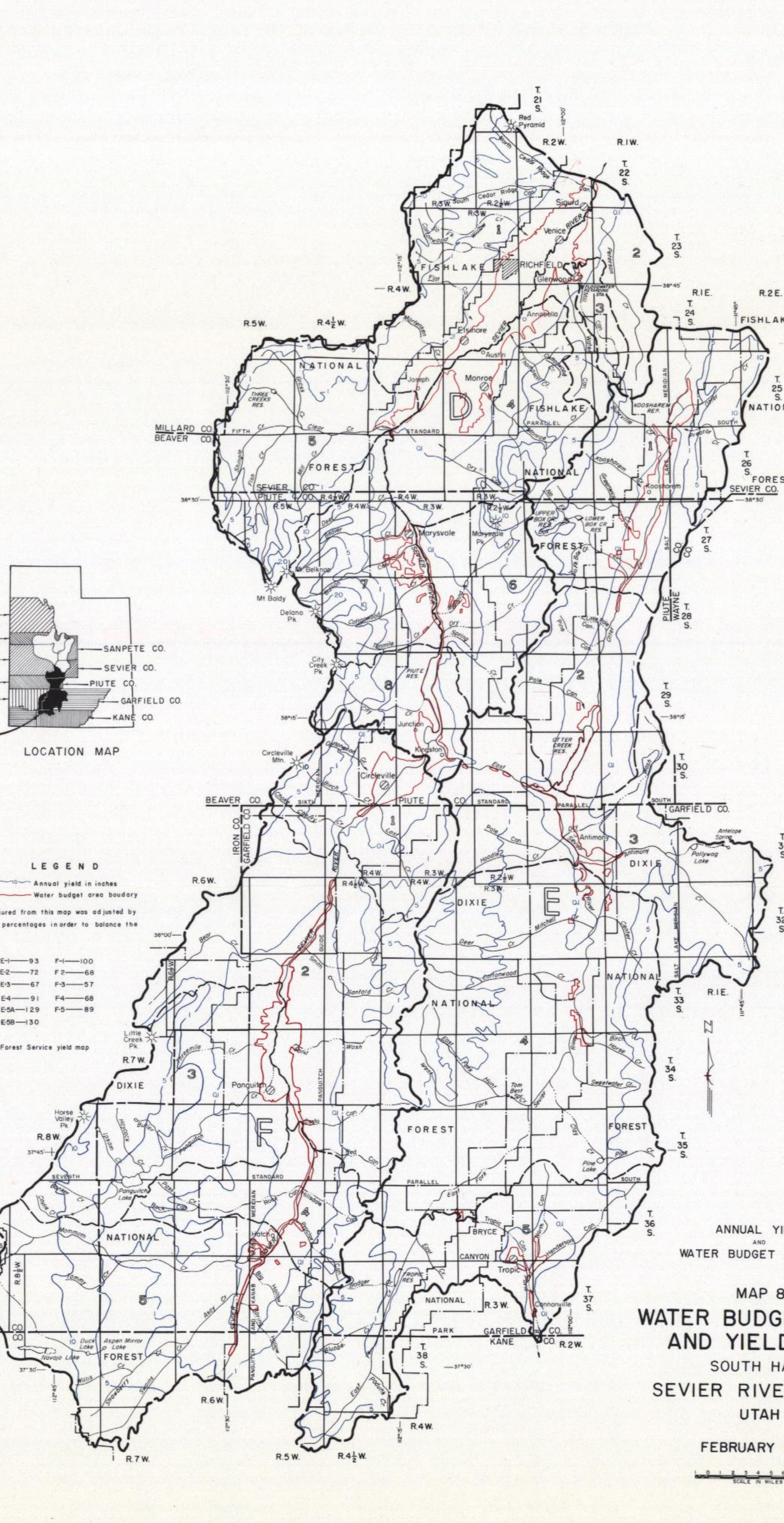
Only 1 percent or 13,690 acre-feet of the total water supply to the water-budget areas annually crosses the lower boundary, almost entirely as groundwater and drainage discharge into the immediate Sevier Lake drainage.

GROUNDWATER

TRIBUTARY INFLOW

Tributary groundwater inflow contributed 162,580 acre-feet annually to the water supply. This is about 22 percent of the total tributary yield (Table 5, p. 51), but does not include 21,370 acre-feet of groundwater outflow to the Virgin and Colorado River drainage, or the discharge of some major springs above the water-budget area.

The major portion of the tributary groundwater flows directly into the groundwater reservoirs. Some of it appears as springs on the upper watersheds, but most of the larger springs are around the periphery of the valleys where they become immediately available for diversion. In fact, the primary supply of water for diversion in Watersheds A-2 and D-3 is from springs along the east edge of the Gunnison Plateau and



LOCATION MAP

LEGEND

- Annual yield in inches
- Water budget area boudary

Note: The yield measured from this map was adjusted by the following percentages in order to balance the water budget.

D-1—68	E-1—93	F-1—100
D2&3—168	E-2—72	F-2—68
D-4—70	E-3—67	F-3—57
D-5—100	E-4—91	F-4—68
D6&7—87	E-5A—129	F-5—89
D-8—185	E-5B—130	

Source: Adopted from Forest Service yield map

ANNUAL YIELD
AND
WATER BUDGET AREA MAP

MAP 8
WATER BUDGET AREA AND YIELD MAP
SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES

Glenwood Springs, respectively. Major springs and their estimated yield are given in Table 6.

TRANSMOUNTAIN GROUNDWATER INFLOW

There are two major areas along the Basin boundary where the groundwater divide lies outside the topographic divide. These are in Watersheds A-2 and E-3.

The northern part of Watershed A-2 has several springs located along the face of the Gunnison Plateau. One spring area, Big Springs, yields more than 5,600 acre-feet annually. The watershed above these springs is very small and the volume of precipitation could not conceivably produce enough water to maintain this flow. A hydrogeologic study has indicated 6,700 acre-feet of groundwater is diverted annually from the west drainage of the Gunnison Plateau to the east drainage through a system of joints, fractures and bedding planes along the dip of a synclinal structure.

Essentially all tributary inflow in Watershed E-3 is produced by Antimony Creek. Primary supply for this stream is a large spring in the upper reaches of the canyon. The constant base flow of about 15 c.f.s. in Antimony Creek indicates a large aquifer that must feed the stream. Other than during snowmelt periods, the average flow of this creek for any month does not vary more than 5 percent from the season average nor more than 25 percent for any one month of the entire period of record.

TRANSMOUNTAIN GROUNDWATER OUTFLOW

Two watersheds, E-5 and F-5, contribute significant amounts of groundwater to the Colorado River and Coal Creek drainages. Geologically, the Paunsaugunt and Markagunt Plateaus of Watersheds E-5 and F-5, respectively, are very similar. These plateaus are capped with the Wasatch formation which is permeated by solution channels similar to those feeding Cascade Spring. As such, it constitutes a groundwater reservoir that is an intricate, interconnected system with channels that are somewhat directed. (27)

Watershed E-5 exports about 40 percent or 6,750 acre-feet of its tributary yield and Watershed F-5 about 18 percent or 14,620 acre-feet through underground channels to drainages around the south and west periphery of these plateaus.

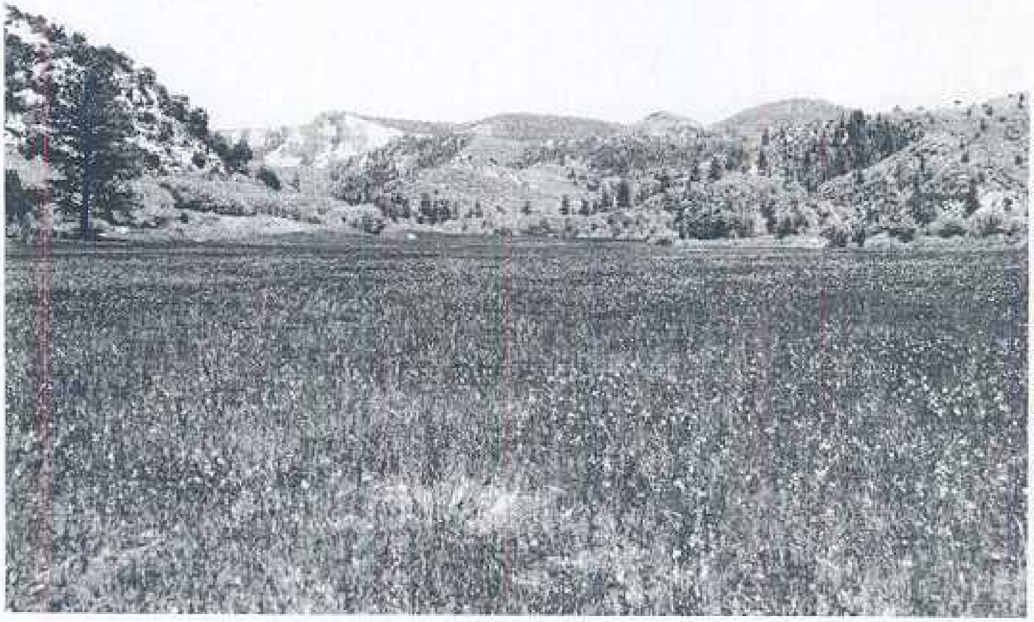
TABLE 6.--Major springs in the Sevier River Basin

Sub-basin	Location	Name	Yield		Temperature (°F)	PPM dissolved solids
			G.P.M.	Date[a]		
A	NW¼, 2, T 14 S, R 2 E	Big Springs near Fountain Green	4,500	R		
	21, T 14 S, R 2 E	Birch Creek Springs	2,700	R		
	SW¼SE¼, 16, T 17 S, R 4 E	City of Ephraim	800	R	45	225
	NW¼NW¼, 20, T 18 S, R 4 E	City of Manti			41	363
	NW¼, 12, T 17S, R 4 E	Big Springs	1,350	R		
B	NW¼, 12, T 17S, R 4 W	Big Spring near Oak City	1,370	1-65		
	SW¼, 26, T 16 S, R 2 W	Blue Spring	10,400	3-63		
	NE¼, 2, T 16 S, R 2 W	Chase Spring	2,700	R		
	NW¼, 11, T 20S, R 7 W	Clear Lake Spring	9,000	R		
	NE¼NE¼, 34, T 16 S, R 2 W	Moulton Spring	2,890	4-63		
C	NE¼SE¼, 19, T 18 S, R 1 E	Fayette Spring	1,900	9-58	64	553
	SW¼NW¼, 18, T 24 S, R 1 E	Little Lost Creek Spring	1,100	R	53	140
	NE¼NE¼, 25, T 20 S, R 1 E	Mickelson Spring	500	12-59	53	612
	SW¼, 36, T 18 S, R 2 E	Morrison Mine Tunnel	1,280	8-64		
	SW¼, NW¼, 9, T 19 S, R 2 E	Nine Mile Spring	980	8-64		
	NE¼SE¼, 4, T 19 S, R 2 E	Peacock Spring	450		67	429
	NE¼, 11, T 21 S, R 1 W	Redmond Lake	6,000	8-59	72	1,530
	SE¼SE¼, 20 T 19 S, R 2 E	Spanish Spring	100	8-57	55	598
D	SW¼SW¼, 16, T 29 S, R 3 W	Barnson Springs	5,400	R	58	271
	SW¼SW¼ 36 T 27 S, R 4½ W	Big Springs	200	R	61	429
	NW¼NW¼ 12, T 23 S, R 2 W	Black Knoll Spring	5,000	1-58	54	
	SW¼SW¼ 24, T 24 S, R 3 W	Central Spring	80	R	55	306
	SW¼SE¼, 25, T 25 S, R 3 W	Cold Spring			47	119
	SW¼SW¼ 27, T 23 S, R 2 W	Cove Spring	4,650	5-58	56	338
	SE¼SE¼ 28, T 23 S, R 2 W	Ford Fish Hatchery	1,400	9-59	55	
	NE¼SE¼ 28, T 23 S, R 2 W	Ford Fish Hatchery	450	9-59	57	
	NW¼SW¼ 36, T 23 S, R 2 W	Glenwood Spring	4,500	R	59	159
	NW¼NW¼ 32, T 24 S, R 4 W	Gooseberry Spring	60	R	52	235
	SE¼NW¼ 25, T 23 S, R 2 W	Indian Creek Spring	300	4-59	59	
	NE¼NE¼, 23, T 25 S, R 4 W	Joseph Hot Spring	100	7-57	147	4,970
	SE¼, SE¼ 10, T 25 S, R 4 W	Monroe Hot Spring	40	7-57	169	2,860
	SW¼SW¼ 25 T 23 S, R 2 W	Parcell Creek Spring	60	4-59	59	
	T 25 S, R 3 W	Red Hill Hot Spring	76	7-64	168	2,500
	SW¼NE¼ 26 T 23 S, R 3 W	Richfield Spring	1,400	R	68	310
	SW¼NE¼ 21, T 29 S, R 4 W	Sawmill Spring			55	134

TABLE 6 continued

Sub-basin	Location	Name	Yield		Temperature (°F)	PPM dissolved solids
			G.P.M.	Date[a]		
D	NW¼SW¼ 4 T 24 S, R 2 W	Spring Hill Springs	4,500	R	54	
	SW¼SE¼ 17 T 27S, R 3 W	Taylor Spring	1,800	R	54	
E	NE¼NW¼ 11, T 32 S, R 2 W	Ant Creek Spring	340	8-62	60	
	NW¼NW¼ 19 T 31 S, R 2 W	Antimony Spring	220	7-62	55	203
	SE¼NE¼ 8 T 27 S, R 1 W	Brindly Spring	50	10-63	58	
	NE¼NW¼ 30 T 26 S, R 1 E	Brown Spring	200	8-62	55	97
	SW¼NW¼ 26 T 25 S, R 1 W	Burr Spring	1,440	7-62	50	120
	NE¼SW¼ 27 T 31 S, R 2 W	Clear Spring	50	R	55	
	SE¼NE¼ 23 T 32 S, R 2 W	Deer Creek Spring	1,640	8-62	50	299
	SE¼SW¼ 11 T 32 S, R 2 W	Gleave Spring	300	8-62	50	
	NW¼NE¼ 1 T 27 S, R 1 W	Koosharem Springs	120	8-62	55	
	NE¼ 35 T 27 S, R 1 W	Parker Mtn. Springs	50	6-61	54-57	
	NW¼ 5 T 30 S, R 1 W	Pete's Spring No. 1	225	10-63	61	
	SE¼SW¼ 15 T 29 S, R 2 W	Pole Canyon Spring	270	7-62	55	180
	SW¼ 13 T 26 S, R 1 W	Red Cedar Grove Springs	540	12-62	53-58	
	SE¼SE¼ 27 T 34 S, R 3 W	Tom Best Spring	500	7-62	50	246
	SW¼NE¼ 2 T 32 S, R 2 W		450	6-62	50	259
F	SW¼NE¼ 18 T 36S, R 7 W	Blue Spring	4,500	8-62	43	
	SW¼NE¼ 14 T 35 S, R 5 W	Casto Springs	50	11-62	48-50	
	NW¼NE¼ 16 T 30 S, R 4 W	Circleville Spring	60	12-62	44	86
	SE¼SW¼ 12 T 38 S, R 8 W	Duck Creek Spring	4,200-	7 & 8-		
			11,200	54	45-50	137-117
	NE¼NW¼ 23 T 32 S, R 5 W	Hawkin Spring	110	8-62	51	
	SW¼ 14 T 36 S, R 5 W	Johnson Creek Spring	200	R	48-51	
	SW¼NW¼ 33 T 37 S, R 6 W	Lower Asay Spring	13,000	8-54	50	132
	NE¼SE¼ 31 T 36 S, R 7 W	Mammoth Spring	900	4-57		
			121,000	6-57	40	103
	NW¼NE¼ 35 T 32 S, R 5 W	Marshall Slough	1,350	8-55	44-57	351
	NW¼SW¼ 17 T 30 S, R 3 W	Mitchell Slough		8-60	50-59	291
	NW¼NE¼ 25 T 35 S, R 5 W	Myers Springs	450	11-62	47-50	
	SW¼ 18 T 34 S, R 6 W	Panguitch Spring	475	12-61	51	129
	NW¼SW¼ 19 T 35 S, R 4½W	Red Canyon Spring	450	11-62	53	
	SE¼SW¼ 16 T 33 S, R 5 W	Tebbs Springs	280	5-62	50-68	218
	NE¼SE¼ 32 T 37 S, R 6 W	Upper Asay Spring	3,600	10-62	47	210
	SE¼ 35 T 32 S, R 5 W	Veater Slough	450	10-62	54	

[a]R - Reported Yield



The meadow pictured above is near the town of Alton at the headwaters of Kanab Creek. It is supplied by springs which appear at the base of the "Pink Cliffs" in the background. These springs are fed by ground water percolating through the Wasatch Formation from tributaries of the East Fork of the Sevier River. Over 21,000 acre-feet of water leave the Basin in this manner every year. FIELD PARTY PHOTO

GROUNDWATER MOVEMENT

According to groundwater studies by the U. S. Geological Survey,[1] groundwater reservoirs in the Sevier River Basin contain over 5,470,000 acre-feet in the upper 200 feet of the alluvial fill. Understanding the characteristics of these reservoirs and their relationship to the surface flows in the river is necessary to evaluate their usefulness.

The groundwater reservoirs are a series of basins along the river each separated from the ones upstream and downstream by a relatively impermeable underground geologic dam. These reservoirs are filled by water from the river channel as it traverses the valley, deep percolation from irrigation, from precipitation, and from tributary inflow entering the valley as groundwater.

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[1]Refer to Table 78, p. 203

When the reservoir is full, it spills over the relatively impermeable groundwater barrier and contributes to the downstream flow of the river. As the soil profile becomes saturated, waterlogging of land occurs thus enabling high-water-using vegetation to grow.

Conversely, as the supply of water declines or when large volumes are pumped from the aquifers, the water table is lowered, drying up wet areas with a subsequent decrease in consumptive use. When this happens, water which normally drains to the river as return flow percolates downward to refill the groundwater reservoir and reduces the river outflow.

The groundwater basin in Watershed B-7 reacts similarly except there are no distinct boundaries and the water is moving across the watershed in a west to southwesterly direction.

Interaction of diversions and return flow is illustrated by the Richfield area. Return flow to Sevier River between the Sevier and Sigurd gages follows the same pattern as diversions in Watershed D-1 through D-5 except the peak return flow lags peak diversions about 5 months and low return flow lags low diversions about 7 months (Figure 7). Calculated average return flow along this reach for the 1945-54 period is 75,980 acre-feet annually. Recorded inflow for March through September for this same period between the Richfield gage and the Sigurd gage is 29,100 acre-feet. This curve is flatter, indicating a more stabilized return flow. It averages about 4,160 acre-feet per month or 67 c.f.s. for the seven months. The other groundwater basins react in a similar manner.

Return flows are important in the regimen of the Sevier River. Water-budget analysis shows that 50 percent of the total tributary inflow and river diversions reappear as surface water for rediversion downstream. As an example, total river diversions between the community of Sevier and Rocky Ford Reservoir almost equal the total river inflow. If there were no return flows, the outflow would be zero instead of 57,500 acre-feet. Many irrigation companies, particularly in the lower Sevier and Sanpete Valleys and Mills area, depend on return flow for their diversion supply.

Groundwater movement is continuous but with less fluctuation than surface-water flows. Groundwater flows from one sub-basin to another are relatively minor (Map 10). These amount to a maximum of 3 percent of the respective surface flow except the 13,000 acre-feet from Sub-basin D to Sub-basin C, which is 23 percent of the surface river flow. However, part of this is groundwater tributary inflow from the northern Pavant Plateau that probably follows the Elsinore Fault and reappears at Redmond Springs.

Transwatershed groundwater flow is more important along the lower reaches of the river. The entire outflow from Watershed B-4 is groundwater movement through a system of en echelon faults in the Flagstaff limestone to Molten and Blue Springs on the Sevier River. More than 80 percent of the outflow from Watershed B-1 is groundwater flow into Watershed B-2. Annual groundwater outflows from Watersheds B-5 and B-6 into Watershed B-7 are 28,420 and 20,800 acre-feet, respectively.

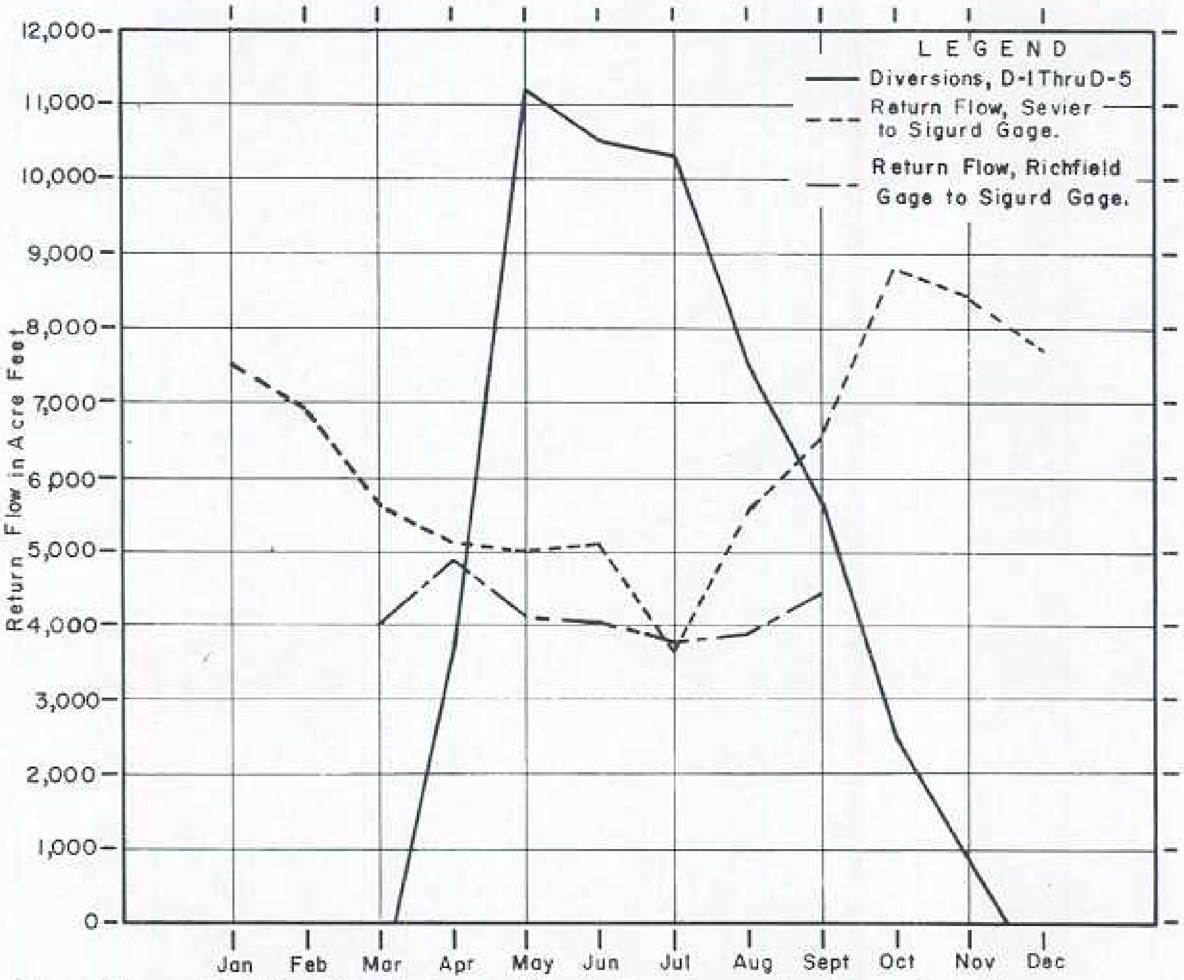
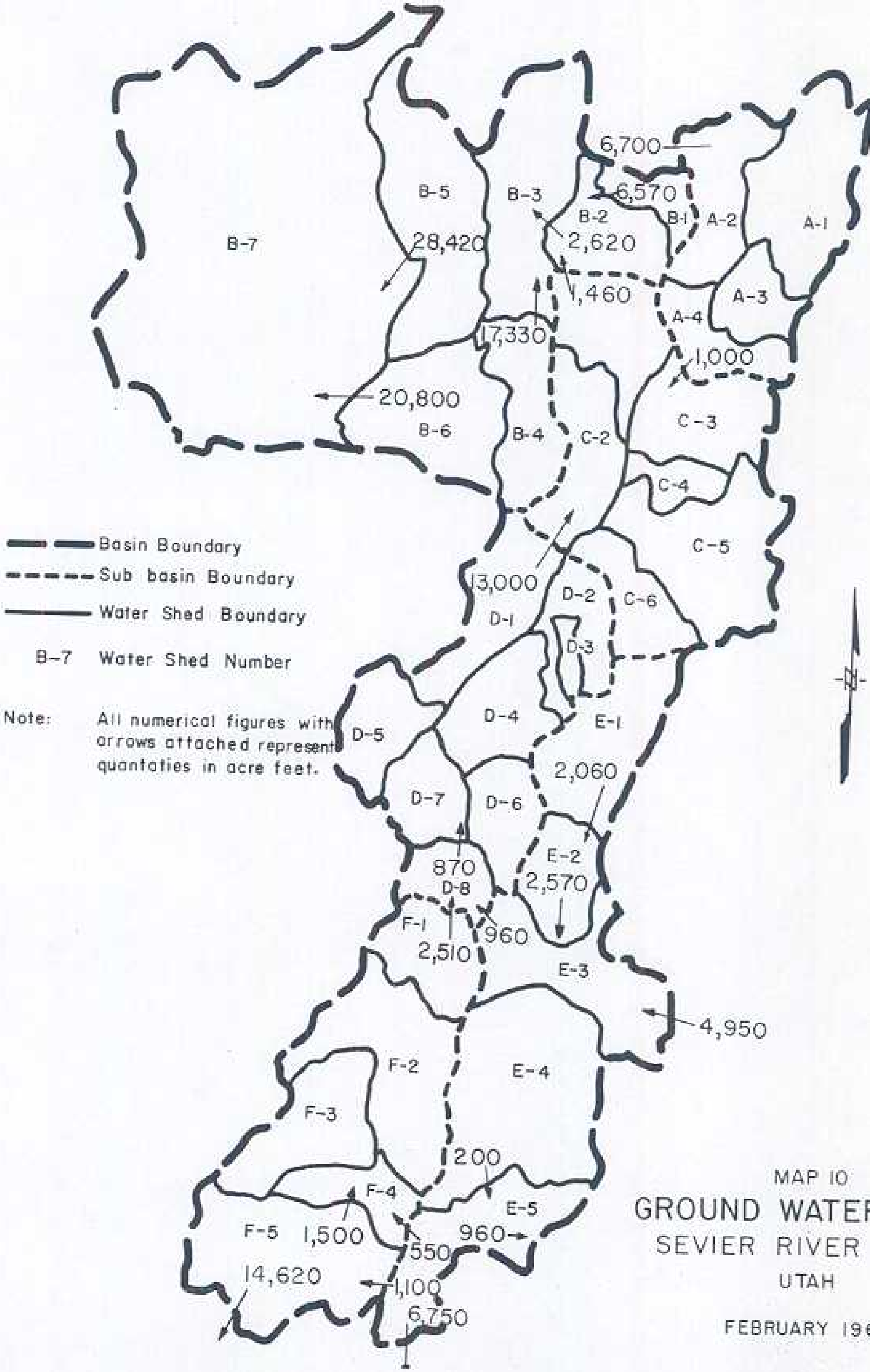


Figure 7: Relationship between direct diversion and return river flow, Sevier to Sigurd. 1945—1954 Average

Sevier River Basin
Utah



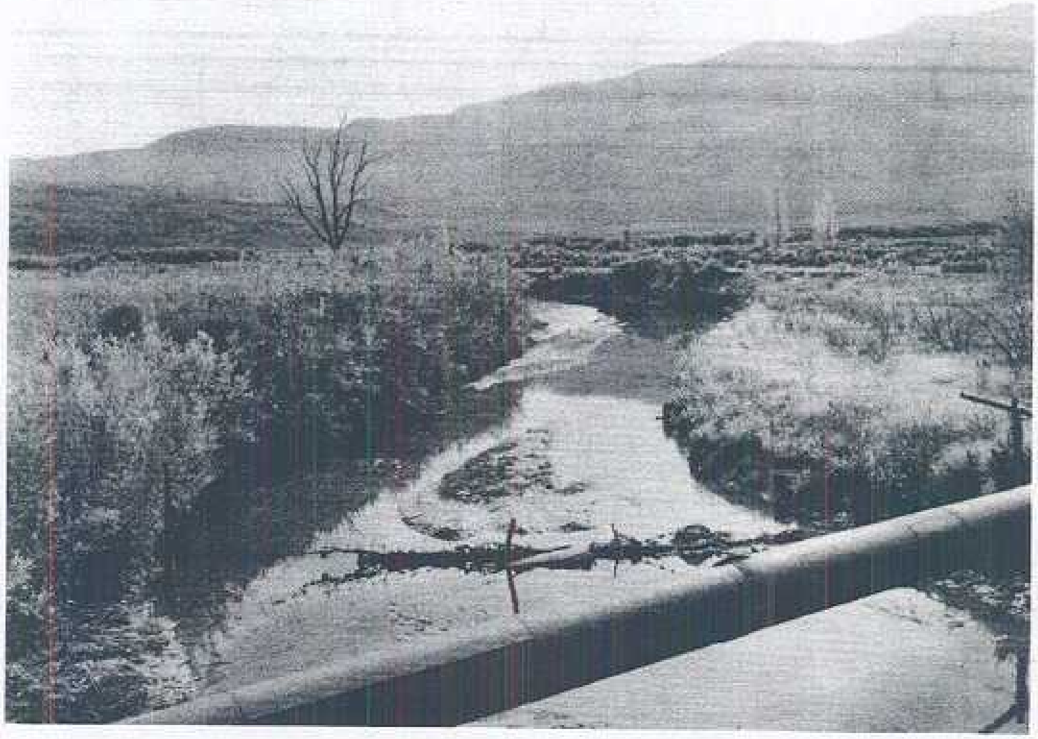
MAP 10

GROUND WATER FLOW

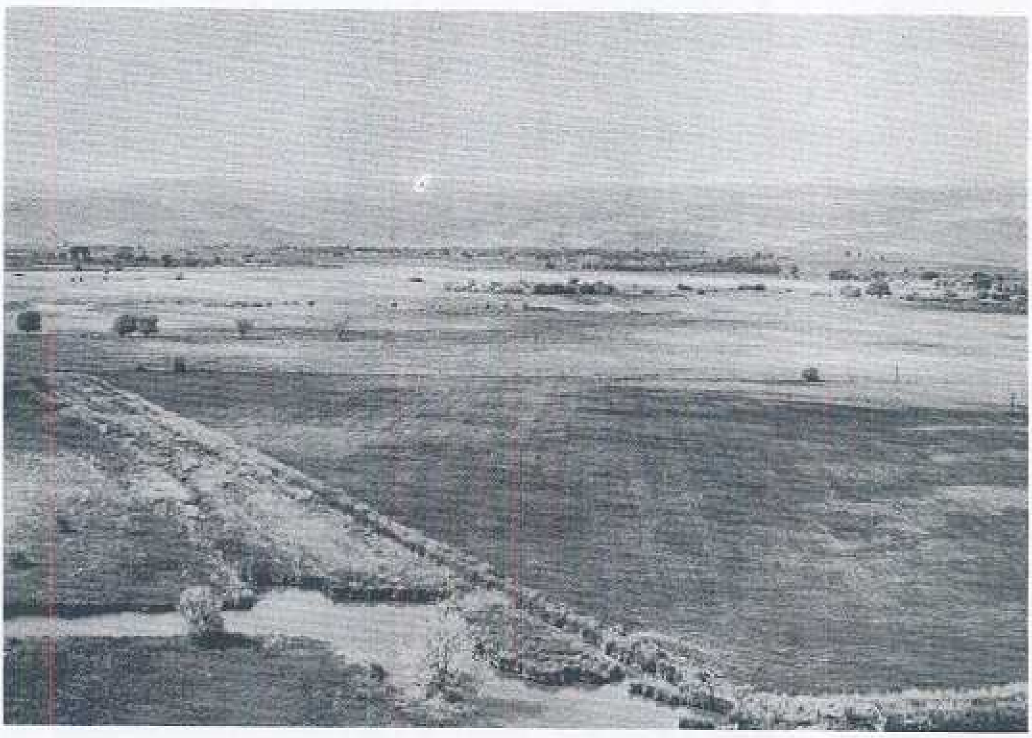
SEVIER RIVER BASIN

UTAH

FEBRUARY 1969



Return flows are an important part of the downstream diversion rights.



WATER USE AND MANAGEMENT

WATER RIGHTS

Current irrigation water management practices have evolved over the years through use and agreements between water users within the framework of the Cox Decree. (6) In 1918, the Richlands Irrigation Company filed suit for the adjudication of all rights of the lower Sevier River system. The State Engineer submitted his proposed determination of water rights to the District Court on February 21, 1926. After numerous amendments and stipulations, a final decree on the Sevier River system was signed by Judge LeRoy Cox on November 30, 1936, and is known as the "Cox Decree."

In the Cox Decree, the Sevier River system has been divided into two distribution zones (Map 9, p. 57), with the exception of the storage rights of the Piute Reservoir and Irrigation Company and the Sevier Bridge Reservoir Company. Zone "A" includes all rights from the Sevier River and its tributaries above and including the dam of the Vermillion Canal Company located in Sevier County. Zone "B" includes all rights from the Sevier River and tributaries where said water is being diverted below the Vermillion Canal Company dam.

All rights in Zones A and B, so far as zones are concerned, are considered independent of each other with the exception of storage rights in Piute and Sevier Bridge Reservoirs. The rights in Zone A are primary to and shall have priority over the rights in Zone B as described in the Cox Decree. Beneficial use shall be the basis, the measure and the limitation over all rights to the use of water.

With the Sevier River system divided into two zones, the lower zone is dependent upon the return flow of water diverted in Zone A. For this reason, the water users in Zone B have objected to any additional development in Zone A that would use more water and curtail the rate of return flow to the river.

The water rights in Piute Reservoir and the Sevier Bridge Reservoir are distributed according to the Cox Decree as modified by a stipulation between the owners of the two reservoirs.

There have been several controversies develop between water users on the Sevier River system. These controversies are generally associated with (1) the interpretation of the distribution of water decreed in the Cox Decree and, (2) the relationship of groundwater appropriation and its effect on the surface-water rights. These controversies are sometimes carried into courts of law and often delay planned water development projects.

SURFACE-WATER USE AND MANAGEMENT

The Sevier River is one of the most completely consumed rivers in the United States. Less than 1 percent or 44,840 acre-feet of the total precipitation of 6.5 million acre-feet is not consumed within the Basin, and of this amount, only 13,690 acre-feet is discharged into Sevier Lake. It should be noted that at least this much outflow is needed from the Delta area to leach accumulated salts from the cropland root zone.

The distribution of water consumed in the water-budget areas is shown in Table 7 and Figure 8. Total water consumption in the water-budget areas is 1,103,540 acre-feet annually with agricultural and related uses accounting for 99 percent. Water consumed on lands outside the water-budget area, including the mountain watersheds, totals 5,351,620 acre-feet annually. A Basin summary water budget is shown in Figure 9.

Nonconsumptive uses of the surface-water resource are also important. Uses related to recreation include boating, fishing, and maintaining waterfowl habitat. Industrial use of water is small at present, but is increasing in importance. Some water is used to transport waste and sewage.

Lake and reservoir storage facilities are an important part of the water resource scheme. A list of the major reservoirs along with surface areas and capacities is shown in Table 8. The storage capacity of all reservoirs above Piute Dam is 50,000 acre-feet more than the total undiverted average annual tributary inflow. This provides a mangement capacity adequate to store all runoff that occurs 7 out of 10 years and provides carryover storage for drier years. This does not preclude the need for additional storage as there are still areas where regulatory storage is needed to provide more stable flows for late summer use.

Present storage below Piute Dam is 306,960 acre-feet or 65,000 acre-feet more than the undiverted runoff. This will store the supply that could be expected 4 out of 10 years. Here again, some local irrigation companies need additional storage to regulate their supply.

GROUNDWATER USE AND MANAGEMENT

Springs and wells in the valleys provide the major source of high-quality water for domestic and stock water purposes. Within range and forest areas, springs are a major source of livestock water and provide many recreation developments as well. Many municipalities obtain domestic water from large springs. In some areas they are the principal source of irrigation water.

TABLE 7.--Average water use - water-budget areas, Sevier River Basin

Watershed	Irrigated lands			Domestic use	Nonirrigated lands			Evaporation on major reservoirs	Total
	Rotated	Nonrotated	Water surfaces		Wet meadows	Phreatophytes	Water surfaces		
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
A-1	55,020		1,560	870	43,170	2,760	1,310		104,690
A-2	14,740		480	170	31,020	2,350	1,310		50,070
A-3	24,050		600	400	7,280	620	270		33,220
A-4	16,490		690	380	26,910	3,440	810		48,720
Total	110,300		3,330	1,820	108,380	9,170	3,700		236,700
B-1	8,690		260	80					9,030
B-2	5,880	3,630	240		4,200	3,080	430	2,290	21,750
B-3					2,460	2,970	680		6,110
B-4	9,090		180	70	3,660	560	60	5,390	19,010
B-5	14,950		350	190	1,840	4,360	1,270	6,330	29,490
B-6	11,260		290	90	5,370	10,180	600		27,790
B-7	111,410			1,160	62,600	96,120	3,390	10,380	285,060
Total	161,280	3,630	1,320	1,590	80,130	119,470	6,430	24,390	398,240
C-1	6,330	6,400	480	40	14,760	3,240	910	28,200	60,360
C-2	39,810	6,320	1,360	200	9,410	4,000	1,270		62,370
C-3	31,370	3,030	790	450	4,430	1,880	240	5,990	48,180
C-4	2,620	140	100	50		640	60		3,610
C-5	5,210	3,480	290	360	1,740	1,400	180		12,660
C-6	4,370	120	100		340	370	60		5,360
Total	89,710	19,490	3,120	1,100	30,680	11,530	2,720	34,190	192,540
D-1	43,480	8,100	1,190	1,790	2,820	1,120	1,840		62,340
D-2	3,740	1,480	90	280	15,550	410	710		22,260
D-3	800	190		60	910				1,960
D-4	26,140	920	520	1,180	790	2,550	120		32,220
D-5	1,860		50			890			2,800
D-6	1,030	1,500	50	80	1,350	270	60		4,340
D-7	6,270	1,610	90		3,450	3,220	290		14,930
D-8	5,220	630	90	90	1,360	1,390	50	8,240	17,070
Total	90,540	14,430	2,080	3,480	26,230	9,850	3,070	8,240	157,920
E-1	11,000	5,460	120	70	8,380	530	250	1,640	27,650
E-2	1,690			50	470	620	80	8,960	11,870
E-3	5,190	2,260	150	40	1,010	2,250	360		11,260
E-4	2,300	550	130		160	660	410		4,210
E-5	4,680	490	280	120	70	1,220		620	7,480
Total	24,860	8,760	680	280	10,290	5,280	1,100	11,220	62,470
F-1	10,400	3,530	130	100	2,270	1,250	220		17,900
F-2	11,020	1,350	130		3,490	700	720		17,410
F-3	9,160	870	130	320	1,250	280	250		12,260
F-4	1,320	400	180		200	670	160		2,930
F-5	2,660	1,480	240	50	290	450			5,170
Total	34,560	7,630	810	470	7,500	3,350	1,350		55,670
GRAND TOTAL	511,250	53,940	11,340	8,740	263,210	158,650	18,370	78,040	1,103,540

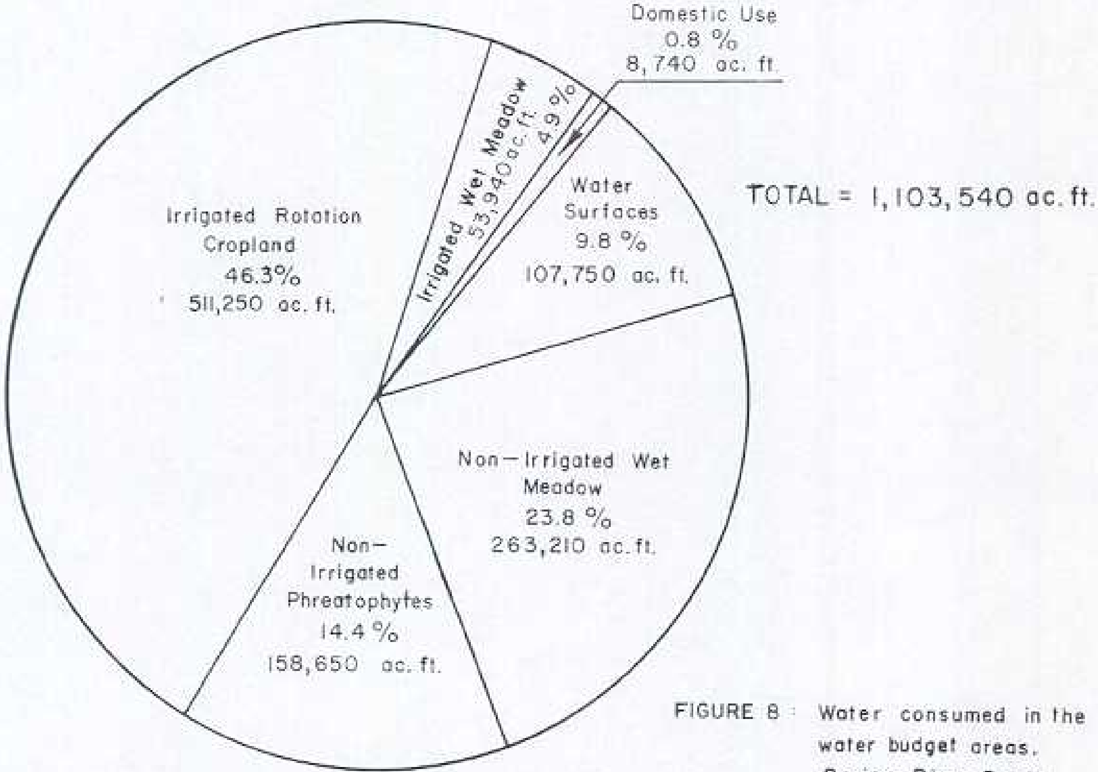


FIGURE 8 : Water consumed in the water budget areas. Sevier River Basin Utah

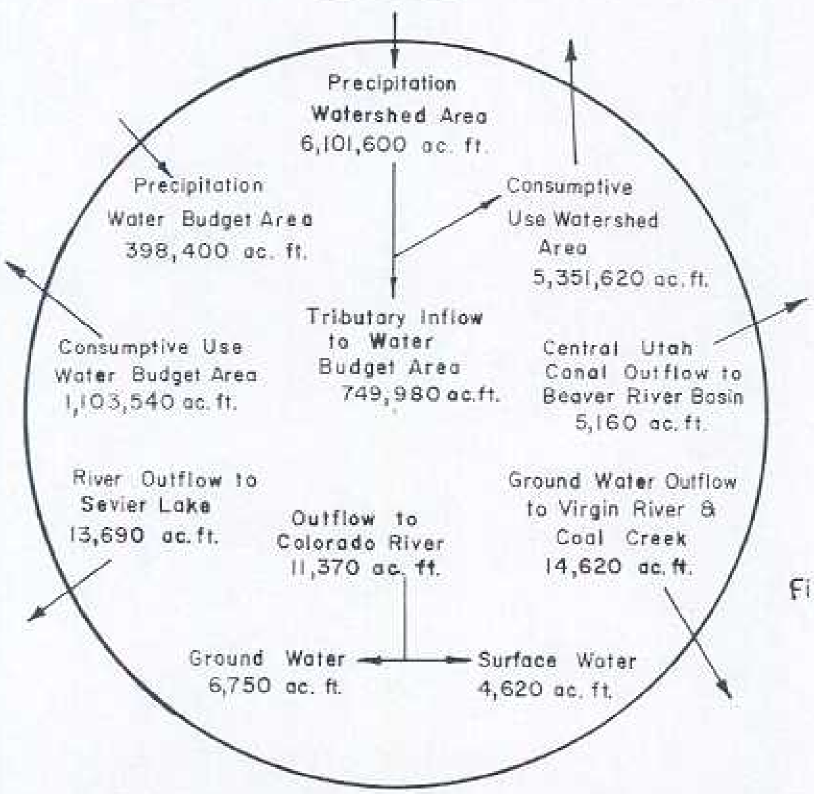


Figure 9 : Basin summary water budget. Sevier River Basin Utah

TABLE 8.--Major reservoirs and lakes in the Sevier River Basin

Sub-basin	Reservoir	Surface area	Capacity	Source of information
		Acres	Acre-feet	
A	Chester Ponds	130	550	CNI
	Fairview Lake	80	2,180	CNI
	Funk's Lake	150	610	CNI
	New Canyon	40	100	CNI
	Wales	200	1,450	CNI
Total		600	4,890	
B	Chicken Creek	510	2,000	SRBI
	Clear Lake	1,050	1,000	SRBI & CNI
	DMAD	1,200	11,000	SRBI Res. Cap. Table
	Fool Creek	640	10,000	SRBI & WSP 920
	Gunnison Bend	750	4,550	SRBI
	Scipio Lake	1,190	7,600	SRBI Res. Cap. Table
Total		5,340	36,150	
C	Gunnison	1,280	18,220	SRBI Res. Cap. Table
	Fransworth Lake	30	100	CNI & WSP 920
	Lost Creek	80	400	CNI
	Nine Mile	210	3,540	WSP 920
	Redmond Lake	270	1,000	SRBI
	Rex Reservoir	30	1,000	CNI
	Sevier Bridge	10,900	236,150	SRBI Res. Cap. Table
	Skutumpah	40	320	SRBI Topog.
	Willow Creek	80	1,050	CNI & SCS Contact Prints
Total		12,920	261,780	
D	Annabella	50	500	CNI
	Big Lake	130	580	CNI
	Deep Lake	30	290	CNI
	Heppler Ponds	80	200	SRBI
	Piute	2,600	71,830	SRBI Res. Cap. Table
	Rocky Ford	260	2,120	WSP 920
	Three Creeks	180	600	WSP 920
Total		3,330	76,120	
E	Booby Hole	40	450	WSP 920
	Koosharem	400	3,860	WSP 920
	Lower Box Creek	20	340	WSP 920
	Otter Creek	2,520	52,660	SRBI Res. Cap. Table
	Pine Lake	80	1,810	WSP 920
	Tropic	170	1,600	WSP 920
	Upper Box Creek	60	1,400	SRBI
Total		3,290	62,120	
F	Navajo Lake	730	14,220	WSP 920
	Panguitch Lake	1,230	18,580	WSP 920
Total		1,960	32,800	
GRAND TOTAL		27,440	473,860	

Note: CNI - Conservation Needs Inventory (unpublished report)
SRBI - Sevier River Basin Investigation
WSP - U. S. Geological Survey Water Supply Paper 920

Present development of groundwater reservoirs is quite limited. Most of the existing wells are for domestic and stock water purposes. Although numerous, they are generally low yielding, small diameter, and shallow (50-200 feet deep). Most are flowing wells but some must be pumped. There are some large diameter, deep wells which produce water for public supplies, irrigation and industrial purposes. Generally, the higher producing, better quality wells yield water from the deeper aquifers at depths up to 800 feet.

A majority of the large irrigation wells have been drilled since 1950. Consequently, the 1931-60 average amount of water pumped for irrigation is considerably less than the amount pumped in recent years (Table 9).

TABLE 9.--Discharge from wells by sub-basin, Sevier River Basin

Sub-basin	Irrigation purposes		Other purposes
	Average	1964	1964
	Acre-feet	Acre-feet	Acre-feet
A	14,240	11,600	4,400
B	9,350	46,300	1,700
C	1,480	4,000	2,500
D	2,200	6,000	3,500
E	1,480	1,300	1,150
F	500	800	150
Total	29,250	70,000	13,400

Source: Portions of the data from U. S. Geological Survey Water Supply Papers and basic data reports. (15)

Prior to 1950, most of the well water used for irrigation was produced by flowing wells. Since that time, as more large pumped wells were developed to alleviate drought conditions, the yield from flowing wells has decreased. This is especially true in Sub-basin B. The following tabulation of wells in Pavant Valley, part of which is outside the Basin, dramatically illustrates the trend. The discharges listed are the total for the Pavant Valley groundwater basin as delineated by the U. S. Geological Survey.

TABLE 10.--Trend in pumped well and flowing well discharge for selected years in Pavant Valley, 1946-65

Year	Estimated discharge			Number of wells	
	Flowing wells	Pumped wells	Total	Pumped irrigation wells	Total in valley
	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
1946	17,300	400	17,700	3	343
1950	17,600	5,100	22,700	20	400
1955	14,400	21,600	36,000	49	466
1960	5,900	61,400	67,300	110	532
1965	2,700	66,100	68,800	129	555

Source: U. S. Geological Survey, "Groundwater Conditions in Utah Spring of 1966," Cooperative Investigations Report No. 4, p. 68.

W I L D L I F E

Early settlers (1849-70) reported that big game was scarce although furbearers, waterfowl, and predators were abundant, and fish were found in good supply in the streams. The few deer present were intensively hunted by the early settlers for food and hides. By the turn of the century, big game was so scarce that the sight of a deer or other game animal was a rarity.

Many different species of birds, animals, reptiles and fish inhabit the Basin area. The traveler is often delighted to see ground squirrels, chipmunks, and perhaps a lumbering porcupine. Walking through a forest, he is likely to hear the scolding of a Chickoree squirrel and in the vicinity of Navajo Lake may even observe the unique flying squirrel. High on the Tushar Mountains, coneys or rock rabbits can be observed cutting grasses and other vegetation and storing it in their miniature haystacks. It may take considerable effort to observe a kit fox on the desert or a cougar or golden eagle, but they too are residents. The Utah prairie dog, a species threatened with extinction, is still found in this area. Songbirds brighten the Basin with their song. Seeing, hearing, and knowing that a variety of wildlife exists, increases man's aesthetic and recreational enjoyment.

The following is a partial list of other important wildlife species:

Big Game	Game Fish	Furbearer	Carnivores
Mule deer	Rainbow trout	Beaver	Black bear
Elk	Cutthroat trout	Muskrat	Coyote
Antelope	Brook trout	Mink	Bobcat
	German Brown trout		Cougar
Small Game	White bass		Weasel
	Black bass		Skunk
Cottontail rabbit	Walleye		Badger
Jack rabbit			Fox
Game Birds	Nongame Fish	Water Fowl	
Mourning dover	Carp	Various species of:	
Ring-necked pheasant	Utah chub	Geese	
Merriam turkey	Leatherside chub	Snipe	
Ruffed grouse	Redside shiner	Coots	
Blue grouse	Mountain sucker	Ducks	
Sage grouse	Utah sucker	Rails	
Chukar	Dace, spp.	Cranes	
	Sculpin, spp.	Herron	

BIG GAME

Utah is famous for mule deer and many hunters travel annually from distant states to participate in this sport. The percentage of hunter success in high. Examples are: Monroe Mountain (herd unit #48) with a high of 73 percent in 1962 and a 1962-66 average of 64 percent; the Fillmore unit (#54) with a high of 69 percent in 1964 and a 1962-66 average of 55 percent (Map 11). In 1966, 52,986 individuals hunted deer on herd units that are partially or entirely within the Basin. (23) The number of hunters has increased about 7 percent during the last 10 years.

Utah residents spent 20.3 percent more money in Utah in 1959 for hunting and fishing than in 1955. Nonresident expenditures within the state increased 60.9 percent in this same length of time. (23)

Big game animals have always received more intensive management than other species of wildlife in Utah because of intense public interest in these animals and their economic significance.

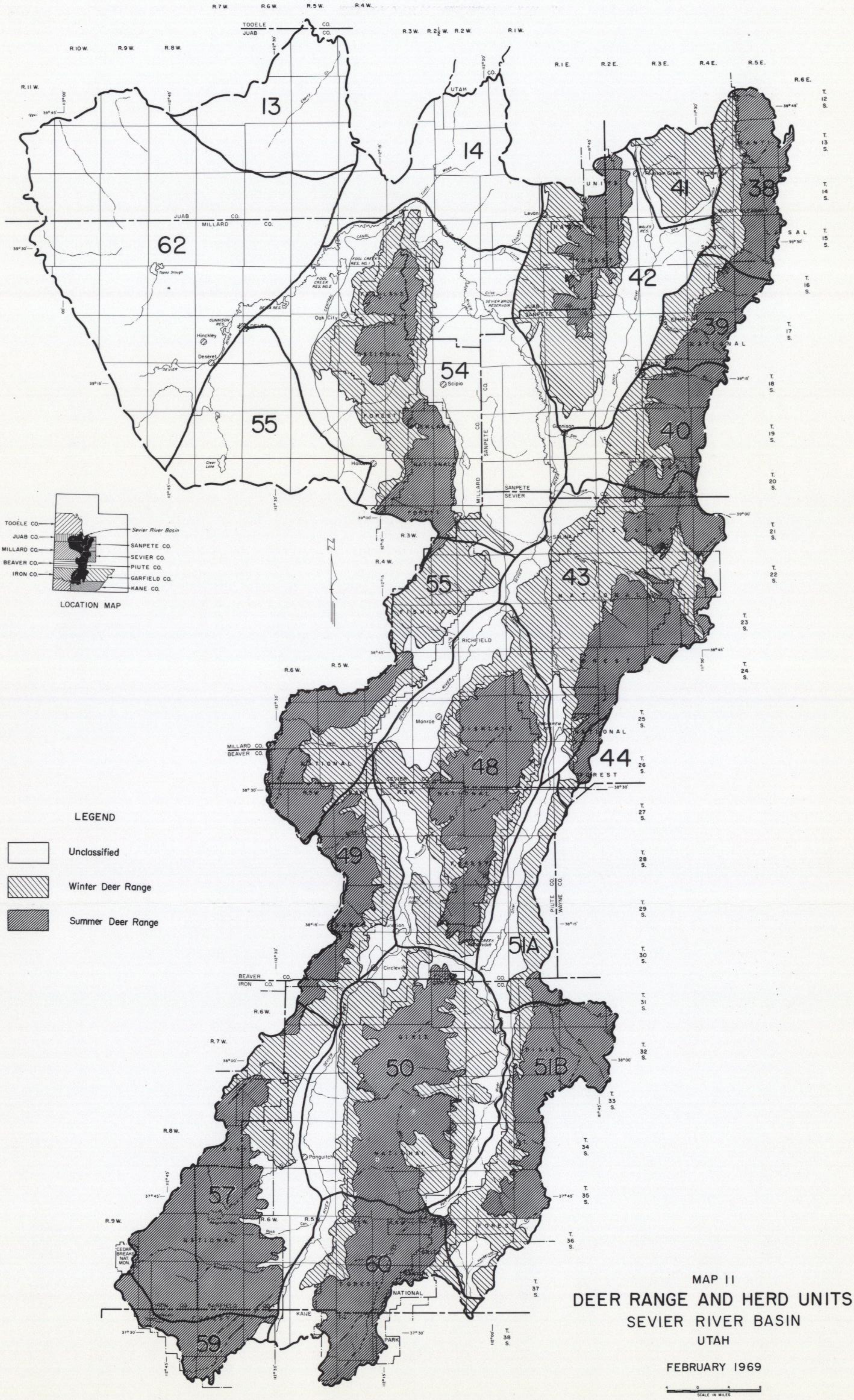
Attempts were first initiated to manage the wildlife resources in 1894. In 1907, hunting and fishing licenses costing $1.00 were required for all male citizens over the age of 14. In 1913, the legislature enacted a "Buck Law" which permitted the taking of buck deer, and the seasons on elk, antelope, and mountain sheep were closed indefinitely. In 1917, a number of game preserves were set aside. The three in the Sevier River Basin were Twelve Mile and Salina Creek in parts of Watersheds C-3, C-4, C-5 and C-6; Forshea Mountain in Watersheds E-2 and D-6; and Paragonah in Sub-basin F.

By 1930 there were signs that the deer range was overstocked, and in 1948 deer starvation was acute over much of the state. Either-sex deer hunts were tried as early as 1934. In 1951, antlerless deer regulations were adopted on a state-wide basis as a tool in managing deer populations. Management philosophy is now one of maintaining the maximum number of animals consistent with range forage production and proper utilization on a herd unit basis.

Game range areas vary. In Sub-basins A, C, E, and in portions of B and D, the winter range is the key habitat limiting deer populations. These winter ranges are mostly within the sagebrush and pinyon-juniper vegetation zones. Sub-basin F and portions of B and D provide extensive areas of winter range and limited areas of summer range. Where summer range is limited, deterioration of the range is often indicated by lack of aspen reproduction (Map 11).

At one time, elk were completely eliminated, but now have been established on four elk management units wholly or partially within the Basin. The Nebo Unit was started with a plant of 48 elk in 1914; the Manti Unit with 24 elk in 1915; the Mt. Dutton herd in the 1930's. On the Fishlake Unit 10 head were planted in 1912 and 37 head in 1913.

A small herd of antelope has been established on Parker Mountain in Sub-basin E as a result of plants made by the State Division of Fish and Game.



MAP 11

DEER RANGE AND HERD UNITS

SEVIER RIVER BASIN

UTAH

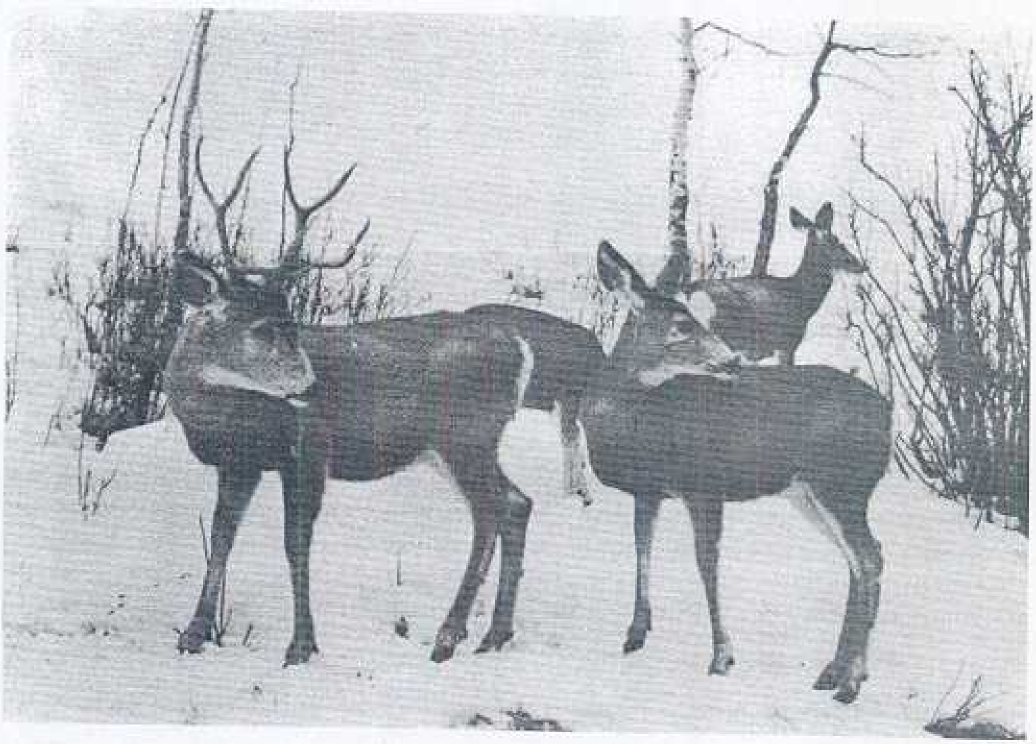
FEBRUARY 1969

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1969

M7-S-18588-N

UTAH STATE DIVISION OF FISH & GAME PHOTO SR81-19

Upland birds and big game provide sport in the Basin.



U. S. FOREST SERVICE PHOTO SR81-18

U. S. FOREST SERVICE PHOTOS SR91-16

Fishing and camping are popular recreation activities.

SR91-17

FISH

Cutthroat, brook and rainbow trout are found in the cold mountain streams and lakes and some German Brown trout in the valley streams. Some streams no longer support abundant fish populations because of silt loads, fluctuating water levels, unstable streambeds, and streamflow diversions. In some of these streams, fish are planted on a put-and-take basis.

Downstream, fishing changes to a warm water fishery. Principal species are German Brown trout, carp, bullheads and suckers. In recent years white bass and Walleye have been planted in Gunnison Bend and DMAD Reservoirs.

In 1958, the Utah Division of Fish and Game published a survey of selected streams, lakes, and reservoirs as a means of identifying potential fishing resources. The results of this survey are shown on Tables 11 and 12.

Only minor parts of the streams are capable of sustaining fish populations without planting. Management of the fishery resource has been confined to a stocking and chemical treatment program along with fishing regulation. Nearly all streams and lakes suitable for planting are stocked each year. In Pine Lake, the State has purchased the water rights to establish a conservation pool.

WATERFOWL

Both migratory and resident waterfowl depend on water for a vital portion of their habitat. The Basin is within the Pacific Flyway and many ducks and geese utilize the streams, lakes, sloughs, and nearby vegetated areas for resting and feeding during their migratory flights.

Some excellent waterfowl habitat has developed as a result of the old meanders of the San Pitch and Sevier Rivers. Wetlands and marshes formed by high water tables provide some nesting areas although the current drought has reduced these areas and future changes in existing streams and water tables will affect remaining habitat. Reservoirs, because of their fluctuating water levels, do not enhance waterfowl nesting, but are beneficial as resting and hunting areas for migrating birds. Nearly all bottom land is privately owned and any waterfowl habitat provided is incidental to agricultural use.

A migratory waterfowl management area has been established by the State at Clear Lake.

TABLE 11.--Physical and biological data for selected lakes and reservoirs, Sevier River Basin, 1958

Sub-basin	Name	Elevation	Surface area	Maximum depth	Maximum fluctuation	Pollution + or -[a]	Plankton cc/10 ft. haul	Bottom fauna	Bottom composition	Temperature oxygen[b] relations	Thermocline
		Feet	Acres	Feet	Feet		cc	cc/sq. ft.			
A	Gunnison Reservoir	5,400	300	28	28	-	0	1.0	Organic muck	T-NC O-NC	No
	Palisades Lake	5,600	50	27	6	-	1.0	1.0	Organic muck	T-NC O-NC	No
	Wales Reservoir	5,500	420	10	8	-	0.9	0.5	Organic muck	T-NC O-NC	No
B	Chicken Cr. Res.	5,100	400	13	3	-	0	0	Silt	T-NC O-NC	No
	Clear Lake	4,590	1,000							T-NC O-NC	No
	DMAD Res.	4,500	700	12	12	+	0.5	.05	Silt-Clay	T-NC O-NC	No
	Fool Creek (Upper)	4,600	400	16	6	-	0.5	0.1	Sand	T-NC O-NC	No
	Fool Creek (Lower)	4,600	400	13	10	-	1.5	0.1	Organic muck Sand	T-NC O-NC	No
	Gunnison Bend. Res.	4,500	320	16	3	+		0.3	Clay	T-NC O-NC	No
C	Gates Lake	10,000	5	10	0	-			Organic muck	T-NC O-NC	No
	Nine Mile Reservoir	5,300	50	20	20	-	0.3	3.0	Organic muck	T-NC O-NC	No
	Redmond Lake	5,000	160	12	4	-	0.2	.17	Silt	T-NC O-NC	No
	Rex Reservoir	7,500	160	35	10	-	0.5	.12	Organic muck	T-NC O-NC	No
	Salina Reservoir	9,000	160	25	5	-			Organic muck	T-NC O-NC	No
	Sevier Bridge Res.	5,000	11,000	65	30	-	0.2	0	Sand-Silt	T-NC O-NC	No
	Skutumpah Res.	9,000	160	22	6	-	0.1	0.1	Organic muck	T-NC O-NC	No
	Twin Lakes	7,500	10	35	20	-	0.1	.04	Organic muck	T-NC O-NC	Yes
D	Piute Reservoir	6,000	3,000	40	30	-	1.7	0.2	Sand-Silt	T-NC O-NC	No
E	Box Cr. Res. (Upper)	8,000	50	18	18	-	0.2	0	Organic muck	T-NC O-NC	No
	Box Cr. Res. (Lower)	8,000	50	23	23	-	0.05	0	Organic muck	T-NC O-NC	No
	Koosharem Res.	7,500	500	22	22	-	0.45	0.37	Organic muck Sand	T-NC O-NC	No
	Otter Cr. Reservoir	6,400	2,000	45	45	-	0.2	0.1	Silt-Clay	T-NC O-NC	No
	Pine Lake	8,300	83	45	35	-	0.2	0.8	Marl	T-NC O-NC	No
	Tropic Reservoir	7,800	170	29	10	-	0.25	0.25	Silt	T-NC O-NC	No
F	Navajo Lake	9,200	500	28	16	-	1.5		Organic muck	T-NC O-NC	No
	Panguitch Lake	8,000	1,200	33	15	-	0.4	0.6	Organic muck	T-NC O-NC	No

[a]Pollution: "+" - limiting; "-" not limiting.

[b]Temperature-Oxygen relations: "T" - Temperature; "O" - Oxygen; "C" - critical; "NC" - not critical.

Source: "Federal Aid in Fish Restoration - Utah Division Fish and Game - An Inventory Survey of Utah's Fishing Waters" 1957-1958.

TABLE 12.--Classification of selected streams for fish habitat, Sevier River Basin, 1958

Sub-basin	Stream	Classification								Total	
		A[a]		B[b]		C[c]		D[d]			
		Miles	Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles	Acres
	Sevier					49.00	243.1	230.00	1141.0	279.00	1384.1
A	Cottonwood Creek			10.00	9.7					10.00	9.7
	Ephraim Creek							11.00	20.00	11.00	20.0
	San Pitch River			10.00	14.5	10.00	14.5	50.00	133.1	70.00	162.1
	Spring Creek	1.00	1.2							1.00	1.2
B	Ivie Creek							17.50	20.6	17.50	20.6
	Maple Grove Creek	5.00	4.8							5.00	4.8
	Molton Spring			0.62	0.7					0.62	0.7
	Willow Creek							5.00	3.0	5.00	3.0
C	Gates Creek			4.75	3.4					4.75	3.4
	Gooseberry Creek			7.00	4.2					7.00	4.2
	Lost Creek			10.00	14.5			2.50	4.5	12.50	19.0
	Big Lost Creek			10.00	12.1					10.00	12.1
	Little Lost Creek			7.00	3.4					7.00	3.4
	Nine Mile Creek							12.50	6.0	12.50	6.0
	Salina Creek			20.00	29.0			4.00	6.3	24.00	35.3
	Six Mile Creek					7.00	8.5			7.00	8.5
	North Fork Six Mile Creek					6.00	8.7			6.00	8.7
	South Fork Six Mile Creek							4.00	1.9	4.00	1.9
	Soldier Creek							12.50	7.6	12.50	7.6
	Twelve Mile Creek			8.00	16.4			12.00	24.7	20.00	41.1
	North Fork Twelve Mile Creek					12.00	21.8			12.00	21.8
	South Fork Twelve Mile Creek			6.00	10.9					6.00	10.9
	Willow Creek					10.00	4.8	9.00	4.3	19.00	9.1
D	Beaver Creek			10.00	13.3					10.00	13.3
	Bullion Creek			7.75	8.4					7.75	8.4
	City Creek			7.00	4.2					7.00	4.2
	Cottonwood Creek							4.00	4.8	4.00	4.8
	Clear Creek			14.00	23.7					14.00	23.7
	Deer Creek			7.50	3.6					7.50	3.6
	Doxford Creek					3.00	1.4			3.00	1.4
	Fish Creek			10.00	8.5					10.00	8.5
	Mill Creek			6.00	2.2					6.00	2.2
	Monroe Creek			6.50	5.5			4.00	2.9	10.50	8.4

TABLE 12 continued

Sub-basin	Stream	Classification								Total	
		A[a]		B[b]		C[c]		D[d]			
		Miles	Acres	Miles	Acres	Miles	Acres	Miles	Acres	Miles	Acres
D	Shingle Creek			8.50	5.1					8.50	5.1
	Skunk Creek							4.00	1.4	4.00	1.4
	Three Creek							7.50	2.7	7.50	2.7
E	Antimony Creek			13.00	18.9					13.00	18.9
	East Fork Sevier River			19.25	23.3			57.00	137.9	76.25	161.2
	Kanab Creek			2.00	1.4					2.00	1.4
	Mitchell Creek			3.00	2.5					3.00	2.5
	Otter Creek			32.50	70.8					32.50	70.8
F	Asay Creek			28.00	84.7					28.00	84.7
	Birch Creek							7.50	2.7	7.50	2.7
	Blue Springs Creek			4.00	8.7					4.00	8.7
	Bunker Creek			2.75	1.4					3.75	1.4
	Duck Creek	3.50	5.1			1.50	2.2			5.00	7.3
	Ipson Creek							5.00	2.4	5.00	2.4
	Mammoth Creek			24.00	40.6					24.00	40.6
Total		9.50	11.1	300.12	445.6	98.50	305.0	459.00	1527.8	867.12	2289.5
Percent		1.1	.5	34.6	19.5	11.4	13.3	52.9	66.7		

[a]Class "A" Streams: Meadow type streams, slow moving with rooted aquatic vegetation, containing a large volume of nonburrowing type aquatic insects and large populations of cold water fish. Will produce creel sized fish through natural reproduction under moderate to heavy fishing pressure.

[b]Class "B" Streams: Characterized by a permanency of acceptable trout habitat, require stocking of catchable size trout to produce or maintain fishing with existing fishing pressure.

[c]Class "C" Streams: Permanent trout habitat, includes intermittent streams below reservoirs, near population centers, and other streams that are stocked regularly because of local fishing pressures.

[d]Class "D" Streams: Not suitable for cold water fish.

Source: Utah Division of Fish and Game "Federal Aid in Fish Restoration - An Inventory Survey of Utah's Fishing Waters" 1957-1958.

UPLAND GAME BIRDS

Pheasants, sage grouse, forest grouse, mourning doves, and chukar partridges are among the upland game bird residents. Development of water in some arid areas has improved habitat for mourning doves and chukars. Upland game birds provide sport for thousands of hunters annually.

R E C R E A T I O N

Hiking, fishing, hunting, sightseeing, and boating are the major outdoor recreation activities within the Sevier River Basin. Recreation sites include campground, picnic areas, summer homes, boat ramps, lodges, and resorts. Most recreation areas are near streams, lakes, or reservoirs and owe much of their attractiveness to the aesthetic benefits of water.

Most of the Basin is located within the "Golden Circle" which encompasses the four-corners of Utah, Colorado, New Mexico, and Arizona. State parks have been established at Palisades Reservoir, Yuba Dam, Piute Reservoir, and Otter Creek Reservoir. Boating and other facilities have been established at these parks.

A substantial portion of recreation time hunting for waterfowl and upland game birds is spent on private lands. Many summer homes are located on private lands within forested areas. There are also several youth camps now established where young people can enjoy lasting rural experiences. And, for the nonhunter, there are archaeological sites in Salina Canyon and many other locations with Moquis (ancient cliff dwellings), petroglyphs, and other examples of the ethnic heritage of the Piute and Navajo Indians.

Recreation areas on National Forests, which have a capacity of 5,000 people, are located as follows:

(1) Sub-basin A - 4 campgrounds, 1 summer home area;
(2) Sub-basin B - 5 campgrounds, 3 picnic areas;
(3) Sub-basin C - 3 campgrounds, 1 picnic area, 1 youth camp;
(4) Sub-basin D - 2 campgrounds, 1 picnic area;
(5) Sub-basin E - 4 campgrounds;
(6) Sub-basin F - 2 resorts, 1 lodge, 4 boating sites, 10 campgrounds, 1 summer home area, 1 scenic overlook, 1 Boy Scout camp.

Recreation visits on National Forest lands are summarized on Table 13.

TABLE 13.--Recreation visits on National Forest lands, Sevier River Basin, 1960 and 1965

Sub-basin	Visits		Increase from 1960-1965
	1960	1965	
	Number	Number	Percent
A	20,370	33,402	64
B	28,688	43,835	53
C	35,280	51,695	47
D	12,892	17,368	35
E	116,940	329,850	182
F	132,422	275,382	108
Total	346,592	751,532	117

Source: U. S. F. S., "Recreation visits - annual statistical report."

Bryce Canyon National Park and Cedar Breaks National Monument are both located on the spectacular erosional escarpment which circles the southern portion of the Basin. Visitor days at these locations number in the hundreds of thousands each year.

The National Park Service reported 271,066 recreation visits to Bryce Canyon National Park in 1960 and 366,799 visits in 1965, an increase of 35 percent. Comparable figures for Cedar Breaks National Monument are 115,822 visits in 1960 and 213,970 in 1965, an increase of 85 percent.

The Bureau of Land Management estimates 31,300 people visited public domain lands in 1960 for recreation purposes and 72,600 in 1965, an increase of 132 percent.

CHAPTER IV

ECONOMIC DEVELOPMENT

In this section, the economic development of the Sevier River Basin, including recent growth, current conditions, and projections of future development, is analyzed. Specifically discussed are the Basin's historical development; its general description, including population figures and characteristics, economic types, employment, markets, and transportation facilities; its agricultural industry, including trends, farm survey findings, incomes, and on-farm improvement practice impacts; and its timber industry, including harvesting, manufacturing, and marketing.

HISTORICAL DEVELOPMENT

The first white man to visit the Sevier River Basin was the Spanish traveler-explorer-cleric, Father Escalante. On his journeys in 1776, Escalante passed through the area on his way from investigating stories of the existence of a "great salt lake."

In 1849, Brigham Young sent an exploration party into the area to determine if the Sevier Basin could support groups of settlers. Following the pattern of settlement in most of Utah, groups to establish whole communities and cultivate the soil were sent from settled areas. These groups included men familiar with farming and also men acquainted with blacksmithing, lumbering, and other necessary trades.

The first community settled was Manti in the fall of 1849. Sanpete County was settled quickly and by 1850, the U. S. Census reported 365 persons in the county. Fillmore and Nephi were settled in 1851 and have been continuously occupied since that time. In 1864, Richfield and Panguitch were settled. Both of these towns had to be abandoned in 1867, Richfield because of frequent Indian raids and Panguitch because of severe winters. Both towns were successfully resettled in the early 1870's.

Crop failures were commonplace throughout the entire Basin in the early years. This problem was overcome and some permanence was reached in the new settlements when livestock was introduced. In later years, alfalfa and sugar beets became important crops.

Irrigation was as important then as it is today. In 1864, the same year as settlement, the Smithfield Canal was constructed in Garfield County. The following year, 1865, water was diverted from the Sevier River to irrigate small areas near Richfield. Efforts to store water were accomplished on a small scale in the early years and in 1886, Gunnison Bend Reservoir with a storage capacity of 4,550 acre-feet was put into operation. Settlement of areas such as Delta depended on water. Once irrigation water became available, prosperous farms developed.

Some areas experienced an extreme lack of moisture, while others required drainage to make them suitable for crop production. By 1918, there were 3 drainage districts serving 70,000 acres of land in Delta. In Sevier County, 7 drainage districts were draining 37,500 acres of land by 1921.

GENERAL DESCRIPTION

POPULATION AND POPULATION CHARACTERISTICS

According to the U. S. Census of Population, 15 of the 29 counties in Utah reached their peak population in census year 1960, while 14 remaining counties reached their population peaks prior to this date. Counties which depend primarily on agriculture have experienced a gradual decline in population. This is accounted for largely by low monetary returns to farming and by increased mechanization which has reduced the need for agricultural laborers.

Counties encompassing the Sevier River Basin each have experienced decreases in population since 1920 when the population was at an all-time high (Table 14). In 1920, the population was 42,043 while in 1960 it was only 31,085. Largest decreases have occurred since 1950. The population decreased 3 percent from 1920 to 1940; 9 percent from 1940 to 1950; and 17 percent from 1950 to 1960.

From 1920 to 1940, employment in the basic industries in Utah--agriculture, mining, and manufacturing--remained about the same while population increased. Prior to 1940, failure of industries to provide employment for the expanding population resulted in excess rural population, unemployment in cities, and many families on relief rolls. About 1940, more employment opportunities in manufacturing resulted in the migration of people from rural agricultural areas to larger cities.

Population pyramids for the Basin and the State indicate basic differences between age and sex characteristics (Figure 10). The following observations can be made: (1) Persons between the ages of 20 and 40 make up 18.14 percent of the population in the Basin; the comparable figure for the State is 25.58 percent; and (2) the percentage of people 60 years of age and above is considerably larger in the

Basin (14.74) than in the State (9.75). Examination of the population pyramid reveals that younger men and women are leaving while older people remain.

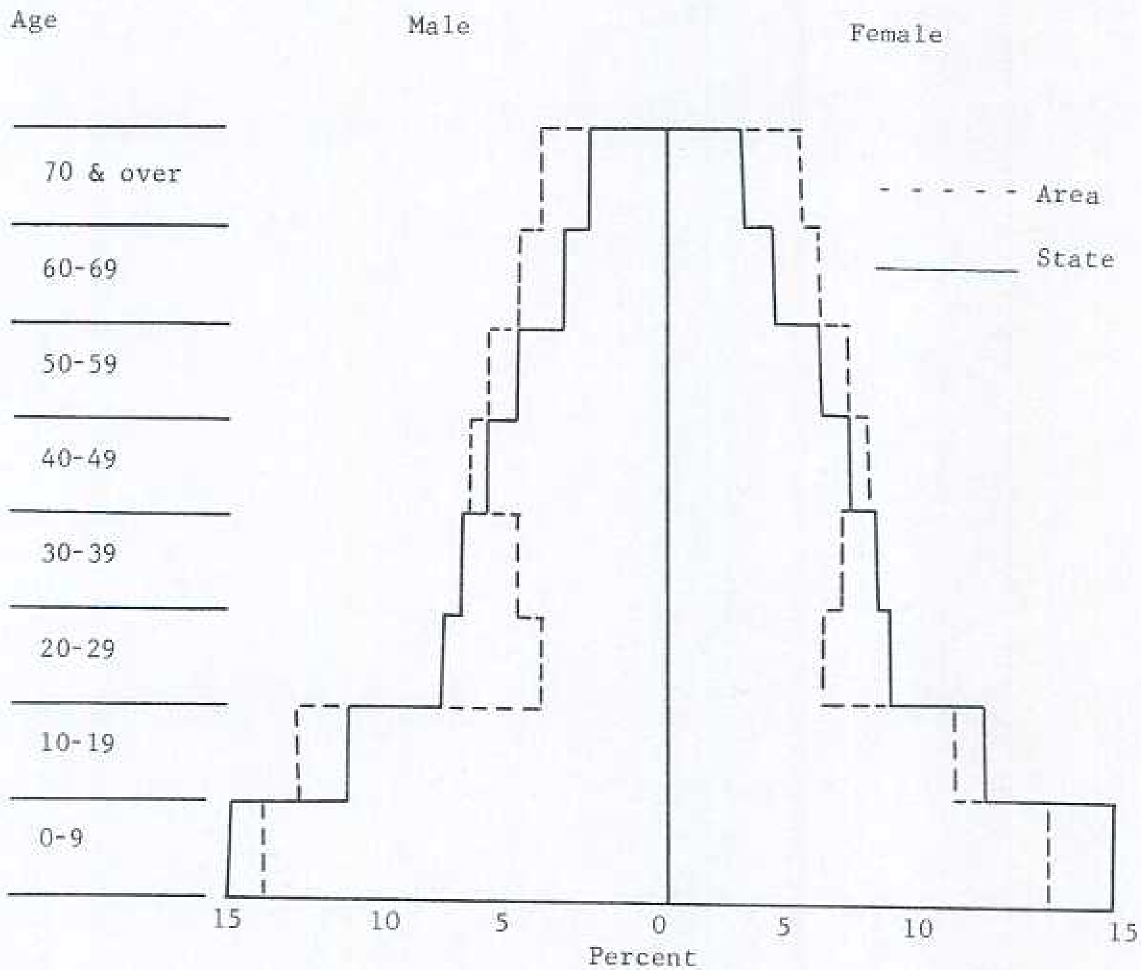
TABLE 14.--Population of the Sevier River Basin and State of Utah, 1890-1960

Census	Sevier River Basin[a]	Utah	Portion Basin was of State
	Number	Number	Percentage
1890	26,955	207,095	12.97
1900	33,636	276,749	12.15
1910	35,657	373,351	9.55
1920	42,043	449,396	9.36
1930	39,667	507,847	7.81
1940	40,909	550,310	7.43
1950	37,426	558,862	5.43
1960	31,085	890,627	3.49

[a]County population data adjusted to reflect Sevier River Basin boundaries.

Source: U. S. Census of Population.

Figure 10.-- Population distribution by sex and age, six-county area and State of Utah, 1960



Source: U. S. Census of Population

Other population characteristics are shown in Table 15. Some significant traits are: (1) The percentage of the total population engaged in agriculture is 5 times greater than for the State in 1960; (2) median family income is considerably below the State level; (3) median education level was approximately the same as the State level.

TABLE 15.--Selected attributes of the population, Sevier River Basin and State of Utah, 1960

Item	Unit	Basin[a]	State
Employment	Number	12,553	302,147
Farm employment	Number	3,571	17,455
Portion engaged in farming	Percent	28.44	5.77
Median family income	Dollars	4,088	5,899
Median education levels of:			
Adult males	Years	11.9	12.2
Adult females	Years	12.0	12.2
Dependency ratio[b]	Number	1.13	0.98

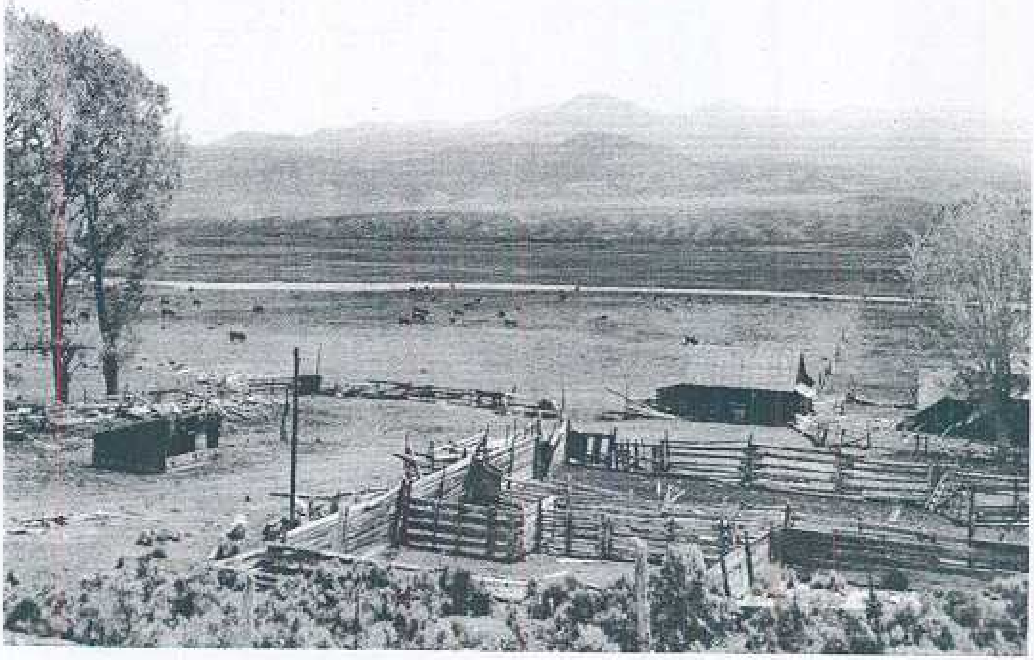
[a]County data adjusted to reflect Sevier River Basin boundaries.

[b]A dependency ratio of 1:1 means that there is one independent (18-64 years) for each dependent (persons below 18 or above 64).

Source: U. S. Census of Population.

PROJECTED POPULATION

It is expected that the population of the Sevier River Basin will continue to be influenced by the dominance of agriculture and related industries. Nevertheless, the number of people directly engaged in agriculture will continue to decline. Past trends within agriculture toward larger and more efficient farms are expected to continue. Development in the near future will likely be limited to presently irrigated and readily accessible lands. Full development of potentially irrigable lands will require importation of irrigation water.



The Sevier River Basin's declining rural population is reflected by this abandoned farmstead. FIELD PARTY PHOTO 8-1155-6

The projected rapid increase in outdoor recreation will influence land and water use as well as population and the trade and service sectors. The majority of the projected increase in the demand for recreation will be from people outside the Basin.

It is expected that some high-labor-using nonagricultural industries will develop and absorb some excess farm labor and provide outside income for part-time farmers. Projections do not anticipate development of any large resource-based industries.

The population should stabilize during the 1965-80 period (Table 16). Declines in employment in agriculture will be offset by increases in other sectors. Projected population increases for the years 2000 and 2020 are influenced by anticipated importation of irrigation water and increased employment resulting from recreational activities and small labor-oriented industries. The past trend of declining population compared with the State population is expected to continue. The Basin will continue to export young people to other areas for better employment opportunities.

TABLE 16.--Projected population for Sevier River Basin and State of Utah, 1965-2020

Year	Sevier River Basin[a]	Utah	Portion Basin is of State
	Number	Number	Percentage
1965	29,570	1,003,000	2.95
1970	29,660	1,134,600	2.61
1975	30,320	1,277,800	2.37
1980	30,720	1,446,800	2.12
2000	33,460	2,050,000	1.63
2020	35,760	2,675,000	1.34

[a]Projected county population figures adjusted to reflect Sevier River Basin boundaries.

Source: Unpublished data provided by Bureau of Economic and Business Research, College of Business, University of Utah.

TYPES OF ECONOMIC ACTIVITY AND PERSONAL INCOME

Personal income has been increasing despite population decreases. Total personal income increased from about $38 million in 1958 to $47 million in 1962 (Table 17). Increases in income have been gradual except for 1962 when income jumped by $5½ million. In 1960, the per capita personal income was about $1,300. During 1960, 3.49 percent of the State's population resided in the Basin and their personal income was only 2.35 percent of the State total. This resulted in a per capita income deficit of $636.

The personal income pattern varies significantly from the State. Wages and salaries account for 73 percent of the personal income in the State but only 48 percent in the Basin. Proprietor's income and transfer payments are about double the percentage figures for the State.

TABLE 17.--Personal income by source of income, Sevier River Basin, 1958-1962[a]

Item	1958	1959	1960	1961	1962
	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars	1,000 dollars
Personal income	37,919	39,469	40,447	41,540	47,023
Wages & salary disbursements	18,945	18,437	19,566	20,083	21,755
Farming	2,181	2,057	2,149	1,985	2,060
Mining	659	590	723	543	564
Contract construction	761	737	689	840	1,299
Manufacturing	3,241	3,399	3,404	3,538	3,839
Wholesale & retail trade	3,249	3,355	3,527	3,704	3,534
Finance, insurance & real estate	417	446	466	475	460
Transportation	866	669	683	726	774
Communication & public utilities	689	741	803	736	688
Services	904	993	1,295	1,280	1,351
Government	5,944	5,419	5,781	6,227	7,154
Other industries	34	31	46	29	32
Other labor income	572	580	691	719	776
Proprietors' income	8,861	9,814	8,747	7,941	10,856
Farm	4,707	5,317	4,423	3,357	5,929
Nonfarm	4,154	4,497	4,324	4,584	4,927
Property income	5,468	6,127	6,724	7,619	8,248
Transfer payments	4,795	5,120	5,402	5,872	6,154
Less: Personal contributions for social insurance	722	609	683	694	766

[a]Individual county data adjusted to reflect Sevier River Basin boundaries.

Source: Hanks, J. Whitney, Personal Income in Utah Counties, 1958-1962, Studies in Business and Economics, Volume 24, Number 2, University of Utah, May 1964.

Wages and salaries during 1962 accounted for 48 percent of personal income in the area; proprietors' income, 23 percent; property income, 16 percent; and transfer payments, 13 percent. All categories, except proprietors' income have registered consistent increases. Farm proprietors' income has fluctuated considerably from year to year, while nonfarm proprietors' income has been relatively stable. During the 1958-62 period, farm proprietors' income varied by 75 percent. Comparable fluctuations in the State were 42 percent. These figures indicate that farm operators' income within the Basin is much less stable than for farm operators in the State. However, during this period wages and salaries paid farm help were remarkably stable amounting to about $2 million a year.

EMPLOYMENT

Employment has decreased during the 1958-65 period (Table 18). Employment reached a peak of 11,424 in 1962, and a low of 10,490 in 1965. The total work force was the largest in 1960 and the smallest in 1965.

TABLE 18.--Average annual work force, unemployment, and type of employment, Sevier River Basin, 1958-66[a]

	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Number	Number	Number	Number	Number	Number	Number	Number	Number
Work force	12,225	12,388	12,442	12,232	12,281	12,107	11,916	11,256	11,378
Unemployment	1,093	1,321	1,239	1,065	857	875	1,000	766	786
Rate (percent)	8.94	10.66	9.96	8.71	6.98	7.23	8.39	6.81	6.91
Employment	11,132	11,067	11,203	11,167	11,424	11,232	10,916	10,490	10,592
Manufacturing	1,150	1,014	1,045	1,119	1,145	1,173	1,220	1,190	1,407
Mining	148	137	171	109	120	114	127	92	80
Construction	183	173	165	177	257	220	231	237	262
Transportation	379	339	347	324	309	324	316	296	301
Trade	1,278	1,288	1,304	1,336	1,310	1,330	1,338	1,325	1,355
Finance	113	116	120	138	125	131	134	138	135
Service	565	578	613	630	645	667	670	670	679
Government	1,483	1,632	1,764	1,776	1,855	1,929	1,958	2,123	2,236
Agriculture	3,808	3,722	3,585	3,389	3,481	3,191	2,781	2,297	2,104
All other	2,025	2,068	2,089	2,169	2,177	2,153	2,141	2,122	2,033

[a]Average annual county employment data adjusted to reflect Sevier River Basin boundaries.

Source: Unpublished county employment data provided by Utah State Department of Employment Security.

The rate of unemployment has always been a problem. During the 1958-61 period, unemployment was about double the State rate. In more recent years the rate has lowered, but it is still considerably above the State averages.

Employment in the different sectors has remained relatively stable, except that the government and agriculture sectors have been increasing and decreasing, respectively. However, the increases in the government sector have not offset the decreases in the agriculture sector. Many former full-time farmers have obtained other employment and continued to farm part-time resulting in a tendency to underestimate the agricultural labor force.

MARKETS AND TRANSPORTATION FACILITIES

The geographical center of Utah is located in Sanpete County in the northern portion of the Basin. It is positioned about 100 miles south of the Salt Lake Metropolitan Area and is about midway between Denver and the Pacific Coast.

U. S. Highways 89, 91, 6, and 50 pass through the region and link it with the major markets of Salt Lake City, Denver, Los Angeles, and Phoenix. New interstate highways will replace some portions of the present highway system in the near future. A mainline of the Union Pacific Railroad and a branchline of the Denver Rio Grande Western Railroad serves the area and connects it with all market areas in the Western States. Limited air facilities are also available to all sections of the country.

The major market areas for both agricultural and manufactured products are the Pacific Coast and Intermountain Areas. A limited amount of livestock, livestock products, and manufactured products move to eastern markets.

A G R I C U L T U R E   I N D U S T R Y

TRENDS IN AGRICULTURE

Data from the U. S. Census of Agriculture were used to establish trends within agriculture over the last 40 years. Census data are only available on a county basis. Of the 8 counties partly or entirely within the study area, 6 were used to represent the Basin. All of the agricultural activities in the study area are located within the six-county area.

The acreages of cropland planted and harvested vary from year to year depending on irrigation water supplies, government programs, and market conditions. Water-supply conditions are probably the dominant factor influencing the acreages planted and harvested in any given year. For example, the lowest acreage of crops harvested was in the drought year of 1934 while the highest was in 1954 following the exceptionally good water year in 1952 (Table 19).

TABLE 19.--Cropland harvested in six-county area, 1924-1964

Census year	Cropland harvested
	1,000 acres
1924	216
1929	249
1934	210
1939	228
1944	266
1949	247
1954	291
1959	220
1964	213

Source: U. S. Census of Agriculture.

FARM SIZE

The trend has been for the average size of farms to increase (Table 20). Except for two periods (1920-34 and 1944-49), average farm size has continually increased, from 192 acres in 1924, to 376 acres in 1944, and to 743 acres in 1964.

TABLE 20.--Average size of farm in six-county area, 1924-1964

Year	Acres	Year	Acres
1924	192	1949	355
1929	224	1955	447
1934	205	1959	623
1939	369	1964	743
1944	376		

Source: U. S. Census of Agriculture

CROP PRODUCTION AND YIELDS

Total crop production over the last 20 years has been relatively stable. Generally, the acreages of major crops have decreased and the yields per acre increased with total production remaining about the same (Tables 21 and 22).

TABLE 21.--Acreages harvested of major crops in six-county area, 1944-1964

Crop	Acres harvested				
	1944	1949	1954	1959	1964
All hay	156,795	123,296	136,718	129,365	140,908
Wheat	59,737	79,729	52,196	30,270	25,702
Barley	27,962	28,506	28,103	30,609	19,316
Oats	10,931	9,931	6,840	3,522	3,515
Alfalfa seed	19,218	30,594	32,601	26,252	35,169
Corn for silage	-------	3,938	6,316	7,242	4,542
Sugar beets	5,670	6,403	7,309	4,600	2,319
Potatoes	5,036	4,199	2,536	1,709	971

Source: U. S. Census of Agriculture.

SOIL CONSERVATION SERVICE PHOTOS 8-447-6

Horse operations have nearly disappeared.

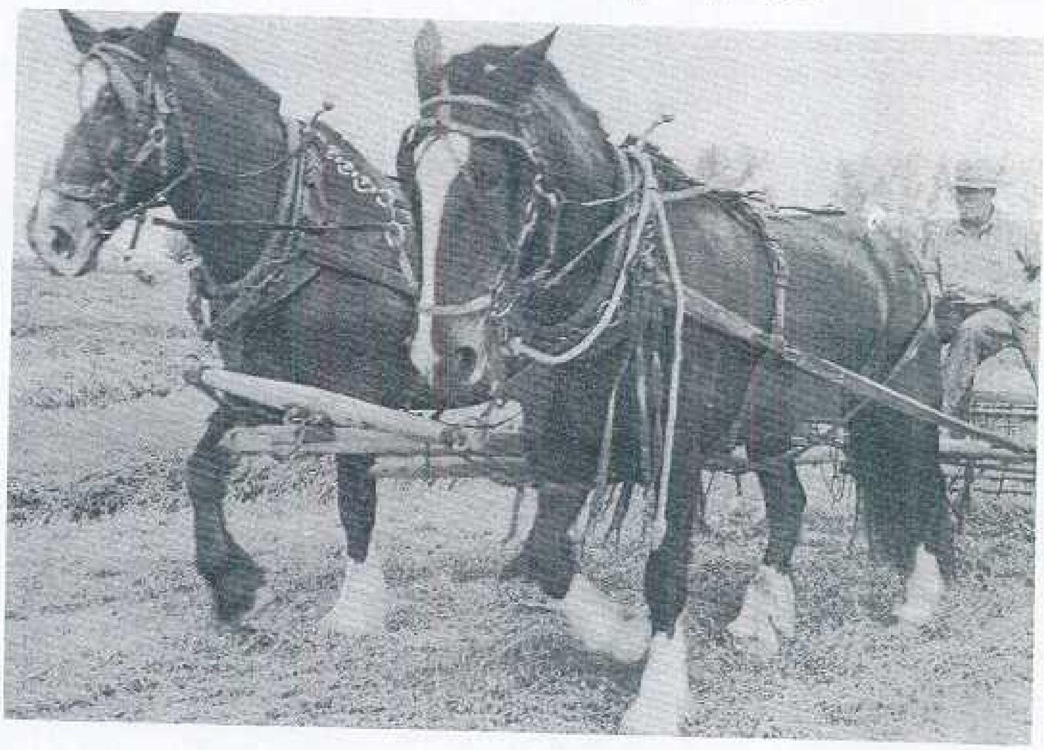


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TABLE 22.--Average yields of major crops grown in six-county area, 1944-1959

Crop	Unit	Yield per acre				
		1944	1949	1954	1959	1964
All hay	Ton	1.8	2.0	2.2	2.3	2.6
Wheat	Bushel	20.0	18.0	17.0	17.0	22.0
Barley	Bushel	58.0	62.0	66.0	65.0	56.0
Oats	Bushel	46.0	44.0	44.0	46.0	50.0
Alfalfa seed	Pound	55.0	231.0	232.0	252.0	149.0
Corn for silage	Ton	----	12.0	13.0	15.0	15.0
Sugar beets	Ton	11.3	15.8	15.2	14.0	13.9
Potatoes	Cwt.	81.0	128.0	135.0	156.0	99.0

Source: U. S. Census of Agriculture.

Hay production has been the most stable crop. Total production has varied from 251,268 tons in 1949 to 366,361 tons in 1964. Consistent increases in yield per acre have been evident. The average yield increased by 44 percent from 1944 to 1964.

Alfalfa is the most important crop grown amounting to 42 percent of the total cropland harvested in 1954 and 56 percent in 1964 (Table 23). It is also important as a cash crop to many farmers. In 1964, 22 percent or around 70,000 tons were sold off the farm.

SOIL CONSERVATION SERVICE PHOTOS 8-118-2

Conversion of salt grass pasture to more productive grasses makes more efficient use of available water.

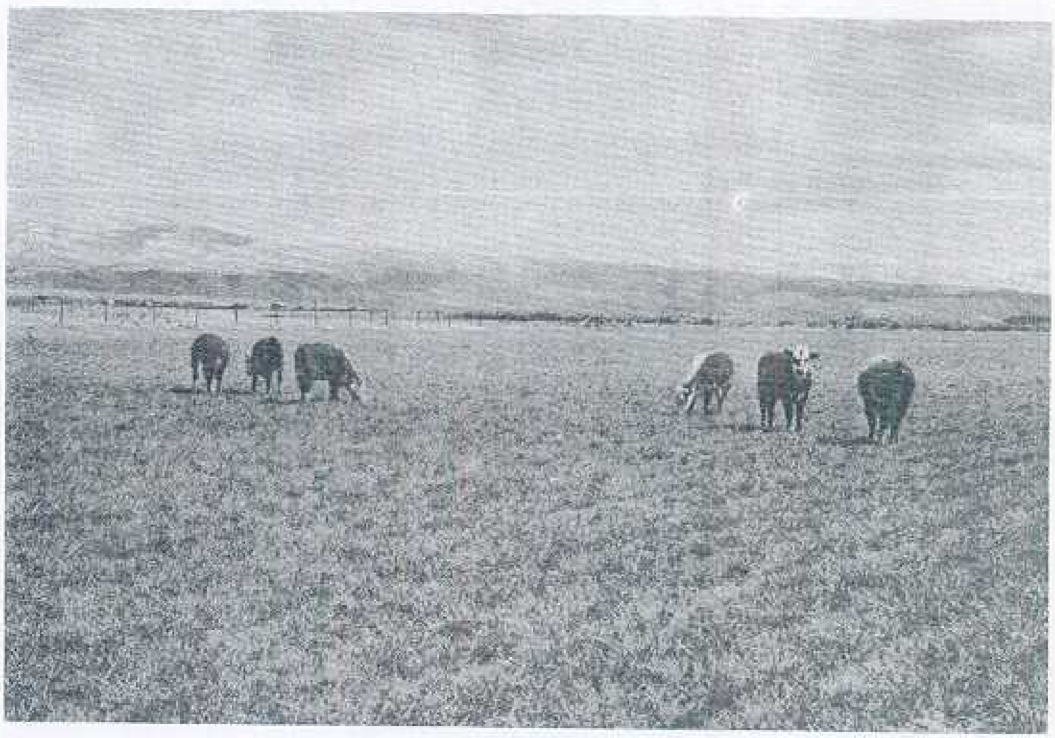

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TABLE 23.--Alfalfa acreage, production, and sales in six-county area, 1954-1964

Item	Unit	Six-county area		
		1954	1959	1964
Alfalfa acreage	Acre	112,457	109,525	119,080
Alfalfa as portion of cropland harvested	Percent	42.1	49.7	56.0
Alfalfa production	Ton	266,661	259,267	317,598
Portion of crop sold	Percent	15.3	14.8	22.1

Source: U. S. Census of Agriculture.

LIVESTOCK PRODUCTION

The six-county area produces about 25 percent of the State's production of livestock and livestock products. This relationship has remained constant for the last 20 years. Some fluctuations within livestock groups have occurred, but total livestock relationship has remained about the same. In 1959, 22.4 percent of the cattle and calves, 13.3 percent of the dairy cows, 25.2 percent of the sheep and lambs, 27.7 percent of the pigs, and 40.4 percent of the turkeys were located

TABLE 24.--Livestock on farms in the six-county area, 1944-1964

Type of livestock	Year				
	1944	1949	1954	1959	1964
	Number	Number	Number	Number	Number
Cattle & calves	132,905	126,349	173,856	160,476	171,986
Dairy cows	14,678	14,357	14,207	12,706	10,285
Sheep & lambs	458,469	237,396	371,502	324,885	304,540
Hogs	22,324	18,055	12,927	18,286	9,066
Turkeys	713,216	922,351	1,169,160	980,471	1,666,076

Source: U. S. Census of Agriculture.

The number of cattle and calves sold has consistently increased from 49,568 in 1944 to 90,327 in 1959. Butterfat sales have consistently decreased from 433,359 pounds in 1944 to 27,394 pounds in 1964. All other livestock and livestock products have not established a consistent trend over the last 20 years (Table 25).

TABLE 25.--Amount of livestock and livestock products sold from farms in six-county area, 1944-1964

Farm products	Unit	Year				
		1944	1949	1954	1959	1964
Cattle & calves sold alive	Number	49,568	62,152	75,365	90,327	90,101
Butterfat sold	Pounds	433,359	182,547	88,357	53,624	27,394
Whole milk sold	1,000 gals.	6,108	5,959	8,993	9,473	9,371
Sheep & lambs sold alive	Number	263,239	152,254	220,418	237,509	206,934
Hogs & pigs sold alive	Number	51,311	25,586	12,788	23,884	13,814
Wool shorn	1,000 lbs.	3,379	1,906	2,455	2,310	2,084

Source: U. S. Census of Agriculture.

VALUE OF FARM PRODUCTS

Total value of farm products sold from the 6 counties increased from $30.5 million in 1954 to $34.5 million in 1964, (Table 26). This increase in sales did not keep pace with increase in the value of farm product sales in the State. The 6 counties increased the value of farm product sales by 10.9 percent from 1954 to 1959, while the State's increase was 26.7 percent for the same period. In 1954, the 6 counties' production accounted for 24.1 percent of the value of the State's agricultural production and in 1959 this figure was 20.7 percent.

TABLE 26.--Value of farm products sold by source, six-county area, 1954-1964

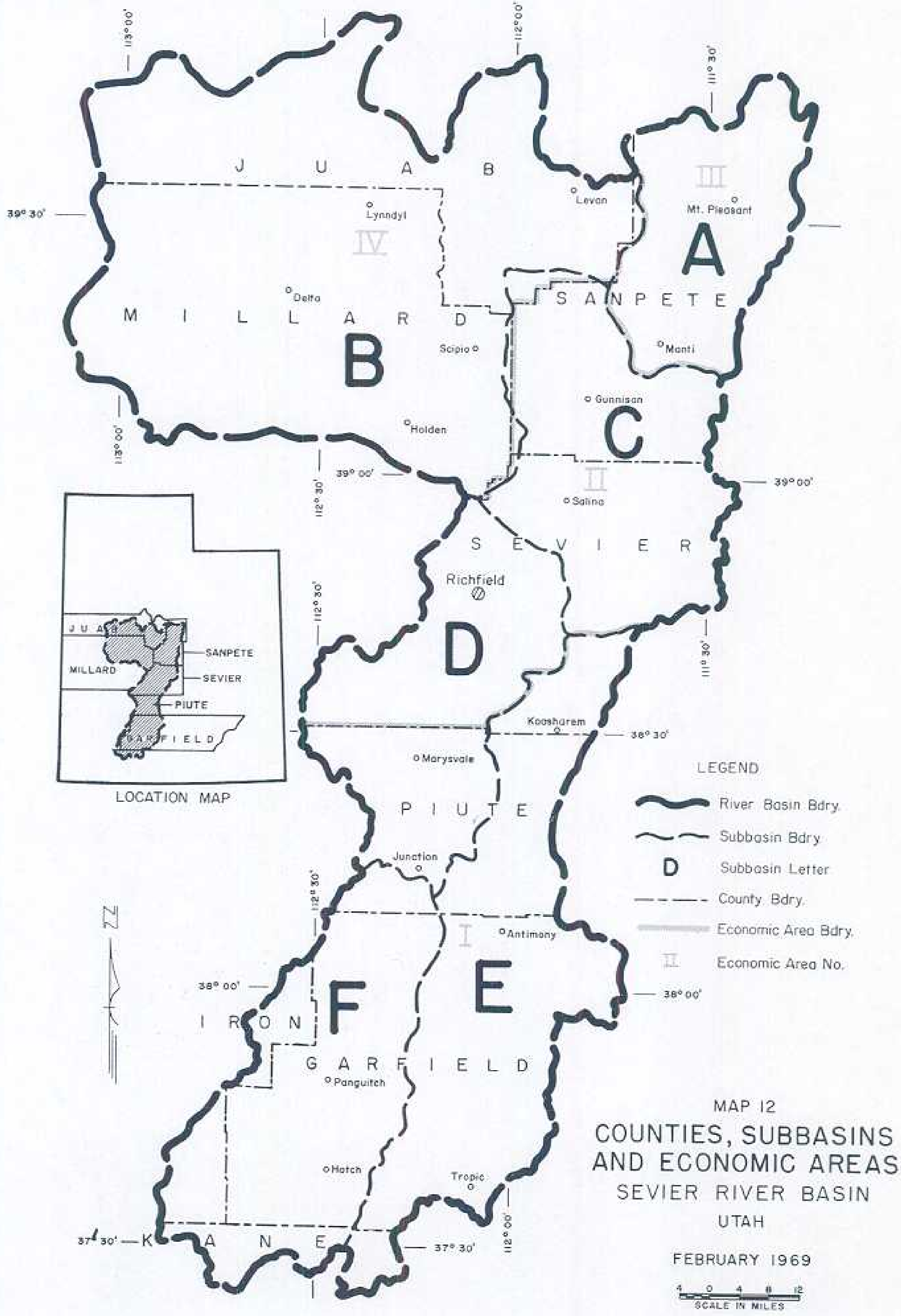
Products sold	Year		
	1954	1959	1964
	1,000 dollars	1,000 dollars	1,000 dollars
Field crops	7,508	5,159	4,776
Other crops	146	61	58
Total crops	7,654	4,220	4,834
Dairy products	2,395	2,858	3,206
Poultry and poultry products	6,026	4,794	8,834
Livestock	14,383	20,030	17,580
Total livestock and livestock products	22,804	27,682	29,622
Total value of sales	30,458	32,902	34,465

Source: U. S. Census of Agriculture.

FARM SURVEY FINDINGS

DESCRIPTION OF AREAS STUDIED

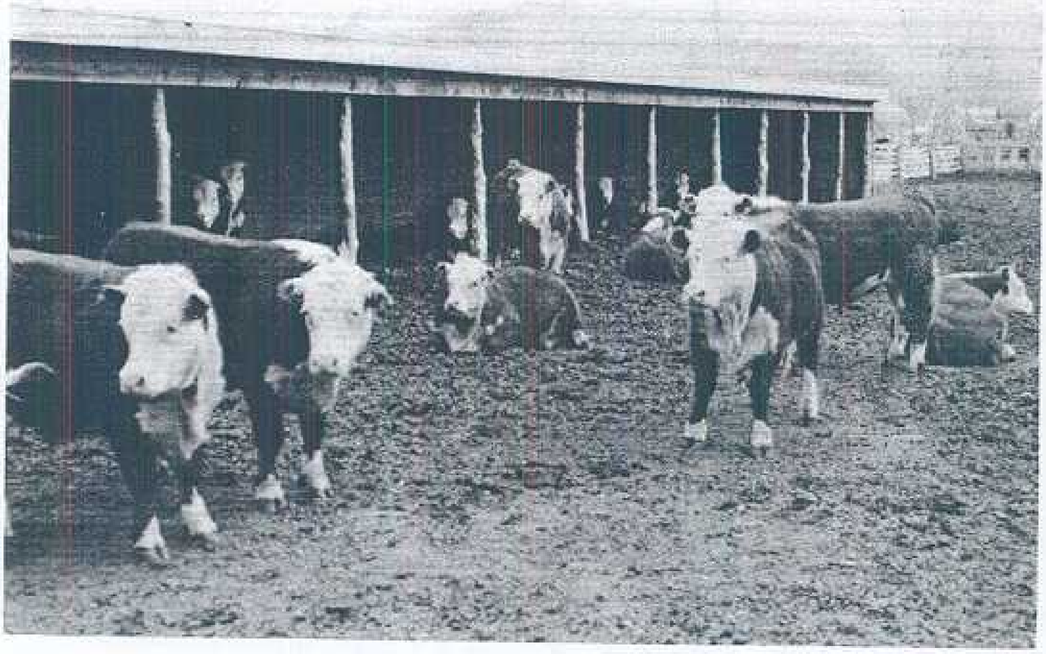
The Sevier River Basin has been divided into 4 economic areas and 6 sub-basins. The economic areas encompassed geographic areas of similar agricultural activity while the sub-basins were selected on the basis of hydrology. Map 12 shows the economic areas and their relationship to sub-basins. Economic areas are designated by Roman numerals I through IV, while the sub-basins are indicated by letters A through F.



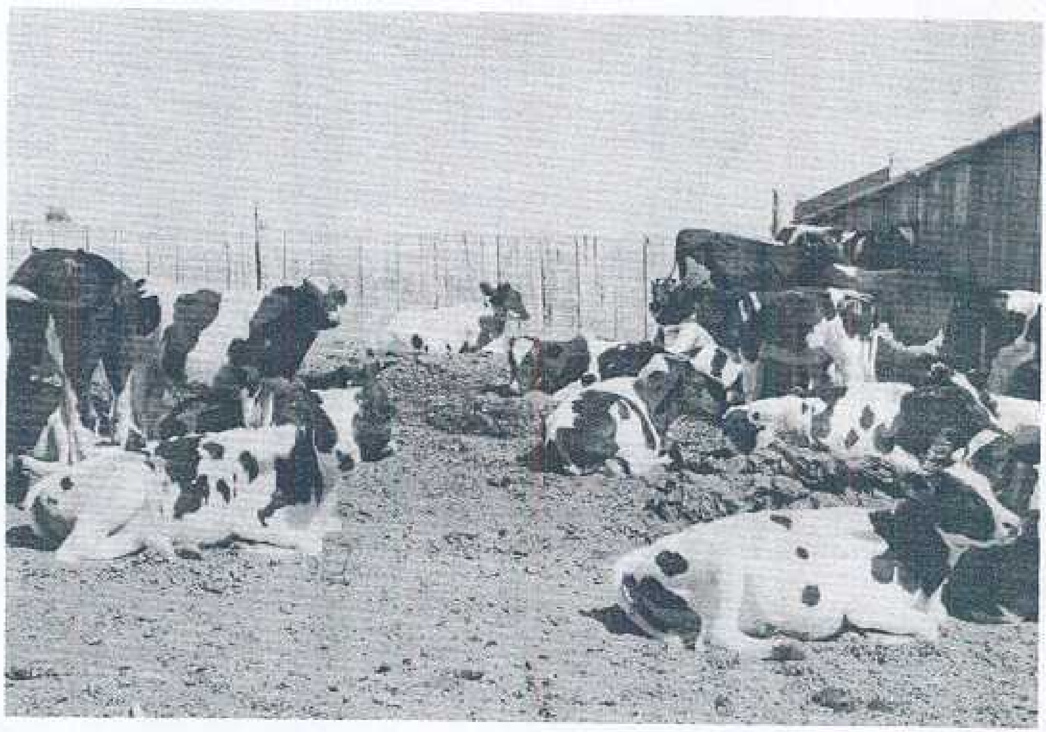
MAP 12
COUNTIES, SUBBASINS AND ECONOMIC AREAS
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SOIL CONSERVATION SERVICE PHOTOS 8-918-10



Beef and dairy herds contribute to the economy.



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Economic Area I comprises all of Sub-basins E and F plus that part of Sub-basin D which is in Piute County. Agricultural production is oriented toward forage crops and livestock production. The elevation is relatively high with valleys above 6,000 feet. The growing season is consequently short. Farmers depend primarily on direct-flow water rights to provide irrigation water supplies.

Economic Area II includes all of Sub-basin C and all of Sub-basin D that lies in Sevier County. The economy is dependent primarily on raising and feeding livestock with some cash crops. Sugar beets are the principal cash crop. Irrigation water supplies come from Sevier River, tributary streams, and reservoir storage.

Economic Area III has the same boundaries as Sub-basin A. The agricultural economy is dependent on forage crops, livestock, and turkeys. The primary source of irrigation water is from mountain streams and springs. Some water is pumped from underground supplies.

Economic Area IV is the same as Sub-basin B. The economy is oriented toward raising and feeding livestock and cash-crop farming. Farm income from these two sources is about equal. Alfalfa hay, alfalfa seed, and wheat are the main cash crops. Most of the irrigation water comes from reservoir storage with some underground supplies.

SURVEY POPULATION DEFINED

A list of all farm operators in each economic area was compiled. The following information for each farm was collected: (1) Name of operator and general location of farm; (2) total acres in farm; (3) cropland acreage; (4) major types of farm enterprises; and (5) grazing permits of public lands.

Institutional farms and farms that were in the soil bank, idle, or of an unknown status were not included in the population to be sampled. Of the 3,052 farms sampled, 231 were in this category (Table 27). Farms were classified into groups on the basis of their major type of livestock or crop enterprise except for small farms which included all farms with less than 40 acres of irrigated cropland regardless of the type or size of livesotck enterprises.

Data collected as a basis for sampling indicated there were 1,048,493 acres of land in farms (Table 28). Cropland acreage was 317,492. Land in farms by economic areas varied from 150,187 acres in Area I to 395,763 acres in Area IV. Cropland acreages included 33,073 acres in Area I, 74,823 in Area II, 68,393 in Area III, and 140,403 in Area IV. A considerable acreage of cropland in Area IV was dry cropland, while the dry cropland acreage in the other areas was relatively minor.

TABLE 27.--Classification of farms by farm type and economic area, Sevier River Basin, 1962

Farm type	Economic Area				Basin total
	I	II	III	IV	
	Number	Number	Number	Number	Number
Beef					
Range beef	85	112	23	88	308
Range beef and range sheep	4	6	2	---	12
Range beef and farm flock sheep	26	1	---	---	27
Farm beef	32	34	62	1	129
Farm beef and farm flock sheep	10	2	1	---	13
Beef total	157	155	88	89	489
Sheep					
Range sheep	5	18	72	---	90
Range sheep and farm beef	---	-----	2	1	3
Farm flock sheep	4	7	20	11	42
Sheep total	9	20	94	12	135
Dairy					
Grade A	2	36	38	1	77
Grade C	18	52	31	11	112
Dairy total	20	88	69	12	189
General					
General livestock	33	159	101	115	408
Feeder	1	42	---	21	64
Dry crop	---	3	16	16	35
Irrigated crop	20	62	56	259	397
General total	54	266	173	411	904
Small farm[a]	165	476	350	113	1,104
Other[b]					
Institutional farm	2	1	7	6	16
Soil bank	3	4	13	44	64
Idle	6	4	---	8	18
Operator unknown	4	53	35	41	133
Other total	15	62	55	99	231
Total all types	420	1,067	829	736	3,052

[a]Farms with less than 40 acres of irrigated cropland.

[b]These farms were not included in the farm survey sample.

Source: Compiled with help of office managers, Agricultural Stabilization and Conservation Service, County Agents, and other agricultural technicians familiar with farmers and their farming operations.

TABLE 28.--Total land, cropland and noncropland, in farms by economic area, Sevier River Basin, 1962

Area	Cropland	Noncropland	Total
	Acres	Acres	Acres
Economic Area I	33,873	116,314	150,187
Economic Area II	74,823	160,464	235,287
Economic Area III	68,393	198,863	267,256
Economic Area IV	140,403	225,360	395,763
Sevier River Basin	317,492	731,001	1,048,493

Source: Compiled from data provided by Agricultural Stabilization and Conservation Service.

SURVEY SAMPLE

The farm survey was designed to obtain costs and returns data relating to agricultural enterprises, resource requirements of various enterprises, and an inventory of resources available to individual farmers. Physical data relating to irrigation water application and crop production response were also collected.

The population from which a sample was surveyed included 2,821 of the 3,052 farmers. Farm schedules were obtained from 55 farmers in Area I, 103 in Area II, 92 in Area III, and 67 in Area IV, for a Basin total of 317. The farm survey included 10.4 percent of the farmers, 16.6 percent of the land in farms, and 13.9 percent of the cropland. The percentage of land in farms in the survey was 30.4 percent in Area I, 10.8 percent in Area II, 21.4 percent in Area III, and 11.7 percent in Area IV.

CHARACTERISTIC OF FARM OPERATORS

Selected general information about farm operators and their families is shown in Table 29. Farmers averaged 52 years of age, and in addition to working 2,601 hours per year on their farms, they also worked 90 days a year off the farm. The average farmer had a nonfarm income of $2,173 per year.

TABLE 29.--General information about farmers and farm families by economic area, Sevier River Basin, 1962

Item	Unit	Economic Area				Basin
		I	II	III	IV	
Operators interviewed	Number	55	103	92	67	317
Age of operators	Year	53.3	51.9	53.6	52.4	52.7
Nonfarm income	Dollar	2,405	2,204	2,302	1,757	2,173
Worked off-farm	Day	103	84	88	91	90
Sons over 10 years of age	Number	1.78	1.88	1.38	1.67	1.67
Daughters over 10 years of age	Number	1.32	1.40	1.43	1.45	1.41
Available operator time	Man-hour	2,463	2,645	2,651	2,578	2,601
Family labor per farm	Man-hour	1,867	1,515	1,539	1,859	1,656

Family labor was an important part of the total farm labor supply. Family labor provided an average of 1,656 man-hour equivalents or about 39 percent of the unhired farm labor. In most cases, the majority of the family labor was provided by the farmers' sons, but in some cases wives and daughters also helped on the farm.

LAND USE AND FARM SIZE

The farm survey included 174,204 acres of land in the Sevier River Basin (Table 30). Land-use distribution included 17.1 percent irrigated cropland, 4.7 percent dry cropland, 2.3 percent native meadow, 9.6 percent permanent pasture, 64.8 percent range, and 1.5 percent other uses. Farmers owned 71.8 percent of the land they operated and rented the remaining 28.2 percent. Crops and forage were harvested from 90.1 percent of the area within farms. Idle cropland and crop failures included 15 percent of the irrigated cropland and 75.5 percent of the dry cropland. The average farm included 549.5 acres of land from which crops or forage were harvested on 495.2 acres. About 24 percent of the land in farms was irrigated.

TABLE 30.--Agricultural land use on study farms, Sevier River Basin, 1962

Land use	Sevier River Basin	Per farm		
		Harvested	Idle or not harvested	Total
	Acres	Acres	Acres	Acres
Cropland	37,879	86.0	33.5	119.5
Irrigated	29,745	79.7	14.1	93.8
Nonirrigated	8,134	6.3	19.4	25.7
Native meadow	4,045	12.6	.2	12.8
Permanent pasture	16,836	50.7	2.4	53.1
Irrigated	7,942	25.1	----	25.1
Nonirrigated	8,894	25.6	2.4	28.0
Range	112,842	345.9	10.0	355.9
Other	2,602	-----	8.2	8.2
Irrigated	105	-----	.3	.3
Dryland	2,497	-----	7.9	7.9
Total	174,204	495.2	54.3	649.5

Economic Area I

The farm survey in Area I included 45,621 acres of land (Table 31). Land-use distribution included 7.9 percent irrigated cropland, 0.8 percent dry cropland, 2.4 percent native meadow, 7.8 percent permanent pasture, 80 percent range, and 1.1 percent other uses. Farmers owned 55.4 percent of the land they operated and rented the remaining 44.6 percent. The rental percentage was highest for rangeland. Crops and forage were harvested from 96.7 percent of the area within farms. Idle cropland and crop failures included 14 percent of the irrigated cropland. The average farm included 829.5 acres of land from which crops and forage were harvested on 802.3 acres. About 14 percent of the land in farms was irrigated.

TABLE 31.--Agricultural land use on study farms, Economic Area I, 1962

Land use	Area I	Per farm		
		Harvested	Idle or not harvested	Total
	Acres	Acres	Acres	Acres
Cropland	3,958	56.8	15.2	72.0
Irrigated	3,613	56.5	9.2	65.7
Nonirrigated	345	.3	6.0	6.3
Native meadow	1,104	19.0	1.1	20.1
Permanent pasture	3,542	64.4	----	64.4
Irrigated	1,601	29.1	----	29.1
Nonirrigated	1,941	35.3	----	35.3
Range	36,517	662.1	1.8	663.9
Other	500	-----	9.1	9.1
Irrigated	19	-----	.3	.3
Dryland	481	-----	8.8	8.8
Total	45,621	802.3	27.2	829.5

Economic Area II

The farm survey in Area II included 25,309 acres of land (Table 32). Land-use distribution included 39.5 percent irrigated cropland, 0.9 percent dry cropland, 1.3 percent native meadow, 20.2 percent permanent pasture, 34.2 percent range, and 3.9 percent other uses. Farmers owned 61.7 percent of the land they operated and rented the remaining 38.3 percent. Crops and forage were harvested from 88 percent of the area within farms. Idle cropland and crop failures include 13.4 percent of the irrigated cropland. The average farm included 245.7 acres of land from which crops or forage were harvested on 216.1 acres. About 43 percent of the land in farms was irrigated.

TABLE 32.--Agricultural land use on study farms, Economic Area II, 1962

Land use	Area II	Per farm		
		Harvested	Idle or not harvested	Total
	Acres	Acres	Acres	Acres
Cropland	10,231	84.1	15.2	99.3
Irrigated	9,996	84.0	13.0	97.0
Nonirrigated	235	.1	2.2	2.3
Native meadow	326	3.2	----	3.2
Permanent pasture	5,119	49.4	.3	49.7
Irrigated	1,818	17.7	----	17.7
Nonirrigated	3,301	31.7	.3	32.0
Range	8,658	79.4	4.7	84.1
Other	975	-----	9.4	9.4
Irrigated	------	-----	----	-----
Dryland	975	-----	9.4	9.4
Total	25,309	216.1	29.6	245.7

Economic Area III

The farm survey in Area III included 57,103 acres of land (Table 33). Land-use distribution within the area included 11.8 percent irrigated cropland, 1.9 percent dry cropland, 4.6 percent native meadow, 6.2 percent permanent pasture, 75.2 percent range, and 0.3 percent other uses. Farmers owned 74.4 percent of the land they operated and rented the remaining 25.6 percent. Crops and forage were harvested from 95.5 percent of the area within farms. Idle cropland and crop failures included 9.3 percent of the irrigated cropland. The average farm included 620.7 acres of land from which crops and forage were harvested on 593 acres. About 21 percent of the land in farms was irrigated.

TABLE 33.--Agricultural land use on study farms, Economic Area III, 1962

Land use	Area III	Per farm		
		Harvested	Idle or not harvested	Total
	Acres	Acres	Acres	Acres
Cropland	7,812	68.7	16.2	84.9
Irrigated	6,733	66.4	6.8	73.2
Nonirrigated	1,079	2.3	9.4	11.7
Native meadow	2,615	28.4	----	28.4
Permanent pasture	3,537	38.1	.3	38.4
Irrigated	2,490	27.0	----	27.0
Nonirrigated	1,047	11.1	.3	11.4
Range	42,971	457.8	9.3	467.1
Other	168	-----	1.9	1.9
Irrigated	86	-----	1.0	1.0
Dryland	82	-----	.9	.9
Total	57,103	593.0	27.7	620.7

Economic Area IV

The farm survey in Area IV included 46,171 acres of land (Table 34). Land-use distribution included 20.4 percent irrigated cropland, 14 percent dry cropland, 10 percent permanent pasture, 53.3 percent range, and 2.1 percent other uses. Farmers owned 90.6 percent of the land they operated and rented the remaining 9.4 percent. Crops and forage were harvested from 78 percent of the area within farms. Idle cropland and crop failures included 21.3 percent of the irrigated cropland and 72.9 percent of the dry cropland. The average farm included 689.1 acres of land from which crops and forage were harvested on 537.8 acres. About 25 percent of the land in farms was irrigated.

TABLE 34.--Agricultural land use on study farms, Economic Area IV, 1962

Land use	Area IV	Per farm		
		Harvested	Idle or not harvested	Total
	Acres	Acres	Acres	Acres
Cropland	15,878	136.5	100.4	237.0
Irrigated	9,403	110.4	29.9	140.3
Nonirrigated	6,475	26.2	70.5	96.7
Native meadow	------	-----	-----	-----
Permanent pasture	4,638	58.8	10.4	69.2
Irrigated	2,033	30.3	-----	30.3
Nonirrigated	2,605	28.5	10.4	38.9
Range	24,696	342.4	26.1	368.5
Other	959	-----	14.4	14.4
Irrigated	------	-----	-----	-----
Dryland	959	-----	14.4	14.1
Total	46,171	537.8	151.3	689.1

CROPPING PATTERN

The percentage distribution of different crops by economic area and the Basin is shown in Table 35. Alfalfa was the leading crop grown and occupies 51 percent of the crop area. Permanent pasture and barley were next in order covering 25 percent and 13 percent of the crop area, respectively. Meadow hay covered 5 percent of the area.

TABLE 35.--Distribution of crops by economic areas, Sevier River Basin, 1962

Crop	Economic Area				Basin
	I	II	III	IV	
	Percent	Percent	Percent	Percent	Percent
Alfalfa	44.5	53.0	39.6	57.6	51.0
Permanent pasture	34.0	18.7	36.9	12.4	25.2
Meadow hay	12.6	1.2	9.6	----	5.3
Barley	8.0	17.1	10.2	12.3	12.5
Corn silage	.5	5.0	.9	2.2	2.3
Rotation pasture	.4	1.0	.8	1.2	.9
Wheat	----	1.1	2.0	4.3	2.0
Sugar beets	----	2.9	----	----	.8
Total	100.0	100.0	100.0	100.0	100.0

CROP YIELDS

Both the 1962 yield and the last 5-year average yield (1958-62) are given for each crop (Table 36). The survey year of 1962 was about a normal year, except for alfalfa seed and corn silage production. An early frost reduced yields on these crops. Survey data indicates that yields were above average for meadow hay, barley, and sugar beets. Yields were

TABLE 36.--Crop yields per harvested acre on study farms by economic area, Sevier River Basin, 1962

Area	Crop	Unit	Yield	
			1962	Average last 5 years
I	Alfalfa	Ton	2.7	3.1
I	Permanent pasture	AUM	3.4	3.8
I	Meadow hay	Ton	1.9	1.6
I	Barley	Bushel	47.0	51.0
I	Corn silage	Ton	10.0	15.3
II	Alfalfa	Ton	4.2	4.2
II	Permanent pasture	AUM	3.3	3.9
II	Meadow hay	Ton	1.8	1.9
II	Barley	Bushel	74.0	68.0
II	Corn silage	Ton	15.7	17.3
II	Rotation pasture	AUM	5.5	5.0
II	Wheat	Bushel	63.6	60.1
II	Sugar beets	Ton	17.5	15.8
III	Alfalfa	Ton	3.0	2.9
III	Permanent pasture	AUM	3.3	3.3
III	Meadow hay	Ton	1.5	1.4
III	Barley	Bushel	55.0	56.0
III	Corn silage	Ton	13.0	14.9
III	Rotation pasture	AUM	5.4	5.4
III	Wheat	Bushel	36.9	34.8
IV	Alfalfa (2 or more cuttings)	Ton	3.9	4.2
IV	Alfalfa (1 cutting + seed)	Ton	1.2	1.2
IV	Alfalfa seed (2nd crop seed)	Pound	196.5	273.0
IV	Alfalfa seed only	Pound	243.9	404.7
IV	Permanent pasture	AUM	7.0	4.1
IV	Barley	Bushel	62.0	62.0
IV	Corn silage	Ton	16.7	20.8
IV	Rotation pasture	AUM	2.6	-----
IV	Wheat	Bushel	45.7	54.8
Basin	Alfalfa	Ton	3.5	3.6
Basin	Alfalfa seed	Pound	159.0	304.0
Basin	Permanent pasture	AUM	3.4	3.5
Basin	Meadow hay	Ton	1.7	1.5
Basin	Barley	Bushel	65.0	62.0
Basin	Corn silage	Ton	15.6	17.7
Basin	Rotation pasture	AUM	3.9	5.2
Basin	Wheat	Bushel	45.6	47.7
Basin	Sugar beets	Ton	17.5	15.8

below average for alfalfa hay, alfalfa seed, pasture, corn silage, and wheat. Although variations from the above observations occurred within economic areas, the 1962 crop yields in general were near normal, except in Economic Area IV which was slightly below normal.

Average value per harvested acre of crops produced was $56.71 in 1962. Comparable figures by economic areas were Area I, $39.34; Area II, $73.18; Area III, $40.78; and Area IV, $72.31.

LAND VALUES AND RENTAL ARRANGEMENTS

Irrigated cropland value and cash rental rate are considerably higher in Economic Area II than in other areas (Table 37). The estimated average value of irrigated cropland is $278 per acre. Irrigated permanent pasture and rangeland values are the highest in Economic Area I. The average for irrigated permanent pasture is $239 per acre and $16 per acre on rangeland. It is a general practice in all areas for the landlord and farmer to share revenue equally on all crops, except sugar beets.

GRAZING ENTERPRISES

Private and Federal grazing lands provide low-cost forage to be used in combination with hay and grain grown on irrigated lands. These feed sources have provided ranchers with the resources necessary for successful range livestock operations since early settlement.

Public lands administered by the Bureau of Land Management in Grazing Districts 3, 5, and 10 and Uinta, Fishlake, Manti-LaSal, and Dixie National Forests, provide grazing. Livestock using BLM lands obtain about 40 percent of their annual feed requirement from these lands. Those grazing on National Forest lands obtain approximately 30 percent of their total annual forage requirements from this source.

Overstocked rangelands and deteriorating forage conditions caused significant reductions in livestock during the 1945-60 period. Both sheep and cattle using BLM lands have decreased; sheep by 29 percent and cattle by 7 percent. On National Forest lands, cattle were reduced by 7 percent and sheep by 22 percent.

In 1962, there were 492 operations with base property in the Basin that grazed cattle and 103 operations that grazed sheep on National Forest lands utilizing 127,057 animal unit months of grazing (Table 38). Comparable figures for BLM lands were 313 cattle permits and 139 sheep permits with 347,825 animal unit months of grazing.

Livestock grazing on BLM lands in 1962 numbered 24,815 cattle and 167,733 sheep; the same year, 21,411 cattle and 58,819 sheep utilized

TABLE 37.--Estimated market value per acre of land and water without buildings, and rental arrangements, economic areas, Sevier River Basin, 1962

Type of land or crop	Unit	Economic Area I	II	III	IV	Sevier River Basin
Value per acre:						
Irrigated cropland	Dollar	258	349	222	260	278
Irrigated permanent pasture	Dollar	264	255	215	229	239
Dry cropland	Dollar	30	68	39	45	43
Dry pasture	Dollar	28	55	33	18	33
Rangeland	Dollar	21	9	17	14	16
Rental arrangements:						
Landlord crop share:						
Small grain	Percent	50	49	50	50	
Beets	Percent	---	25	---	---	---
Alfalfa	Percent	50	49	50	50	---
Cash rental:						
Cropland	Dollar	15.50	21.70	9.00[a]	4.70	---
Dryland (range)	Dollar	-----	.03	.05	.04	
Estimate of most efficient size of irrigated farm	Acre	200	150	150	300	---

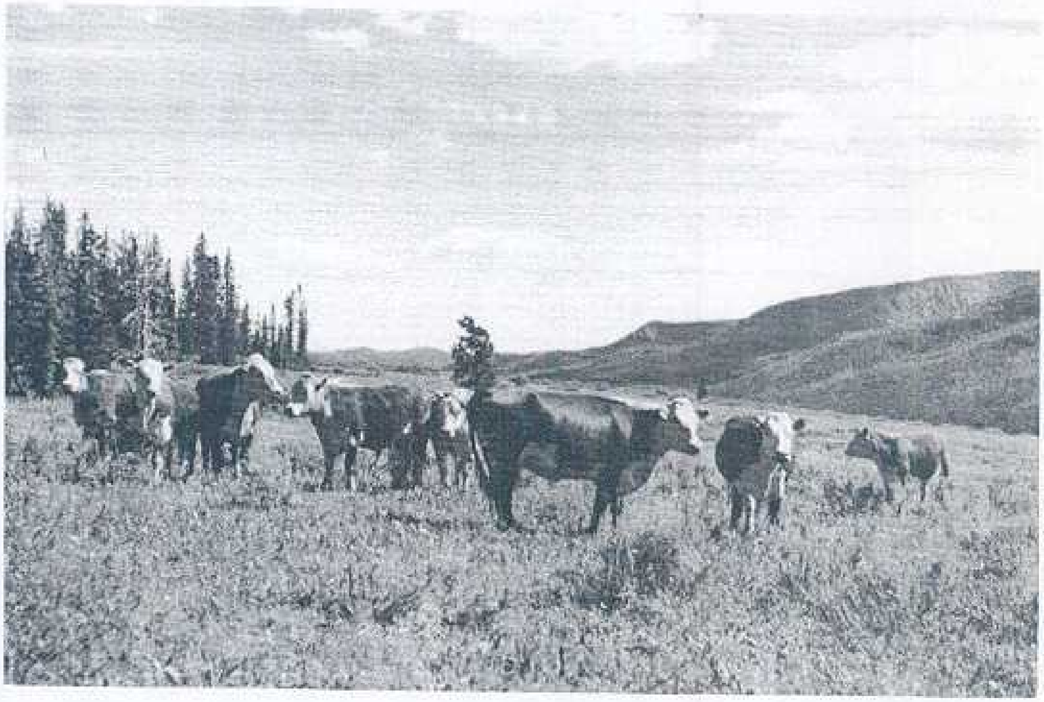
[a]Represents rental value of farm land without water.

TABLE 38.--Use of public grazing land by farm operators with base property within the Sevier River Basin, 1962

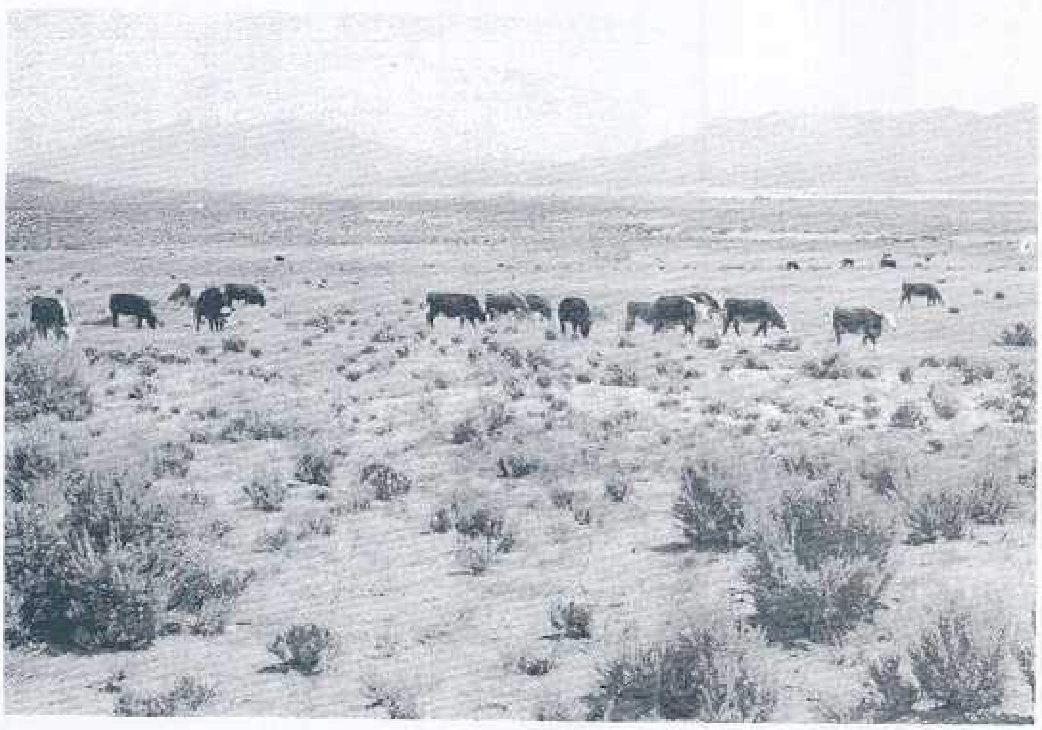
Item	Unit	Economic Area				Basin
		I	II	III	IV	
National Forest lands						
Operators with cattle permits	Number	137	150	122	93	492
Permitted cattle	Number	6,473	8,298	3,604	3,036	21,411
Authorized grazing	AUM	25,978	36,216	14,884	11,394	88,472
Average size of permit	Number	47.2	55.3	32.2	32.6	43.5
Average size permit	AUM	189.6	241.4	132.9	122.5	179.8
Operators with sheep permits	Number	14	25	63	1	103
Permitted sheep	Number	10,212	11,596	36,061	950	58,819
Authorized grazing	AUM	6,217	7,803	24,248	137	38,585
Average size permit	Number	729.4	463.8	572.4	950.0	571.1
Average size permit	AUM	444.1	312.1	384.9	137.0	374.6
Public lands administered by BLM						
Operators with cattle permits	Number	111	68	13	121	313
Permitted cattle	Number	11,660	4,460	635	8,060	24,815
Authorized grazing	AUM	51,429	23,717	5,473	47,580	128,199
Average size permit	Number	105.5	65.6	48.8	66.6	79.3
Average size permit	AUM	463.3	348.8	421.0	393.2	409.6
Operators with sheep permits	Number	17	35	85	2	139
Permitted sheep	Number	17,990	30,298	111,385	8,060	167,733
Authorized grazing	AUM	14,520	41,192	133,373	10,541	219,626
Average size permit	Number	1,058.2	857.1	1,310.4	4,030.0	1,206.7
Average size permit	AUM	2,030.6	1,176.9	1,569.4	5,270.5	1,580.0

Source: Compiled from data provided by U. S. Forest Service and Bureau of Land Management.

U. S. FOREST SERVICE PHOTO 5881-14



Cattle grazing on the Fishlake National Forest.



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forage from National Forest lands. These figures include only operations with base property within the Basin. Operators with headquarters outside the Basin also used a considerable amount of forage from these areas. However, only part of the public land utilized by these operators is actually within Basin boundaries.

Data indicates that 20 percent of the farm operators have National Forest grazing permits. Permit holders on BLM lands number 14.8 percent of the total farm operators. In Economic Area I, 36 percent of the operators have National Forest permits and 31 percent BLM permits. Comparable figures for other areas are: 16 percent and 10 percent of operators in Economic Area II; 22 percent and 12 percent of operators in Economic Area III; and 13 percent and 17 percent of operators in Economic Area IV.

The farm survey indicated that in 1962, 16 percent of the cattle over 1 year of age grazed on National Forest lands and 15 percent on BLM lands. Use of Federal grazing by sheep was much higher. About 80 percent of the sheep used BLM lands and 79 percent also used National Forest lands.

About 680,000 acres of private and State rangelands are within the Basin and about 136,000 animal unit months of grazing are provided by these lands (Table 39). Private and State rangelands are not evenly distributed; about 16 percent of these lands are in Economic Area I, 22 percent in Economic Area II, 27 percent in Economic Area III, and 35 percent in Economic Area IV.

TABLE 39.--Acreage and animal unit months of forage provided by private and State lands, Sevier River Basin, 1962

Area	Acreage	Amount of forage
	Acres	AUM's
Area I	108,000	21,600
Area II	150,000	30,000
Area III	185,000	37,000
Area IV	237,000	47,400
Sevier River Basin	680,000	136,000

Many areas of public lands are steep with rough broken topography and limited livestock water. Additional adjustments in livestock grazing in some areas are needed to protect watershed and other resource values. Both livestock numbers and their grazing distribution need to be coordinated into a system that will protect the forage resource as well as provide satisfactory returns to livestockmen. On other areas of gentle slopes, favorable soils, and climate, forage production can be increased through chaining of Pinyon-juniper, spraying of sagebrush, and reseeding with desirable forage species. Increased carrying capacity due to range improvement will help offset adjustments in other areas.

AGRICULTURAL INCOMES

PROCEDURES

Estimates of agricultural incomes were derived by farm-budgeting procedures. Farm sizes and livestock enterprises were selected to represent actual conditions as nearly as possible. Farm-survey findings were used to vary farm resources and production rates between farms and economic areas. Detailed descriptions of available land and water resources, livestock enterprises, crop yields, cropping patterns, production practices and water-yield relationships are available in separate publications. (1, 12, 21) Prices used for estimating farm incomes and associated costs were based on price projections by the U. S. Department of Agriculture adjusted to fit local conditions.

Farm types used in arriving at agricultural incomes were based on existing types of farms and available Federal grazing permits. Four farm types were predominant in the farm survey--range beef, general livestock, cash crop, and small farms. A brief description of each farm type used in the analysis follows:

Small grade C dairy--This farm type was used to represent the dairy enterprises and small farms. Small dairies were shown in Areas I, II, and III. The number of dairy cows per farm varied from 15 to 24. The cropping pattern was fitted to livestock feed needs.

General farms--Feeder calves were purchased on the fall, wintered and grazed on irrigated and wet pastures the following summer, and sold as grass-fat long yearlings. The size of herd varied from 90 to 180. General farms were used in Areas I and III.

Range-beef farms--Range-beef farms were used in the analyses to represent the beef and sheep farms along with available Federal grazing resources. The number and size of range-beef farms in each area were fitted to available off-farm grazing resources. Available grazing was divided into 4 periods and on-farm cropping pattern balanced to meet livestock feed needs. Range-beef farms were shown in all areas.

<u>Cash-crop-feeder farm</u>--A combination of cash-crop and livestock-feeder farms was used in Areas II and IV to evaluate larger, more intensive operations. Alfalfa hay and grain were fed to livestock with sugar beets and alfalfa seed sold for cash. The size of the feeder operations varied from 250 to 450 head.

<u>Cash-crop farm</u>--Both large and small cash-crop farms were used in Area IV. Alfalfa hay, alfalfa seed, and barley were produced on these farms.

PROJECTED PRICES

All prices used for estimating farm incomes and associated costs are based on the May 1965 normalized price projections of the U. S. Department of Agriculture. State price projections were adjusted to fit local conditions.

Information obtained during the field survey showed some variations in local and State prices. For example, alfalfa hay price was lower than the State price. All prices were adjusted for marketing costs and are net prices to farmers. Prices used for selected items are shown in Table 40.

CROP YIELDS

Crop yields used in estimating farm incomes are shown in Table 41. Estimates are based on farm-survey findings and represent average conditions in each area. Yields are not directly comparable between areas because water supplies, fertilizer use, soils, and climatic conditions vary.

TABLE 40.--Projected normalized prices received and selected prices paid, Sevier River Basin, 1965

Product	Unit	Price[a]
Price received		
Crops		
All hay, baled[b]	Ton	21.60
Straw, baled	Ton	15.00
Corn	Ton	7.50
Barley	Bushel	1.05
Pasture	AUM	4.50
Sugar beets	Ton	14.50
Alfalfa seed	Pound	.40
Livestock and livestock products		
Milk, butterfat	Pound	.83
Calves (beef steers)	Cwt.	25.50
Calves (beef heifers)	Cwt.	23.50
Long yearlings (beef steers)	Cwt.	23.00
Long yearlings (beef heifers)	Cwt.	21.00
Cull cows (beef)	Cwt.	13.50
Cull cows (dairy)	Cwt.	14.50
Bulls (beef)	Cwt.	17.00
Fat steers (beef)	Cwt.	25.00
Prices paid		
Hired labor	Hour	1.25
Custom rates:		
Baling hay	Ton	4.00
Combining grain	Acre	7.00
Chopping corn	Acre	15.00
Harvesting beets	Ton	2.10

[a]Net prices received by farmers.

[b]Price after shrinkage.

Source: Farm survey findings and normalized price projections by U. S. Department of Agriculture, May 1965.

TABLE 41.--Crop yields used in estimating farm incomes by economic areas, Sevier River Basin, 1962

Crop	Unit	Economic Area			
		I	II	III	IV
Alfalfa hay	Ton	3.0	4.0	3.0	3.5
Meadow hay	Ton	1.75	1.75	1.75	----
Rotation pasture	AUM	6.0	6.0	6.0	----
Irrigated permanent pasture	AUM	5.0	5.0	5.0	5.0
Wet pasture	AUM	4.0	4.0	4.0	4.0
Barley	Bushel	50.0	60.0	55.0	55.0
Corn silage	Ton	----	16.0	----	15.0
Sugar beets	Ton	----	15.5	----	----
Alfalfa hay (first crop)	Ton	----	----	----	1.1
Alfalfa seed (second crop)	Pound	----	----	----	175

FARM INCOMES

The agricultural incomes and selected organizational items for representative farms and average farm income are shown in Tables 42-45. Average farm incomes varied between economic areas from a low of $3,275 in Area I to a high of $6,330 in Area IV. Farm incomes in Areas II and III were $5,814 and $5,824, respectively. Weighted (farm numbers) average farm income for all operators was $5,481.

Farm incomes do not necessarily indicate the income that farmers have available for family living expenses. Payments for interest on borrowed capital, principle payments, income taxes, and social security taxes have to paid before income for family living can be determined. Farm-survey findings indicate that the average farmer also has $2,173 of nonfarm income. Nonfarm incomes by economic areas were: Area I, $2,405; Area II, $2,204; Area III, $2,302; and Area IV, $1,757.

Capital requirements for all operators averaged $81,865. Comparable figures by economic areas were: Area I, $64,510; Area II, $84,304; Area III, $85,902; and Area IV, $87,678.

The return to operators for their labor and management averaged $1,397. Within economic areas, returns for labor and management were the lowest in Area I ($49) and the highest in Area IV ($1,946). Farmers in Area II received $1,598 and the farmers in Area III, $1,529. Returns by types of farms varied from a minus $74 for range-beef farms in Area I to $3,857 on large cash-crop farms in Area IV.

TABLE 42.--Agricultural incomes and organizational items for selected farm types and sizes, Economic Area I

Item	Unit	Small grade C dairy	General farm	Range-beef farm	Weighted average
Farms	Number	150	75	225	450
Total land	Acre	60	493	927	566
Irrigated rotation cropland	Acre	30	67	112	76
Irrigated nonrotation cropland	Acre	9	20	34	24
Nonirrigated nonrotation cropland	Acre	8	18	29	21
Irrigable under system	Acre	8	16	25	18
Other	Acre	5	372	727	427
Productive livestock	Number	15	90	100	70
Operator and family labor	Hour	1,821	1,372	2,476	2,074
Investment	Dollar	26,834	55,958	92,495[a]	64,510
Land	Dollar	12,721	35,914	61,118	40,785
Buildings and improvement	Dollar	3,375	3,136	4,236	3,766
Machinery	Dollar	5,565	6,720	8,491	7,221
Livestock	Dollar	4,650	9,540	17,950	12,115
Other	Dollar	523	648	700	623
Farm receipts	Dollar	4,802	16,624	11,222	9,982
Farm expenses[b]	Dollar	3,296	13,636	6,671	6,707
Farm income[c]	Dollar	1,506	2,988	4,551	3,275
Interest on investment[d]	Dollar	1,342	2,798	4,625	3,226
Return to labor and management	Dollar	164	190	-74	49

[a]Does not include any capital investment in grazing permits.

[b]Does not include interest on investment.

[c]Return to labor, management and capital.

[d]At 5 percent.

types and sizes, Economic Area II

Item	Unit	Small grade C dairy	Cash-crop-feeder farm	Range-beef farm	Weighted average
Farms	Number	274	411	137	822
Total land	Acre	66	159	619	205
Irrigated cropland	Acre	39	133	45	87
Irrigated noncropland	Acre	7	-------	78	15
Nonirrigated noncropland	Acre	7	-------	88	17
Irrigable under system	Acre	3	9	8	7
Other	Acre	10	17	400	79
Productive livestock	Number	24	250	166	161
Operator and family labor	Hour	2,572	2,990	2,916	2,838
Investment	Dollar	40,336	105,530	108,561[a]	84,304
Land	Dollar	18,680	47,890	65,940	41,162
Buildings & improvements	Dollar	5,634	3,974	4,485	4,612
Machinery	Dollar	7,646	9,976	8,491	8,952
Livestock	Dollar	7,350	42,000	28,135	28,139
Other	Dollar	1,026	1,690	1,510	1,439
Farm receipts	Dollar	7,983	28,131	14,551	19,152
Farm expenses[b]	Dollar	5,459	20,161	8,628	13,338
Farm income[c]	Dollar	2,524	7,970	5,923	5,814
Interest on investment[d]	Dollar	2,017	5,277	5,428	4,216
Return to labor and management	Dollar	507	2,693	495	1,598

[a]Does not include any capital investment in grazing permits.

[b]Does not include interest on investment.

[c]Return to labor, management and capital.

[d]At 5 percent.

TABLE 44.--Agricultural incomes and organizational items for selected farm types and sizes, Economic Area III

Item	Unit	Small grade C dairy	General farm	Range-beef farm	Weighted average
Farms	Number	130	135	165	430
Total land	Acre	83	500	1,146	622
Irrigated cropland	Acre	37	146	153	116
Nonirrigated noncropland	Acre	28	112	115	88
Irrigable under system	Acre	8	34	35	27
Other	Acre	10	208	843	391
Productive livestock	Number	24	180	185	135
Operator and family labor	Hour	2,465	2,821	3,122	2,829
Investment	Dollar	33,469	92,360	121,930[a]	85,902
Land	Dollar	14,490	59,600	76,320	52,378
Buildings and improvements	Dollar	5,412	3,812	6,856	5,464
Machinery	Dollar	5,565	8,491	8,491	7,606
Livestock	Dollar	7,350	19,080	28,135	19,008
Other	Dollar	672	1,377	2,128	1,446
Farm receipts	Dollar	8,282	14,771	16,477	13,464
Farm expenses[b]	Dollar	5,422	6,980	9,926	7,640
Farm income[c]	Dollar	2,860	7,791	6,551	5,824
Interest on investment	Dollar	1,673	4,618	6,097	4,295
Return to labor and management	Dollar	1,187	3,173	454	1,529

[a]Does not include any capital investment in grazing permits.

[b]Does not include interest on investment.

[c]Return to labor, management and capital.

[d]At 5 percent.

TABLE 45.--Agricultural incomes and organizational items for selected farm types and sizes, Economic Area IV

Item	Unit	Small cash crop	Large cash crop	Cash-crop-feeder farm	Range-beef farm	Weighted average
Farms	Number	150	300	50	200	700
Total land	Acre	75	400	875	1,100	564
Irrigated cropland	Acre	29	154	336	95	123
Irrigated noncropland	Acre	------	------	-------	6	2
Nonirrigated noncropland	Acre	------	------	-------	225	64
Irrigable under system	Acre	8	43	94	134	65
Other	Acre	38	203	445	640	310
Productive livestock	Number	------	------	450	249	103
Operator and family labor	Hour	484	1,553	3,492	3,660	2,065
Investment	Dollar	11,228	65,147	205,188	149,435[a]	87,678
Land	Dollar	7,980	50,450	93,820	90,169	55,795
Buildings and improvements	Dollar	732	1,794	8,497	6,949	3,518
Machinery	Dollar	2,506	12,093	14,711	8,491	9,544
Livestock	Dollar	------	------	84,000	42,210	18,060
Other	Dollar	10	------	4,160	1,616	761
Farm receipts	Dollar	2,239	12,259	44,713	21,505	15,072
Farm expenses[b]	Dollar	1,455	5,145	31,822	13,834	8,742
Farm income[c]	Dollar	784	7,114	12,891	7,672	6,330
Interest on investment[d]	Dollar	561	3,257	10,259	7,472	4,384
Return to labor and management	Dollar	223	3,857	2,632	199	1,946

[a]Does not include any capital investment in grazing permits.

[b]Does not include interest on investment.

[c]Return to labor, management and capital.

[d]At 5 percent.

IMPACTS OF ON-FARM IMPROVEMENT PRACTICES

PROCEDURE

Farm-income budgets, representing costs and returns for all the enterprises anticipated with different farm types, were used for estimating changes in farm incomes with the installation of on-farm improvement practices and economic effects from development of both on-farm and off-farm improvement possibilities. The evaluation procedure involved budgeting three different situations for all farm types and economic areas. These situations were as follows: (1) Present level of resource use and incomes; (2) changes from present situation and incomes with the inclusion of on-farm improvement practices (difference between present level of practices already installed and potential level); and (3) changes from present situation and incomes with the inclusion of on-farm improvement practices, all irrigable lands (lands which are not now irrigated but could be successfully irrigated if irrigation water were available) under present irrigation systems, and a full irrigation water supply for all irrigated lands.

Improvement practices, irrigable lands, and irrigation water were assumed to be equally distributed on the basis of presently irrigated acreage. The evaluation of improvement practices assumed that irrigation water diversions would remain the same as in the past. Irrigation water was not considered as a limiting factor in evaluating the effects of the full development of on-farm resources. Off-farm development opportunities are sufficient to meet the needs of irrigable lands under the present irrigation systems and also to overcome shortages on presently irrigated lands.

IMPROVEMENT PRACTICES

The evaluation of on-farm improvement practices was limited to irrigated rotation cropland. Irrigated nonrotation cropland and non-irrigated nonrotation cropland were not considered in arriving at levels of improvement practices. Sufficient data for on-farm improvement opportunities in wet areas were not available to provide a foundation for an area-type economic analysis. It will be necessary to evaluate opportunities in wet areas on a small-area basis because of the wide variation in physical conditions which affect the feasibility of alternative opportunities in these areas.

Farm reservoirs, farm ditch lining, and land leveling were the on-farm improvement practices considered. Installation of on-farm ditch lining was limited to the area in which land leveling was also recommended. Ditch lining was not considered in Economic Area IV.

The present level of improvement practices already installed was considered in arriving at present crop yields and irrigation efficiencies. The difference between the present level and the level for full development of improvement practices was used in the economic evaluation. The costs and effects of improvement practices are shown in Table 46.

The cost of improvement practices was amortized over a 50-year period using a 5-percent interest rate. On irrigable lands, an additional $50 per acre land development cost was assumed to bring these lands to the same levels of productivity as other irrigated lands.

TABLE 46.--Present level of development and recommended levels of improvement practices for full development of on-farm resources and estimated costs by areas, Sevier River Basin

Improvement practice	Unit	Area				
		I	II	III	IV	Basin
Farm reservoirs						
Present level	Acre	2,000	8,410	13,900	7,760	32,070
Recommended for full development	Acre	2,000	1,680	9,430	2,180	15,290
Per acre installation cost	Dollar	18.18	11.00	13.66	11.00	15.62
Effect on irrigation efficiency	Percent	6.00	6.00	6.00	6.00	6.00
Change in farm irrigation efficiency	Percent	.27	.12	1.14	.16	.35
Farm ditch lining						
Recommended for full development	Acre	18,105	55,520	35,290	------	108,915
Per acre installation cost	Dollar	105.00	105.00	105.00	------	105.00
Effect on irrigation efficiency	Percent	6.00	6.00	6.00	------	6.00
Change in farm irrigation efficiency	Percent	2.42	3.94	4.27	------	2.46
Land leveling						
Present level	Acre	2,945	17,540	5,480	43,220	69,185
Recommended for full development	Acre	18,105	55,520	35,290	45,700	154,615
Per acre installation cost	Dollar	57.15	54.21	64.80	48.49	55.28
Effect on irrigation efficiency	Percent	5.29	6.02	4.66	4.94	5.30
Change in farm irrigation efficiency	Percent	2.13	3.97	3.31	2.79	3.15
All improvement practices						
Average cost per irrigated acre	Dollar	63.98	99.27	112.83	23.99	71.27
Change in farm irrigation efficiency	Percent	4.82	8.03	8.27	2.95	5.88
Change in water-use efficiency	Percent	3.37	5.97	5.55	2.06	4.17

FINDINGS

Economic Area I

The installation of on-farm improvement practices will result in increasing the present on-farm irrigation efficiency by 4.8 percent and the overall area water-use efficiency by 3.4 percent. In addition to increasing irrigation efficiency, installed practices would also result in reducing farm labor requirements and provide small increases in crop yields through better distribution of irrigation water to the crop root zone. Irrigation water diversion requirements could be reduced by 18,500 acre-feet and still have a full water supply on presently irrigated lands. The amortized annual cost of these practices would be $162,800 and the annual direct agricultural benefits $115,200 (Table 47). However, the value of the 18,500 acre-feet reduced diversion requirements should be considered when comparing benefits and costs of improvement practices.

With full development of on-farm resources, the annual direct agricultural benefits will be about $333,500 and the annual development cost about $223,700. The $109,800 difference between benefits and costs would be available to pay the costs of the additional 10,000 acre-feet of irrigation water necessary to irrigate the 8,000 acres of additional irrigable lands. This irrigation water could be obtained from improving the 290 miles of distribution canals and draining all or part of the 4,000 acres of low-value phreatophyte areas. Present losses from distribution canals are 55,000 acre-feet annually. Over 13,000 acre-feet of water are also being consumptively used by nonbeneficial phreatophytes. In general terms, there are more than enough off-farm water development opportunities for improvement practices to provide all irrigable lands under the present irrigation systems with a full water supply.

Economic Area II

The installation of on-farm improvement practices will increase the average on-farm irrigation efficiency by 8.0 percent and the overall area water-use efficiency by 6.0 percent. Additional water would be available to crops and increased yields would result from practices. Farm labor requirements for irrigating would also be reduced. Present diversion requirements would be reduced by 6,600 acre-feet in addition to providing 18,400 acre-feet more water to crops. The annual direct agricultural benefits from these practices would be about $642,000 (Table 48). Amortized annual costs of practices would be $485,200. Available income to farm operators would be increased by $156,800 a year in addition to reducing irrigation water diversion requirements.

TABLE 47.--Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present irrigation systems and full water supply for all irrigated lands, Economic Area I

Item	Unit	Present situation	Addition of recommended on-farm improvement practices	Addition of practices, irrigable acreage and full water supply to all lands[a]
Cropland	Acre	55,880	55,880	63,884
Irrigated rotation	Acre	35,717	35,717	43,721
Irrigated nonrotation	Acre	10,733	10,733	10,733
Nonirrigated nonrotation	Acre	9,430	9,430	9,430
Level of improvement practices				
Farm reservoirs	Acre	2,000	4,000	4,900
Farm ditch lining	Acre	------	18,105	22,165
Land leveling	Acre	2,945	21,050	25,760
Farm income affects				
Net farm income[b]	Dollar	49	205	1,230
Cost of labor[c]	Dollar	------	+100	-403
Adjusted net farm income	Dollar	49	305	827
Annual area income affects				
Amortized cost of development[d]	Dollar	------	162,800	223,700[e]
Direct agricultural benefits	Dollar	------	115,200	333,500[f]
Area change in water use				
Consumptive use by crops	Acre-feet	------	0	+15,020
Irrigation diversion needs	Acre-feet	------	-18,500	+10,000

[a]Represents the change in resource use and incomes from the present situation to the situation with the installation of on-farm improvement practices and a full irrigation water supply to all irrigated lands.

[b]Return to operator and family labor and management.

[c]Adjusted to reflect the saving or cost of operator and family labor resulting from development at $1.25 per hour.

[d]Cost of improvement practices is amortized over a 50-year period at 5 percent interest.

[e]A $50 per acre land development cost, in addition to costs of improvement practices, was assumed to bring irrigable lands to present level of productivity of other presently irrigated lands.

[f]Benefits discounted to allow for a 3-year development period.

TABLE 48.--Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present irrigation systems and full water supply for all irrigated lands, Economic Area II

Item	Unit	Present situation	Addition of recommended on-farm improvement practices	Addition of practices, irrigable acreage and full water supply to all lands[a]
Cropland	Acre	104,600	104,600	110,030
Irrigated rotation	Acre	76,150	76,150	81,580
Irrigated nonrotation	Acre	13,080	13,080	13,080
Nonirrigated nonrotation	Acre	15,370	15,370	15,370
Level of improvement practices				
Farm reservoirs	Acre	8,410	10,090	10,810
Farm ditch lining	Acre	-------	55,520	59,480
Land leveling	Acre	17,540	73,060	78,270
Farm income affects				
Net farm income[b]	Dollar	1,598	2,271	2,799
Cost of labor[c]	Dollar	-------	+108	+4
Adjusted net farm income	Dollar	1,598	2,379	2,803
Annual area income affects				
Amortized cost of development[d]	Dollar	-------	485,200	538,800[e]
Direct agricultural benefits	Dollar	-------	642,000	943,700[f]
Area change in water use				
Consumptive use by crops	Acre-feet	-------	+18,380	+30,630
Irrigation diversion needs	Acre-feet	-------	-6,600	+13,400

[a]Represents the change in resource use and incomes from the present situation to the situation with the installation of on-farm improvement practices and a full irrigation water supply to all irrigated lands.

[b]Return to operator and family labor and management.

[c]Adjusted to reflect the saving or cost of operator and family labor resulting from development at $1.25 per hour.

[d]Cost of improvement practices is amortized over a 50-year period at 5 percent interest.

[e]A $50 per acre land development cost, in addition to costs of improvement practices, was assumed to bring irrigable lands to present level of productivity of other presently irrigated lands.

[f]Benefits discounted to allow for a 3-year development period.

With full development of all available on-farm resources, the annual direct agricultural benefits will be about $943,700. Amortized annual development costs would be $538,800. The $404,900 of excess benefits over costs would be available to pay the costs of the additional 13,400 acre-feet of irrigation water necessary to irrigate the 5,400 acres of additional irrigable lands. This additional irrigation water could be obtained from improving the 420 miles of distribution canals and draining the 6,280 acres of low-value phreatophyte areas. Present losses from these sources amount to about 100,000 acre-feet annually. The groundwater resource could be developed to insure that seasonal and dry-year shortages are overcome. In general terms, there are more than enough off-farm water development opportunities to provide all irrigable lands under the present irrigation systems with a full water supply.

Economic Area III

The installation of on-farm improvement practices will result in improving the average on-farm irrigation efficiency by 8.7 percent and the area water-use efficiency by 5.6 percent. Additional water would be available to crops and increased yields would result from practices. Farm labor requirements for irrigating would also be reduced. Present diversion requirements would not be affected, but 8,060 acre-feet of additional water would be available to crops as a result of practices. The annual direct agricultural benefits from practices would be about $354,800 (Table 49). Amortized annual costs of practices would be $335,300.

With full development of all available on-farm resources, the annual direct agricultural benefits will be about $870,100. Amortized annual development costs would be $444,700. The $425,400 of excess benefits over costs would be available to pay the costs of the additional 64,500 acre-feet of irrigation water necessary to irrigate the 11,550 acres of additional irrigable lands and provide a full water supply to presently irrigated lands. This additional irrigation water would have to be obtained by improving distribution facilities and draining wet areas. Complete development of all potential off-farm resources would be required to obtain enough water to supply irrigable lands. It would be necessary to develop the potential groundwater resource to insure that seasonal and dry-year irrigation water shortages are overcome.

Economic Area IV

The installation of on-farm improvement practices will increase the average farm irrigation efficiency by 3.0 percent and the overall area water-use efficiency by 2.1 percent. Additional water would be available to crops and increased yields would result from practices. Farm labor requirements for irrigating would also be reduced.

TABLE 49.--Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present irrigation systems and full water supply for all irrigated lands, Economic Area III

Item	Unit	Present situation	Addition of recommended on-farm improvement practices	Addition of practices, irrigable acreage and full water supply to all lands[a]
Cropland	Acre	93,150	93,150	104,700
Irrigated rotation	Acre	54,250	54,250	65,800
Nonirrigated nonrotation	Acre	38,900	38,900	38,900
Level of improvement practices				
Farm reservoirs	Acre	13,900	23,330	28,300
Farm ditch lining	Acre	------	35,290	42,800
Land leveling	Acre	5,480	40,770	49,450
Farm income affects				
Net farm income[b]	Dollar	1,589	2,326	4,119
Cost of labor[c]	Dollar	------	+88	-406
Adjusted net farm income	Dollar	1,589	2,414	3,713
Annual area income affects				
Amortized cost of development[d]	Dollar	------	335,300	444,700[e]
Direct agricultural benefits	Dollar	------	354,800	870,100[f]
Area change in water use				
Consumptive use by crops	Acre-feet	------	+8,060	+37,100
Irrigation diversion needs	Acre-feet	------	0	+64,500

[a]Represents the change in resource use and incomes from the present situation to the situation with the installation of on-farm improvement practices and a full irrigation water supply to all irrigated lands.

[b]Return to operator and family labor and management.

[c]Adjusted to reflect the saving or cost of operator and family labor resulting from development at $1.25 per hour.

[d]Cost of improvement practices is amortized over a 50-year period at 5 percent interest.

[e]A $50 per acre land development cost, in addition to costs of improvement practices, was assumed to bring irrigable lands to present level of productivity of other presently irrigated lands.

[f]Benefits discounted to allow for a 3-year development period.

Diversion requirements would remain the same, but 4,400 acre-feet of additional water would be available to crops. The annual direct agricultural benefits from practices would be $476,000 with amortized annual costs of $122,700 (Table 50). Income available to farm operators would be increased by $353,300 a year by installing practices.

With the development of all available on-farm resources, the annual direct agricultural benefits will be about $2,777,600. Amortized annual on-farm development costs will be $366,100. Farmers would have available $2,411,500 income to offset the cost of obtaining the additional 295,800 acre-feet of irrigation water needed to irrigate the 45,370 acres of additional irrigable lands and provide a full water supply to presently irrigated lands.

Potential off-farm improvement practices in Economic Area IV are not sufficient to provide necessary water for the development of all irrigable land under the present irrigation systems. It would be necessary to develop potential sources of water in Economic Areas I and II to provide enough irrigation water to irrigate all of the irrigable lands under the present irrigation system in Economic Area IV. Both economic areas would have excess water if all potential sources were developed. This assumes that irrigable lands above present irrigation systems would not be developed.

Sevier River Basin

The installation of on-farm improvement practices will increase the average farm irrigation efficiency by 5.9 percent and the overall Basin water-use efficiency by 4.2 percent. Diversion requirements would be reduced by 25,100 acre-feet and consumptive use by crops increased by 30,840 acre-feet as a direct result of on-farm improvement practices. The annual direct agricultural benefits from practices would be $1,588,000 with amortized annual costs of $1,106,000 (Table 51). Income available to farm operators would be increased by $482,000 annually.

With the development of all available on-farm resources, an additional 70,000 acres of irrigable lands under the present irrigation systems will be irrigated. Diversion requirements would be increased by 383,700 acre-feet and consumptive use by crops increased by 225,800 acre-feet. The annual direct agricultural benefits would be $4,924,900 with annual amortized costs of $1,573,300. Farmers would have available $3,351,600 additional income to offset the off-farm development costs necessary to obtain the additional 383,700 acre-feet of irrigation water at the point of diversion necessary to provide a full water supply to all irrigated lands.

TABLE 50.--Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present irrigation systems and full water supply for all irrigated lands, Economic Area IV

Item	Unit	Present situation	Addition of recommended on-farm improvement practices	Addition of practices, irrigable acreage and full water supply to all lands[a]
Cropland	Acre	138,460	138,460	183,830
Irrigated rotation	Acre	92,240	92,240	137,610
Irrigated nonrotation	Acre	1,120	1,120	1,120
Nonirrigated nonrotation	Acre	45,100	45,100	45,100
Level of improvement practices				
Farm reservoirs	Acre	7,760	9,940	14,830
Land leveling	Acre	43,220	88,920	132,660
Farm income affects				
Net farm income[b]	Dollar	1,946	2,541	6,352
Cost of labor[c]	Dollar	-------	+85	-241
Adjusted net farm income	Dollar	1,946	2,626	6,111
Annual area income affects				
Amortized cost of development[d]	Dollar	-------	122,700	366,100[e]
Direct agricultural benefits	Dollar	-------	476,000	2,777,600[f]
Area change in water use				
Consumptive use by crops	Acre-feet	-------	+4,400	+143,050
Irrigation diversion needs	Acre-feet	-------	0	+295,800

[a]Represents the change in resource use and incomes from the present situation to the situation with the installation of on-farm improvement practices and a full irrigation water supply to all irrigated lands.

[b]Return to operator and family labor and management.

[c]Adjusted to reflect the saving or cost of operator and family labor resulting from development at $1.25 per hour.

[d]Cost of improvement practices is amortized over a 50-year period at 5 percent interest.

[e]A $50 per acre land development cost, in addition to costs of improvement practices, was assumed to bring irrigable lands to present level of productivity of other presently irrigated lands.

[f]Benefits discounted to allow for a 3-year development period.

TABLE 51.--Estimated costs and changes in net farm incomes with addition of on-farm improvement practices, irrigable lands under present irrigation systems and full water supply for all irrigated lands, Sevier River Basin

Item	Unit	Present situation	Addition of recommended on-farm improvement practices	Addition of practices, irrigable acreage and full water supply to all lands[a]
Cropland	Acre	392,090	392,090	462,444
Irrigated rotation	Acre	258,357	258,357	328,711
Irrigated nonrotation	Acre	24,933	24,933	24,933
Nonirrigated nonrotation	Acre	108,800	108,800	108,800
Level of improvement practices				
Farm reservoirs	Acre	32,070	47,360	58,840
Farm ditch lining	Acre	-------	108,915	124,445
Land leveling	Acre	69,185	223,800	286,140
Farm income affects				
Net farm income[b]	Dollar	1,408	1,972	3,777
Cost of labor[c]	Dollar	-------	+96	-217
Adjusted net farm income	Dollar	1,408	2,068	3,560
Annual area income affects				
Amortized cost of development[d]	Dollar	-------	1,106,000	1,573,300[e]
Direct agricultural benefits	Dollar	-------	1,588,000	4,924,900[f]
Area change in water use				
Consumptive use by crops	Acre-feet	-------	+30,840	+225,800
Irrigation diversion needs	Acre-feet	-------	-25,100	+383,700

[a]Represents the change in resource use and incomes from the present situation to the situation with the installation of on-farm improvement practices and a full irrigation water supply to all irrigated lands.

[b]Return to operator and family labor and management.

[c]Adjusted to reflect the saving or cost of operator and family labor resulting from development at $1.25 per hour.

[d]Cost of improvement practices is amortized over a 50-year period at 5 percent interest.

[e]A $50 per acre land development cost, in addition to costs of improvement practices, was assumed to bring irrigable lands to present level of productivity of other presently irrigated lands.

[f]Benefits discounted to allow for a 3-year development period.

Potential off-farm improvement practices could provide more than enough irrigation water for a full water supply to all potentially irrigable lands under the present irrigation systems. It is estimated that water salvage projects on wet areas would provide 215,000 acre-feet of additional irrigation water. A 10-percent increase in the canal distribution efficiency would reduce Basin diversion requirements by 280,000 acre-feet.

T I M B E R   I N D U S T R Y

The timber resources are managed to provide a continuing supply of wood fiber. The volume of commercial sawtimber on National Forest land is approximately 3,478 million board-feet. Higher value species are Ponderosa pine, spruce, and Douglas fir, while aspen, whitebark pine, and limber pine are lower value species. This volume is scattered over 456,900 acres (Table 52).

TABLE 52.--Acreage and volume of commercial timber on National Forest lands, Sevier River Basin, 1965[a]

Sub-basin	Volume of commercial timber	Commercial timber	Non-commercial timber	Nonforested National Forest lands
	MMBM	Acres	Acres	Acres
A	214	25,500	10,100	82,300
B	67	8,900	52,800	147,800
C	28	53,200	47,300	183,200
D	158	42,700	68,400	190,300
E	1,547	176,600	128,300	194,200
F	1,209	150,000	14,200	225,500
Total	3,478	456,900	321,100	1,023,300
Percentage of total		25	18	57

[a]Acreage and volumes shown on the above table indicate the total resource of commercial timber. Some of this volume and area is unloggable because of topography and multiple-use considerations.

Source: Computed by the field party and based on timber management plans for the National Forests.

The commercial forest area of lands not in National Forest ownership was computed (Table 53) by prorating the commercial forest area by counties.

TABLE 53.--Commercial forest area of lands not in National Forest, Sevier River Basin, 1961[a]

Economic Area	Area in acres
I	24,400
II	19,500
III	14,800
IV	4,200
Basin	62,900

[a]Commercial forest area is forest land which is producing or is physically capable of producing usable crops of wood.

Source: "Forests in Utah", U. S. Forest Service Resource Bulletin, INT-4 Intermountain Forest and Range Experiment Station.

HARVESTING

Sawtimber is harvested according to the silvicultural requirements of the species or to meet management objectives. Although other methods are used, Ponderosa pine is commonly harvested in small clear cuts on a group selection basis. Other species are also usually harvested by clear cutting; the goal is to convert to even-aged management of timber.

Wood products other than sawtimber are harvested. Juniper posts, pole-sized trees of all species, Christmas trees, and firewood are important products. The use of aspen for excelsior and core stock is increasing and making this species more valuable.

The economics of harvesting timber have changed. In earlier times, a minimum investment in a team of horses, a crosscut saw, and an axe were all that were necessary to be in the business. Now loggers have high labor costs; they must pay insurance and social security for their employees; and they have a great deal of money invested in chain saws, tractors, loaders, trucks, and road construction equipment.

Harvesting Ponderosa Pine on the Dixie National Forest.

U.S. FOREST SERVICE PHOTO SR81-15

MANUFACTURING AND MARKETING

The principal timber industry is centered in Sub-basins E and F where the Kaibab-Crofts sawmill is the dominant single industrial feature. This mill has an annual production of approximately 26 million board-feet of lumber, nearly all harvested from National Forest lands. About 15.5 million board-feet are cut annually in Sub-basin F and 10.5 million board-feet in Sub-basin E. Approximately 200 employees receive an annual payroll of just under a million dollars. Operating expenses are also just under a million dollars and include taxes, cost of stumpage, capital investments, interest on working capital, and purchases. The wholesale value of the end product is slightly over two million dollars. Studs, boards and structural timber are produced for markets in the Salt Lake Valley, Las Vegas, and the West Coast.

There are some small sawmills which operate on a part-time basis. They saw lumber or structural timber on order or for a limited local market but cannot compete with larger, more efficient lumber suppliers. The two mills at Ephraim and one at Fairview are the more active of the smaller mills.

Aspen bolts are produced for manufacturing plants at Cedar City and Salt Lake City, where they are made into excelsior, core-filler stock and other products. Operators at Ephraim and in Sub-basin E specialize in this product.

Many diversified products other than sawtimber make up a significant segment of the timber industry. Many conifers are utilized as Christmas trees. Cedar posts are obtained from juniper trees. Pinyon pine provides high quality firewood, and many people harvest the edible pinyon nuts as recreation in the fall. Pole-sized trees needing only limited processing are used in corral fence construction and other uses.

The U. S. Treasury receives about $90,000 (1964) annually from timber sales on National Forest lands. Twenty-five percent ($22,500) of these receipts are returned to the counties where these lands are located.

CHAPTER V

WATER AND RELATED RESOURCE PROBLEMS

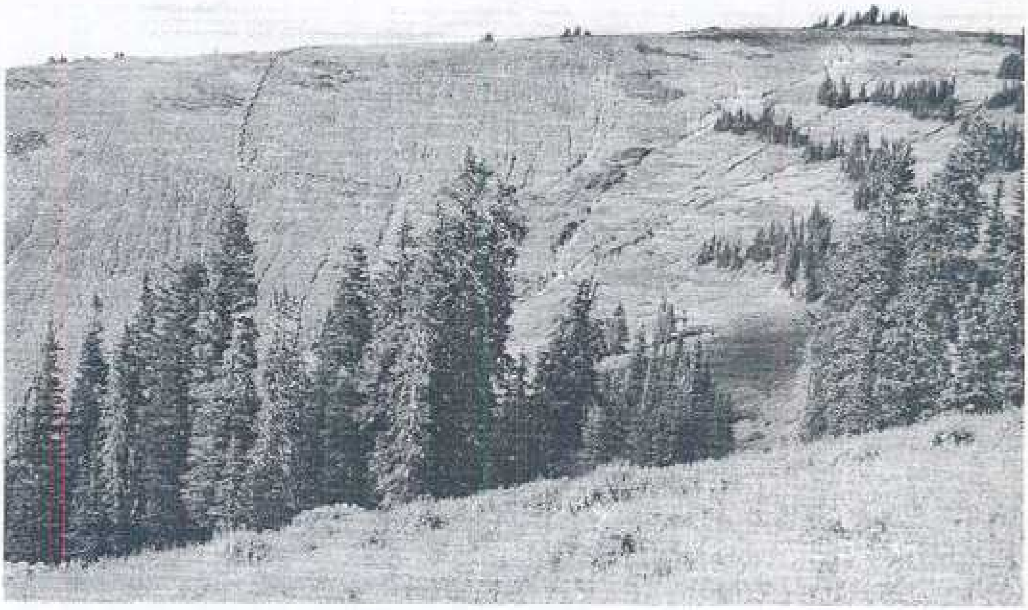
In this section, the causes, the extent and frequency, and the economic and social consequences of the water and related land resource problems within the Sevier River Basin are discussed. The results of studies are summarized in physical and monetary terms. The specific problems involved include erosion, sediment, and floodwater damage; impaired drainage; irrigation problems; nonirrigation water shortages; water pollution; phreatophytes; forest and range fire and insect damage; and natural beauty impairment.

E R O S I O N   D A M A G E

Any improper practice that uses land beyond its capability contributes to erosion. Within the Sevier River Basin these practices take a variety of forms. Roads and trails that are improperly located, too steep, or inadequately drained contribute to erosion. Some road construction has changed the natural regimen of stream channels and accelerated their erosive force. A recent problem is the use of 4-wheel drive vehicles, trail scooters, and motorcycles which are often used when the soil is soft and easily rutted, making tracks which, in some cases, develop into active gullies. The lack of proper soil stabilization measures connected with timber harvesting and mining has resulted in increased erosion. The effect of accelerated wind erosion is magnified north and east of Delta in an area of several thousand acres covered by sand dunes not unlike some vast desert.

Erosion is accelerated by improper irrigation and farm management practices. Irrigation of straight-row crops on slopes too steep or long and construction of ditches down steep grades contribute heavily to on-site erosion. The conversion of lands with shallow topsoil from permanent grass pastures to rotated cropland induces wind and water erosion.

The principal cause of accelerated erosion related to man's activities is overgrazing by domestic livestock. The number of sheep and cattle reached a peak between 1875 and 1910, and there is historical evidence that domestic livestock depleted the vegetation to the extent that accelerated erosion became a dominant feature in some areas. This has reduced the productivity of rangelands, caused streams to erode deeper and lower water tables, and increased sediment pollution. Many areas of streambank erosion are evident where protective vegetation has been removed and some once lush meadow lands now grow rabbitbrush, greasewood, and sagebrush.



A well developed gully system at the head of Pleasant Creek, Sanpete County, prior to land treatment.

U. S. FOREST SERVICE PHOTO 5881-12

Erosion caused by a flood in 1967 from Flat Canyon near Elsinore.

FIELD PARTY PHOTO 8-1402-2

Erosion has contributed to floods and mud-rock flows. Reduced infiltration has changed water yield from groundwater to overland flows, decreasing late season supplies.

Lt. R. L. Hoxie, a member of Wheeler's mapping expedition, crossed from Beaver to Panguitch Valley through Bear Valley on September 29, 1872. In his diary he speaks of abundant beaver dams, grass, and trout throughout the length of Bear Creek. (10) (Bear Creek is in Watershed F-2 and Utah State Highway 20 now follows this drainage.) Due to climatic changes, erosion, and irrigation diversions, Bear Creek now flows only part of the year in a wash 10 feet deep in places. The creek no longer provides beaver and trout habitat.

In 1902, Mr. Albert Potter was assigned to make a detailed inspection of lands proposed to be included within Forest Reserves. His diary documents many of the conditions at that time. "The main valley above Fountain Green is now entirely covered with sagebrush and no grass. The same story is told as in other localities. In early days it was all a grass meadow and the settlers came out with their mowing machines and cut great stacks of hay. Since the destruction of the grass by stock, the country has all grown up with sagebrush." (17)

In the vicinity of Mt. Pleasant, Mr. Potter states" "Going along the main divide north to the head of Pleasant Creek the soil is badly trampled by sheep and is bare of vegetation. Saw a band on the head of Potter Canyon which were quite thin in flesh and seemed to be living on fresh air and mountain scenery." (17)

However, some early writings indicate that conditions in the valleys were not always as good as indicated by other writers. C. E. Dutton when he worked in the Basin during the mid 1870's wrote:

"The broad valley of the Sevier is treeless, and supports but scantily even the desert-loving Artemisia. It is floored with fine loam which, under the scorching sun, is like ashes, except where the fields are made to yield their crops of grain by irrigation." (7)

An erosion condition survey evaluated the present situation as a basis for remedial measures under four classifications: (1) Incipient, (2) light to moderate, (3) heavy to excessive and (4) geologic. Unclassified areas included wetlands, water surfaces, lava flows and cultivated lands (Map 13 and Table 54).

TABLE 54.--Erosion condition classification

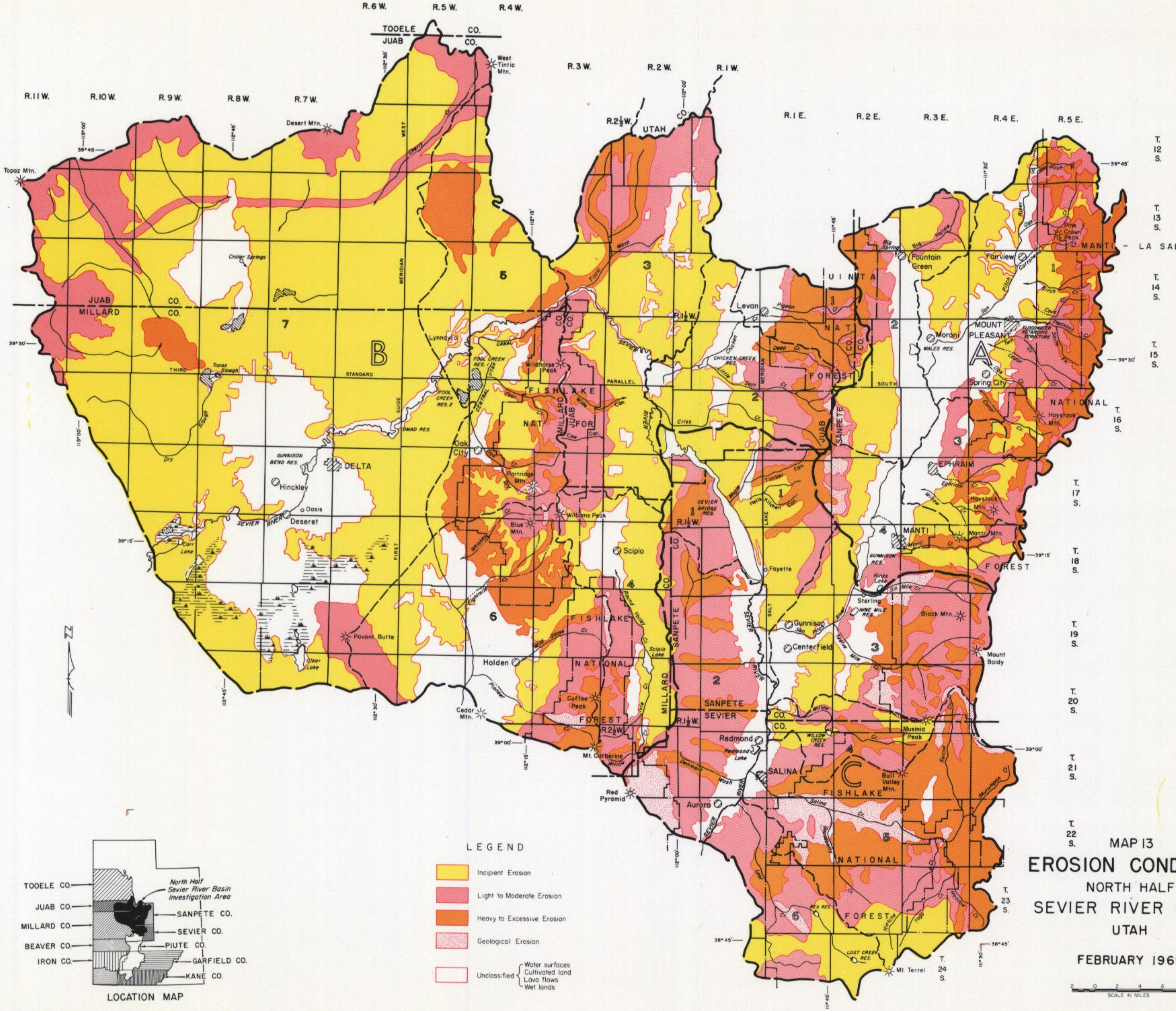
Watershed	Total area	Incipient[a]	Light to moderate[b]	Heavy to excessive[c]	Geologic[d]	Unclassified
	Acres	Percent	Percent	Percent	Percent	Percent
			Sub-basin A			
A-1	210,500	41	24	10	-	25
A-2	103,200	43	23	5	3	26
A-3	59,100	43	22	22	3	10
A-4	73,700	33	17	18	3	29
Total	446,500	41	22	12	2	23
			Sub-basin B			
B-1	45,600	7	42	35	-	16
B-2	97,200	45	23	18	1	13
B-3	216,400	49	33	6	10	2
B-4	102,900	46	6	9	28	11
B-5	210,100	54	3	21	13	9
B-6	212,500	40	6	20	16	18
B-7	937,400	70	2	-	2	26
Total	1,822,100	58	9	8	7	18
			Sub-basin C			
C-1	117,600	45	19	16	9	11
C-2	132,900	3	53	15	8	21
C-3	137,500	61	8	14	1	16
C-4	45,400	41	17	15	-	27
C-5	199,000	63	1	27	7	2
C-6	74,100	51	10	36	-	3
Total	706,500	46	17	21	5	11
			Sub-basin D			
D-1	135,600	13	7	25	34	21
D-2	58,700	29	7	48	3	13
D-3	15,100	57	-	38	-	5
D-4	114,200	6	14	42	22	16
D-5	114,800	20	12	60	7	1
D-6	76,100	12	-	73	12	3
D-7	80,400	5	51	30	5	9
D-8	49,300	11	55	23	-	11
Total	644,200	14	17	43	15	11
			Sub-basin E			
E-1	151,400	22	67	1	-	10
E-2	88,600	20	38	41	-	1
E-3	162,200	23	45	28	-	4
E-4	311,800	23	44	32	-	1
E-5	145,700	14	31	45	8	2
Total	859,700	21	45	30	1	3
			Sub-basin F			
F-1	92,900	13	40	36	2	9
F-2	209,600	28	36	31	-	5
F-3	139,500	54	18	16	-	12
F-4	70,500	59	2	36	-	3
F-5	208,500	60	22	6	-	12
Total	721,000	43	26	22	-	9
Basin total	5,200,000	41	21	20	5	13

[a]Incipient erosion: No erosion to some cutting in channels. Sheet erosion in beginning stages evidenced by light hummocking and some soil accumulation behind debris and vegetation. Plant and litter cover thin enough (50%-80%) that soil is not fully protected. Areas of wind erosion and sand dunes may be present.

[b]Light to moderate erosion: An active gully system beginning to form with cutting taking place in main channels and some secondary channels. Sheet erosion is light to medium. Some soil hummocks are present around plants. Erosion pavement is present, vegetation is patchy or predominantly tap-rooted species with less than 50% of the soil surface protected.

[c]Heavy to excessive erosion: Gully systems are well developed with active small gullies evident after heavy rains. Sheet erosion and hummocking is extreme, root systems of shrubs and trees may be exposed. In extreme cases, topsoil is eroded and gullies are cutting into sub-soil. Plant cover, often annual, is low in the successional stages and in extreme cases is so limited it has no stabilizing influence on the soil. There is little or no litter present.

[d]Geologic erosion: Scattered plants usually exist but large areas of bare soil are exposed. Soils often lack a distinctive "A" horizon. Erosion is a result of climatological and geological factors.



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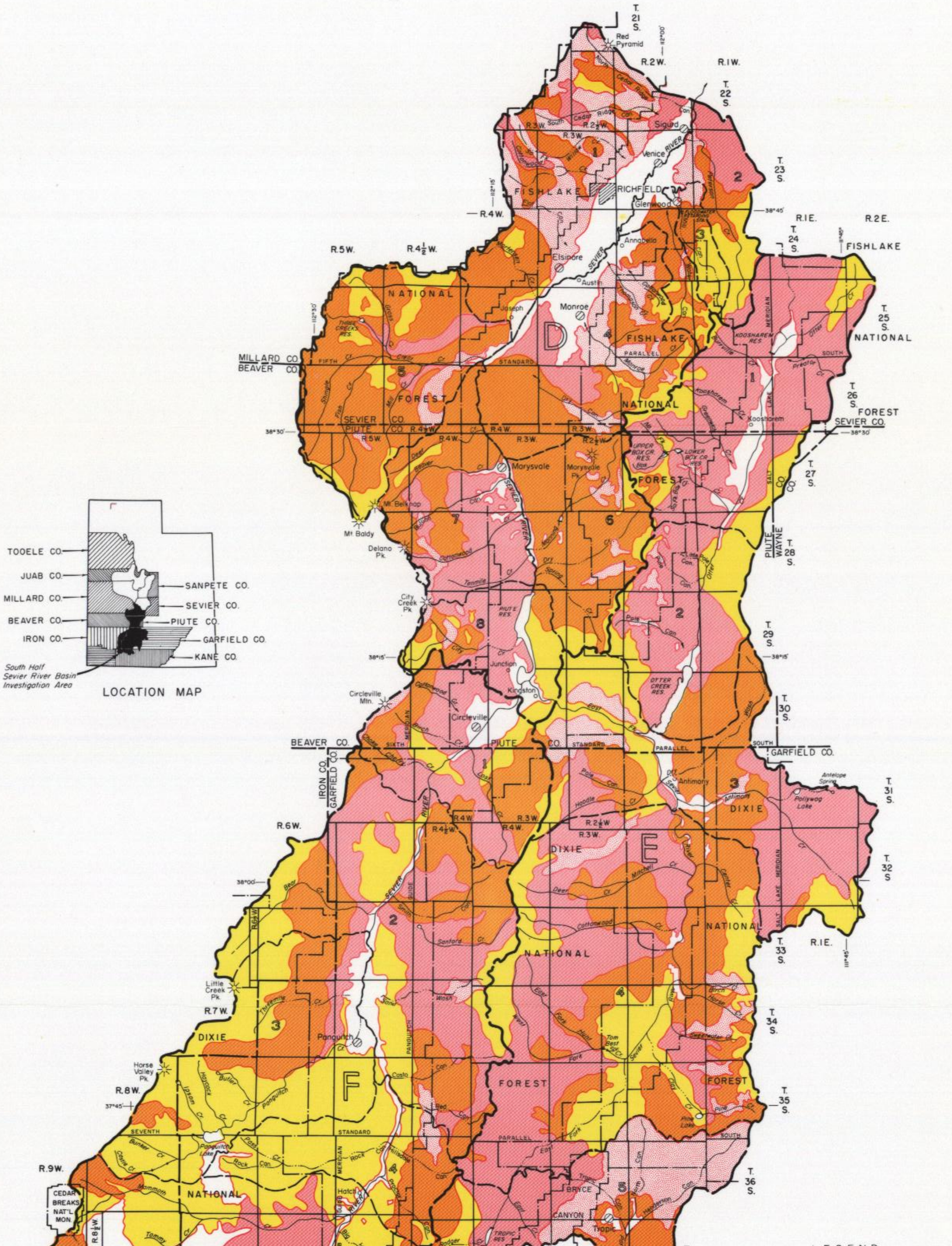


MAP 13

EROSION CONDITION

SOUTH HALF
SEVIER RIVER BASIN
UTAH

FEBRUARY 1969

SCALE IN MILES

Another problem is streambank erosion of established drainages by increased flows from periodic reservoir storage releases. The major drainage channels within the headwater areas on National Forest lands were evaluated and classified as follows:

Good: Stream channels with predominantly stable banks. Cutting may occur at bends or where the water is directed toward the bank. Protective vegetation grows on the streambanks and bottom.

Fair: Actively eroding channels with many areas lacking streambank vegetation. Heavy sediments are found in the flatter gradients. Stream bottom vegetation occurs as small patches on larger rocks.

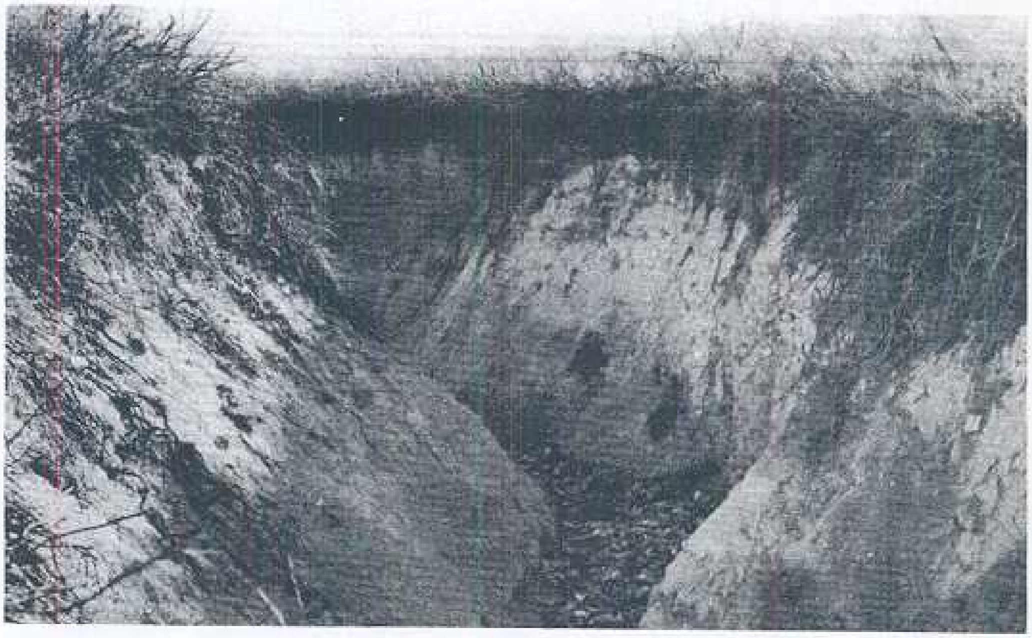
Poor: Actively cutting channels where protective streambank and bottom vegetation is largely lacking.

On National Forest lands, stream channels were evaluated as good, 7 percent; fair, 49 percent; and poor, 44 percent.

There are 15 transmountain diversions in Sub-basin A which divert water from the Colorado River drainage into the San Pitch drainage. In Sub-basin F, a transmountain diversion transports water from Castle Creek to Panguitch Lake. Some of these ditches transport water for only a short distance across the topographic divide where it is mingled with existing flows. The effect the additional water has on the stream regimen is difficult to evaluate. Poor watershed conditions in the headwater areas of the streams have resulted in serious erosion. The transmountain diversions contribute to this condition. Other transmountain diversions travel many miles before joining an existing stream or irrigation system. Most of these ditches are causing serious erosional problems. Some of the ditches have failed in the past releasing their water directly downslope and cutting gullies 15 feet or more deep.

S E D I M E N T   D A M A G E

Sediment damage falls in two major categories: (1) Spectacular cloudburst-flood sediments and (2) insidious sedimentation associated with perennial flows. Sediment deposition by cloudburst-floods generally require immediate attention to restore damaged areas to their former usefulness. Low intensity, perennial sedimentation accumulates over longer periods and is generally corrected at less frequent intervals. Costs from both types are enormous and probably have never been completely evaluated. Some idea of their magnitude can be gained from the annual damages evaluated by watersheds (Table 55). This does not include loss of storage capacity in reservoirs or decreased productivity from loss of topsoil.



Larsen Ditch near Ephraim. U. S. FOREST SERVICE PHOTO 6881-13

Sediment has completely covered this concrete-lined canal. SCS PHOTO 8-958-2

TABLE 55.--Estimated annual sediment damages for selected watersheds, Sevier River Basin

Watershed	Annual damages
	Dollars
A-1	$2,750
A-2	1,500
A-3	2,000
A-4	18,000
B-1 & 2	2,500
C-5	39,890
D-1	15,900
D-2 & 3	1,500
D-4	900[a]
E-5	3,200
F-3	$2,500

[a]There were residual damages of $11,000 before this PL-566 project was installed. Project measures will reduce this amount to $900.

Sediment damages to irrigation enterprises occur in three forms. First, deposition in diversion works and canals causing continuous cleanout requirements. This problem is more serious above major reservoirs and on tributary streams. Second, deposition from floodwater intercepted by canals. Third, deposition on irrigated lands, especially those areas irrigated with water not regulated by storage reservoirs. Periodic releveling is required in many instances to maintain present irrigation efficiencies.

Mud, rocks, and debris deposited by flash floods bury yards, roads, streets, railroads, and the interiors of low-lying buildings. Cleanup is a slow process and becomes extremely difficult and costly at times.

Sediments in many streams cover aquatic vegetation and gravel beds. This vegetation is needed to stimulate insect life used for fish food and clean gravel beds are required by trout to spawn. Loss of fish and waterfowl habitat and reduced recreational values caused by suspended sediment is a major problem.

Sedimentation in three major irrigation reservoirs is shown in Table 56. Average sediment concentrations are over 1 acre-foot per 1,000 acre-feet of inflow into the reservoirs. Average annual sediment deposition ranged from 0.57 to 0.102 acre-feet per square mile contributing area. Average annual deposition per 1,000 acre-feet of surface water inflow is: Otter Creek, 1.4 acre-feet; Piute, 1.01 acre-feet; Sevier Bridge, 1.07 acre-feet. These figures do not represent total sediment transport because of the large entrapment of sediment immediately above the reservoirs as well as in smaller upstream structures, irrigation systems, and other areas of deposition.

Sediment yield from some small drainages is evaluated in Table 57 and indicates the intensity of the problem in many areas.

Sedimentation on lands administered by the U. S. Department of Agriculture and other forested lands was based on an evaluation of existing watershed conditions. Findings are shown on Table 58 and were used in evaluating the land treatment opportunities and benefits shown on page 230.

TABLE 56.--Sedimentation in Otter Creek, Piute and Sevier Bridge Reservoirs, Sevier River Basin, 1963

Item	Unit	Reservoir		
		Otter Creek	Piute	Sevier Bridge
Average annual water inflow	Acre-feet	41,250	122,780	11,700
Total drainage area	Square miles	1,150	2,440	5,120
Sediment contributing area	Square miles	1,020	1,220	2,030
Years since previous survey	Years	37	22	28
Sedimentation:				
Total	Acre-feet	2,140	2,730	3,340
Average annual	Acre-feet	58	124	119
Average annual yield per square mile	Acre-feet	0.057	0.102	0.059
Storage capacity loss	Average annual	0.116%	0.173%	0.031%

TABLE 57.--Average sediment yield from selected drainages, Sevier River Basin

Watershed	Reservoir or debris basin and drainage or nearest town	Drainage area		Annual water yield per square mile	Annual sediment rate per square mile
		Square miles	Acres	Acre-feet	Acre-feet
A-1	Mt. Pleasant Fan, Pleasant Creek	16.50	10,560	645	1.90
A-3	Ephraim Fan, Ephraim Creek	23.05	14,750	670	4.20
C-2	Denmark Wash, Salina	28.33	18,130	50	0.53
C-5	Bull Pasture Basin, Salina Creek	37.84	24,220	470	0.71
C-5	Skutumpah Res., Skutumpah Creek	8.88	5,680	395	0.70
C-5	Soldier Basin, Soldier Canyon	12.61	8,070	30	0.57
C-6	Seven Mile Reservoir, Lost Creek	1.88	1,200	410	0.145
D-1	Cottonwood Fan, Richfield	16.67	10,670	205	1.70
D-1	Flat Canyon, Elsinore	14.48	9,270	55	0.72
D-3	Mill Canyon Ret. Str., Glenwood	17.50	11,200	40	0.40
D-4	Magleby Reservoir, Monroe Creek	2.95	1,890	320	0.31
D-4	Sand and "H" Canyon, Monroe	2.34	1,500	80	1.10
E-1	Booby Hole Reservoir, Booby Creek	4.05	2,590	255	0.115
E-1	Koosharem Reservoir, Daniels Creek	54.38	34,800	195	0.22

TABLE 58.--Annual gross sediment production based on hydrologic condition of National Forest and other forested lands, Sevier River Basin, 1968

Condition class	Sub-basin											
	A		B		C		D		E		F	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
	Acres	Acre-feet	Acres	Acre-feet	Acres	Acre-feet	Acres	Acre-feet	Acres	Acre-feet	Acres	Acre-feet
I[a]	52,870	13	80,750	20	86,880	22	93,620	23	203,430	51	218,820	55
II[b]	21,990	37	35,140	59	40,770	68	56,650	94	135,070	225	83,200	139
III[c]	25,930	43	31,420	52	52,270	87	61,090	102	81,360	136	52,930	88
IV[d]	26,360	132	59,600	298	81,200	406	87,500	437	67,960	340	47,980	240
V[e]	590	3	2,570	13	28,220	141	46,190	231	12,450	62	1,700	8
Total	127,740	228	209,480	442	289,340	724	344,940	887	500,270	814	404,630	530
	Average annual gross sediment rates											
Acre-feet per square mile	1.1		1.3		1.6		1.6		1.0		0.8	

[a]Low accelerated runoff and sediment contribution. Average erosion less than .005 in./yr. Runoff curve no. less than 45.

[b]Moderate accelerated runoff and sediment contribution. Average erosion .005 to .040 in./yr. Runoff curve no. 45-70.

[c]High accelerated runoff and moderate sediment contribution. Average erosion .005 to .040 in./yr. Runoff curve no. greater than 70.

[d]High accelerated runoff and high sediment contribution. Average erosion greater than .040 in./yr. Runoff curve greater than 70.

[e]High normal or geological runoff and high sediment contribution. Average erosion greater than .040 in./yr. Runoff curve no. greater than 70.

Runoff curve number: An expression of topography, ground cover, and soils which indicates the amount of surface runoff with a given rainfall. Example: If a 3" rain falls on an area with a curve number of 55, surface runoff will be 0.2"; with a curve number of 70, surface runoff will be 0.4".

Average erosion rates: A composite of findings at the Great Basin Experiment Station, Ephraim, Utah; the Sheep Creek water evaluation study conducted in Salina Canyon by the Forest Service on the Fishlake National Forest; the Chalk Creek Hydrologic Analysis also on the Fishlake National Forest; Reservoir and Debris Basin Surveys by the Soil Conservation Service.

Source: National Forest Field Surveys.

F L O O D W A T E R   D A M A G E

There is a history of flooding on nearly all tributary streams and portions of the main stem of the Sevier River. These floods have generally been caused by high-intensity, convective summer storms.

Some rainstorms cause mud-rock flows containing up to 85 percent silt, boulders, and debris. Deposition, along with the force of the moving flows, disrupts many services and causes damage to agricultural, municipal, industrial, and residential property. In mountain areas, floods damage fish and wildlife habitat, roads, trails, and other structural improvements along with the watershed. Occasional floods occur from excessive snowmelt runoff.

The major flood source areas are watersheds which are in poor hydrologic condition. Because of soil compaction and a lack of vegetative protection, their ability to absorb high-intensity storms is decreased. In some cases, developments have reduced channel capacities and gradients, causing flooding.

Most communities were founded near the mouth of mountain drainages where water was easily accessible for irrigation and domestic use. Subsequent history has proved that most of these locations are vulnerable to floodwater damage.

Although some tributaries discharge floodwaters in areas remote from municipal development and thus are not generally reported, floods are frequently dramatic and often receive wide publicity. Such a flood occurred July 24, 1946 at Mt. Pleasant causing damages estimated at $106,000. Debris was piled up to four feet in depth; mud and water swept through homes and ruined furniture, food, and supplies. Bridges were washed away and livestock lost. Sediment was deposited on cultivated lands and irrigation diversion structures were destroyed.

Historically, floods have claimed the lives of five Basin residents. As the land becomes more fully occupied by the works of man and property values increase, the potential for floods causing greater property damage is present.

The frequency of reported flooding has increased during the last four decades. This may be partially the result of increased interest and improved reporting facilities during recent years.

Table 59 lists the reported floods by sub-basin and relative magnitude. A frequency analysis could not be made because of insufficient data on peak flows. ( )

Manti - 1901

COURTESY LLOYD TUTTLE SR01-10

Flood water has been a serious problem since the earliest settlements.

Near Richfield - 1967

COURTESY REED MADSEN SR01-11

TABLE 59.--Reported floods in the Sevier River Basin, 1890-1968

Sub-basin	Relative magnitude			
	Small	Medium	Large	Total
	1890-1930			
A	8	15	40	63
B	0	7	10	17
C	9	9	13	31
D	9	17	19	45
E	3	0	2	5
F	5	10	9	24
Total	34	58	93	185
	1931-1968			
A	15	25	14	54
B	7	5	4	16
C	9	14	8	31
D	38	52	19	109
E	9	5	4	18
F	11	12	3	26
Total	89	113	52	254

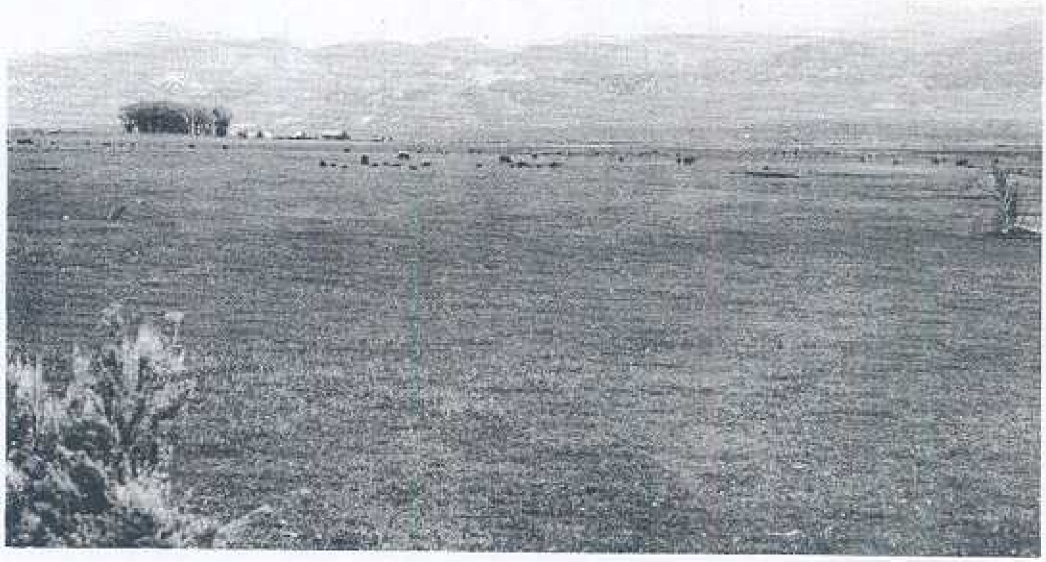
I M P A I R E D   D R A I N A G E

Most of the wetland areas exist because of impaired drainage. Artesian water pressure and poor surface drainage are often associated with these areas.

Water tables lying between 3 and 10 feet of the land surface are a significant source of water for some of the irrigated cropland although drainage problems may exist when water tables are within 5 feet of the surface. Table 60 indicates the extent of crop and pasture land with water tables at 5 feet or less.

TABLE 60.--Crop and pasture lands influenced by water tables, Sevier River Basin

Sub-basin	Croplands	Pasture lands			Total
	Water table depth				
	0-60"	0-12"	12-36"	36-60"	
	Acres	Acres	Acres	Acres	Acres
A	3,500	29,700	7,900	6,800	47,900
B	5,000	4,600	27,100	20,600	57,300
C	3,700	6,500	8,400	5,100	23,700
D	5,000	5,800	6,300	3,000	20,100
E	600	1,500	6,400	800	9,300
F	neg.	3,200	4,300	1,400	8,900
Total	17,800	51,300	60,400	37,700	167,200



Wild flooding and poor control of irrigation water waste our water and land resources.

Drainage problems may be increased as sufficient water is applied to the soil to prevent excessive salt accumulation. Also, attempts to store soil moisture when water supplies are plentiful have resulted in over-irrigation and have compounded the drainage problem.

The current drought has tended to reduce the drainage problem. In some areas, increases in irrigation efficiencies due to land leveling, ditch and canal lining and better water management have materially lowered water tables.

IRRIGATION PROBLEMS

Irrigation water shortages result in considerable economic loss and concern to the local people. During a year of average water supply and use, this deficit totals nearly 78,000 acre-feet root zone supply or over 240,000 acre-feet diversion requirement, at present irrigation efficiencies (Table 61).

TABLE 61.--Average annual consumptive-use deficits, Sevier River Basin, 1931-60

Sub-basin	Root zone	Diversion
	Acre-feet	Acre-feet
A	13,750	49,460
B	43,810	124,110
C	9,090	31,020
D	8,390	25,500
E	2,790	10,690
F	negligible	------
Total	77,830	240,780

A larger deficit actually exists than that indicated as all irrigation water is not distributed equally among the water users within one area or even within one irrigation company. Also, seepage and management losses associated with distribution and irrigation water transportation alter equal distribution. Water use by phreatophytes growing along canals contribute to the water shortage problem besides restricting the flow and reducing canal carrying capacity.

The main distribution canals were classified according to the following criteria: Good condition, less than 3 percent loss per mile; fair condition, between 3 and 6 percent loss per mile; and poor condition, over 6 percent loss per mile (Table 62).

TABLE 62.--Irrigation distribution system condition, Sevier River Basin

Sub-basin	Condition			Total Length[a]
	Good	Fair	Poor	
	Miles	Miles	Miles	Miles
A	160	200	70	430
B	105	25	210	340
C	80	175	10	265
D	50	95	65	210
E	45	40	25	110
F	5	120	---	125
Total	445	655	380	1,480

[a]These figures do not include major laterals of canal systems or transmountain diversions.

Improper irrigation practices include down-slope furrow irrigation on steep slopes, allowing tail water to stand at the bottom of fields, over-irrigation in spring months when the supply is plentiful, and not applying the proper amount of water each irrigation.

One of the major problems is an unstable irrigation water supply. Even in the larger irrigation systems where storage is the primary resource, supplies fluctuate from 1 acre-foot to 3 acre-feet or more per share in a two to three year period. This problem is illustrated for the Central Sevier area in Figure 11. The three canals illustrated receive their water supply from reservoir storage. Irrigation companies whose only source of water is tributary streams experience even greater fluctuations. An unstable irrigation water supply prevents accurate advance planning of crop acreages and results in fluctuating crop production.

OTHER WATER SHORTAGES

Lack of livestock water in many areas limits animal distribution and prevents the most efficient use of available forage on rangeland. Areas near streams, ponds, and other water developments are often damaged by over-use while other areas are not grazed. Also, the widespread practice of distributing winter livestock water through irrigation systems damages water control structures and canal lining and creates management problems.

Groundwater supplies are generally available to meet rural domestic requirements although some of the larger communities suffer recurrent summer shortages. Present legal restraints prohibit development of large wells and purchase of existing rights is difficult. Rationing of existing supplies for lawns and gardens has been an interim solution in some areas.

Development of a significant volume of high quality water on a sustained basis would be necessary if nonagricultural uses are to be expanded. This would require dedicating reservoir capacity and groundwater supplies for this purpose at the expense of present uses.

The demand for more and better recreational facilities is increasing. Limited potable water may restrict future development of campgrounds, picnic areas, organizational camps, and other water-using facilities. Competition for available water limits fishing and waterfowl habitat and creates conflicting interests between water uses.

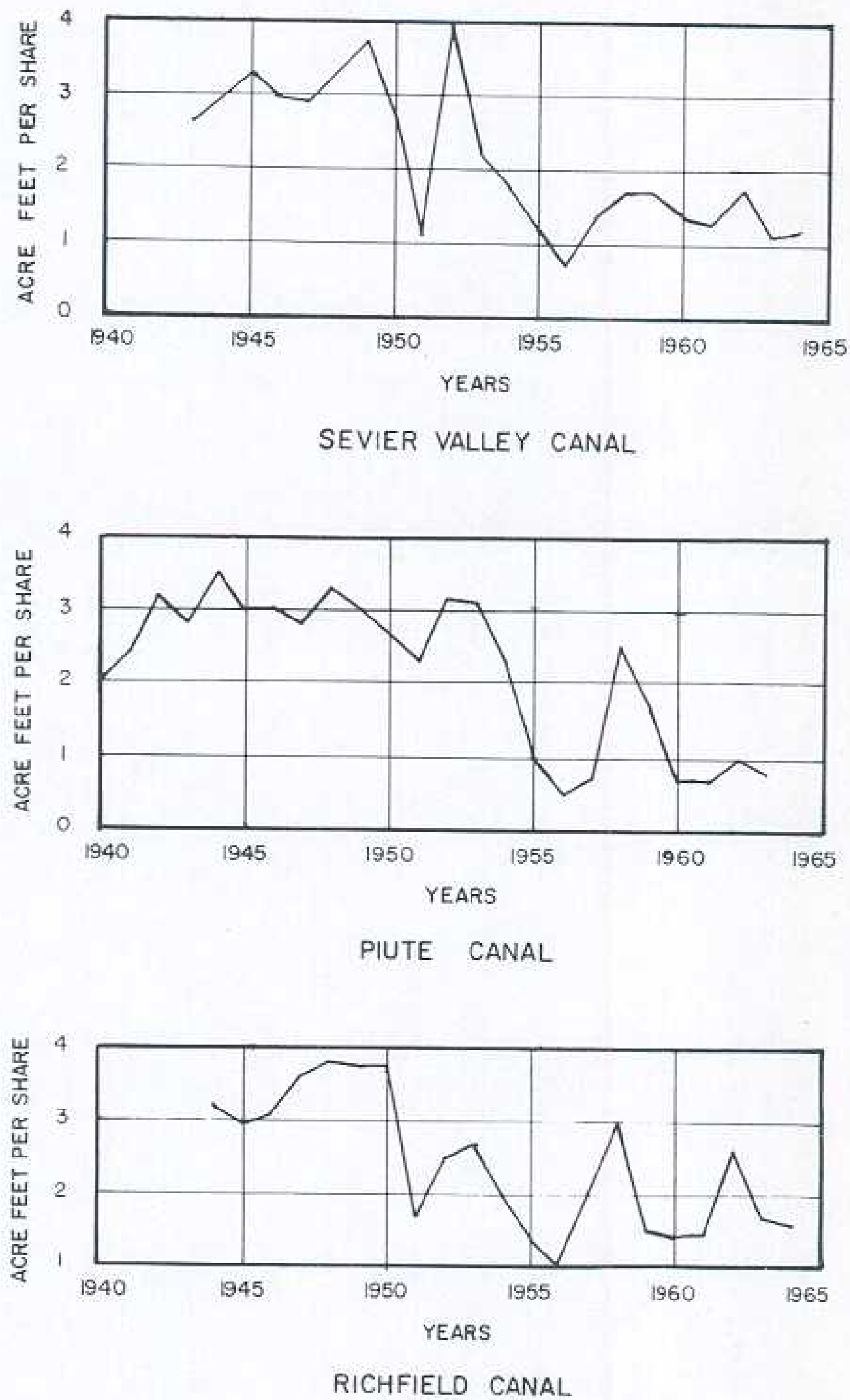


FIGURE 11: Water delivered to shareholders of three irrigation companies in Central Sevier Valley
1940–1964
Sevier River Basin
Utah

W A T E R   P O L L U T I O N

Both the present and future uses of the Sevier River and its tributaries are limited by pollution. The major pollution problems are excessive suspended sediment, dissolved solids, and bacteriological and chemical contamination. Of these, suspended sediment and dissolved solids are the most extensive and cause the greatest losses.

SUSPENDED SEDIMENT

Pollution from suspended sediment is a major problem in those irrigation systems that divert water from unregulated streams or that are susceptible to flood flows from side drainages. These irrigation companies are faced with annual cleanout costs even though they sluice much of the heavier bed-load back into the river system. Elaborate structures constructed to overcome this problem do considerable good, but they are not completely adequate.

Those areas just below watersheds with sedimentary rock parent material, especially those composed of fine-grained material, experience the greatest difficulty. Surface waters carrying heavy sediment loads reduce the efficiency of irrigation systems, decrease reservoir storage capacity, and decrease the irrigability and productivity of cultivated land.

DISSOLVED SOLIDS

Dissolved solids originate from two principal sources: (1) Leaching during irrigation; and (2) surface and groundwater leaching salts and gypsum from bedrock formations, principally Arapien shale in the central Sevier area. The extent of the problem is indicated in Figure 12. Field data was collected in a cooperative effort by the Utah State Division of Health, U. S. Geological Survey, Soil Conservation Service, Forest Service, and the Sevier River Water Commissioners.

Upstream from Richfield, concentrations of dissolved solids are under 500 milligrams per liter. Downstream concentrations increase rapidly, particularly with the inflow from Lost Creek which ranges from 2,000 to 38,500 milligrams per liter. Groundwater inflow between Redmond and Sevier Bridge Reservoir contributes large quantities of dissolved solids.

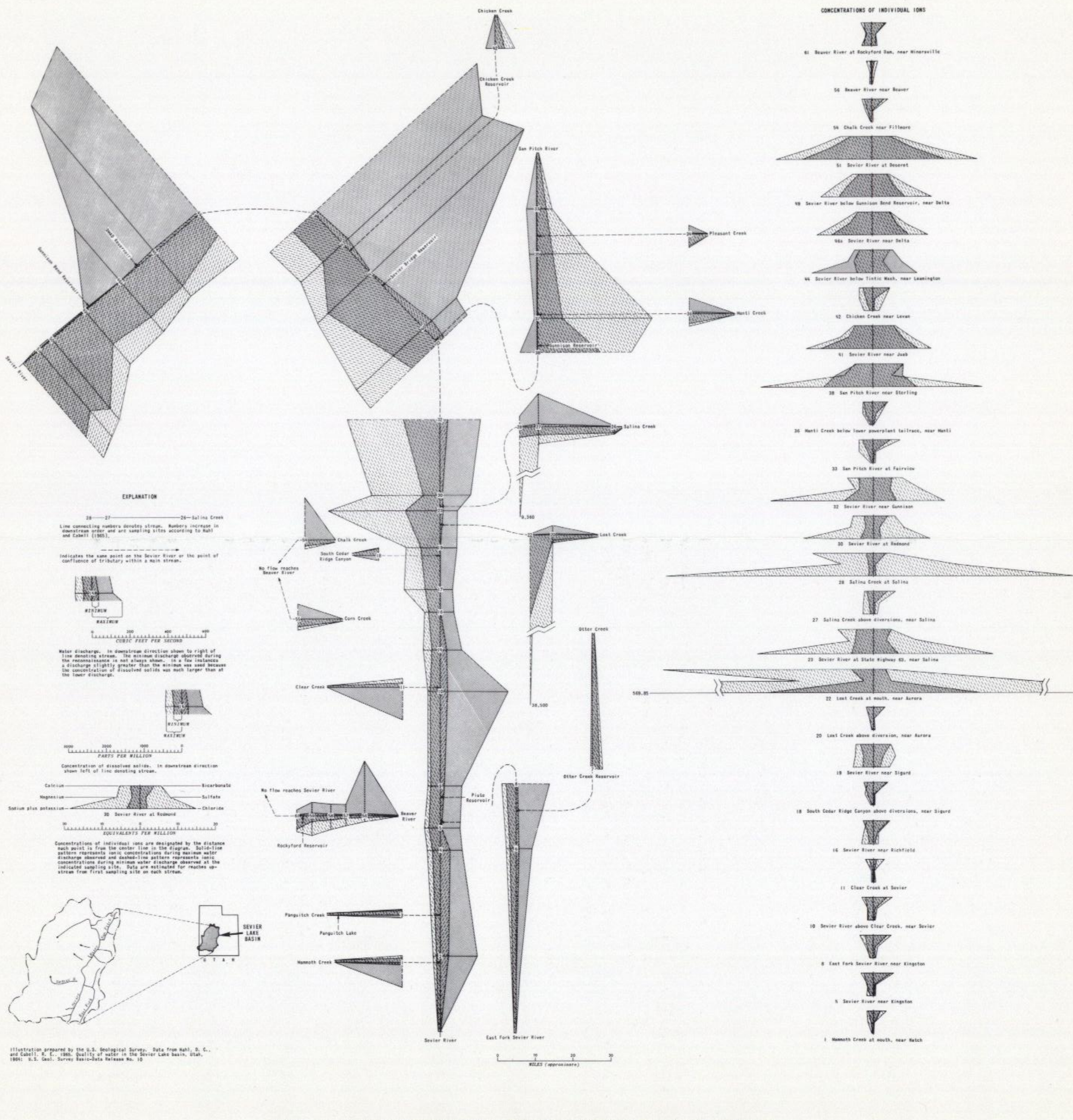


Figure 12: Diagram showing extreams in water discharge and corresponding concentrations of dissolved solids observed during the 1964 reconnaissance in the Sevier Lake Basin, Utah

BACTERIAL AND CHEMICAL

Precautions are necessary to prevent further bacterial contamination in headwater areas at administrative sites, summer homes, recreational developments, and at livestock and big game concentrations. Downstream sources include effluent from individual septic tanks and sewage treatment plants at Richfield, Salina, and Gunnison; drainage from livestock feedlots and corrals; and inadequate garbage disposal. Contamination has created health hazards in some canals and at points along the river.

Table 63 shows some of the extremes of most probable number (m.p.n.) of coliform organisms per 100 milliliter sample found. There were many other sample sites where the coliform count exceeded the accepted safe standard of 2,000 per 100 ml. in at least one sample.

TABLE 63.--Bacteriological contamination at selected sites, Sevier River Basin, 1964

Sample site	Date of sample	MPN Coliform per 100 ml.[a]
Vermillion Canal at Glenwood Road near Richfield	March 9	43,000
Salina Creek at Salina	September 21	23,000
Sevier River at Redmond	July 28	15,000
Sevier River at highway bridge, near Hinkley	March 11	23,000
	July 29	230,000

[a]Accepted safe standard is 2,000 per 100 ml.

Chemical pollution is not a serious problem at present, but its sources are widespread. Chemicals used in fertilizers, pest-control sprays and dusts, herbicides, and those that are leached from saline soil adversely affect water quality. Organic solutes from livestock feedlots, corrals, manure-storage sites, and barns may be carried by overland flows and groundwater drainage. These chemicals are often toxic in themselves and in other cases may add nutrients to the water that increase undesirable slime and bacteriological growths.

Pollution from industrial sources is not significant at present, but it could become a problem without adequate controls.

Water quality is not a serious problem for most rural and community domestic-water supplies using groundwater sources. These supplies require only limited treatment or none at all, but most communities are lax in maintaining adequate facilities.

Irrigation and stock water can be of lesser quality than is required for most other uses. A coliform count up to 5,000 per 100 ml. is acceptable. The mineral salt content of the water increases downstream where return flows carry leached salts from the soil. When this water is used along the lower reaches, the high salt content requires additional water for leaching.

Water containing excessive pollutants is neither safe nor suitable for fishing, boating, water skiing, or other recreational uses. Some fishing habitat has been destroyed by sediment, chemical and bacterial pollution, or an increase in water temperature.

PHREATOPHYTES

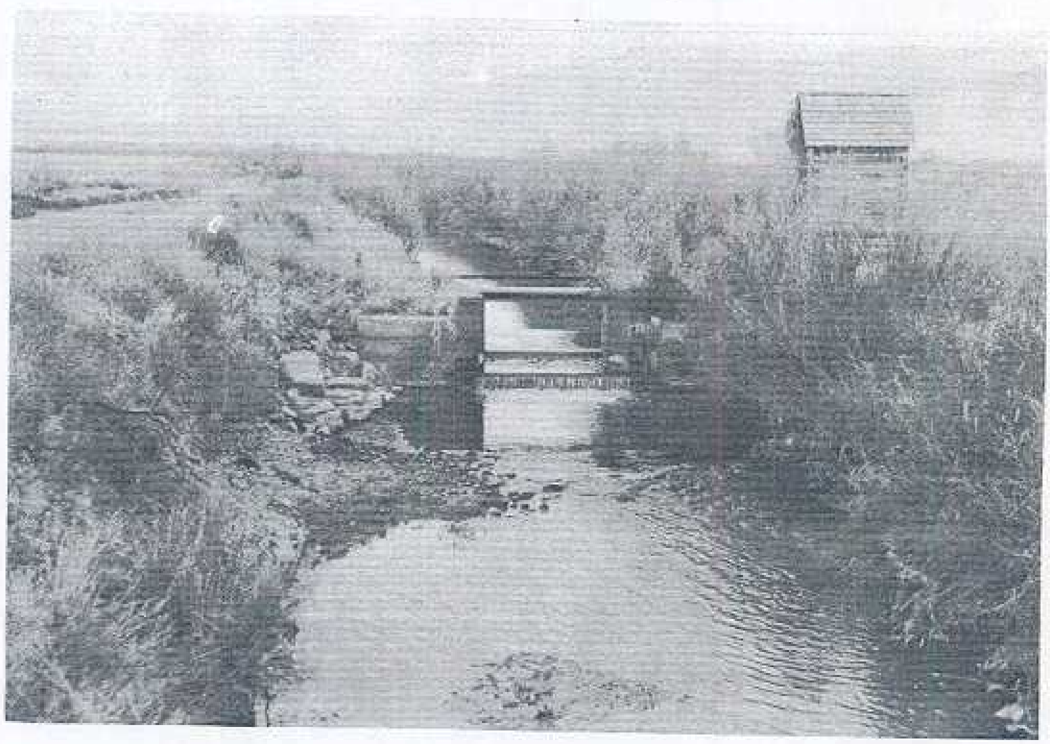
Phreatophytes are plants that habitually obtain their water supply from the zone of saturation, either directly or through the capillary fringe. References below refer to those phreatophytes only within the water-budget areas.

Phreatophytes include wet meadows, nonrotated pastures, saltcedar, cottonwood, willows, greasewood, sagebrush, rabbitbrush, cattails, and tules. Totally, they use about 285,000 acre-feet of groundwater annually. Wet meadows and nonrotated pastures, which constitute 54 percent of the total phreatophyte area and use nearly 60 percent of the groundwater, are economically the most valuable of all phreatophytes because of their use for grazing livestock or, in the case of the wet meadows, for harvesting hay.

The other phreatophytes, while not as economically profitable as these lands, are beneficially utilized to some extent. They provide habitat for waterfowl and furnish food and cover for game, and create aesthetic vistas. However, they do create some water use problems. They use 159,000 acre-feet of groundwater annually, and certain phreatophytes, notably saltcedar and willows, infest reservoirs, canals, and wet meadows which increases the costs and time needed to maintain these areas.

FIELD PARTY PHOTOS 8-682-7

Phreatophytes waste valuable irrigation water.



8-879-10

FOREST AND RANGE FIRE AND INSECT DAMAGE

There is historical evidence that fires burned large areas of Sevier River Basin forest lands 75 to 100 years ago. Historians relate that burning concentrations of heavy brush or timber near sheep bed grounds to prevent coyotes from molesting the flocks and burning rangeland to improve grazing were common in the late 1800's. Some lightning fires probably burned uncontrolled for many days or even weeks. Until National Forests were established, there were probably few attempts made to halt such fires. Recent losses due to wildland fire have not been large, but there is always a possibility of large conflagrations.

Insect and disease damage on forest and rangelands is a greater menace than fire. Such damage is not dramatic and often goes almost unnoticed until epidemic proportions are reached. Ips and Dwarfmistletoe are destructive to all conifers. Douglas-fir beetles attack Douglas fir. Spruce budworm is found on true firs and as populations of this insect increase, other conifers may be attacked. Spruce bark beetle and root rot are destructive to spruce. Aspenleaf miner and Hypoxylon Canker destroy a great deal of aspen. Browse plants such as chokecherry, serviceberry, and bitterbrush are attacked by a species of tent caterpillar. Grasshoppers have been a serious pest. A new destructive insect, Labops hesperius, which feeds on the sap of wheatgrasses of all species, is doing extensive damage, particularly to reseeded crested wheat stands.

IMPAIRMENT OF NATURAL BEAUTY

Many clear streams which once enhanced the beauty of the landscape are no longer attractive. Some large reservoirs contain suspended solids and possibly other pollutants which make them unattractive for recreational use instead of havens for boating, fishing, swimming, and other recreational pursuits.

Some small tributary streams which once meandered through grassy meadows or bubbled in their natural channels through canyon bottom stands of cottonwood and willow are now laden with sediment and reach the valley floor by travelling in washes many feet deep.

CHAPTER VI

PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

In this section, the present and future needs related to water and land resources within the Sevier River Basin are described. The specific areas covered include watershed protection and management; flood protection and sediment control; drainage and irrigation developments; municipal, rural domestic, livestock, and industrial water supplies; recreation, fish, and wildlife; and water quality control.

WATERSHED PROTECTION AND MANAGEMENT

Watershed improvement is needed to increase on-site productivity of the land and help prevent floods, reduce sediment, improve water quality, stabilize stream channels, and sustain the flow of unregulated streams into the drier summer months. Since heavy to excessive erosion occurs on 20 percent, or 1,040,000 acres of the total Basin area, a need is indicated for accelerating soil stabilization activities on these lands. Erosion problems resulting from transmountain diversions in both Subbasins A and F need correction. Also, management and structural measures are needed to control pollution.

In addition to these programs, improved watershed management is needed to promote better distribution of livestock and big game and thereby avoid overgrazing and cover deterioration in the more accessible and preferred areas; to limit soil disturbance in harvesting timber, constructing roads, and mining; and to confine motorized traffic to roads and trails.

In addition to impairing water resources, erosion and sediment problems have far reaching effects on aesthetics, wildlife and fish, recreation, and the total agricultural economy. The measures needed to help solve these problems on National Forest and other forested land include 285,600 acres of watershed improvement, 225,175 acres of range improvement, 1,980 miles of road, trail, and gully stabilization, 763 miles of management fence installation, and 365 separate range water developments.

FLOOD PROTECTION AND SEDIMENT CONTROL

Although many flood protection and sediment control measures in varying degree are needed, major developments in 12 watersheds--A-1, 2, 3, 4; B-1, 2; C-5; D-1, 2; E-5; and F-1, 3--should be completed in the near future. Smaller flood retarding and sediment control reservoirs are required along with the other control measures in Watersheds B-4; C-1, 2, 6; D-6, 7, 8; E-1, 3, 4; and F-2, 4, 5.

Since they were first settled, communities in most watersheds have been recurrently damaged by floodwater and sediment. Unless flood protection and sediment control measures are adopted within the next 10 to 15 years, the damages to communities from these problems will likely increase. In order to improve the value of irrigation, livestock and recreation water uses, nearly all areas should adopt such protective measures.

DRAINAGE AND IRRIGATION DEVELOPMENTS

Drainage and irrigation developments are needed to improve economic returns from present water supplies, along with supplemental water for agricultural production. Facilities to lower water-table levels in selected areas are needed to improve the productive capabilities of some irrigated lands, to decrease or eliminate consumptive use of water by low-economic-value vegetation, and to prevent salt buildup in the soil in the following areas: Sub-basin A; and Watersheds B-1, 2, 7; C-1, 2, 4, 5; D-1, 2, 3, 4, 6, 7, 8; E-1, 3, 4; and F-1, 2, 3.

Improved agricultural water management, including increased irrigation efficiency to achieve best use of drained lands and water salvaged from low-value vegetation, is needed. Proper application of water is also required to leach salts from some irrigated lands.

Leaching requirements in the Delta area, the only area now requiring wide scale leaching, are given in Table 64 as the percentage of irrigation water needed to prevent salt buildup and maintain productivity. Listed requirements are based on the assumption that drainage is provided to lower water tables to 3 to 4 feet below the land surface.

TABLE 64.--Leaching requirements in the Delta area, Sevier River Basin

Type of crop[a]	Irrigation water[b]	
	Percent	Acre-feet
Salt tolerant	36	49,300
Moderately salt tolerant	42	57,500
Salt sensitive	47	64,400

[a]Salt tolerant crops: Tomatoes, oats, sweet clover, alfalfa, sugar beets, milo, barley.

Moderately salt tolerant crops: Wheat, smooth brome.

Salt sensitive: Potatoes, peas, beans, fruit trees, clover (White Dutch, Ladino, Red, Alsike).

[b]Requirements are for long-time average conditions. Variations in rainfall and irrigation supplies may alter leaching requirements to maintain salt balances for shorter periods.

Reference: U. S. Department of Agriculture 1954, Diagnosis and improvement of saline and alkali soils, Handbook No. 60, page 37.

Leaching in other areas may become necessary as the irrigation efficiency is increased and additional saline soils are converted to production of less salt tolerant crops.

There are 250,000 acres of potentially irrigable lands that would require expansion of the present distribution systems and additional gross diversions of about 1,000,000 acre-feet annually if completely developed. Use of return flows from new diversions would be limited as only 200,000 acre-feet would be diverted above Sevier Bridge Reservoir. Table 65 lists the need for additional irrigation water. These needs are based on maintaining a high level of agricultural water management on these lands.

In order to better utilize the present distribution networks, there is a need for long term and regulatory storage capacities. These reservoirs will help stabilize the cyclical and seasonal variations in water supply. About 50,000 acre-feet (Table 78, page 203) of additional storage capacity are needed in the next 10 to 15 year period.

TABLE 65.--Present and potential irrigation water needs, Sevier River Basin

Item	Units	Sub-basin						Total
		A	B	C	D	E	F	
Present diversions	Acre-feet	158,900	199,300	178,000	191,900	50,600	136,400	915,100
Efficiency[a]	Percent	29.0	37.0	29.5	33.0	25.5	31.5	31.8
Additional diversions needed with present efficiency	Acre-feet	62,500	123,000	47,400	37,200	5,000	1,900	277,000
Efficiency needed with present diversion	Percent	40.0	60.0	37.0	39.0	28.0	32.0	41.5
Irrigable lands	Acres	24,250	194,890	7,050	6,260	4,300	13,240	249,990
Additional diversions needed for new lands[b]	Acre-feet	101,000	812,000	29,500	26,000	18,000	55,000	1,041,500

[a]Weighted average delivery and on-farm efficiency.

[b]Computed on the basis of 40 percent efficiency, a net root zone requirement of 20 inches not including precipitation, and no diversion of return flows.

MUNICIPAL, RURAL DOMESTIC, LIVESTOCK, AND INDUSTRIAL WATER SUPPLY

Although some communities experience shortages during high-use periods in the drier years, the declining population of the Basin indicates that present needs for municipal and rural domestic water are generally limited to system replacement. However, there is a need for installing treatment plants and improving distribution systems, and in some communities, for increasing inadequate fire protection capacities. Demands are expected to increase approximately 32 percent (3,800 acre-feet) by the year 2020 (Table 66).

Livestock water supply development is needed for grazing management and to decrease irrigation system maintenance. Winter livestock watering developments are needed to replace the present inefficient method of using irrigation facilities. Development of range watering points with better geographic distribution is a necessity for the best utilization of grazing lands.

Industrial uses of water may be expected to increase 700 percent (15,700 acre-feet) by 2020. This is based on an anticipated need for increased industrial employment as well as on increased population. Although it is not anticipated that high water-using industries will be established, the construction of facilities such as the beryllium refining plant near Lyndyll could invalidate the projections. Development of water may be on a self-supplied basis, but purchase of water rights is more probable. There may be an occasional need for community action to make supplies available for promotion of new industries.

TABLE 66.--Projected municipal, rural domestic, and industrial water diversion demands in the Sevier River Basin

Item	Units	1960	1980	2000	2020
Municipal and rural domestic					
Daily per capita	Gal/day	346	366	376	396
Annual	Acre-feet	12,040	12,610	14,090	15,860
Increase over previous 20 years	Percent		4.7	11.7	12.6
Industrial					
Annual	Acre-feet	2,210	9,390	13,470	17,880
Increase over previous 20 years	Percent		324.9	43.5	32.7
Total	Acre-feet	14,250	22,000	27,560	33,740

Source: Harline, Dr. Osmond L., & others, 1963, Use of water for municipal and industrial purposes, Utah Counties 1960-61, Bureau of Economics and Business Research, College of Business, University of Utah.

Harline, Dr. Osmond L., Projection of water withdrawals for municipal and industrial uses. Bureau of Economics and Business Research, College of Business, University of Utah. Unpublished paper.

R E C R E A T I O N , F I S H A N D W I L D L I F E

RECREATION

Recreational needs are based on projected demands to 1980, 2000, and 2020 (Table 67). The need to provide for this expanding demand, which will increase at least 8-fold by 2020, requires that water and related land resources be evaluated for aesthetic suitability, accessibility, and other factors which influence recreational and other uses. A detailed study is needed which includes determination of water quality improvement to meet projected recreation demands. Projections indicate that all water-based developments should include recreation.

Recreational opportunities exist at Otter Creek, Piute, Sevier Bridge, and DMAD Reservoirs. Efforts should be made to provide shade, enhance aesthetics, increase accessibility, and develop facilities at these locations. Additional facilities are needed on the Markagunt and Paunsaugunt Plateaus near the "pink cliffs." Also, improved roads should be constructed to provide access to many desirable recreation sites not now available to the public.

Skyline Drive in Sub-basin A is planned for expansion into a high standard scenic drive. This will provide a connecting link from U. S. Highway 6 and 50 to Interstate 70 and will treat the traveler to many scenic panoramas.

Interstate 70, now under construction, will follow Salina Canyon in Sub-basin C, into Sevier Valley and up Clear Creek Canyon in Sub-basin D. The Utah State Department of Highways has estimated traffic along this route will be 2,500 vehicles a day by 1986. Many of these travelers will be recreation visitors and facilities to accommodate them are needed.

In order to meet the recreational demand expressed in Table 67, an accelerated development program is needed. It will require that 104 new development units and 37 replacement units be constructed each year by 1980. By the year 2000, development units and replacement units will increase to 186 and 142 respectively; similar units needed and replaced each year by 2020 are 200 and 328 respectively (Table 87, page 233).

On National Forest lands, present facilities provide approximately one acre of recreation development for every 1,000 visitor-days use. These developments include campgrounds, picnic sites, organization camps, commercial public service sites, and summer homes on 730 acres. Applying this same rate to the night and day visitor-days use indicates that by 2020, 7,141 acres in all ownerships will be required for exclusive recreation use. By this date it is also likely that the present large

TABLE 67.--Present and projected visitor days of recreation demand,[a] Sevier River Basin, 1963-2020

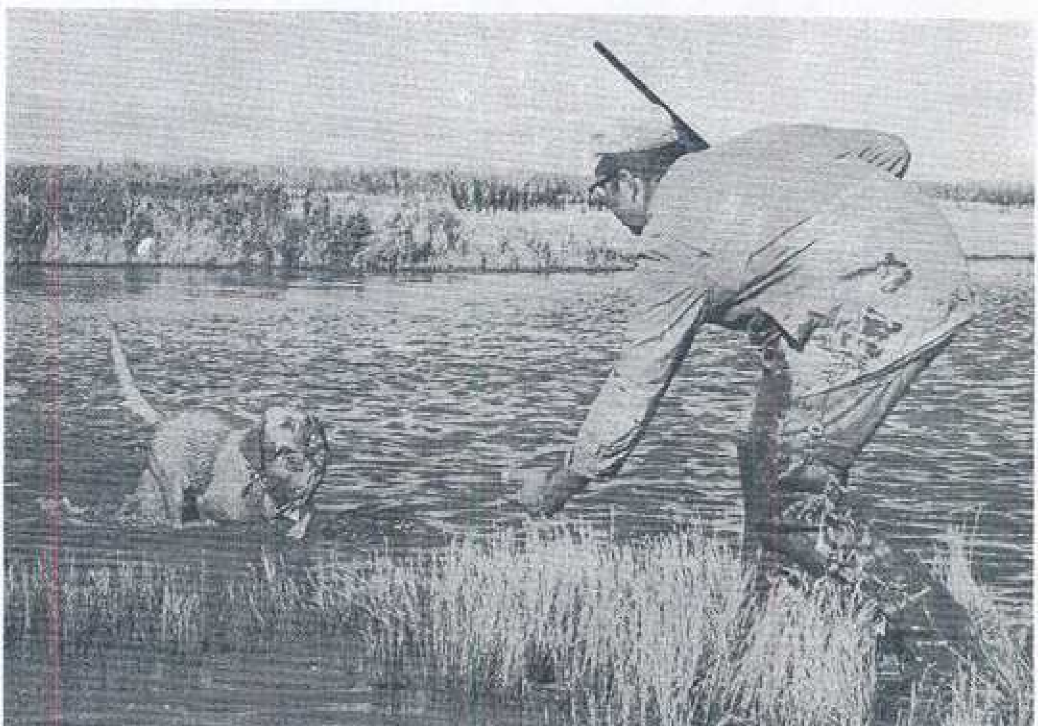
Sub-basin	1963		1980		2000		2020	
	Day	Night	Day	Night	Day	Night	Day	Night
	Number	Number	Number	Number	Number	Number	Number	Number
A	133,875	44,425	344,000	114,000	592,000	196,000	839,000	279,000
B	40,922	33,110	97,000	78,000	162,000	131,000	228,000	184,000
C	33,732	24,895	75,000	56,000	125,000	92,000	174,000	128,000
D	37,050	31,923	73,000	63,000	116,000	100,000	158,000	136,000
E	287,264	126,862	1,137,000	502,000	2,137,000	944,000	3,137,000	1,385,000
F	307,616	115,399	993,000	372,000	1,799,000	675,000	2,605,000	977,000
Total	840,459	376,614	2,719,000	1,185,000	4,931,000	2,138,000	7,141,000	3,089,000

[a]A visitor day is equal to a 12 hour period. These estimates, based on a rate of increase the same as population, are conservative. Higher personal disposable income, more leisure time, and increased mobility should accelerate recreation demands faster than population growth.

Reference: Utah State Recreation Planning Subcommittee, 1966, Outdoor recreation for Utah 1965-1975. Black, Teral R., 1966, Age and sex population for Utah counties.

UTAH STATE DIVISION OF PARKS & RECREATION PHOTO SR81-7

Water based activities are becoming more popular.



UTAH STATE DIVISION OF FISH & GAME PHOTO SR81-8 proportion of dispersed recreation such as hunting and fishing will decrease and will be replaced by recreation oriented toward developed sites. However, total hunting and fishing demand will increase.

FISH AND WILDLIFE

The aesthetic demand on fish and wildlife resources will increase as population expands. Greater emphasis is needed in maintaining a variety of wildlife as well as optimum numbers of popular game species. Improved fish habitat is needed on 399 miles of stream classed as suitable for fish, and development of suitable fish habitat is needed on portions of 459 miles now classed unsuitable (Table 12, page 80).

Habitat for waterfowl is diminishing as land and water become more intensively used and developed. There is a need to preserve and enhance this resource in selected areas. Additional water developments are needed in drier areas to serve the needs of upland game birds and other wildlife.

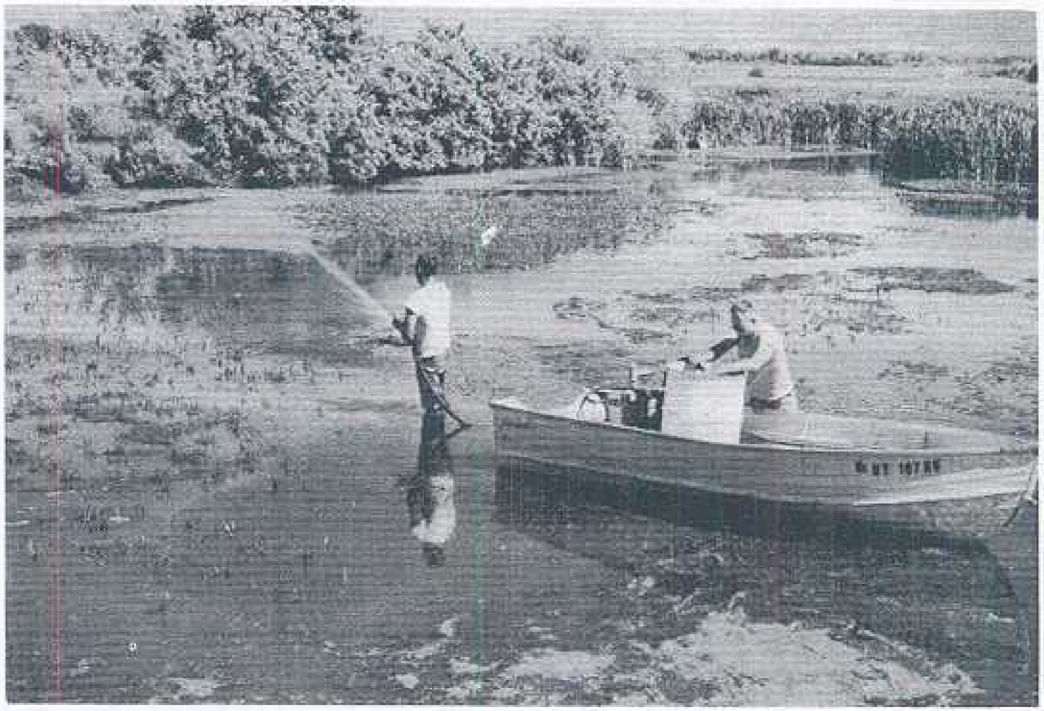
There is a need to improve deer herd management on damaged range to allow recovery of this habitat and improve forage conditions. Domestic livestock often compete with wildlife for available forage, and indirectly they produce erosion and other environmental changes which affect wildlife. There is a need for additional coordination between these uses of the resource.

Highway construction and other development of wildland areas limit wildlife habitat, interfere with migration between summer and winter ranges, and open new areas to an influx of people which may have a disturbing affect on wildlife species. Wildlife and their needs should be considered in all development and use of water and related land resources.

W A T E R   Q U A L I T Y   C O N T R O L

Irrigation, domestic, industrial, recreation, aesthetic, and fish and wildlife water uses all require water quality protection and improvement. Water quality in the main stem of the Sevier River to Gunnison Bend Reservoir needs to be maintained or improved to meet the standards of Class "C" waters as defined by the State. Class "C" waters are defined as follows:

Heavy sediment loads are typical of many streams. Note clear flow entering from the right. FIELD PARTY PHOTO 8-882-2



Many potential fishing areas need treatment to provide suitable habitat. SOIL CONSERVATION SERVICE PHOTO 8-1392-3

Class "C" Waters shall be so protected against controllable pollution, including heat, as to be suitable at all times for domestic water supplies which are treated before use by coagulation, sedimentation, filtration, and disinfection. Class "C" waters shall be suitable without treatment for irrigation, stock watering, propagation and perpetuation of fish, other aquatic life, and wildlife, recreation (except swimming), as a source of industrial supplies, and for other uses as may be determined by the Boards. (24)

In order to meet the above standards, there is a need to locate sources of contamination through a sampling and testing program and to reduce the bacteriologic count in the lower reaches of the river and in several canals.

The quality of irrigation water needs to be improved. In most areas, particularly where irrigation supplies are not obtained from reservoir storage, the suspended sediment load should be reduced to prevent detrimental effects on diversion works, canals, and fields.

It is difficult to precisely define the limits of concentrations of dissolved solids allowable in irrigation water. Successful irrigation enterprises exist along the lower reaches of the river where salt concentrations range from 1,000 to 2,000 milligrams per liter. This is possible because of extra water used for leaching salts. Increased demands for irrigation water will require importation of high quality water to maintain the dissolved solids concentration below 1,000 milligrams per liter. Otherwise, the water available for consumptive use downstream from Salina will be reduced. Upstream concentrations are presently below this amount.

Existing limitations on recreational developments and fishing habitat are often connected with impaired water quality. As the demand for more outdoor facilities increase it will be imperative to improve the water quality in the larger storage reservoirs to make them more attractive for such uses as boating, water skiing, swimming and fishing. This will require reduction of suspended sediment, dissolved solids, and bacteriologic pollution to acceptable levels.

Present and projected demands do not indicate a need for using surface waters for domestic or industrial purposes. With the exception of a few saline aquifers in the central and lower parts of the Basin, the deep groundwater now used is of high quality and requires little precautionary treatment. However, there is a need to protect these groundwater supplies from pollution. Many of the existing systems are not approved by the State. Some are provisionally approved pending system improvement. Status at the end of 1965 is shown in Table 68. The four classifications used by the Utah State Division of Health are:

"Approved": (1) The system has no defects which might result in water contamination, (2) the required number of samples has been submitted for bacteriologic analysis, (3) bacteriologic quality of the water has met the requirements, and (4) operation reports (where required) have been submitted regularly.

"Provisionally Approved": (1) The supply has met all of the requirements for an "Approved" rating, except for minor defects in the process of correction.

"Not Approved": (1) Bacteriological quality of the water has not met the requirements, or (2) the required number of water samples has not been submitted regularly for bacteriologic analysis, and (3) the system has defects not in the process of being corrected, and (4) operation reports (where required) have not been submitted regularly.

"Classification Pending": Related to "Not Approved" supplies for which acceptable plans and timetable for improvements have been submitted and accepted. The plans must insure correction of system deficiencies. The rating is continued, so long as the planning improvements are completed on the agreed schedule and until a suitable surveillance program is conducted. Following the conclusion of the surveillance program, the system is re-rated.

TABLE 68.--Status of public water systems, Sevier River Basin

System	County	Classification			
		Approved	Provisional approval	Classification pending	Not approved
Annabella	Sevier	X			
Antimony	Garfield				X
Aurora	Sevier		X		
Austin	Sevier				X
Burrville	Sevier				X
Cannonville	Garfield				X
Centerfield	Sanpete		X		
Central	Sevier	X			
Chester	Sanpete				X
Circleville	Piute				X
Delta	Millard	X			
Elsinore	Sevier		X		
Ephraim	Sanpete			X	
Fairview	Sanpete				X
Fayette	Sanpete				X
Fountain Green	Sanpete		X		
Freedom	Sanpete				X
Glenwood	Sevier		X		
Gunnison	Sanpete			X	
Hatch	Garfield		X		
Holden	Millard				X
Joseph	Sevier				X
Junction	Piute				X
Kingston	Piute				X
Koosharem	Sevier		X		
Leamington	Millard				X
Levan	Juab				X
Lynndyl	Millard	X			
Manti	Sanpete			X	
Marysvale	Piute				X
Mayfield	Sanpete				X
Monroe	Sevier		X		
Moroni	Sanpete		X		
Mt. Pleasant	Sanpete				X
Oak City	Millard		X		
Panguitch	Garfield			X	
Redmond	Sevier		X		
Richfield	Sevier		X		
Salina	Sevier		X		
Scipio	Millard				X
Sevier	Sevier				X
Sigurd	Sevier		X		
South Monroe	Sevier				X
Spring City	Sanpete				X
Sterling	Sanpete				X
Tropic	Garfield				X
Wales	Sanpete				X
Total		4	14	4	25

Source: Utah State Division of Public Health.

CHAPTER VII

EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

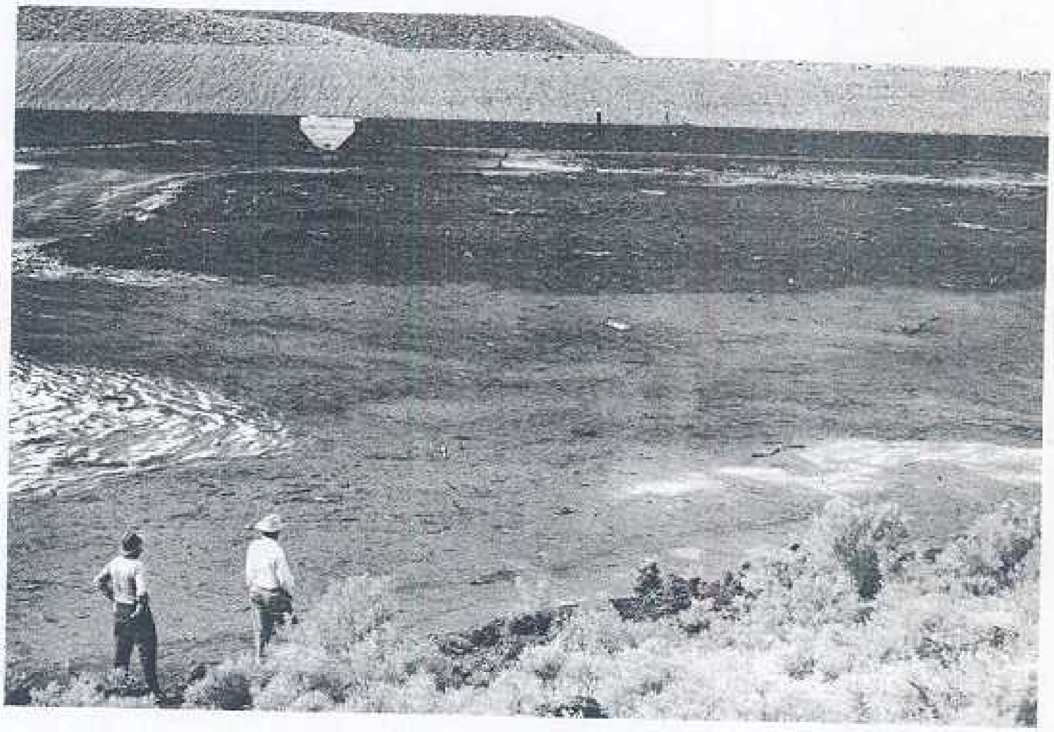
In this section, the existing water and related land resource projects and programs in the Sevier River Basin are described. The projects are analyzed according to the contributions they are making, the level of development they have attained, and the significance they have in meeting projected needs. The specific areas covered include Watershed Protection and Flood Prevention Projects; Soil Conservation District programs; Conservation Operations programs; Cooperative State-Federal Forestry programs; National Forest development and multiple-use programs; other public lands; and State developments.

WATERSHED PROTECTION & FLOOD PREVENTION PROJECTS

Pleasant Creek and Mill Canyon-Sage Flat Watershed projects have been completed and Monroe-Annabella is now under construction through PL-566, the Watershed Protection and Flood Prevention Act. In addition, local sponsors have submitted applications for nine additional projects. Planning has been completed on one of these. (25) The authorized projects are described in the following paragraphs.

PLEASANT CREEK PROJECT

The Pleasant Creek Pilot Watershed Project in Watershed A-1 was installed on a perennial stream which experienced frequent flooding from high intensity thunderstorms. The project provided land treatment for soil stabilization and floodwater retention. Debris basins remove the remaining sediment load from floodwaters and provide flood routing capacity to control the size of flood peaks. Benefits to Mt. Pleasant and surrounding cultivated lands resulted from reduced floodwater and sediment damages, increased irrigation diversions, and improved watershed conditions. An evaluation report on the effects of this project has been prepared. (16)



Mill Canyon floodwater and sediment control structure above Glenwood, Utah.

SOIL CONSERVATION SERVICE PHOTO 8-860-4

Contour trenching on Pleasant Creek watershed project near Mt. Pleasant, Utah.

U. S. FOREST SERVICE PHOTO, SRBI - 6

MILL CANYON - SAGE FLAT PROJECT

The Mill Canyon-Sage Flat Project in Watershed D-3 included land treatment on the upper watershed for soil stabilization, improved forage production for livestock and wildlife habitat, and floodwater retention. Structural measures included a floodwater and sediment control reservoir, floodwater channel, and minor irrigation system structures. The benefits are reduced floodwater and sediment damage in the town of Glenwood and surrounding irrigated area. This was the first project completed under PL-566 in the United States.

MONROE - ANNABELLA PROJECT

The Monroe-Annabella Watershed Project in Watershed D-4 is currently under construction. Project features include land treatment and structural measures in the upper watershed and the foothill area to reduce flood runoff, retard sediment movement, curb erosion, increase forage production, and protect utilities and urban property from flood damage; on-farm land treatment and structural measures to conserve irrigation water and improve the maintenance and productivity of irrigated cropland; and agricultural water management structural measures to control and stabilize canal flow and reduce seepage losses.

SOIL CONSERVATION DISTRICT PROGRAMS

The eight Soil Conservation Districts in the Basin--Delta, Juab, Millard County, Piute County, Sanpete County, Sevier County, Upper Sevier, and Canyonlands--all have progressive programs underway to provide proper conservation practices on private lands through cooperative agreements with 2,842 of the 3,052 farm operators (1962). Through these agreements, private landowners obtain technical assistance from the Soil Conservation Service for application of conservation practices. Additional activities include assistance to irrigation companies, drainage districts, recreation groups, and rural communities. The U. S. Forest Service and U. S. Bureau of Land Management cooperate with the Districts when public lands are involved in development programs.

C O N S E R V A T I O N   O P E R A T I O N S   P R O G R A M

SOIL CONSERVATION SERVICE

The Conservation Operations program enables the Soil Conservation Service to furnish technical assistance to Soil Conservation Districts through PL-46 to facilitate soil and water conservation. There have been a significant number of land treatment and agricultural water management practices installed under this program. Table 69 lists three common practices.

TABLE 69.--Land leveling, on-farm ditch lining, and canal lining completed in Sevier River Basin

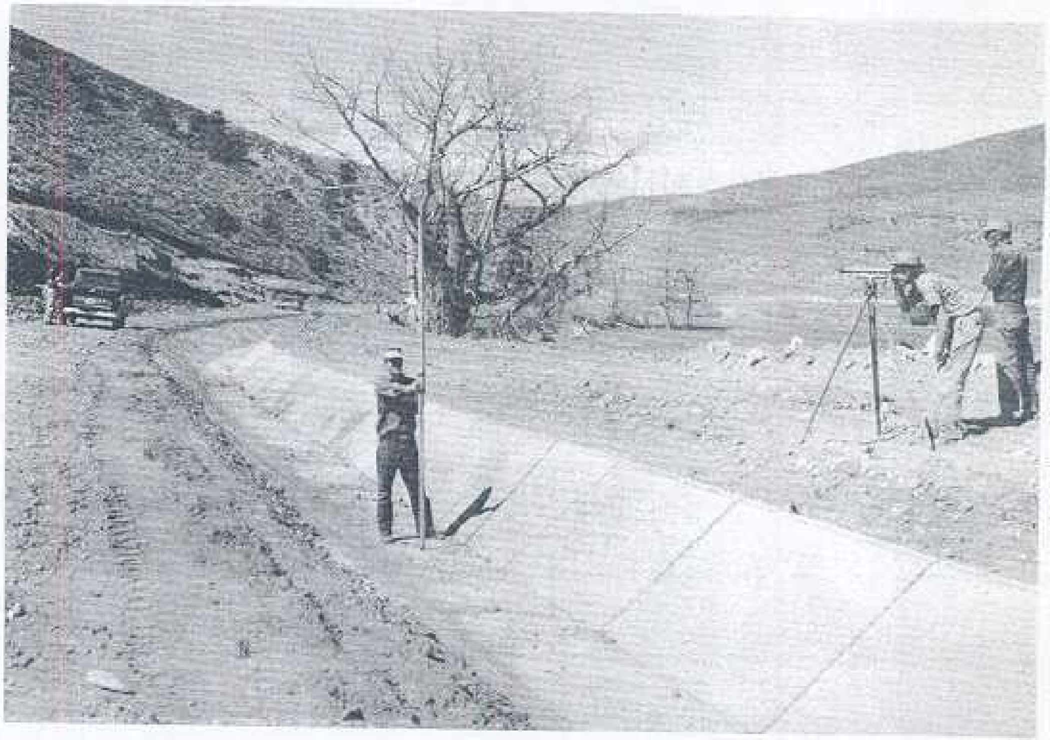
Sub-basin	Land leveling	On-farm ditch lining	Canal lining
	Acres	Miles	Miles
A	6,000	35	45
B	41,000[a]	20	105
C	8,500	15	10
D	10,500	20	20
E	500	Less than 5	10
F	2,500	10	5
Total	69,000	100	195

[a]Does not include 6,000 acres of releveling.

In addition to these and many other conservation practices, sprinkler systems have been installed on 4,000 acres, 500 farm ponds have been constructed, and about 90 irrigation water diversion structures installed.

FIELD PARTY PHOTO 8-966-2

Lining irrigation canals improves the efficiency of water use.



SOIL CONSERVATION SERVICE PHOTO 8-656-12

There are approximately 30 snow courses within and immediately adjacent to the Basin which are presently being used in the Cooperative Federal-State-Private Snow Survey program to forecast streamflow and water supply conditions.

AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE PROGRAM

The Agricultural Stabilization and Conservation Service provides financial assistance for installing conservation practices to nearly all farm and ranch units. The extent of the assistance in 1966 is indicated in Table 70.

TABLE 70.--Conservation practice cost sharing in Sevier River Basin Counties, 1966

County	Participants	Cost sharing
	Number	Dollars
Garfield[a]	112	22,889
Millard[a]	404	109,863
Juab[a]	96	29,393
Piute	42	14,530
Sanpete	414	102,269
Sevier[a]	105	37,261
Total	1,163	316,205

[a]Figures for counties lying partly within the Basin include the entire county.

FARMERS HOME ADMINISTRATION

The Farmers Home Administration has contributed considerable financial assistance and advice to residents of the Sevier River Basin. Current loan participants and values are shown in Table 71.

TABLE 71.--FHA loan status, by county, Sevier River Basin, 1966

County	Real estate loans	Amount	Non-real estate loans	Amount
	Number	Dollars	Number	Dollars
Garfield[a]	48	$1,082,006	134	$1,317,075
Millard[a]	48	1,279,275	212	502,370
Juab[a]	9	205,145	32	137,280
Piute	20	450,806	21	104,287
Sanpete	117	2,578,573	260	851,738
Sevier[a]	61	1,408,273	110	390,136
Total	303	$7,004,078	769	$3,302,886

[a]Where a county lies partly outside the Basin, figures are for the entire county.

COOPERATIVE STATE - FEDERAL FORESTRY PROGRAMS

The U. S. Forest Service is responsible for leadership in cooperative forest management and protection on private, State, and other non-federal lands. Technical assistance and advice is provided through the Utah State Forester and Utah State Extension Service.

The State of Utah Forestry and Fire Control is responsible for fire protection on State and private lands and for furnishing forestry assistance to private landowners. Towns and counties have been provided 27 military surplus firefighting units, and the State maintains two pumper units. Fire protection and State cooperative firefighting units in each county are listed in Table 72.

TABLE 72.--Cooperative fire protection by county, Sevier River Basin, 1965

County	Area protected	Fire fighting units
	Acres	Number
Juab	336,000	4
Millard	96,000	4
Sanpete	342,000	8
Sevier	180,000	5
Piute	87,000	1
Garfield	129,000	5
Total	1,170,000	27

Volunteer fire departments, sheriffs, privately-owned heavy equipment, county and state road maintenance equipment, and other available manpower and equipment are under agreement to assist in suppressing fires when called upon by the State.

Two State Area Foresters are available to give private owners of timbered land advice and help. Under the Clark-McNary program farmers can purchase trees from the State Forestry nursery at Logan, Utah, to be planted for windbreaks or other purposes.

NATIONAL FOREST DEVELOPMENT AND MULTIPLE-USE PROGRAMS

The Basin includes portions of four National Forests--Uinta, Manti-LaSal, Fishlake and Dixie--containing 1,801,310 acres. Increased population and economic expansion within Utah and neighboring states are increasing the demand for resources and uses. They have increased the need for multiple-use management to assure coordination of all resources.

On these lands, which yield over 80 percent of the tributary inflow, producing optimum flows of water is a primary goal. In all activities, the Forest Service strives to minimize erosion by maintaining vegetative cover adequate to stabilize the soil. Ground cover has been improved through grazing management, removing undesirable vegetation, and reseeding to obtain a grass cover. Contour trenching and other treatment in many areas helps stabilize the soil. Table 73 lists watershed improvement work completed as of 1965 on National Forest lands.

Opportunities for recreation include gathering edible pinyon pine nuts, hunting, fishing, boating, camping, and sightseeing. Expanding construction and management programs are designed to provide services for a maximum number of people and to make their visits enjoyable.

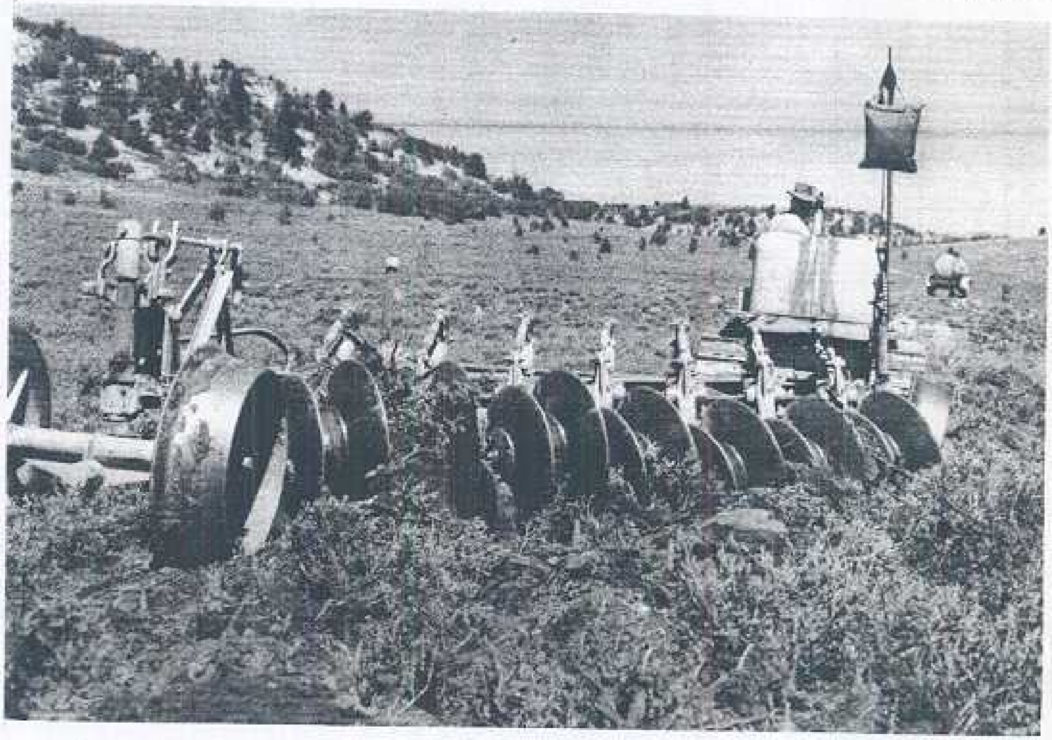
Forage is harvested by 21,411 cattle and 58,819 sheep, amounting to 88,472 and 38,585 AUM's, respectively, which represents a significant resource used by the agricultural industry.

Sawtimber from these lands supports the principal manufacturing industry in Sub-basins E and F. Other wood products harvested include posts, poles, Christmas trees, and aspen bolts.

The U. S. Forest Service has the responsibility for doing research on forest and rangelands. This work is done both independently and in cooperation with universities, states, and other Federal organizations. This area is served by the Intermountain Forest and Range Experiment Station with headquarters in Ogden, Utah. The Great Basin Research Station at Ephraim is the oldest Forest Service research area in the United States. Some of the earliest research on alpine watersheds and grazing relationships was pioneered here.

OTHER PUBLIC LANDS AND DEVELOPMENTS

The Bureau of Land Management administers the unreserved public domain land which has long produced wildlife and fish habitat, timber and



Reseeding and contour terracing on the Dixie National Forest help stabilize soil, improve grazing and reduce flood damage.

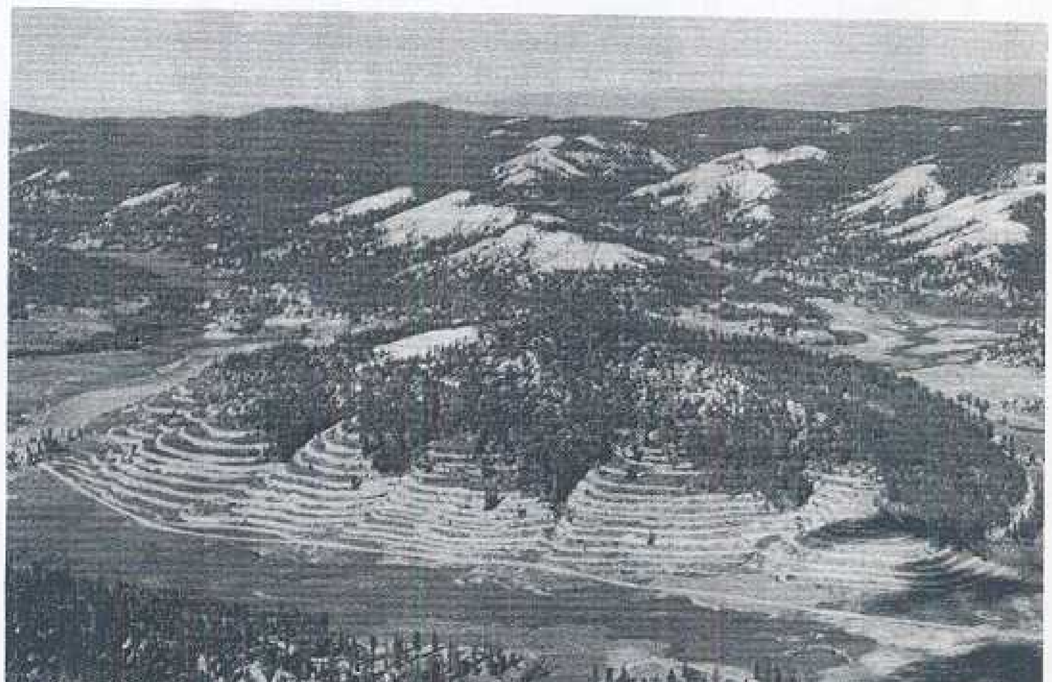


TABLE 73.--Watershed improvement work completed on National Forest lands prior to 1965, Sevier River Basin

Treatment	Unit	Sub-basin						Basin total
		A	B	C	D	E	F	
Contour trench and seed	Acres	1,930			15	1,301		3,246
Contour furrow and seed	Acres	993	945			2,210		4,148
Plow or pit and seed	Acres		9,870	1,761	13,750	76,240	11,355	112,976
Pinyon-Juniper or oak chain and seed	Acres		5,579	1,034	3,600			10,213
Aerial spray	Acres		2,000		1,400		750	4,150
Aerial seed	Acres	485	2,200					2,685
Other revegetation	Acres			5,610		1,412	893	7,915
Protection fence	Miles	2	14		15	8		39
Gully plugs	Number	60				200		260
Streambank stabilization	Miles	1				11		12
Road and trail stabilization	Miles					10		10
Drop structures	Number			4		32		36

Source: Data collected and compiled from National Forest district files.

other wood products, water, recreation, minerals, and grazing. These lands are protected from fire, insects, and erosion and are managed to provide the best combination of all uses that will provide maximum benefits. These lands are classified for retention in public ownership or for disposal to either private individuals or other government agencies.

Improved watershed conditions have largely been accomplished by replacing pinyon-juniper and sagebrush with grass cover to provide better soil protection and improved grazing. Undesirable vegetation on 12,160 acres has been removed and the area reseeded with range grasses. Pinyon-juniper has been removed on 3,650 acres to allow growth of native grasses without reseeding.

Two areas administered by the National Park Service, Bryce Canyon National Park and Cedar Breaks National Monument, lie partially within the Basin and annually attract thousands of visitors, thus adding to the Basin's economy. The primary management goals for these two areas of unique natural beauty--their towers, cliffs, and escarpments formed by the erosion of the white and red layers of the Wasatch formation--are to preserve their beauty and associated plant and animal life, and to provide interpretative services and facilities for the convenience and safety of the tourists.

The Corps of Engineers has authority under the Flood Control Act of 1938 to investigate the flood and related water resource problems on streams such as the Sevier River. Investigations under this authority led to the construction of channel improvements for 14 miles on the Sevier River from Salina downstream. These improvements, which were completed in 1951, consisted of widening, realigning, and leveling channels, and replacing two diversion structures. In addition, snagging and clearing and other emergency flood control work amounting to $48,000 has been completed through 1968. A summary flood plain report is scheduled for completion in 1971.

S T A T E   D E V E L O P M E N T S

The Division of Water Resources under authority of Title 73, Utah Code, makes studies, investigations, and plans for the development and utilization of water resources to assist the local people and for the best interest of the State, either separately or in cooperation with other agencies. They have provided significant contributions through financial and technical assistance to many water conservation projects. Development of a State Water Plan is now underway and is scheduled for completion by 1970.

The Division of Parks and Recreation has established State boating parks at Piute Reservoir, Otter Creek Reservoir, Palisades Lake, and Sevier Bridge Reservoir. Boat launching, picnicking, and restroom facilities are provided.

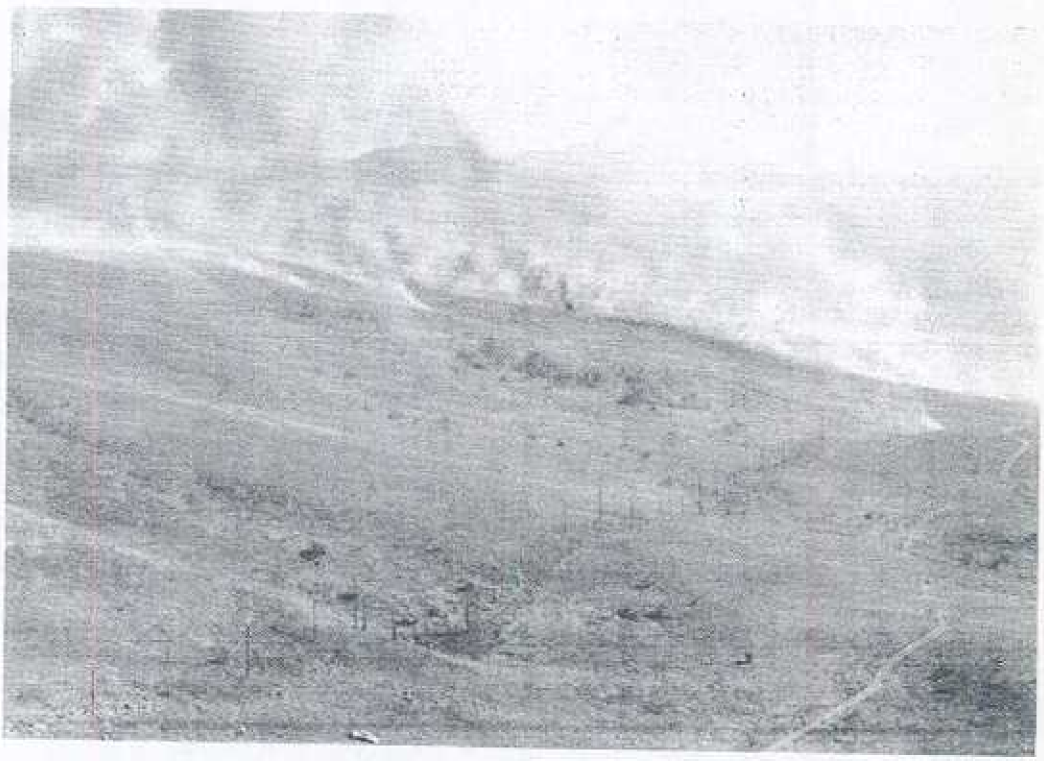
The Division of Fish and Game operates fish hatcheries at Fountain Green, Glenwood, and on Mammoth Creek near Hatch. They also manage a waterfowl refuge at Clear Lake.

Large blocks of land in Watersheds A-4, C-3, and B-6 are managed by the Division of Fish and Game to provide winter habitat for deer. On much of this area, pinyon-juniper has been cabled and the area seeded to grasses and browse plants to provide more desirable forage. On some State lands, improvement work was completed by the Forest Service under provisions of the Granger-Thye Act.

Other State lands are administered by the State Land Board and are in scattered tracts. These lands are managed to provide a maximum monetary return and are commonly leased to private individuals for grazing or other purposes.

The cooperative snow survey program furnishes water supply information.

SOIL CONSERVATION SERVICE PHOTO 5-1115-12



State agencies provide fire protection on state and private lands.

UTAH STATE DEPARTMENT OF FORESTRY & FIRE CONTROL PHOTO 5881-5

CHAPTER VIII

WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

In this section, the Sevier River Basin's capability of supplying water and related land resource developments is described. The Basin's physical potential for development is discussed, not in terms of specific projects or programs, but in terms of meeting identifiable needs and appropriate problems. The general categories involved include the availability of land and water; channel improvements; irrigation system and water management improvements; recreational developments; fish and wildlife developments; water quality control; and associated land treatment and adjustments.

AVAILABILITY OF LAND

There are 250,000 acres of irrigable land[1] in the Sevier River Basin which are not now cultivated mainly because of insufficient water supplies (Table 74). Limited areas within the total 250,000 acres have soil or topographic limitations which categorize them as marginal rotated cropland. These particular areas can be used feasibly as semipermanent pasture. Of the total irrigable land, 70,000 acres lie below established irrigation systems. In view of current water shortages and irrigation system construction costs, it is not feasible to develop large areas of the other 180,000 acres. Smaller areas, however, could be developed by drilling irrigation wells or by enlarging and extending existing systems.

There are 241,000 acres of wetlands which should be considered as potential for development. These areas are classified as follows: 24,200 acres of irrigated nonrotated cropland; 106,100 acres of nonirrigated nonrotated cropland; and 110,700 acres of noncropped phreatophytes.

About 110,000 acres of nonrotated cropland and 70,000 acres of noncropped phreatophytes can be converted to rotation cropland and improved pastures to provide greater economic returns. Some of the wetter phreatophyte areas, however, provide excellent waterfowl habitat and add to the aesthetics of these areas. Consideration should be given to this use before these lands are drained.

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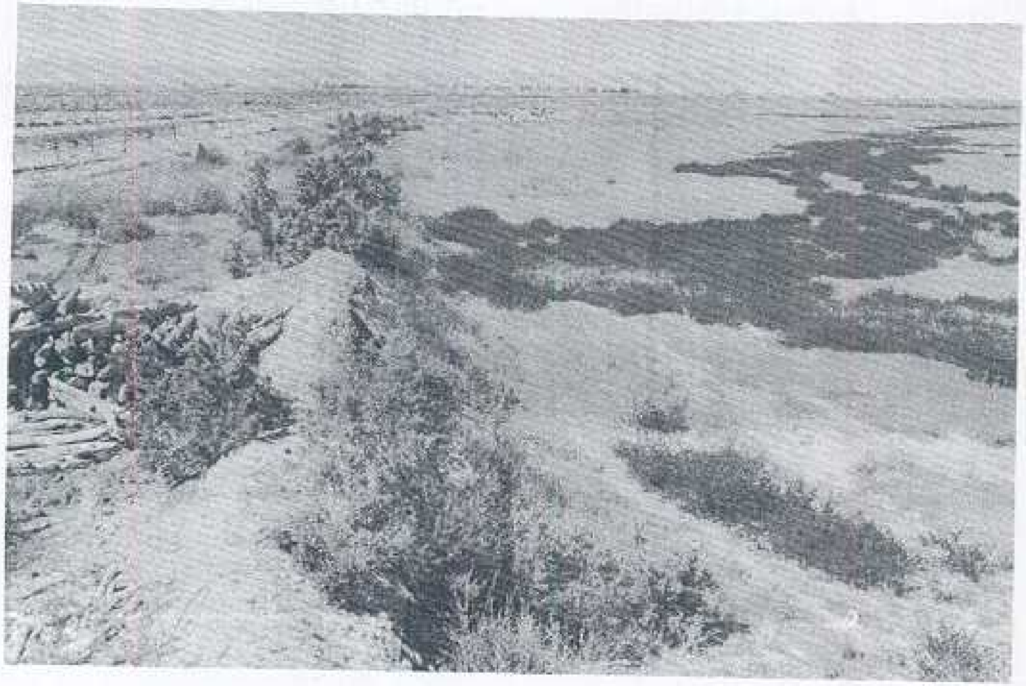
[1]Irrigable lands are defined as lands capable of being irrigated by any method and for which irrigation will enhance crop production.

TABLE 74.--Additional irrigable land available for potential development, Sevier River Basin

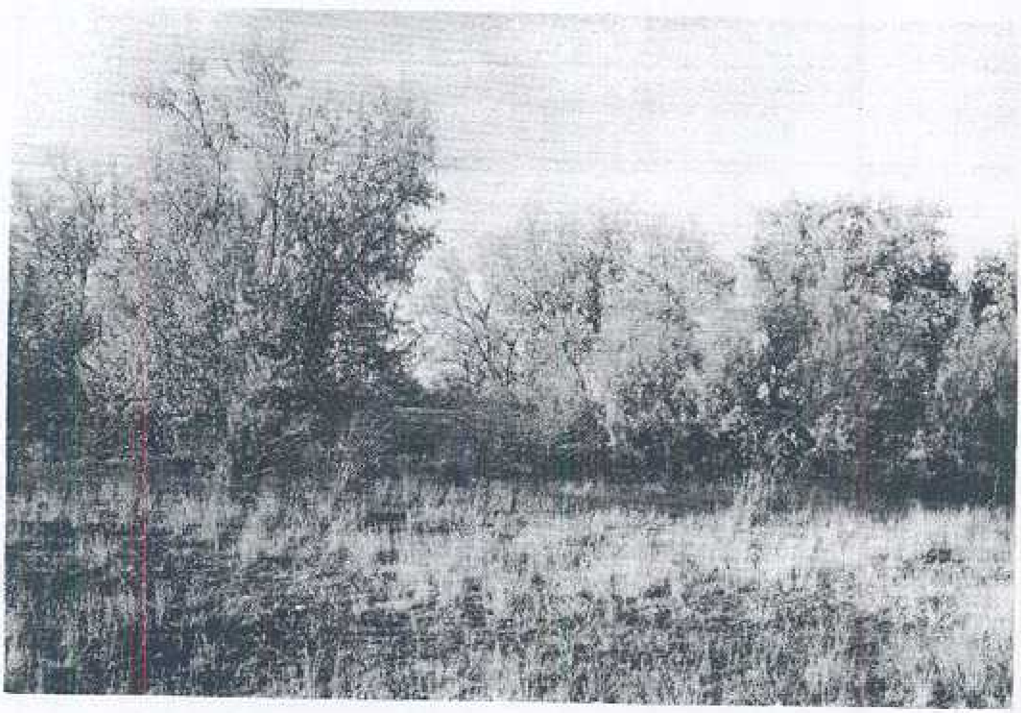
Sub-basin	Irrigable land			Wetlands	Total
	Under present systems	Above present systems	Total		
	Acres	Acres	Acres	Acres	Acres
A	11,550	21,700	33,250	44,600	77,850
B	45,370	140,520	185,890	139,700	325,590
C	4,840	2,430	7,270	20,900	28,170
D	1,530	4,510	6,040	16,500	22,540
E	4,300	Negligible	4,300	10,000	14,300
F	1,950	11,290	13,240	9,300	22,540
Total	69,540	180,450	249,990	241,000	490,990

The potential of the Basin area which is not adapted to irrigation lies in its vast space, its mineral wealth, and its ability to better accommodate existing uses such as grazing, providing fish and wildlife habitat, harvesting wood products, and recreation. In the future, cultural developments associated with the needs of a rapidly expanding population, such as transportation and communications facilities, should occupy the wildland area more than at present so existing croplands can be reserved for needed production of food. Higher watershed areas have the potential to be developed for maximum production of goods and facilities with increasing emphasis on outdoor recreation. Technological innovation will assist in development of these resources. This expanded technology is already evident from the relatively insignificant use of guzzlers for collection of livestock water to the anticipated importation of water from other basins.



Many acres of land under existing systems need only a water supply to be productive.

SOIL CONSERVATION SERVICE PHOTO 8-1084-2



Phreatophytic vegetation consumes large quantities of water that could be applied to higher economic use.

FIELD PARTY PHOTO 8-1084-9

A V A I L A B I L I T Y   O F   W A T E R

All of the water resources are now appropriated so water for potential development must be converted from an existing use or imported. Means of importing new water, or its availability are beyond the scope of this investigation; however, projects such as the U. S. Bureau of Reclamation's importation of water through the Central Utah Project represents a means of further developing the resources. The initial phase which is under construction, will deliver about 30,000 acre-feet of water to Sevier Bridge Reservoir.

WATER-USE CONVERSION

Some water used for producing rotated crops, wet meadows, and non-cropped phreatophytes along with that used on higher watersheds could increase returns through higher-use efficiencies. The average irrigation efficiency of 32 percent could be increased resulting in better utilization of irrigation water.

Water now consumptively used in the wetlands by phreatophytic plants is available for development. The maximum or desirable limits to which this water could be salvaged has not been established. Estimates indicate that large-scale projects could salvage up to three-fourths of the water, other than precipitation, consumed in the wetlands. Table 75 indicates water salvage possibilities.

TABLE 75.--Potential annual water salvage from wetlands by sub-basin, Sevier River Basin

Sub-basin	Salvage potential
	Acre-feet
A	60,000
B	92,000
C	25,000
D	24,000
E	8,000
F	6,000
Total	215,000

UNDERGROUND RESERVOIRS

Underground reservoirs are not utilized at their greatest potential. They should be regulated so that water could be withdrawn during dry years and recharged during wet years. If just 10 percent of the storage capacity of 9 major underground reservoirs were used for regulation, the volumes shown in Table 76 would be available. Sufficient control is necessary to assure a stable supply over long periods of time.

TABLE 76.--Management potential of underground reservoirs, Sevier River Basin

Reservoirs	Estimated storage	Management potential[a]
	Acre-feet	Acre-feet
Grass Valley (5)	150,000	15,000
Johns Valley (5)	90,000	9,000
Panguitch Valley (5)	570,000	57,000
Circle Valley (5)	210,000	21,000
Sevier-Sigurd (28)	800,000	80,000
Aurora-Redmond (28)	200,000	20,000
Redmond-Gunnison (28)	150,000	15,000
Gunnison-Sevier Bridge (28)	300,000	30,000
Sanpete Valley (3)	3,000,000	300,000
Total	5,470,000	547,000

[a]Management potential is based on an estimated 10 percent use of groundwater reservoirs.

In areas where saline groundwater influences vegetative growth, control of the water table is a necessity as well as a potential improvement. By providing proper inflow-outflow relationships and lowering the water table, it is possible to convert areas of salt concentration into productive croplands. This is particularly true in the Delta area.

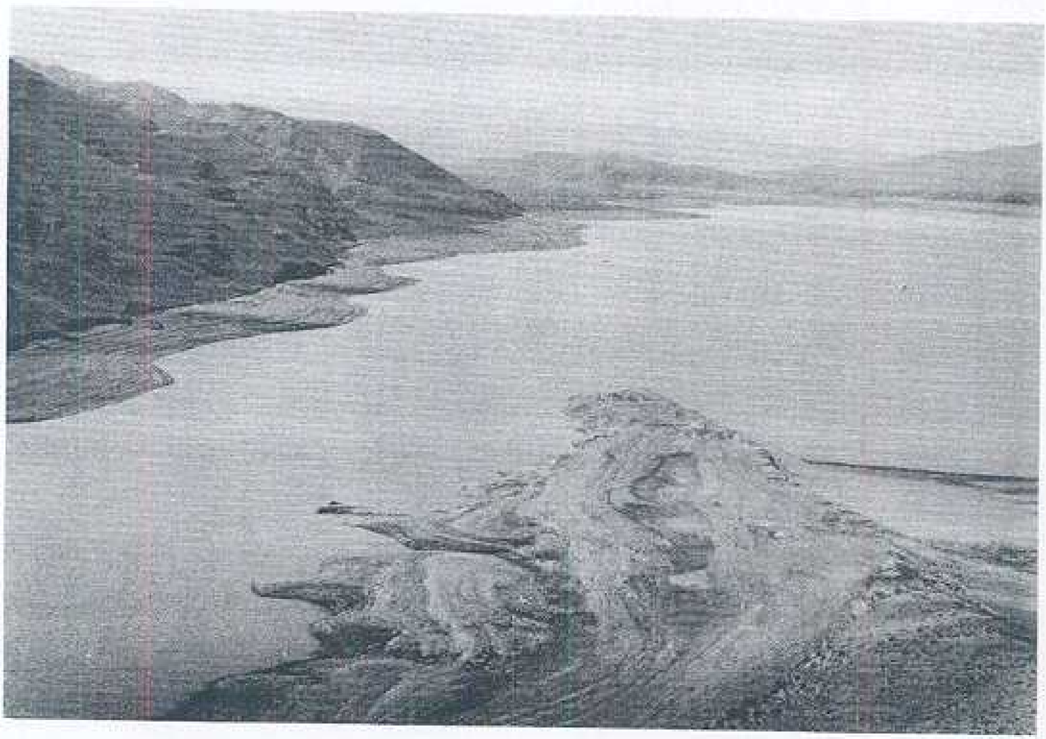
SURFACE RESERVOIR STORAGE

Otter Creek, Piute, and Sevier Bridge Reservoirs have unused capacity available to store water obtained from water salvage projects or importation. Table 77 lists the average unused storage capacity in these reservoirs together with the unused storage capacity which could be expected 2 years out of 10.

TABLE 77.--Unused storage capacity in three major reservoirs, Sevier River Basin

Reservoir	Unused storage	
	Average	2 years out of 10
	Acre-feet	Acre-feet
Otter Creek	16,000	2,000
Piute	24,000	2,000
Sevier Bridge	110,000	38,000
Total	150,000	42,000

There are many sites where new reservoirs should be built or existing reservoirs enlarged to provide needed water storage capacity for full development of the water and related land resources (Table 78). Reservoirs developed primarily for irrigation purposes should also provide recreation, floodwater detention and sediment storage.



Existing reservoirs often contain unused storage capacity.

FIELD PARTY PHOTO 8-714-5

TABLE 78.--Potential reservoir sites and enlargements

Index Number[a]	Name	Nearest town	Storage capacity: Not allocated	Sediment	Recreation	Irrigation	Flood	Total
			Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet	Acre-feet
A1-1	Narrows	Fairview	-----	75	2,425	15,000	------	17,500
A1-2	Moroni	Moroni	-----	500	3,000	8,500	------	12,000
A2-1	Big Hollow	Fountain Green	-----	400	370	1,060	370	2,200
A3-1	Ephraim Canyon	Ephraim	500	------	------	------	------	500
A3-2	Willow Creek	Ephraim	450	------	------	------	------	450
A3-3	New Canyon	Ephraim	-----	25	------	175	------	200
A4-1[b]	Loggers Lake	Manti	-----	300	500	800	------	1,600
A4-2	Manti Debris Basin	Manti	-----	620	------	------	------	620
A4-3[b]	Funks Lake	Sterling	200	------	------	------	------	200
B1-1	Upper Chicken	Levan	-----	50	630	1,200	------	1,900
B1-2	Pigeon Creek	Levan	-----	300	150	10	------	460
B1-3	Lower Chicken	Levan	-----	320	120	20	------	460
B4-1	Scipio	Scipio	-----	------	100	5,050	------	5,150
C3-1	Six Mile Storage	Sterling	-----	100	------	200	100	400
C5-1	Soldier Canyon	Salina	-----	680	------	------	------	680
C5-2	Rattlesnake Point	Salina	-----	1,090	------	------	------	1,090
C5-3[b]	Taylor's Flat	Salina	-----	250	------	------	------	250
C5-4[b]	Bull Pasture	Salina	-----	1,030	540	------	4,430	6,000
C5-5[b]	Skutumpah	Salina	-----	450	150	500	------	1,100
C5-6	Blackberry	Salina	-----	6,000	1,230	------	------	7,230
C5-7	Tipparary	Salina	-----	300	------	500	------	800
C5-8	Salina	Salina	-----	7,240	------	------	------	7,240
C6-1	Lost Creek Evaporation Basin	Aurora	-----	940	------	------	------	940
D1-1a	Flat Canyon	Richfield	-----	1,100	------	------	600	1,700
D1-2	Flat Canyon	Richfield	100	------	------	------	------	100
D1-3	Flat Canyon	Richfield	140	------	------	------	------	140
D1-4[illegible]	[illegible]	Richfield	3,000	------	------	------	------	3,000
D1-4b	Flat Canyon	Richfield	1,200	------	------	------	------	1,200
D1-5	Cottonwood	Richfield	-----	1,200	------	------	600	1,800
D1-12	Cottonwood	Richfield	1,200	------	------	------	------	1,200
D1-15	Cottonwood	Richfield	1,000	------	------	------	------	1,000
D5-1	Clear Creek Reservoir	Sevier	-----	1,200	40	200	300	1,740
D7-1	Beaver Creek Reservoir	Marysville	-----	800	10	300	200	1,310
E1-1[b]	Koosharem Reservoir	Burrville	-----	------	60	600	------	660
E1-2	Burr Creek Reservoir	Burrville	-----	100	10	200	150	460
E1-3	Greenwich Creek Reservoir	Koosharem	-----	100	10	200	200	510
E3-1	Antimony Creek Reservoir	Antimony	-----	750	------	500	250	1,500
E5-1[b]	Tropic	Tropic	-----	------	------	470	------	470
F1-1	Circleville Canyon Reservoir	Circleville	-----	1,700	1,900	------	500	4,100
F2-1	Red Canyon Debris Basin	Panguitch	-----	560	------	------	140	700
F2-2	Casto Canyon Debris Basin	Panguitch	-----	600	------	------	160	760
F3-1	West Panguitch	Panguitch	-----	50	150	140	160	500
F5-1	Hatch Town	Hatch	-----	9,400	400	3,600	5,000	18,400
Total			7,790	38,230	11,815	39,225	13,160	110,220

[a]This numbering system indicates the watershed number and the structure number within the watershed.

[b]Enlargement of existing reservoir for additional storage capacity.

CHANNEL IMPROVEMENT

Stream channels may be improved by excavation to provide drainage of high water table areas. There is potential for improvement of tributary channels to reduce transmission losses and route flash floods through cultivated areas.

Channel improvements in the following areas would lower the water tables, prevent erosion, and allow an increased crop production potential: Portions of the San Pitch River in Sub-basin A; portions of the Sevier River in Watersheds B-5 and 7, C-1, 2, and 3, D-1 and 2, and F-1, 2, and 3; and portions of the East Fork of the Sevier River in Watershed E-3.

Channel improvement potential areas for floodwater and transmission control are: Sub-basin A--Cottonwood Creek, Ephraim Creek; Sub-basin B--Round Valley Creek, Fool Creek, Wild Goose Creek; Sub-basin C--Maple Creek, Willow Creek; Sub-basin D--Willow Creek, Cottonwood Creek, Flat Canyon, Peterson Creek, Monroe Creek; Sub-basin E--Water Canyon, Henderson Canyon; Sub-basin F--Panguitch Creek.

IRRIGATION SYSTEM AND WATER MANAGEMENT IMPROVEMENTS

One of the foremost potentials for overcoming the limited availability of water lies in improving the efficiency of water use. This should be considered in two parts--delivery systems and on-farm efficiencies.

Delivery systems can be upgraded by canal lining through high-loss areas, using more efficient diversion structures, and creating more effective measurement and management controls. The consolidation of parallel canal systems through the merging of irrigation companies is another of the significant development potentials. The present average loss of 4.5 percent per mile could be reduced to half this amount.

Irrigation practices on individual farms probably have more potential for better water use and management than any other practice. There especially is a potential for better management and regulation of water applied on individual fields.

Ditch lining and land leveling can increase on-farm irrigation efficiency as much as 25-30 percent when properly designed. Furrow and corrugation systems can attain efficiencies of 50-70 percent, while basins, level and graded borders, and sprinklers can raise efficiencies

Before

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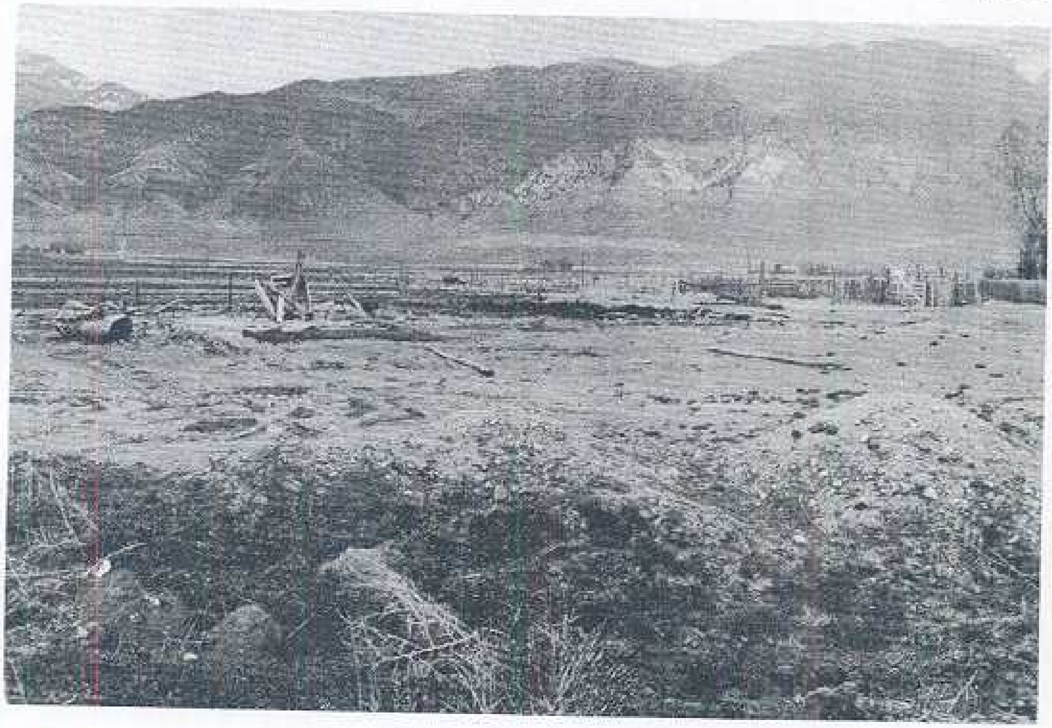
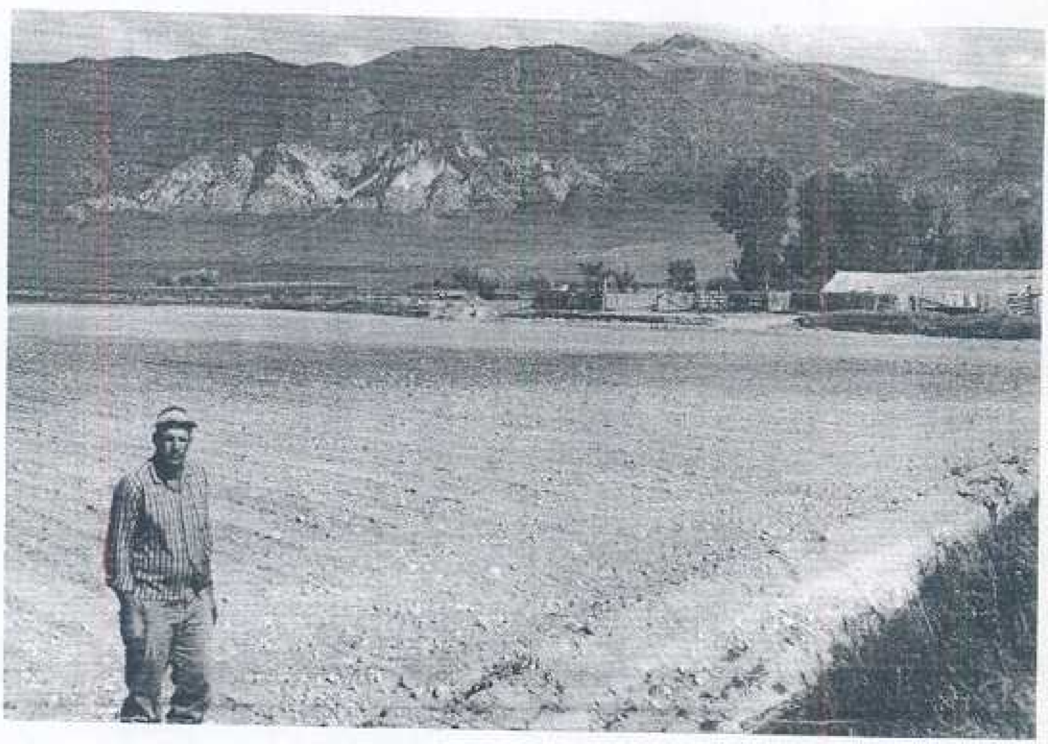


Undeveloped land is a potential resource.



After

8-807-10

to 60-80 percent. This indicates that the average on-farm efficiency can be raised from the present 45 percent to at least 60 percent.

If the overall-use efficiency of diverted water were increased about 10 percent, the present deficit of nearly 78,000 acre-feet on irrigated lands would be nonexistent.

RECREATIONAL DEVELOPMENT

Recent developments such as improved highways, mobile population, more leisure time, and larger personal income, all combine to create a potential demand for expanded recreational development.

Specific areas of greatest recreation potential are: The Skyline Drive in Sub-basin A; areas near Interstate Highway 70 in Salina Canyon, Sevier Valley, and Clear Creek in Sub-basins C and D; and the unique erosional and geologic areas known as the "pink cliffs" on the south edge of the Markagunt and Paunsaugunt Plateaus in Sub-basins E and F. The development of youth camps and vacation ranches and farms providing rural living experiences for urban residents also have potential.

With limited development, the large wildland area lends itself readily to dispersed types of recreation such as hiking, riding, hunting, fishing, picnicking, camping, and sightseeing. Better access to many scenic areas now difficult to reach and improved water quality to make major reservoirs more suitable for fishing and other recreational uses have potential. New developments are limited by lack of demand, and in some cases, lack of water suitable for culinary use in campgrounds and other facilities.

Recreation facilities on public lands are being expanded. On National Forest lands, a recent survey (22) indicates, there are ample potential recreation sites available to meet demands beyond the year 2020.

Water and land resources are also available for outdoor recreation development on private land and these developments will probably become feasible as future recreation demands increase.

FISH AND WILDLIFE DEVELOPMENTS

The potential development of fish habitat is directly related to improved water quality and stream channel stabilization. Many of the perennial tributary streams could provide good fishing if related land

and water problems are solved. Some reservoirs, because of heavy water drawdown during the irrigation season, reduce the water level to a point incapable of sustaining fish. This problem could be solved by purchasing water rights sufficient to maintain a minimum storage level at which fish could survive.

Conservation recreation pools should be purchased in Otter Creek, Koosharem, Tropic, Piute, Gunnison, Sevier Bridge and DMAD Reservoirs as well as in any new reservoirs constructed. There is a potential to rehabilitate some lakes with a fish poisoning program.

Improvement of big-game habitat is dependent on better forage conditions. On many areas, pinyon-juniper has been removed by chaining and preferred browse species such as bitterbrush and fourwing saltbush are planted along with a grass cover to stabilize the soil. There is a potential for expanding these programs. Management of big game and domestic livestock for proper use of forage will also maintain and improve the habitat.

A potential exists to enhance the habitat for all animals in the biological community. For example, mourning dove, chukar, and other desert wildlife habitat can be improved by developing water in arid areas. Because of the aesthetic and economic values related to it, however, big-game management has been emphasized while other species of wildlife have been ignored. Many people may obtain as much enjoyment from seeing a porcupine at close range as a hunter does viewing deer through the sights of his rifle. Unique wildlife species such as rock rabbits and flying squirrels along with fur-bearers like beaver and muskrats should be maintained. The enhancement of all wildlife habitat for those who wish to observe and photograph these animals will have an increasing potential.

Although grazing, cultivation and other land uses have greatly reduced the habitat of fish, big game, and waterfowl, they have enhanced the habitat for pheasants. Generally, fish and wildlife habitat is diminished in proportion to the intensity of occupation and development of the land. The value of these resources must be considered in light of economic and social values of other uses.

In those streams where dams and diversions for irrigation have reduced the water level and subsequently impaired the fish habitat, low flow augmentation should be considered to restore the habitat to some measure of its former value.

W A T E R   Q U A L I T Y   C O N T R O L

Two major water quality problems are excessive amounts of sediment and dissolved solids. The sediment load carried in the streams could be significantly reduced by improving vegetal cover in areas subject to erosion and by installing sediment control devices. The potential for complete control of sediment is impossible in areas such as Red Canyon in Watershed F-2, and Flat, Cottonwood, and Willow Creek Canyons in Watershed D-1 where establishment of an adequate vegetal cover is limited by soils, topography, and precipitation.

Opportunities for reducing quantities of dissolved solids are limited. When water comes in contact with the salt bearing Arapien shale in the Central Sevier area, it carries large quantities of these solids to the river. Lost Creek in Sevier County contributes up to 100 tons of salt per day during times when flows are from 0.1 to 1.5 c.f.s. This occurs at a time when the Sevier River above Lost Creek is also carrying about 100 tons of salt per day with flows of approximately 50 c.f.s. However, during times of low flow when the salt concentration is the highest, the flow of Lost Creek below diversions could be diverted into evaporation basins instead of adding its heavy salt load to the river.

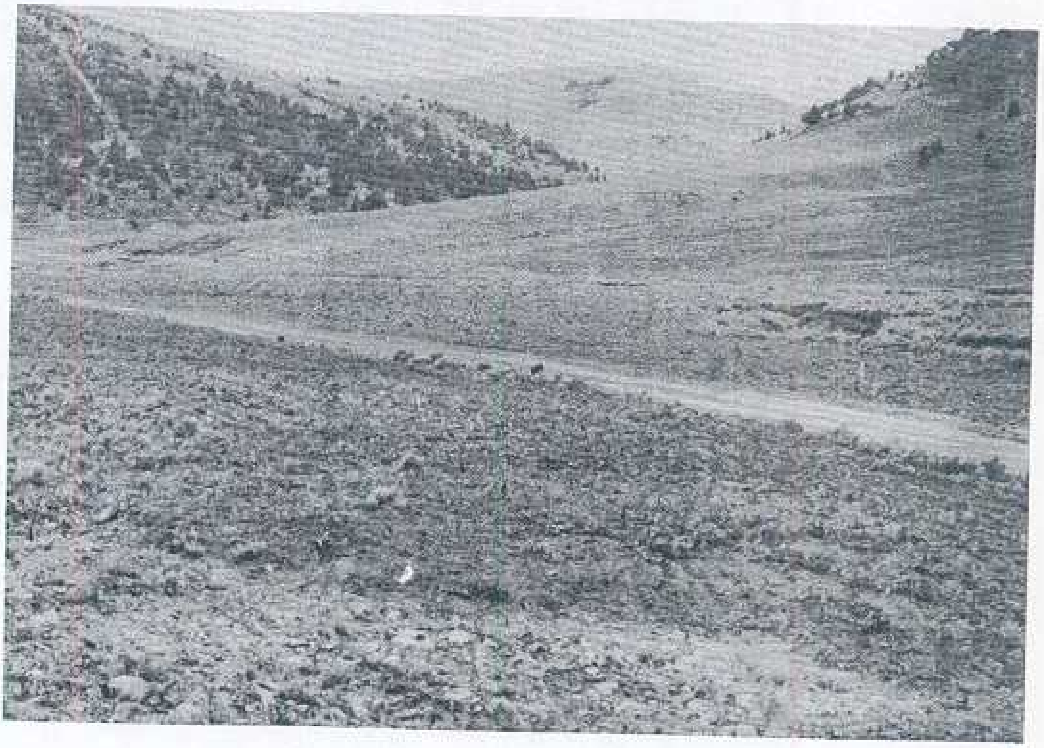
Extensive irrigation developments contribute return flows to be used and reused as the Sevier makes its way downstream. With each rediversion, additional amounts of dissolved solids are leached from the soil and returned to the river. This salt problem is aggravated because there is so little water for leaching in the last irrigated areas along the river.

Importation of high quality water probably offers the best opportunity to dilute the dissolved salt concentration of the river water. The addition of 30,000 acre-feet annually from the Central Utah Project would reduce the average salt concentration in Sevier Bridge Reservoir from 1700 mg/l to 1300 mg/l.

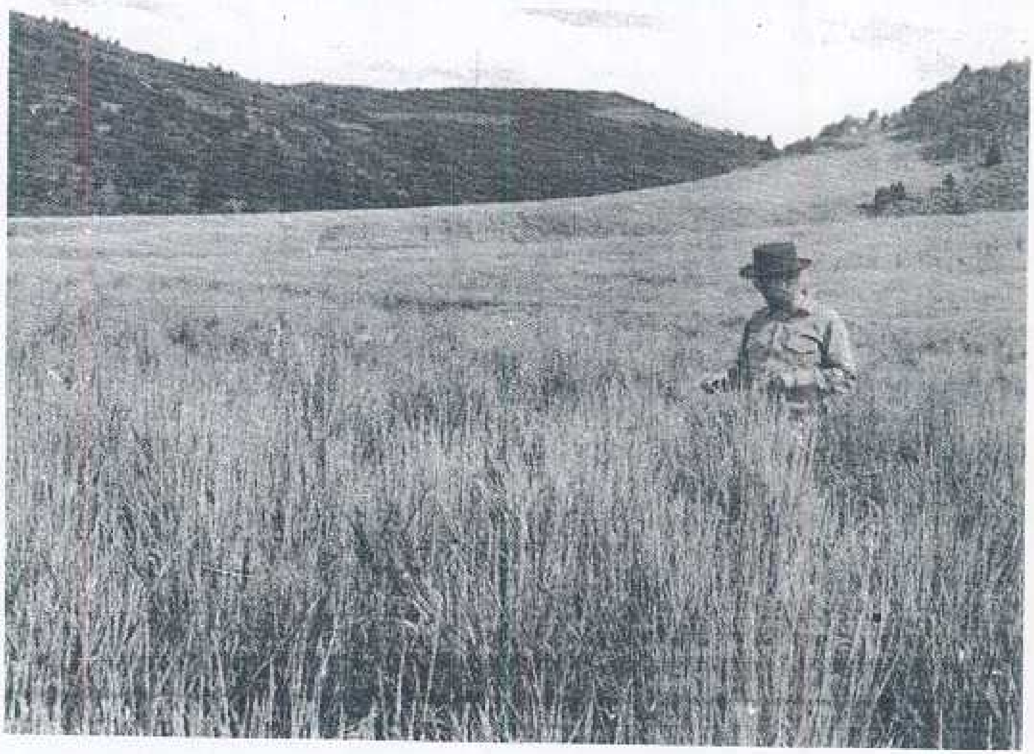
Biological contamination should be reduced to a nonhazardous level. Tighter controls and improved means of treatment and disposal of organic materials should be sought so that pollution emanating from such places as headwaters, sewage treatment plants, septic tanks, and barnyards and corrals can be controlled.

Sagebrush is removed

U. S. FOREST SERVICE PHOTOS SR81 - 1



Treatment of watersheds on Chicken Creek.



and the area is seeded.

SR81 - 2

ASSOCIATED LAND TREATMENT AND ADJUSTMENTS

In the water yielding areas, there is a potential for increasing the quality and quantity of runoff and possibly for extending streamflows into the drier summer months through the use of land treatment and vegetative adjustments which include contour trenching and furrowing, establishing better protective ground cover through vegetative type conversion, and stabilizing stream channels.

The Forest Service has recently established a barometer watershed program to determine how land use and treatment measures influence the water resource. Through the aid of a computer program, a given activity on land in other watersheds can be correlated with a barometer watershed and evaluated in relation to the water resource. This study has a potential to help determine which combined land uses and treatments will produce a greater yield of higher quality water and any associated changes in the timing of runoff.

CHAPTER IX

OPPORTUNITIES FOR DEVELOPMENT

The study operated within the framework of existing programs, policies, and developments. Without these limitations, additional opportunities exist for complete development of the water and related land resources. This will require, however, more flexibility regarding existing developments, established water rights, and industrial policies. Coordination between the local people and assisting organizations concerned with the development of the resources is imperative.

POTENTIAL PL-566 PROJECTS

There are many opportunities in the Sevier River Basin for PL-566 projects to solve watershed problems. Of the 35 watersheds in the Basin, there are 25 which have possibilities for this kind of project, and of these, 14 show feasibility for construction within the next 10 to 15 years.

The impact of these projects will include increased economic returns and conservation of natural resources. Economically, benefits begin to accrue as soon as project operations start as a result of expenditures for structural measures. After completion, there will be benefits accruing into the future. These projects enhance and conserve the landscape and provide recreational facilities and other benefits in the rural areas.

Four main elements contribute to the feasibility of PL-566 projects in the Sevier River Basin. They include: (1) Prevention of floodwater and sediment damage with the benefits exceeding the cost of the preventative measures, (2) increased efficiency of irrigation systems and on-farm operations and maintenance, (3) reduction of irrigation water shortages, (4) reduction of drainage problems in conjunction with land reclamation and water salvage.

There are also several conditions which limit the feasibility of these projects. These include: (1) Minor flood and sediment damage with the cost of control exceeding the benefits, (2) problems which can be solved by local group action or current programs better than by installation of PL-566 programs, (3) legal or institutional restraints or limited availability of water, (4) a limited population or number of farm units within the area, (5) adverse repercussions, primarily through reduced return flow, outside the watershed boundary.

There are also several things which could influence either favorably or unfavorably the feasibility of these projects. They include: (1) The importation of water into the Basin, (2) a change in the present legal constraints concerning water rights or interpretation, (3) a change in administrative interpretation of PL-566 to allow more flexibility in agricultural water management portions of a project, (4) Basin-wide project coordination to provide measures that will offset downstream impacts or permit purchase and exchange of water rights, (5) conflicts between alternative resource uses.

The major portion of the potential project area is within public ownership. The Forest Service and Bureau of Land Management, who administer these lands, will play an important role in the development of the projects and in the improvement of watershed conditions through land treatment.

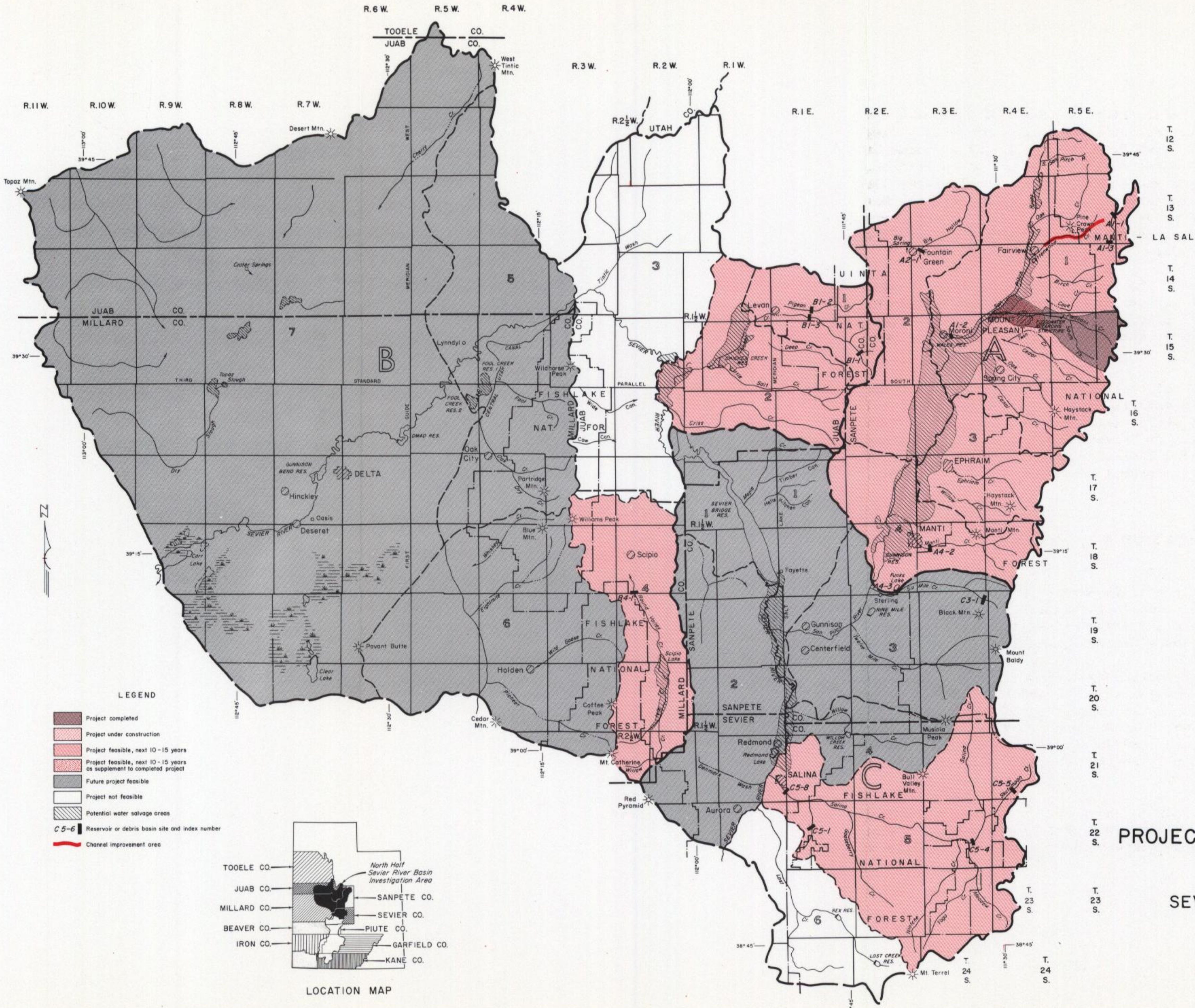
A brief discussion of the watershed area, problems, improvement measures, feasibility, and impacts of those projects needed and most likely to develop in the next 10-15 years follows. Map 14 and Table 79 show the location and feasibility of these projects. A more detailed discussion is found in the Watershed Investigation Reports Appendix. Table 80 lists the opportunities for structural measures in all watersheds.

WATERSHED A-1, NORTH SANPETE

Watershed A-1 is located in Sanpete County and contains 210,500 acres including 58,900 acres in the Manti-LaSal National Forest. Problems include a deficient and erratic irrigation water supply, flood and sediment damage, inadequate drainage, and lack of recreation facilities.

This project would include agricultural water management, flood protection, sediment and erosion control, and fish and wildlife and municipal water supply developments. The project includes a 17,500 acre-foot capacity reservoir of which 15,000 acre-feet are for irrigation; 2,425 acre-feet are for fishery, and 75 acre-feet are for sediment; 20 wells yielding a total of 3,700 acre-feet annually; a waterfowl-management area; and a small fishery.

The people are organized and a work plan has been formulated. However, restraints involving water rights will require resolution before action continues. The proposed projects will have no affect on downstream water rights.



MAP 14

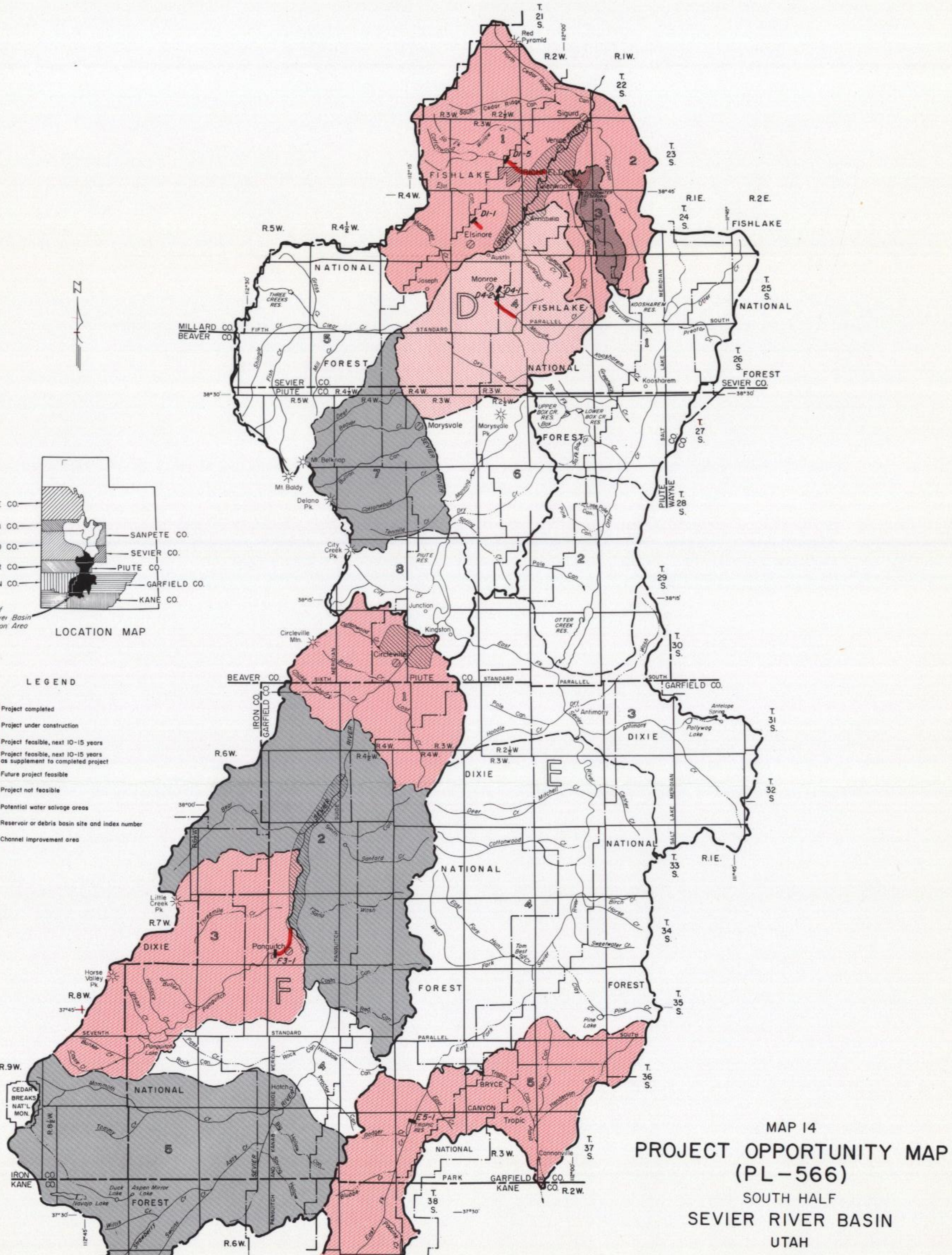
PROJECT OPPORTUNITY MAP (PL-566)

NORTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969



MAP 14

PROJECT OPPORTUNITY MAP (PL-566)

SOUTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

SOUTH HALF M7-S-18914-N

TABLE 79.--PL-566 project cost and benefit-cost ratios, Sevier River Basin[a]

Watershed		Construction features				Land treatment[b]	Total project cost	Total project benefit-cost ratio
Number	Name	Structural costs	Recreational costs	Total costs	Project benefit-cost ratio			
A-1	North Sanpete	$4,570,000	$225,000	$4,795,000	2.7:1	$1,325,000	$6,120,000	2.3:1
A-2	Fountain Green	1,690,000	170,000	1,860,000	1.6:1	520,000	2,380,000	1.6:1
A-3	Ephraim	1,260,000	-----	1,260,000	2.4:1	2,145,000	3,405,000	1.8:1
A-4	Manti	620,000	15,000	635,000	3.1:1	670,000	1,305,000	2.4:1
B-1, 2	Levan	1,290,000	180,000	1,470,000	2.9:1	1,770,000	3,240,000	2.1:1
B-4	Scipio	1,850,000	40,000	1,890,000	1.9:1	755,000	2,645,000	1.7:1
C-5	Salina Creek	1,895,000	290,000	2,185,000	1.2:1	1,345,000	3,530,000	1.1:1
D-1	Richfield	3,780,000	-----	3,780,000	1.2:1	1,860,000	5,640,000	1.1:1
D-2, 3	Glenwood	285,000	-----	285,000	1.1:1	200,000	485,000	1.0:1
E-5	Tropic	160,000	-----	160,000	2.5:1	1,035,000	1,195,000	1.3:1
F-1	Circleville	665,000		665,000	1.4:1	1,185,000	1,850,000	1.3:1
F-3	Panguitch Creek	$435,000	$65,000	$500,000	1.1:1	$3,525,000	$4,025,000	1.0:1

[a]Costs are based on 1967 prices except for Watershed A-1 which were taken from the North Sanpete Watershed Work Plan (1961).

[b]Benefit-cost ratio for land treatment measures is assumed to be 1:1.

TABLE 80.--Opportunities for selected structural measures, project feasibility, and PL-566 planning status in watersheds, Sevier River Basin

Watershed	Canal lining	Wells	Reservoir[a]	Pipelines	Channel improvement	Water salvage[b]	Feasible PL-566 project[c]	Remarks
A 1	X	X	I, R	X	X	C	Yes	Work Plan completed.
2	X	X	I, R	X		C	Yes E	Application filed for planning assistance in Tids Canyon area.
3	X	X	D		X	C	Yes E	
4	X	X	I, R, D		X	C	Yes E	Application filed for planning assistance.
B 1	X	X	I, F, R, D	X		W	Yes	Application filed for planning with B-1. Project feasible where B-1 is
2	X	X					Yes	planned with B-2.
3							No	No irrigated land. No residents. BLM soil stabilization program in operation.
4	X		I, R			W	Yes	
5	X	X				C	Yes E	Groundwater outflow from B-5 and B-6 consumed in wet areas of B-7.
6	X	X				C	Yes E	Water salvage would lower water table in B-7.
7	X	X				C	Yes	Project limited to Delta area.
C 1	X	X				C	Yes E	
2	X	X				C	Yes E	
3	X	X					Yes E	C-3 & C-4 should be combined and formulated as one project. Features described
4	X	X			X		Yes E	for a project are for C-3 and C-4.
5	X		I, R, D			C	Yes E	Application for planning assistance filed.
6			Q				No	
D 1	X	X	F, D, I		X	C	Yes E	
2						C	Yes	
3				X		C	Yes	PL-566 flood program completed.
4	X		D	X		C		PL-566 project began 1966.
5			I			C	No	Possible storage site for downstream benefits. Limited benefits.
6						C	No	No group action required. Limited benefits.
7						C	Yes	
8	X					C	No	Possible PL-566 with F-1. Limited benefits.
E 1	X	X	I, R			C	No	No group action required. Part of a canal lining program completed.
2							No	Limited benefits.
3	X	X				C	No	Limited benefits.
4		X					No	Limited benefits.
5	X		I	X			Yes E	Application filed for planning assistance.
F 1	X	X	I, F, D			W	Yes	
2	X	X				C	Yes E	Project would involve new lands and water exchange.
3	X		I, F, R, D		X	C	Yes E	Planning assistance requested.
4							No	Limited benefits.
5	X		I, F, R, D				Yes E	Needs to be planned with D-3, F-1, F-2.

[a] I - irrigation; F - flood protection; R - recreation, fishing, boating; D - debris basins, sediment; Q - water quality control.

[b] W - wholly within watershed area. C - in conjunction with adjacent watershed(s).

[c] E - project will probably have effect on downstream flow of Sevier River.

A D D E N D U M

Summary of PL-566 project cost and benefit estimates,[a] Sevier River Basin

Watershed	Watershed name	Sediment control & flood prevention	Recreation	A.W.M.	Total structural measures	Benefit cost ratio[b]	Land treatment cost: B:C @ 1:1	Total project cost
		Dollars	Dollars	Dollars	Dollars		Dollars	Dollars
A-1	North Sanpete	50,000	225,000	4,520,000	4,795,000	2.2:1	1,325,000	6,120,000
A-2	Fountain Green	280,000	170,000	1,410,000	1,860,000	1.4:1	520,000	2,380,000
A-3	Ephraim	---	---	1,260,000	1,260,000	2.0:1	2,145,000	3,405,000
A-4	Manti	235,000	15,000	385,000	635,000	2.6:1	670,000	1,305,000
B-1 & 2	Levan	100,000	180,000	1,190,000	1,470,000	2.3:1	1,770,000	3,240,000
B-4	Scipio	---	40,000	1,850,000	1,890,000	1.5:1	755,000	2,645,000
C-5	Salina Creek	1,830,000	290,000	65,000	2,185,000	0.9:1	1,345,000	3,530,000
D-1	Richfield	1,570,000	---	2,210,000	3,780,000	0.9:1	1,860,000	5,640,000
D-2 & 3	Glenwood	---	---	285,000	285,000	0.8:1	200,000	485,000
E-5	Tropic	---	---	160,000	160,000	2.1:1	1,035,000	1,195,000
F-1	Circleville	---	---	665,000	665,000	1.3:1	1,185,000	1,850,000
F-3	Panguitch Creek	110,000	65,000	325,000	500,000	0.9:1	3,525,000	4,025,000
Grand total		4,175,000	985,000	14,325,000	19,485,000	---	16,335,000	35,820,000

[a] Price Base 1967.

[b] The benefit cost ratios were recomputed using the F. Y. 1970 value of 4 5/8 percent interest rate in accordance with Part V, G.2 of Senate Document 97. The original benefit cost ratios were computed using 3¼ percent. Although some watershed ratios have changed to a less than 1:1 value, these watersheds are considered feasible for planning within the next 10 to 15 years.

WATERSHED A-2, FOUNTAIN GREEN

Watershed A-2 is located in Sanpete and Juab Counties and contains 103,200 acres, of which 10,521 acres are in the Uinta National Forest. The primary problem is an irrigation water shortage. There is an average root zone deficit of 5,100 acre-feet--one-fourth of the total potential consumptive use. Minor flood damage has occurred near the mouth of several of the drainages.

The program consists of flood protection, land treatment, water salvage, and irrigation and recreation development. Project features include a reservoir with storage capacity of 1,055 acre-feet for irrigation water, 405 acre-feet for sediment, and 370 acre-feet for recreation; approximately 21 miles of canal lining; 3 miles of pipelines; and 50 irrigation wells to provide 3,040 acre-feet of irrigation water available at the crop root zone. A program with these features will affect the downstream river flow and will require concurrent planning with projects in Watersheds A-3 and A-4 to protect these water users.

WATERSHED A-3, EPHRAIM

Watershed A-3, located in Sanpete County, contains 59,100 acres, of which 26,750 acres are in the Manti-LaSal National Forest. The primary problems are sediment damage and irrigation water shortages--there is an average root zone deficit of 3,070 acre-feet. Damage from recent flooding is minor; however, the upstream watershed is severely eroded.

A program of land treatment, irrigation system improvement, and sediment-control construction is feasible. The project measures include 75 miles of canal lining and approximately 10 irrigation wells to furnish 1,800 acre-feet of crop root zone water. This program will affect downstream river flow and require planning with Watersheds A-2 and A-4.

WATERSHED A-4, MANTI

Watershed A-4 is located in Sanpete County and contains 73,700 acres of which 21,720 acres are in the Manti-LaSal National Forest. The primary problem is a shortage of irrigation water. There is an average root zone deficit of 1,830 acre-feet. Although recent flood damage has been minor, a low frequency, heavy flood damage threat exists and sediment problems will increase the irrigation water deficit and the irrigation systems maintenance costs.

There is an opportunity for a project including sediment control, land treatment, water development for irrigation, and recreation. The major features include one debris basin to provide 260 acre-feet of sediment storage and 50 acre-feet of recreation storage: one campground development; 11 miles of canal lining; and approximately 10 irrigation wells to provide 1,800 acre-feet of crop root zone water. A program with these features will affect the downstream river flow.

The local people have applied for planning assistance.

WATERSHEDS B-1 AND B-2, LEVAN

Watersheds B-1 and B-2, which are located in Juab and Sanpete Counties, were planned as one project. The project contains 142,800 acres of which 33,790 acres are in the Uinta National Forest. The primary problems are water shortages and floodwater and sediment damages. Annually, there is direct flood damage of $2,000 and sediment damage of $7,600. The upper watershed contributes between 15 and 24 acre-feet of sediment per year. Irrigation water supplies are inadequate about two-thirds of the time. The average annual shortage is about 4,600 acre-feet of root zone soil moisture.

The project will include flood and sediment control, land treatment, and water development for irrigation and recreation. A water-salvage project centered around Juab Lake (Chicken Creek) Reservoir will be necessary to protect water rights of downstream users. The project's possible features include three reservoirs for storage of 1,230 acre-feet of irrigation water, 665 acre-feet of floodwater and sediment, and 925 acre-feet and 65 surface area acres for recreation; 16 miles of canal lining; 14 miles of pipelines; approximately 27 irrigation wells to supply 20,000 acre-feet of water; and 3 campground developments.

Importation of irrigation water will play an important role in development of the area.

WATERSHED B-4, SCIPIO

Located in Millard, Sanpete, and Sevier Counties, Watershed B-4 contains 102,900 acres of which 32,180 acres are in the Fishlake National Forest.

A shortage of irrigation water is the major problem. Supplies are inadequate 9 out of 10 years and there is an average annual shortage of

3,330 acre-feet. This results from high losses in the irrigation distribution system and high use of water in the reservoir area. Low on-farm irrigation efficiencies are also a contributing factor. Only 3,010 acre-feet of the 19,440 acre-feet average yield above the reservoir are consumptively used by irrigated crops in the watershed.

A project would include land treatment and water development for irrigation and recreation. A water salvage project in the Scipio Lake Reservoir area and construction of a new reservoir nearer Scipio will make more water available for irrigation and overcome detrimental downstream effects. Specific project features include one reservoir to provide 5,040 acre-feet of irrigation water storage and 110 acre-feet of recreation storage with 18 surface acres; 35 miles of canal lining; 4 miles of pipelines for drains; and 1 campground for recreation.

The local people have expressed their interest by applying for planning assistance through the PL-566 program.

WATERSHED C-5, SALINA CREEK

Watershed C-5 is located in Sevier County and contains 199,000 acres of which 145,700 acres are in the Fishlake National Forest. The primary problem within the area is sediment control. Soil, streambank, and channel erosion is a major problem in areas historically barren of sufficient vegetation to prevent it. The average sediment rate for the upstream watershed is 0.46 acre-feet per square mile with some areas exceeding 0.7 acre-feet per square mile. The annual direct floodwater and sediment damages are $1,650 and $39,890, respectively.

Irrigation water supply studies indicate shortages can be expected at least 20 percent of the time. Sediment buildup in irrigation distribution systems contributes to these shortages.

There is an opportunity for a project including land treatment, irrigation water storage, sediment and flood control, and recreation. The features include four reservoirs to provide regulatory storage for 500 acre-feet of irrigation water, 9,790 acre-feet of sediment, 690 acre-feet of water with 120 surface acres of water for recreation, and 3 campgrounds. When Interstate Highway I-70 through Salina Canyon is completed, it will provide easy access to recreational and roadside rest facilities constructed in conjunction with Reservoir C5-8, all within a mile of the city of Salina.

The local people have filed a watershed application for planning assistance.

WATERSHED D-1, RICHFIELD

Watershed D-1 is located in Sevier County and contains 135,600 acres; 65,584 acres are within the Fishlake National Forest. The primary problems of the area are flash flooding and irrigation water deficits. The average root zone water shortage is approximately 4,200 acre-feet. The present average annual flood and sediment damage is estimated at $37,450.

The project opportunities include land treatment, floodwater diversions, channel and irrigation system improvement, and irrigation water development. The features are two debris basins with a sediment storage capacity of 3,110 acre-feet, consolidation of several irrigation companies with one canal, and 72 miles of canal lining. An important factor in formulating a project will be construction of Interstate Highway I-70 which will traverse the watershed. Its location in relation to the flood-yielding canyons will have a definite influence on program features.

The local people are now compiling data to file an application for planning assistance.

WATERSHEDS D-2 AND D-3, GLENWOOD

Watersheds D-2 and D-3, located in Sevier County, were planned as one project. The project contained 73,800 acres--12,565 acres in the Fishlake National Forest and 37,775 acres of land administered by the Bureau of Land Management.

The area's primary problems are erosion control and agricultural water management. Peterson Creek contributed 6.7 acre-feet of sediment annually to Rocky Ford Reservoir. Total entrapment rate averages 26.5 acre-feet a year. The irrigated areas need accelerated management practices to increase their efficiencies. The watershed has an irrigation water deficit of 78 acre-feet per year. There are 400 acres of wetlands needing drainage. Project features include converting 275 acres of the wetlands to rotated cropland.

A program including sediment-erosion control, water salvage, land treatment, agricultural water management, wetland conversion, and recreation development would be feasible. Project features would include 77,000 feet of pipeline for sprinkler systems.

Other possibilities include development of additional water for the Utah State Fish Hatchery near Glenwood and additional recreational facilities at Big Lake. The Mill Canyon-Sage Flat Watershed Project has been completed on part of this area. There are possibilities for water salvage through drainage of the wetland areas. This would provide supplementary water available to downstream users. If this feature is included, it will require coordination with any work planned for Watershed D-1.

WATERSHED E-5, TROPIC

Watershed E-5 in Garfield County contains 145,700 acres of which 20,520 acres are in Bryce Canyon National Park and 90,170 acres are in Dixie National Forest. The primary problem in the watershed is irrigation water deficiency. Supplies are critically short with an average consumptive-use deficit of 1,570 acre-feet on 3,200 irrigated acres. Two years in ten this shortage will approach 4,000 acre-feet. Factors which contribute to this problem are the reduced capacity of Tropic Reservoir through sedimentation, excessive losses in some sections of the canal systems, and low on-farm irrigation efficiencies. Most irrigated lands need leveling or installation of sprinkler systems to overcome the effects of uneven and rough topography.

Erosion and sediment problems have occurred throughout the area and most noncultivated areas need land treatment. Sediment picked up by the Tropic and East Fork Canal through the geologic erosion areas of the National Park poses a major problem.

There is an opportunity for a project including land treatment, water development for irrigation, and sediment control. The project's main features would be increased reservoir storage for 400 acre-feet of irrigation water and sediment storage; 4 miles of canal lining; and 1,700 feet of pipeline.

The local people have made application for planning assistance under the PL-566 program.

WATERSHED F-1, CIRCLEVILLE

Watershed F-1 is located in Piute and Garfield Counties. It contains 92,900 acres of which 41,133 are within the boundaries of the Fishlake and Dixie National Forests. Its primary problem is an inadequate supply of irrigation water. Half the time water supplies are not sufficient to supply presently irrigated cropland and water shortages approach 3,000 acre-feet some years. The water deficit 8 out of 10 years is 480 acre-feet. There are 3,400 acres of wetlands that could be improved to provide higher returns.

The project would include land treatment, irrigation system improvement, and irrigation water development. The main features would be 15 miles of canal lining, 8 miles of pipelines, and 5 irrigation wells to provide 6,000 acre-feet of water. Salvage of water from the wetlands would offset any downstream effects.

WATERSHED F-3, PANGUITCH CREEK

Watershed F-3 is located in Garfield and Iron Counties and contains 139,500 acres of which 92,602 acres are within the Dixie National Forest. The primary problem is regulation of flood and irrigation waters. The average annual flood damage is $4,300. Loss of irrigation water through canal breaks caused by summer floods and ice problems caused by overtopping of channels during winter freezes costs an additional $3,000 annually with water losses averaging 200 acre-feet per year. There are erosion-problem areas in the upper watershed which contribute sediment and flood runoff.

There is an opportunity for a project including floodwater and sediment control, land treatment, and recreation and irrigation water development. The main features would be a reservoir with storage for 75 acre-feet of irrigation water, 225 acre-feet of floodwater, 50 acre-feet of sediment, and 150 acre-feet with 17 surface acres for recreation; 2 miles of flood channel through Panguitch City; and 18 miles of canal lining and 1 recreation development.

The local people have made application for planning assistance in the Three-Mile Creek-Panguitch area which includes 96,080 acres of this watershed.

LAND TREATMENT UNDER THE CONSERVATION OPERATION PROGRAM (PL-46)

Many of the problems in those areas where PL-566 project action cannot be used, can be overcome by the current program of the Soil Conservation Service. This program includes implementation of off-farm land treatment programs along with on-farm work through Soil Conservation District programs and related authorities. In areas where there are potentially feasible PL-566 watershed projects, there is the opportunity to accelerate these programs when these projects are authorized.

There are 172,000 acres of the 260,730 acres of irrigated cropland where leveling or sprinkler systems are recommended. Sprinkler systems are especially recommended on 10,000 acres because of shallow topsoils or steep slopes. There is the opportunity to install ditch lining to serve 156,000 acres. Land treatment opportunities are listed by sub-basin in Table 81.

TABLE 81.--On-farm land treatment opportunities,[a] Sevier River Basin

Sub-basin	Land leveling or sprinkler systems	Sprinkler systems recommended	On-farm ditch lining
	Acres	Acres	Acres served
A	46,500	---	38,000
B	45,500	2,000	36,000
C	29,500	---	36,000
D	26,000	1,000	29,000
E	4,000	3,000	6,000
F	10,500	4,000	11,000
Total	162,000	10,000	156,000

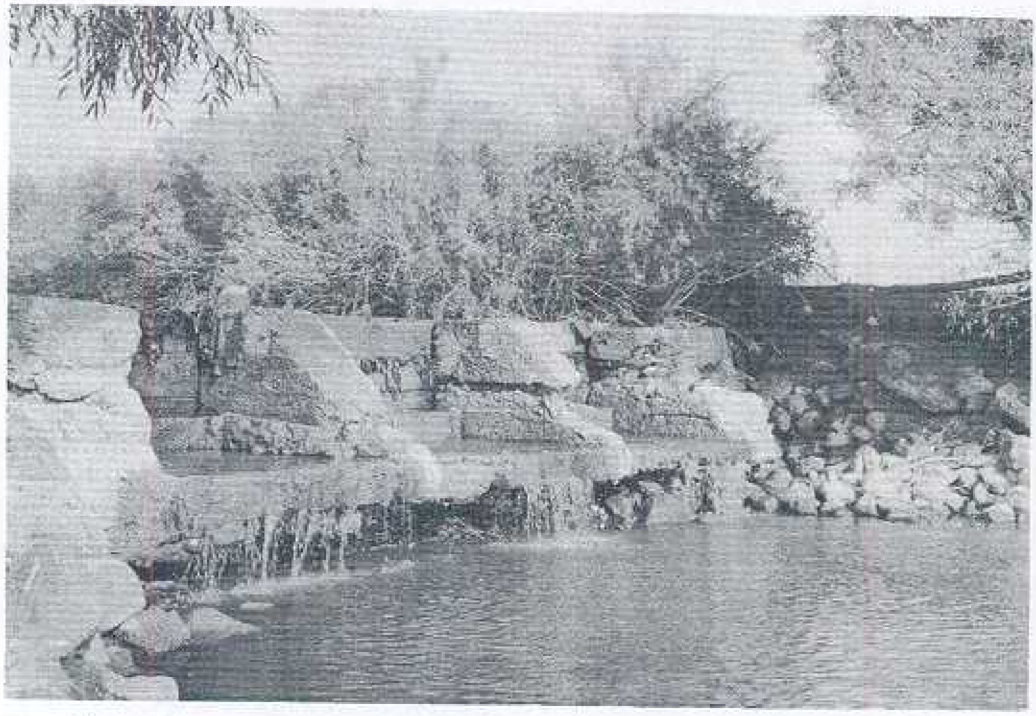
[a]Total acres indicated may not agree with economic analysis because of availability of data at the time that analysis was made.

Many diversion structures are needed, particularly on smaller tributary streams. Opportunities exist to improve the distribution of irrigation water by installing measuring devices on ungaged river and tributary diversions and on individual farm headgates, and on storage and regulatory reservoirs.

There are opportunities for increasing fish and wildlife populations and habitat, including stocking of farm ponds with game fish and improving wildlife cover, feed, and watering facilities.

Before

FIELD PARTY PHOTO 8-991-4



There is an opportunity to replace many inefficient structures and provide better water management.

After

SOIL CONSERVATION SERVICE PHOTO 8-1157-5

There are opportunities to overcome erosion problems on range and dry croplands as well as on irrigated lands. Much of the present water shortage can be overcome through implementation of land treatment measures and improvement of water management practices. Better irrigation water distribution will alleviate drainage problems, reduce the supply to nonbeneficial phreatophytes, and reduce deep percolation.

COOPERATIVE STATE - FEDERAL FORESTRY PROGRAMS

The Utah State Forestry and Fire Control feels there is a need to expand its fire protection organization and facilities. The ultimate goal is volunteer fire departments equipped with fire fighting units located in each town and available for rural fire protection. Table 82 presents a brief economic evaluation of doubling the present fire fighting capability which is interpreted as full development.

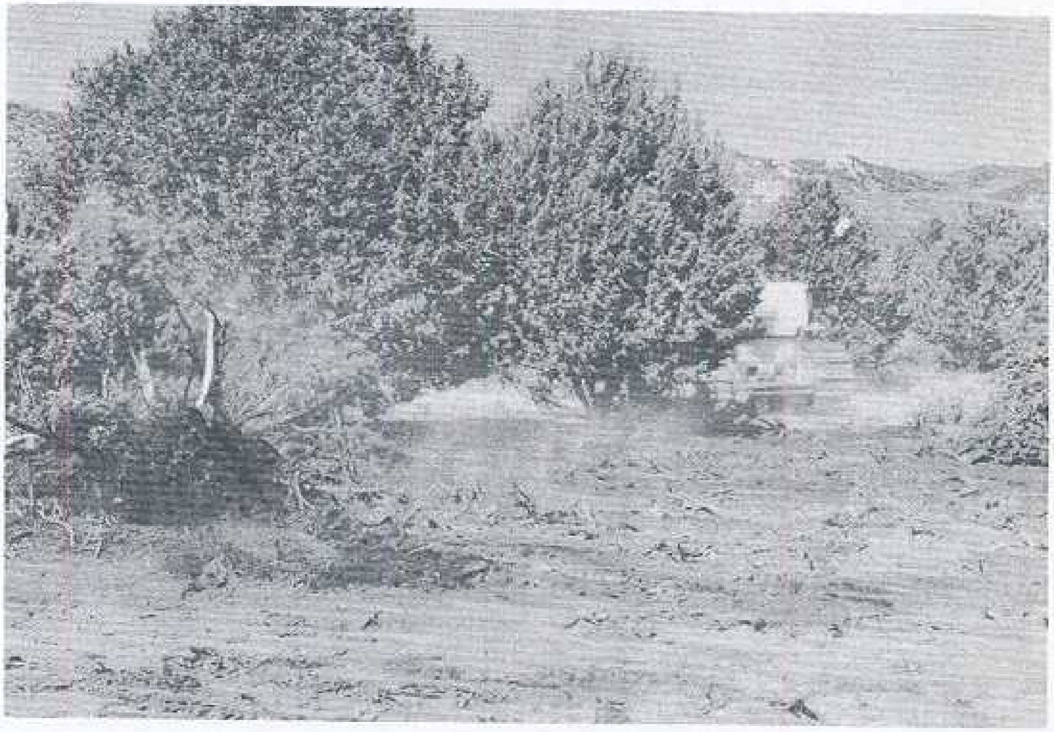
TABLE 82.--Benefit-cost relationship of cooperative State-Federal fire protection of State and private lands, Sevier River Basin

Annual average	Present	Full development
Cost of protection/acre	$.0041	$.0082
Total costs	$4,797	$9,594
Fire suppression costs	$8,073	$1,615
Resource damages	$23,400	$4,680
Total costs and damages	$36,270	$15,889
Benefits of full development		$20,381
Benefit-cost ratio		2.1:1

State and Federal cooperative programs provide an opportunity to help private owners by showing them that in some instances (especially where a high value species is involved) growing timber in conjunction

U. S. FOREST SERVICE PHOTO SR81-23

Cooperative improvement programs with Federal agencies provide many opportunities for resource development.



SOIL CONSERVATION SERVICE PHOTO F-376-4

with using their land in other ways will provide them a greater return. The same programs can also help private timber owners to improve the composition and quality of their timber stands.

NATIONAL FOREST DEVELOPMENT AND MULTIPLE-USE PROGRAMS

National Forest development opportunities will facilitate better management and protection of forest lands; provide maximum sustained production of water, wood, forage, recreation, and wildlife; and make the beauty and other resources of the forest more readily available to a maximum number of people. Development, in this sense, connotes the technological manipulation of resources to meet the needs or desires of man. Opportunities for such development within the Sevier River Basin include bettering transportation facilities, improving wildlife habitat, protecting the land from fire, insects, and disease, harvesting timber, and many other activities.

A watershed stabilization and improvement program, a range improvement program, and a recreation development program to meet projected demands are proposed and have been evaluated on an economic feasibility basis. Full development of the National Forests will require other development programs supplemental to the three evaluated. Recreation, watershed, and range improvement on National Forest lands, however, have the greatest opportunity to contribute to the alleviation of Basin-wide problems and should receive priority for acceleration.

WATERSHED AND RANGE IMPROVEMENT PROGRAM

Both watershed and range improvement will stabilize the soil, reduce peak flows which cause floods, and improve forage production; therefore, these two programs were evaluated together.

On National Forest and other forested lands, erosion control opportunities were related indirectly to the erosion problems identified on Table 54, page 145, and are aimed specifically at reducing sedimentation and flood problems. The range improvement program has as its primary purpose stabilization and improvement of the agricultural economy. Developments needed to implement the two programs are described in Tables 83 and 84. Table 85 shows the effect the proposed development program will have on two factors, sediment production and grazing, and evaluates the feasibility of the projects on an economic basis which is summarized into benefit-cost ratios.

TABLE 83.--Range improvement development opportunities on National Forest and other forested lands in the Sevier River Basin

Treatment	Unit of measure	Sub-basin						Total
		A	B	C	D	E	F	
Pinyon-Juniper control and seeding	Acre	6,175	15,990	8,400	10,200	24,940	9,550	75,255
Sagebrush control and seeding	Acre	17,000	4,280	12,350	8,400	21,400	6,800	70,230
Plow and seed	Acre	4,350	5,620	6,120	5,000	9,800	8,600	39,490
Fertilization[a]	Acre	4,200	3,200	8,000	9,500	12,200	3,100	40,200
Fences	Mile	70	52	98	59	119	77	475
Spring water development	Each	25	25	39	26	24	28	167
Reservoirs	Each	15	52	61	31	21	18	198
Total installation costs[b]	Dollar	$749,425	$724,990	$847,300	$730,400	$1,551,940	$763,150	$5,367,205

[a]Acres planned for fertilization do not include any other practice.

[b]Based on average costs of similar existing installations on National Forests.

Source: Developed from National Forest 1967 Project Work Inventory Information.

TABLE 84.--Erosion control development opportunities on National Forest and other forested lands in the Sevier River Basin

Item	Unit	Sub-basin						Total
		A	B	C	D	E	F	
Gully and stream channel stabilization	Miles	73	56	55	78	101	68	431
Drop structures	Each	200	19	27	61	128	155	590
Road and trail erosion control	Miles	179	70	167	183	277	290	1,166
Fences	Miles	39	58	19	40	20	72	248
Contour furrow or trench and seed	Acres	9,400	1,100	10,500	9,600	7,800	21,500	59,900
Pit or rip and seed	Acres	---	900	300	200	17,200	18,000	36,600
Plow (disc) and seed	Acres	2,300	4,600	3,600	1,200	12,600	1,200	25,500
Aerial application herbacide and/or seeding	Acres	3,200	2,300	15,100	9,300	18,100	13,000	61,000
Dixie harrow and seed	Acres	2,400	2,300	600	---	---	11,000	16,300
Ground rig spray and seed	Acres	---	---	---	---	---	3,100	3,100
Pinyon-Juniper or oak cable and seed	Acres	100	15,400	17,800	5,800	11,800	23,000	73,900
Seeding only	Acres	1,300	1,100	---	4,700	2,100	---	9,200
Browse seeding	Acres	100	---	---	---	---	---	100
Total acres	Acres	18,800	27,700	47,900	30,800	69,600	90,800	285,600
Total cost[a]	Dollars	$920,600	$651,124	$1,295,092	$880,656	$1,763,088	$2,507,880	$8,018,440

[a]Based on average costs of similar existing installations on National Forests.

Source: Field party estimates based on information from National Forest District Rangers (1963).

TABLE 85.--Benefit and cost evaluation of watershed and range improvement programs, Sevier River Basin

	Unit	Sub-basin A	B	C	D	E	F	Total
Watershed improvement program								
Annual benefits								
On-site sediment reduction	Cu. Yds. Annually	77,230	121,200	245,240	128,770	249,470	324,860	1,146,770
Damage reduction value @ 30¢/cu. yd.[a]	Dollars	23,169	36,360	73,572	38,631	74,841	97,458	344,031
Grazing capacity increase	A.U.M.	2,200	8,870	11,270	6,730	20,600	23,100	72,770
Value per A.U.M.[b]	Dollars	2.59	2.07	2.04	2.09	3.88	3.73	
Grazing benefits	Dollars	5,700	18,360	22,990	14,070	79,930	86,160	227,210
Total benefits	Dollars	28,860	54,720	96,562	52,701	154,771	183,618	571,241
Annual costs								
Total installation cost	Dollars	920,600	651,124	1,295,092	880,656	1,763,088	2,504,880	8,018,440
Average annual cost 100 yrs. @ 3½%	Dollars	31,190	22,060	43,878	29,837	59,733	84,967	271,665
O&M and replacement costs 10% replacement/25 yrs. @ 3½%	Dollars	3,682	2,604	5,180	3,523	7,052	10,032	32,073
Total costs	Dollars	34,872	24,664	49,058	33,360	66,785	94,999	303,738
Benefit-cost ratio		0.8:1	2.2:1	2.0:1	1.6:1	2.3:1	1.9:1	1.9:1
Range improvement program								
Annual benefits								
On-site sediment reduction	Cu. Yds. Annually	44,130	49,910	70,070	71,540	91,910	25,650	353,210
Damage reduction value @ 30¢/cu. yd.[a]	Dollars	13,239	14,973	21,021	21,462	27,573	7,695	105,963
Grazing capacity increase	A.U.M.	10,570	9,700	11,620	11,030	22,780	9,350	75,050
Value per A.U.M.[b]	Dollars	2.59	2.07	2.04	2.09	3.88	3.73	
Grazing benefits	Dollars	27,380	30,080	23,700	23,050	88,390	34,870	217,470
Total benefits	Dollars	40,619	35,053	44,721	44,512	115,963	42,565	323,433
Annual costs								
Total installation costs	Dollars	749,425	724,990	847,300	730,400	1,551,940	763,150	5,367,205
Average annual costs 100 yrs. @ 3½%	Dollars	25,390	24,560	28,710	24,750	52,580	25,860	181,850
O&M and replacement costs 30% replacement/25 yrs. @ 3½%	Dollars	8,990	8,700	10,170	8,760	18,623	9,160	64,403
Total costs	Dollars	34,380	33,260	38,880	33,510	71,200	35,020	246,250
Benefit-cost ratio		1.2:1	1.1:1	1.1:1	1.3:1	1.6:1	1.2:1	1.3:1

[a]Damages per cubic yard of sediment produced are based on the 1950 "Survey Report-Sevier Lake Watershed." USDA publication. Both on-site and downstream damages are included.

[b]A.U.M. value from the 1966 Western Grazing Fee Study plus the benefits offsetting maintenance costs normally incurred by the permittee.

Secondary Rural and Community Benefits

The River Basin is within the Four Corners Economic Development Area. Chronic unemployment, low per-capita income, and a declining population are symptoms of the Basin's lagging economy. Maximum benefits will result by using locally available construction materials, labor, and equipment. For example, locally available wooden juniper posts used in place of steel posts in fence construction will generate one week of employment in cutting and handling the posts per mile of fence.

Employment opportunities created by the watershed improvement and range development programs are evaluated on Table 86. Employment will be provided for people who are now on welfare, changing their status from a liability to an asset, and for this reason wages earned are shown as a secondary benefit.

BENEFITS

The proposed watershed and range development programs will reduce sediment production from National Forest and other forested lands 26 percent, and will provide grazing valued at $444,680 annually. Other direct benefits, which were not evaluated, will result from the program. These include improved productivity of upper watersheds, better fishing, less cleanout of irrigation systems, longer life of reservoirs, reduced size and costs of sediment containment structures, and improved aesthetics.

Indirect benefits of the program will be multiplied two to four times the primary benefits as money is circulated within the local economy (Table 86). (11) Additional stimulation to the local economy will result from approximately 1,170 man years of employment. Other indirect benefits will include stabilization of grazing and the many social and economic benefits resulting from a reduced flood hazard.

RECREATION DEVELOPMENT

Recreation demand on National Forests will increase at a rate at least comparable to that of the entire Basin (Table 87); therefore, 1965 actual use figures from National Forests were projected into the future at this same rate of increase. The National Forest Recreation Survey has inventoried potential recreation development sites with capacity that exceeds this future demand.

TABLE 86.--Employment opportunities in watershed and range improvement projects, Sevier River Basin
(Secondary rural and community benefits)

	Unit	Sub-basin						Total
		A	B	C	D	E	F	
Watershed improvement								
Employment in watershed improvement	Man days	41,750	20,050	29,710	30,330	52,670	65,770	240,280
Wages at $16.00/day	Dollars	668,000	320,800	475,360	485,280	842,720	1,052,320	3,844,480
Annual secondary benefits 25 yr. @ 3½%	Dollars	39,412	18,927	28,050	28,630	49,720	62,090	226,829
Primary benefits (Table 85) plus secondary	Dollars	68,281	73,647	124,612	81,331	204,491	245,708	798,070
Benefit-cost ratio primary and secondary benefits		2.0:1	3.0:1	2.5:1	2.4:1	3.1:1	3.9:1	3.5:1
Range improvement								
Employment in range improvement	Man days	12,610	10,940	15,420	12,340	24,690	12,170	88,170
Wages @ $16.00/day	Dollars	201,760	175,040	246,720	197,440	395,040	194,720	1,410,720
Annual secondary benefits 25 yr. @ 3½%	Dollars	11,904	10,327	14,557	11,648	23,308	11,488	83,232
Primary benefits (Table 85) plus secondary	Dollars	52,523	45,380	59,278	56,160	139,271	54,053	406,665
Benefit-cost ratio primary and secondary benefits		1.5:1	1.4:1	1.5:1	1.7:1	2.0:1	2.2:1	1.7:1

TABLE 87.--Benefit-cost relationship of recreation development on National Forests to accommodate projected demand in Sevier River Basin

Item	Unit	Year			
		1965	1980	2000	2020
Annual recreation use[a]	Visitor days (1,000)	752	2,420	4,383	6,343
Use in developed areas compared to total use[b]	Percent	30	35	45	50
Visitor days converted to number of people (÷ 120 day season)[c]	Each	1,880	7,060	16,430	26,430
Total development units needed (5 persons per unit x 2)[d]	Each	752	2,842	6,572	10,572
New development units constructed each year[e]	Each	634 development units are existing (1965) on National Forests within the Basin	104	186	200
Cost @ $2200 per unit	Dollars		228,800	409,200	440,000
Replacement units needed each year (20 year life)[f]	Each		37	142	328
Cost @ $1500 per unit	Dollars		55,500	213,000	492,000
Annual O&M costs @ $50 per unit[g]	Dollars		142,100	328,600	528,600
Total annual costs	Dollars		426,400	950,800	1,460,600
Annual benefits @ $1.50 per visitor day (people using developed areas)[h]	Dollars		1,270,500	2,958,500	4,757,250
Benefit-cost ratio			3.0:1	3.1:1	3.3:1

Footnotes to Table 87

[a]In 1965 National Forests provided 752,000 visitor days of recreation use (Table 13, page 83). This use was projected into the future at a rate comparable to Basin-wide projections (Table 67, page 175).

[b]Annual National Forest Recreation reports indicate that 30 percent of the recreation visitors utilized a campground, picnic area, or other developed facility. It was assumed that as recreation increases, a larger percentage of people will use recreation facilities.

[c]Visitor days were reduced to the Item b figure, then divided by 120 (length of season) to arrive at the number of people using developed facilities each day of the season.

[d]An arbitrary development unit was selected that will accomodate 5 persons. Campgrounds were the most commonly used facility in the River Basin and a family unit consisting of a parking space, table, grill, sanitation facilities, and water source was selected as a model and called a unit. It is recognized that many diversified developments other than campgrounds exist and are needed within the Basin, but it is assumed that the development unit defined represents an average in cost. Item c is divided by 5 to get the number of development units required if use was uniform throughout the year. This number of development units needed was then doubled to allow for peak periods of use and to provide for maintenance of vegetation, differences in degree of use due to location, and other factors.

[e]To keep up with the accelerating recreation demand, a minimum of 104 development units each year will need to be constructed by 1980. Number of units needed minus the number existing 20 years previous, divided by a 20 year interval, equals the number to be built each year. (Less than the number needed actually existing in 1965, and the period 1965 to 1980 is only 15 years, but the accelerated program needed to catch up was not evaluated and all figures are, therefore, conservative.) The cost per development unit is based on average costs within the Basin.

[f]Replacement units needed each year based on a 20 year life. Units existing 20 years previous were divided by 20. Replacement costs are assumed to be cheaper than new development costs because roads, water systems, etc. can be expected to have a life longer than 20 years.

[g]Operation and maintenance costs are average and do not include such items as Land and Water Conservation fund administration or visitor information services.

[h]Annual benefits are from "Evaluation Standards for Primary Outdoor Recreation Benefits", Ad. hoc., Water Resources Council; Washington, D. C.; June 4, 1964. Benefits were reduced to the Item b figure to evaluate only use in developed areas.

Table 87 summarizes an economic evaluation of recreation facilities adequate to accommodate projected demand. Several assumptions were made in developing the table and each table entry is explained in the footnotes. By 1980, 104 new development units will need to be built each year, 37 existing units will need to be replaced each year, and operation and maintenance costs will be $142,100 annually. Secondary benefits to the Basin economy were not evaluated.

OTHER DEVELOPMENT OPPORTUNITIES

There are other projects that should be included with the previously mentioned opportunities for development to coordinate the Basin's water and related land resources. They provide for reducing or eliminating the downstream impacts of upstream projects as well as increasing the utilization of the resources. A brief description of these projects is given below.

HATCH-PANGUITCH AREA

Construction of Hatch Town Reservoir will provide storage for supplemental irrigation water, floodwater and sediment along with recreation. Floodwater and sediment storage structures on Red Canyon and Casto Canyon would reduce sediment deposition in irrigation systems. Combining all irrigation systems on the east side of Panguitch Valley into one canal system would improve irrigation and management efficiencies and reduce groundwater loss to the wetlands. In addition, pumping of the groundwater in Panguitch Valley could salvage water now consumed by phreatophytes and stabilize late summer river flows.

CIRCLEVILLE-JUNCTION-KINGSTON AREA

A reservoir in Circleville Canyon would provide floodwater and sediment storage along with irrigation water regulation. Recreation storage in the reservoir and low-flow augmentation to maintain a downstream fishery are important features. The present Junction and Junction Middle Ditch canals and diversions could be replaced by a canal around west Circle Valley and into the Junction area to provide more efficient operation. All the irrigation systems on the east side of the valley and likewise, the major canals in the Kingston area could be combined into one system with a saving in water and management.

The available water supply from City Creek near Junction can be increased through construction of a diversion structure and completion of the present lining.

ANTIMONY AREA

Sediment, floodwater and regulatory storage for irrigation water and recreation facilities on Antimony Creek would provide benefits to this area. Improvement of the diversion works for the Otter Creek Reservoir Canal is recommended in order to better regulate high flood flows and prevent excessive sediment deposition in the canal. Drainage of the wetlands in Antimony Valley will reduce water consumption by phreatophytes, reclaim lands and salvage water for downstream use.

KOOSHAREM AREA

Enlargement of Koosharem Reservoir would provide storage for recreation and supplement the irrigation water supply. Construction of storage reservoirs on Burr Creek and Greenwich Creek could eliminate the winter water problem on the former and provide multiple-purpose storage on both drainages. Pumping from the groundwater reservoir will salvage water to stabilize downstream supplies and compensate for upstream uses.

RICHFIELD-AURORA AREA

A reservoir on Clear Creek is needed to provide floodwater and sediment storage. Recreation storage should be included to enhance the potential of the proposed State park. Development of the groundwater reservoir in the Richfield area provides one of the largest potentials in the Basin. Lowering the water table in this area would salvage water to augment late summer downstream flows, drain lands for conversion to higher value crop production and offset detrimental downstream effects of increased water use planned in PL-566 projects in Watersheds D-1, 2 and 3. An off-channel evaporation basin on Lost Creek would prevent large quantities of dissolved solids (mineral salts) from entering the river.

GUNNISON AREA

Impact of upstream developments on the Sevier River and in Sanpete Valley can be offset through a combination of the following alternatives: (1) Water salvage and utilization of the groundwater reservoirs in Sanpete Valley, the Richfield area and Gunnison Valley, (2) storage of additional irrigation water in Bull Pasture Reservoir on Salina Creek for use in the Gunnison Valley, and (3) exchange of water rights through importation from the Central Utah Project. Delivery of this water to the east side of the valley would be through a canal diverting water from the Sevier River near Redmond and through the present system below Gunnison Reservoir. Pumping from the groundwater reservoir in Gunnison Valley will supply the lower areas. Construction of Blue Meadow Reservoir on Six Mile Creek would provide recreation, floodwater and sediment storage and regulatory storage for irrigation water.

DELTA AREA

In this area, in addition to 15,000 acre-feet of Central Utah Water and water salvage upstream, additional pumping is needed. If the consumptive use by phreatophytes were reduced one-third, over 30,000 acre-feet could be salvaged. Three alternates were considered concerning the Central Utah Canal: (1) Line the high loss areas and use Sevier Bridge Reservoir for storage, (2) eliminate the canal from Lyndyll to McCormick, store water in DMAD Reservoir and pump into the canal at McCormick, (3) eliminate the canal from Lyndyll to McCormick and pump from the groundwater into the canal in the McCormick-Greenwood area, (4) eliminate the canal below Lyndyll. In any event, Fool Creek Reservoir should be eliminated.

BASIN-WIDE COORDINATED PLANNING AND DEVELOPMENT

EARLY ACTION PROGRAM OBJECTIVES 1980

Goals of the U. S. Department of Agriculture are to strengthen the economy and protect and improve the resources of the Sevier River Basin. The income level of people within the Basin is significantly below the State income level. Some natural resources are deteriorating while other resources are not used to their full potential.

The early action water related activities should endeavor to meet the following objectives: (1) Eliminate the water deficits on presently irrigated lands, (2) reduce the consumptive use of water by nonbeneficial phreatophytes, (3) reduce erosion and sediment rates on 677,700 acres of U. S. Department of Agriculture administered lands where erosion exceeds .005 inches per year, (4) alleviate flood problems within areas of municipal and agricultural development and reduce damage in other areas to maintain cultural and resource values, and (5) improve water quality and its aesthetic value.

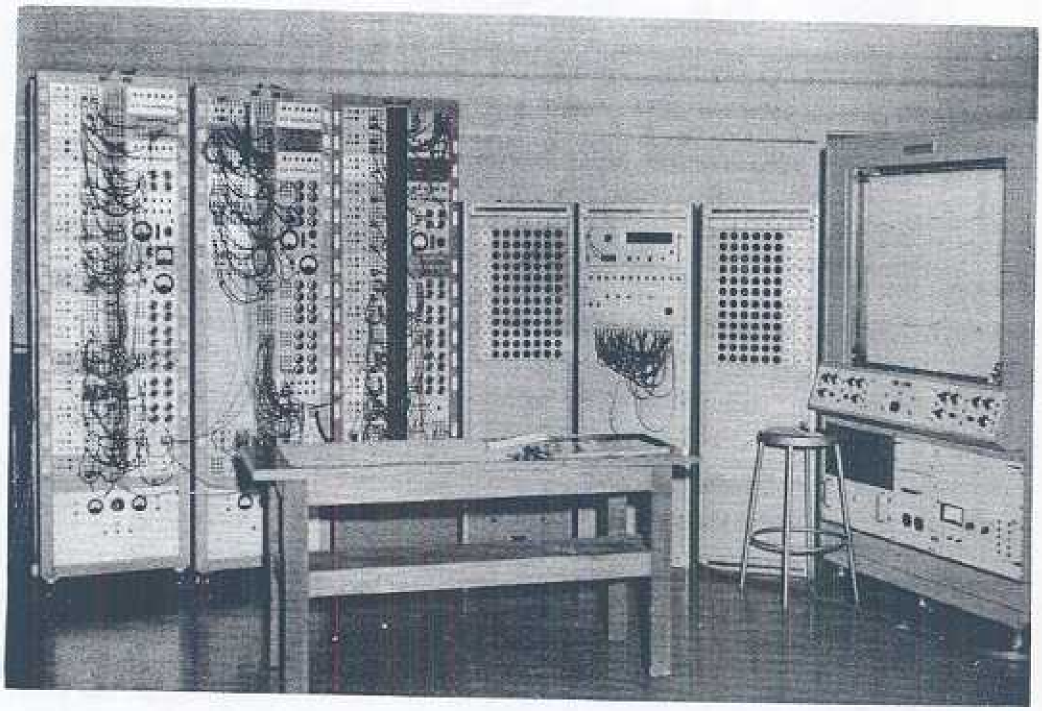
The early action land related activities on private and U. S. Department of Agriculture administered lands include: (1) Providing necessary recreation facilities, (2) improvement of fish and wildlife conditions and aesthetic values, (3) increase grazing capacities, and (4) improved fire protection capabilities.

EARLY ACTION PROGRAM OPPORTUNITIES - 1980

Elimination of water deficits of 78,000 acre-feet on presently irrigated lands can be accomplished through the 12 feasible PL-566 watershed projects and additional canal lining, on-farm improvement practices, pumping projects to salvage water from phreatophytes, and surface water storage to improve water management. (8) Some of the projects are identified in earlier portions of this report.

The installation of on-farm improvement practices would increase the overall Basin water-use efficiency by 4 percent. The annual direct agricultural benefits from practices would be $1,588,000 with amortized annual costs of $1,106,000. Income available to farm operators would be increased by $482,000 annually.

An alternative was investigated to eliminate the consumptive-use deficits on the presently irrigated lands by increasing irrigation efficiencies and converting water use by native phreatophytic vegetation to irrigated cropland uses. The physical feasibility and impacts of change in hydrologic conditions were analyzed with an analog computer. Findings were based on present average irrigation diversions.



Sevier River Basin Electronic Analog Model. FIELD PARTY PHOTO 8-1155-14

Results indicate that upstream from Sevier Bridge Reservoir, the irrigation water shortages could be eliminated (except for 2,800 acre-feet in the Tropic area) by increasing the irrigation efficiency from the present 30 percent to 40 percent. A 10,000 acre-foot increase in river flow could be generated by increasing the efficiency from the above 40 percent to 50 percent. Increased irrigation efficiencies would decrease the wetland consumptive use about 10 percent. An additional 3,000 acre-feet of storage would be required to supplement late season river diversions in Sub-basin C. Below Sevier Bridge Reservoir, in addition to increasing the irrigation efficiency to 50 percent, pumping of 26,700 acre-feet is required. This would result in a 20 percent reduction in wetland consumptive use.

This program will eliminate the cropland consumptive use deficit only in years of average or greater water supply. Fluctuations in water supply could be reduced by more extensive development of the groundwater reservoirs. This would require careful planning, coordination, and close controls to avoid permanently depleting this water resource.

On-site erosion and sediment production on lands administered by the U. S. Department of Agriculture can be reduced 26 percent, or over 900 acre-feet annually, through watershed improvement on 285,600 acres and range improvement on 225,200 acres. Sediment storage to protect downstream developments included in the 12 feasible PL-566 projects includes 14,500 acre-feet. Additional sediment containment of 16,500 acre-feet is provided by storage not included in these projects.

Flood problems within areas of municipal and agricultural development would be reduced by 2,300 acre-feet of floodwater storage provided by the 12 PL-566 projects and storage capability of 7,000 acre-feet in the additional structures. Watershed improvement will reduce peak flood flows, contribute to the effectiveness of downstream structures, and improve protection for other existing cultural and resource values.

Water quality will also be improved by the above sediment storage and through the on-site sediment yield reduction on watershed lands. Reduction of bacteriological and chemical pollutants are also needed but will require assistance through other programs.

On National Forests, recreation facilities are planned to meet anticipated demand. By 1980, 2,840 recreation units will be required to accommodate a demand of 2,420,000 annual visitor-day use, and 37 units (Table 87, page 233) will require replacement each year by this date. On private lands, it is anticipated that selected recreation facilities will be made available.

Water quality improvement, forage improvement, and reduction in erosion will improve fish and wildlife habitat and aesthetics. PL-566 projects will increase recreation facilities by 400 water surface acres and 600 surface acres will be provided by additional projects. Fish habitat will also be restored or improved on portions of 431 miles of streams on National Forests where channel stabilization measures are planned and through low flow augmentation along the main stem.

A range improvement program is planned on the National Forests to increase grazing capacities 75,000 animal unit months. The 12 PL-566 projects will convert wetland areas to irrigated pasture and increase the grazing capacity to over nine AUM's per acre. Other opportunities also exist on other public and private lands outside U. S. Department of Agriculture programs for increases in grazing capacity.

Cooperative State and Federal fire control forestry programs can be expanded to reduce current resource damages from $23,400 annually to an estimated $4,680 annually.

With the development of all available on-farm resources, an additional 70,000 acres of irrigable lands under the present systems could be irrigated. The annual direct agricultural benefits would be $4,925,000 with annual amortized costs of $1,573,000. Farmers would have available $3,352,000 additional income to offset the off-farm development costs necessary to obtain the additional 383,700 acre-feet of irrigation water needed at the point of diversion to provide a full water supply to all these lands. In addition, 180,000 acres of arable land above present systems could be irrigated with adequate water. Water-budget studies were made to determine the total amount of additional water required to develop these lands.

This analysis included development of irrigable land to the extent of its capability, including drainage of selected wetland areas. Average water use was computed for the total irrigable land resource, including that presently cultivated. This water requirement was compared with the available water supply and a new outflow was computed for each sub-basin. Amounts by which the outflow from each sub-basin would be reduced under the above conditions is shown in Table 88.

TABLE 88.--Reduction in outflow with potential development of present water resources, by sub-basin, Sevier River Basin

Sub-basin	Outflow at present	Outflow with full development	Change
	Acre-feet	Acre-feet	Acre-feet
A	21,500	0[a]	-21,500
B	13,500	0	-13,500
C	140,500	96,500	-44,000[b]
D	130,000	112,500	-17,500
E	51,500	51,000	-500
F	88,500	72,000	-16,500

[a]It would probably not be possible or even desirable to completely eliminate the outflow from these areas.

[b]The reduction in outflow from Sub-basin C reflects the total reduction in river flow due to all project effects upstream from Sevier Bridge Reservoir.

If downstream effects were disregarded, there would be sufficient water supply to fully develop all irrigable lands except those in Sub-basins A and B. An additional 7,000 acre-feet would be required in Sub-basin A and 510,000 acre-feet in Sub-basin B. Potential development of water resources for agricultural use and maintaining the present rate of nonagricultural use was assumed.

COORDINATION

Coordination of development opportunities is needed between diverse hydrologic areas with the Basin. Development will change the regimen of water flow requiring that planned projects not only meet objectives within a given area but provide compensating effects to other areas. Coordination is also needed between alternative resource uses. There are areas along the Sevier River system where habitat should be improved and set aside for waterfowl and excluded from water salvage projects. Range management and proper grazing must be coordinated between the dual needs for improved resource conditions on rangelands and the economic need of an expanding livestock industry. A third need for coordination is in choosing alternative opportunities to meet a given objective.

Consideration should be given to include the groundwater resource in a coordinated Basin water plan. Present limitations do not allow using some groundwater basins as a management tool. However, potential development should make use of this presently idle resource.

In some areas, water shortages can be overcome by one or a combination of: (1) Improving surface storage facilities, (2) pumping or other means to salvage water from phreatophytes, (3) mining groundwater supplies, (4) improving on-farm efficiencies or, (5) water importation. Each alternative or combination of alternatives chosen should be the one that minimizes costs and maximizes progress toward the objectives.

CHAPTER X

OTHER PROGRAMS FOR FURTHER DEVELOPMENT

Other measures beyond the scope of this report should be considered for further development of the Basin resources. Some of these are currently under study by research organizations. Other agency programs have a definite impact on the Basin and should be considered in future planing.

A L T E R N A T E   A P P R O A C H E S

WEATHER MODIFICATION

Weather modification techniques are being developed which may prove feasible for controlled use in the near future. In some areas, experiments have obtained measurable increases. Although these kinds of programs could possibly reverse the past trend of decreasing water supplies, more research is needed before full-scale use is planned.

WATER IMPORTATION

Water importation will be necessary to develop large blocks of the arable lands which are located mostly in the lower reaches of the river system. The most logical source of importation in the near future would be through facilities of the Central Utah Project which diverts water from the Colorado River drainage. Long range planning, however, should include possible importation from other areas.

WATER YIELD IMPROVEMENT

Some research has shown that supplies to tributary inflow and ground water can be increased by watershed treatment. To date, most research has been conducted on limited areas and the results are not conclusive that a net yield can be achieved over an extended period. Feasibility is presently limited by high costs, inadequate knowledge of specific methods applicable to a given area, and a lack of information about what effects extensive treatments would have on other resources and their uses.

In Colorado, research has attempted to evaluate water yield improvement using various techniques in alpine areas similar to the Tushar Mountains and Wasatch Plateau. Intentional avalanching may remove snow from an exposed place where it is rapidly melted to a shady protected place where its melt is retarded. Materials can be placed on the snow surface to either increase or retard the melting rate. Snow fences intended to increase accumulation were evaluated and found to be effective only at carefully selected sites. For example, snow accumulation on two sites behind 8-foot fences added approximately 1 acre-foot of water for each 100 to 125 feet of fence. (13)

Below the alpine areas, vegetation manipulation both to reduce evapo-transpiration and to increase yield from snowpack was investigated. On the Fraser watershed in Colorado, when lodgepole pine and sub-alpine fir were clear cut in strips removing 50 percent of the timber stand, snowpack in the clear cut area was increased 29 percent and water yield increased from 2 to 4 inches. (14) On the Workman Creek watersheds in central Arizona, a mixed conifer stand of Ponderosa pine, White fir, and Douglas fir was selectively cut removing 50 percent of the basal area with no significant increase in water yield. In a similar area, removing moist site vegetation along stream channels (one-third of the watershed area) increased water yield 55 percent. (18)

Potential water yield increases resulting from conversion of aspen stands to grass cover were estimated to be three inches based on average conditions. (19) On oak brush and pinyon-juniper areas where precipitation is less, however, research has not conclusively found that stream flows can be increased by conversion to a grass cover. There are some indications that soil moisture and groundwater supplies may be improved through such treatment.

There is danger in applying specific research findings to other areas where conditions may differ. Within the Sevier River Basin, Antimony Creek on the Dixie National Forest, and Sheep Creek on the Fishlake National Forest are being studied to determine the feasibility of water yield improvement and the relationship of water to other resources.

O T H E R A G E N C Y P R O G R A M S

Many agencies other than those within the U. S. Department of Agriculture have programs with impacts on the water and related land resources. Some of these programs have already been discussed in detail within the report. Following is a brief resume of the majority of these.

State of Utah

Department of Natural Resources

Division of Fish and Game - Protection, management, and propagation of fish and wildlife resources.

Department of Highways - Construction and maintenance of the State and federal highway system.

Division of Parks and Recreation - Development and management of state recreation facilities and enforcement of regulations governing boating on the waters of the State.

Division of Public Health - Air and water pollution monitoring and control.

Division of State Lands - Administration and development of State lands.

Division of Water Resources - Development of the waters in the State.

Division of Water Rights - Administration and management of the waters of the State.

Section of Forestry and Fire Control - Fire protection on State and private lands and forestry assistance to private land owners.

Universities within the State - Research on many aspects of water and related resources and cooperation in planning activities.

Utah State Extension Service - Agricultural and home economics education and information.

U. S. Department of Army

Corps of Engineers - Develops plans for prevention of flood damages and improvement in water supply, hydroelectric-power generation, reccreation and other water resource developments.

U. S. Department of Commerce

Economic Development Administration - Providing research, planning and funds in the development of the economy of the Four Corners Area which includes the Sevier River Basin.

Environmental Science Service Administration - Weather and water supply information and forecasting.

U. S. Department of Interior

Bureau of Land Management - Manages the unreserved public land for watershed values, grazing, forestry, recreation, minerals and wildlife. Also performs functions concerned with the identification, classification, use and disposal of public lands.

Bureau of Mines - Research and development of mineral and related resources.

Bureau of Outdoor Recreation - Provides funds and planning assistance to states, counties or communities in developing outdoor recreation.

Bureau of Reclamation - Development of water resources for irrigation use. In the basin, the Central Utah Project includes plans for importation of water and ultimate development of this project may greatly alleviate present water shortages.

Bureau of Sport Fisheries and Wildlife - Management of migratory waterfowl and enforcement of laws pertaining to this resource. Wildlife services including predator control and assistance in propagation and management of wildlife.

Geological Survey - Mapping, mineral and geologic information services. Water resources information service.

National Park Service - Preservation and administration of lands within National parks and monuments.

U. S. Department of Transportation

Bureau of Public Roads - Development of a national system of roads and highways.

JOINT PLANNING WITH OTHER AGENCIES

All planning for development of the water and related resources should be coordinated and in most cases, jointly planned with the other agencies concerned.

The South-Central and South-Western Utah Planning Region organizations, both covering parts of the Basin, should coordinate their activities with others to effect more efficient planning. These organizations also could be instrumental in formulation of an information program.

Specifically, an intensive information and educational program is needed so that everyone concerned will have a common understanding of the water and related land resource problems. Often the relationship of present water management practices and the regimen of the river is not adequately understood by water users. As a result, some conservation practices have been applied in a piecemeal and local manner instead of a coordinated Basin-wide approach.

A better understanding of the programs of land managing agencies is needed. People often resist some conservation programs not realizing that reaping short-term benefits can impair or destroy resources far into the future.

POTENTIAL BEYOND BASIN NEEDS

There is already an export of goods and services to residents outside the Basin. With the implementation of a development program, these exports can be increased to supply residents of the more populous areas in the State. Also, residents of these areas are now heavy users of Basin recreation resources. This demand will increase considerably in years to come.

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