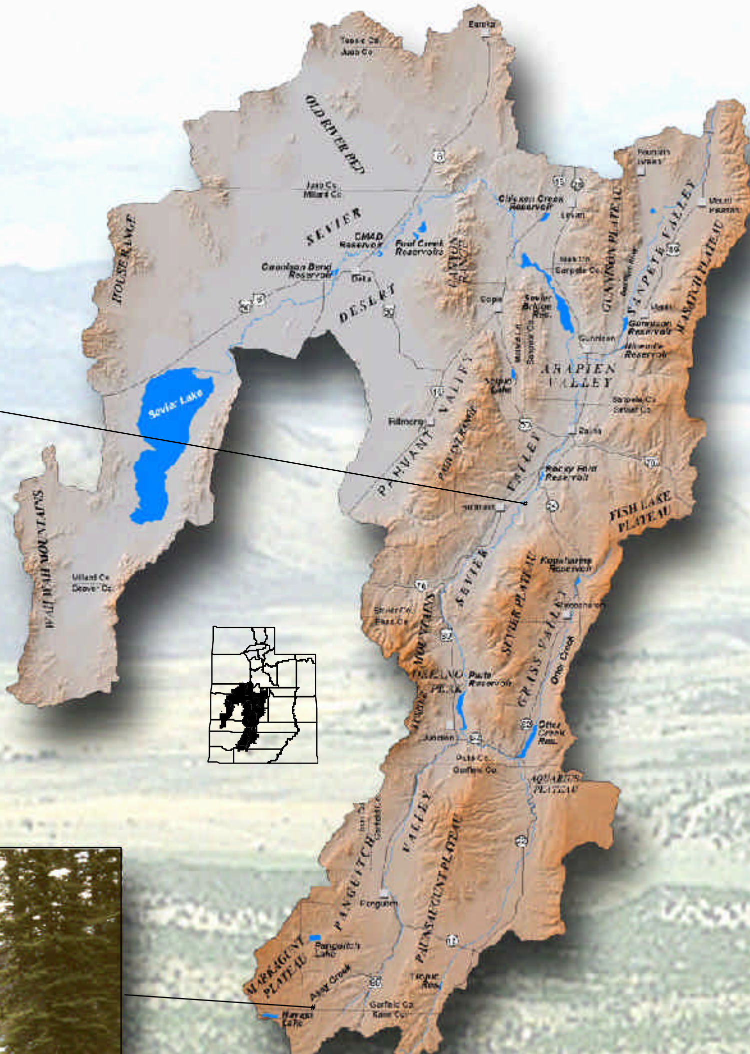
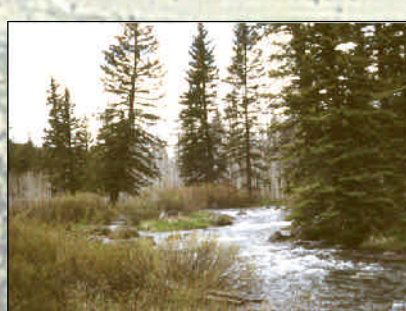
Utah State Water Plan

SEVIER RIVER BASIN

June 1999





STATE OF UTAH
NATURAL RESOURCES
Division of Water Resources

State Water Plan - Sevier River Basin

State Water Plan

Sevier River Basin

Utah Board of Water Resources
1594 West North Temple, Suite 3 10
Salt Lake City, UT 84114-6201

June 1999

Foreword

The State Water Plan (1990) was prepared to provide a foundation for establishment of state water policy. Within the framework of water policy planning, the state meets its obligation to plan and implement programs to best serve the needs of the people.

In addition to the State Water Plan, more detailed plans have been prepared for the Bear River, Cedar/Beaver, Kanab Creek/Virgin River, Jordan River, Utah Lake and We Basin ber River hydrologic basins. The Sevier River Plan discusses water-related resources and the problems, needs and alternatives for conservation and development measures. Final selection of alternatives will rest with the local decision makers.

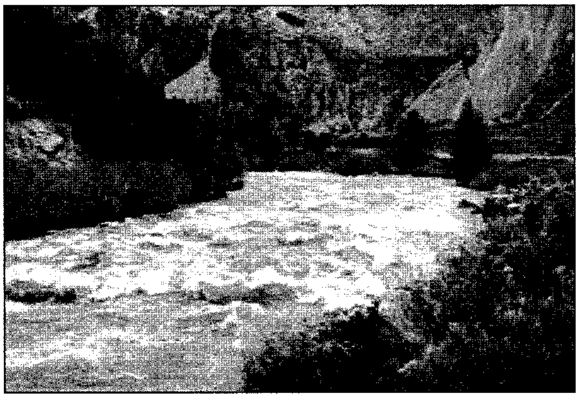
This plan is based on information now available, but it can be re-evaluated and revised to reflect changing circumstances. Successful planning needs the participation of all concerned individuals and entities and their responses to the issues at hand. In addition, coordination at all levels of government improves the quality of planning. Common acceptance of resource conservation and development goals enhances the likelihood of reaching these objectives. However, individuals are often able to bring about progress where centralization can stifle innovation. This basin plan is intended to help bring about greater coordination between those involved to assure the needs and demands of the local people are met.

The Sevier River Basin is unique as it is Utah's largest river basin and its entire drainage area is contained within the state. The Sevier River is one of the most utilized rivers in the nation. Only four percent or an average of about 32,900 acre-feet of the total tributary inflow reaches its terminus, Sevier Lake, and then only on an intermittent basis.

To achieve this level of use, water is diverted upstream, used, and then it reappears as return flow and is rediverted downstream and used again. Water users repeat this process along the entire length of the Sevier River. The groundwater reservoirs are used for storage with recharge and discharge continually occurring, thus maintaining the downstream river flows.

A complex management and distribution system based on judicially decreed water rights defines and protects the use and reuse of the river as it flows downstream. This system includes adjustments for variations in water supply. The Sevier River system is sensitive to even minor changes in weather patterns, Changes in use in upstream sections of the river also have an impact, although sometimes not direct and precise, on downstream return flows, both in timing and volume.

The distribution regime of the Sevier River has been established, both by facilities controlling and managing the river flows, and by stipulation, decree and certification of water rights. Any changes in use must be made according to the laws administering the river.



Sevier River above Clear Creek

ACKNOWLEDGMENT

The Board of Water Resources gratefully acknowledges the dedicated efforts of the State Water Plan Steering Committee and Coordinating Committee in preparing the Sevier

River Basin Plan. This work was spearheaded by the River Basin Planning Staff, Division of Water Resources, with valuable assistance from individual coordinating committee members and their associates representing state agencies with water-related missions. Their high standards of professionalism and dedication to improving Utah's natural resources were essential.

We appreciate the input and assistance of representatives of state and federal cooperating entities, the statewide advisory group and the basin planning advisory group who expressed opinions and provided expertise from a broad spectrum of Utah's population. Representatives of many local entities and groups provided much needed assistance at the "grass-roots" level.

We extend thanks to those who attended meetings and provided written and oral comments. In endorsing this plan, we reserve the right to consider local water projects on their own merits. This plan is an important guide for water development and conservation in the Sevier River Basin.

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Section 2 Sevier River Basin
EXECUTIVE SUMMARY

Section Two Sevier River Basin - State Water Plan

Executive Summary

This section summarizes the *Sevier River Basin Plan*. This plan contains 19 sections and is modeled after the *State Water Plan* (1990). In addition, this plan contains Section A; *Acronyms, Abbreviations and Definitions,* and Section B; *Bibliography.*

Sections 1 and 3-19 are summarized under the following headings. Those sections should be studied for more detailed information.

2.1 FOREWORD

The *State Water Plan* provides a foundation for state water policy. This helps the state meet its obligation to plan and implement programs to best serve the needs of the people.

More detailed plans have been prepared for the Bear River, Cedar/Beaver, Kanab Creek/Virgin River, Jordan River, Utah Lake and Weber River hydrologic basins. The remaining basins will be completed by the year 2000. This plan was prepared under the direction of the Board of Water Resources.

The Sevier River is unique in Utah and is one of the most utilized rivers in the nation. It is used and managed under a complex system of water rights determined by court decrees, stipulations, agreements and certifications. Water rights are influenced by even small changes in weather patterns.

2.3 INTRODUCTION

Water planning has always been a part of Utah's history. Current water planning adds more impetus to the process and establishes guidelines that are critical to the concept. Preparation of this plan has involved many local, state and federal entities who are involved in and have expertise regarding water resources.

The Sevier River Basin is located in Central and South Central Utah. It covers nearly 6.8 million acres (10,575 square miles) which contain large variations in topography, climate, soils and vegetation. Elevations drop from 12,173 feet to about 4,500 feet with precipitation ranging from more than 35 inches to less than 8 inches. Growing seasons range from 74 days at Panguitch to 144 days at Fillmore. The geologic parent materials provide a wide variety of soils producing vegetation from alpine conifer forest complexes to desert shrubs and grasses. Private lands cover about 23 percent of the area, federally administered lands 69 percent and state lands 8 percent. Indian tribal lands cover 1,735 acres.

Although the Fremont Indians irrigated land for crops about 1,000 years ago along Gooseberry Creek, Sanpete County settlers in 1849 were the first recent irrigators. Settlements soon sprang up all around the basin along with developments for culinary and irrigation water. Construction of reservoirs became necessary to manage the water resources beginning in 1860 with construction of Scipio Reservoir. Even today, projects are still being planned and facilities built to make the best use of the water and related resources.

2.4 DEMOGRAPHICS AND ECONOMIC FUTURE

The Sevier River Basin is essentially an agricultural-based economy. As such, the viability of the area is mostly controlled by the economics of the agricultural industry. Richfield is the basin's largest city as well as its service and trade center.

The 1997 population of the basin was more than 56,700 people. The area is expected to grow to nearly 86,000 people by 2020 and about 150,000 people by 2050, annual growth rates of 1.82 percent and 1.9 percent, respectively. Total job growth is expected to parallel the population. Total jobs were nearly 29,200 in 1997 and are expected to be more than 46,700 by 2020, increasing at an annual rate of 2.1 percent. Jobs in government, trade and services will grow at about the same rate while jobs in agriculture will decline slightly.

2.5 WATER SUPPLY AND USE

The total water supply comes from precipitation except for small transmountain diversions and groundwater movement into the basin. This precipitation produces both surface water and groundwater. Most of the precipitation is used directly by native vegetation (primarily in the upper watershed areas) except in the cropland areas where it is used by cultivated crops. Total surface water tributary yield is nearly 823,000 acre-feet. Groundwater tributary yield is estimated at 20-25 percent of the surface water yield. The Sevier River is gaged at several points throughout the system, with several reaches flowing around 200,000 acre-feet annually. Major tributaries are the East Fork of the Sevier River, San Pitch River, Chicken Creek, Chalk Creek and Corn Creek.

Total diversions for irrigation were 903,460 acre-feet; culinary use, 23,360 acre-feet; and secondary irrigation, 8,590 acre-feet. Industrial use is 26,290 acre-feet of which 1,170 acre-feet is supplied from culinary water systems. After water is diverted for use, the unused portion returns to the river as return flow for rediversion downstream. Wetland and open water use is 262,620 acre-feet. This use is not considered part of the tributary yield but is included in the water budgets.

Surface water imports from the Colorado River basin to Sanpete Valley is 9,340 acre-feet annually. There is 4,800 acre-feet of water exported through the Tropic East Fork Canal to Tropic in the Colorado River basin. Groundwater moves in and out of the basin at several locations. There is movement into the basin through the Gunnison Plateau and from the Awapa Plateau. Movement out of the basin occurs from the Paunsaugunt Plateau, Markagunt Plateau and Pahvant Valley.

Water quality deteriorates as the flows move downstream. Water quality in the upper reaches is good with total dissolved-solids of about 300 mg/L. Salinity increases to about 1,040 mg/L in the Redmond area and is about 1,025 mg/L near Lynndyl.

2.6 MANAGEMENT

Management of the water resources became imperative when average diversions exceeded the supply. Storage reservoirs were built, beginning with Scipio Reservoir in 1960, in order to save water during high flows for later use. Court decrees allocated water rights in an effort to divide up the available supplies. Even though the Higgins and Morse decrees and later "Bacon's Bible" managed the river system well, the Cox Decree in 1936 was the final determination of all the water rights. Although there have been modifications in this decree, it is still in use today.

There are several water users associations and water conservancy districts throughout the Sevier River Basin which assist with water management and development. More than 40 major water storage reservoirs have been built by water users. There are 72 mutual irrigation companies serving more than 1,000 acres each and an additional 103 irrigation companies serving less than 1,000 acres each.

Real-time monitoring systems have been installed at several locations in the Richfield and Delta areas. The issues at the end of this section address the need for more real-time monitoring stations. It is recommended that water-user groups take this responsibility.

2.7 REGULATION/INSTITUTIONAL CONSIDERATIONS

State agencies are required by law to provide administrative control and regulatory authority over the state's water resources. The State Engineer, as Director of the Division of Water Rights, has responsibility for administering the water rights and for dam safety. Currently, there are 20 high hazard reservoir dams that could cause loss of life and considerable property damage if they failed. Water quality regulations are administered by the Water Quality Board and the Drinking Water Board. The Division of Water Quality and Division of Drinking Water, respectively, are staff for these two boards.

Other entities also have responsibilities for regulating and managing certain aspects of the water resources. These include mutual irrigation companies, water conservancy districts, special service districts, drainage districts, and cities and towns. These entities can levy taxes and assessments for maintenance and operation of their facilities.

Water is an important part of our environment, making it possible to have healthy lives and pleasing surroundings. It is important to improve and maintain the quality of the water resources in order to provide a good, clean water supply for human use and for wildlife habitat.

Problems include the increasing demand for domestic wells as more summer homes are built and people continue to build in valley areas not served by community water systems. Another problem is the deterioration of water quality.

2.8 WATER FUNDING PROGRAMS

Funds have always been a part of development of the water resources. In the days of early settlement, most of the funds came from local sources although the state started participating at a later date. There are now many state and federal programs with funding available for water development using either grants or loans or a combination of both. More than $106 million of state funds and nearly $15 million of federal funds have been made available for water resources development. Loan funds have to be repaid so much of this investment eventually comes out of the pockets of the local water users.

2.9 WATER PLANNING AND DEVELOPMENT

Since agriculture is the largest water user, management of the river system is centered around meeting these demands. There is a need for development of more storage to provide better water management for some users with only direct flow rights but this is limited under the current water rights constraints. Water quality (primarily salinity) is a problem from the Redmond-Gunnison area to the lower end of the river. It is also a problem in the lower Chicken Creek area and in Pahvant Valley. Water quality studies are now underway by the Division of Water Quality to consider ways to reduce pollution of the river system.

Two communities in Sanpete County and four in Sevier County will be short of culinary water supplies by 2020. This shortage will be caused by a lack of water rights or system capacity. If the demand for domestic wells increases as it has in the past, there will be a shortage of water outside of community systems. These total domestic culinary water needs are expected to be nearly 1,200 acre-feet or water for about 4,800 people. With the existing closure on development of the groundwater reservoirs, meeting this demand will require purchase of existing water rights, which is becoming increasingly difficult.

Total depletions for mans use were about 618,460 acre-feet for 1996. This is expected to increase to 630,960 acre-feet by 2020. The extra water to meet this increased demand is expected to come from importing additional water from the Colorado River basin through the Gooseberry Project, more efficient use of the existing supplies, and cloud seeding.

Water education for young people is becoming more important. This is carried out though such things as Project WET (Water Education for Teachers) and the Young Artists' Water Education Poster contest. The goal of Project WET is to facilitate and promote awareness, appreciation, knowledge and stewardship of water resources. This is done by

Pivot sprinkler near Circleville

training public and private school teachers through hands-on training.

2.10 AGRICULTURAL WATER

The economy of the Sevier River Basin is centered around agriculture. The major agricultural operations are cow-calf and beef production although the turkey industry is important in Sanpete County. Most of the irrigated agriculture supports these operations.

The average farm size has increased from about 200 acres in 1924 to 390 acres in Sevier County, 790 acres in Millard County and 1,640 acres in Juab County in 1992. This trend has resulted in a one-third decrease in the number of farms. Presently, 903,460 acre-feet of water is diverted onto 354,320 acres of irrigated lands. About 783,000 acre-feet of this water is diverted from surface water supplies and 120,460 acre-feet from groundwater. Major irrigated crops are 40 percent alfalfa, 14 percent pasture and grass hay and 13 percent small grains with 12 percent idle and fallow. There are 40,400 acres of dry cropland, mostly grain and exotic grasses, and more than five million acres of rangeland.

An important irrigated agriculture problem is low on-farm application efficiencies in some areas. Water salinity is a problem in the lower reaches of the river. In addition, overgrazing in the upper watersheds has caused erosion. It is estimated there are about 1 .0 million acres with heavy to excessive erosion and 1 .O million acres with moderate erosion. This erosion in turn increases downstream sediment deposition. Increased water-use efficiency and restoring and maintaining, healthy watersheds can help to overcome these problems.

The issue discussed in this section is the need for a rangeland condition survey. The Division of Water Quality and soil conservation districts should take the lead with assistance by state and federal agencies as needed.

2.11 DRINKING WATER

All of the drinking water supplies come from either springs or wells with only chlorination being needed. Systems are both publicly and privately owned. There are 57 public community water systems. These are all subject to the state and federal safe drinking water acts. Communities must submit source protection plans for each of their sources. At this time, only 48 plans have been submitted so there is considerable work to do. The Drinking Water Board has funds available for improving drinking water systems and preparing the plans needed.

There were 14,322 acre-feet of culinary quality water delivered by public water suppliers during 1996. The basin-wide use was 267 gallons per capita per day. Average use varied from 190 gallons per capita per day in Sanpete County to 357 gallons per capita per day in Millard County and 415 gallons per capita per day in Juab County.

Water for future demand can come from existing undeveloped rights for wells or springs. It is possible to purchase and convert agricultural water rights to culinary use. Another possibility for meeting future demands is to establish a water bank.

2.12 WATER QUALITY

The highest water quality is found in the upper reaches of the Sevier River, its tributaries and the streams flowing into Pahvant Valley. As the water flows downstream, the chemical and biological quality of the water deteriorates. During studies in the 1980s and 1990s by the U.S. Geological Survey, both surface water and groundwater quality data were obtained. The following water salinity data comes from surface water measurements taken during the survey: Sevier River near Hatch, 190 mg/L; East Fork of the Sevier River near Kingston, 255 mg/L; Sevier River above Clear Creek. ‘283 mg/L; Sevier River at Sigurd, 590 mg/L; San Pitch River below Milburn, 448 mg/L; San Pitch River below Gunnison Reservoir, 920 mg/L; Sevier River below San Pitch River, 1,103 mg/L; Chicken Creek Reservoir outlet, 780 mg/L; Sevier River near Lynndyl 1,162 mg/L; and the Sevier River near Hinckley, 2,730 mg/L (1964). Salinity measurements in Pahvant Valley were taken on Chalk Creek near Fillmore, 435 mg/L and Corn Creek near Kanosh, 395 mg/L. The groundwater quality also was found to deteriorate in a downstream direction but was generally of better quality than the surface water except in some localized instances.

The beneficial use classifications for the reservoirs and streams are mostly 2B and 3A. All water bodies had use classification 4. Navajo Lake, Panguitch Lake and Otter Creek Reservoir have been studied under the Clean Lakes Program. Funds have been expended in the Panguitch Lake watershed. More recently, $375,000 have been expended on the Otter Creek Reservoir watershed to implement best management practices to improve water quality.

2.13 DISASTER AND EMERGENCY RESPONSE

Natural disasters and other major emergencies are perennial problems. Water-related disasters are generally floods and droughts. Local governments have the responsibility to initiate the first response to a disaster or emergency. If an event is beyond the scope of local government, the governor can declare an emergency and make state assistance available. The Division of Comprehensive Emergency Management is the state lead agency, coordinating state and, if necessary, federal assistance.

Flooding is the most frequent natural disaster. Flood-prone communities should have a flood insurance program in place. Flood plain maps have been prepared for most communities. Droughts can also have a disastrous impact, especially in prolonged situations.

The only issue discussed in this section concerns flood plains. It is recommended nonparticipating communities should become qualified under the National Flood Insurance Program.

2.14 FISHERIES AND WATER-RELATED WILDLIFE

Fishing is clearly dependent on quality aquatic habitat. Riparian vegetation provides food, cover and nesting sites for wildlife. A wide diversity of fish, wildlife and plant species are found in the basin; interacting to contribute to a well functioning ecosystem. Early settlers found big game scarce although furbearers, waterfowl and predators were abundant. Today, most species of fish and wildlife are abundant in most of the basin. Because of diversions for irrigation, fish habitat condition has deteriorated. Most of the lakes, reservoirs and stream reaches are 3A or 3B for aquatic use class. However, most of the stream reaches are partially or non-supporting as a fishery. Water quality is also a problem, especially in the downstream reaches.

2.15 WATER-RELATED RECREATION

Water is often the center of outdoor recreation, either directly or just part of the setting. The Utah State Comprehensive Outdoor Recreation Planning process provides data on a regular basis to guide development of the recreational base. More than $2 million has been expended on 32 Land and Water Conservation Fund matching-grant projects. The Division of Parks and Recreation manages six state parks, all but one having water as an on-site use or amenity. Local community parks are an important part of the scene as are federal parks and campgrounds. Recreation visits to the Sevier River Basin are popular and are increasing at an accelerating rate.

Two issues are discussed in this section. One concerns unethical behavior in recreational settings. It is recommended that the Division of Parks and Recreation organize recreators and managers to obtain suggestions for controlling the problem. The second issue addresses comprehensive planning. The Division of Parks and Recreation should continue to update and prepare management plans.

2.16 FEDERAL WATER PLANNING AND DEVELOPMENT

The federal role and involvement in planning and development is changing. Many past activities concern development of the resources but are now oriented toward conservation and protection. The main concern is the part federal agencies should play compared to state and local involvement. Coordinated planning and use is needed, especially with the large land areas administered by the federal government.

Major local projects with federal agency involvement include assistance with the real-time monitoring network by the Bureau of Reclamation, the Redmond Channel Project by the Corps of Engineers and four watershed protection and flood prevention projects by the Natural Resources Conservation Service.

2.17 WATER CONSERVATION

Conservation is one way of making an existing water supply go farther. In many cases, it can be achieved without sacrificing an existing life style. Water conservation was a way of life in the early days of settlement; it needs to be made a part of our lives again.

The culinary water use for 1996 in the Sevier River Basin was 267 gallons per capita day (gpcd). This is just under the statewide average use of 268 gpcd. Secondary water use for 1996 was 153 gpcd compared to 50 gpcd statewide.

There are several ways conservation can take place. Conservation of irrigation water can be achieved in local areas but not in the basin as a whole. Outside culinary water use can be reduced by increased application efficiencies and by replacing high-water using landscapes with vegetation using less water. Secondary water can be used instead of culinary quality water. Water use indoors can be reduced by using low volume fixtures. Ultimately, education on water availability and use is the best way to achieve conservation.


Well near Flowell

Four water conservation issues are presented. These are; the need for water management and conservation plans, more use of secondary water, use of low water-using landscapes on city property, and implementation of rate schedules to encourage saving water. These measures should all be implemented by communities and public water suppliers.

2.18 INDUSTRIAL WATER

Industry uses a small but important part of the total water supply. Total self-supplied industrial water use is 25,120 acre-feet of which 7,120 acre-feet is potable. Public community systems provide 1,170 acre-feet. The Intermountain Power Project is the largest industrial water user in the basin. There are 12 hydroelectric power plants operating , mostly owned by communities.

2.19 GROUNDWATER

Although groundwater is difficult to discern, it is evidenced by the seeps and springs that reach the surface in numerous locations throughout the basin. There are 19 groundwater reservoirs described in this section. Wells have been constructed to evaluate and use these reservoirs under each of the valleys. The Sevier River Basin above Sevier Bridge Reservoir is characterized by a series of groundwater reservoirs, each separated from the one upstream by a relatively impermeable, underground geologic restriction. These reservoirs are an integrated part of the operation of the Sevier River system. When a groundwater reservoir is full, it spills over the geologic restriction and contributes to the downstream flow of the river. For this reason, any change in a reservoir has an impact on downstream water rights.

Average withdrawals from groundwater are 155,540 acre-feet. The quality of groundwater varies from good to poor, depending on location and depth. Wells used for culinary purposes penetrate the deeper, better quality aquifers while those for irrigation use water of lesser quality.

The Division of Water Rights is implementing new groundwater management plans throughout the basin. In March 1997, the basin was closed to additional well permits.

Studies by the U.S. Geological Survey indicate that limited use of the 5.5 million acre-feet in storage above Sevier Bridge Reservoir could occur although there would be impacts, both within the groundwater reservoir basin and downstream. These potential impacts require additional investigation. Use of this water also would require approval from the State Engineer.

Section 3 Sevier River Basin
INTRODUCTION

Tables

Figures

Introduction

River basin planning provides a framework for orderly development, conservation and preservation of water and other natural resources.

3.1 BACKGROUND

Water planning has always been a part of Utah's early history and development. State water planning was emphasized by the Legislature in 1963. Current statewide water planning was initiated in 1986 and resulted in the State Water Plan (1990).[19] Since then, six of the eleven basin plans have been prepared.

This section of the Sevier River Basin Plan presents the planning principles and purposes and describes the organization and review process for plan preparation. It also discusses the physiographic and hydrologic aspects and water-related history.

The Sevier River Basin Plan describes the water and related-land resources and the problems at a reconnaissance level. Present and projected water demands are presented along with alternative ways to satisfy the needs and demands of the local people. Pertinent issues are discussed, along with recommendations for resolving them. Studies by the Division of Water Resources and others provided data and information to prepare this plan. See Section B, Bibliography. This plan presents information intended to help the local people make decisions to carry out their selected alternatives.

3.2 PLANNING GUIDELINES

The State Water *Plan* (1990)[19] described the basic premises and laid the foundation for statewide water planning, including preparation of this basin plan. This provides continuity so the purposes and principles of the basin plans will be consistent with the statewide plan and with each other.

State water planning is the responsibility of the Division of Water Resources under the auspices of the Board of Water Resources. This plan was developed according to the following principles.

- All waters are held in trust by the state as public property and their use is subject to rights administered by the State Engineer.
- It is our responsibility to leave good quality water for the generations to follow.
- The interests of Utah's residents should be protected through a balance of economic, social, aesthetic and ecological values.
- Where it is difficult to identify beneficiaries for such uses as recreation and aesthetics, they should be included in program costs.
- Public input is vital to water resources planning.
- All residents are encouraged to exercise water conservation.
- Water rights owners are entitled to transfer their rights under free market conditions.
- Water resources projects should be technically, economically and environmentally sound.
- Local, state and federal planning and management activities should be coordinated.
- Local governments, with state assistance as appropriate, are responsible for protecting against emergency events such as flooding and droughts.
- Designated water uses and quality should be improved or maintained unless there is evidence the loss **is** outweighed by other benefits.
- Educating Utahns about water is essential.

The State Water Plan Coordinating Committee provided expertise, data and review. Other state, federal and local agencies, entities and individuals were involved. After the planning, review and approval process were complete, the final basin plan was distributed to the public for their information and use. It was provided to give guidance for water use, conservation, preservation and development, primarily for local entities but also for state and federal agencies.

All data presented in this report from other sources are given in the units used in the original document. This is particularly true of the water salinity data. To maintain consistency for the reader, all water salinity data are shown in mg/L (milligrams per liter). If the data from referenced reports are given in other units, these values will follow in parentheses. See Section A, Acronyms, Abbreviations and Definitions for a description of the water quality units of measurement.

3.3 BASIN DESCRIPTION

The Sevier River Basin, shown in Figure 3-1, is located in central and south-central Utah. Major topographic features are also shown. Extreme changes in elevation, brilliantly colored rock formations, vegetation and climatic variations make the area a pleasant place to live or visit. Skyline Drive (part of the Great Western Trail) along the divide between the Colorado and San Pitch rivers, provides a scenic vista of unending beauty.

The pink Tertiary cliffs of the Markagunt and Paunsaugunt plateaus are described by Captain C.E. Dutton:[25]

"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. We stand upon the great cliffs of tertiary beds which meanders to the eastward till lost in the distance . . . To the west the Basin Ranges toss up their angry waves in characteristic confusion, sierra behind sierra."

From these colorful borders, one is led down the gentle slopes of the plateaus with their ponds and lakes, through forests of pine and aspen to the river valleys below. Thence, the path leads to the vast delta built by the Sevier River and molded under the influence of ancient Lake Bonneville where it emerges into the Sevier Desert; then into the simmering desert with its barren mountains and vast expanse; here the river dissipates into a dry lake playa, Sevier Lake.

The Sevier River Basin is bounded on the south by the Kanab Creek/Virgin River Basin, on the east by the West Colorado River Basin, on the north by the Utah Lake Basin, on the west by the Great Salt Lake Desert Basin and on the southwest by the Cedar/Beaver Basin.

The "backbone" or Wasatch Line (a high curving belt of mountains and plateaus), a portion of which runs northeasterly from the Markagunt Plateau to Mt. Nebo, roughly divides Utah into the High Plateaus of the Colorado Plateau (highest in North America) on the east, and the Basin and Range Province on the west.

The East Fork of the Sevier River (including Otter Creek) and San Pitch River are the major tributaries of the Sevier River. Chicken Creek and Pigeon Creek feed the Levan-Mills area and Chalk, Meadow and Corn creeks are important streams in Pahvant Valley.

The headwaters of the Sevier River rise in the Markagunt Plateau (Cedar Mountain). The East Fork of the Sevier River originates near Bryce Canyon on the Paunsaugunt Plateau, while the San Pitch River is a product of the Wasatch Plateau.

Asay and Mammoth creeks join together above Hatch to become the Sevier River which flows northward to Piute Reservoir. The East Fork flows northward to Antimony and is joined by Otter Creek where it turns to the west and into Piute Reservoir. From here, the Sevier River flows northward and is joined by the San Pitch River just before emptying into Sevier Bridge Reservoir. At this point, the river makes a broad turn to the west and southwest, flows through the Delta area and terminates in Sevier Lake.

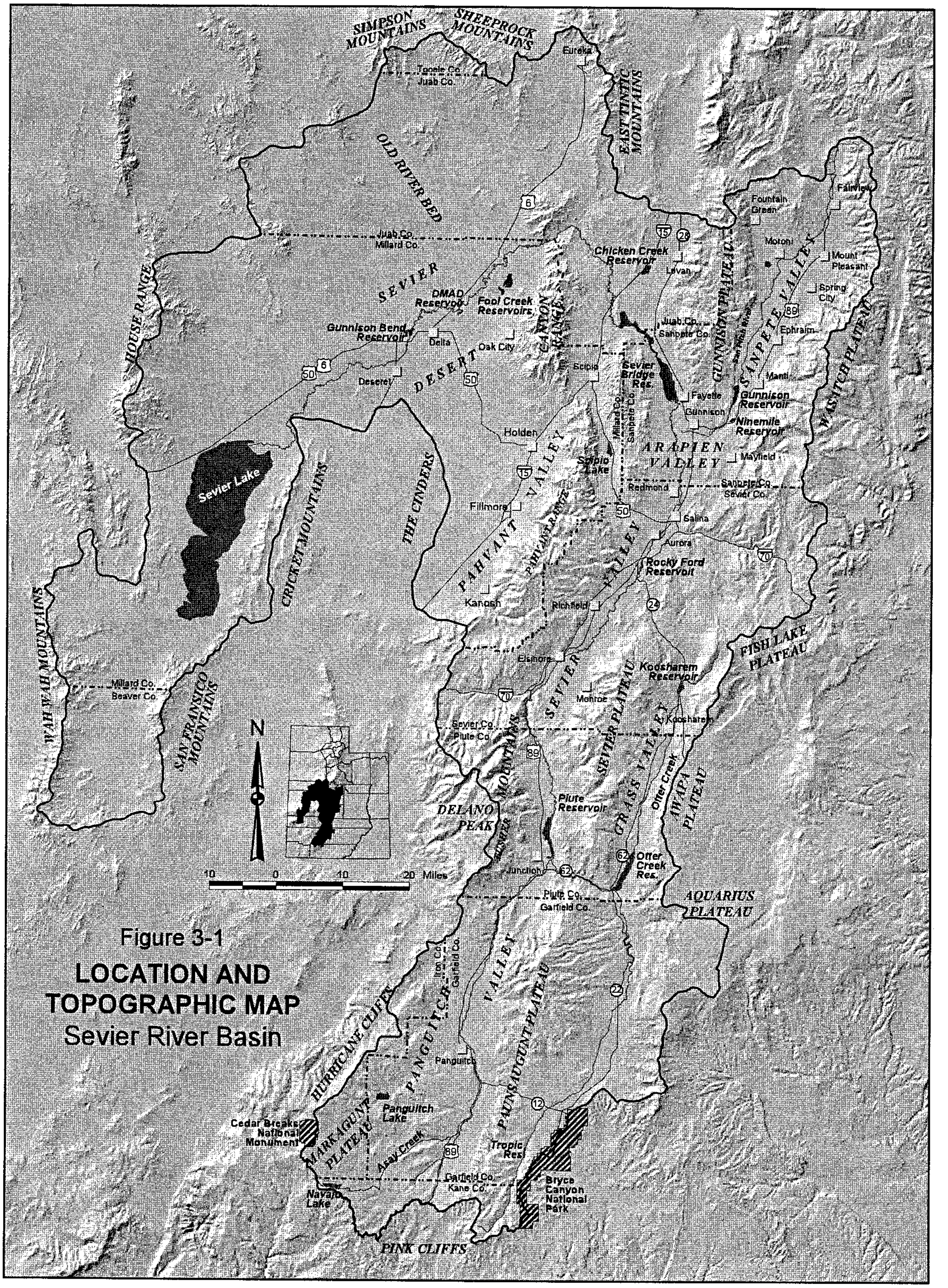


Figure 3-1

LOCATION AND TOPOGRAPHIC MAP

Sevier River Basin

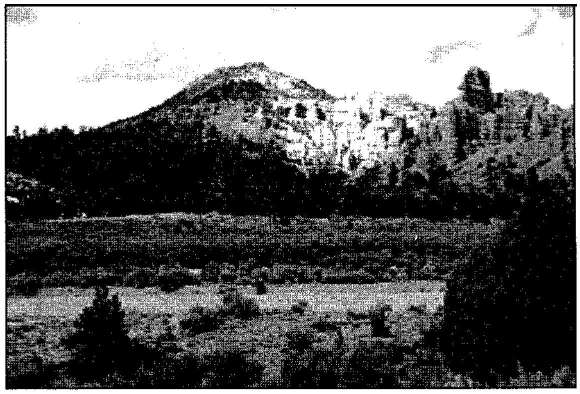
3.3.1 Physiography and Geology [57,63]

The Sevier River Basin contains 6,768,070 acres (10,575 square miles); is about 180 miles from north to south and 125 miles from east to west. It includes parts of Beaver, Garfield, Iron, Juab, Kane, Millard, Piute, Sanpete, Sevier and Tooele counties. It includes the drainage of the Sevier River proper and the Fillmore-Kanosh area, often called Pahvant Valley. These areas, along with the drainage of the Beaver River, make up the Sevier Lake Sub-Region. These are all part of the landlocked Great Basin Region.

Throughout the vast expanse of geologic time, the areas contained within the boundaries of the Sevier River Basin have undergone tremendous change. The basin has been covered seven times by marine seas and once by a great system of freshwater lakes. It has been an enormous and majestic highland as well as a humid, subtropical area dotted with swamps. Once it was a vast desert covered by sand dunes. Evidence for all these changes is recorded in the rock layers exposed within the area. The Sevier River Basin now contains some of the outstanding physiographic and geologic features in Utah. These features include the broad expanse and sheer cliffs of the Markagunt and Paunsaugunt Plateaus, the lofty Tushar Mountains, high mountain valleys, the Wasatch monocline and the Sevier Desert and its serrated mountain ranges.

The Sevier River once terminated in ancient Lake Bonneville near the present town of Axtell, south of Gunnison. All of the Sevier Desert and Pahvant Valley were under water. As Lake Bonneville receded, the Sevier Lake drainage flowed into the Great Salt Lake by way of the "old river bed." This channel, north of Delta, is 45 miles long, from 1,000 to 5,000 feet wide and 100 feet deep near the Simpson Mountains. It is about 4,630 feet in elevation. In more recent times, the Sevier River was joined by the Beaver River southwest of Delta and flowed into Sevier Lake, now usually a dry playa.

Prominent mountain ranges and geologic features separate the Sevier River basin from other drainages. The Sevier River basin is



Sevier fault near Red Canyon

bounded on the south by the Pink Cliffs of the Grand Staircase and on the east by the Aquarius and Awapa plateaus. The Wasatch Plateau and southern Wasatch Mountains are on the east and north. The northern boundary runs along the Tintic and Sheeprock mountains to Topaz Mountain. The House Range defines the western edge from where the boundary crosses to the east around the south side of Sevier Lake, north of Clear Lake and to the transition between the Pahvant Range and the Tushar Mountains. From here, the boundary runs south along the Tushar Mountains to the rim of the Markagunt Plateau which forms the southwest boundary.

The topography is diverse. The irrigated valleys lie between 4,600 and 7,000 feet above sea level. The highest point is Delano Peak in the Tushar Mountains at 12,173 feet. There are 12 other peaks rising more than 11,000 feet above sea level. Over its 250-mile course, the Sevier River falls 2,500 feet from its confluence with Asay Creek south of Hatch to the 4,518-foot elevation of Sevier Lake. The average fall is 10 feet per mile, varying from 3 feet per mile near Delta to 23 feet per mile through Marysvale Canyon.

Within the mixed physiography, each plateau and mountain range has its own character, influencing soils as well as surface and groundwater hydrology. Past erosion and deposition cycles have left piedmont benches and terraces. Erosion has produced the spectacular scenery of Bryce Canyon and Cedar Breaks.

Prior to Lake Bonneville, geologic restrictions across the drainage of the Sevier River and its tributaries at several locations formed the groundwater reservoirs.

Rocks from all eras of geologic time are represented, but most of the area is covered by either Tertiary volcanic or Jurassic, Cretaceous, Tertiary or Quatemary sediments. Quarternary basalts are found on the Markagunt and Paunsaugunt plateaus and in the Sevier Desert (See Figure 3-2).

Two major faults trend northeasterly through the area. The Paunsaugunt fault runs from northern Arizona, past Bryce Canyon and through Grass Valley. The Sevier fault runs from near Pipe Springs in northern Arizona, through the eastern side of Sevier Valley, and into Sanpete Valley to the Cedar Hills. The maximum displacement of these faults, downthrown on the west, is about 2,000 feet. The Elsinore fault on the west side of Sevier Valley, although smaller, is one of the most active faults in Utah. There are major thrust faults in the Pahvant and Gunnison plateaus and in the Canyon Range. The Wasatch monocline, with a maximum displacement of more than 8,500 feet, is the one major fold. See Figure 3-2 and Figure 13- 1.

Minerals include numerous deposits of hydrocarbons, metallic and nonmetallic minerals, and other associated materials. Most of the deposits are noncommercial at present with the exception of the beryllium mining operations northwest of Delta and gypsum processing near Richfield. Mineral fuels (coal) are mined extensively in Salina Canyon, much of the production for shipment to Japan and for use by the coal-fired electrical generating Intermountain Power Project. There have also been minerals extracted from brine at the south end of Sevier Lake where halite and potassium sulfate were produced. Rock salt is mined near Redmond for use by animals. It is also processed for use as table salt.

Early-day mining has periodically influenced the area's economy. By 1917, Tintic Mining District was second only to Bingham with total production valued at $180.4 million. Other districts included Piute County, $3.7 million and West Tintic $139,000. Uranium mining became important near Marysvale during the 1950s and 60s. Eureka, Kimberly and Marysvale have been mining boom towns.

3.3.2 Climate[3,44]

The climate of the Sevier River Basin reflects its location in the transition zone from the Basin and Range Province to the Rocky Mountain-Colorado Plateau Province. The high mountain valleys in the upper drainage areas blend into the semi-arid climate common to the southwest deserts. The northern part of the basin reflects different storm patterns than the southern part.

There are 36 National Weather Service climatological stations located throughout the basin. These have varying lengths of records. Data from 12 of these at selected representative locations based on the period 196 l-90 are listed in Table 3-l. These 12 stations are representative of the valley areas. Winter snowfall is measured at 13 automated SNOTEL data collection sites and 17 manual snow courses by the Natural Resources Conservation Service. The 12 climatological, 10 SNOTEL and seven snow course stations and sites are shown on Figure 3-3.

Mean annual temperatures vary from a high of 50.9" F at Fillmore to a low of 43.6" F at Koosharem. The record high temperature is 110" F at Delta and the record low is - 40" F at Scipio. At some stations, temperatures are around 100" F every summer and fall to below zero in the winter.

Precipitation is influenced by two major storm patterns: one, frontal systems from the Pacific Northwest during winter and spring; the other, late summer and early fall thunderstorms from the south and southwest. These systems are further influenced by the topographic aspects of the area. A study was made in the 1960s by the Natural Resources Conservation Service[63] to determine the effect of storm paths on snow packs.

The average 193 l-60 snow water equivalents were plotted for eight snow courses in the Sevier River Basin north of Gunnison along with 13

SEVIER RIVER BASIN
GENERALIZED GEOLOGIC UNITS

Quaternary

Qa Unconsolidated deposits of alluvium, colluvium, windblown and glacial origin, includes some quatemary basalt flows in the Sevier Desert, and the area between Panguitch and Navajo Lake.

Ql Unconsolidated deposits of lake or playa origin.

Qls Landslides

Tertiary

T Weakly to semi-consolidated sedimentary basin-filling rocks of the Salt Lake, Sevier River, Green River, Flagstaff Limestone, and Claron (Wasatch) Formations. Also, other valley-filling alluvial, lacustrine, and volcanic materials.

Tv Igneous rocks of Tertiary age; includes various intrusions such as the Spry Intrusion, also many extrusive units of the west desert and Marysvale volcanic area such as the Mt. Belknap Volcanics, Mt. Dutton Formation, and Bullion Canyon Volcanics.

Mesozoic

M Consolidated sedimentary rocks; locally includes the North Horn, Price River, Indianola, Morrison, Arapien Shale, Navajo/Nugget, Ankareh and Thaynes Formations in the north. In the south it includes the Kaiparowits, Wahweap, Straight Cliffs, Tropic, Dakota, Carmel, Navajo, and Chinle.

Paleozoic/Precambrian

P Consolidated sedimentary rock locally includes the following formations; Oquirrh Group, Manning Canyon Shale, Great Blue Limestone, Humbug, Deseret Limestone, Gardison Limestone, Fitchville, Pinyon Peak, Victoria, Bluebell Dolomite, Fish Haven Dolomite, Opohonga Limestone, Ajax Dolomite, Maxfield Limestone, Ophir and Tintic Quartzite. Precambrian sedimentary and metamorphic rocks locally include the following formations; Mutual, Inkom, Caddy Canyon Quartzite, Papoose Creek, Blackrock Canyon Limestone, and Pocatello.

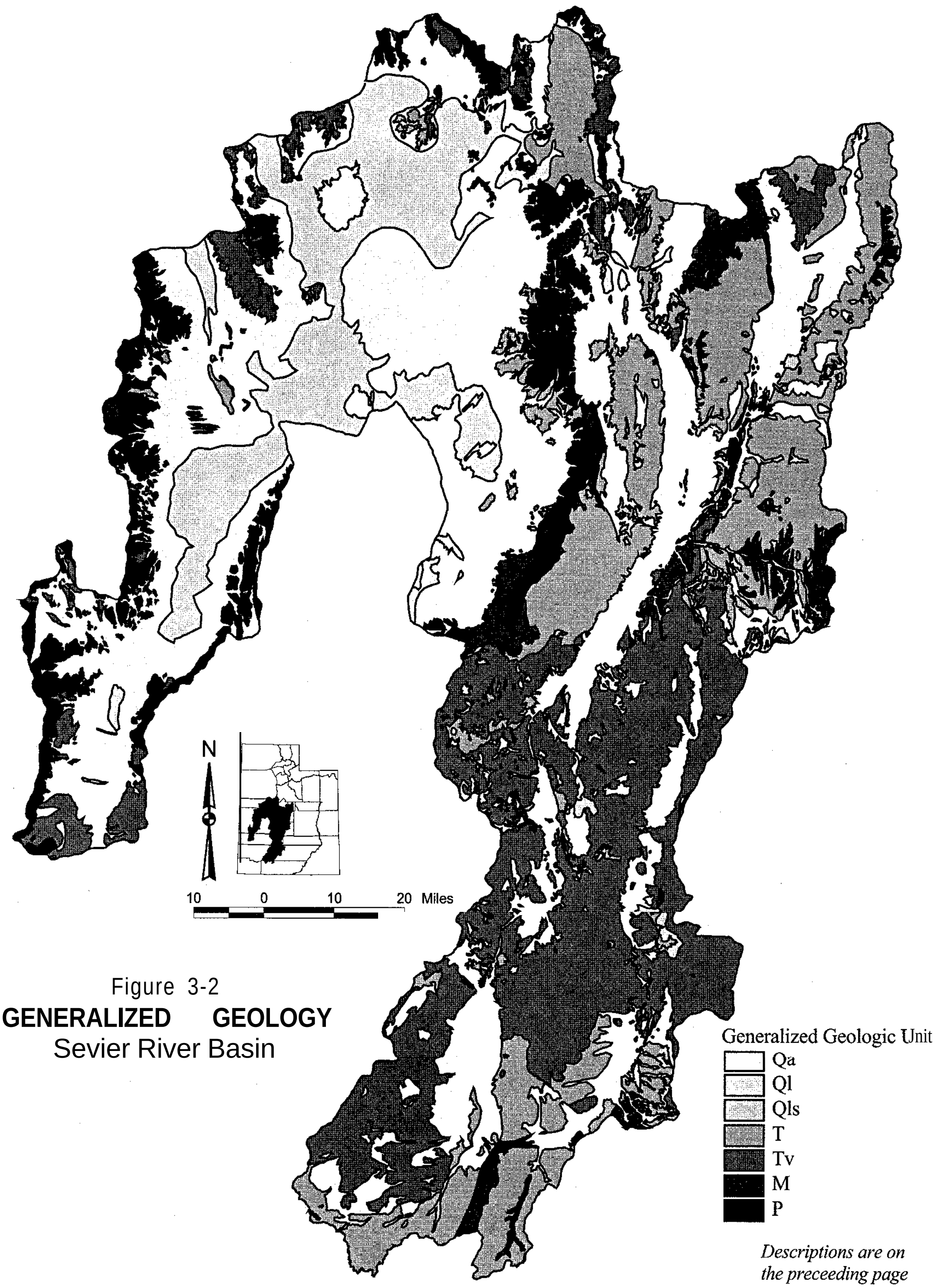


Figure 3-2
GENERALIZED GEOLOGY
Sevier River Basin

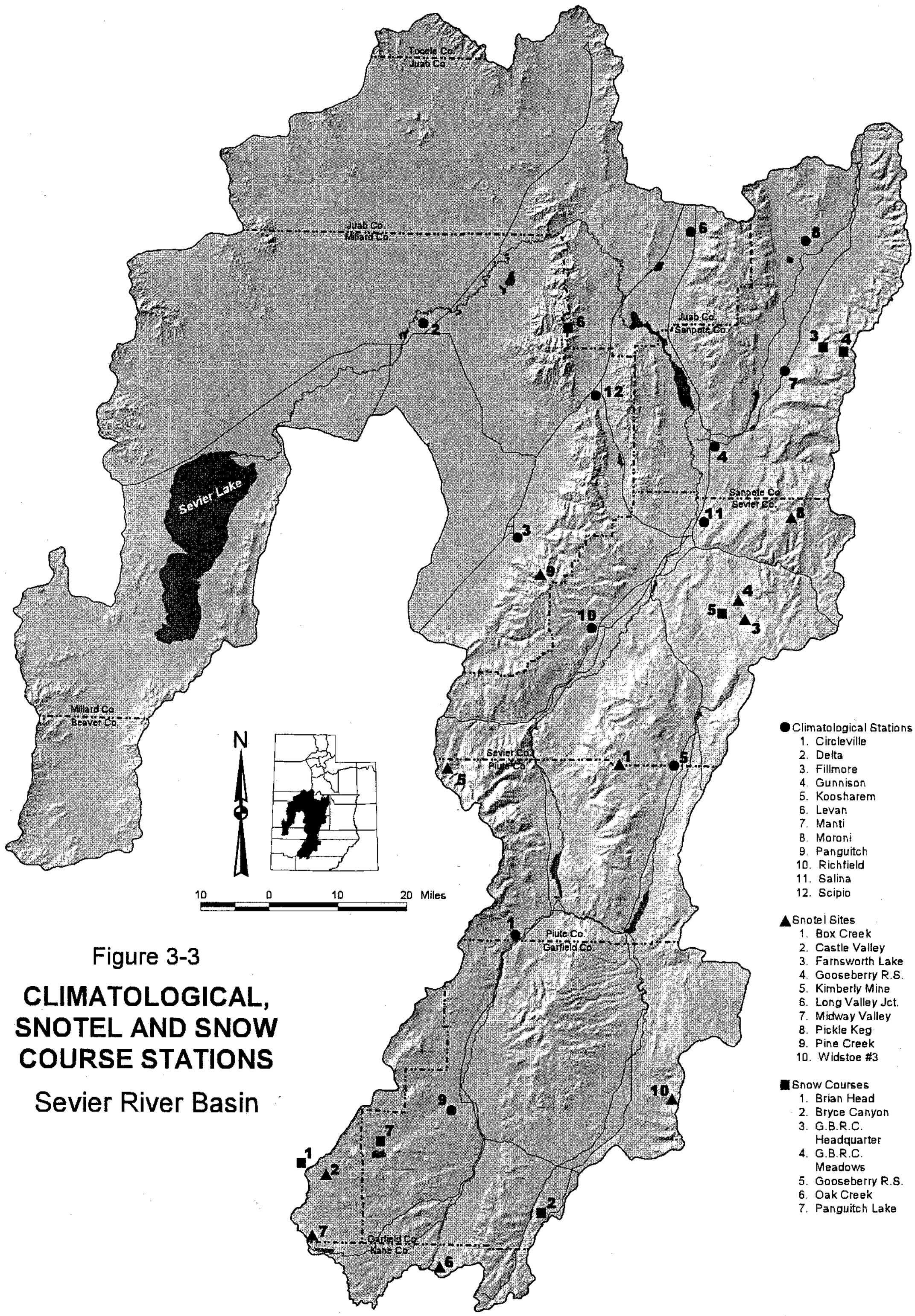


Figure 3-3

CLIMATOLOGICAL, SNOTEL AND SNOW COURSE STATIONS

Sevier River Basin

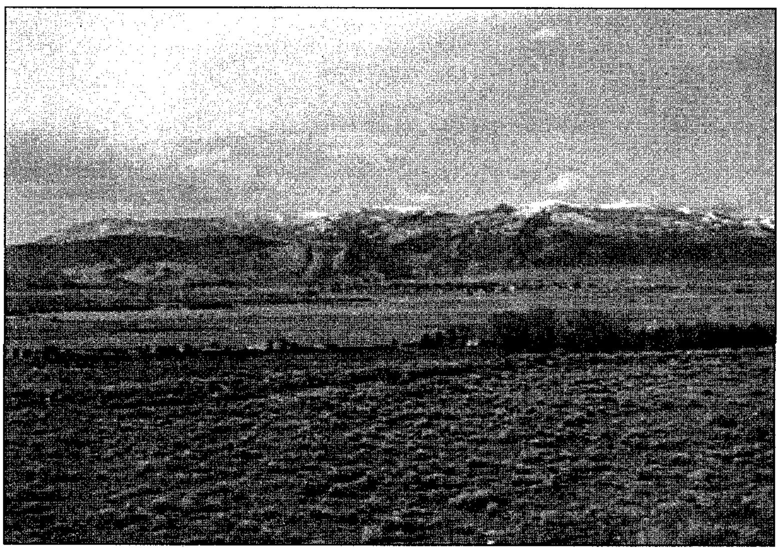
snow courses south of Gunnison. The average snow water equivalents for snow courses north of Gunnison were six inches more than those in the south. This would indicate the effect of the winter storm tracks across Utah. It was also found that wet and dry cycles occurred about every 10-15 years.

Mean annual valley precipitation varies from a high of 16.00 inches at Fillmore, elevation 5,120 feet, to a low of 8.11 inches at Delta, elevation, 4,620 feet, a distance of only 36 miles and 500 feet in elevation. This indicates the influence of topography. Precipitation ranges from more than 35 inches in the highest mountain areas to less than 8 inches in the Sevier Desert. The National Weather Service record measured daily valley rainfall is 2.6 1 inches at Circleville and the record daily valley snowfall is 33.3 inches at Gunnison. Another source states the record 24-hour snowfall was 35.0 inches at Kanosh on February 5, 1953. Figure 3-4 shows the precipitation for the 1961-90 base period. The April 1 readings at the snow courses are used to estimate the stream flows for the coming runoff season. Snow course and snotel data are shown in Table 3-2.

Frost-free days vary from a high of 144 days at Fillmore to 74 days at Panguitch. It is said that freezing temperatures occur every month of the year in Panguitch. The average annual water-surface evaporation is about 40 inches, varying from 43.0 inches at Delta to 35.9 inches at Koosharem. Average wind movement is a low of 40 miles per day in December to a high of 80 miles per day in May in the Sevier River valleys and 100 miles per day in the Fillmore-Delta area. Sunshine varies from a low of about 55 percent of the daylight hours in January to a high of nearly 85 percent in September.

3.3.3 Soils, Vegetation and Land Use

Orville Pratt, Secretary of War, stated in 1848 "The Valley of the Sevier . . . is the finest I have seen since leaving the United States . . . Many thousands acres of the best bottom lands all lie in a body . . . "[78]



Snow capped Tushar Mountains

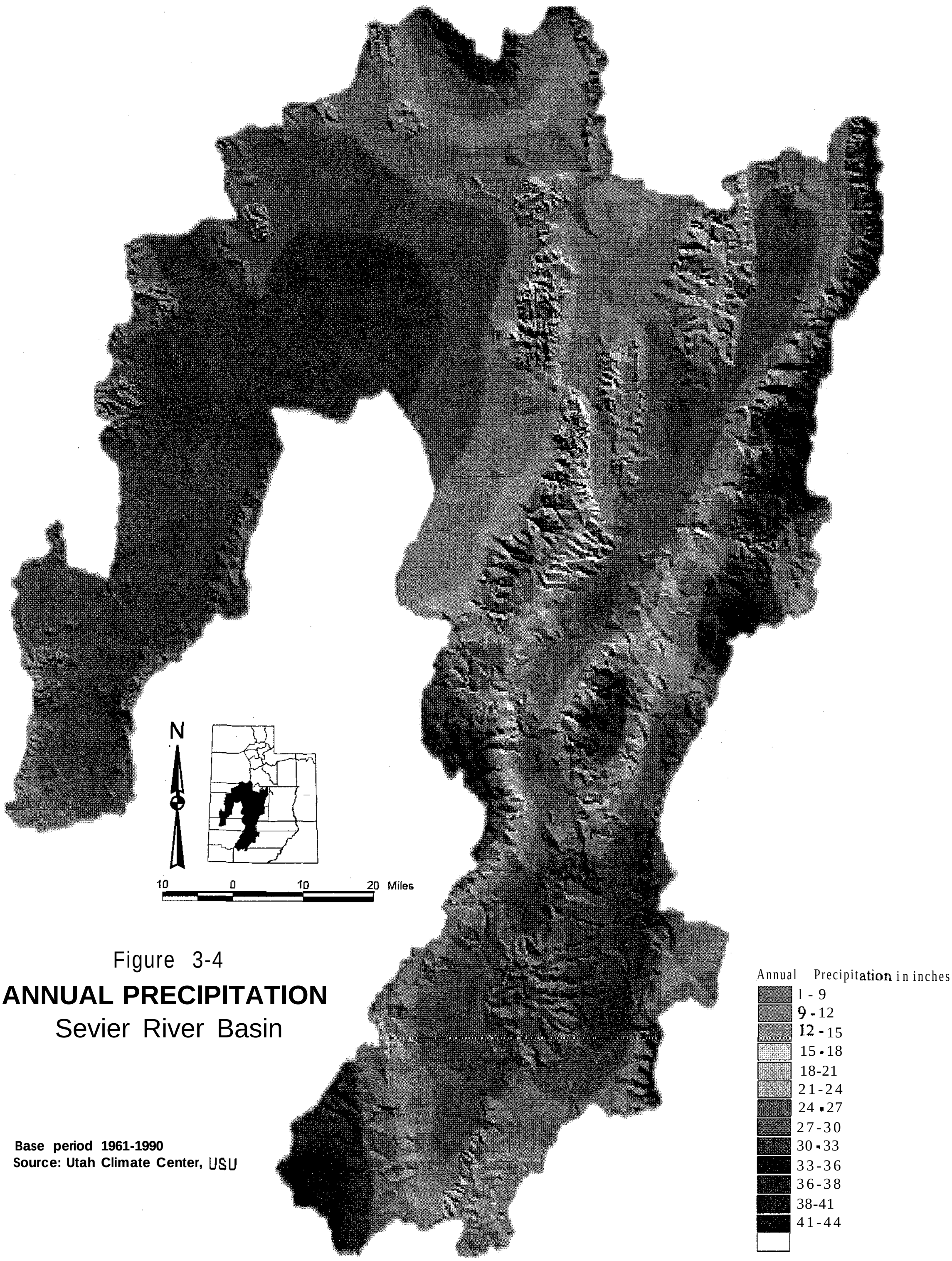


Figure 3-4

ANNUAL PRECIPITATION

Sevier River Basin

Base period 1961-1990
Source: Utah Climate Center, USU

Table 3-1
MEAN TEMPERATURES AND PRECIPITATION
196 l-90 Average

	Station	Temperatures Jan Max. (°F)	Jan Min. (°F)	July Max. (°F)	July Min (°F)	Mean Ann. (°F)	Record Max. (°F)	Record Min. (°F)	Frost[a] Free Period (days)	Precipitation Mean Ann. (in)	Record Day Rain (in)	Record Day Snow (in)
1	Circleville	41.7	12.5	88.4	52.1	47.3	103	-31	94	8.81	2.61	18.0
2	Delta	36.8	11.2	93.1	57.2	49.6	110	-30	135	8.11	2.59	16.0
3	Fillmore	39.5	16.5	91.6	59.1	50.9	107	-23	144	16.00	2.32	23.0
4	Gunnison	38.4	11.4	91.5	51.4	48.1	104	-28	104	9.18	1.33	33.3
5	Koosharem	38.9	8.4	84.7	46.7	43.6	105	-20	83	9.38	1.46	18.0
6	Levan	37.2	13.4	90.4	56.1	48.9	105	-28	129	15.15	2.00	20.0
7	Manti	36.9	13.9	86.7	54.7	47.6	103	-27	127	13.74	1.67	15.0
8	Moroni	35.6	9.8	89.4	49.3	46.0	102	-27	103	9.87	2.36	14.0
9	Panguitch	40.1	7.8	85.3	46.2	44.3	100	-31	74	10.32	1.87	12.0
10	Richfield	40.6	13.3	89.5	52.4	48.5	104	-33	116	8.57	1.80	16.0
11	Salina	39.9	12.1	92.4	54.1	49.2	105	-32	109	10.13	2.10	14.0
12	Scipio	38.2	9.9	89.7	54.1	47.6	105	-40	102	13.90	2.27	15.0

Note: Numbers in first column indicate station location on Figure 3-3.
Source: Utah Climate, Utah Climate Center, U.S.U.
[a] Frost-free days are between last spring and first fall 32” temperatures.

When Captain C.E. Dutton[25] worked in the area in 1880, he described the broad valley of the Sevier as “treeless and supports but scantily even the desert-loving Artemisia (big sagebrush). 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.”

Soils - Soil surveys are made to describe the soil profile and the related vegetation. Land use is generally dictated by the soil types and the vegetation produced. These surveys are published in soil survey reports. The Natural Resource Conservation Service has the responsibility for all soil surveys regardless of land ownership or administration. Under certain conditions, soil surveys are carried out by others such as the Forest Service or Bureau of Land Management.

Soil surveys have been completed or are in progress for most of the private, state and public lands in the basin with the exception of national forest lands. The status of soil surveys is shown on Figure 3-5. Soil surveys conducted at different levels of detail. For all but the most intense surveys, data is collected at three levels: 2nd, 3rd and 4th order mapping described as follows:

> The 2nd order surveys are made for intensive land uses. This type survey is conducted on all cropland areas.
>
> The 3rd order surveys are made for land uses not requiring precise knowledge of small areas or detailed soil information. This type survey is conducted on all

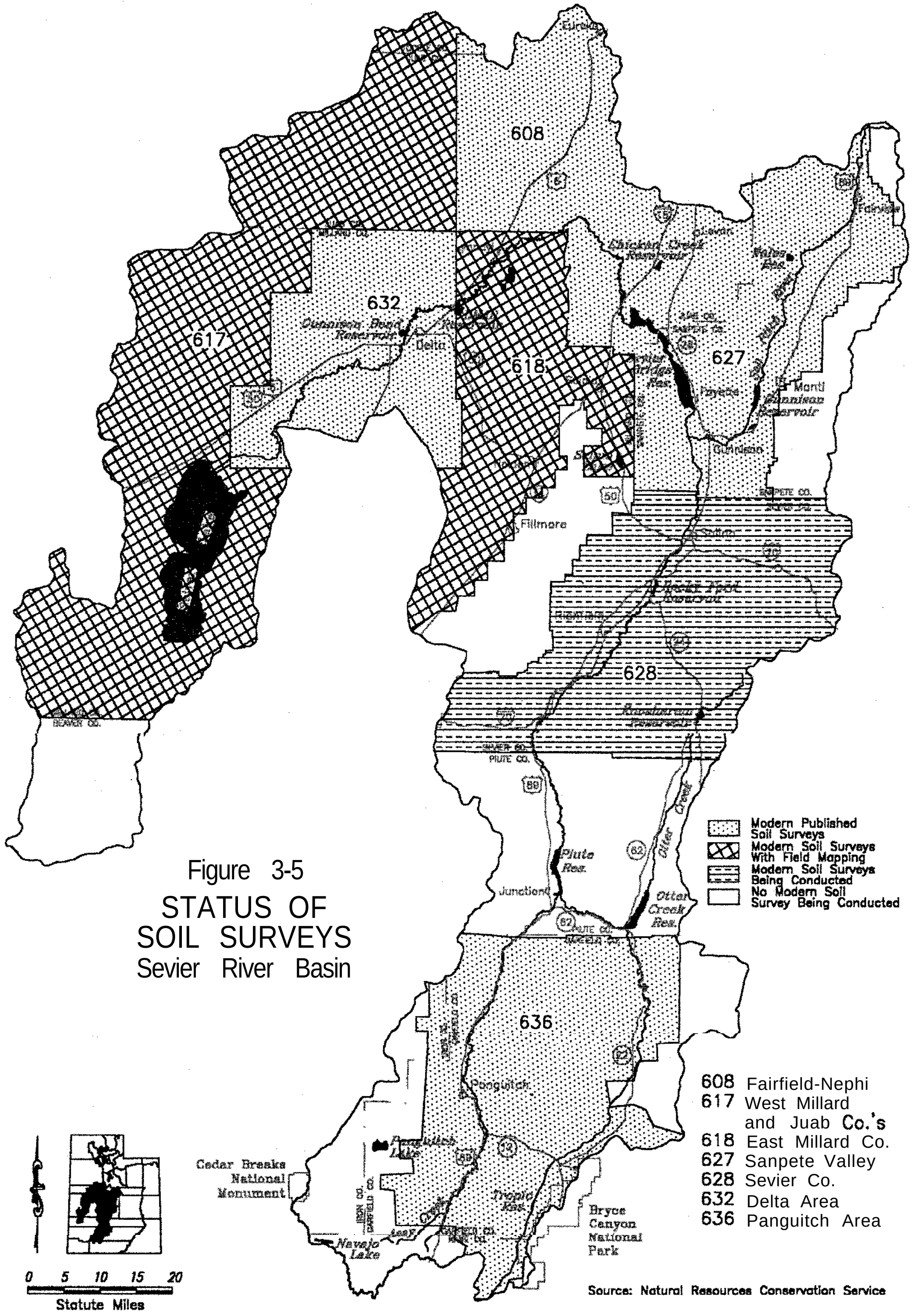


Figure 3-5
STATUS OF SOIL SURVEYS
Sevier River Basin

national forest lands and the majority of private and public rangelands.

The 4th order surveys are used to provide data for broad land use potential planning and general land management.

Five climatic zones are summarized in Table 3-3. The generalized soil descriptions for these zones are described below.

High. Mountain soils have high development and are usually found on mountain slopes and in mountain valleys. The mollic horizons are organically enriched surface layers. The next or argillic horizon is a textural clay. The pH is about 6.0 to 7.5 due to leaching by the higher precipitation. Most of this zone is used for rangeland and timber production.

Mountain soils are highly developed and are found on mountain slopes. The mollic horizons are organically enriched surface layers. The argillic horizon is a textural clay. The pH is about 7.0 to 8.0 due to leaching by the higher precipitation. Most of this zone is rangeland with some timber production.

Upland soils have moderate development and are found on alluvial fans and hills. The mollic horizons, usually minimally expressed, are organically enriched surface layers. The argillic horizon is a textural clay. The pH is about 7.5 to 8.0 due to the higher precipitation which leaches the calcium carbonate. The majority of this zone is used for rangeland with only a small amount of cropland.

Semidesert soils are deep, generally have very little development and are usually found in alluvial deposits and lake sediments. The surface ochric horizons are light in color. The subsurface calcic horizons show accumulations of calcium carbonates. The pH is more than 8.0. This zone contains most of the cropland.

Desert soils are located in the lowest elevation and precipitation areas. Soils primarily occur on lake bottoms, lake terraces, alluvial fans and flood plains. Soils are generally saline with a pH of over 8.0. The soils are similar to those in the semi-desert zone although there are areas of sand dunes.

Vegetation - There are five vegetative types which occur from the higher elevations with precipitation over 35 inches to the valley floors where precipitation is less than 8 inches. In addition, barren areas include desert playas, recent extrusions of volcanic basalt, and areas covered predominantly with annual weeds such as pickleweed or gray Molly. There is also a barren rock area on the higher flanks of the Tushar Mountains.

Conifer-Aspen Forest is found on mountain slopes and contains mostly white fir, Douglas fir, Ponderosa pine, spruce and quaking aspen. This area produces most of the stream flow, all of the commercial timber and a wide variety of wildlife. Precipitation ranges from 20 to 35 inches and elevations are usually over 8,000 feet.

Mountain Brush occurs on steep slopes with gambel oak, serviceberry and curlleaf mountain mahogany as the predominant vegetation. This area is used for grazing, wildlife habitat and recreation. Precipitation is 18 to 25 inches and elevations are usually between 7,500 feet and 8,500 feet.

Pinyon-Juniper trees lend a pigmy forest aspect to the foothills. Predominant vegetation is pinyon pine and Utah juniper with scattered areas of brush, grasses and forbes. This area provides grazing, wildlife habitat, materials for fence posts and firewood. It is also a source of pinyon pine nuts and a place of recreation. Precipitation is from 10 to 20 inches and elevations range from 5,500 feet to 7,500 feet.

Table 3-2
SNOTEL AND SNOW COURSE DATA
196 l-90 Average

	Station	Elevation	April 1 Snowtel SWE[a] Average
1	Box Creek	9,800	13.8
2	Castle Valley	9,580	14.4
3	Farnsworth Lake	9,600	20.5
4	Gooseberry R.S	8,000	11.7
5	Kimberly Mine	9,300	16.2
6	Long Valley Jct.	7,500	0.1
7	Midway Valley	9,800	24.6
8	Pickle Keg	9,600	18.8
9	Pine Creek	8,800	21.4
0	Widstoe #3	9,500	12.1
			Snow Courses SWE[a] Average
1	Brian Head	10,000	21.2
2	Bryce Canyon	8,000	3.6
3	G.B.R.C. Headquarter	8,700	17.2
4	G.B.R.C. Meadows	10,000	24.2
5	Gooseberry R.S.	8,400	12.5
6	Oak Creek	7,760	12.9
7	Panguitch Lake	8,200	4.0

Snow water equivalents in inches.
Jote: Numbers refer to station location in Figure 3-3.
;ource: Utah Cooperative Snow Survey Data, NRCS.

Table 3-3
CLIMATIC ZONES

Climatic Zone	Precipitation (inches)	Temperature (°F)	Frost Free Period (days)	**Elevation** (feet)
High Mountain	22-40	34-45	40-90	8,000-10,000
Mountain	16-22	42-50	70-170	6,000-8,200
Upland	12-16	45-59	120-170	4,500-6,900
Semidesert	8-12	52-59	120-190	4,500-6-300
Desert	6-8	50-59	120-200	4,500-5,800

Source: Natural Resources Conservation Service

Sagebrush is found at nearly every elevation and range of precipitation on deep, well-drained soils. These areas furnish spring-fall range at lower elevations and summer range for sheep and cattle as well as wildlife habitat at higher elevations. A wide variety of grasses, browse and forbes is found, with big sagebrush the predominant species.

Grass and the Northern Desert Shrub are found at elevations from 4,500 feet to about 5,000 feet where precipitation is from 8 to 10 inches. Important vegetation includes Indian ricegrass, needle and thread grass, winterfat, black greasewood and shadscale. Most of these are found in the bottom lands where soils are affected by salts. These areas provide winter range for livestock.

Land Use - Soils are generally used to provide the highest production or best use according to its capability. The Natural Resources Conservation Service capability groupings show the soil suitability, limitations and expected response to treatment.

Capability classes, the broadest group, are classified on a numerical scale from one to eight indicating progressively greater limitations and narrower choices for agricultural cultivation. Other uses, such as for grazing or, wildlife, may not be as restrictive. The lower class numbers are choice lands suitable for growing irrigated crops. The higher class numbers are more suitable for permanent pasture and progressively to grasslands, forested areas and rocklands.

Lands used for farming can also be defined according to their agricultural production ability and potential. There are two categories describing the better croplands: prime farmlands and farmland of statewide importance. About 144,600 acres of prime farmlands are used for irrigated agriculture.

Less intensively developed areas surround the farmlands. About 92 percent or about 6.2 million acres are used for grazing, wildlife, timber production, mining and other purposes. There are about 500,000 acres of commercial timber. These less intensive developed areas are also used for recreation in a wide variety of pursuits from rock hounding and sightseeing to hunting, snowmobiling and ATV activities.

3.3.4 Land Status

The total area of the Sevier River Basin is 6,768,070 acres. The areas by subbasin are shown in Table 3-4. See Figure 5-l for watershed and subbasin delineations. Private lands cover only about 23 percent of the area. Federally administered lands cover about 69 percent and state lands account for 8 percent. There are about 1,235 acres of Indian Trust Lands located in Sevier County and 500 acres in Millard County. The breakdown of land ownership and administration is shown in Tables 3-5 and 3-6. The federally administered lands are under the jurisdiction of the Bureau of Land Management, Forest Service and National Park Service.

The Manti-La Sal National Forest was established in the Manti area in 1903. The Fish Lake National Forest was first established in 1899 and final boundaries were established in 1911. The Dixie National Forest, originally the Aquarius, was designated in 1903. The original Uintah National Forest was established in 1897. The name was changed to Uinta in 1906.

Originally called the Temple of the Gods National Monument (1919), Bryce Canyon National Park was established in 1928. Its total area is now 37,277 acres. Cedar Breaks National Monument, originally part of Powell National Forest, came into being in 1933. Its total area is now 6,154 acres.

3.4 WATER-RELATED HISTORY

Between 1000 A.D. and 1500 A.D., 8,000 years after Lake Bonneville had receded from the Sevier River Basin for the last time, volcanos erupted and deposited black lava flows in the Navajo Lake area of the Markagunt Plateau. They also deposited lava in areas of the Paunsaugunt Plateau and on the western side of Pahvant Valley. These lava flows allow the precipitation to penetrate easily, reduce erosion and influence groundwater movement. There is evidence of a large Fremont habitation site, Nawthis Village, along Gooseberry Creek in the Salina Creek drainage that was occupied from about A.D. 800 to 1150.

East of this village site, a buried channel in the alluvial flood plain has been exposed by a recent mudslide. It appears to be the remains of an artificial channel, constructed and maintained by the inhabitants to irrigate their crops. This is evidenced

Table 3-4 BASIN AND SUB-BASIN AREAS		
Name	Area (acres)	(sq miles)
Panguitch Valley	623,530	974
East Fork Sevier	801,680	1,253
Junction-Marysvale	418,150	653
Sevier Valley	909,930	1,422
Sanpete Valley	555,170	867
Scipio-Levan	696,940	1,089
Delta	2,266,300	3,541
Pahvant Valley	496,370	776
Total	6,768,070	10,575

Source: Hydrologic Inventory of the Sevier River Basin, Division of Water Resources

Table 3-5
LAND OWNERSHIP AND ADMINISTRATION

County	Private	State (acres)	Federal	Total
Beaver	13,540	18,990	165,760	198,290
Garfield	112,440	63,470	784,520	960,430
Iron	9,880	1,520	115,980	127,380
Juab	239,420	78,460	731,150	1,049,030
Kane	21,160	120	76,070	97,350
Millard	475,350	213,820	1,508,100	2,197,270
Piute	64,910	5 1,440	352,150	468,500
Sanpete	396,330	62,500	293,990	752,820
Sevier	236,080	48,800	590,810	875,690
Tooele	3,860	3,110	34,340	41,310
Total	1572,970	542,230	4,652,870	6,768,070

Table 3-6 FEDERAL LAND ADMINISTRATION						
County	Forest Service	Bureau of Land Mg't	Native American (acres)	Dept of Defense	Park Service	Total
Beaver	420	165,340	0	0	0	165,760
Garfield	590,310	187,920	0	0	6,290	784,520
Iron	103,800	11,700	0	0	480	115,980
Juab	76,480	654,560	0	110	0	731,150
Kane	73,340	250	0	0	2,480	76,070
Millard	27 1,400	1,236,200	500	0	0	1,508,100
Piute	188,590	163,560	0	0	0	352,150
Sanpete	179,950	113,270	0	770	0	293,990
Sevier	476,680	112,895	1,235	0	0	590,810
Tooele	14,620	19,720	0	0	0	34,340
Total	1,975,590	2,665,415	1,735	880	9,250	4,652,870

by abundant corn remains and less common remains of beans and squash. When the first white men entered south-central Utah, they found the Western Utes living as roving bands; the Pahvants around Fillmore and Sevier Lake, and the San Pitch around Sanpete Valley. By 1847, there were less than 20,000 Native Americans in all of Utah.

Discovered by various explorers at different locations and times, the Sevier River was called by various names. The Dominguez-Escalante Expedition camped in Mills Valley near the Sevier River (west of Levan) on September 29, 1776. Their last camp in the Sevier River Basin was near Sugarloaf (Pahvant Butte). The explorers' cartographer, Don Bernardo de Miera, named what is now Sevier Lake after himself and called the river Rio Buenaventura, the "river of the good journey." In 1813, the traders Moricio Arce and Lagos Garcia called it the Rio Sebero (also reported as Severo or Seviro -- Spanish for severe or violent). This is the most likely source of the name "Sevier River."

Jedediah Smith opened up the beginnings of the Spanish Trail in 1826 when he traveled down Salina Canyon, up the Sevier River (Smith called it Ashley's River) to Clear Creek where he crossed over to Cove Fort. The most used portion of the Spanish Trail went down Salina Canyon, along the Sevier River to near Joseph and over the low hills to Marysvale and on up to Orton, up Bear Valley and over to Red Creek and Paragonah. A trapper, Daniel T. Potts, traveling the lower Sevier River, called it Rabbit River because of the great number of jack rabbits. William Wolfskill and George C. Yount, while traveling the Old Spanish Trail, spoke of the river the Indians called the Pooence.

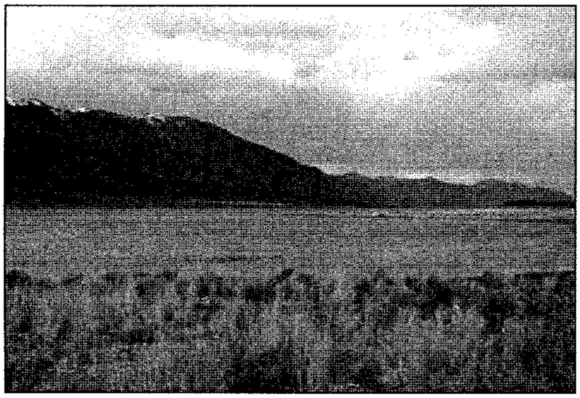
The first Anglo settlers arrived in Sanpete County in 1849. They probably diverted water to irrigate their crops in the spring of 1850. This was the first diversion for irrigation in modem times. Soon there were settlements in Pahvant Valley (1851), Mt. Pleasant and Ephraim (1852), Deseret (1857), Gunnison (1859), Monroe and Salina (1863), Richfield and Panguitch (1864) and Grass Valley (1867).

The territorial legislature passed a joint resolution on October 4, 1851 creating Millard County from the portion of Iron County known as Pahvant Valley and made Fillmore the county seat. This resolution also relocated the territorial capital to Fillmore. Two companies left Salt Lake City for

Pahvant Valley. One was headed by Brigham Young to select the site of the territorial capital; the other, headed by Anson Call, was to establish the settlement.

3.4.1 Early Water Development

As soon as settlers were established, they started developing local water resources for domestic use and irrigation. Water was first diverted from the Sevier River mainstem near Deseret in 1860. This dam was abandoned in 1889. Water to serve the Deseret, Hinckley and Oasis area has been diverted at Gunnison Bend from 1889 until the present, first from a diversion structure and later from the reservoir.



Scipio Reservoir-Constructed in 1860

One of the more detailed descriptions given was of the construction of the Richfield Irrigation Canal in 1865. This 1 l-mile long canal was dug with pick and shovel and completed in the amazing short time of five weeks.[78]

Increasing numbers of settlers put more and more land under irrigation until the resources of the Sevier River were completely utilized. Those higher up on the river were inclined to take the water as long as it was available, whether it was theirs by priority or use, or belonged to others lower downstream. When the demand for water was the greatest, the stream flow was the least. It soon became apparent dams were needed to store water for use later in the season. The first was Scipio Reservoir, constructed in 1860, to store irrigation water from Ivie Creek. Panguitch Lake was next when the dam was completed in 1872.

The years from 1890 until about 1915 were the dam-building years when most of the reservoirs were constructed. Refer to Table 6-1 for more data on reservoirs. During this same time, two of the longest canals in the state were completed; the 65-mile Sevier Valley-Piute Canal and the 52-mile Central Utah Canal. The Central Utah Canal now terminates at the Fool Creek Reservoirs.

The Delta-Melville diversion dam north of Delta was built in 1907. It washed out in 1909 and was rebuilt. It washed out again in 1910 and was eventually rebuilt 4-1/2 miles upstream at the present location of DMAD Reservoir.

Gunnison Reservoir is located about one-half mile above the mouth of Six Mile Creek on the San Pitch River. The original earth fill dam, 23 feet high, was built about 1890. The middle section washed out before July 1891. In 1900, the dam was raised to 40 feet with an outlet tunneled through solid rock. The dam is owned by the Gunnison Irrigation Company with a storage right for 20,264 acre-feet and a priority date of 1860. The spillway was rebuilt after the heavy flooding of 1983.

Gunnison Bend Reservoir, owned by Deseret Irrigation Company and Abraham Irrigation Company, was surveyed in 1885 and first stored water in 1891. It was enlarged to its present capacity in 1898.

A severe drought beginning in 1895 prompted plans by Sevier Valley farmers to build reservoir storage to regulate the seasonal flow of the river. The first work was done in April 1897 to legally claim title to the site of Otter Creek Reservoir near Antimony. Construction was started in October 1897 under the direction of Robert D. Young after an on-site inspection by the State Engineer. The dam was completed in 1901. Many of the work crew were boys, as the fathers had to stay home to take care of the farms. Otter Creek Reservoir is now cooperatively owned by a consortium of ten irrigation companies.

After a series of extremely dry years and many meetings, the Deseret Irrigation Company decided to construct a dam at the Sevier River Bridge near Juab to store water for irrigation.' On August 26, 1902, Jacob C. Hawley posted a notice for appropriation of water and selection of the site near the Sevier River Bridge. Construction started during October 1902. During the period 1903-07, nearly every available man and.boy in Deseret, Oasis and Hinckley worked at the dam. Sevier Bridge (Yuba) dam was completed to 40 feet in the spring of 1906 and raised to 66 feet with the spillway at 60 feet in 1907. In 1908, Deseret Irrigation Company sold one-half interest of the Hawley filing to Melville Irrigation Company and two-sixths interest to Oasis Land and Water Company. Melville Irrigation Company then sold one-sixth interest to Oasis Land and Water Company.

An additional agreement known as the Four-Party Contract was negotiated in 1913 to raise the dam 30 feet to store an estimated 250,000 acre-feet. The dam enlargement was completed in 1916. The present capacity is 236,145 acre-feet. Parties to the contract were Sevier River Land and Water Company, Deseret Irrigation Company, Delta Land and Water Company, and Melville Irrigation Company.

The Piute Project has a history of its own. Although it was started by the local people, the project was completed by the State Board of Land Commissioners. The Piute Reservoir dam was surveyed in 1907 and the site was filed for on August 21, 1908. The dam was originally completed in 1914. Considerable work was done later but was designated as rebuilding. The Piute Reservoir, with a present capacity of 7 1,826 acre-feet, was to furnish irrigation water for about 20,000 acres in Sevier and Sanpete counties from a point two miles north of Richfield to an area west of Fayette. The state owned about 11,000 acres of this land and a Jewish colony at Clarion bought 5,000 acres.

The depression and drought of the 1930s reduced the farmers' ability to repay loans to the State Land Board for projects the Central Utah Water Company and the Piute Reservoir and Irrigation Company had built. The Central Utah Water Company had borrowed money from the State Land Board to build a canal system and pay reservoir costs. They still owed $452,500. The Piute Reservoir and Irrigation Company was in similar straits, owing money for a reservoir and canal. Their remaining obligation was $545,577.'

It appeared the State Land Board did not have much hope of collecting any of the monies due. After much study, it was decided the State Land Board was to foreclose on the mortgages and claim title to the projects for the state. When the Legislature convened in 1937, it decided to sell the Central Utah Water System and the Piute Reservoir and Irrigation Company System to these companies for the consideration of one dollar each. This was passed March 11 and approved March 22, 1937. The acceptance of $1 .OO each for complete payment gave the companies back to the original owners and relieved the State Land Board of a difficult problem.

The Hatch Town Dam was located just over a mile south of the town of Hatch. The first dam built at this site was constructed in 1900 by a private irrigation company. It was a small, earth-fill dam with a lime-mortar culvert. The dam soon started to leak and subsequently washed out. A second dam was built by May 1901. It was 40 feet high with a timber spillway four feet deep and 20 feet wide located near the middle of the structure. Spring flooding and an inadequate spillway caused overtopping of the dam. The entire structure was carried away except for part of the culvert.[56]

From 1906-08, the State Land Board reconstructed the Hatch Town Dam to impound water for irrigation of about 5,700 acres on the Panguitch Bench. The land was sold to colonizers, mostly from Missouri. The total cost of the dam and canal was $329,185 and was paid from the Reservoir Land Grant Funds. When the reservoir filled in early 1910, the gates (since called the Jenson Lock Gates after the construction engineer) were ordered opened but they wouldn't budge. This was reported to the State Engineer who sent the construction engineer down to "show the country guys how to do it." They still wouldn't open so it was decided to give them a jar with a stick of dynamite. The blast jarred the gates open but also created a leak in the culvert wall.

This trouble persisted until on May 25, 1914 at about 8:00 p.m., the dam failed, releasing a wall of water 30 feet high. Flooding reached the flour mill at Panguitch in about two hours. By the next day, Circleville was deserted and a newspaper account stated "Main Street is now a raging river." There was considerable damage along the river valley. Noting urgent appeals for investigation of problems with the dam, the local paper editorialized, "There seems to be no trouble in having State Officers and competent engineers look at the dam or remains of it now." Governor Spry made sure all damages were repaid. The State Land Board considered rebuilding the dam and local initial reaction favored this. Still, the dam was never replaced.

Through all of these active water development years, four important documents were produced. The Higgins Decree, Morse Decree, "Bacon's Bible," and the Cox Decree. See Section 6 for information on these works.

Farming continued to expand as more people moved into the basin. Irrigation companies were formed so the water could be better managed. With the increase in irrigation, alkali began to accumulate in some soils, creating a problem. If the salts were not leached down through the root zone, crop production was reduced. As a result, additional water was applied to control the problem. This in turn raised the water table.

As a result, four drainage districts were organized in the Delta area between 1914-18. These four drainage districts issued bonds for $3 million to install drains under about 80,000 acres. Between 1916-20, seven drainage districts were organized in Sevier County covering 15,000 acres. Total cost of these projects was about $413,000. A small drainage district was organized in Sanpete County covering 3,600 acres. The drainage was installed in 1919-21 at a cost of $95,000.

3.4.2 Recent Water Planning and Development

The only storage reservoirs constructed since the 1936 Cox Decree are Three Creeks Reservoir enlargement (1949, originally built about 1895) in the Clear Creek drainage, DMAD Reservoir (1960) on the Sevier River, Manning Meadow Reservoir (1967) on Manning Creek and reconstruction and enlargement of Nine Mile Reservoir to restore its original capacity (1982) on the San Pitch River. Three Creeks Reservoir was constructed with private funding while the other three reservoirs received financial help from the Board of Water Resources.

In 1956, the Sevier River Water Users requested a review of the water and related land resources problems. After many meetings and several somewhat unrelated but important work programs had been started, the Sevier River Study Group requested a "framework plan" be formulated for the coordinated development of water and related land resources. The principal features of the study included the following items: 1) Salvage of water from phreatophytes, controlling groundwater tables and improving irrigation and drainage systems; 2) management of stream flows and more efficient transportation of water supplies through the main river channel; 3) review of groundwater conditions as they relate to return flow, drainage, phreatophyte control and the location, extent, and availability for use of groundwater supplies; 4) relationship of public and private lands and the use of water on these lands as they affect other water related activities; and 5) opportunities for adjustments in use and management of land, water and other resources and possible economic development.

Governor George D. Clyde, in response, made a formal request for assistance from the U.S. Department of Agriculture. As a result, a field party was established in 1960 under provisions of Section 6 of the Watershed Protection and Flood Prevention Act. The State Engineer was assigned to carry out the state of Utah's responsibilities.

This reconnaissance study resulted in the publication of a summary report, twelve numbered appendices and two unnumbered reports. The final document was an Early Action Program (1970) for accelerated development of the water and related-land resources as requested in the objectives and principal features of the plan of work.[63] This coordinated total resources development program would entail a total cost of $56.1 million of which $39.0 million would be federal funds and $17.1 would be non-federal. About 97,000 acre-feet of water would be developed and 632,000 acre-feet of groundwater would be available for dry-wet year management. After a series of public meetings, the program was rejected by the lower basin water users because of the impact on water rights.

In 1968, Governor Calvin L. Rampton requested the U.S. Department of Agriculture to expand the Sevier River Basin Water and Related-Land study to include all of the Sevier Lake Drainage. Part of the area added included Pahvant Valley, Tintic Watershed and Sevier Lake which, along with the original Sevier River Basin Study, now makes up the area covered by this Sevier River Basin Plan.

In 1967, counties in the Sevier River Basin petitioned to join the Central Utah Water Conservancy District. They hoped to obtain water through the Central Utah Project to supplement the existing irrigation water supplies. Their petition was enjoined and they were to receive a gross diversion of 36,000 acre-feet. After a number of years, it appeared the federal requirements for the use of project water were becoming too stringent. It was felt the federal claim to all the return flow and waste water resulting from the project would jeopardize the rights of users who could not participate in an exchange with Sevier Bridge Reservoir. There were increasing environmental concerns along with some other unresolved problems. As a result, in June 1994, Millard County petitioned and was released from the district. Sevier County followed suit in September 1994.

Garfield, Juab, Piute and Sanpete counties are still members of the Central Utah Water Conservancy District and pay taxes for its operation. Membership and future participation will have to be resolved. Some funding has been obtained under the Mitigation and Conservation Plan for water conservation and development.

The Soil Conservation Service(SCS) implemented four flood prevention and irrigation water projects in the basin. In addition, three other projects were carried to various stages of completion. These are described below.

Under a pilot program, Utah was awarded two of 11 national flood prevention projects. The Pleasant Creek Pilot Watershed Project near Mt. Pleasant was one of these with construction beginning in 1954. Under the Watershed Protection and Flood Prevention Act of 1954, three projects were approved. The Mill Canyon-Sage Flat Watershed Project, authorized in 1956 and completed in 1961, was primarily flood protection. Two others, the Monroe-Annabella (1966) and Glenwood (1975) projects included irrigation water conservation and development. The original application for the Glenwood Watershed Project was changed to be a supplement of the Mill Canyon-Sage Flat Watershed Project. This project was reopened under the name Glenwood Watershed Project.

A Flood Plain Study was completed by the SCS for Richfield in 1974. This was done under the National Flood Insurance Program.

SCS planning was terminated on the Richfield-West Sevier Watershed Project in March 1977 after four years of planning and completion of the work plan and environmental impact statement; Increased costs from higher earthquake design standards made the project prohibitive, however, some flood control features have since been constructed by Richfield City.

Planning was approved for the Chalk Creek Watershed during January 1955. Planning for flood control and irrigation features continued until August 1956 at which time the sponsors voted to terminate planning. Sporadic interest continues but no action has been taken.

Section 4 Sevier River Basin
DEMOGRAPHICS AND ECONOMIC FUTURE

Tables

Figures

Demographics and Economic Future

The Sevier River Basin is a rural agricultural area although it is the economic center of central Utah. Recreation is a growing part of the economy.

4.1 INTRODUCTION

This section discusses the population, employment and economic future of the Sevier River Basin. The basin population was about 38,000 in 1900. Many of the smaller rural communities have lost population or have remained about the same since the turn of the century. Eureka had the largest drop going from a population of 3,085 in 1900 to 716 in 1997. Several other communities show fluctuations reflecting local activities. Sanpete County remained essentially the same from 1900 (16,313) until 1990 (16,259) although it has been growing during the 1990s.

The basin population was 47,508 in 1990. It had increased to 56,746 by 1997 and is expected to be 85,974 by 2020. This will be an increase of 29,228 people or 52 percent from 1997 to 2020. The annual rate of population growth is expected to be 1.82 percent.

Employment patterns should not change much although government, trade and service sectors will continue to increase. Agricultural employment is expected to slow down while other sectors will show steady growth. There will be an estimated 17,553 new jobs, for an annual growth rate of 2.1 percent.

The Governor's Office of Planning and Budget prepared the projected population estimates. The Division of Water Resources then used these estimates as a basis for estimating the culinary water supply requirements shown in Section 11, Drinking Water. Projections for agricultural, industrial and secondary water use were also influenced by population projections.

All residents of Piute and nearly all of Sevier and Sanpete counties live in the basin. The majority of the population of Millard County and part of the population of Garfield, Iron, Kane and Juab counties also live within the basin. There is only an isolated ranch or two in Beaver and Tooele counties. Richfield is the major population center with 7,040 people in 1997. Ephraim, with 3,838 people and Delta with 3,443 people are other centers of activity.

4.2 DEMOGRAPHICS

Richfield has 38 percent of the Sevier County population while Ephraim has 19 percent of Sanpete County and Delta has 28 percent of Millard County. The unincorporated areas account for 17 percent of the total basin population. The communities are the economic and social center for the area and reflect the rural atmosphere. Richfield is the regional center for many state and federal agencies.

Communities with the highest growth rates are Richfield and Salina, at 2.2 percent. The unincorporated population is increasing in some counties but in some cases, may face annexation by nearby cities and towns. See Table 4-1 for community populations and projections.

Data for 1990 reflects the April census count after correcting for geography mistakes and/or other changes since the 1990 census. Data for 1997 are estimates of the Governor's Office of Planning and Budget. Figures 4-1a and 4-1b present the information for 1990 to 2020.

The Governor's Office of Planning and Budget made additional extrapolations to aid in estimating long-range municipal and industrial water demands. Assuming a constant annual growth rate beyond 2020 of about 1.9 percent, the population would increase to about 150,000 by 2050. See Table 4-2.

Table 4- 1
POPULATION AND PROJECTIONS

City	1990	1997	2000	2020
Garfield				
Antimony	83	112	115	139
Hatch	103	106	109	132
Panguitch	1,444	1,623	1,722	2,300
Unincorporated	250	300	350	400
County Total	1,880	2,141	2,296	2,971
Iron				
Unincorporated	150	200	250	500
Juab				
Eureka	562	716	731	841
Levan	416	644	668	851
Unincorporated	50	55	55	100
County Total	1,028	1,415	1,454	1,792
Kane				
Unincorporated	150	200	275	400
Millard				
Delta	**2,998**	3,443	3,709	5,241
Fillmore	1,956	2,161	2,324	3,258
Hinckley	658	730	769	993
Holden	402	425	444	557
Kanosh	386	402	412	468
Learnington	253	266	269	288
Lynndyl	120	105	107	119
Meadow	250	266	268	283
Oak City	587	660	682	805
Scipio	291	347	373	522
Unincorporated	3,432	3,455	3,552	4,113
County Total	11,333	12,260	12,909	16,647
Piute				
Circleville	417	521	535	604
Junction	132	136	154	238
Kingston	134	183	201	290
Marysvale	364	475	510	678
Unincorporated	230	252	270	354
County Total	1,277	1,567	1,670	2,164

Table 4- 1 -- Continued POPULATION AND PROJECTIONS				
City	1990	1997	2000	2020
Sanpete				
Centerfield	766	837	905	1,340
Ephraim	3,363	3,838	4,178	6,354
Fairview	960	1,265	1,367	2,020
Fayette	183	209	225	330
Fountain Green	578	833	906	1,376
Gunnison	1,298	2,164	2,344	3,498
Manti	2,268	2,718	2,956	4,479
Mayfield	438	499	537	781
Moroni	1,115	1,701	1,851	2,809
Mount Pleasant	2,092	2,678	2,895	4,288
Spring City	715	893	968	1,447
Sterling	191	250	269	391
Wales	189	214	230	335
Unincorporated	2,103	2,566	2,733	3,804
County Total	16.259	20.665	22,364	33,252
Sevier				
Annabella	487	571	611	870
Aurora	911	992	1,065	1,541
Elsinore	608	689	742	1,088
Glenwood	437	530	570	829
Joseph	198	241	257	361
Koosharem	266	321	344	500
Monroe	1,472	1,945	2,096	3,082
Redmond	648	767	823	1,186
Richfield	5,593	7,040	7,622	11,427
Salina	1,943	2,258	2,449	3,707
Sigurd	385	497	526	716
Unincorporated	2,483	2,447	2,513	2,945
County total	15,431	18,298	19,618	28,248
Basin Total	47,508	56,746	60,836	85,974

4.3 EMPLOYMENT

Agriculture is expected to remain steady or decrease slightly although there will be increases in agricultural related jobs such as lawn care, soil preparation, and veterinary and animal services. Two new saw mills, one near Gunnison and one by Vermillion, should add to the employment. Mining is expected to increase as coal production in Salina Canyon expands. All other sectors will likely grow with services increasing at the most rapid rate. In fact, 65 percent of the workers in Garfield County were involved in the travel and recreation industry in 1996 with Sevier County a distant second with 11 percent. Basin employment will increase at an annual rate of 2.1 percent. See Table 4-3 and Figure 4-2.

The employment shown in Table 4-3 may indicate more jobs than there is population. This indicates some of the people are employed on more than one job.

Figure 4-l a
POPULATION PROJECTIONS

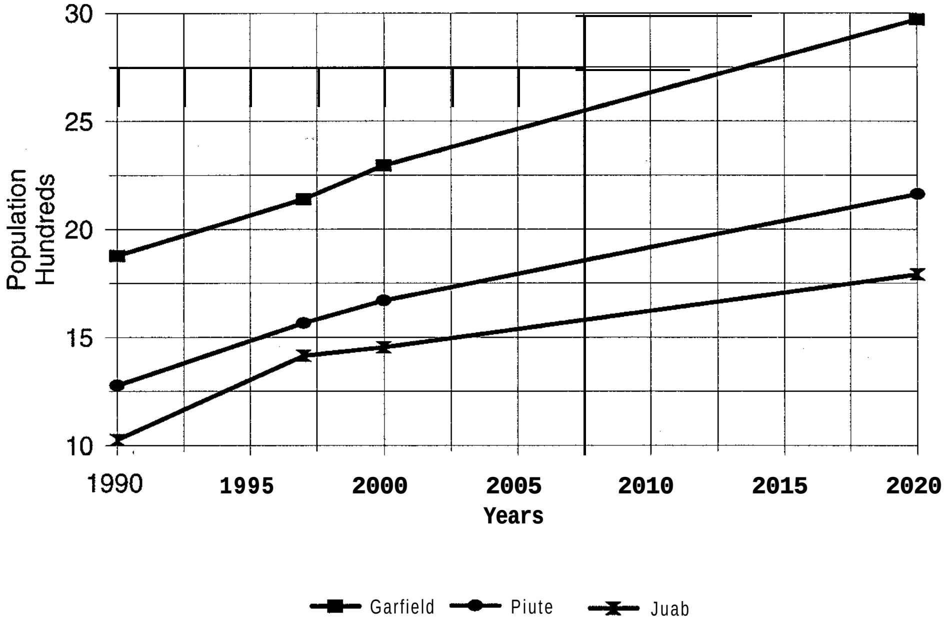


Figure 4-lb
POPULATION PROJECTIONS

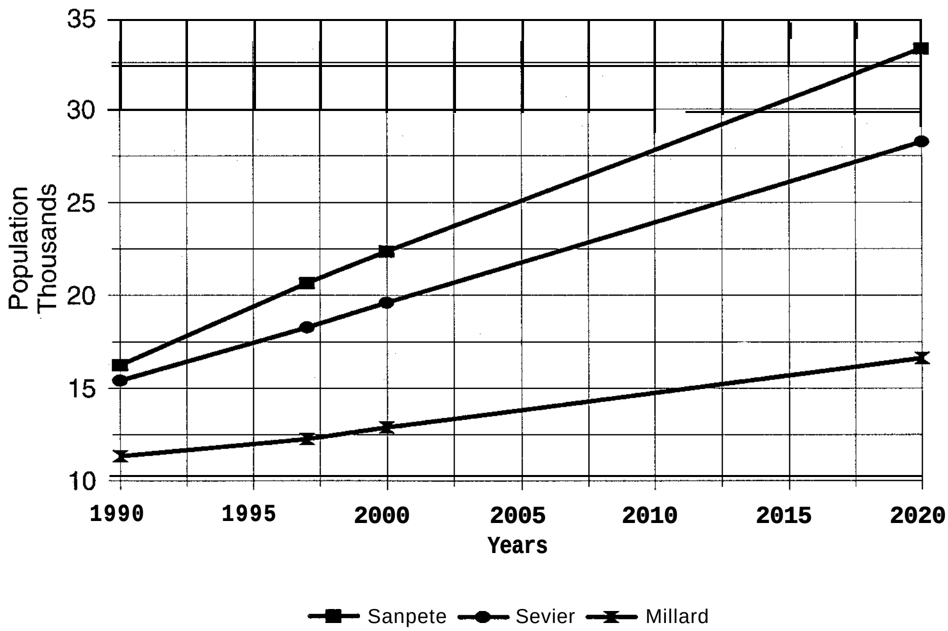


Table 4-2 LONG-RANGE POPULATION ESTIMATES			
County	1990	2020	2050
Garfield	1,880	2,971	6,570
Iron	150	500	779
Juab	1,028	1,792	4,592
Kane	150	400	1,148
Millard	11,333	16,647	24,378
Piute	1,277	2,164	3,192
Sanpete	16,259	33,252	60,282
Sevier	15,431	28,248	48,808
Basin Total	47,508	85,974	149,749

4.4 ECONOMIC FUTURE

The long-term outlook for the economy is positive. In addition to the projected employment, increasing numbers of people are moving into the area after retirement. Recreation is growing and will likely continue to expand.

Figure 4-2
Employment Projections

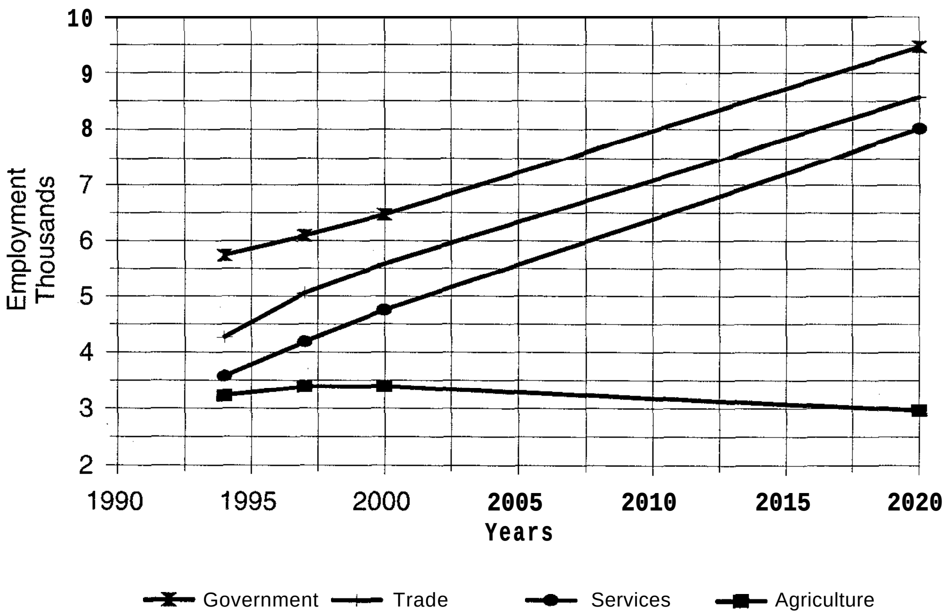


Table 4-3
EMPLOYMENT PROJECTIONS

County/Sector	1994	1997	2000	2020
Garfield				
Agriculture	279	280	278	242
Mining	27	24	128	149
Construction	61	78	80	98
Manufacturing	117	99	116	173
TCPU	87	109	120	168
Trade	254	265	308	431
FIRE	20	20	26	32
Services	699	813	940	1,496
Government	514	518	547	792
Non-Farm Prop	450	495	561	818
County Total	2,508	2,701	3,104	4,399
Juab				
Agriculture	290	303	301	262
Mining	19	13	15	24
Construction	112	73	87	152
Manufacturing	321	324	347	444
TCPU	54	81	89	141
Trade	561	726	792	1,194
FIRE	39	35	37	53
Services	495	562	633	1,070
Government	535	561	570	812
Non-Farm Prop	404	449	494	759
County Total	2,830	3,127	3,365	4,911
Millard				
Agriculture	868	921	943	837
Mining	169	114	125	198
Construction	86	100	136	272
Manufacturing	150	219	230	282
TCPU	706	702	716	787
Trade	837	970	1,060	1,532
FIRE	60	57	62	84
Services	558	613	692	1,129
Government	1001	1,025	1,040	1,405
Non-Farm Prop	1083	1,209	1,332	1,974
County Total	5,518	5,930	6,336	8,499

Table 4-3 -- Continued
EMPLOYMENT PROJECTIONS

County/Sector	1994	1997	2000	2020
Piute				
Agriculture	149	158	157	136
Mining	0	0	0	0
Construction	1	1	2	3
Manufacturing	25	12	13	15
TCPU	15	22	24	41
Trade	18	22	27	44
FIRE	6	7	8	12
Services	8	16	23	34
Government	122	147	160	249
Non-Farm Prop	43	49	59	100
County Total	387	434	473	634
Sanpete				
Agriculture	1,033	1,084	1,074	936
Mining	1	10	20	21
Construction	172	235	309	673
Manufacturing	756	911	985	1,378
TCPU	170	212	233	392
Trade	1,012	1,211	1,349	2,238
FIRE	154	159	175	270
Services	722	897	1,019	1,835
Government	2,146	2,332	2,576	3,967
Non-Farm Prop	1,202	1,364	1,534	2,615
County Total	7,368	8,415	9,274	14,325
Sevier				
Agriculture	613	641	635	553
Mining	330	345	347	446
Construction	249	324	411	798
Manufacturing	482	552	591	771
TCPU	488	563	615	979
Trade	1,590	1,868	2,050	3,145
FIRE	134	141	153	220
Services	1,094	1,288	1,448	2,459
Government	1,428	1,512	1,578	2,250
Non-Farm Prop	1,212	1,348	1,496	2,352
County total	7,620	8,582	9,324	13,973
Basin Total	26,231	29,189	31,876	46,741

Section 5 Sevier River Basin
WATER SUPPLY AND USE

Tables

Figures

Section 5 Continued

Section Five Sevier River Basin - State Water Plan

Water Supply And Use

The Sevier River is one of the most completely consumed rivers in the United States.

5.1 INTRODUCTION

This section discusses the present water supply available and the water use from the Sevier River as well as its tributaries. Water supplied to and used from groundwater sources, primarily wells and springs, is also discussed.

Projected water uses and demands are discussed in Section 9, Water Planning and Development. Section 10, Agricultural Water and Section 11, Drinking Water, discusses these respective uses in more detail.

There are surface water exports and imports, and groundwater movement into the basin from other areas as well as groundwater flow out of the basin.

5.2 BACKGROUND

The Sevier River was divided into 13 subbasins or subareas[16,20] by the Division of Water Resources (See Figure 5-l). This made it possible to prepare more accurate water budgets and to present the water and related-land resources data for smaller, more specific areas and in a more understandable manner.

The base period used in this plan for determining and presenting the surface water supply is 194 1- 1990. Some of the groundwater data are discussed for different time periods depending on the records available. The municipal and industrial water-use data are for 1996.[18] The water-budget water supply data are based on the period 1951-1980.

A water budget[16] is an accounting procedure for determining all the water inflows, supplies, uses and outflows within a given hydrologic area (these are the subareas referred to above). These areas were delineated to take advantage of hydrologic and geologic conditions that limit unknown variables. Water budgets were based on more recent data than was used in the decrees apportioning the Sevier River. As a result, they will not agree. Surface water and groundwater data were provided primarily by the Division of Water Rights, the river commissioners, Division of Water Resources and the U.S. Geological Survey. There are some short-term (1963-65) current- meter measurement data on ungaged streams available from the Natural Resources Conservation Service.”

The land-use inventories covered the lower valley areas where the agricultural croplands and the cities and towns are located. The land use was inventoried under contract between the years 1981 and 1985. This inventory provides the acreages used to calculate the water budgets.[16] A more recent land-use inventory was made in the upper Sevier River area in 1993 and the balance was completed in 1995.[21] Because of time constraints, water budgets have not been prepared using this later data. This later land-use data is shown in Table 10-2, Section 10, Agricultural Water. All of the land-use data shows what was on the ground at the time of the inventory. As a result, these acreages will vary from those presented in Bacon’s Bible and used in the Cox Decree.

Much of the main stem surface-water supply comes from the Sevier River and East Fork (including Otter Creek) of the Sevier River above Piute Reservoir. The San Pitch Subarea produces over one-fourth of the total yield. There are several gages where the recorded flow is around 200,000 acre-feet annually, depending on the period of record. Major tributaries include Clear Creek, Salina Creek, San Pitch River and Chicken Creek. Chalk Creek and Corn Creek are important tributaries that do not flow directly into the Sevier River.

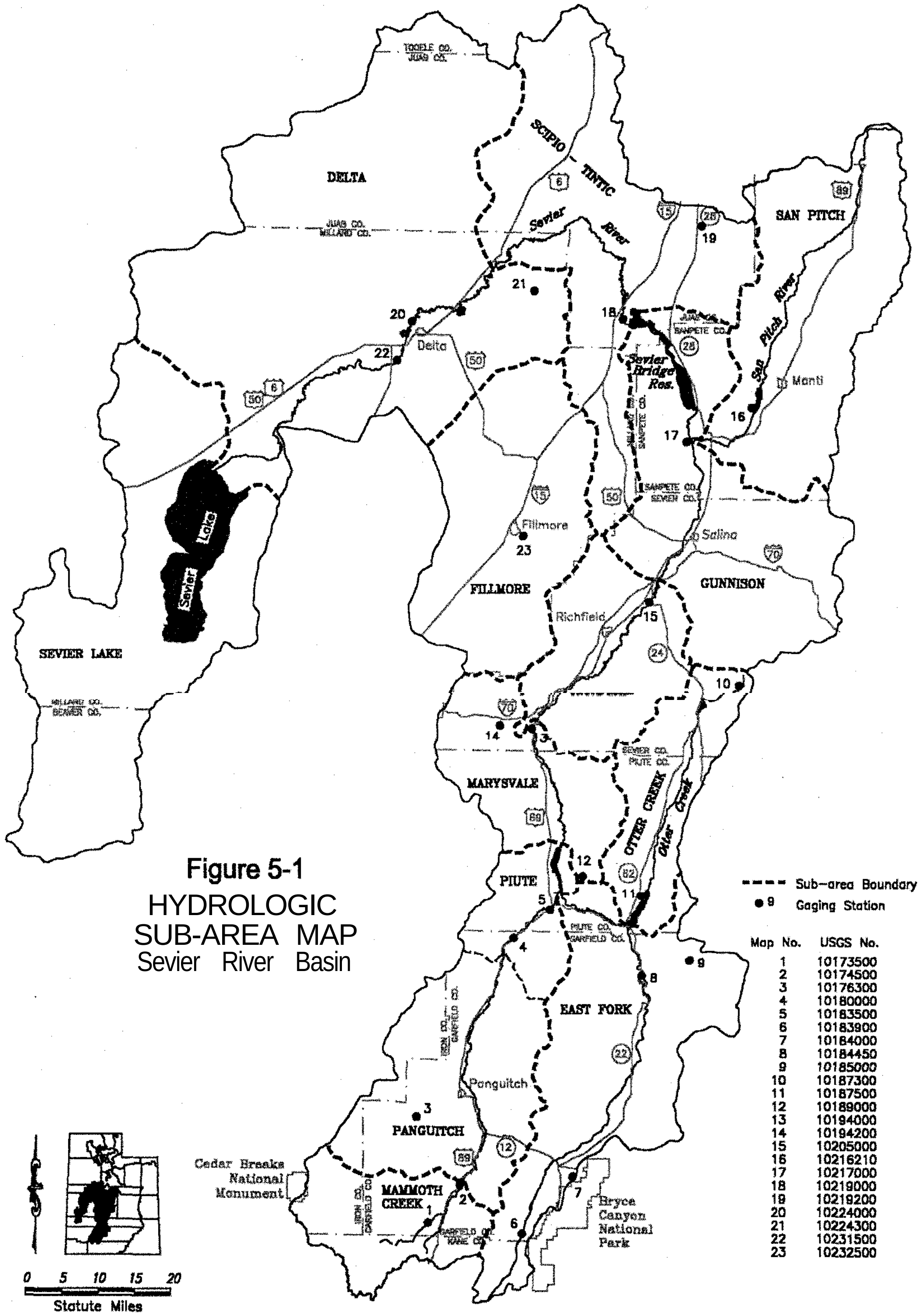


Figure 5-1
HYDROLOGIC
SUB-AREA MAP
Sevier River Basin

Many normally dry drainages experience short-duration flows produced by high intensity cloudburst-storms or snow-melt runoff. These are not a dependable supply of surface water.

The primary use of water is for irrigation. Developing irrigation systems was one of the first activities undertaken by the early settlers. Culinary supplies originally came from surface water sources or nearby springs. Later, wells were dug and springs improved to provide good culinary water for the growing communities.

5.3 WATER SUPPLY

The total water supply comes from precipitation except for the small surface-water transmountain diversions along the Wasatch Plateau and the groundwater inflow through the Gunnison Plateau and from the Awapa Plateau. Native vegetation in the upper watersheds consumes up to 90 percent of the precipitation. This need must be met before there is surface water runoff or infiltration to supply groundwater aquifers that feed springs and provide groundwater inflow. Because of this relationship, .a small change in precipitation can cause a large change in water yield. This is particularly true in the semi-arid area where the Sevier River Basin is located.

The Sevier River Basin is water short on a long-term basis. The average water supply is short of the normal demand by about 12,340 acre-feet. This is based on average water budgets (1951-80)[16] and the land-use inventory of irrigated lands during 198 1-85.[20] Generally, small volumes of groundwater are pumped except in the Sevier Desert and Pahvant Valley where use is high every year and to be lesser degree in Southern Juab Valley.

5.3.1 Surface Water Supply

Captain C.E. Dutton, during studies in 1875-77,[25] reported the flow of the Sevier River in the upper end of Sevier Valley was about 1,000 c.f.s in July and about one-half that amount in September. J.W. Powell reported that on July 6 & 7, 1877, the East Fork of the Sevier River was flowing 410 c.f.s., the South Fork of the Sevier River was flowing about 450 c.f.s. and the San Pitch River at Gunnison was 60 c.f.s.

Most of the surface water runoff comes from snow-melt during the months of April, May and June. Tributary streams peak at different times depending on the watershed aspect, elevation and configuration. Surface water flows are also modified by storage reservoirs. In the lower reaches of the river system, much of the streamflow is made up of return flows from upstream irrigation. This tends to modify the river flow even further. It takes about one year for a major climatological event in the upper watersheds to be reflected in the lower reaches of the system.

Figure 5-2 is a graphical representation of the average annual streamflows, diversions and return flows for the period 1941 to 1990. This is the base period used for all surface water data except the water budgets. The width of the arrows and bands indicates the average annual flow volume. The flow volumes are derived or estimated from stream gage data, other records and by correlation. Some of the stream gages are operated by the U.S. Geological Survey on a cost-share basis with various state and local entities (See Figure 5-l). A few gages are also part of a real-time water management project carried out with assistance from the Bureau of Reclamation.[45]

The annual and monthly mean flows for most stream gages are given in Table 5-l. These flows are for the period of record indicated in the table. The annual flows at several locations are shown graphically as follows: Sevier River at Hatch, Figure 5-3; Sevier River and East Fork Sevier River near Kingston, Figures 5-4 and 5-5; Sevier River above Clear Creek, Figure 5-6; Sevier River below San Pitch River, Figure 5-7; Sevier River near Juab, Figure 5-8; and Chalk Creek near Fillmore, Figure 5-9. The maximum and minimum daily flow is given in Table 5-2.

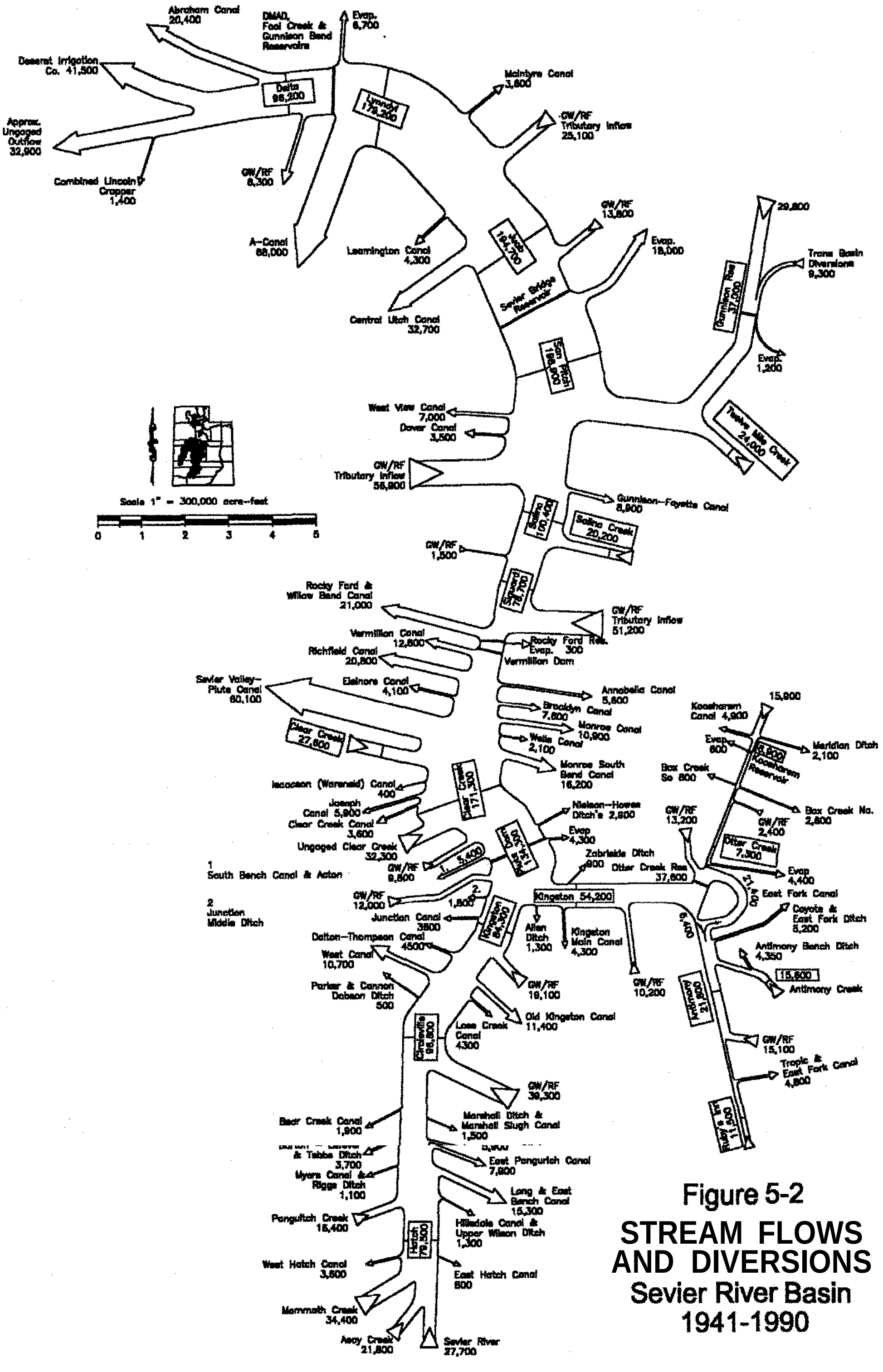


Figure 5-2
STREAM FLOWS
AND DIVERSIONS
Sevier River Basin
1941-1990

Sevier River Basin

Table 5-1
ANNUAL AND MONTHLY FLOWS
(acre-feet)

Gauge #	GaugeName	Years	Oct.	Nov.	Dec.	Jan	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sep.	Ann
10173450	MAMMOTH CREEK ABV WEST HATCH DITCH, NEAR HATCH,	65-96	1,291	1,045	865	723	645	786	1,744	10,672	10,513	3,775	2,061	1,481	35,602
10173600	MIDWAY CR NR HATCH UT	58-62	0	0	0	0	0	0	0	389	252	0	0	0	641
10173900	DUCK CREEK NR HATCH, UT	54-59	366	281	227	111	68	67	278	2,064	2,416	1,024	721	553	7,000
10174000	ASAY CR. ABV WEST FORK NR HATCH, UT	54-59	1,510	1,330	1,298	1,102	906	1,009	1,959	5,486	3,685	2,290	1,857	1,644	17,89(
10174500	SEVIER RIVER AT HATCH, UT	15-28	4,689	4,421	4,210	3,853	3,718	4,678	7,757	20,946	16,044	7,488	5,630	4,684	87,08(
		40-96													
10176300	PANGUITCH CREEK NEAR PANGUITCH, UT	61-80	314	284	243	222	279	456	1,267	2,695	4,048	3,132	2,667	1,333	16,787
10180000	SEVIER RIVER NEAR CIRCLEVILLE, UT	12-27	6,375	7,570	7,915	7,183	7,315	9,066	9,906	18,391	14,163	6,444	5,972	5,504	96,928
		50-95													
10183500	SEVIER RIVER NEAR KINGSTON, UT	14-95	5,116	7,742	8,917	88,169	1 5	1,549	9,433	13,974	9,422	3,19	3,271	3,510	89,373
10183900	EAST FORK SEVIER RIVER NEAR RUBYS INN, UT	62-95	618	615	533	495	534	957	2,202	3,419	1,391	630	580	523	12,496
10184000	TROPIC AND EF CANAL NEAR TROPIC, UT	50-60	92	1	0	0	0	0	69	610	745	533	365	271	2,583
10184450	E FK SEVIER RIVER NEAR ANTIMONY, UT	61-66	1,148	1,144	1,173	1,134	1,527	3,110	3,988	4,379	1,778	1,150	1,204	1,178	19,682
		61 has just the last three months													
10185000	ANTIMONY CREEK NEAR ANTIMONY, UT	47-48	1,002	984	1,034	1,008	924	1,032	1,518	3,474	1,317	1,006	1,013	963	14,670
		58-76													
10187300	OTTER CREEK NEAR KOOSHAREM, UT	75-82	583	530	521	500	459	538	734	1,627	1,213	793	653	582	7,923
10187500	OTTER C AB. RES. NR. ANTIMONY, UT	61-64	83	534	838	825	1,370	2,194	871	357	81	22	10	17	6,210
		71-80													
10189000	EAST FORK SEVIER RIVER NEAR KINGSTON, UT	13-84	2,279	1,608	1,385	1,366	1,444	2,362	4,622	10,082	8,956	10,300	8,284	5,058	56,962
10189001	COMBINED FLOW SEVIER R AND E FK SEVIER R	44-77	6,019	8,441	9,423	8,455	9,046	10,732	9,776	15,933	14,200	10,898	9,593	7,119	119,635
10190500	SEVIER RIVER NEAR JUNCTION, UT	11-16	391	449	507	412	441	1,001	10,067	6,774	2,971	855	513	431	24,811
10191500	SEVIER RIVER BELOW PIUTE DAM, NEAR MARYSVALE, UT	11-96	3,633	2,213	1,555	1,439	3,107	4,450	11,536	17,103	13,909	16,240	13,669	7,579	95,326
10194000	SEVIER RIVER ABOVE CLEAR CREEK, NEAR SEVIER, UT	11-16	8,314	5,363	4,087	3,608	5,641	7,499	14,576	30,218	29,215	29,584	24,063	15,671	175,084
		39-95													
10194200	CLEAR CREEK ABOVE DIVERSIONS, NEAR SEVIER, UT	57-95	815	728	661	638	749	1,393	3,267	8,283	6,559	2,427	1,116	802	25,612
10195000	"LEAR CREEK AT SEVIER, UT	12-19	400	595	807	848	872	1,319	3,245	6,412	5,268	1,417	429	232	21,70;
		41-58													
10195500	SEVIER RIVER AT SEVIER, UT	17-29	16,555	10,594	6,518	4,941	3,343	6,801	22,761	50,091	42.215	38,259	29,463	20,493	251,776
10204200	MILL CREEK NEAR GLENWOOD. UT	63-74	0	0	0	0	0	2	0	4	0	1	2	0	(
10205000	SEVIER RIVER NEAR SIGURD, UT	44-96	5,023	6,022	7,587	8,058	10,134	11,278	8,028	7,232	8,416	2,056	1,579	3,164	77.18
lo205030	SALINA CREEK NEAR EMERY, UT	64-96	616	495	441	402	362	468	898	4,177	2,813	1,071	854	684	13,28(
10205100	SHEEP CREEK NEAR SALINA, UT	58-69	5	4	4	4	3	4	9	66	90	30	10	6	23.'
10205200	WEST FORK SHEEP CREEK NEAR SALINA, UT	58-69	0	0	0	0	0	0	7	72	20	1	0	0	10

Sevier River Basin

Table 5-1 Continued - -
ANNUAL AND MONTHLY FLOWS
(acre-feet)

10205300	SHEEP CREEK AT MOUTH NEAR SALINA, UT	58-69	8	7	7	6	6	11	65	294	159	41	13	8	623
10206000	SALINA CREEK AT SALINA, UT	18,19	507	818	826	858	1,007	1,255	1,886	8,023	3,908	387	263	131	19,450
		43-55 61-95													
10206001	SEVIER RIVER BELOW SALINA CREEK NEAR SALINA, UT	44-86	5,947	7,179	8,789	9,072	11,193	12,157	10,903	17,578	13,608	2,544	2,057	3,644	101,987
10208000	SEVIER RIVER NEAR GUNNISON, UT	10-17	21,391	22,609	22,407	21,770	20,700	31,374	21,974	26,181	19,328	6,364	8,995	11,344	220,826
10215500	BIG HOLLOW AT FOUNTAIN GREEN, UT	65-68	0	0	0	0	0	22	10	0	1	4	4	1	41
10215700	OAK CREEK NEAR SPRING CITY, UT	65-74	324	275	254	230	206	228	306	1,586	2,612	990	478	357	7,615
		80-94													
10215900	MANTI CREEK BELOW DUGWAY CREEK, NEAR MANTI, UT	65-96	528	401	327	296	263	375	1,089	6,018	8,340	2,815	1,061	651	21,399
10216210	SAN PITCH RIVER NEAR STERLING, UT	65-80	263	68	406	1,205	2,544	4,919	4,499	3,744	3,739	4,504	4,037	2,636	32,564
10216400	TWELVEMILE CREEK NEAR MAYFIELD, UT	60-80	835	620	547	518	478	652	1,599	6,192	5,826	2,690	1,469	996	22,420
10217000	SEVIER RIVER BLW SAN PITCH RIVER, NR GUNNISON,UT	18-96	11,890	14,024	16,483	16,806	18,655	21,926	16,815	23,123	22,982	7,656	6,654	7,913	184,928
10219000	SEVIER RIVER NEAR JUAB, UT	12-96	3,870	1,982	2,140	3,784	3,540	7,185	17,983	45,221	36,101	33,437	22,564	10,088	185,780
10219200	CHICKEN CREEK NEAR LEVAN, UT	63-95	156	127	109	111	121	256	946	2,172	903	376	243	177	5,529
10220000	SEVIER RIVER NR MILLS, UT	14-17	20,257	13,740	3,873	3,493	3,563	9,850	27,150	53,280	46,993	37,595	32,853	29,270	261,435
10223500	SEVIER RIVER AT LEMMINGTON, UT	12-14	21,060	14,185	8,965	4,190	3,440	4,360	32,175	48,005	45,430	28,017	26,353	23,757	214,477
10224000	SEVIER RIVER NEAR LYNNDYL, UT	14-19	4,756	4,622	4,208	5,711	6,451	10,654	17,720	37,850	33,099	28,555	19,418	8,004	179,942
		43-96													
10224100	OAK CREEK ABOVE LITTLE CREEK, NEAR OAK CITY, UT	65-96	42	48	58	57	70	179	513	784	271	70	38	31	2,095
10224300	OAK CR. BELOW BIG SPRING NR OAK CITY, UT	79-86	315	292	310	371	439	1,008	2,165	3,345	1,803	696	414	335	9,099
10228000	SEVIER RIVER NEAR DELTA, UT	13-19	5,920	5,372	4,074	3,683	3,895	6,574	14,540	21,357	16,843	13,383	11,010	8,606	94,179
10231500	SEVIER RIVER AT OASIS UT	12-27	4,673	4,508	3,914	4,960	4,420	6,321	9,166	5,165	7,514	2,207	2,737	2,957	56,168
10232500	CHALK CREEK NEAR FILLMORE UT	45-71	649	620	615	621	674	1,105	3,610	7,831	3,517	1,266	829	635	21,970
10233000	MEADOW CREEK NEAR MEADOW UT	65-75	139	125	132	138	139	290	714	1,773	911	367	204	135	4,636
10233500	CORN CREEK NEAR KANOSH, UT	65-75	417	409	404	403	383	817	2,467	4,284	1,586	750	557	411	11,803

Source: U.S. Geological Survey Water Data Reports
Note: Flows are for the period of record for each gage.

Figure 5-3

ANNUAL FLOWS

Sevier River at Hatch

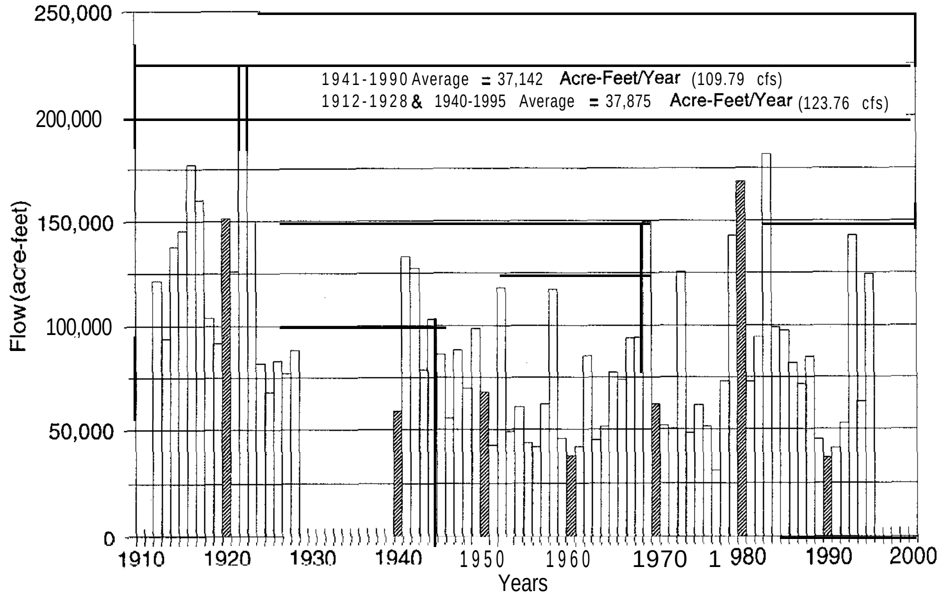


Figure 5-4

ANNUAL FLOWS

Sevier River near Kingston

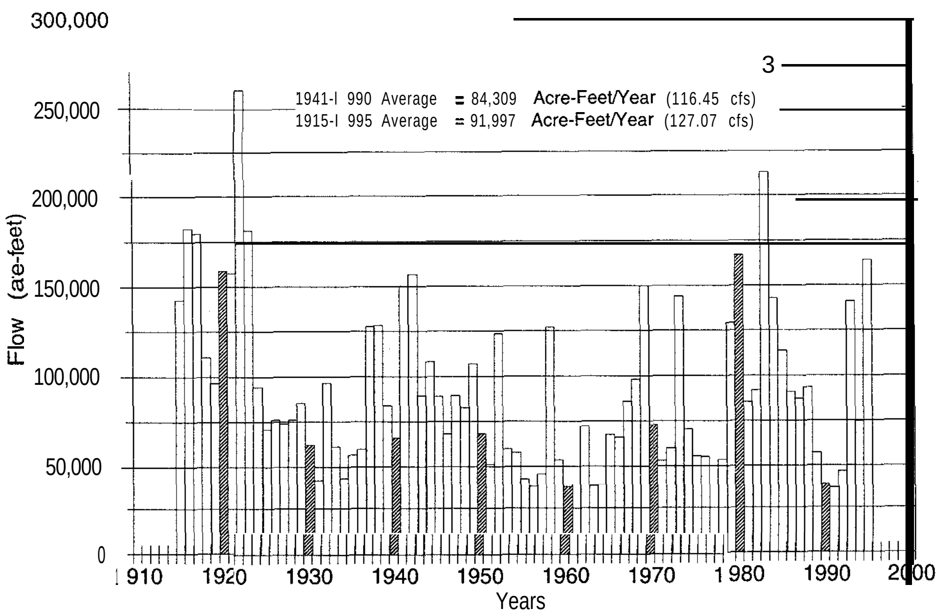


Figure 5-5

ANNUAL FLOWS

East Fork Sevier River near Kingston

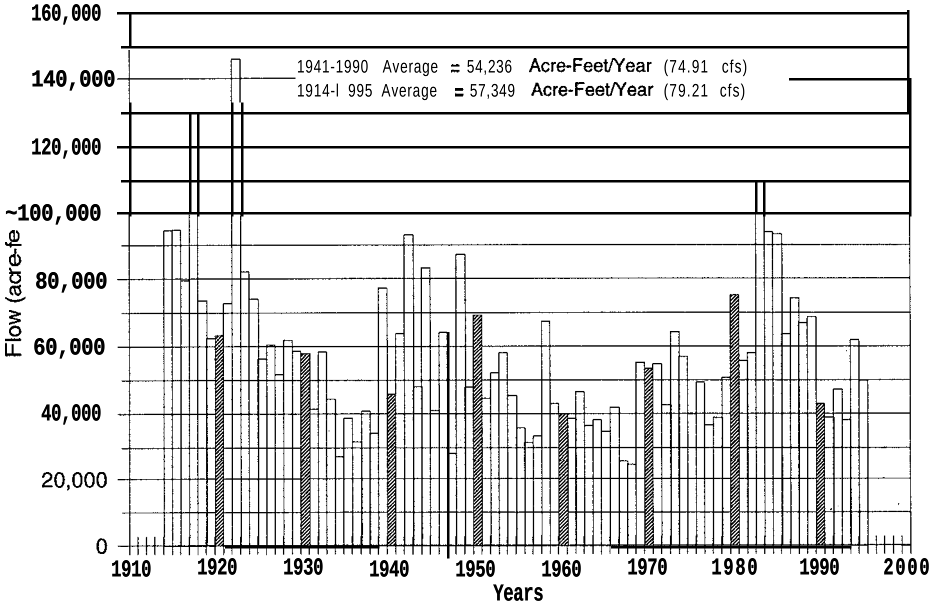


Figure 5-6

ANNUAL FLOWS

Sevier River above Clear Creek

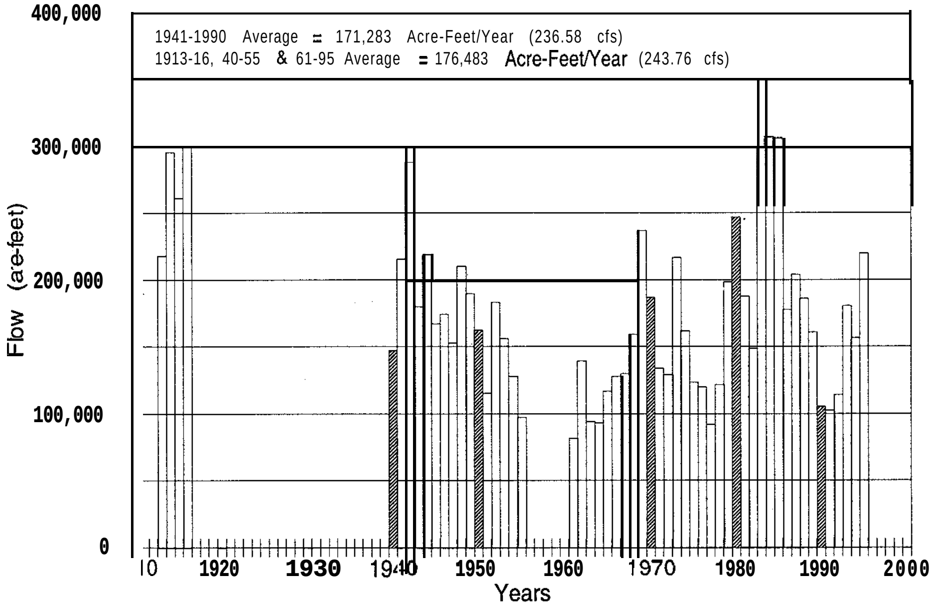


Figure 5-7

ANNUAL FLOWS

Sevier River below San Pitch River

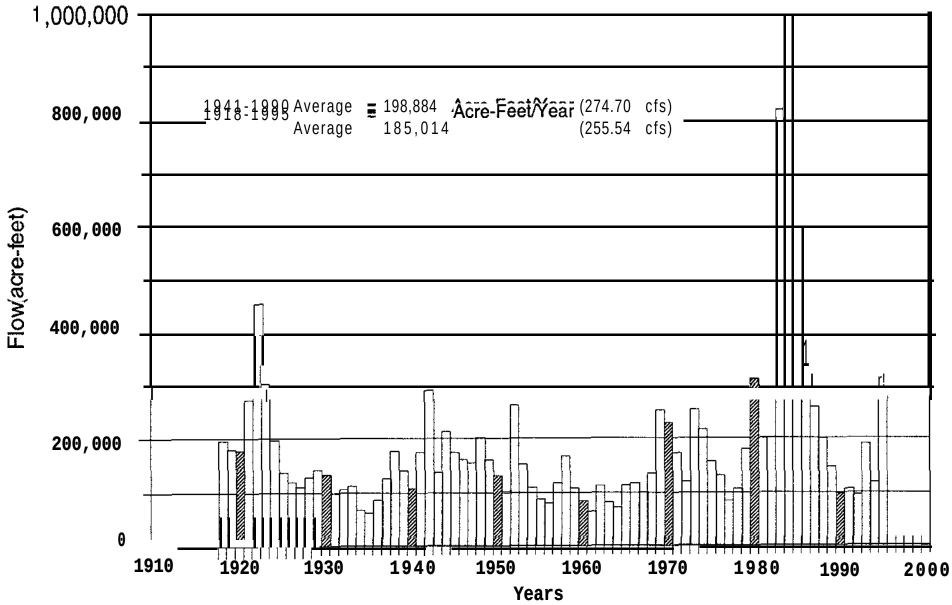


Figure 5-8

ANNUAL FLOWS

Sevier River near Juab

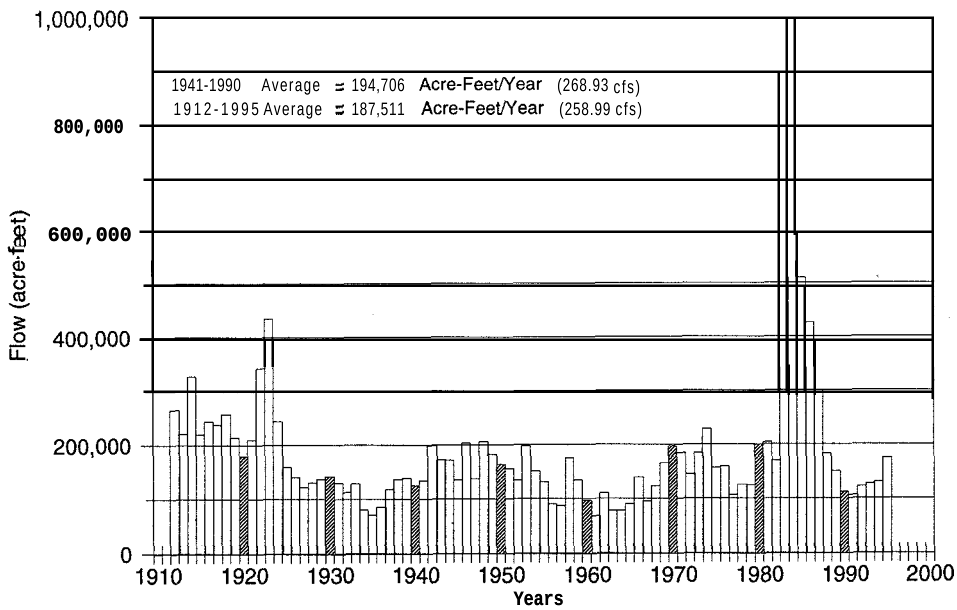


Figure 5-9
ANNUAL FLOWS
Chalk Creek near Fillmore

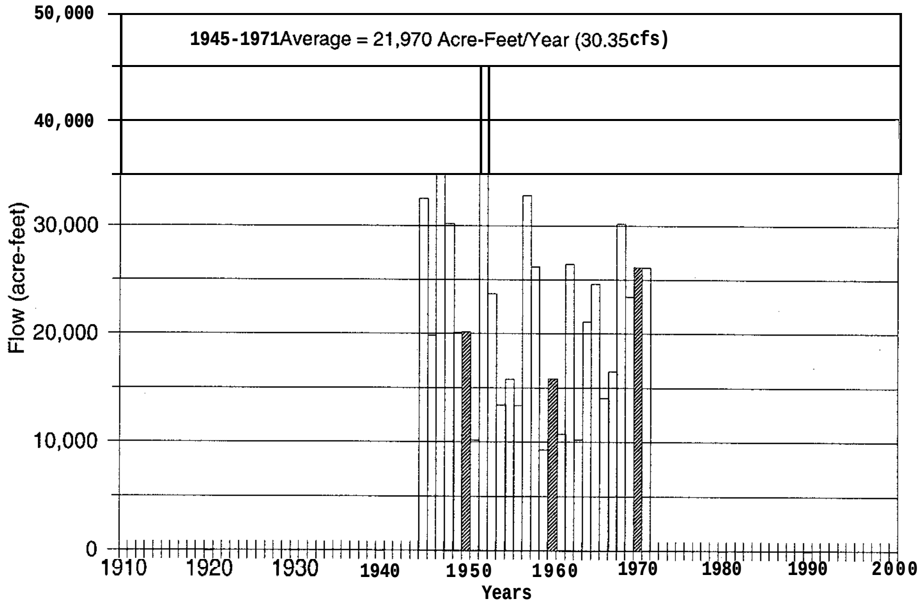


Table 5-2
PEAK FLOWS IN THE SEVIER RIVER BASIN

Station	Max (cfs)	Date	HDM[a] (cfs)	Date	LDM[b] (cfs)	Date
Hatch	1,490	5-26-22	1,340	6-02-83	21	9-08-77
Kingston	3,000	3-04-38	1,560	6-03-83	2	7-24-63
EF Kingstson	2,030	5-12-41	1,740	5-12-41	6	2-25-77
SR nr Clear Cr.	2,500	6-03-83	2,450	6-02-83	6	1-1 1-79
Gunnison	5,400	5-29-84	5,400	5-29-84	6	7-18-77
Juab	5,190	6-25-83	4,920	6-25-83	0	3-07-18
Mammoth Cr.	838	6-19-83	720	6-19-83	1	1 1-20-77
Clear Cr.	906	8-26-88	623	5-24-84	2	1-26-79
Salina Cr.	2,650	6-07-84	1,620	5-13-84	0	8-13-62
Manti Cr.	705	6-28-95	547	6-28-95	2	1-08-81
Chicken Cr.	390	8-08-81	380	6-01-83	0	12-24-90
Chalk Cr.	1,850	7-31-81	NA		3	12-12-63

a High Daily Maximum
b Low Daily Minimum
Source: USGS Surface Water Records

The dampening effect of the major reservoirs is apparent as shown by daily records of gages below and above those facilities. The exception is during extremely wet years such as 1983-84. The gage on Chalk Creek reflects a typical tributary inflow from an unregulated watershed.

Variations in runoff patterns will be different in a watershed such as Chalk Creek which is steeper and shorter (500 ft/mi) when compared to Salina Creek (150 ft/mi). Vegetation and soils also influence runoff patterns. The flows at different probability levels of the Sevier River at Hatch and near Gunnison are shown on Figures 5-10 and 5-l 1, respectively and of Chalk Creek near Fillmore on Figure 5-12.

A probability level of 90 percent means nine times in 10 the flows will be greater than the values shown. A level of 50 percent means near average conditions. The numbers are based on a log normal frequency analysis.

Most of the basin is prone to flash flooding from high-intensity, convective, summer thunderstorms. This type flooding has more impact on tributaries than on the main stem of the Sevier River.

Rapid snow-melt or rain on snow generally has more impact on main stem flows. The floods of 1983-84 were caused by a sudden increase in temperature melting a greater than normal snow pack with a moisture filled soil profile. As a result, flood flows in the Sevier River main stem continued well into the summer.

During water-budget compilation, river inflow into the area was determined from stream gauge records. Some tributary inflows (surface water yield) are ungaged. Ungaged flows were

Figure 5-10

MONTHLY STREAMFLOW PROBABILITIES

Sevier River at Hatch

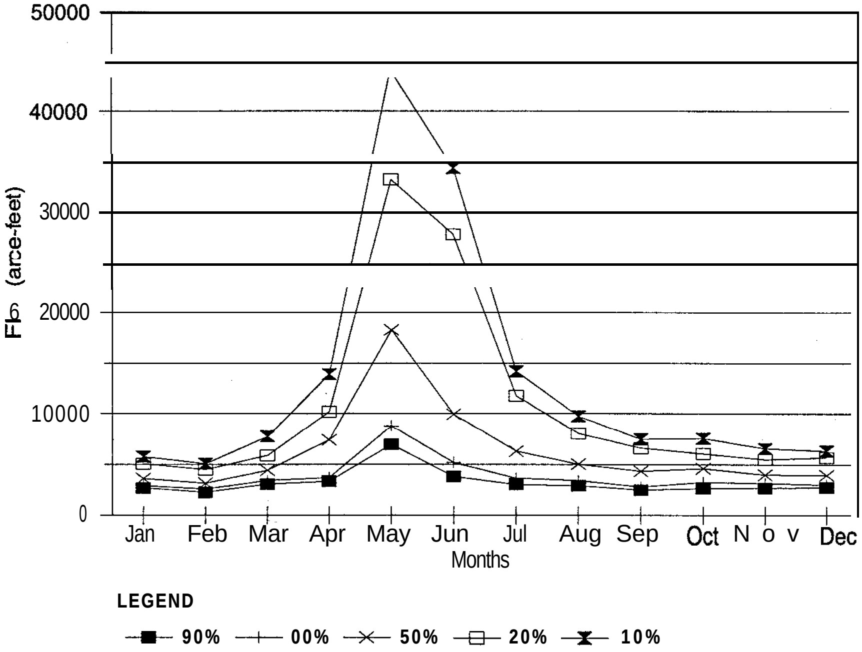


Figure 5-11

MONTHLY STREAMFLOW PROBABILITIES

Sevier River below San Pitch River near Gunnison

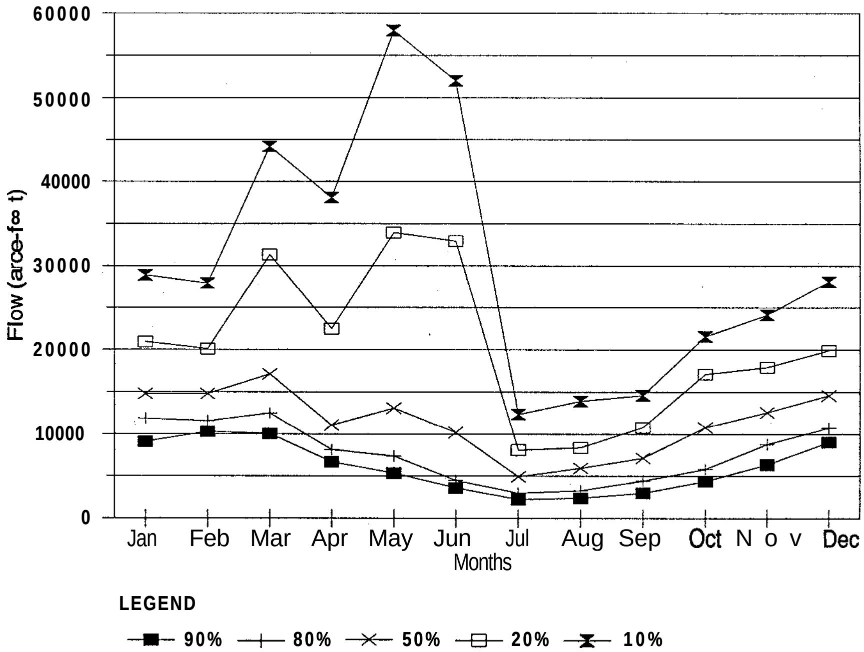
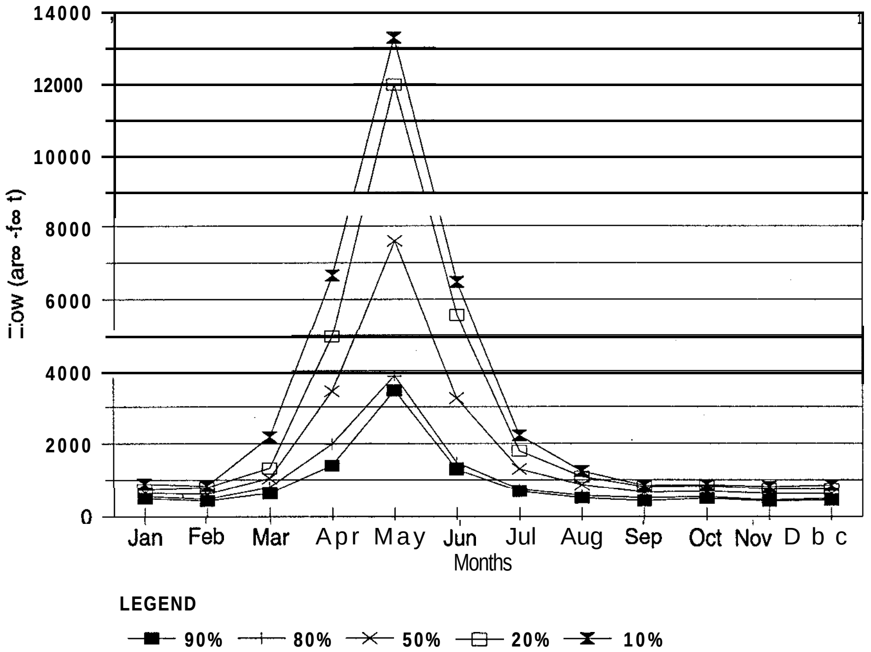


Figure 5-12
MONTHLY STREAMFLOW PROBABILITIES
Chalk Creek near Fillmore



correlated using nearby tributary gaged records. The average annual gaged river flows are shown in Table 5-1. The yield for each subarea is shown in Table 5-3.

53.2 Groundwater Supply

Groundwater is a vital part of the total water supply. This supply is utilized through wells, pumped and flowing; springs and seeps; and subsurface water which supports vegetation. Most of the groundwater supply is pumped from wells. These wells tap groundwater reservoirs located throughout the basin. See Figure 19-l.

There is substantial groundwater movement into and out of the basin. Groundwater originates on the west slope of the Gunnison Plateau in the Nephi area contributing to the spring flows in the Fountain Green-Wales area in Sanpete Valley. Groundwater from the Awapa Plateau in the Fremont River drainage supplies Antimony Spring in the East Fork of the Sevier River. There is groundwater outflow to the Colorado River drainage and to the Great Basin from the Paunsaugunt and Markagunt plateaus.[63] There is also groundwater flow from Pahvant Valley to Clear Lake Springs.[40] See Section 5.5.

Maior Springs - Many of the major springs appear above or near the edge of the water-budget area and are available for immediate diversion. The primary supply of water for diversion along the western side of Sanpete Valley and near Glenwood comes from springs. Mohlen and Blue springs are supplied by groundwater from the Scipio area and feed the Sevier River just below Yuba Dam. Data on water quality and yield from selected springs are shown in Table 5-4.

Groundwater Reservoirs - There are 18 groundwater reservoirs in the Sevier River Basin (See Figure 19-1). Most of these are along the Sevier River, each one separated from the ones upstream and downstream by relatively impermeable underground geologic restrictions. These reservoirs are recharged by water seeping from canals, the river channel, deep percolation from irrigation, precipitation and from groundwater tributary inflow.

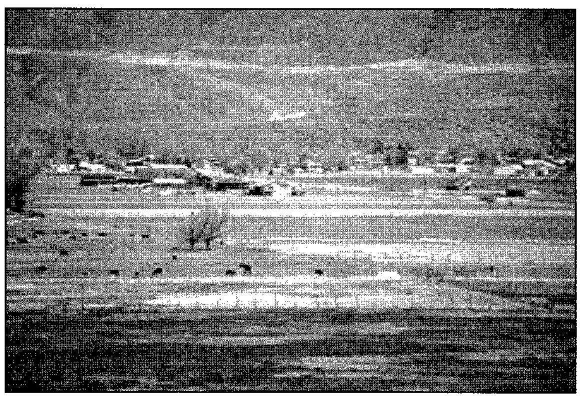
The Sevier Desert groundwater reservoir is beneath the delta formed when the Sevier River flowed into Lake Bonneville. It does not have distinct geologic boundaries like those upstream along the Sevier River. The Pahvant Valley groundwater reservoir is a southeast extension of the Sevier Desert groundwater reservoir. It contributes a small amount of groundwater flow to the Sevier Desert and supplies Clear Lake Springs. For additional information on the groundwater reservoirs refer to Section 19, Groundwater.

5.4 WATER USE

Most of the water supply is used for agricultural purposes. Other uses are for culinary, secondary and industrial purposes, commonly called municipal and industrial water; and water used by wet/open water areas.

5.4.1 Agricultural Water Use

Water diverted for agriculture is the largest use in the Sevier River Basin. The average annual amount of water diverted for cropland irrigation is 903,460 acre-feet. Of this amount, over 135,000 acre-feet are pumped from groundwater. About 40 percent of the diversions are return flows from upstream uses. The irrigated acreage and diversions to cropland reflect recent data and are not based on decreed water rights or land areas.[20] Table 5-5 shows the irrigated area and the average annual diversions for each county. See Section 10, Agricultural Water, for more information.



Agricultural land-Glenwood

Table 5-3 AVERAGE ANNUAL YIELD			
Sub-area	Inflow (acre-feet)	Sub-area	Inflow (acre-feet)
Mammoth Creek	**94,260**	San Pitch	225,060[b]
Panguitch	26,710	Gunnison	**90,550**
Otter Creek	**27,980**	Scipio-Levan	**47,450**
East Fork	51,080[a]	Delta	41,280
Piute	27,610	Fillmore	**86,880**
Marysvale	61,130	Sevier Lake	0
Richfield	**42,890**		
		Total	**822,880**

[a] Includes 4,800 acre-feet export to Tropic and East Fork Irrigation Company in Paria River Drainage.
[b] Does not include 9,345 acre-feet of transmountain diversions from Colorado River drainage.

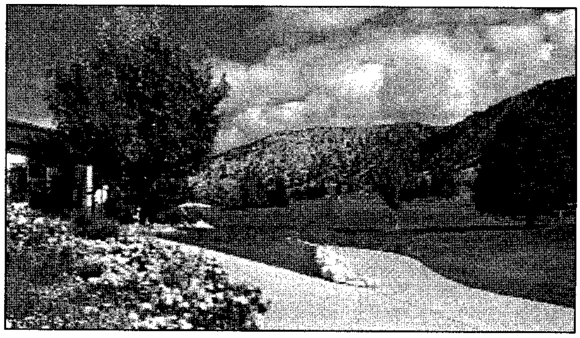
5.4.2 Municipal and Industrial Water Use

Municipal and industrial (M&I) water diversions average about 49,960 acre-feet.[18] Of this amount, industrial diversions are estimated at 26,290 acre-feet of which 1,170 acre-feet comes from public community systems. M&I water is classed as potable or non-potable. The term potable water is used interchangeably with culinary or public water supplying homes, both indoors and outdoors, parks, golf courses, school yards, and other outdoor uses. The total culinary water diverted in 1996 was 23,360 acre-feet of which 14,320 acre-feet was delivered by public water suppliers. Culinary water diversions and depletions are shown in Table 5-6. Table 1 l-3 provides more detail on culinary water use. See Section 18 for more information on industrial water use.

5.4.3. Secondary Water Use

Secondary water is of lower quality and is used to conserve culinary water. It is used to irrigate lawns and gardens, parks, cemeteries and golf courses. These systems can use water of less than culinary quality.

Secondary systems are owned and operated by cities and towns, irrigation companies and others. Secondary water use is shown in Table 5-7.



Palisade Golf Course

5.4.4 Wetland and Riparian Water Use

Most of the wetland areas inventoried in the water-budget areas are found along the main stem of the Sevier River and its major tributaries.

Table 5-4
SELECTED SPRINGS

Subbasin/Spring	Date	Specific (µS/cm)	Conductance (mmhos/cm)	Yield (gal/min)
MAMMOTH CREEK				
Blue Spring	8-62			4,500:
Duck Creek	7-89	235	(7-54) 137[ab]	(7-54) 4,200[a]
Duck Creek	8-54		(8-54) 117[ab]	(8-54) 11,200[a]
Lower Asay	10-68	400	-	13,000
Mammoth	6-89	170	-	(4-57) 900[a]
Mammoth	6-57	-	103ab	121,000[a]
PANGUITCH VALLEY				
Marshall Slough	5-62	570	-	(8-56) 1,350
Marshall Slough	6-89	360	-	-
Veater Slough	10-62	-	-	450[a]
EAST FORK SEVIER				
Deer Creek	'60s	-	300[ab]	1,640[a]
Tom Best	7-62	410	246[ab]	500
OTTER CREEK				
Burr	7-62	-	120[ab]	1,400
MARYSVALE				
Barnson	'60s	-	271[ab]	5,400
Taylor	'60s	-	-	1,800[a]
RICHFIELD				
Black Knoll	1-58	-	-	5,000[a]
Black Knoll	8-88	-	740	6,960
Cove	5-58	-	338	4,650[a]
Ford Fish Hatchery	9-59	-	-	1,400[a]
Glenwood	'50s	-	159[ab]	4,500[a]
Joseph Hot	9-57	-	7,520	100[a]
Monroe	9-57	-	4,020	40[a]
Richfield	7-57	550		(date?)1,400
Spring Hill	'50s			4,500"
SANPETE VALLEY				
Big-Fountain Green	4-89	430		3.320
Big-8 mi.E. Ephraim				('60s) 1,350"
Birch Creek	4-89	800		7

Table 5-4 Continued

SELECTED SPRINGS

Subbasin/Spring	Date	Specific Conductance (μS/cm) (mmhos/cm)		Yield (gal/min)
Birch Creek	' 60s	-	-	2,700
Nine Mile	8-64	-	-	980
GUNNISON				
Fayette	10-87	1,000	-	1,900[a]
Michaelson-Willow	5-87	920	-	(12-59)500[a]
Redmond Lake	9-68	950	-	-
Redmond Lake	8-59	-	1,530[ab]	6,000[a]
SCIPIO-TINTIC				
Blue[c]	1-63	-	607	2,730
Chase	6-63	-	1,91	(1963)1,400
Mohlen[c]	10-62	-	725	10,350
Maple Grove	7-63	-	435	-
Palmer	4-94	-	4,190[b]	430
Rosebush	6-63	-	1,320[b]	-
DELTA				
Baker Hot (N Delta)	7-79		6,080[b]	1,200
Indian (lower Cherry Cr.)	8-79	-	1,100[b]	500
Lime Kiln (Oak Creek)	10-63	-	370[b]	-
Whiskey (NW McCormick)	4-79	-	590[b]	-
FILLMORE				
Church	9-85	-	620[b]	790
Devil's Ridge	12-85		13,000[b]	135
Wild Goose	9-85		640"	1,080

[a] Data. from USDA-SCS study (1969)

[b] Milligrams per liter (mg/L)

[c] 1963 was a dry water year. During wet water years, flows from Blue and Mohlen springs combined could reach 50 cfs (22,500 gpm) or more.

Note: Unless otherwise noted, data was taken from Division of Water Rights Technical Publications 98, 102, 103, 112, 113 and 114 along with their Basic Data Open-File Reports; and from U.S. Geological Survey Water Supply Papers 1787, 1794, 1836, 1848 and 1896.

Note: See Section A for definition of μs/cm and mmhos/cm.

Table 5-5[16,20]

IRRIGATION WATER USE BY COUNTY

County	Area (acres)	Diversions (acre-feet\year)
Beaver	Neg.	Neg.
Garfield	19,630	67,850
Iron	250	1,010
Juab	21,690	25,300
Kane	200	720
Millard	134,050	294,330
Piute	22,230	66,540
Sanpete	115,030	25 1,200
Sevier	68,010	196,510
Tooele	Neg.	Neg.
Total	381,090	903,460

Note: Based on 1981-85 land use data and 1951-1980 water supply data.
No estimates were made for small acreages in Beaver and Tooele counties.

Table 5-6
CULINARY WATER PROVIDED BY PUBLIC WATER SUPPLIERS-1996[18]

County/Use	Diversions (acre-feet)	Depletions (acre-feet)
Garfield	500	200
Juab	560	200
Millard	3,730	1,490
Piute	450	140
Sanpete	3,720	1,300
Sevier	5,360	1,880
Total	**14,320**	**5,210**

Note: Based on public water supply inventory by Division of Water Resources, 1996.

They also occur near springs, reservoirs, bogs, wet meadows, lakes and ponds. Many additional wetlands are also found in the upper watersheds away from the irrigated areas. Wetlands and riparian vegetation are varied and support a large diversity of wildlife species.

The total consumptive use of water by wetlands includes precipitation. Depletion is the net use without precipitation. The water remaining after depletion by wetlands is the supply to satisfy decreed water rights. Only the wetland and open water areas within or adjacent to the irrigated cropland areas were inventoried during the land-use surveys. These wet areas, riparian vegetation strips and open water (including reservoirs) in the water-budget subareas cover 92,000 acres or 1.37 percent of the basin area. The water depleted by these areas is 262,620 acre-feet. This is shown in Table 5-8.

5.4.5 Instream Flows

Instream flows are non-consumptive and usually contribute to the quality of habitat for water-related species. Manning Creek, now owned by the Division of Wildlife Resources, is the only designated instream flow for water-related wildlife habitat in the Sevier River Basin.

Flows diverted for hydropower production often divert part or all of a stream for a short distance, sometimes reducing habitat quality. There are two hydroelectric power plants in Juab County, seven in Sanpete County and three in Sevier County. These divert water from small tributary streams for power production.[31] For more detail, see Section 18, Industrial Water.

5.4.6 Recreational Water-Related Use

Recreational water uses includes boating, water skiing, fishing and waterfowl hunting. These are all non-consumptive uses. Recreational water consumptive uses are generally for camping and picnicking. There are six state parks, two national parks, one federal recreation area, four national forests and public domain, all with campgrounds, picnic or other areas which require culinary water supplies. Four of the state parks utilize water storage reservoirs for major water sport activities. More detail is given in Section 15, Water-Related Recreation.

5.5 INTERBASIN SURFACE WATER FLOWS AND GROUNDWATER MOVEMENT

There are both surface water flows and groundwater movement into and out of the Sevier River Basin. Surface water transmountain imports are about 1.1 percent of the total tributary surface- water yield. Groundwater movement into the basin is 2.1 percent of the yield and outflow is 4.4 percent. The interbasin water flows are shown on Figure 5-13.

Table 5-7
SECONDARY WATER USE-1996[18]

System Name	Residential	Commercial	Institutional (acre-feet)	Industrial	Total	Served By
GARFIELD						
Hatch	97	0	14	0	110	Hatch Irrigation Co.
Panguitch	168	0	33	0	201	W. Panguitch Irr.(Pang.City)
Non-Community Systems	0	0	0	0	0	
Garfield County Total	265	0	47	0	311	
JUAB						
Eureka	0	0	2	0	2	City secondary well
Non-Community Systems	0	0	0	0	0	
Juab County Total	0	0	2	0	2	
MILLARD						
Delta	34	0	42	0	76	Delta Canal Co.
Deseret-Oasis SS	6	0	0	0	6	Deseret Irrigation Co.
Fillmore	461	0	4	0	465	Fillmore Water Users Assoc.
Hinckley	92	0	56	0	148	Deseret Irrigation Co.
Holden	142	0	0	0	142	Holden Irrigation Co.
Kanosh	178	0	0	0	178	Corn Creek Irrigation Co.
Leamington	6	0	4	0	10	Leamington Irrigation Co.
Lynndyl	0	0	0	0	0	None
Meadow	0	0	0	0	0	Corn Creek Irrigation Co.
Oak City	192	0	0	0	192	Oak City Irrigation
Scipio	0	0	0	0	0	Scipio Irrigation Co.
Sherwood Water Company	3	0	0	0	3	Delta Canal Co.
Non-Community Systems	0	0	0	0	0	
Millard County Total	1,114	0	106	0	1,220	
PIUTE						
Circleville	0	0	15	0	15	Circleville Irrigation Co.
Junction	81	0	12	0	93	City Creek Reservoir Irr.Co.
Kingston	7	0	8	0	15	Kingston Irrigation Water Co.
Non-Community Systems	0	0	0	0	0	
Piute County Total	88	0	35	0	123	
SANPETE						
Axtell	13	0	0	0	13	Willlow Creek Irrigation Co.
Centerfield Wtr&Imp	32	0	75	0	107	Gunnison Irrigation Co.
Ephraim	30	0	0	0	30	Ephraim Irrigation Co.
Fairview	170	0	69	0	239	Cottonwd-Gooseberry Irr.Co.

Table 5-7 Continued ..
SECONDARY WATER USE-1996

System Name	Residential	Commercial	Institutional	Industrial	Total	Served by
Fayette	14	0	0	0	14	New Fayette Irrigation System
Fountain Green	93	0	11	0	105	Fountain Green Irrigation Co.
Gunnison	215	0	65	0	280	Gunnison Irrigation Co.
Manti	570	0	118	0	688	Manti Irrigation Co.
Mayfield	57	0	19	0	76	Mayfield Irrigation Co.
Moroni	273	0	0	0	273	(1) M&M Irrg.(2) Moroni Irr.
Mt. Pleasant	782	0	86	0	868	Mt. Pleasant City
Spring City	598	0	11	0	608	Horseshoe Irrigation Co.
Sterling	72	0	24	0	96	Sterling Irrigation Co.
Wales	7	0	0	0	7	Wales Irrigation Co.
Non-Community Systems					390[a]	
Sanpete County Total	2,926	0	478	0	3,794	
SEVIER						
Annabella	83	0	12	0	95	Annabella Town
Aurora	211	0	24	1	236	Aurora Irrigation Co.
Brooklyn Tapline Co.	2	0	0	0	2	Brooklin Canal Co.
Central Valley	4	0	0	0	4	Elsinore & Richfield Canal Co.
Cove SSD	9	0	0	0	9	Clear Creek Irrigation Co.
Elsinore Town	49	0	0	0	49	Elsinore Irrigation Co.
Glenwood	73	2	2	0	77	Glenwood Irrigation Co.
Joseph	11	0	6	0	17	Joseph Irrigation co.
Koosharem	14	0	12	0	26	Koosharem Irrigation
Monroe	483	0	917	0	1,400	Monroe City
Redmond	378	0	12	0	390	Redmond Lake Irrigation Co.
Richfield	20	0	168	0	188	Richfield City & Piute Irr Co
Salina	587	0	54	0	641	Salina City
Shadow Mnt. Estes. Subdiv.	8	0	0	0	8	Private Wells
Non-Community Systems	0	0	0	0	0	
Sevier County Total	1,932	2	1,207	1	3,142	
BASIN TOTAL	6,325	2	1,875	1	8,592	

Source: Division of Water Resources-Municipal and Industrial Water Supply and Use.
[a] Palisade State Park, 300 acre-feet and Skyline Mountain Resort, 90 acre-feet.

Table 5-8 WET/OPEN WATER DEPLETIONS AND WATER SURFACE EVAPORATION[16]		
Sub-area	Wet Area Depletion (acre-feet\year)	Net Reservoir Evaporation (acre-feet\year)
Garfield	8,830	2,370
Iron	130	0
Juab	23,840	2,520
Kane	480	80
Millard	45,940	16,050
Piute	22,450	7,850
Sanpete	76,910	16,030
Sevier	38,130	1,000
Total	216,710	45,910

5.5.1 Surface Water Imports

There are 15 canals and tunnels located along the Wasatch Plateau between Fairview and Ephraim where water is imported into Sanpete Valley. The application for the first transmountain import was filed in 1914. The filing was for 6 cfs from Cottonwood Creek in the Colorado River drainage to Oak Creek near Spring City in the San Pitch River drainage.

The transmountain imports bring 9,340 acre-feet of water annually from the Price River and San Rafael river drainages to the San Pitch River drainage. They collect water from the snowpack on the eastern slopes, often using perforated corrugated metal pipe, and deliver it through tunnels or in open canals. There have been periodic disputes over these imports betweeen east slope and west slope water users.

Data for 13 of these import locations are shown in Table 5-9. Locations are shown on Figure 5-14.

5.5.2 Surface Water Exports

The Tropic and East Fork Canal is the largest surface water diversion out of the basin. In fact, the Tropic and East Fork Canal delivers the only water imported into the Colorado River Basin. This canal diverts 4,800 acre-feet of water stored in Tropic Reservoir on the East Fork of the Sevier River into the Tropic area in the Colorado River Basin. The Roy Tanner Ditch near Milburn diverts about 100 acre-feet from the San Pitch River Drainage to Indianola in the Utah Lake Basin.

5.5.3 Transbasin Groundwater Movement[63]

Its estimated there are at least 6,700 acre-feet of groundwater flowing from the west slopes of the northern Gunnison Plateau above Nephi into the Fountain Green-Wales area. This water originates as precipitation on the west slope and follows a system of joints, fractures and bedding planes along the dip of a synclinal structure (primarily Indianola conglomerate), to the spring areas at the base of the east slope.

There is some evidence that a large part of the base flow of Antimony Creek comes from the Awapa Plateau in the Fremont River drainage.

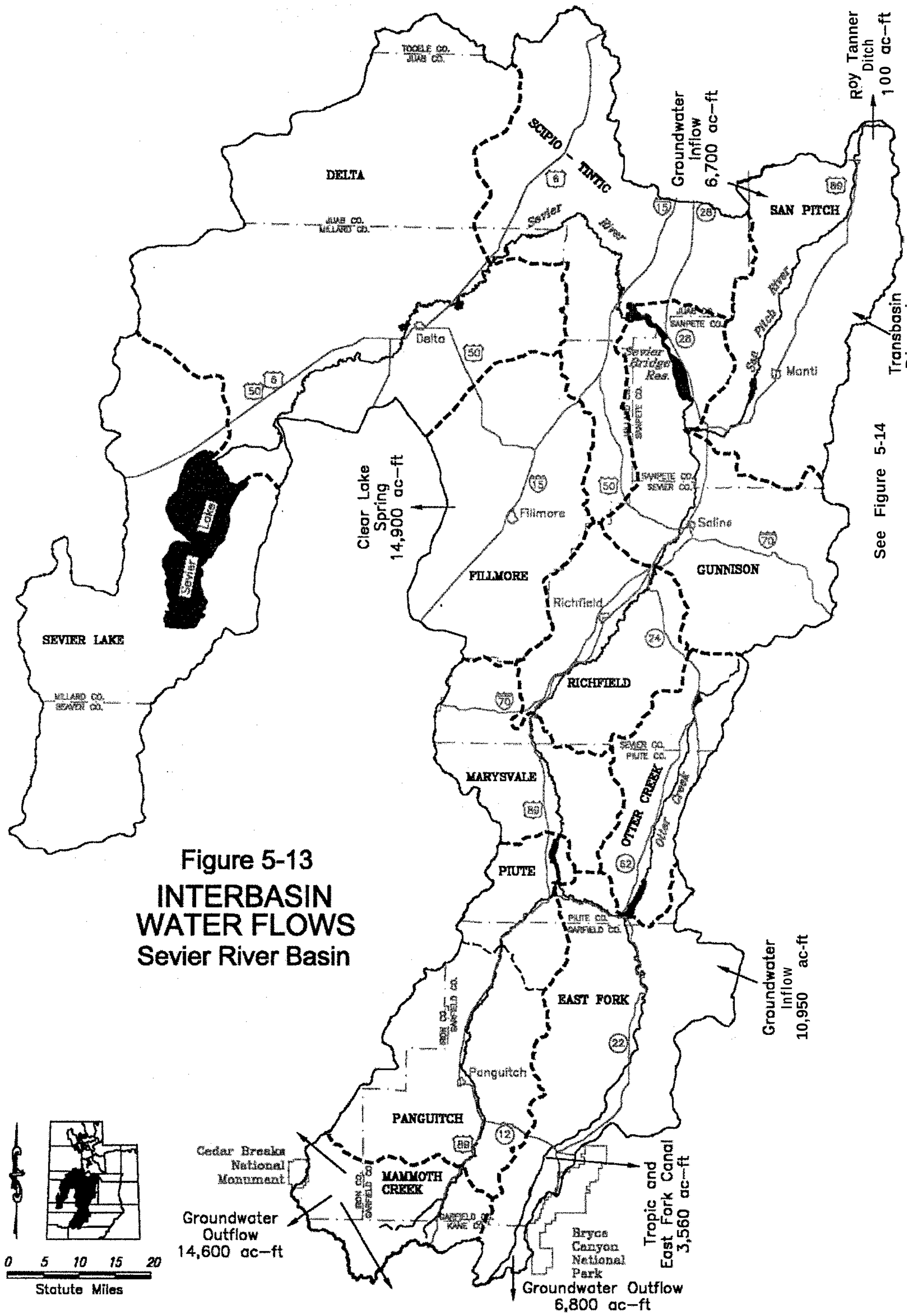


Figure 5-13
INTERBASIN WATER FLOWS
Sevier River Basin

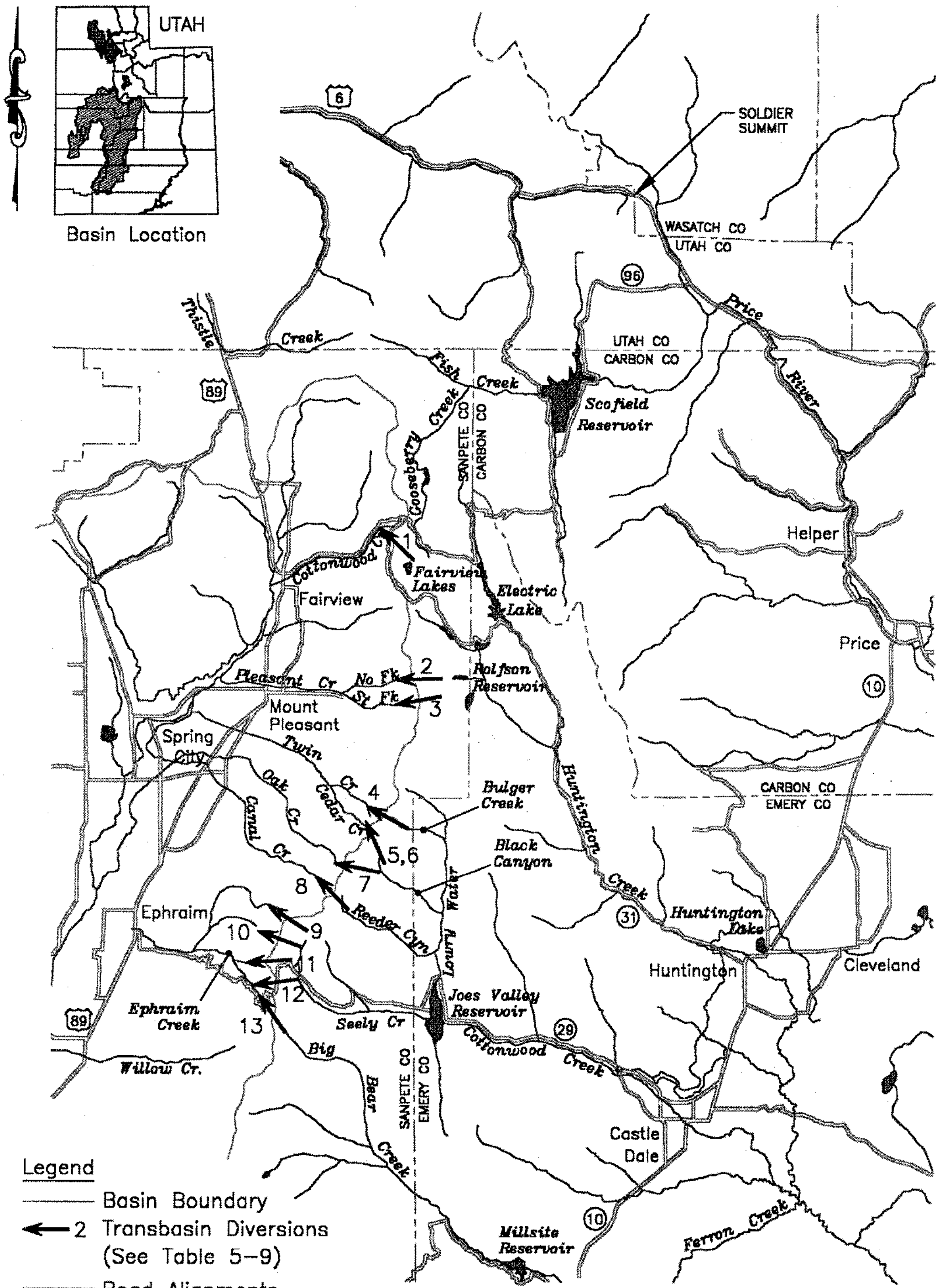


Figure **5-14**

TRANSBASIN DIVERSIONS - IMPORTS

Sevier River Basin

Table 5-9 SURFACE WATER IMPORTS		
Conveyance	Maximum Flow (cfs)	Volume (acre-feet/year)
Fair-view Lakes (Gooseberry)	NA	2,470
Candland Ditch	NA	200
Coal Fork Irrigation Co.	NA	260
Twin Creek Tunnel	NA	200
Cedar Creek Tunnel	NA	340
Black Canyon Ditch	NA	290
Spring City Tunnel	NA	1,900
Reeder Ditch	NA	250
Horseshoe Canal	NA	600
Larson Tunnel	30	690[a]
Ephraim Tunnel	NA	1,900
Madison Ditch	15	40
John August Ditch	NA	200
Total		9,340

[a] Longest transmountain diversion tunnel - 2,200 feet

Much of the constant base flow of 15 cfs or nearly 11,000 acre-feet comes from large spring areas in the upper reaches of the drainage. This much flow would require a supply outside the basin.

The upper watersheds of the southern Sevier River drainage contribute significant quantities of groundwater outflow. It has been estimated 6,800 acre-feet of groundwater from the East Fork of the Sevier River contributes to Kanab Creek-Johnson Wash flows. There is about 14,600 acre-feet of groundwater outflow from the south edges of the Markagunt Plateau (Cedar Mountain) into the Virgin River tributaries and from the west edges into the Great Basin. This groundwater outflow includes water from Navajo Lake that flows into sink holes in the lake bottom, a large part of which reappears in Cascade Spring in the North Fork of the Virgin River.

5.6 WATER QUALITY

The stream and river flows are generally of good quality in the upper reaches, but deteriorate as they flow downstream. Upstream from Richfield, concentrations of dissolved solids in the Sevier River are generally less than 300 mg/L (milligrams per liter) or 509 µS/cm (microsiemens per centimeter - a term used to report specific conductance). See Section A for definitions of water quality terms. Downstream concentrations increase, especially in the Central Sevier Valley area. The dissolved solids in Brine and Lost creeks range from 1,180 mg/L to 29,500 mg/L (2,000 µs/cm to 50,000 µS/cm). Part of the increase in dissolved solids comes from irrigation water leaching salt into the return flows but most of the increase is from geologic sources such as the Arapien shale. Sevier River water south of Redmond has dissolved solids of about 1,040 mg/L (1,763 µS/cm).

Groundwater inflow between Redmond and Sevier Bridge Reservoir contributes large quantities of dissolved solids. The tributary streams flowing into the San Pitch River are good quality.

However, the San Pitch River below Melburn was 448 mg/L (760 µS/cm) while the lower reaches below Gunnison Reservoir were about 920 mg/L (1,560 µS/cm). Late summer flows (1964) at the Juab gage were 1,590 mg/L and 1,380 mg/L near Lynndyl. Flows at Lynndyl were 1,025 mg/L in 1988. Flows in Chicken Creek were 263 mg/L (445 µS/cm) above Levan while a 1993 sample below the Chicken Creek Reservoir outlet showed 780 mg/L (1,320 µS/cm). Samples from Chicken Creek near Mills showed 4,290 mg/L (7,270 µmhos/cm) with a flow of 0.5 cfs during June 1963.

Tributary inflows measured in 1985 in Pahvant Valley are generally of good quality (240-435 mg/L or 400-700 µS/cm) but the groundwater is becoming increasingly contaminated with the dissolved solids exceeding 2,950 mg/L (5,000 µS/cm) in some locations. See Section 12, Water Quality and Section 19, Groundwater, for more information.


Good water quality is important

Section 6 Sevier River Basin MANAGEMENT

Tables

Figure

Section Six Sevier River Basin - State Water Plan

Management

Management of the Sevier River Basin water resources has evolved from fights with shovels and guns to litigation, stipulation and decrees; and recently to more cooperative efforts.

6.1 INTRODUCTION

The management of agricultural water in the Sevier River system has been controversial almost since the area was settled. Management of water in Pahvant Valley has been less contested historically, but is becoming more intense. This section describes the management of the Sevier River Basin water resources. Management of the water is carried out under the auspices of stipulations, decrees, filings and certifications presently in place. A water user may not sell, give away, waste or otherwise dispose of surplus water. This water must remain in the stream for other appropriators.

An increasing proportion of the management problems relate to domestic water use and filings. Also, there is no point "de minimus" where the effects of a change in diversions would be so small that compensation or adjustments can be ignored.

6.2 SETTING

In the Sevier River Basin, water was first managed by informal groups. Later, irrigators organized more formal groups, such as mutual irrigation companies.

Culinary water systems were established soon after settlement by communities to take care of domestic needs. They now operate under rules and guidelines established by state and federal standards administered by the Division of Drinking Water, Division of Water Quality and local boards of health.

Various means have been used to determine water rights. At one time, the tributary streams were split into fractional parts. The general practice around 1900 was to award water use by the capacity of a ditch or canal. Later, cubic feet per second became the standard practice for measurement. Regardless of the method, there were still frequent conflicts.

The regimen of streams is highly variable, not only from month to month but from year to year. It soon became apparent there was a need for reservoirs to regulate and store water for irrigation. The first reservoir constructed was Scipio Reservoir in 1860.

The next phase was inevitable. Litigation started in 1886 to determine ownership of the waters of Bill Allreds Creek, a tributary to the San Pitch River.[77] Thus early in the history of water use, the civil courts became involved to settle disputes.

A significant event occurred when the Deseret and the Learnington Irrigation companies filed litigation against all the water users up to the West View Diversion in Sevier County alleging upstream diversions were infringing on their rights. The District Court threw the case out because the alleged violations crossed a county line. This ruling was appealed to the Utah Supreme Court in 1898. They ruled "where an act committed in one county caused injury to realty in another, suit might be brought in either, and not necessarily only in that county in which the resulting injury occurs." This made it clear the broader authority of the state was needed to control the use of water. This eventually resulted in the Higgins Decree of 1901. This decree adjudicated the primary water of the Sevier River main stem from the West View Canal to Gunnison Bend Reservoir.

The Morse Decree of 1906 was instigated by the case of Richfield Irrigation Company, et al, vs. Circleville Irrigation Company, et al. This decree adjudicated all the primary waters of the Sevier River main stem from Vermillion Dam to the headwaters.

In 19 14, a plan was adopted for a cooperative study of the entire river system by the U.S.

Geological Survey and the State Engineer. The river was divided into three parts: (1) All of the river system above the confluence of the East Fork and the Sevier River (Piute Reservoir); (2) from this confluence to the Westview Canal diversion near Redmond; and (3) the remaining lower part of the river system. Each of the parts were regulated by reservoirs.

From the time this study was initiated in 1914 until the Cox Decree in 1936, distribution of most of the primary water rights of the Sevier River system was made under provisions of the Morse Decree and the Higgins Decree with stipulations made in the early 1930s. This left about 22 miles between the Vermillion Diversion and the West View Diversion without a decree. The only diversion in this reach was at the Rocky Ford Reservoir so essentially the entire river was covered.

Richland Irrigation Company requested adjudication of its rights on the lower Sevier River system in 1916. Before this could be done, the State Engineer, George M. Bacon, instigated a study to determine the factual situation of all the water rights along the Sevier River System. Bacon's fact finding study was completed in 1926 and is commonly known as "Bacon's Bible."' Bacon's Bible lists the acreage under each right so the beneficial use could be recommended.

By this time, there had been over 40 court decrees rendered on suits concerning water rights on the Sevier River System. As part of and prior to the time the final determination was completed, water users along the Sevier River and its tributaries had filed claims regarding their water rights in the Fifth Judicial District Court at Fillmore.

In the spring of 1926, priorities of Piute and Sevier Bridge reservoirs were brought to trial in the Fourth Judicial District. The participants in this case exceeded the capacity of the court room in Fillmore, so the trial was moved to the House of Representatives Chambers in the State Capitol building at Salt Lake City. The cost of litigating the case to this point was about $350,000 and the documents filled a pickup truck. The decision awarded the owners of Sevier Bridge Reservoir a first priority for storage water of 89,280 acre-feet against Piute Reservoir. The time and expense expended for this one determination indicated the need to expedite the settlement on the remaining 700-800 claims on the river.

Later on, two committees were formed; one on the upper Sevier River and one on the lower; each working independent of the other. In addition, another committee was appointed to work out the rights between Piute Reservoir and Sevier Bridge Reservoir. The outcome of the latter committee awarded the rights shown in Table 6-1.

The first two committees only made minor changes in the Higgins and Morse decrees. Under the Morse Decree, the A to L users (a designated group of water rights in Sevier Valley above Vet-million Dam) were awarded year-round rights. These users, except for Monroe South Bend Irrigation Company and Vet-million Irrigation Company, gave up their winter rights for storage in Piute Reservoir. During this process, the Millard County rights were decreased and the Sanpete County rights were increased.

These events led to a final determination of water rights on the Sevier River system. On November 30, 1936, Judge LeRoy Cox signed what is now known as the "Cox Decree." [13]

This decree divided the river system into two distribution zones with the exception of storage rights in the Piute Reservoir and the Sevier Bridge Reservoir. Zone "A" includes the river and tributaries above and including the Vermillion Canal Company diversion dam just east of Richfield. Zone "B" includes all rights from the Sevier River and tributaries below the Vermillion Canal Company diversion dam.

The decree also states that all rights provided for the use of waters of the Sevier River System in Zone A and Zone B shall be, so far as zones are concerned, independent of each other. All rights, except for storage rights in Sevier Bridge and Piute reservoirs, to be diverted in Zone A being primary to and shall have priority over all rights in Zone B. Beneficial use shall be the basis, the measure and the limitation of all rights.

Table 6-l PIUTE RESERVOIR/SEVIER BRIDGE RESERVOIR WATER RIGHTS		
Priority	Storage Right (acre-feet)	Reservoir
1st	89,280	Sevier Bridge Reservoir
2nd	40,000	Piute Reservoir
3rd	75% or 32,000	Sevier Bridge Reservoir
4th	25% of 32,000	Piute Reservoir
5th	13,720	Sevier Bridge Reservoir
5th	75% of 75,000	Sevier Bridge Reservoir
5th	25% of 75,000	Piute Reservoir
6th	85% of balance	Sevier Bridge Reservoir
6th	15 % of balance	Piute Reservoir

Note: If there is sufficient water, both reservoirs could be filled simultaneously.

An agreement was made in 1938 making changes regarding the stipulated rights of the owners of Sevier Bridge Reservoir and the Piute Reservoir and Irrigation Company. The 1938 Agreement encouraged the release of storage water due Sevier Bridge Reservoir from Piute Reservoir after January 1 instead of later in the season. In order to reduce the large transmission losses without jeopardizing the receipt and use of water allocated under the Cox Decree to the Piute Reservoir and Irrigation Company, an estimation by the Sevier River Commissioners of the storage water accretion between Piute Reservoir and Sevier Bridge Reservoir is required. In the event the estimation results in the release of storage water belonging to Piute Reservoir that could have been retained by Piute Reservoir, the excess release less annual losses would be the first water captured by Piute Reservoir in the next succeeding year.

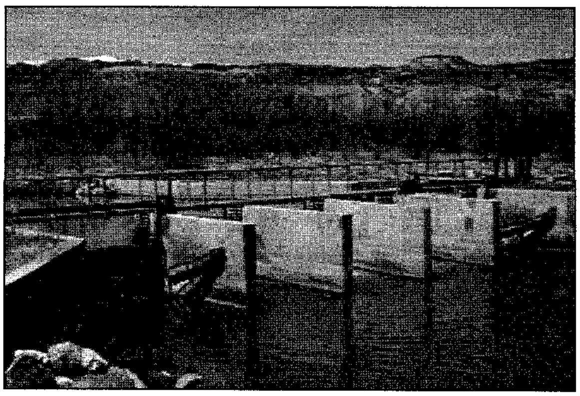
Piute Reservoir and Irrigation Company is the owner of approximately 1,200 shares of Deseret Irrigation Company water stock. If the water cannot be exchanged in the year accumulated, this water, less losses, can be held in Sevier Bridge Reservoir to be exchanged in the next succeeding year. The 1938 Agreement provided for the exchange of these and other Zone B waters.

The first and most important item of the 1938 Agreement was the modification of the Four Party Contract of 1913. The wasteful practice of allocating the first 104,000 acre-feet of the annual water supply to each of the owners of Sevier Bridge Reservoir and consequently to each of the irrigation companies' stockholders on a "use or lose" basis was changed. This change allowed each stockholder in the five irrigation companies owning Sevier Bridge Reservoir to holdover and manage his allocated water from year to year. This practice yields the most beneficial use of the ownership of water stock shares.

During the 1940s, there was increased interest by the water users in Panguitch Valley to rebuild the Hatch Town Dam and Reservoir. There were 23 water users who submitted applications to the State Engineer for a change in place of diversion and use. On protest of the water users below Kingston measuring station, the State Engineer rejected all applications. This decision was appealed to the district court where the State Engineer's ruling was reversed. This decision was appealed to the Supreme Court of Utah. The Supreme Court ruled that the applications must be granted based on the water savings measures proposed under the following conditions: The amount and quantity of water flowing at the Kingston measuring station on each and every day of every year operating under such changes must be maintained the same as it would have been had the operations continued under the old system without the changes being made. The ruling came on May 28, 1954. In effect, this killed reconstruction of Hatch Town Dam at this time. (East Bench Irrigation Co. V. Deseret Irrigation Co., 2 Utah 2d 170,271 P.2d 449: Utah 1954).

As time passed, one thing became evident. Much of the water diverted for irrigation would show up downstream as return flow to the river. Even below dry dams, the river soon starts to flow again downstream, at times to near prediversion levels. This phenomenon has also complicated the management of the water rights. For instance, when an irrigation water right is transferred to another subbasin, only the depletion part can be moved and the irrigated lands under the water right must be abandoned if existing water rights are to remain unimpaired.

The irrigation practices have created a somewhat predictable diversion-return flow pattern to the point it has become manageable, but proposed use changes still invoke controversy. Battles over the management of the water resources continue to this day, although they are less intense. They will probably continue into the future at some level.



Vermillion Dam divides Zones A and B

6.3 MANAGEMENT ENTITIES AND SYSTEMS

The Sevier River Water Users Association, Inc. is an organization representing irrigation water companies along the Sevier River main stem. The association is composed of a president, a board of directors and a secretary. The two river commissioners, one for Zone A and one for Zone B, are recommended for appointment and paid by the water users but are employees of the State Engineer. The association also communicates water users concerns to the commissioners and the Division of Water Rights.

The Upper San Pitch River Distribution System covers the area down to the grade crossing east of Ephraim. The Lower San Pitch River Distribution System covers the lower part of the San Pitch River system from the Ephraim-Olsen Dam to its confluence with the Sevier River. Water rights are administered by an upper and lower river commissioner recommended for appointment and paid by the water users but who are employees of the State Engineer. The water users in the upper and lower San Pitch River are organized and function similar to the Sevier River water users organization.

There is no organization representing the water users in Pahvant Valley. Pahvant Valley does not have a river commissioner to regulate the diversion of tributary water to the irrigation companies and systems so each irrigation company hires a water master to divide and regulate the water. Some systems divide water among shareholders according to the number of shares they own and the flow available. During high flows, water is divided into two or more streams. Water is delivered on turns in rotation.

The Central Utah Water Conservancy District was established March 2, 1964 and covered seven counties in north central Utah. Garfield, Piute, Sevier, Sanpete and Millard counties in the Sevier River system petitioned to join the district in early 1967. This was approved by the district board in May 1967 and ratified by the Fourth Judicial Court in June 1967. In 1993, Millard and Sevier counties petitioned to withdraw from the district in accordance with Section 206 (a) of the Central Utah Project Completion Act. The Central Utah Water Conservancy District Board approved the Millard County petition June 15, 1994 and the Sevier County petition September 21, 1994. The Central Utah Project Completion Act specifically excluded importing any project water into the Sevier River Basin. There is now the problem of how to assist the remaining counties.

The Sanpete County Water Conservancy District, Millard County Water Conservancy District, Kane County Water Conservancy District and Eastern Iron County Water Conservancy District cover all or part of their respective counties. The Upper Sevier River Water Conservancy District serves the upper Sevier River area.

Unorganized groups and individuals also have water rights and serve their own area. There are also municipalities and local culinary water systems with management responsibilities. The final discussions regarding use of a water right rests with the entity retaining ownership.

6.3.1 Agricultural Water Management

Agricultural water management is carried out primarily by mutual irrigation companies at the local level. These companies operate canal distribution systems and storage reservoirs, either separately or jointly. Table 6-2 presents data on existing lakes and reservoirs. Larger lakes and reservoirs are shown on Figure 6-l. Flood control structures with a high-hazard safety rating are also shown. See Table 7-l for data on high-hazard dams. Many additional sites have been investigated over the years. Some of these sites are shown for information purposes in Table 6-3.

The river commissioners are responsible for regulating diversions according to established water rights. The mutual irrigation companies are responsible for managing their water after it enters the canal systems. Water masters are hired by the companies to make sure the water is delivered and used according to company policy.

Many of the irrigation companies also deliver secondary water to cities and towns for lawn and garden use. Some of these are open ditch systems although many are converting to pipelines as the demand and need increases. This gives the companies better control as well as safety and conservation benefits.

The irrigation companies serving areas larger than 1,000 acres are listed in Table 6-4 and are shown on Figure 6-2. There are about 103 companies serving areas smaller than 1,000 acres. These areas are served by mutual irrigation companies, water user groups, associations or individuals.

6.3.2 Municipal and Industrial Water Management

Most of the municipal and industrial water is managed by cities and towns, usually through their public works staff or volunteer members of the community. These water systems are described in Section 11, Drinking Water.

There are a few industries that operate their own systems. These are discussed in Section 18, Industrial Water.

6.3.3 Waterfowl Management Areas

There are two waterfowl management areas in the Sevier River Basin. One is the Manti Meadows Wildlife Management Area located west of Manti on the San Pitch River covering about 480 acres. The other is the Topaz Slough northwest of Delta.

6.4 PROBLEMS AND NEEDS

Many of the management problems are the inability to deliver water to the headgate in an efficient and timely manner. Long travel times between reservoir releases and arrival at canal diversions is inefficient and can waste water. Manual control of diversion facilities makes it difficult to respond to changes in stream flow in a timely manner.

Table 6-2
EXISTING LAKES AND RESERVOIRS

Subbasin/Name	County	Owner	Source Stream	Capacity (acre-feet)	Area (acres)	Use”	Data Source[b]
PANGUITCH VALLEY							
Navajo Lake	Kane	Sevier River System		14,220	730	IR,RE	WSP 920
Panguitch Lake	Garfield	W Pang Irr & Res Co	Panguitch Cr	23,730	1,248	IR,RE	WSP 920
Dog Valley	Garfield	Unknown	Eckard Can Cr	430	175	IR	WSP 920
EAST FORK SEWER							
Booby Hole	Sevier	King Ranch	Booby Hole Cr	483	48	IR	WSP 920
Koosharem	Sevier	Koosharem Irr Co	Otter Cr	3,858	340	IR	WSP 920
Lower Box Creek	Piute	Beaver Cr Irr Co	Box Cr	231	21	IR	SE
Otter Creek	Piute	Otter Cr Res Co	Otter Cr	52,662	2,520	IR	SRBI Topog
Pacer Lake	Garfield	Jensen & Duncan	Center Cr	108	27	IR,RE	
Pine Creek	Garfield	Div Wildlife Resources	Pine Cr	1,808	77	RE	WSP 920 & DWR
Pollywog Lake	Garfield	Bench Irr Co	Antelope Sp	500	30	IR	
Tropic	Garfield	Tropic & E Fork lrr Co	E Fork Sevier R	1,850	170	IR,RE	SE
Upper Box Creek	Piute	Beaver Cr Irr Co	Box Cr	1,401	62	IR	SRBI
JUNCTION - MARYSVALE							
Barney lake	Piute	Dry Cr Irr Co	Doxford Cr	172	19	IR	
Manning Meadow	Piute	Div Wildlife Resources	Manning Cr	1,000	50	RE	
Piute	Piute	Piute res & Irr Co	Sevier river	71,826	2,508	RE	SRBI Topog
SEVIER VALLEY							
Annabella	Sevier	Cottonwood Irr Co	Cottonwood Cr	230	19	IR	FS Topog
Big Lake	Sevier	Glenwood Irr Co	Water Cr	950	123	IR,RE	CNI
Deep Lake	Sevier	Cottonwood Irr Co	Cottonwood Cr	290	29	IR	CNI
Farnsworth Lake	Sevier	John Jorgeson	Gooseberry Cr	100	12	IR	CNI & WSP 920
Lost Creek	Sevier	Lost Cr Irr Co	Lost Cr	400	20	IR	SRBI
Magelby	Sevier	John Magelby	Monroe Cr	510	14	IR,RE	
M.C.-S.F. DB	Sevier	Glenwood Town	Mill Canyon	200	20	F	SRBI
Redmond Lake	Sevier	Redmond Irr Co	Redmond Springs	1,080	160	IR,RE	SRBI
Rex Reservoir	Sevier	Lost Cr Irr Co	Lost Cr(off str)	975	46	IR,RE	CNI
Rocky Ford	Sevier	Rocky Ford Canal Co	Sevier River	1,700	180	IR	SE
Skutumpah	Sevier	Salina Cr Irr Co	Skutulmpah Cr	1,360	40	IR,RE	SRBI Topog
Soldier Canyon	Sevier	Sevier County	Soldier Canyon			F	SRBI
Three Creeks	Sevier	Sevier Valley Canal Co	Three Crks	1,000	160	IR	WSP 920
Willow Creek	Sanpete	Willow Cr Irr Co	Willow Cr	988	138	IR	CNI & SCS

Table 6-2 Continued ..

Subbasin/Name	County	Owner	Source Stream	Capacity (acre-feet)	Area (acres)	Use	Data Source
SANPETE VALLEY							
Chester Ponds	Sanpete	Chester Irr Co	Oak Creek	550	130	IR	CNI
Fairview Lake	Sanpete	Cottonwood Irr Co	Gooseberry Cr	2,180	80	IR	CNI
Gunnison	Sanpete	Gunnison Irr Co	San Pitch River	20,264	1,287	IR	L
Nine Mile	Sanpete	Gunnison Irr Co	Nine Mile Cr	3,500	213 10,905	RE	WSP 920
Sevier Bridge	Juab	Consol Sevier Br Co	Sevier River	236,145	66	IR	SRBI Topog
Palisades	Sanpete	Manti Irr & Res Co	Six Mile Cr	780	18	IR	SE
Twin Lake	Sanpete	Mayfield Irr Co	Twelve Mile Cr	175	600	IR	WSP 920
Wales	Sanpete	Silver Cr Res Co	Silver Cr	1,450		IR	CNI
SCIPIO-LEVAN							
Chicken Creek	Juab	Juab Lake Irr Co	Chicken Cr	1,500	510	IR	SRBI WSP 920
Scipio Lake	Millard	Scipio Irr Co	Ivie Cr	7,600	1,190	IR	SRBI
DELTA							
DMAD	Millard	DMAD Companies	Sevier River	10,991	1,199	IR	L
Fool Creek #1	Millard	Central Utah Water Co	Fool Cr/Sevier R	17,781	1,200	IR	SRBI WSP 920
Fool Creek #2	Millard	Central Utah Water Co	Fool Cr/Sevier R	5,217	650	IR	SRBI WSP 920
Gunnision Bend	Millard	Abraham Irr Co &	Sevier River	5,000	706	IR	SE
Sevier Lake	Millard	Public Domanin & State Lands	Sevier River	Limited	only by	supply	CNI
Dutchman	Beaver	Unknown	Wah Wah Sp	220	63	IR	CNI
PAHVANT VALLEY							
Meadow Creek DB	Millard	Meadow Cr Irr Co	Meadow Cr	100	10	IR, F	scs
Corn Creek DB	Millard	Corn Cr Irr Co	Corn Cr	89	22	IR, F	SE

a IR- Irrigation, RE - Recreation, F - Flood Control, S - Stockwater
b WSP - Water Supply Paper, SRBI - USDA Sevier River Basin Investigation, FS - Forest Service, CNI - Conservation Needs Inventory, SCS - Soil Conservation Service, SE - State Engineer, L - Local

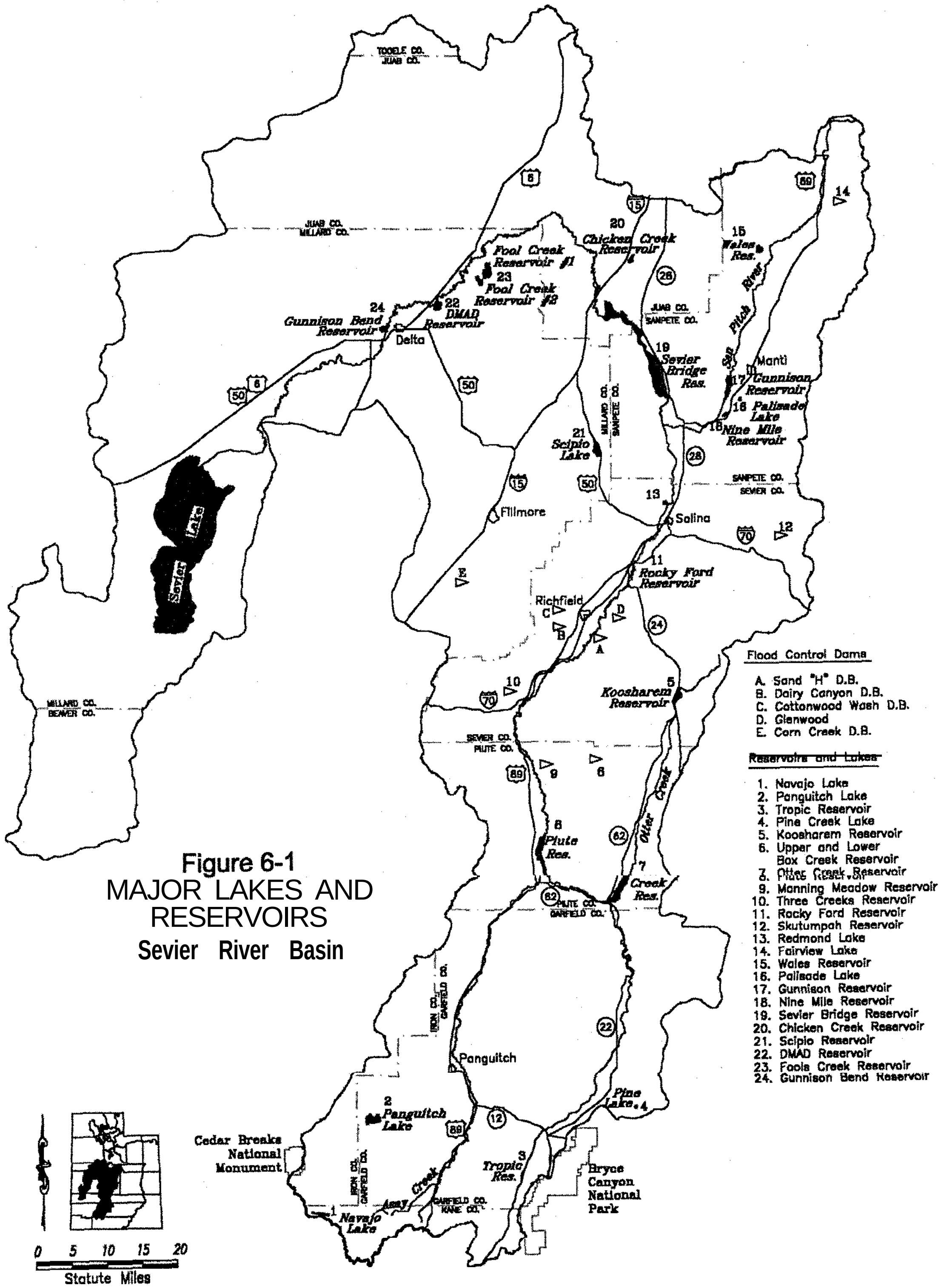


Figure 6-1
MAJOR LAKES AND RESERVOIRS
Sevier River Basin

Table 6-3[17]
SELECTED POTENTIAL RESERVOIR SITES

County/Name	Stream	Capacity (acre-feet)	Surface Area (acres)
Garfield			
Circleville Canyon	Sevier River	4,000	200
Hatchtown	Sevier River	21,200	630
West Panguitch	Panguitch Creek	500	34
Juab			
Chicken Creek	Chicken Creek	455	50
Millard			
Chalk Creek	Chalk Creek	7,400	150
Corn Creek	Corn Creek	4,000	140
Sanpete			
Blue Meadow	Six Mile Creek	1,100	50
Dairy Dam	Highland Canal	150	20
Narrows	Gooseberry Creek	14,500	600

Source: Unpublished report by Division of Water Resources.
Note: These sites have been investigated by various entities over a period of many years. Their listing does not indicate construction is anticipated. This is for information purposes only.

This points out the need for real-time monitoring and control facilities to reduce loss of water to individual irrigation companies.

Inefficient on-farm management of water reduces crop production through poor distribution, causing some areas to be short of water while others receive too much. Over-irrigation can erode the soil and transport sediment downstream. Deep percolation of water beyond the root zone leaches salts out of the soil and into the groundwater, reducing its quality.

Hatch Town Reservoir has been considered for storage of water for recreation, water quality and irrigation. Construction of this reservoir would require transfer of water rights, probably from Panguitch Valley, in order to alleviate any downstream impact. Winter water rights would have to be passed through since they are part of the storage rights in Piute and Sevier Bridge reservoirs.

There is a need for storage on both Chalk Creek near Fillmore and Corn Creek near Kanosh. These sites have been studied to various degrees. These reservoirs could regulate peak flows for later use.

There are other needs for reservoirs throughout the system. These would be regulatory rather than long-term storage. West Panguitch Reservoir on Panguitch Creek just

Table 6-4
MAJOR IRRIGATION WATER COMPANIES

Subbasin/Company	Service Area (acres)	County
Panguitch Valley		
Hatch Irr Co	1,010	Garfield
Long Canal & E Bench Irr Co	2,460	Garfield
East Panguitch Irr Co	1,260	Garfield
West Panguitch Irr Co	4,350	Garfield
East Fork Sevier		
Bench Irr Co	1,000	Garfield
Coyote and East Fork Irr Co	1,400	Garfield-Piute
Koosharem Irr Co	2,420	Sevier-Piute
Box Creek Irr Co	2,110	Piute
Kingston Irr Co	1,090	Piute
Circleville-Matysvale		
Circleville Irr Co (3 canals)	4,230	Piute
Bullion Creek Irr Co	1,310	Piute
Sevier Valley		
Joseph Irr Co	1,400	Sevier
Sevier Valley Canal Co	4,280	Sevier
Piute Res & Irr Co	14,000	Sevier-Sanpete
Monroe-South Bend Irr Co	2,630	Sevier
Monroe Irr Co	2,910	Sevier
Brooklyn Irr Co	1,060	Sevier
Annabella Irr Co	2,280	Sevier
Elsinore Irr Co	1,200	Sevier
Richfield Canal Company	8,410	Sevier
Cove River Irr Co	1,060	Sevier
Vermillion Irr Co	4,290	Sevier
Cedar Ridge Irr Co	2,230	Sevier
Willow Bend Irr Co	1,680	Sevier
Rocky Ford Canal Co	3,230	Sevier
Lost Creek Irr Co	2,000	Sevier
Gooseberry Creek Irr Co	1,060	Sevier
Salina Creek Irr Co	2,050	Sevier
Redmond Lake Irr Co	1,280	Sevier
West View Irr Co	1,610	Sevier
Willow Creek Irr Co	1,230	Sevier
Dover Irr Co	2,050	Sanpete
Gunnison-Fayette Irr Co	3,120	Sanpete

Table 6-4 Continued - -
MAJOR IRRIGATION COMPANIES

Subbasin/Company	Service Area (acres)	County
Sanpete Valley		
Birch Creek Irr Co	1,300	Sanpete
Gooseberry-Cottonwood Irr Co	1,360	Sanpete
Moroni-Mt Pleasant (M&M) Irr Co	3,510	Sanpete
North Creek Irr Co	1,850	Sanpete
Pleasant Creek Irr Co	1,810	Sanpete
Pleasant Creek Highland Irr Co	1,820	Sanpete
Moroni Irr Co	2,190	Sanpete
Silver Creek Irr Co	1,190	Sanpete
Twin Creek Irr Co	2,120	Sanpete
West Point Irr Co	2,000	Sanpete
Cedar & Twin Creek Sloughs	1,100	Sanpete
Horseshoe Irr Co	4,640	Sanpete
Fountain Green Irr Co	3,290	Sanpete
Ephraim Irr Co	5,350	Sanpete
Ephraim-Willow Cr Irr Co	1,630	Sanpete
Manti-Willow Creek Irr Co	1,350	Sanpete
Island Irr Co	4,820	Sanpete
Rock Dam Irr Co	1,450	Sanpete
Sanpitch River Drainage Dist	2,700	Sanpete
Manti Irr Co	5,200	Sanpete
North Six Mile Irr Co	1,270	Sanpete
Sterling Irr co	1,180	Sanpete
Mayfield Irr Co	3,000	Sanpete
Gunnison Irr Co	13,570	Sanpete
Scipio-Levan		
Levan Irr Co	2,930	Juab
Scipio Irr Co	4,950	Millard
Central Utah Canal	4,680	Millard
Learnington Irr Co	1,180	Millard
McIntyre Investment Co	1,100	Millard
Delta		
Fool Creek Irr Co	1,040	Millard
Oak Creek Irr Co	1,830	Millard
Delta Canal Co	24,230	Millard
Melville Irr Co	10,800	Millard
Deseret Irr Co	22,470	Millard
Abraham Irr Co	13,200	Millard
Pahvant Valley		
Holden Irr Co	1,280	Millard
Chalk Creek Irr Co	3,200	Millard
Pine Creek Irr Co	1,100	Millard
Meadow Irr Co	4,350	Millard
Corn Creek Irr Co	4,000	Millard

Note: Acreages are taken from various surveys and may not agree with adjudicated areas.

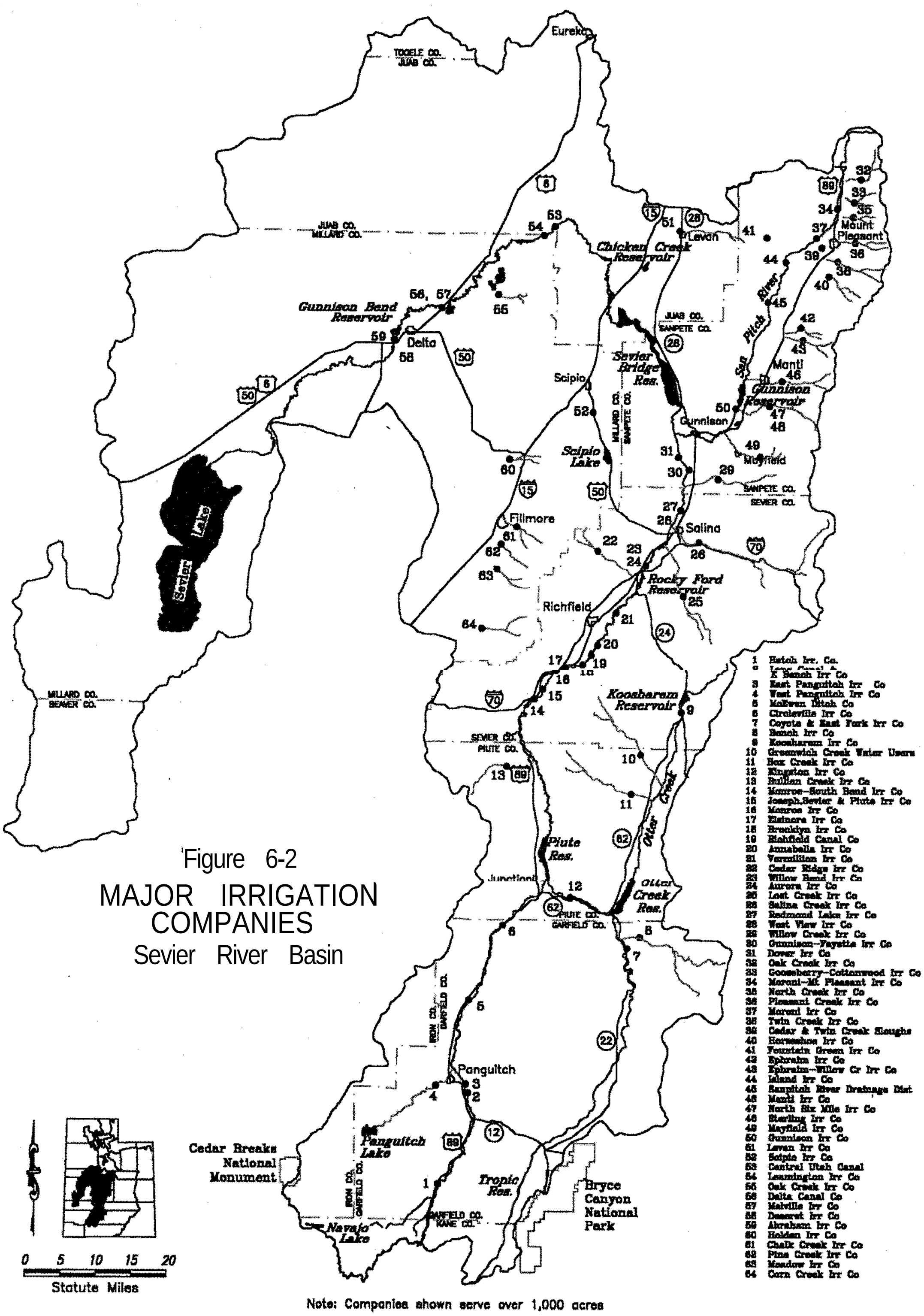


Figure 6-2
MAJOR IRRIGATION COMPANIES
Sevier River Basin

above town is one of these as is Dairy Reservoir east of Centerfield. Devil's Pass Water Company is also considering a regulatory reservoir just north of Fairview.

There are areas of high erosion resulting in large sediment loads being deposited in storage reservoirs. It may be possible to regain all or part of this lost storage capacity by increasing the dam heights. Alternate sites may also be available to recover this lost capacity. It may also be feasible to excavate sediment deposits to regain lost storage capacity although this could become costly. these options would have to meet all environmental and legal criteria and requirements.

Some concern has been expressed about the water leaving the river system and flowing into Sevier Lake. Uses for this water are limited. Some of the water below the last gage is diverted into the Conk Ditch and the Cropper and Lincoln Ditch. Most of the remaining flow is drainage water with total dissolved solids over 10,000 mg/L. About the only feasible use for this water would be for waterfowl habitat. Even then, it may be too saline without introduction of fresh water occasionally.

6.5 ISSUES AND RECOMMENDATIONS

The only issue discussed is real-time monitoring and control systems.

6.51 Real-Time Monitoring and Control Systems [45]

Issue - Improved irrigation water management systems and methods can improve control, save water and reduce costs.

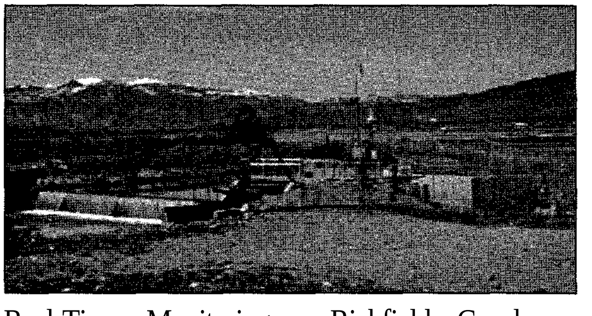
Discussion - Water is a valuable commodity as well as a finite resource. It is becoming imperative that water be managed and used to obtain the best returns possible. The cost of improving the management and use of water is considerably less than developing additional supplies. A real-time monitoring and control system is the most cost-effective means available to achieve these goals.

There is often a time lag between the need to change gate settings and the physical ability to make the adjustments. For instance, when flood flows approach diversion structures, there is silt and debris diverted into the canals. A solar-powered control system operated from a base station would make gate closures possible in a fraction of the time and would save a costly clean up operation. A more sophisticated system can be installed for even better control. Instead of adjusting the gates up or down by remote control, a predetermined canal flow can be set and the gates will move automatically to maintain this flow rate.

Monitoring stations can also be established at given reaches of the river system and at critical points along the canals. This will assist the water master in making sure the canal are operating as is intended. This will allow management of the water supply to meet the requirements of the water rights. Communication is by line-of-sight radio and telephone. Repeaters would be required to maintain contact in remote areas.

The Richfield Irrigation Company installation of real-time monitoring on the Sevier River has saved up to 12 percent of its water supply. This could be critical, especially during the inevitable dry years. There will also be a savings in the cost of water management.

Recommendation - The San Pitch Water Users should investigate and the Sevier River Water Users should continue to install solar-powered, real-time monitoring and control systems.



Real-Time Monitoring - Richfield Canal

Section 7 Sevier River Basin REGULATION/INSTITUTIONAL CONSIDERATIONS

Table

Section Seven Sevier River Basin - State Water Plan

Regulation/Institutional Considerations

Regulations are required to avoid or resolve conflicts as they arise and for the protection of water users.

7.1 INTRODUCTION

This section discusses the regulations to protect and manage the water resources in the Sevier River Basin. It also discusses the environmental concerns.

The amount of arable land far exceeds the surface water supply. This has led to long, drawn-out and costly litigation so local irrigators could settle water disputes and arrive at a definition of their respective water rights. This process became increasingly complex and difficult with community growth, stream discharge fluctuations, and the added fact that litigation was filed in three judicial districts, depending on location of use.

The mission of Utah's water-related regulatory agencies is to provide orderly water rights administration, adequate good quality water supplies and an environment to meet the needs of the people. This is carried out by several agencies, primarily the divisions of Water Rights, Water Quality and Drinking Water,

7.2 SETTING

There is extensive regulation of the water resources throughout the Sevier River Basin. River commissioners regulate the use of water at the local level. Water masters and ditch riders operate the systems within each irrigation company. Cities and towns operate the community systems. Various types of entities administer and manage water delivery.

Local Entities - The health aspect of water is a concern. The Central and the Southwest Utah Boards of Health are involved at the local level in health-related water matters. They carry out state regulations and local policy related to wells, their construction, and septic tanks and their effects on water quality.

Department of Natural Resources - This state agency is concerned with water resources and their relationship to the environment. The Division of Water Rights is responsible for water allocation, distribution, dam safety and stream channel alteration. The Division of Water Resources regulates the cloud seeding program and is responsible for state water resources planning and development. The Division of Wildlife Resources is responsible for water-related wildlife habitat and aesthetics and the Division of Parks and Recreation enhances water-based recreational activities. See Sections 9, 14 and 15, respectively.

Department of Environmental Quality - This state agency has primary responsibility for water quality. The Division of Drinking Water ensures everyone has a high quality, dependable source of culinary water. The Division of Water Quality regulates the quality of streams, lakes and groundwater. The activities of these two agencies are discussed in Section 11, Drinking Water and Section 12, Water Quality.

Federal - Federal agencies also have responsibilities for water quality and environmental concerns. The Environmental Protection Agency has federal responsibility for water quality through the federal Clean Water Act and the Safe Drinking Water Act although the state of Utah has primacy for carrying out these regulations. The Fish and Wildlife Service has a role in protecting water-related environments, particularly where they affect endangered fish, waterfowl and plants.

There are many types of organizations involved in water delivery to irrigated cropland. In addition to the mutual irrigation companies described below, there are 13 ditch systems, 12 water user groups and 78 private systems. In general, ditch systems have several owners, water users groups are larger organizations to manage water, and private systems generally consist of only one or two water rights owners.

Other Entities - **Mutual irrigation companies** are the most numerous (about 85) of the water distribution organizations in the Sevier River Basin. They are responsible for most of the water development and delivery. Table 6-2 lists those serving more than 1,000 acres. These companies are formed under the state corporation code, are all nonprofit organizations, and are governed by boards of directors. Stockholders have the right to a quantity of water and they pay the expenses of their company's operations proportional to the number of shares they hold.

Water conservancy districts are formed by a district court in response to a formal petition from residents of an area. A board of directors is appointed by the county legislative body when the district is in only one county and by the governor with the advice and consent of the Senate when the district covers more than one county. Conservancy districts have broad powers. They include constructing and operating water systems, levying taxes and contracting with government entities. Districts cover both incorporated and unincorporated areas. There are five water conservancy districts in the basin; Sanpete County, Millard County, Upper Sevier River, Kane County, Central Iron County and Central Utah. The Upper Sevier River Water Conservancy District covers Garfield and Piute counties and the Central Utah Water Conservancy District covers Garfield, Juab, Piute and Sanpete counties.

Special service districts have many of the same duties and authorities as other districts and can be created by either counties or municipalities. They can be established to provide water, sewer, drainage, and flood control, as well as non-water related services. There are 16 special service districts in the Sevier River Basin.

Drainage districts deal with problems created by high water tables in areas where natural drainage conditions inhibit farming or other operations. There are four drainage districts in Millard County, one in Sanpete County and seven in Sevier County.

City water departments are established by cities and towns to provide water service to residents. Some provide secondary as well as culinary water supplies.

7.3 WATER RIGHTS REGULATION

Utah's statutory water rights law is contained in the *Utah Code Annotated, (UCA) Title 73.* Water rights are administered by the State Engineer and are based on the doctrine of prior appropriation. The Division of Water Rights has a regional engineer based in Richfield.

The State Engineer is responsible for determining whether there is unappropriated water and if additional applications will be processed. This is accomplished through data analysis and consideration of public input. Before approving an application to appropriate water, the State Engineer must find; 1) There is unappropriated water in the proposed source, 2) the proposed use will not impair existing rights, 3) the proposed plan is physically and economically feasible, 4) the applicant has the financial ability to complete the proposed works, and 5) the application was filed in good faith and not for the purpose of speculation or monopoly. The State Engineer will withhold action on or reject an application if he determines it will interfere with a more beneficial use of water or prove detrimental to the public welfare or the natural resources environment. The State Engineer has determined that all of the water in the Sevier River Basin has been appropriated.

Utah water law allows changes in the point of diversion, place of use and/or nature of use of an existing right. To make any change, the water user must file a change application with the State Engineer who will approve or reject the application depending on whether it will impair other rights. If this is the case, compensation can be made or conflicting rights may be acquired.

Perfected, decreed or diligence water rights are considered real property. A pending application and stock in mutual water companies are considered personal property. As such, they can be bought and sold on the open market and are a primary source of collateral to finance farm operations.

The 1998 Legislature passed H.B. 302 amending Section 73-l-10 and 73-l-l 1 of the *UCA*. In part, this amendment states "A water right, whether evidenced by decree, a certificate of appropriation, a diligence claim to the use of surface or underground water, or a water user's claim filed in general determination proceedings, will be transferred by deed in substantially the same manner as is real estate." Also, it defines transfer of water rights when a part of the land irrigated is transferred.

The owner of a perfected water right may lose the right if beneficial use ceases for longer than five years. The owner may file for, and be granted, an extension of time to resume use to protect a right not being used.

Recent legislation has revised the time limit for proving up on water rights with respect to public water suppliers. Extensions of time, not exceeding 50 years from the date of approval of the application, may be granted on proper showing of diligence or reasonable cause for delay. Extensions of time beyond 50 years can be made for public entities if it can be demonstrated the water will be needed to meet the reasonable future requirements of the public. Also, the rules for filing a diligence claim have been made more restrictive.

Circleville Diversion

A provision in the state constitution (Article XI, Section 6) prohibits municipalities from selling or otherwise disposing of any water rights they hold. The only exception is if they trade for other water rights of equal or greater value. Municipalities are still subject to forfeiture for five years of nonuse.

In the appropriation process, the State Engineer analyzes the available data and, in most cases, conducts one or more public meetings to present findings and receive input before adopting a final policy regarding future appropriation and administration of water within a given area.

Through regulatory authority, the State Engineer influences water management by establishing and/or regulating diversion limitations for various uses and by setting policies on water administration for surface water and groundwater supplies. It is the policy of the State Engineer to allow improved irrigation efficiency but not expansion of acreage.

The Division of Water Rights is responsible for a number of functions in addition to the appropriations process which include; 1) Distribution of water in accordance with established rights, 2) administration of adjudicated water rights under an order of a state district court, 3) approval of plans and specifications for construction of dams and inspection of existing structures for safety, 4) licensing and regulating the activities of water well drillers, 5) regulation of geothermal development, 6) authority to control streamflow and reservoir storage or releases during a flooding emergency, and 7) regulation of stream channel alteration activities. In addition, the State Engineer works with federal agencies on reserved water rights, wetlands and other federal activities where their mandates impact state water law.

The surface waters of the Sevier River Basin were closed to all new appropriations under a Governor's Proclamation dated December 19, 1946. Effective March 19, 1997, the State Engineer closed the Sevier River Basin, except for the western Sevier Desert, to all new appropriations of groundwater. These two actions applied to the Sevier River and its tributaries but did not include the Pahvant Valley underground reservoir. Future groundwater development will be based on acquiring a valid water right and filing an application for a change in point of diversion and place and purpose of use. Each application will be considered on its own merits. Generally, transfers between groundwater basins will not be allowed.

Pahvant Valley is covered by a separate groundwater policy announced on March 2, 1994. The State Engineer has conducted a hydrologic inventory in Pahvant Valley and has surveyed the uncontrolled artesian wells. At the present time, the groundwater levels are being monitored using a representative sample of wells. A goal has been established to limit the total well withdrawals to 60,000 acre-feet annually using a five-year moving average. Applications for domestic wells are still being accepted. If water mining and quality deterioration still continue, additional restrictions will be considered.

7.4 WATER QUALITY CONTROL

The discharge of pollutants is regulated under the Utah Water Quality.Act (UWQA) found in *Utah Code Annotated, Title 19, Chapter 5.* The Utah Water Quality Board (UWQB) has developed rules, regulations, policies and continuing planning processes necessary to prevent, control and abate new or existing water pollution, including surface water and groundwater. These are carried out by the Department of Environmental Quality, Division of Water Quality. They are described in Section *7* of the *State Water Plan.*

Water quality certification by the state is covered under Section 401 of the federal Water Pollution Control Act, 1977. This act requires state certification on any application for a federal license or permit resulting in discharge into waters, and/or wetlands of the United States. These activities include, but are not limited to the construction or operation of the discharging facilities. Any discharges will comply with applicable state water quality standards and the applicable provisions of the Clean Water Act (CWA). In addition, the UWQB adopted and enforces "Ground Water Protection Regulations." These regulations are building blocks in a formal program to protect beneficial uses of groundwater in Utah.

Three main regulatory concepts are provided. They are to; 1) Prohibit the reduction of groundwater quality, 2) prevent groundwater contamination rather than clean up after the fact, and 3) provide protection based on the differences in existing groundwater quality. There are five significant components; 1) Groundwater quality standards, 2) groundwater classification, 3) groundwater protection levels, 4) aquifer classification procedures, and 5) a groundwater discharge permit system. Statutory authority for the regulations is contained in *Chapter 19-5 of the UCA.*

The groundwater permitting system controls activities affecting groundwater quality. A permit will be required if, under normal circumstances, there may be a release to groundwater. Owners of existing facilities will not be obligated to apply for a groundwater discharge permit immediately if they were in operation or under construction before February 10, 1990. Owners of these facilities will notify the Executive Secretary of the UWQB of the nature and location of their discharge.

These regulations provide for a permit by rule for certain facilities or activities. Many operations pose little or no threat to groundwater quality. Some are already adequately regulated by other agencies. These are automatically extended a permit. Therefore, facilities qualifying under provisions of the Utah Administrative Rules, Section R3 17-6-6.2 will administratively be extended a groundwater discharge permit (Permit by Rule). However, these operations are not exempt from the applicable class total dissolved solids limits or groundwater quality standards.

The authority for CWA, Section 401 certification, commonly known as 401 Water Quality Certification, is carried out through the UWQB by the Division of Water Quality. Whether the Environmental Protection Agency (EPA) administers a CWA program directly or delegates it to a state (primacy), EPA retains the oversight role to ensure compliance with all rules, regulations and policies.

Local communities are encouraged to set up and carry out a "Local Aquifer Protection Management Plan." They can contact the Division of Water Quality for information.

7.5 DRINKING WATER REGULATION

The Safe Drinking Water Board is empowered to adopt and enforce rules establishing standards prescribing maximum contaminant levels in public water systems. This authority is given by Title 19, Chapter 4 of the *Utah Code Annotated.* The rules and regulations setting drinking water standards were adopted after public hearings. These standards govern bacteriologic quality, inorganic chemical quality, radiologic quality, organic chemical quality and turbidity. Standards are also set for monitoring frequency and procedures.

The Safe Drinking Water Board, through the Division of Drinking Water, also operates under the federal Safe Drinking Water Act. This act sets federal drinking water standards and regulations. The Safe Drinking Water Act was reauthorized and amended in 1996. The act sets up new monitoring procedures that are less stringent than before and authorizes a state revolving loan fund (SRF). Some requirements of the act are more stringent.

Through the 1996 Reauthorized Safe Drinking Water Act, the Drinking Water Board receives funding to establish a Drinking Water State Revolving Fund (SRF). The purpose of the fund is to ensure all drinking water systems within the state are capable of maintaining and protecting the supply of drinking water at an affordable cost. The Drinking Water board expects to receive grants, a portion of which will go into the SRF for project construction. The amounts for project construction are: $9.76 million in 1998, $6.0 million in 1999, $6.5 million in 2000, and between $6.0 million and $6.5 million each year through 2003. The state is expected to provide an additional 20 percent of each appropriation, or a total of $9.8 million, as matching cost-share funds.

In order to make the best use of these funds, considerable planning will be required. To accomplish this, the Drinking Water Board expects to have a portion of its federal appropriations available for regional water systems planning.

The Division of Drinking Water serves as staff for the Drinking Water Board to assure compliance with the standards. At the local level, considerable reliance is placed on public water supply operators. Systems serving more than 800 people are listed in Table 11-3. Systems of this size and larger are required to have a certified operator.

7.6 ENVIRONMENTAL CONSIDERATIONS

Water is an intricate part of our existence and influences many of our activities each day throughout our lives. Water is most often recognized for its place in supporting our life but other values are often ignored or placed in subordinate roles. An adequate quantity and quality of water are needed for maintenance of healthy wildlife populations and habitat. This includes providing instream flows where possible and maintaining wetland areas.

The Legislature recognized the value of instream flows when it approved legislation allowing the Division of Wildlife Resources and the Division of Parks and Recreation to acquire water rights for this purpose. This authority has not been in general use in the Sevier River Basin as normal operation and use of the water resources generally provides the necessary flows. The only instream flow is the one in Manning Creek purchased in connection with Manning Meadow Reservoir and the Elbow Ranch by the Division of Wildlife Resources.

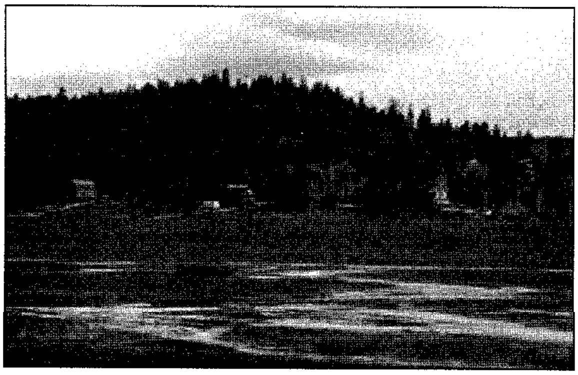
Wetlands are important features in the groundwater recharge and discharge cycles. They also provide flood storage, trap sediment, control pollution, provide food chain support and habitat for fish and wildlife, and recreation.

There are two sources of pollution; geologic and man-caused. Both sources of pollution can adversely affect the surface water and the groundwater quality. Geologic pollution generally cannot be controlled. Man-caused pollution sources include agriculture, on-site waste treatment systems, solid wastes, mining, oil and gas exploration, and urban runoff. The Sevier River Basin is primarily an agricultural area which may be a source of pollution from pesticides and other chemicals used for insect and disease control.

Groundwater is an important resource and it must be protected. It is much easier to maintain high quality groundwater than to restore it.

Open space is becoming a public environmental concern and its value increases as communities continue to grow. Urban encroachment into the agricultural areas not only detracts from the beauty of open space but increases the potential for groundwater pollution.

The Legislature passed the Quality Growth Act of 1999 to provide assistance to local governments for open space planning. This source of funding should be utilized.



Summer homes near Swains Creek

7.7 PROBLEMS AND NEEDS

More summer homes in the mountain areas and increased home building activity around most communities have resulted in more domestic wells. This is particularly true in the Navajo Lake, Duck Creek, Panguitch Lake areas, on Monroe Mountain and along the Wasatch Plateau above Fairview. There are 900 summer homes in Garfield County alone, mostly in the Sevier River drainage area. Many of these haul their own water but there is still a potential demand for on-site culinary water and waste disposal systems. Increased demands in valley areas include Sevier Valley and Sanpete Valley among others. This is beginning to have an impact on some water rights, especially those affected by return flows.

When more wells are constructed in the valley areas, the increase in discharge lowers groundwater elevations. However, the decrease in downstream flow will be smaller than the volume of water pumped. With a lower water table, there will be an increase in recharge which will come from seepage from the valley floor and from surrounding consolidated rocks. The additional recharge generally will not be in the same area as the discharge so down-gradient springs and wells will be impacted.

With the Sevier River drainage closed to new applications for domestic wells, other sources of water will be in demand. Optimally, communities with a public water supply system will be able to expand their area of service to accommodate some of these extended areas. Otherwise, purchase of other existing water rights will be required. This could be an existing well right or purchase of a share of stock in an irrigation company. Some companies may resist selling stock for use outside their delivery system as it would reduce the carrier water and eventually affect the conveyance efficiency.

Groundwater quality is deteriorating in southern Pahvant Valley, primarily due to increased pumping for irrigation. Depending on the on-farm irrigation efficiency, up to half of the water applied percolates down through the root zone, leaching out salts, and eventually returning to the groundwater reservoir. The total salts leached will vary depending on the nature of the soils and the type of irrigation system used.

7.8 DAM SAFETY

A dam is assigned a hazard rating if the reservoir stores sufficient water where failure may cause loss of life or significant property damage. Hazard ratings measuring the potential effects of failure is either high, moderate or low. This also determines the frequency of inspection. High-hazard dams are inspected yearly;

moderate, every other year; and low, every fifth year. The high hazard dams are described in Table 7-l and shown on Figure 6-l. See Table 8-l and 8-2 for funding information. All of the major reservoir owners have emergency action plans.

Following inspection, the State Engineer may suggest maintenance needs and request specific repairs. He may declare the dam unsafe and order it breached or drained. Efforts are always made to work with dam owners to schedule necessary actions. The State Engineer has outlined design standards in the publication "State of Utah Statutes and Administrative Rules for Dam Safety." Plans and specifications must be consistent with these standards and efforts are made to resolve problems before approval. Dam safety personnel monitor dam construction to insure compliance with plans, specifications and design reports.

The State Engineer is currently assessing the ability of all high hazard dams to pass the Probable Maximum Flood (PMF). The assessment also includes the seismic stability of a dam. High hazard dams are shown in Table 7-l.

Table 7-1
HIGH HAZARD RESERVOIR DAMS

County/Name	Owner	Stream	Height (feet)	Capacity (acre-feet)	Surface Area (acres)
Garfield County					
Panguitch Lake	West Panguitch Irr Co	Panguitch Creek	28	23,730	1,248
Tropic	Tropic-East Fk Irr Co	EF Sevier River	29	1,850	170
Juab County					
Sevier Bridge*	Consol Sevier Brd Co	Sevier River	92	236,145	10,905
Millard County					
Corn Creek DB	Corn Creek Irr Co	Corn Creek	45	89	22
DMAD	DMAD Co	Sevier River	34	10,991	1,199
Gunnison Bend	Deseret & Abr Irr Co	Sevier River	19	5,000	706
Piute County					
Beaver Cr-Upper*	Beaver Creek In & Res Co	Box Creek	58	1,401	62
Beaver Cr-Lower*	Beaver Creek Irr & Res Co	Box Creek	36	231	21
Otter Creek*	Otter Creek Res Co	Otter Creek	40	52,662	2,520
Piute*	Piute Res & Irr Co	Sevier River	90	71,826	2,508
Sanpete County					
Gunnison*	Gunnison Irr Co	San Pitch River	38	20,264	1,287
Nine Mile*	Gunnison Irr Co	Nine Mile Creek	55	3,500	213
Palisades Lake*	Manti Irr & Res Co et al	Six Mile C-Offst	24	780	66
Sevier County					
Cottnw Wash DB	City of Richfield	Cottonwood Wash	50	695	28
Dairy Canyon DB	City of Richfield	Dairy Wash	41	110	10
Glenwood DB	Glenwood Town	Mill Creek	57	200	20
Koosharem*	Koosharem Irr Co	Otter Creek	26	3,858	340
Rocky Ford	Rocky Ford Canal Co	Sevier River	25	1,700	180
Sand H DB	Monroe City	Sand Can	30	80	
Three Creeks	Sevier Valley Canal Co	Three Creeks	22	1,000	160

Source: Division of Water Rights and Division of Water Resources.
Note: An * indicates hazard investigations or remedial work has started.

Section 8 Sevier River Basin
WATER FUNDING PROGRAMS

Tables

Water Funding Programs

Funding water development requires cooperation, persistence and ingenuity. This has been and is still required today.

8.1 INTRODUCTION

This section briefly describes the state, federal and local funding sources available to help conserve and develop the water resources of the Sevier River Basin. State and federal agencies have funds available for planning as well as for development. Some also have funds to provide various levels of management assistance. Generally, planning funds are not a part of the project funds available for construction.

Some of the planning programs are discussed in various sections of this basin plan. Specific agency activities and responsibilities are discussed. River basin planning by the Division of Water Resources and others responsible for preparing this document is discussed in Section 3. Other state water-related planning programs include the Division of Water Rights funding for groundwater and related studies and Utah Geological Survey groundwater studies. Federal planning includes U.S. Geological Survey stream gaging and groundwater measurements and modeling and Bureau of Land Management and Forest Service watershed management planning. Also Corps of Engineers water resources and river basin and watershed management planning, environmental restoration, flood control studies and projects and Natural Resources Conservation Service river basin, watershed and environmental quality improvement project (EQIP) planning. More information is found in the *State Water Plan (1990)*; Section 3, Introduction; Section 8, State and Federal Water Resources Funding Programs; and Section 16, Federal Water Planning and Development.

8.2 BACKGROUND

Early settlers quickly began construction of water delivery systems. This took a local cooperative effort with little funding and lots of hard work. Exchanging help between families, such as farm work for a water system assessment, was a common practice. To this day, water projects are developed through a common effort by all those involved.

Many of the early projects were for agricultural purposes. This included construction of reservoirs to store irrigation water and building canals and ditches to deliver it to the fields. Interspersed with these agricultural pursuits were projects to improve delivery of culinary water to all the homes in a community.

8.3 STATE FUNDING PROGRAMS

It is difficult to determine the total funds spent historically for planning and implementation of water and water-related projects in the Sevier River Basin. One thing is certain, local entities and individuals provided a majority of the financing from their own resources through either upfront funding or by repaying development loans. Tables 8-1 and 8-2 show the funding programs and the recent funding provided by state agencies for water-related projects. The time periods shown vary due to available data. Presently, funding for projects can be grants and/or loans and they can be provided by more than one agency. Funds for dam safety repairs are provided by the Board of Water Resources to help meet the requirements of the state Dam Safety Act.

8.4 FEDERAL WATER FUNDING PROGRAMS

There are seven federal agencies with water funding programs. Most have funds available for construction of facilities. There are some agencies with funds available for planning. The Bureau of Reclamation has provided planning funds for water management purposes.

Funding Agency/Program	Contact	Purpose	Type
Board of Parks and Recreation	Div of Parks and Rec		
Land and Water Conservation Fund		Rec facilities	Cost-share
Riverway Enhancement Program		Rec facilities	Cost-share
Board of Water Resources	Div of Water Resources		
Revolving Construction Fund		Small irr/cul projects	Loans
Cities Water Loan Fund		Municipal cul systems	Loans
Conservation & Development Fund		Large water projects	Loans
Dam Safety		Dam safety requirements	Grants/loans
Community Development Block Grants	Div of Community Dev		
Block Grants		Rural living improv	Grants
Drinking Water Board	Div of Drinking Water		
State Revolving Fund Program		Drinking water systems	Loans
Perm. Community Impact Board	Div of Community Dev		
Permanent Community Impact Fund		Rural living improv	Grants/loans
Disaster Relief Board Fund		Disaster mitigation	Grants
Soil Conservation Commission	Dept of Ag & Food		
Agri Resource Development Loan		Improve priv agri land	Loans
Nonpoint Source Program		Water quality	Grants
Utah Wildlife Board	Div of Wildlife Res		
Wallup-Breaux Bill		Fish habitat-boating	Grants
Water Quality Board	Div of Water Quality		
Revolving Const Loan Program		Wastewater treat facil	Loans
Federal Construction Grants		Wastewater treat facil	Grants

Table 8-l
STATE WATER-RELATED FUNDING PROGRAMS

Funds available from the Environmental Protection Agency are generally distributed through state agencies. There are some grant funds available for water quality planning. Federal expenditures for planning and construction are shown in Tables 8-3 and 8-4.

8.5 LOCAL WATER FUNDING PROGRAMS

While all funding ultimately comes from the pockets of the tax payers and the water users, this becomes more obvious at the local level. The local water users obtain their funds from more observable sources such as user fees, water company assessments, local taxes or from local private lending institutions. These are shown in Table 8-5.

Table 8-2
STATE WATER-RELATED FUNDING EXPENDITURES

Funding Agency/Program	Period	Garfield	Juab	Millard ($1,000)	Piute	Sanpete	Sevier
Board of Parks & Recreation							
Land & Water Conservation Fund		54	-0-	643	76	541	511
Riverway Enhancement Program		-0-	-0-	-0-	12[a]	7	-0-
Board of Water Resources							
Revolving Construction Fund	1947-97	436	925	7,745	604	9,659	2,261
Cities Water Loan Fund	1947-97	870	342	2,295	-0-	1,958	663
Construction & Development Fund	1947-97	220	-0-	-0-	-0-	24,955	4,060
Dam Safety	To date	26	-0-	-0-	390	92	14
Community Development Committee							
Community Block Grants		364[b]	-0-	466	-0-	276	1,770
Drinking Water Board							
Financial Assistance Program	1990-96	425	-0-	398	-0-	2,238	300
Permanent Community Impact Board							
Permanent Community Impact Fund	1992-96	2,441	2,580	743	2,091	5,267	13.605
Disaster Relief Board	1983-84	97	744[b]	515	105	1,669	244
Soil Conservation Commission							
Agriculture Resource Development Loan	1993-97	318	103	2,467	355	725	711
Nonpoint Source Program							
Water Quality Board							
State Revolving Loan Program	To date	753		450		1,053	1,385
Federal Construction Grants	To date	53				410	1,200
EPA 3 19 NPS Program	To date				763		

[a] $2,000 to BLM for Paiute ATV Trail and $10,000 to Fish Lake NF for Great Western and Paiute ATV Trail.
[b] Total for county.

Table 8-3
FEDERAL WATER-RELATED FUNDING PROGRAMS

Agency	Program	Purpose	Funds
Department of Agriculture			
Farm Service Agency	Agricultural Cons Prog	Soil, water, energy cons	Grant
	Emergency Cons Prog	Disaster damaged farmland rehab	Grant
	Conservation Res Prog	Reduce erosion, maintain wetland	Grant
Rural Development	Rural Development	Water supply, wastewater disposal	Grant,loan
Natural Res Conserv Service	Wtrshd Protct & Fld Prv	Flood contol & water development	Grant
	EQIP	Environmental quality improvement	Grant
	RC&D	Resources conservation & dvlpment	Grant
	Emergency Wtrshd Program	Natural disasters	Grant
Dept of the Army			
Corps of Engineers	Civil Works	Flood cntrl, wtr spply, recreation	Cost-share
	Continuing Authorities	Flood cntrl & envir restoration	Cost-share
	Emergency Services	Flood & other disaster assistance	Grant,Cost-share
	Flood Plain Mgt Program	Flood plain delineation	Grant
Dent of the Interior			
Bureau of Reclamation	Investigation Program	Water management	Loan
Environmental Protect Agency	Nonpoint Source Program	Water quality	Grants
Fed Emergency Mgt Agency	President Dclrd Disaster	Damage mitigation	Grant
	Flood Plain Management	Str aquisition-flood plains	Grant

Table 8-4
FEDERAL WATER-RELATED FUNDING EXPENDITURES

Funding Agency/Program	Period	Garfield	Juab	Millard	Piute	Sanpete	Sevier
					($1,000)		
Corps of Engineers							
Civil Works	1992-94	50	50	50	50	50	50
Emergency Authorities	1975-84		6			20	30
Continuing Authorities	1983-93	50	10	10	10	50	150
Farm Service Agency							
Agriculture Conservation Prog	1993-97	8	130	373	36	220	89
Federal Emergency Management Agency							
Presidential Declared Disaster	1983-84	172	3,630	1,592	126	3,008	824
Natural Res Conservation Service							
Wtrshd Prot & Flood Prv Program	1991	-0-	-0-	-0-	-0-	-0-	414
Environ Quality Incentive Program	1990-97	11		88	34	143	69
Emergency Watershed Program	1990-97	82	-0-	-0-	112	-0-	45
Rural Development							
Rural Development Loans	1990-97	-0-	-0-	-0-	508	806	-0-
Rural Development Grants	1990-97	-0-	-0-	-0-	839	922	-0-

Table 8-5
LOCAL FUNDING SOURCES

Entity	Purpose	Type
Private Financial Institutions	Approved water-related projects	Loan
Cities and Towns	Water systems	Bonding, cash flow
Western Farm Credit bank	Agricultural projects	Loans

Section 9 Sevier River Basin
WATER PLANNING AND DEVELOPMENT

Tables

Figures

Water Planning and Development

Water planning is essential to ensure that development and conservation will meet all of the future needs of the resources' users.

9.1 INTRODUCTION

This section describes the major existing and proposed water planning and development activities in the Sevier River Basin. It also discusses the problems and needs and alternative solutions.

The existing water supplies are essential to the existence of local agricultural and industrial interests and the local communities. At the same time, water resources can provide aesthetic and environmental values and meet the recreational needs, not only of the local residents, but of others outside the area.

A goal of this plan and the Division of Water Resources is to assist local entities and to help them coordinate with other state and federal agencies in effective water resources management. However, the primary decision-making process is still the responsibility of the local people. This plan provides local decision makers with data and information to help solve existing problems and to plan for future implementation of the most viable alternatives.

9.2 BACKGROUND

Water resources development began at the time each community was settled. Facilities usually consisted of small earth or earth and brush structures to divert water for irrigation and stock uses, oft times on an individual basis. Drinking water was supplied by springs or taken directly from streams. Later, it was found more convenient to organize formal groups such as irrigation companies, cities and towns.

9.2.1 Early Settlement and Water Development

The first settlers arrived in Sanpete County in 1849. The following spring of 1850, they were the first in recent history to divert irrigation water in the Sevier River Basin. Soon there were settlements throughout the basin from Pahvant Valley (185 1) to Grass Valley (1867).

As soon as the settlements were established, settlers started developing local water resources for domestic use and irrigation until they were interrupted by the Walker and Black Hawk Indian wars. The diversion dam at Hinckley (Oasis) was constructed in 1860. It washed out and was rebuilt at least 5 times. The Richfield Irrigation Canal was constructed in 1865. This 1 l-mile long canal was dug mostly with pick and shovel and completed in five weeks. Scipio Reservoir was constructed in 1860, the first storage reservoir in the Sevier River Basin. Storage was added to Panguitch Lake when the dam was completed in 1872. By the turn of the century, several dams for storage of irrigation water were under construction throughout the river system. Section 3 describes early water history in more detail.

The irrigation of lands continued to expand, and along with a more reliable water supply, water tables began to rise in the irrigated areas. This created the need to leach soluble salts out of the vegetative root zone so crop growth would not be restricted. As a result, 14 drainage districts were organized to install drains in the Delta area, Sevier Valley and Sanpete Valley.

9.2.2 Past Water Planning and Development

The only storage reservoirs constructed since the 1936 Cox Decree were Three Creeks enlargement (1949), DMAD (1960), Manning Meadow (1967) and Nine Mile reconstruction (1982). Renovation work has also been done on Tropic, Gunnison, Gunnison Bend and Piute reservoirs and Panguitch and Palisades (Funks) lakes. During the 1950s and 60s, many of the major diversions and conveyance facilities were upgraded or replaced. All of these activities were carried out by local irrigation companies and individuals with additional financial and technical assistance by state and federal agencies.

Much of the water planning by the state of Utah has been and is now being done through the Division of Water Resources. The Board of Water Resources and its predecessor, the Utah Water and Power Board, have provided technical assistance for 276 projects by 1996 in the Sevier River Basin and funding of about $35.7 million. Federal and local entities have provided matching funds amounting to $16.4 million.

Board of Water Resources projects have included sprinkler irrigation systems, canal lining, pipelines, diversion dams, reservoir dams and repairs, wells, culinary water systems and stock watering facilities. The first Water and Power Board projects constructed in the basin were in 1948. These were Bullion Creek Irrigation Company pipeline, Gunnison-Fayette Irrigation Company diversion dam and West View Irrigation Company diversion dam. All board projects are listed in Table 9-l and shown on Figure 9-l. The column of the left of the Table 9-1 shows the project number with the numbering starting over for each county. These numbers show the project location on Figure 9-l. Where an irrigation company or city/town had more than one loan for the same type project, only one number is shown. More than one number is shown where an entity had different kinds of projects.

The Division of Water Quality does considerable planning to maintain water quality standards. The Water Quality Board provides financial and technical assistance by division staff. So far, loans and grants for these board projects are $5.3 million.

The Division of Drinking Water maintains and regulates drinking water. The Drinking Water Board has funded eight projects at a cost of $3.361 million.

Several federal projects have been completed. Generally, local sponsors were required to provide land easements and rights of way for each project and to supply cost-share funding in some cases. These descriptions follow.

The Corps of Engineers has completed three projects in the Sevier River Basin. The largest was the Redmond Channel Improvement Project completed in 195 1. The project consisted of 14 miles of improved channel along the Sevier River downstream from the mouth of Salina Creek, levees from the Westview Irrigation Company diversion dam to Redmond Lake Dam, and gated structures in place of two diversion dams to improve the carrying capacity of the river. The project protects the community of Redmond and about 3,000 acres of adjacent cropland. Federal cost was $919,000 and sponsor cost was $118,000. Channel and levee improvements were made under emergency authority in 1975 along Salina Creek through Salina. Also, in preparation for the 1983 flood, an emergency levee was constructed in Gunnison on the north bank of the San Pitch River adjacent to the U.S. Highway 89 bridge.

The Natural Resources Conservation Service (NRCS) has completed three watershed protection and flood prevention projects. The Pleasant Creek Pilot Watershed Project near Mt. Pleasant (where the Indians called "place of many floods") was installed to reduce erosion, floodwater and sediment damages and to make related irrigation system improvements. It was also a research watershed project designed to compare damage reduction from a treated watershed with damage from an untreated watershed. The project was completed in 1958 at a cost of $560,701. All of the costs except land, easements and rights-of-way were federal funds. Effectiveness of the project is shown by only $3,000 damages by one flood in 1955 when the watershed was 25 percent complete and another in 1961 causing no damage.

The Mill Canyon-Sage Flat Watershed Project is located in the drainage above Glenwood. Its purpose was to reduce floodwater and sediment damage in and around Glenwood. This was the first project completed (1959) in the United States under the Watershed Protection and Flood Prevention Act, PL-566. A major flood occurred during the final stages of completion. The flow exceeded 3,000 cfs above the flood control structure and was reduced to 15 cfs in the flood channel through town. Local citizens claim the project paid for itself by controlling this one flood.

The Glenwood Watershed Project (an amendment to the Mill Canyon-Sage Flat Project) was constructed (1975) to improve the use of the limited irrigation water supply. The project consisted of installing a gravity pressure sprinkler irrigation system on croplands served by the Glenwood Irrigation Company. It also included a pressure secondary water system for lawns and gardens in-the town of Glenwood. Total cost was $2,530,811 with the local sponsors contributing $570,785.

Table 9-1
BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS

Sponsor	Number	Type	Year
GARFIELD COUNTY			
1. Bonanza Estates Water Co	1	Cl	1991
2. Long C.L. & East Bench Irr Co	1	Misc	1978
3. McEwen Canal Co, et al	1	Div Dam	1960
4. Panguitch City	2	Cl	1977,91
5. Panguitch City	1	ss	1982
6. West Panguitch Irr Co	1	DamRp	1975
7. West Panguitch Irr Co	3	PrPlSp	1979,83,85
Total-Garfield County	10		
JUAB COUNTY			
1. Central Utah Water Co	1	Div Dam	1974
2. Deep Canyon Irr Co	1	PrPl	1982
3. Eureka	1	ClW	1982
4. Juab Lake Irr Co	2	CL	1959,64
5. Levan Irr Co	1	CL	1955
6. Levan Irr Co	1	Irr Well	1959
7. Levan Irr Co	2	PrPl	1967,72
8. Levan Irr Co	2	Div Dam	1969,83
9. Levan Town	1	Cl	1985
10. Riverbed Irr Co	1	Irr Well	1957
11. Individual	1	Stk	1977
Total Juab County	13		
MILLARD COUNTY			
1. Abraham & Deseret Irr Co	1	DamRp	1983
2. Abraham Irr Co	2	CL	1977,91
3. Chalk Creek Irr Co	2	PrPlSp	1977.80
4. Chalk Creek Irr Co	1	Div Dam	1983
5. Corn Creek Irr Co	1	ss	1975
6. Corn Creek Irr Co	1	PrPl	1984
7. Corn Creek Irr Co	1	Div Dam	1984
8. Delta Canal Co	4	CL	1961,71,77,83
9. Delta Canal Co	1	Pl	1965
10. Delta City	1	Cl	1983
11. Deseret Irr Co	3	CL	1977,83,95
12. Deseret-Oasis SSD	2	Cl	1981,85
13. DMAD Company	2	DamErg	1959,83
14. DMAD Company	1	Irr Well	1974
15. East Leamington Irr Co	1	CL	1964
16. Fillmore City	2	Cl	1982,86
17. Fillmore Water Users Assoc	2	ss	1979,83

CL-Canal lining
Cl-Culmary system
ClW-Culinary system well
Dan-&p-Dam repair
Div Dam-Diversion dam
DamErg-Dam enlargement
Irr Well-Irrigation water well
Pl-Pipeline
PrPl-Pressure pipeline
PrPlSp-Pressure pipeline, Sprinkler
Spk-Sprinkler
Ss-Secondary water system
Stk-Stockwater well

Table 9-1 Continued --

BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS

Sponsor	Number	Type	Year
18. Fool Creek Irr Co	2	Irr Well	1952,57
19. Fool Creek Irr Co	3	Cl	1965,73,92
20. Golden Harvester Irr Co	1	Irr Well	1959
21. Green Fields Irr Co	1	Irr Well	1964
22. Greenwood Irr Co	1	CL	1961
23. Hinkley Town	1	Cl	1983
24. Holden Irr Co	2	Div & Pl	1963,77
25. Kanosh Town	2	Cl	1980,85
26. Learnington Irr Co	1	CL	1983
27. Leamington town	1	Cl	1977
28. Lynndyl Irr Co	1	Irr Well	1957
29. Lynndyl Town	1	Cl	1983
30. McComick	1	CL	1961
31. McComick	3	Irr Well	1967,75,81
32. Meadow Irr & Canal Co	3	Irr Well	1950,51,61
33. Meadow Irr & Canal Co	2	CL	1953,71
34. Meadow Town	1	Cl	1980
35. Melville Irr Co	5	CL	1961,74,76,79,90
36. Northfields Irr Co	3	CL	1956,70,71
37. North McComick Irr Co	1	CL	1971
38. North McComick Irr Co	1	Irr Well	1958
39. Oak City Town	1	Cl	1985
40. Pahvant Development Co	2	Irr Well	1961,77
41. RCJJ Irr Co	1	Pl	1961
42. Scipio Irr Co	2	Irr Well	1957,61
43. Scipio Irr Co	1	ss	1977
44. Scipio Irr Co	2	CL	1984,89
45. Scipio Town	1	Cl	1984
46. Sinks Irr Co	1	Irr Well	1958
47. Sinks Land Co	1	Spk	1971
48. Taylor Flat Irr Co	2	Irr Well	1962
49. Walker Creek Assoc	1	Irr Well	1959
50. West Holden Irr Co	1	CL	1960
51. West Holden Irr Co	1	Spk	1977
52. Individual Ranchers	28	Stk	1977 & 78
Total-Millard County	112		
PIUTE COUNTY			
1. Beaver Creek Irr & Res Co	1	DamRp	1985
2. Bullion Creek Irr co	1	Pl	1948
3. Circleville & Loss Cr Irr Co	1	CL	1953
4. City Creek Irr Co	1	Spk	1974
5. Greenwich Waterworks Co	1	Cl	1974
6. Koosharem In Co	2	Spk	1982
7. Loss Creek Irr Co	1	CL	1960
8. Manning Meadows Res-Wildlife	1	Dam	1966
Total-Piute County	9		
SANPETE COUNTY			
1. Axtell Community SSD	1	CL Spk	1982
2. Birch Creek Irr Co	3	Spk	1978, 80, 81

Table 9-l Continued . .

BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS

Sponsor	Number	Type	Year
3. Birch Creek Irr co	1	Div Dam	1983
4. Brady Ditch Co	1	CL	1968
5. Cedar Creek Irr Co	1	Pl	1985
6. Centerfield Town	1	Cl	1981
7. Chester Irr Co	1	Dam	1968
8. Chester Irr Co	1	Spk	1982
9. Cottonwood Gooseberry Irr Co	1	Tunnel	1967
10. Cottonwood Gooseberry Irr Co	2	Spk	1977,82
11. Cottonwood Gooseberry Irr Co	1	ss	1980
12. Ephraim City	2	Cl	1982,91
13. Ephraim Irr Co	3	Spk	1977,91,92
14. Ephraim Irr Co	1	Pl	1992
15. Excell Irr Co	1	CL	1963
16. Fairview City	1	Cl	1978
17. Fairview-Birch Crk Irr Co et al	1	Irr Well	1957
18. Fan-view-Birch Creek Irr Co	1	CL	1965
19. Fayette Water Co	1	Cl	1956
20. Fountain Green Coop Assoc et al	1	Irr Well	1960
21. Fountain Green Irr Co	3	CL	1959,60,61
22. Fountain Green Irr Co	4	PI-Spk	1975,77,83,95
23. George Sorenson Well Co	1	Spk	1977
24. Gunnison City	2	ClW	1978,91
25. Gunnison City	1	ss	1986
26. Gunnison City Canal Co	1	CL	1956
27. Gunnison Irr Co	3	Spk	1982,83,85
28. Gunnison Irr Co	2	DamRp	1981,83
29. Gunnison Irr Co	1	Pl	1986
30. Gunnison-Fayette Canal Co	1	Div Dam	1984
31. Gunnison-Fayette Irr Co	1	Dam	1948
32. Horseshoe Irr Co	5	Spk	1976,79,80,82
33. Horseshoe Irr Co	1	ss	1981
34. M & M Canal Co	1	Spk	1979
35. Manti City	1	Cl	1977
36. Manti Irr & Res Co	1	CL	1963
37. Manti Irr & Res Co	1	Spk	1977
38. Manti Irr & Res Co	1	ss	1980
39. Manti Irr Co	1	Spk	1979
40. Manti Irr Co	1	ss	1977
41. Mayfield Irr Co	1	CL	1960
42. Mayfield Irr Co	3	Spk	1983,87,91
43. McArthur Frandsen Ditch Co	1	CL	1976
44. Milbum Dry Creek Irr Co	1	Spk	1979
45. Milbum Irr Co	1	Spk	1981
46. Moroni City	1	Cl	1982
47. Moroni Irr Co	2	CL	1969
48. Mt. Pleasant Big Ditch Irr Co	1	Pl	1970
49. Mt. Pleasant City	2	ss	1983,87
50. Mt. Pleasant City	1	Cl	1992
5 1. North Creek Irr co	1	CL	1965
52. Pleasant Creek Irr Co	2	Spk	1977,82

Table 9-1 Continued -- BOARD OF WATER RESOURCES DEVELOPMENT PROJECTS			
Sponsor	Number	Type	Year
53. Rock Dam Irr Co	1	CL	1957
54. Rock Dam Irr Co	2	Div Dam	1962,85
55. Sanpete-Oak Creek Irr Co	1	Spk	1978
56. South Extension Canal Co	1	CL	1961
57. Spring Canyon Irr Co	1	Spk	1980
58. Spring City	2	Cl	1976,84
59. Sterling Irr Co	1	Spk	1977
60. Sterling Town	1	Cl	1980
6 1. Wales Irr Co	2	PrPlSp	1971,82
62. West View Irr Co	1	Dam	1948
63. West View Irr Co	1	CL	1966
64. Willow Creek Irr Co	1	CL	1967
65. Willow Creek Irr Co	1	Div Dam	1983
Total-Sanpete County	93		
SEVIER COUNTY			
1. Annabella Irr and Canal Co	2	CL	1974,83
2. Annabella Irr and Canal Co	2	Pl	1981,92
3. Aurora City	1	Cl	1978
4. Austin Community SSD	1	Cl	1982
5. Brooklyn Tap Line Co	1	Cl	1994
6. Cedar Ridge Irr Co	1	CL	1963
7. Central Waterworks Co	3	Cl	1952,73,94
8. Cottonwood Res & Irr Co	1	Spk	1971
9. Cottonwood Res & Irr Co	1	ss	1972
10. Dry Creek Irr Co	1	Pl	1968
11. Elsinore Town	1	Cl	1979
12. Glenwood Irr Co	2	Spk	1976,87
13. Joseph Irr Canal Co	1	CL	1979
14. Joseph Town	1	Cl	1981
15. Kings Meadow Ranches, Inc	1	Pl	1959
16. Koosharem Irr Co	1	CL	1961
17. Koosharem Irr Co	1	ss	1986
18. Koosharem Town	1	Cl	1977
19. Monroe City	1	ss	1981
20. Monroe South Bend Canal Co	1	CL	1983
21. Monroe South Bend Canal Co	1	Div Dam	1985
22. Monroe South Bend Canal Co	1	Pl	1992
23. Otter Creek Reservoir Co	1	CL	1983
24. Piute Reservoir & Irr Co	1	Div Dam	1984
25. Redmond Lake Irr Co	1	Pl	1994
26. Redmond Town	1	Cl	1977
27. Richfield City	1	Cl	1987
28. Richfield Irr Canal Co	1	Div Dam	1989
29. Salina City	2	ss	1980,84
30. Salina City	1	Cl	1986
3 1. Salina Creek Irr Co	1	Pl	1961
32. Vermillion Irr Co	1	Div Dam	1990
33. Wells Irr Co	1	CL	1993
Total-Sevier County			

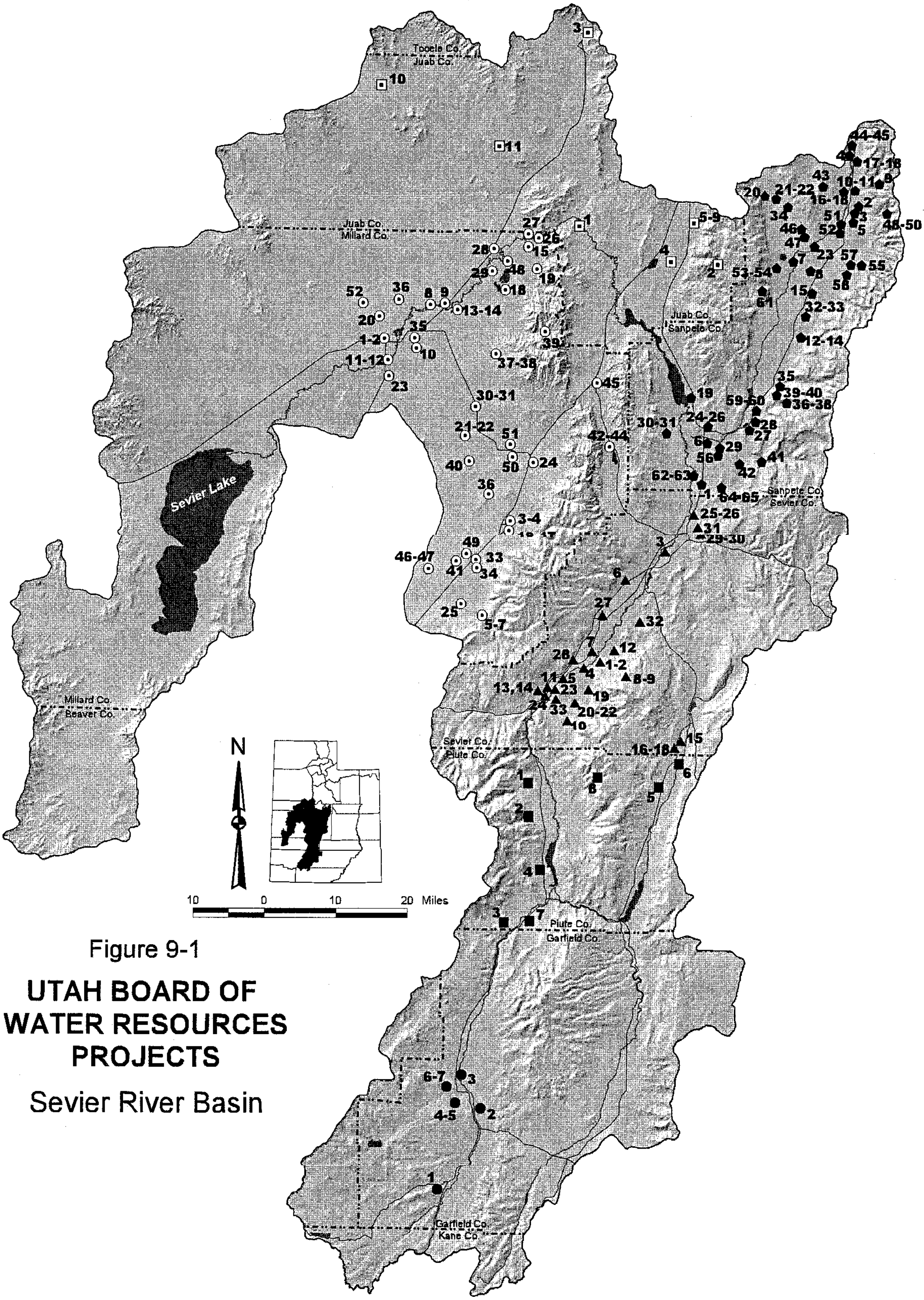


Figure 9-1

UTAH BOARD OF WATER RESOURCES PROJECTS

Sevier River Basin

NRCS also completed the Richfield Flood Hazard Study (1974) to determine flood plain zones for compliance under Federal Emergency Management Agency regulations. Also, a plan of work and an environmental impact statement were prepared for the Richfield-West Sevier Watershed Project (1977).

9.2.3 Current Water Planning and Development

Major reservoir storage projects are among those things remembered because of the hard work and sacrifice and they are not forgotten because of the rewards. The Cox Decree determinations in 1936 has reaffirmed most of the Higgins and Morse Decrees and brought about some other changes in development on the Sevier River by establishing a water right structure. In addition, much of the irrigated acreage data in "Bacon's Bible" was referenced. The Cox Decree has made construction of storage reservoirs unlikely and the magnitude of other irrigation projects smaller as they may affect the established water rights. As a result, most current irrigation projects are designed to improve delivery and irrigation efficiencies and/or reduce labor costs.

Most of the larger current (1999) project planning and development projects are receiving assistance from the Board and Division of Water Resources. The dam safety projects are to help owners bring their reservoir dams into compliance with the dam safety requirements. These projects are as listed:

- Palisade Lake Water Users Association is replacing 1,000 feet of irrigation pipeline.
- Sanpete Water Conservancy District in conjunction with Manti Irrigation Company, is converting 1,600 acres from flood to sprinkler irrigation.
- Spring City is improving their culinary water system and constructing a new 250,000-gallon storage tank.
- Redmond Town is upgrading their culinary water system.
- Deseret Irrigation Company is lining parts of their canal system.
- Koosharem Irrigation Company is replacing part of their canal lining which has failed.
- Dam safety studies have been authorized and funded for 11 dams. Seven of the studies are complete and awaiting corrective action. One is starting construction.
- Manti City is upgrading its culinary water system.
- Fairview City is making culinary water system improvements.
- Gunnison-Fayette Irrigation Company is doing diversion dam rehabilitation/reconstruction.
- Westview Irrigation Company is doing diversion dam rehabilitation/reconstruction.
- Otter Creek Reservoir Company is doing Dam Safety construction.

The Division of Water Quality is conducting a water quality study in the Sevier River Basin. This study will also investigate potential projects to improve surface water and groundwater quality.

In the early 1990s, the Division of Wildlife Resources requested the Corps of Engineers to investigate further environmental restoration of the Redmond Channel Project. This project would restore meanders to improve fish and wildlife habitat. Because of water users protests, the Division of Wildlife Resources has decided to put this restoration on hold indefinitely.

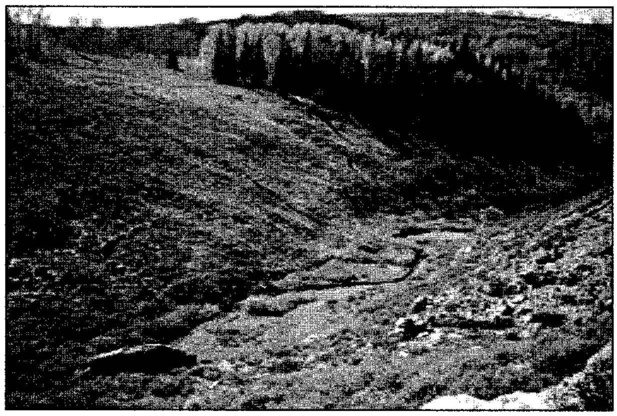
The Natural Resources Conservation Service is continuing -work on the Monroe-Annabella Watershed Project, originally authorized in 1961. Project features include upper watershed and foothill area land treatment, structural measures to reduce erosion and floodwater, and improvements to several irrigation systems. This will also protect downstream urban property and utilities. The project will be complete when the current irrigation measures are finished.

Manti Irrigation Company is installing an irrigation system with gravity and pumped sprinkler irrigation and flood irrigation.
The project includes 2,700 acres of irrigated cropland with a total cost of $4.0 million. A loan of $1.5 million will come from the Board of Water Resources and $1.9 million from the Water Conservation Credit Program through the Central Utah Water Conservancy District.

Hatch Town Dam and Reservoir - Several attempts have been made to develop plans for a water storage reservoir near Hatch since the third failure of the Hatch Town Dam in 1914. These have all failed because of water rights problems. The Division of Water Resources prepared an engineering feasibility report in 1974 for a structure at the site. In 1984, the division contracted for geological and engineering investigations at the original site as part of the state water planning effort. The division also conducted a study of a dam site about 600 feet downstream from the original location. A report was completed in 1986 concluding a safe dam could be built at either the upper or lower site. The lower site was recommended because of better conditions and less cost.

There is still the possibility of long-term storage on the upper Sevier river at the Hatch Town Dam site. The reservoir would have to be filled during years of high runoff. A transfer of water rights and abandonment of irrigated lands, probably in the upper Sevier River area, would be necessary. This is because the original water rights were sold to Piute Reservoir and Irrigation Company. Constructing the dam and filling the reservoir would require innovative planning and operation to reduce the downstream impact. The principal purpose of the reservoir could be for recreation and for releasing high quality water to dilute the total dissolved solids in late-summer downstream flows.

In their August 1998 meeting, the Central Utah Water Conservancy District Board voted to consider construction of Hatch Town Dam in Garfield County. An updating of construction costs and discussions with the State Engineer were started. Assistance for other projects in those counties still part of Central Utah Water Conservancy District has also been requested.



Narrows Reservoir site

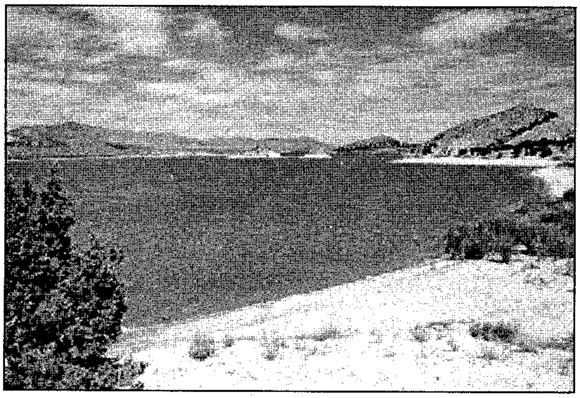
Narrows Project - There is the possibility of bringing additional water into the basin through the Narrows (Gooseberry) Project in Sanpete County. A Draft Environmental Impact Statement was issued in March 1998 with public hearings in April 1998.

The Narrows Project would divert water from Gooseberry Creek in the Price River drainage into the San Pitch River drainage for agricultural and municipal and industrial water uses. The project includes a dam and reservoir on Gooseberry Creek with a capacity of 17,000 acre-feet of which 14,500 acre-feet would be active storage. The water would be diverted through the existing Narrows Tunnel into Cottonwood Creek, a tributary of the San Pitch River. The Narrows Tunnel has deteriorated and will require restoration. Pipelines would deliver 5,400 acre-feet of water annually; 4,920 acre-feet to canals for supplemental irrigation of 15,420 acres of irrigated land in the Fairview, Mt. Pleasant, Spring City and Moroni area and 480 acre-feet of municipal and industrial water for residential outside uses.

Other project features would add to or mitigate other affected resources. The project would include realigning about one mile of State Road 264. Recreation facilities would be built around and in connection with the proposed reservoir. There will also be measures mitigating the fishery, wetlands and wildlife values that are impacted by the project.

The original Gooseberry Project Report of 1940 described a project conceived during the 1930s. It included the Gooseberry Reservoir and Tunnel, Mammoth Reservoir and Tunnel, the Gooseberry Highline Canal and a number of feeder canals. These facilities would divert water from the headwaters of the Price River and Huntington Creek into Sanpete Valley. The project would enlarge Scofield Reservoir on the Price River to enable complete diversion of water to meet the needs in the Price area.

Scofield Reservoir was reconstructed and enlarged during World War II because it was unsafe and to ensure water for power production needed in the war effort. As part of the Scofield Reservoir construction work, the Bureau of Reclamation; 1) Increased the capacity of the reservoir by over 30,000 acre-feet, 2) established an operational plan which specifically provided for the transmountain diversion features of the Gooseberry Project, and 3) obtained a subordination of all Price River Water Users Association's water rights to the Gooseberry Project transmountain diversion rights. Work has since been completed to increase the Scofield Dam's resistance to earthquakes.



Sevier Bridge Reservoir

Following the war, several planning efforts were undertaken to complete the Gooseberry Project. In 1964, the Narrows Tunnel was constructed. Soon, controversy developed over the final project feature, Gooseberry Dam. The controversy was thought to be resolved by; 1) A ruling by the Utah Supreme Court in 1982 reaffirming the binding effect of the Scofield Reconstruction and Repayment Contracts, 2) a Tripartite Agreement between Sanpete Water Conservancy District, Carbon Water Conservancy District and Price River Water Users Association concerning building of storage and diversion works on the Price River System for transmountain diversion from Gooseberry Creek to the San Pitch River System (this was upheld by the Utah Supreme Court in July 1987), and 3) a 1989 agreement with the U.S. Department of Justice whereby the United States subordinated its federal reserve water rights to the Gooseberry Project.

The future of the project now depends on the outcome of the recent public hearings. If the decision is favorable, the project could be implemented, however there is still opposition by Carbon County and environmental groups.

9.2.4 Environmental Considerations

Water resources both reflect and shape the environment of an area. Most of the streams flow through forested lands where there is high quality water providing opportunities for fishing, hunting, camping, hiking and other outdoor recreational activities. Some of these streams are accessible by automobile, others lend themselves more to horseback riding or hiking.

Streams in the upper watershed areas should remain in their original meandering channels. This prevents erosion and helps maintain the original riparian vegetation. Channels in the downstream areas often need more capacity to carry high flows of water. In some cases, it may be necessary to modify the channels to prevent damages to surrounding areas.

The primary reason for the construction of storage reservoirs has been to provide reliable irrigation supplies. However, instream flows were an incidental benefit that supports fisheries during the summer when natural flows would be too low. A water right is required if instream flows are to be maintained. Just the presence of water, whether it is a stream or a reservoir, makes more pleasing surroundings.

9.3 WATER RESOURCES PROBLEMS

The Sevier River main stem is one of the most efficiently used river systems in the United States as only 4 percent of the total yield reaches Sevier Lake. Most of this is intermittent flood flows and small amounts of groundwater and drainage system's outflow. Although the water resources are already highly developed, numerous management problems remain. As demand increases, driving the value of water higher, there will be increasing problems. There are basinwide water supply and use problems as well as those peculiar to the various subareas along the Sevier River.

9.3.1 Water Regulation Problems

The areas of the Sevier River above Circleville have only one surface water storage facility. As a result, the irrigation water supply in areas without storage is more than adequate during the early part of the irrigation season but is more limited during late summer, especially in drier years. Water users tend to divert more water than is needed or their rights allow early in the season when the runoff is high.

Although this over-application (diversion) reappears as return flow later in the year, it is also lower in quality. This same thing happens in other areas of the river system. As a result of this diversion, return flow, diversion, a "regime of the river" has been established.

There are other places along the river system, in Pahvant Valley and in the Levan area where small reservoirs to regulate flows would be an advantage in making best use of available water supplies. One example is a recently approved small reservoir in the lower end of the Highland Canal on the Gunnison Irrigation Company system. Other potential sites are on the lower end of Panguitch Creek and on Chicken and Pigeon creeks. Also, small reservoirs on Chalk Creek and Corn Creek would help regulate the stream flows. These reservoirs could regulate flows on the short-term for use later and may even improve the water quality.

9.3.2 Water Quality Problems

Water quality is a problem in the lower parts of the Sevier River, especially from Rocky Ford Reservoir downstream. In August 1988, the surface water quality south of Redmond was 1040 mg/L and the groundwater quality as measured in a well east of the river was 450 mg/L. The San Pitch River was measured at 920 mg/L below Gunnison Reservoir. Part of the increased pollution in the Sevier and San Pitch rivers comes from the Arapien shale in the Glenwood-Sigurd area and along the west side of Sanpete Valley. The Arapien shale in Southern Juab Valley contributes salts to flows into Chicken Creek Reservoir. Over-irrigation also leaches salts into the surface water and groundwater. As water is diverted, used for irrigation, reappears as return flow and is again diverted, additional salts are leached from the soil profile and concentrated in the river flow. The Sevier River at Lynndyl contained 1,025 mg/L in August 1988 with 281 cfs. Winter flows during 1988 reached 2,340 mg/L at 29 cfs.

Water quality is becoming the major problem in Pahvant Valley. This is the result of the small volume of groundwater outflow compared to the tributary inflow along with reuse of the groundwater. The high quality streamflow (240-435 mg/L)[58] is applied to the cropland and, as it percolates through the soil profile, it leaches salts into the groundwater reservoir. As groundwater is pumped for irrigation, it percolates down through the soil profile again, leaching more salts into the groundwater reservoir. This has slowly increased the total dissolved-solids to 765 mg/L (1,300 µS/cm) in the McCornick area and to more than 1 ,118 mg/L (2,000 µS/cm) in areas west of Meadow. The total dissolved-solids have increased from about 1,770 mg/L (3,000 µS/mg) in an area southwest of Black Rock Volcano during the period 1957-67 to nearly 5,310 mg/L (9,000 µS/cm) during the 1977-87 period.

The groundwater reservoir level has been declining over parts of Pahvant Valley due to well withdrawals in excess of recharge. The State Engineer has prepared a water management plan to protect the groundwater resources within the existing water law.

The groundwater quality also deteriorates in lower Southern Juab Valley and Mills Valley.[59] The water in upper Chicken Creek has been measured from 141 mg/L to 593 mg/L (240 to 1,005 µmhos/cm). The outflow from Chicken Creek Reservoir was measured at 780 mg/L (1,320 µS/cm) on November 17, 1993. A sample taken two miles downstream from Chicken Creek Reservoir in 1963 was measured at 4,290 mg/L (7,270 µmhos/cm) with a flow of 0.5 cfs. Chase Spring in Mills Valley was measured at 1,125 mg/L (1,910 µmhos/cm) at a flow of 3.1 cfs on June 13, 1963. The U.S. Geological Survey made a seepage run during October 1963 with water quality measurements as follows: Gage near Juab (just below the outlet of Sevier Bridge Reservoir), 1,800 mg/L (3,050 µmhos/cm) at 3.3 cfs; railroad crossing near Mills (below Blue and Mohlen springs) 725 mg/L (1,230 µmhos/cm) at 33.3 cfs; and at the head of Leamington Canyon, 710 mg/L (1,200 µmhos/cm) at 30.2 cfs.[11] This shows the dilution effect of good quality spring water on poor quality groundwater inflow. See Appendix A for the definition of water quality units of measurements.

9.3.3 Groundwater Development Problems

During a U.S. Geological Survey study, data was analyzed to determine the effect of irrigation water diversions in the upper Central Sevier Valley on two downstream wells, one on each side of the river.[39] Data was analyzed for 1987 and 1988.

One well was about two miles southeast of Elsinore and about one mile southeast of the Sevier River. The lag time from the high point of the diversions to the lowest well water level was about six months. The well water level ranged from two feet above to 3 ½ feet below average. The other well was about three miles southeast of Richfield near the northwest side of the Sevier River. The lag time was about eight months and the well water level varied from one foot above to 1 ½ feet below average.

Earlier studies by the U.S. Geological Survey described the relationship of the water level in an artesian well to the discharge of alluvial springs north of the Hepler Ponds.[79] During 1959, each foot of drop in the well water level reduced the spring flow about 1.7 cfs.

These studies indicate the direct relationship between the regime of the Sevier River, the groundwater levels and the discharge from springs. Any change in discharge from the system will probably impact other water rights.

Withdrawals from groundwater has been increasing at a faster rate in recent years because of the large number of small domestic wells being drilled. Domestic wells have been drilled to supply water for homes in the valley areas outside public water supplier service areas. Wells are also being drilled for summer home sites in the mountain areas throughout the basin.

The construction of more domestic wells is beginning to impact the groundwater in several ways. The use of this water will eventually have an effect on the spring flows in the area as well as on groundwater outflow to the river system. When a domestic well is developed, a spetic tank will also be installed. This will contribute to the contamination of the groundwater. Septic tanks are already becoming a pollution problem in the Fait-view, Levan, Monroe, Moroni and Mt Pleasant areas where populations are increasing at a faster rate.

There are 57 public community water systems supplying culinary water. All of these systems depend on groundwater (springs or wells) for their water supply. There are only six systems where existing supply will not be adequate to meet the needs of the projected population in the year 2020. The projected 1997-2020 population increase and the portion current water supplies wil serve are shown in Table 9-2

Table 9-2
COMMUNITIES WITH WATER SHORTAGES BY 2020

Community	Projected Growth	Growth Served by Existing Supply (no. of people)	Shortage (acre-feet)
Sanpete County			
Centerfield	503	502	Neg.
Fountain Green	543	0	136
Total	1,046	502	136
Sevier **County**			
Elsinore	399	216	54
Glenwood	299	211	53
Richfield	4,387	1,118	280
Salina	1,449	312	78
Total	6,534	312	465

Note: Projected supplies could be limited by water rights or by system capacity.

In March 1997, the State Engineer put a moratorium on all new appropriations of groundwater. The surface water has been closed to new appropriations since 1946. The growing number of new appropriations created a cumulative effect on downstream water rights. The most common appropriations were for domestic water rights entitling the user to not more than two acre-feet per year. Installation of more domestic water wells affects both the timing and the total volume of the return flow. With the groundwater moratorium in place, the total additional amount of groundwater diverted will be less.

It is still possible to drill a new domestic well under an existing approved filing. Otherwise, a water right would have to be purchased from another source such as stock in an irrigation company. Under this option, a change application would have to be filed requesting a change in point of diversion, place and purpose of use. If stock from an irrigation company is purchased, only the amount of water that would be depleted can be transferred. In addition, the place of use cannot be in another groundwater basin. Obtaining water through this means will become more difficult as irrigation companies are reluctant to allow transfer of stock out of the company. In fact, many irrigation companies in the basin are amending their bylaws to prohibit such actions.

Population increases in areas outside those served by public community systems will continue to demand increased amounts of water. The 1997 population of 9,495 people in the unincorporated areas is projected to increase to 12,616 people by 2020, an increase of 3,121 people. Assuming the same use rate with no conservation measures applied, the increased demand would be 960 acre-feet for domestic use in the unincorporated areas.

Table 9-3
CURRENT (1991) AND PROJECTED AGRICULTURAL WATER USE

	1991		2020	
County	Diversions	Depletions	Diversions	Depletions
Garfield	67,840	39,500	67,240	39,270
Iron	1,010	590	1,000	580
Juab	25,300	14,770	25,080	14,650
Kane	720	420	710	410
Millard	294,330	171,960	291,770	170,380
Piute	66,540	38,860	65,960	38,520
Sanpete	251,210	146,760	253,940[a]	148,300
Sevier	196,510	114,720	194,800	113,750
Total	903,460	527,580	900,500	525,860

[a] Includes imports from Narrows Project in Sanpete County.

9.4 WATER USE AND PROJECTED DEMANDS

Irrigated agriculture is the largest water user in the Sevier River Basin with depletions of 63.17 percent of the total use. The current use of water for municipal and industrial purposes is small, only 5.38 percent of the total use, however, this will be an increasing demand on the limited water supply.

9.4.1 Agricultural Water

Irrigation water supply and use have remained relatively stable over the years, fluctuating only with changes in precipitation cycles. Where there has been a change in total irrigated cropland areas, this has been according to the available water supply. Other factors have also had some influence such as the Intermountain Power Project.

Irrigation water use was about 10,000 acre-feet in 1850 when only 2,520 acres were under irrigation. By the turn of the century, this had increased to about 800,000 acre-feet. The current diversions are 903,460 acre-feet, but are to decrease slightly to 900,500 acre-feet by 2020 as agricultural water is converted to municipal projected and industrial uses. The current and projected demand is shown in Table 9-3. Refer to Section 10 for more information on irrigation water use.

9.4.2 Municipal and Industrial Water Use

New municipal and industrial water projects are usually formulated to develop additional water supplies. There is also a need to replace, update and expand existing community drinking water systems with a growing population.

Industrial use represents only a small portion of the total basin water use. Future industrial water use may increase as new industries are established. The present self-supplied industrial water use is 25,120 acre-feet. Also, there is an additional 1,170 acre-feet of culinary water supplied by public community systems for industrial use.

The demand for culinary water will grow as the population increases. The curent and projected demand for culinary water is given in Table 9-4.

9.4.3 Secondary Water

Communities are making increased use of secondary (dual) water systems to limit demand on their culinary water supply. There are 47 communities with secondary systems installed. The current and projected secondary water use is shown in Table 9-5.

Table 9-4
CURRENT (1996) AND PROJECTED CULINARY (M&I) WATER USE[a]

County	1996 Diversions	1996 Depletions	2020 Diversions	2020 Depletions
	(acre-feet)			
Garfield	500	250	710	360
Juab	560	280	740	370
Millard	3,730	1,870	5,120	2,560
Piute.	450	220	640	320
Sanpete	3,720	1,860	6,180	3,090
Sevier	5,360	2,680	8,460	4,230
Total	14,320	7,160	21,850	10,930

[a]Includes water delivered by public community systems only.

Table 9-5
CURRENT (1996) AND PROJECTED SECONDARY (M&I) WATER USE

County	1996 Diversions	1996 Depletions	2020 Diversions	2020 Depletions
	(acre-feet)			
Garfield	310	220	440	300
Juab	neg.[a]	neg.[a]	neg.[a]	neg.[a]
Millard	1,220	850	1,680	1,180
Piute	120	80	170	120
Sanpete	3,790	2,650	6,770[b]	4,740
Sevier	3,150	2,210	4,970	3,480
Total	8,590	6,010	14,030	9,820

a Levan diverts about 800 acre-feet of culinary quality water from an irrigation water well into the public water supply system which includes lawn and garden uses.
b Includes 480 acre-feet import from Narrows Project.

9.4.4 Recreational Water Use

All of the reservoirs provide some type of recreation. The larger water areas such as Piute, Otter Creek and Sevier Bridge (Yuba Lake) reservoirs provide nearly 16,000 surface acres for boating, fishing and water skiing. In addition, the smaller reservoirs are used for fishing and asdestination sites for camping, picnicking and other recreational activities. See Section 15, Water-Related Recreation for more information.

9.4.5 Environmental Water Needs

A significant portion of the water supply is used to support riparian vegetation and wetlands. Instream flows provide habitat for fish and wildlife. Phreatophytes provide cover and food for wildlife. There are 92,000 acres of wetlands and small open water areas including 25,340 acres of riparian vegetation determined from the Division of Water Resources 1990s land-use surveys. These include natural as well as man-made areas. These areas deplete 262,620 acre-feet of water. Most of these areas act as natural filters, removing some nutrients and other pollutants from the waters flowing through them.

9.4.6 Water Use Summary

All current water use and projected demands are based on currently available data. These are shown in Table 9-6 for 1996, 2020 and 2050. Figure 9-2 shows current and projected water demands.

The industrial use represents only a small portion of the total basin water use. Future industrial water use may increase as new industries are established. The present self-supplied industrial water use is 25,120 acre-feet. Also, there is an additional 1,170 acre-feet of culinary water supplied by public community systems for industrial use.

9.5 WATER DEVELOPMENT AND MANAGEMENT ALTERNATIVES

All water resources in the Sevier River Basin are considered to be appropriated. The only way to meet additional water demands **is** by changing from one use to another or at different locations. The supply can continue to be enhanced through cloud seeding.

Table 9-6
SUMMARY OF CURRENT AND PROJECTED WATER DEMANDS

Use	1996 Diversions	1996 Depletions	2020 Diversions	2020 Depletions	2050 Diversions	2050 Depletions
	(acre-feet)					
Municipal and Industrial						
Industrial[a]	25,120[c]	22,610	29,040	26,140	30,960	27,860
Culinary	23,360	16,350	33,190	23,230	37280	26,100
Secondary	8,590	6,010	14,030[f]	9,820	16,110	11,280
Irrigation[b]	903,460[d]	527,580	900,500[g]	525,860	887,990	518,570
Wet/Open Areas[b]	216,710	216,710	216,710	216,710	216,710	216,710
Net Evaporat.[b] (Major revors.)	45,910	45,910	45,910	45,910	45,910	45,910
Basin Total	1,223,150[e]	835,170	1,239,380	847,670	1,234,960	846,430

[a] Assumes use by Intermountain Power Projects remains constant.
[b] Based on 1985 land use surveys.
[c] Does not include 1,170 acre-feet supplied by public community systems.
[d] Current use of 903,460 acre-feet is for 1991.
[e] Includes return flows as water is diverted more than once.
[f] Includes 480 acre-feet from the Narrows Project in Sanpete County.
[g] Includes 4,920 acre-feet from the Narrows Project

9.5.1 Water Supply Management

Construction of small surface water reservoirs at selected locations may be a way of controlling some water supplies for local groups or individuals. These would be operated as a short-term storage reservoir rather than for long-term storage.

Real-Time Control - Automated stations can be a more efficient way to regulate the diversion of water from the river and stream systems. These systems can be operated by remote control to regulate gates at canal diversion structures, saving trips for the water master and allowing better response times. Automated systems can be adjusted to change the diversion depending on the call for water or in case of sudden flood flows. Some additional work will be required to adapt each station for automation but this can be done by the river commissioner thus saving installation costs. The stations will also have to be protected from vandalism. Some of these systems are now in use in the Richfield and Delta areas. Automation can also be used at gaging station sites to obtain real-time data.

9.52 Groundwater Management (Conjunctive Use)

Some communities are now and soon will be facing a shortage of culinary water as the demand for water increases to meet the needs of an expanding population. The challenge facing water managers is to devise ways to conjunctively use the surface water and groundwater and not adversely impair prior rights. Some alternatives include the following. These are not listed in order of priority.

- Utilizing the groundwater reservoirs
- Using treated surface water supplies
- Restricting home construction in areas outside existing community service areas
- Expanding the present community service areas
- Conversion of agricultural water to municipal and industrial uses
- Increasing the use of secondary systems to reduce the demand for culinary water

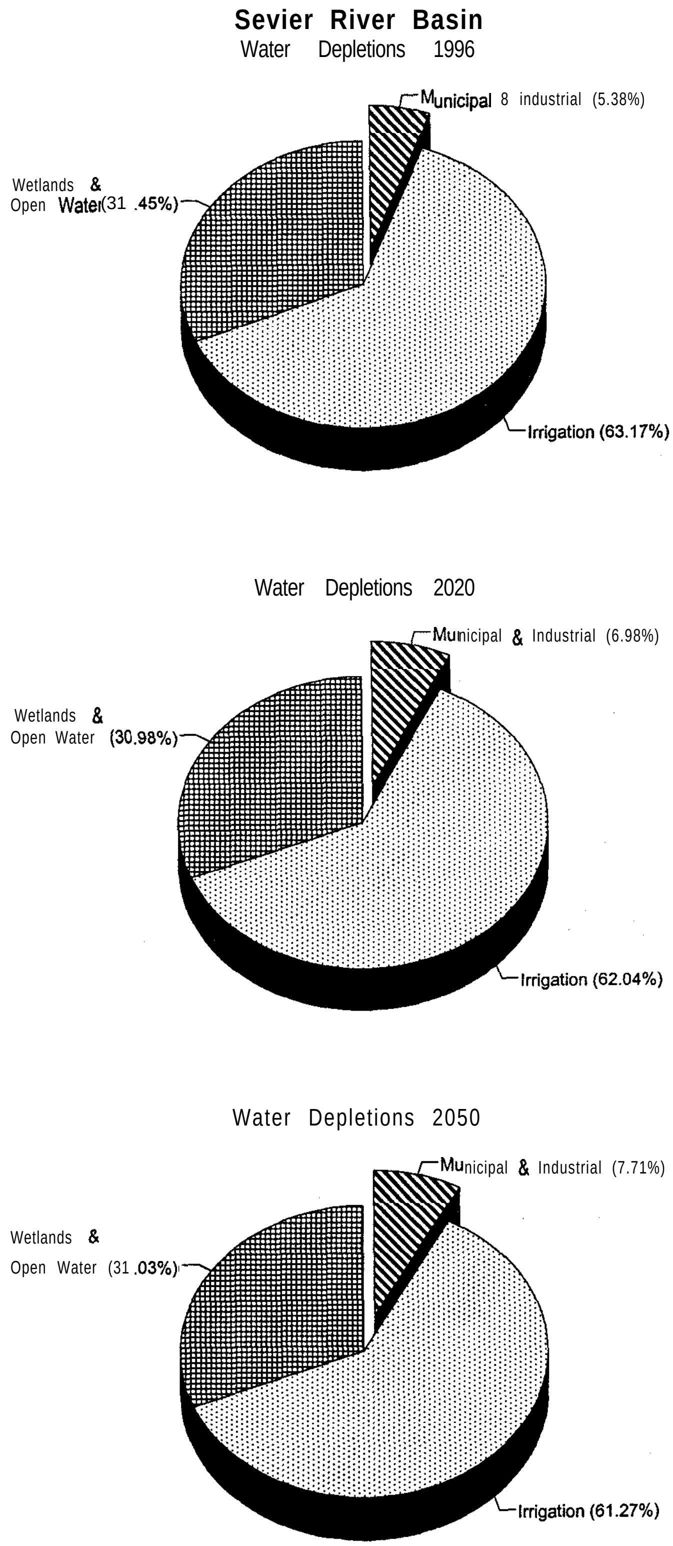


Figure 9-2

CURRENT AND PROJECTED WATER DEMANDS

Planning for future needs may involve one or a combination of the above alternatives. This will require a cooperative approach which should involve all the prior right holders. New users of culinary water should be assured a firm, dependable supply. At the same time, impacted water right holders will have to be compensated.

Recent studies were conducted by the U.S. Geological Survey in in the Sevier River Basin[30,31,33,52,68] These studies have indicated if more groundwater is pumped or additional acreages changed from flood to sprinkler irrigation, there would be an impact on the river system hydrology.

This impact would vary from basin to basin. Models were based on a simplified set of assumptions regarding the hydrologic system but appear to adequately represent the physical conditions. The varying data on groundwater inflow from consolidated rocks around the boundary and the groundwater reservoir strata, i.e., clay/sand-gravel layers, were not completely modeled. However, as indicated in the reports, the actual results would probably have less impact than shown by the simulations.

Table 9-7 shows the results of a simulation using increased pumpage from the Sevier-Sigurd Basin.[33] Similar studies were performed for Panguitch Valley, Sanpete Valley, Pahvant Valley and Sevier Desert.

Decreases in discharge from groundwater would be spread over several uses. The largest impact would be seepage to the Sevier River. Computed groundwater-level declines of less than six feet occurred over most of the area.

More detailed studies are needed because of the complex relations between the surface water and the groundwater. Additional data collection is needed to improve estimates of discharge to the Sevier River and to the large alluvial springs.

Another alternative has been discussed - tapping the deep aquifers below 800 feet for additional water. However, the water quality is poor in many areas where deep wells have been drilled. This could be a potential for future consideration.

9.5.3 Cloud Seeding

The Utah Cloud Seeding Program has the goal of increasing winter precipitation within targeted mountain watersheds. Enhanced winter snowpack leads to additional streamflow runoff and underground water storage during the spring and summer months.

Operational cloud seeding is a relatively lowcost method of increasing water supplies. The state, through the division and Board of Water Resources, cost-shares with local sponsors for cloud seeding projects. The effectiveness of a cloud seeding project cannot be determined without several years of operation, because of the wide variability in the weather from year to year.

Evaluations have been made of the Central and Southern Utah Project precipitation and snowpack water content data from gage sites within the areas affected by cloud seeding. These evaluations indicate that over the long term (since cloud seeding began in 1974), snowpack water content is averaging about 9 percent more each seeded season than would have been expected at highly correlated unseeded sites. Total precipitation through the bulk of the winter period (December-March) has been increased by more than 14 percent on the average when compared to the most probable amount predicted by statistical analyses.

Cloud seeding is most effective when it is continued over several years providing increased soil moisture, increased groundwater for springs, and maintaining base flows. Seeding only in dry years may not be as effective because of a lack of seedable storm systems.

The cloud seeding program covers all of the counties in the Sevier River Basin. This program has provided additional water supplies through increased surface water flows as well as more groundwater inflows to the valley areas. Increased groundwater is especially valuable as the delayed regime provides flows during the late summer when additional water is needed.

9.5.4 Water Education

Numerous programs are available for promoting water education. The annual Young Artists' Water Education Poster contest is an event which continues to be the highlight of October, Water Education month. Children in kindergarten to 6th grade participate in this statewide contest each year. Themes chosen each year all relate to water as a

Table 9-7
SIMULATED EFFECTS OF GROUNDWATER PUMPING FOR CENTRAL SEVIER VALLEY

Item	Steady-State (acre-feet)	Effects Prediction at End of 20-year Period with 15,000 AF Increased Pumpage (acre-feet)	Change (acre-feet)
Seepage from precipitation	2,200	2,200	0
Seepage from irrigation	43,200	43,200	0
Inflow from consolidated rock	10,600	11,600	1,000
Seepage from canals	9,000	9,000	0
Seepage from Sevier River	8,400	12,000	3,600
Seepage from other streams	14,200	14,200	0
Storage		200	200
Total	87,600	92,400	4,800
Discharge			
Evapotranspiration	14,600	13,300	-1,300
Seepage to Sevier River	29,800	26,700	-3,100
Springs	18,900	16,500	-2,400
Drains	12,100	9,900	-2,200
Pumping wells	1,100	17,500	16,400
Flowing wells	8,600	6,000	-2,600
Subsurface outflow	2,500	2,500	0
Total	87,600	92,400	4,800

Source: U.S. Geological Survey and Division of Water Rights Technical Publication 103.

resource. The same amount of water exists today as when earth was first formed. However, demand for water keeps increasing. According to some water resources specialists, water usage has tripled since 1950. Human needs have to be satisfied while protecting the ecological integrity of natural systems. Communities need to balance their use of water with their responsibility for its quality and availability. These and other problems will continue to confront us into the 21st century. Finding the answers depends on a populace sensitive to and knowledgeable about water and related resources. Education provides one of the best approaches to ensuring responsible behavior toward water. Project WET (Water Education for Teachers), through its education services and programs, will help prepare students for citizenship in the next century.

The goal of Project WET is to facilitate and promote awareness, appreciation, knowledge and stewardship of water resources. This is done through the development and dissemination of classroom-ready teaching aids and through the establishment of state and internationally sponsored programs.

Project WET is sponsored in Utah by the Division of Water Resources. A state coordinator supervises the training of public and private school teachers in a workshop setting where innovative water related, hands-on, and fun activities prepare them for classroom successes. Water fairs can be conducted in individual schools where classes are taught by teachers trained in Project WET workshops and by trained local water professionals.

Section 10 Sevier River Basin
AGRICULTURAL WATER

Tables

Figures

Section Ten Sevier River Basin - State Water Plan

Agricultural Water

Agriculture is the backbone of the Sevier River Basin economy.

10.1 INTRODUCTION

This section describes the agricultural resources in the Sevier River Basin. It also describes the problems, needs and future of agriculture.

The success of agriculture is dependent on the climate, soils and water supply in each locality but it can only aspire to what each farmer and rancher wants for the future. Agriculture is the major industry; as such, it has a direct impact on the economy of the area. Spinoffs from agriculture help support employment and production in other sectors along with providing economic diversity.

10.2 BACKGROUND

The irrigated land was estimated at 2,520 acres in 1850 and had increased to about 100,000 acres by 1870. By 1884, only 14 years later, the irrigated cropland area had doubled to 200,000 acres. By the turn of the century, an additional 100,000 acres was under irrigation and by 1920, the total irrigated area was 350,000 acres. An inventory of the irrigated cropland during the 1980s showed there were 381,090 acres.[20] However, a Division of Water Resources land-use survey conducted during the early 1990s show 354,320 acres of irrigated cropland.[21] The water budgets[16] and projected agricultural water use are based on the 1985 inventory. A water budget was not prepared based on the data of the 1990s.

Large increases in irrigated lands came between 1869-80; 112,300 acres in 11 years. 1902 saw the biggest single- year increase of 77,000 acres The increase in irrigated land gradually slowed until it was controlled by the available water supply. Fluctuations in streamflows are indicated by the increase or decrease in the acres of idle and/or fallowed cropland.

These changes in water supply are less pronounced in Pahvant Valley where pumped water is a larger proportion of the total supply. During the drier years, more water is pumped from groundwater to supply the total crop demand. Conversely, less water is pumped during the wetter years.

Fluctuations in cropland irrigated in the Levan area are less than on the Sevier River but larger than Pahvant Valley. This reflects the volume of groundwater pumped in relation to surface water use.

There are many tracts of arable land where crops could be cultivated if there were a dependable water supply. Some areas are restricted because of topography, others because of lands such as national parks and monuments and state parks. Nearly the entire basin is suitable for grazing by livestock and wildlife.

Typically, irrigated cropland is in the valley bottoms where the land is relatively flat. Much of the non-irrigated dry cropland areas is located where there is arable land with sufficient precipitation. Rangeland is found from the low-lying desert areas to the high-mountain forests.

The number of farms has decreased by about one-third over the years.[65] This has been accompanied by an increase in average farm size from about 200 acres in 1924 to about 750 acres in 1964. This included all uses such as irrigated and dry cropland and rangeland. In 1992, the average farm size varied from 390 acres for Sevier County to 790 acres in Millard County and 1,640 acres in Juab County. This reflects the need for more acreage to maintain a viable operation. An increase in the number of part-time farmers may offset this trend. There may be a continual adjustment as existing irrigated cropland is converted to other uses. Water for agriculture is limited and restricts increases in the irrigated cropland acreage.

Beef cattle production is currently the largest farm-related industry, primarily consisting of cow-calf operations along with feedlots. Most of the crops grown are used to support these activities along with pasture and rangelands.

There are several large dairy operations that depend on feed and pasture. The turkey industry is important in Sanpete Valley. It depends on feed production from irrigated lands and uses agricultural and culinary water. The mushroom plant near Fillmore distributes produce throughout Utah and Colorado. A large chicken operation is planned northwest of Delta.

10.3 AGRICULTURAL LANDS

Agricultural lands cover a major portion of the Sevier River Basin. These lands are in all kinds of ownership and administration categories: private, state, tribal and federal. All the irrigated croplands are in private ownership while most of the grazing lands are under state, tribal and federal administration.

10.3.1 Irrigated Croplands

The irrigated acreage stabilized at just under 350,000 by 1920. Irrigation water use followed the same trends. Irrigated areas are shown on Figure 10-1. Most of the crop current production is used to support the livestock industry, although some alfalfa is shipped out of the area, primarily to Nevada, California and Japan. Most of the exported alfalfa is from the Delta area.

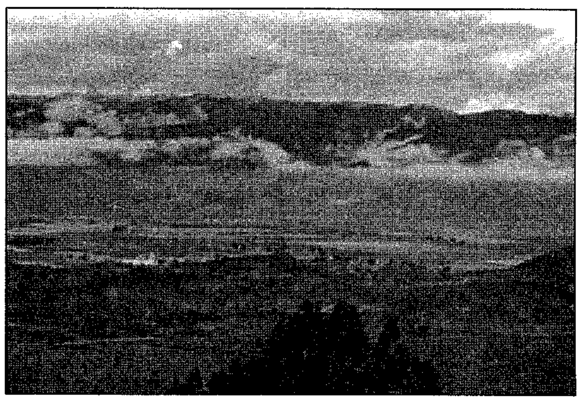
Irrigation water use has remained relatively stable over the past 50 years, fluctuating only with the wet and dry cycles. The effects of the short-term cycles are dampened somewhat by the extensive surface-water storage facilities. Groundwater pumping in Pahvant Valley and Levan tend to reduce the impact of dry years.

The extent of irrigated cropland is reflected in the water use. An average of about 903,460 acre-feet of the total water supply is diverted for irrigation of croplands. It is estimated 783,000 acre-feet comes from surface water and 120,460 acre-feet is pumped from groundwater. This use is based on the 1980s land use surveys, water budgets based on the period 1951-80 and several studies by the U.S. Geological Survey during the 1960s, 1980s and 1990s. Irrigation water use is shown on Table 10-l. For definitions of diversion, depletion and consumptive use see Appendix A.

There has been no significant change in the total basin-wide acreage of irrigated cropland for the last 50 years except for the cropland taken out of production when the Intermountain Power Project purchased water rights in the Delta area for their operation. A study was conducted by the Soil Conservation Service during the early 1960s to determine the irrigated cropland acreages. The Division of Water Resources contracted for land-use surveys in the early 1980s for the upper, middle and lower portions of the Sevier River Basin. The division again conducted land-use surveys in the early 1990s using aerial photography with field checks to delineate the cropland areas. Most of the differences in acreage determined by these surveys can be attributed to methodology used and definition of croplands. The inventories show irrigated acreages at that point in time. Each survey will vary as methodology improves. Also, they are not intended to show the irrigated lands as described in Bacon's Bible or used in the Cox Decree.

The most recent survey (1995) by the Division of Water Resources is the most accurate. This land-use survey inventoried the cropland by various categories of land use. The irrigated cropland inventory included idle and fallow lands as these usually are included in the crop rotation patterns. The total irrigated cropland area in 1995 was 354,320 acres. The major crops include alfalfa, 40 percent; small grains, 13 percent; pasture and grass hay, 14 percent; and idle and fallow, 12 percent. The pasture and grass hay include surface and subirrigated cropland.

Changes in cropland acreage came about by various reasons. Part of the idle land is now in the



Irrigated Cropland in Sevier Valley

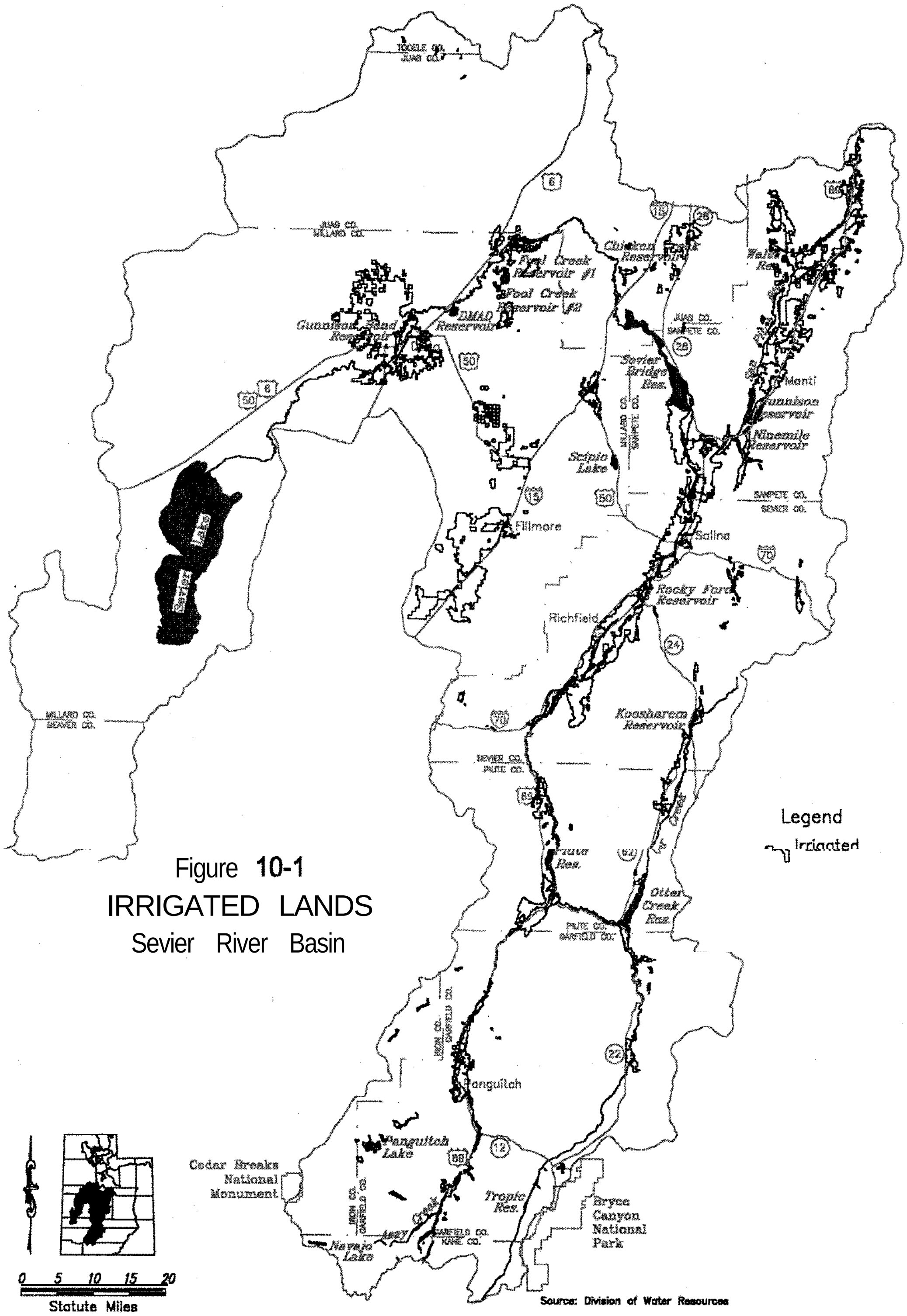


Figure **10-1**
IRRIGATED LANDS
Sevier River Basin

Table 10-1 IRRIGATION WATER USE AND DEPLETION			
Subbasin	Area (acres)	Diversion (acre-feet)	Depletion (acre-feet)
Upper Sevier	15,200	60,720	13,960
East Fork	17,540	24,800	20,530
Junction-Marysvale	14,680	57,410	28,340
Richfield	4 1,260	121,870	50,640
Gunnison	52,940	151,950	58,850
San Pitch	83,740	167,080	116,990
Scipio/Levan	34,800	36,900	30,940
Delta	69,510	139,970	125,520
Pahvant Valley	51,430	142,760	81,810
Total	381,100	903,460	527,580

Source: Land-use surveys, 1981-85 and water budgets, 1991 Division of Water Resources

Changes in cropland acreage came about by various reasons. Part of the idle land is now in the USDA Conservation Reserve Program. The interstate highway construction had a minor impact primarily in the Pahvant Valley. The Intermountain Power Project had a greater impact locally as irrigated land was retired when water rights were purchased for operation of the plant. Better inventory methods changed some acreages. The irrigated land by crop is shown in Table 10-2. This shows irrigated land inventoried in the 1990s. The irrigated land by crop is also shown on Figure 10-2.

Lands used for farming can be defined according to their agricultural production ability and potential. The Natural Resources Conservation Service uses two major categories to define the best farmlands: prime farmlands and farmlands of statewide importance. The national definition has been modified for application to the state of Utah. There are about 144,600 acres of prime farmlands used for agriculture in the basin. The acreage of farmlands of statewide importance was not estimated.

Irrigation of cropland in the Delta area is carried out using water high in total dissolved solids on soils with a large fraction of clay. By the time upstream flows reach Sevier Bridge Reservoir, the total dissolved solids (TDS) are upwards of 1,500 mg/L. This water is made up of high-sodium summer return flows and low-sodium winter flows.

In dry years, the inflow water quality is much lower than during wet years. As the water moves downstream, the salt load increases until the TDS are about 2,500 mg/L near Hinckley. Beyond this point, the water often reaches 3,000 mg/L.

The crops and soils in the Delta area have adapted somewhat to the chemical constituents through intense cultural practices and management. This included drilling deep wells to provide higher quality water; leveling cropland and lining canals to increase conveyance and irrigation efficiencies to help lower the water table; and establishing a realistic leaching program which includes deep scarifying, using humus to control sodium, applying irrigation water for leaching and constructing drains to carry away the excess water.

10.3.2 Dry Cropiand

There are 40,400 acres of dry cropland. Of this amount, 95 percent is in Millard County and most of the balance is in Juab County.[63, 64] Minor areas of dry cropland are also in Sanpete Valley. About 55 percent of the total dry cropland is either idle, fallow or not cropped for other reasons on any given year. Many of these idle acres are in the Conservation Reserve Program, a federal program designed to reduce soil loss and bolster the grain price.

Table 10-2
SUMMARY OF LAND COVER BY COUNTY
(1993 and 1995)

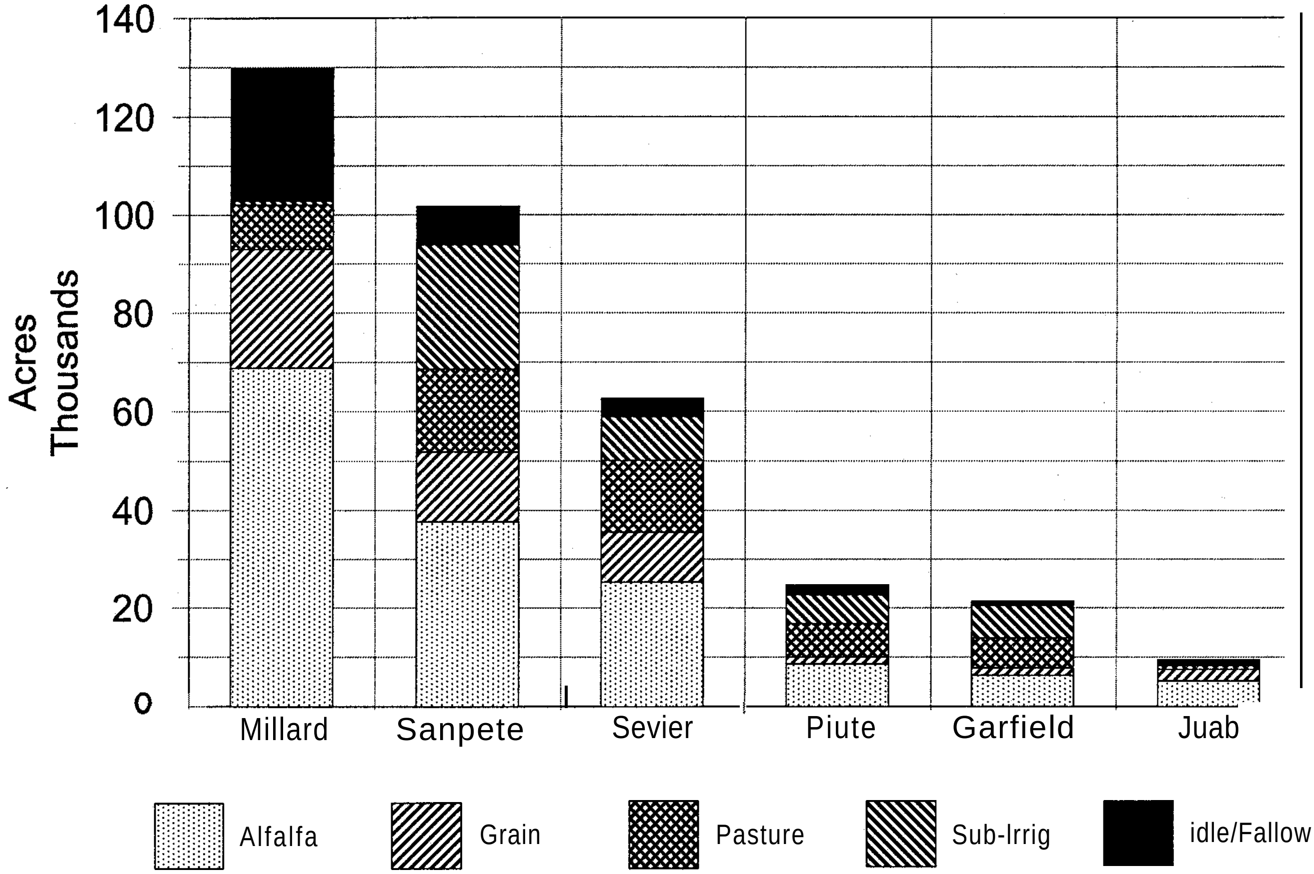
Cover	Iron	Piute	Garfield	Kane	Sevier	Sanpete	Millard	Juab	Tooele	Total
						(acres)				
Surface Irrigated **Cropland**										
Orchard	0	0	0	0	20	10	40	0	0	70
Grain	0	1,550	1,530	0	5,860	12,370	21,310	2,400	0	45,020
Corn	0	40	20	0	4,440	2,040	2,790	100	0	9,430
Row Crops	0	0	0	0	10	30	1,240	0	0	1,280
Alfalfa	0	6,660	4,990	0	23,420	31,610	68,470	5,060	0	140,210
Grass/Hay	0	1,910	1,370	0	1,940	5,960	460	60	0	11,700
Pasture	30	6,810	6,070	110	14,600	16,560	9,130	570	200	54,080
Grass/Turf	0	0	0	0	170	10	0	230	0	410
Idle Plowed	0	390	250	0	910	1,100	3,210	490	0	6,350
Idle Overgrown	0	1,660	600	0	2,710	6,660	23,900	790	0	36.320
Pasture (Surf & Sub)	440	5,230	6,320	230	8,250	8,910	180	130	0	29,690
Grass/Hay (Surf & Sub)	0	0	0	0	0	2,140	0	50	0	2,190
Subtotal	470	24,250	21,150	340	62,330	87,400	130,730	9,880	200	336,750
Sub-Irrigated **Cropland**										
Sub-irrigated Pasture	70	420	290	200	480	14,200	370	1,380	0	17,410
Sub-irrigated Grass/Hay	0	0	0	0	0	160	0	0	0	160
Subtotal	70	420	290	200	480	14,360	370	1,380	0	17,570
Total **Irrigated** Croplands	540	24,670	21,440	540	62,810	101,760	131,100	11,260	200	354,320

Source: Division of Water Resources, Water-Related Land Use Inventories, Sevier River Basin, 1996

Figure 1 O-2

IRRIGATED CROPLAND

Sevier River Basin



Some of the dry cropland areas produce grasses for livestock grazing. These grasses are both native and exotic varieties. Only about 8,000 acres of dry cropland are used for small grain production. There are small acreages of dry cropland alfalfa production but only one crop is harvested for hay. There may be some use as pasture.

10.3.3 Rangelands

Rangelands comprise the largest segment of agricultural land with just over five million acres or 75 percent of the total basin area. Some of this land is forested, but is also grazed by livestock and/or wildlife. Large areas of grazing land are located in the western part of the basin. These areas are used for winter grazing.

Winter grazing areas have also been bought by the Division of Wildlife Resources to protect land frequented by deer. These areas tend to run along the foothills between the irrigated areas and forested lands. Other lands are used by waterfowl and the three state fish hatcheries. These areas cover a total of 48,790 acres.

Permitted grazing on public lands declined after the 1940s, but since then has remained fairly stable. Many grazing permits have changed from sheep to cattle. As rangeland conditions improve, grazing permits should be restored where vegetation has been stabilized.

There has been considerable work done in localized areas to increase livestock and wildlife forage on rangelands with practices such as chaining pinyon-juniper and brush, and reseeding with grass. Management practices have been improved. Forage production varies greatly between types of vegetation, range condition, and good and bad years. Range in fair condition produces 50 to 80 percent as much forage as range in good condition. Variations in range conditions from good to bad years can reduce forage production by 40 to 70 percent.

There are between 600,000 and 650,000 animal unit months (AUMs) of grazing produced. These are supported by base property in the irrigated cropland areas where pasture and winter feed is produced.

There are about 500 cattle and 100 sheep operations, with base property in the Sevier River Basin, that graze on national forest lands. These permittees utilize between 100,000 and 150,000 AUMs. In addition, 300 cattle and 130 sheep operations grazed on lands administered by the Bureau of Land Management where about 350,000 AUMs were utilized. State and private lands provide about 150,000 AUMs.

The Bureau of Land Management has allocated from 30,000 to 40,000 AUMs for wildlife. The Forest Service estimates about 10-15 percent of the AUMs allocated are utilized by wildlife. The cattle/sheep and wildlife ratios should be maintained to protect the viability of the livestock operations.

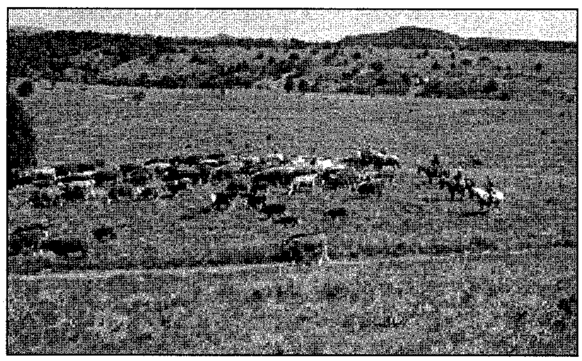
10.3.4 Watershed Management

Watershed management is the protection, conservation and use of all the natural resources of a drainage area to keep the soil mantle in place and productive and to produce the quality water needed for downstream uses. Poorly managed watersheds are readily damaged from erosion, flooding, sediment and fire.

Following are some of the treatment measures used to keep watersheds viable:

- Livestock and wildlife management
- Vegetation improvement
- Structural measures
- Watering facilities protection
- Controlled burns

Clean Lakes Program improvement projects were implemented in the watershed area to reduce non-point source pollution in Otter Creek Reservoir. Three projects totaling 2,280 acres were spearheaded by the Bureau of Land Management. The project



Cattle on Pahvant Range-Fish Lake National Forest lands are improved through brush control and reseeding using funding from private, state and federal sources.

10.3.5 Other Lands

There were 129,950 acres of other lands inventoried during the land-use survey in 1995.[21] These lands included 92,000 acres of wetlands and open water areas and 37,950 acres of residential and industrial areas. These lands are in the valley bottoms; lands in the foothills and mountain areas were not included.

10.4 AGRICULTURAL WATER PROBLEMS AND NEEDS

Most of the water problems are related to irrigation water use and management since agriculture is the largest user. Other problems include watershed erosion and sediment production.

Weed control is a problem throughout the valley agricultural lands as well as in the upper watershed areas. Thistle control is a particular problem.

10.4.1 Irrigation Water Problems

Water quality in some of the groundwater reservoirs is deteriorating. Most of the contamination is coming from deep percolation of irrigation water and leaching from geologic formations. This water is leaching salts out of the soils and into the groundwater. This is a problem in the irrigated areas upstream from Sevier Bridge Reservoir and in Pahvant Valley. However, there are many examples of well-managed farm operations in all of these areas where deep percolation and the resulting pollution of groundwater are lower.

The Sevier Desert area is unique. In this area, leaching of salts from the crop root zone is necessary to assure continued crop production. After considerable trial and error, the water table, salt balance and leaching requirements are now in critical balance so crop production can be maintained or increased.

A major irrigation water problem is low efficiency in both conveyance and on-farm irrigation systems. Over-irrigation also leaches saline contaminants into the groundwater.

Use of the Sevier River is based on inefficiency. Return flows from inefficient use upstream is generally a downstream water right. This is particularly true along the Sevier River mainstem where there are geologic restrictions between groundwater basins. For example, more efficient use in Panguitch Valley may not change the volume in downstream flows if there is a reduction in the amount of water diverted and the acreage irrigated remains the same. There would be a change in timing as the flows not diverted are immediately available where return flows from irrigation takes longer to reach the river. A change in timing could impact some water rights. However, return flow timing is further modified by downstream storage reservoirs. If late summer shortages were supplemented by improved efficiencies, there would be some increased use resulting in less return flows.

In off main-stem areas such as Chalk Creek, Meadow Creek and Corn Creek in Pahvant Valley or Chicken and Pigeon creeks near Levan, increased water use would decrease recharge to the groundwater. In addition, improved overall delivery and application efficiencies, would reduce deep percolation to the groundwater reservoirs. To compensate, the diversions could be reduced allowing more water to flow to the natural recharge areas. However, as increased acreage cannot be brought under irrigation, the only incentive to the farmer would be labor savings and increased crop production through more efficient water application.

There are water shortages from time to time throughout the Sevier River Basin. Water-budget data indicates there is an average annual shortage of nearly 7,500 acre-feet to fulfill crop potential consumptive use needs. This would require a diversion of 12,930 acre-feet. At present, the acreage of irrigated cropland increases or decreases from year to year depending on the available water supply.

10.4.2 Erosion

Any improper practice using land beyond its capabilities contributes to erosion. Examples are improper road and trail location and changes in natural stream regimen. The increased use of 4-wheel drive vehicles, ORVs and motorcycles leave tracks that can develop into small gullies and increase erosion. Land administering agencies should increase the control of watershed abuse by the recreating public. The effect of accelerated wind erosion is spectacular in-the Little Sahara area. Several thousand acres are covered by sand dunes not unlike some vast desert. This phenomenon has been turned into a popular recreation area.

There are more than 200,000 acres of geologic erosion, nearly 1 ,OOO,OOO acres of heavy to excessive erosion and 1 ,OOO,OOO acres of moderate erosion. Areas of heavy to excessive and geologic erosion are shown on Figure 10-3. These two erosion classifications are described as follows.

Heavy to excessive erosion Gully systems are well developed with active small gullies. Sheet erosion and hummocking is extreme, root systems of shrubs and trees may be exposed. Plant cover, often annuals, is low in the successional stages and often has no
stabilizing influence on the soil. There is little or no humus present.

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

Erosion conditions were mapped from information in the National Forest Range Allotment Analysis surveys and Bureau of Land Management Range Condition surveys and data developed during the USDA investigations on the Sevier River Basin in the 1960s.

Although range condition has improved, the principal cause of accelerated erosion is still over-grazing by domestic livestock and overpopulation of wildlife. Grazing reached its peak between 1875 and 1910. This depleted the vegetation to the extent accelerated erosion became a dominant feature in some areas, contributing to extreme flooding and mud-rock flows. Since then, grazing has been reduced and better management practices have been implemented. Vegetation manipulation and reseeding practices have improved the watersheds resulting in reduced erosion.

Transmountain and transwatershed diversions have created erosion problems in several areas. These include transmountain diversions conveying water from the Colorado River drainage to the San Pitch River drainage and diversion of Castle Creek to Panguitch Lake.

10.4.3 Sedimentation

Sediment damage falls into two major categories: (1) Spectacular cloudburst flood sediments, and (2) insidious sedimentation with perennial stream flows. Costs can be large from either type of sedimentation. The highest sedimentation rates are in the following five drainages.[63] Rates are given in acre-feet per square mile of drainage area. These are: (1) 4.20, Ephraim Creek; (2) 1.90, Pleasant Creek near Mt. Pleasant; (3) 1.70, Cottonwood Creek near Richfield; (4) 1 .10, Sand and "H" Canyons near Monroe; and (5) 0.72, Flat Canyon near Elsinore.

Sediment records were collected for the Sevier River at Hatch for 1992 to 1995. Based on this data, the sedimentation rate was 0.03 acre-feet per square mile. This rate shows sedimentation in the headwater of the Sevier River is very low.

Sediment damages to irrigation facilities occur in three forms. First, deposits in diversion structures and canals from the water supply. This requires continuous clean out and is more serious in areas above major reservoirs and on tributary streams. Second, deposits from floodwater intercepted by canals. This requires sediment removal unless the flood flows can be bypassed. Third, deposits on irrigated lands, especially in those areas irrigated with water not regulated by storage reservoirs. Sediment deposition requires periodic releveling of cropland to maintain irrigation efficiencies. Conversion to sprinkler systems and the accompanying sediment removal facilities can eliminate this problem.

Sediment deposition rates were determined for Otter Creek, Piute and Sevier Bridge Reservoirs.[63] These rates were based on surveys of the three reservoirs in 1962-63 and on the original surveys conducted between 1926 and 1941. Sediment accumulations were determined and the annual storage capacity loss was calculated.

The average annual storage capacity loss was as follows: Otter Creek Reservoir, 0.110 percent; Piute Reservoir, 0.173 percent; and Sevier Bridge Reservoir, 0.051 percent. At this rate, all three reservoirs will last more than 500 years. A total of about 8,000 acre-feet of sediment has been deposited

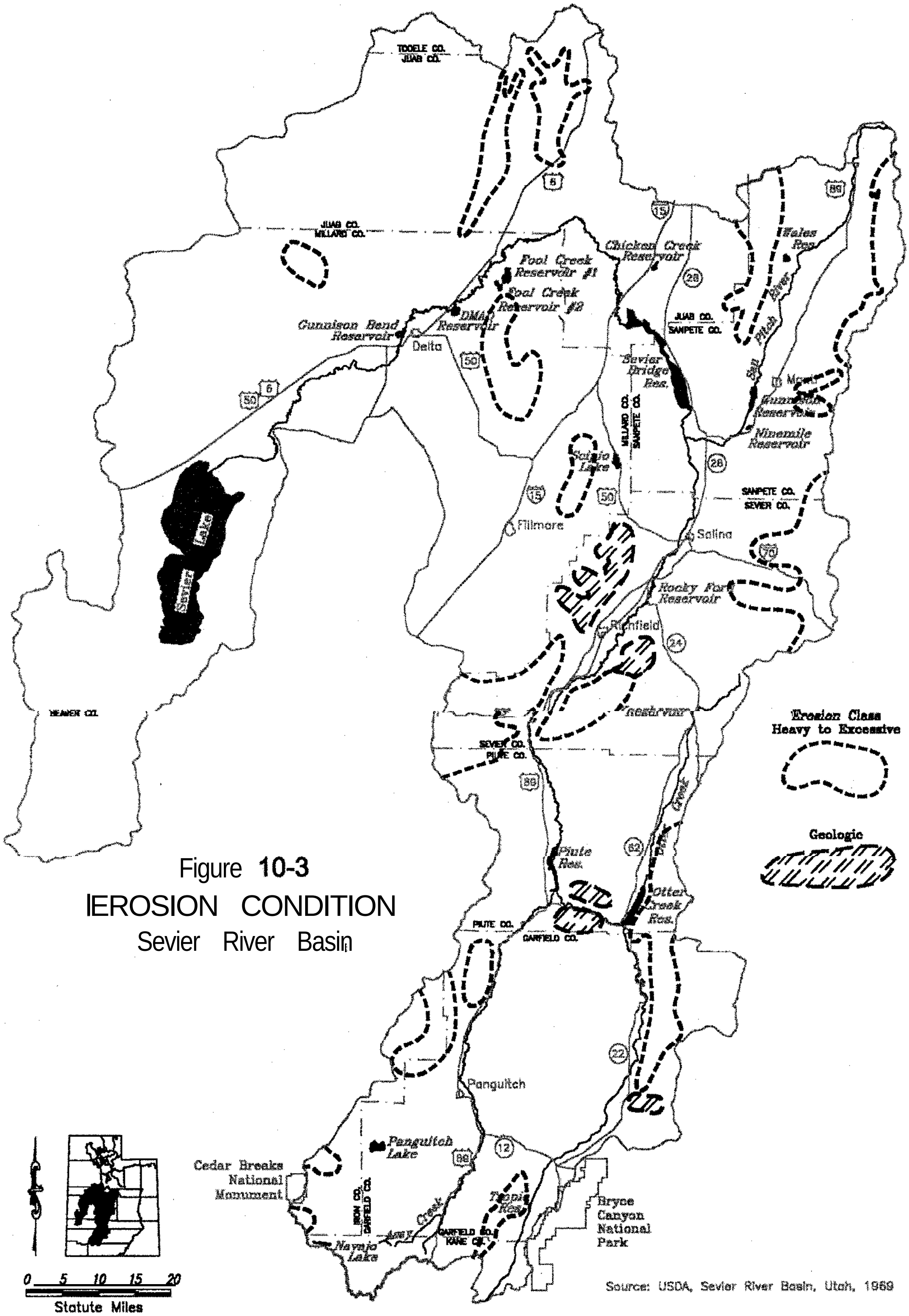


Figure 10-3
EROSION CONDITION
Sevier River Basin

in these reservoirs. This is not the total volume of sediment transported into the reservoir area as there are large volumes of sediment entrapped immediately above the reservoirs. The sediment deposition rate could not be established for Gunnison Reservoir since no previous survey had been made to determine capacity. However, an original survey was completed in 1964 to determine the area-capacity relationships.

10.5 CONSERVATION AND DEVELOPMENT ALTERNATIVES

The only possibility for additional water from outside the basin is the potential Narrows (Gooseberry) Project. Since there is no water available from the Central Utah Project, the only other option is to make additional water available within the basin. This can come from three sources: better management of the surface water supplies, increased utilization of the groundwater reservoirs and maximizing the cloud-seeding program.

Improvement of water use efficiency is one way to realize additional monetary benefits from an existing supply. Delivery systems can be upgraded by lining high seepage areas in canals with concrete or plastic lining and by installing pipelines. Improving or rebuilding diversion structures and effective measurement and management controls can also increase efficient use of water. This could include use of real-time stream gauging station data.[45] See the issue on real-time monitoring and control systems in Section 6.5.1.

Real-time instrumentation on canal diversions is being used in the Delta and Richfield areas. Results are up to expectations so far with water savings more than 10 percent. This approach could be a valuable tool in other areas.

On-farm irrigation efficiency improvements are a way to reduce the increasing contamination of the groundwater reservoirs. If water is applied more efficiently, less will be used and the deep percolation to groundwater will be reduced. This will decrease the volume of total dissolved solids removed from the soils and conveyed into the groundwater. Over-irrigation is common throughout the basin.

The best way to reduce accelerated erosion is to establish a healthy watershed. If there are a variety of grasses and forbes along with brush in the lower elevations and a mixture of conifers and aspen along with grasses in the higher elevations, erosion will be drastically reduced. This will require an intensive rehabilitation program along with intensive management livestock and wildlife grazing. With reduced erosion, there will be less sedimentation.

Along this same line, recent studies by the Forest Service have indicated increases in runoff can be achieved if upper watershed vegetation can be managed.[8,9,10] However, this will require more research. Studies to date indicate water yield can be increased if aspen dominated stands exist rather than mixed conifer with some aspen. For every 1,000 acres of forest lands converted from conifer to aspen, annual water gain can be 250-500 acre-feet. In addition, there is a potential gain of 500 to 1,000 pounds of undergrowth, most of which is forage. This could lead to a gain in numbers and kinds of plants and animals.

Not only does this increase the downstream water supply and forage for livestock and wildlife, it also provides sites for recreational opportunities, wood fiber, landscape diversity and esthetics. The loss of these benefits has come from the successional process, reduction of wildfire which has allowed dense conifer stands, and long-term overuse by cattle and wildlife. There are several, although often controversial, alternatives to reduce replacement of aspen stands by conifers, sagebrush or tall shrubs. These include fire, harvesting, spraying, ripping and chaining.

10.6 ISSUES AND RECOMMENDATIONS

There is one issue. It is the need for a study of range practices.

10.6.1 Rangeland Erosion Study

Issue - A study of rangeland condition is needed to determine potential erosion reduction practices.

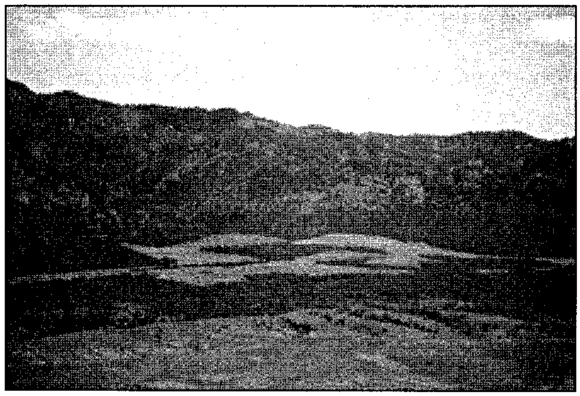
Discussion - All land has a natural productivity potential and a natural rate of erosion based on undisturbed conditions. An inventory is needed to determine the present condition of the land, what future condition can be expected and the treatment alternatives to improve the productivity and reduce erosion.

Basic information is provided by hydrologic, agronomic, soils and economic analyses in order to make intelligent choices among the alternative treatments to alleviate the problems. This basic information comes from the present condition inventory.

Watersheds yielding the highest volumes of sediment should be prioritized. These watersheds should be inventoried by order of priority to evaluate the present condition and to determine the structural and non-structural measures needed to control erosion, sediment yield and floods. These measures include land treatment, structures and land management.

Urban lands make up part of the watershed. In urban areas, soil and land use information are needed to identify areas most suited for urban development and poorly suited for agriculture. This will allow planners to guide urban expansion and protect good agricultural areas from encroachment.

Recommendation - The Division of Water Quality in cooperation with the local Soil Conservation Districts should take the lead in identifying high priority watersheds needing treatment. The Department of Agriculture and other state and federal agencies should assist as requested.



Rangeland vegetation improvement

Section 11 Sevier River Basin
DRINKING WATER

Tables

Figure

Drinking Water

Public water purveyors need to apply diligent management to consistently supply high-quality drinking water to water users.

11.1 INTRODUCTION

This section discusses public and private culinary water supplies in the Sevier River Basin. It reviews the systems and their present conditions. The problems are discussed and alternative solutions are presented.

11.2 SETTING

Even though water systems provide many categories of uses, the primary purpose is to supply drinking water to the people. Although the earliest settlers located near streams, they were quick to pipe spring water to the community or dig wells to assure a high quality, readily available supply. More distant communities utilized wells or piped water long distances from springs near the mountains.

Population is the main factor controlling culinary water demand. It is expected future demand will be met from groundwater supplies. Culinary water use in homes is fairly consistent throughout the year but use for lawn and garden irrigation adds substantially to the demand during spring and summer.

State of Utah Administrative Rules for Public Drinking Water Systems, R309-200 thru R309-211, define a public water system (PWS) as one with at least 15 connections or serves an average of at least 25 people at least 60 days per year. PWSs are further categorized into community water systems (CWSs) or non-community water systems (NCWSs). A CWS serves at least 15 connections used by year-round residents or regularly serves at least 25 year-round residents.

Non-community water systems are categorized as either non-transient non-community water systems (NTNCWSs) or transient non-community water systems (TNCWs). NTNCWSs regularly serve at least 25 of the same nonresident persons per day for more than six months per year. Examples include water systems that serve churches, schools, and work places. TNCWSs regularly serve at least 25 different nonresident persons per day for more than six months per year, and do not serve 25 of the same nonresidents per day. Examples include campgrounds, restaurants and retail stores with fewer than 25 permanent nonresident staff. Private water systems include self-supplied industrial facilities and domestic wells or springs. Examples include isolated individual homes or industries located outside CWS service areas.

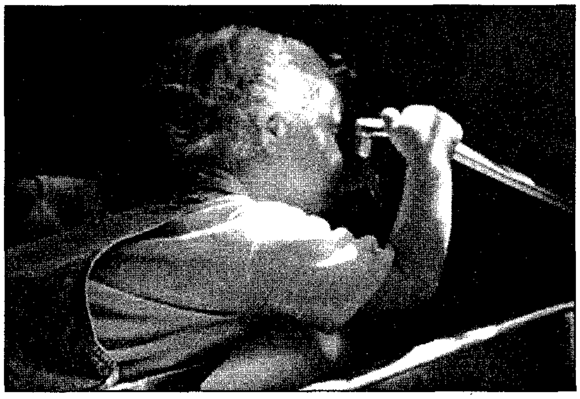
The State of Utah Division of Drinking Water (DDW) designates each CWS, NTNCWS and TNCWS as “approved” or “unapproved” on the basis of compliance with various federal regulations and state rules for drinking water systems. Drinking water systems seldom remain on the unapproved list very long. The Kanosh-Paiute Indian Reservation in Millard County and the Shadow Mountain Estates in Sevier County are not presently rated.

Presently, surface water supplies are regulated to a much greater degree than groundwater or spring water supplies. All surface water supplies require minimum treatment in the form of disinfection against waterborne, disease-causing organisms and viruses. Additionally, filtration is frequently mandated as a secondary barrier against their occurrence in water distribution systems. All of the public water systems in the Sevier River Basin obtain their water from springs and/or wells. There are no surface water sources at present.

CWSs serve both municipal and industrial (M&I) users. While not all industrial users require culinary quality water, the bulk of industrially delivered water is of culinary quality because of the convenience of using the local community water production and delivery systems.

11.3 ORGANIZATIONS, REGULATIONS AND RULES

All public drinking water supplies are subject to the Utah Safe Drinking Water Act and the Utah Public Drinking Water Regulations. In addition, all public drinking water supplies are subject to federal regulations promulgated under the authority of the federal Safe Drinking Water Act (SDWA) of 1974, the SDWA Amendments of 1986, and the 1996 Reauthorized Safe Drinking Water Act.


Drinking water quality is important

11.3.1 Local

Towns, cities and counties each have primary responsibility for drinking water quality control within their respective jurisdictions. There are 57 public drinking water systems in the basin.

11.3.2 State

The Utah Safe Drinking Water Act (USDWA) of 1974 and Amendments of 1986 and 1996 created the Drinking Water Board and empowered it to adopt, as necessary, Administrative Rules for Public Drinking Water Systems. The Division of Drinking Water administers and enforces the federal regulations and state rules. In addition, the Division of Water Rights and local boards of health regulate certain issues that pertain to drinking water well construction.

The USDWA authorizes rule promulgation by the board designed to; 1) Establish standards for drinking water quality, 2) establish standards for the design and construction of new and expanded water treatment and conveyance facilities, 3) protect watersheds and other sources of raw public water supplies, 4) provide technical and financial assistance to train operators, construct new treatment and distribution facilities, and renovate existing ones, 5) administer federal programs providing technical and financial assistance to local water agencies, 6) carry out emergency plans when natural disasters contaminate public drinking water supplies, and 7) provide enforcement of both state and federal drinking water regulations.

State rules are equal to or more stringent than federal regulations. More stringent state rules have resulted when the Board and Division of Drinking Water have made a determination after public hearings that federal regulations do not adequately protect some aspect of drinking water quality.

Maximum contaminant levels (MCLs) have been established by the Division of Drinking Water setting treatment thresholds. MCLs have been established for primary and secondary water quality parameters and treatment process objectives. Primary standards apply to water quality parameters that affect public health and safety while secondary standards apply to maintenance of aesthetic water quality parameters such as taste, odor and turbidity.

The Division of Drinking Water also administers construction funding. These funds are used to construct new water system infrastructure as well as repair existing treatment and distribution facilities. Construction funds are allocated in four ways -- interest loans, credit enhancements, direct grants, and interest buy-downs.

Through the federal 1996 Reauthorized Safe Drinking Water Act, the Drinking Water Board presently receives funds to establish a drinking water State Revolving Fund (SRF). The purpose of this fund is to ensure all drinking water systems within the state are capable of

Table 1 l-l STATE REVOLVING FUND PROJECTIONS			
Year	Federal	State (millions)	Total
1998	9.76	$1.95	$11.71
1999	6.0	1.2	7.2
2000	6.5	1.3	7.8
200 l-2003	6.0-6.5/vear	1.2-l .3/year	7.2-7.8/vear

maintaining and protecting the supply of public drinking water at an affordable cost. Funding projections through the next several years for Drinking Water Board projects are shown in Table 1 l-l.

The Drinking Water Board has committed funds greatly in excess of the federally required minimum 20- percent match. These state funds come from both repayments and cash reserves associated with the SRF and general tax revenues.

The scope and nature of extreme emergencies endangering the public health must be reported to the Division of Drinking Water. If the report shows significant decline in the public water supply quality, the division takes immediate action to rectify the hazard. Water system operating policies may then be revised to prevent similar problems in the future.

The 1986 federal Safe Drinking Water Act (SDWA) amendments require all states to develop wellhead protection programs. As a result, the Division of Drinking Water has created the Drinking Water Source Protection Rule (DWSPR) outlining the general requirements to protect wellheads from outside surface contamination. Procedures are outlined in the State's Administrative Rules for Public Drinking Water Systems R309-200 through R309-211. Requirements of the DWSPR include preparation of a Drinking Water Source Protection Plan for each groundwater source in all public water systems. The system operators have primary responsibility for preparation of these plans. An exception may be granted when the operator of a public water system cannot afford the cost of preparing the plan. DWSPR also requires proof of ownership and maintenance of all land in and around wellheads where recontamination from surface water sources can occur. Monitoring programs established by state rules and federal regulations are used to determine if public water systems are meeting standards.

The Rules for Public Drinking Water Systems, R309-102-9 requires all public water systems; 1) Serving more than 800 individuals, 2) employing treatment processes in surface water production facilities, or 3) distributing well or spring water that may be under the influence of surface water; to have an operator certified in accordance with the standards of R309-201. The Division of Drinking Water recently received authorization to amend the rules to extend the operator certification requirement to all CWSs, NCNTWSs and NCTWSs. The rule modifications will likely appear in 1999.

R309-104 of the Rules for Public Drinking Water Systems set allowable contaminant levels and address state requirements for public water system operators to monitor existing drinking water quality by testing and analyzing water samples. The rules also outline the documentation requirements of water quality analysis by others for submission to the Division of Drinking Water.

11.3.3 Federal

The federal Safe Drinking Water Act (SDWA) of 1974 authorized the Environmental

Protection Agency (EPA) promulgation of natural drinking water regulations to protect the public from waterborne diseases. The SDWA was expanded and strengthened via the SDWA Amendments of 1986. This increased the responsibility of the EPA to; 1) Establish maximum levels of contamination for established pollutants, 2) set deadlines for owners/operators of treatment facilities to comply with federal regulations, 3) regulate sources for lead and copper protection, and 4) strengthen enforcement of all regulations in the act.

The SDWA requires EPA to regulate chemical, radiological, physical and bacteriological substances in drinking water posing a health risk to the public. The EPA has established maximum contaminant levels (MCLs) for an extensive list of organic and inorganic contaminants. In addition, the SDWA established a strict schedule for EPA to set MCLs for additional contaminants. These are regularly identified and subjected to additional regulations.

The reauthorization of the 1996 Safe Drinking Water Act added some additional requirements. These amendments created several new programs and included authorization of $12 billion nationwide in federal funds for various drinking water programs and activities from '1997 through 2003.

New capacity development provisions were also part of the Reauthorized SDWA. The EPA was required to complete a review of existing state capacity development efforts and publish information to assist the states and public water suppliers with these efforts by February 6, 1997.

The EPA was to have published regulations by August 6, 1998 requiring community water systems to prepare and distribute consumer confidence reports at least once a year. However, the state governors were empowered to waive the direct mailing requirement for these reports for community water systems of fewer than 10,000 people.

Under present law, EPA must publish a maximum contaminant level goal (MCLG) and promulgate a National Primary Drinking Water Regulation (NPDWR) for contaminants where; 1) There may be an adverse effect on human health, 2) contaminants are known, or are likely, to occur in public water systems at a frequency and concentration of significance to public health, and 3) regulation offers a meaningful opportunity to reduce health risk for people served by public water systems.

EPA is also legislatively directed to issue regulations establishing criteria for a monitoring program for unregulated contaminants. The regulations will not require sampling by all systems but by only a representative group serving 10,000 or fewer people. By August 6, 1999, and every five years thereafter, EPA must issue a list of no more than 30 unregulated contaminants to be monitored and included in the occurrence data base by public water systems. The Reauthorized SDWA also allows EPA to provide grants to states for the development and implementation of state programs to ensure the coordinated and comprehensive protection of groundwater resources.

11.4 DRINKING WATER PROBLEMS

Demand for high quality water supplies and the potential for contamination has increased in areas of population growth. Much of the water for culinary use comes from springs, the balance from wells.

11.4.1 Deterioration of Facilities and Supplies

When the basin was first settled, communities developed culinary water supply systems. Many of these early systems have been replaced or upgraded to provide an adequate culinary water supply. Within the next few years, parts or all of other community drinking water facilities need to be upgraded or replaced to ensure water supplies are sufficient and in compliance with increasingly stringent water quality standards.

Natural geologic conditions, along with human activities such as mining, hazardous waste spills, agriculture and construction, all contribute to drinking water quality deterioration. Contamination also comes from upper watershed activities such as improper timber harvesting, over-grazing by wildlife and livestock, and recreation. These activities tend to reduce vegetation and expose the soil to erosion and sediment production. This can reduce the water infiltration process, which is the source of groundwater supply to springs. In some areas such as along the western slopes of the Wasatch Plateau and on the Markagunt Plateau, summer home wastewater systems such as septic tanks can contribute to the pollution of both springs and down slope domestic water wells unless proper waste disposal practices are in place.

In addition, there is a need for affordable water quality testing methods for domestic well owners, preferably home testing kits. Domestic well users may need affordable home treatment units for remediation of contamination by nitrates, pesticides, or volatile organics.

11.4.2 Spring and Wellhead Area Protection

Currently, public water suppliers are required to own or control protection zones around their supply sources. However, many of the culinary water sources were established prior to the state's protection requirements. As a result, many springs and wells used for culinary water supplies do not meet the current rules for protection from sources of pollution. However, if contamination occurs, state rules mandate protection of the source from further pollution.

Current regulations require source protection plans for public community water systems wells by the end of 1998 and for springs by 1999. These rules apply to community systems serving less than 3,300 people. The Division of Drinking Water has funding available of $2,500 for each source protection plan.

There are 57 public community water systems in the basin. Only 22 of these have submitted water source protection plans for one or more of their sources. Plans were submitted for 72 water sources. The status of the plans submitted is as follows: Concur, 9; concur/recommendations, 2; disapproved, 24; incomplete, 6; and no status, 3 1. Figure 1 l-1 shows the location of the public community water systems.

There were 10 systems not classed as public that submitted water source protection plans for 18 sources. The status of the plans submitted is: Concur, 3; concur/recommendations, 4; disapproved, 2; incomplete, 4; and no status, 5.

11.4.3 Culinary Water Shortages

Public water suppliers will need additional sources of culinary water to meet the increasing demands. In some locations, existing springs can be developed to produce more water or additional springs can be diverted into the existing systems. This would all require a water right.

In many locales, however, new wells will need to be constructed to meet the increased demands. This will require an existing groundwater right or purchase and change in place and nature of an existing surface water right. However, the ability to acquire water rights is becoming more difficult.

11.5 CULINARY WATER USE AND PROJECTED DEMANDS

The average water use in the Sevier River Basin in 1996 was 267 gallons of culinary water per capita per day (gpcd). About 133 gpcd or 50 percent of the culinary water was used indoors. The statewide average is about 268 gpcd. Average use during 1996 varied from 190 gpcd in Sanpete County to 357 gpcd in Millard County and 415 gpcd in Juab County. The culinary water demand for each community is shown in Table 1 l-2. The current use (1996)and projected demand for each county through the year 2020 are shown in Table 9-2. The variability between communities can be attributed to the amounts of culinary water used for outside lawn and garden irrigation and the amounts lost to system leaks and other deficiencies. Some water systems also have large users such as dairies or feed lots that skew the average usage data for the general population.

There are hundreds of homes built in mountain areas such as the Markagunt Plateau, Monroe Mountain and the Wasatch Plateau. The demand for domestic water supplies in these areas has been, and will continue to increase. Water production from private domestic wells has been increasingly popular. Since the basin

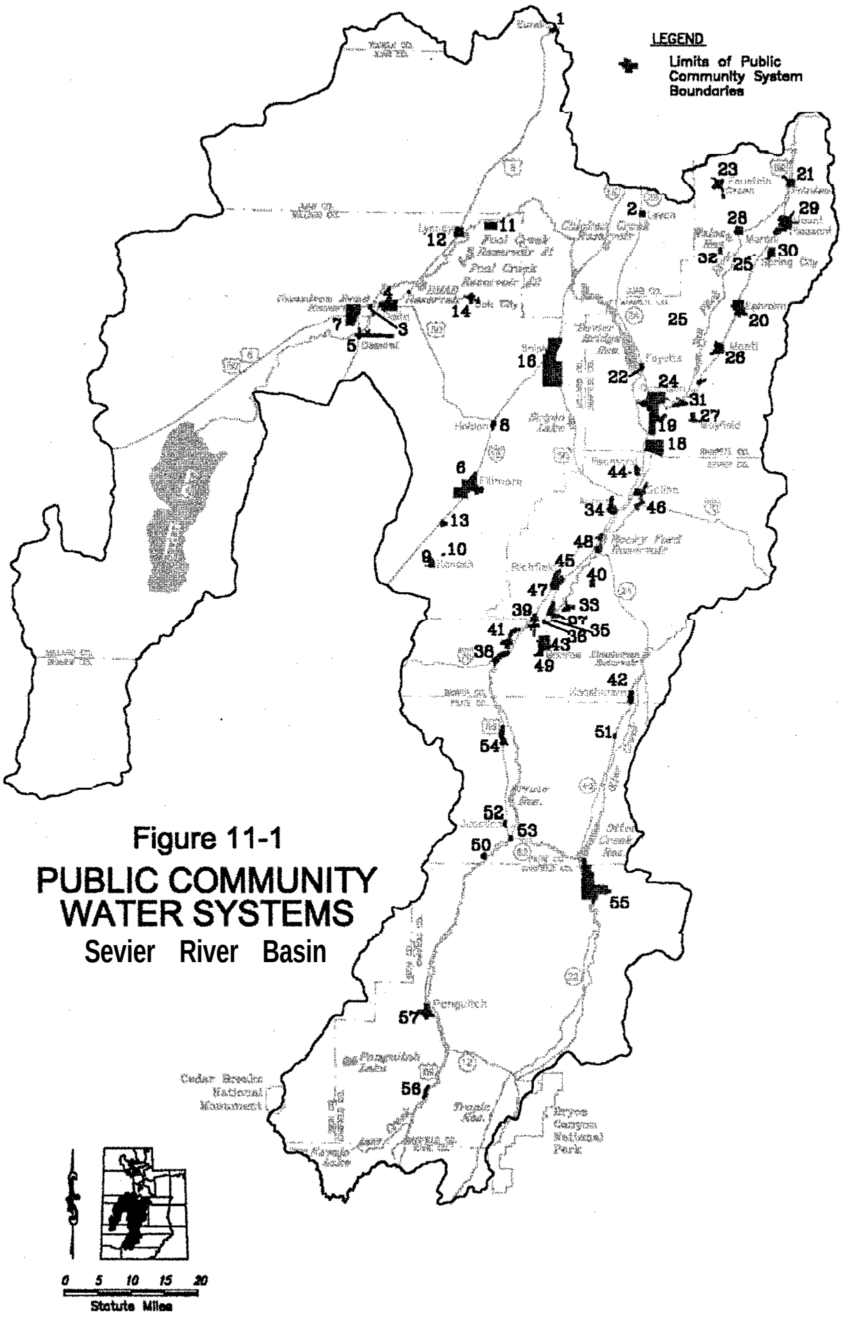


Figure 11-1
PUBLIC COMMUNITY WATER SYSTEMS
Sevier River Basin

JUAB COUNTY

1. Eureka City Wcter
2. Levan Culinary Water

MILLARD COUNTY

3. Country Estates
4. Delta City
5. Deseret-Oasis Special Service District
6. Fillmore Municipal Water System
7. Hinckley City Water
8. Holden Town Corporation Water
9. Kanosh City Water System
10. Kanosh-Paiute Indian Reservation
11. Leamington Town Water
12. Lynndyl
13. Meadow Town Corporation Water
14. Oak City Municipal Water System
15. Oak Meadows Subdivision
16. Scipio Culinary Wcter System
17. Sherwood Water Company

SANPETE COUNTY

18. Axtell Community Service District
1% Centerfield Water and Improvement District
20. Ephriam Municipal Wctar Department
21. Fairview Municipal Water
22. Fayette Town
23. Fountain Green
24. Gunnison City Corporation Wctar
25. Heartland Mobile Home Park
26. Manti City Corporation Water
27. Mayfield Wctar Department
28. Moroni Municipal Water System
29. Mt. Pleasant City
30. Spring City Municipal Water System
31. Sterling Municipal Wcter System
32. Wales Town Water

SEVIER COUNTY

33. Annabella
34. Aurora
35. Austin Community Special Service District
36. Brooklyn Tap Line Company
37. Central Waterworks Company
38. Cove Special Service District
39. Elsinore Town
40. Glenwood Municipal Water System
41. Joseph
42. Koosharem
43. Monroe City
44. Redmond
45. Richfield City
46. Salina
47. Shadow Mountain Estates Subdivision
48. Sigurd Municipal Water System
49. South Monroe

PIUTE COUNTY

50. Circleville Culinary Water
51. Greenwich Waterworks Company
52. Junction Town
53. Kingston Town Corporation
54. Marysvale Culinary Water

GARFIELD COUNTY

55. Antimony Town Water System
56. Hatch Culinary Water
57. Panguitch City Water

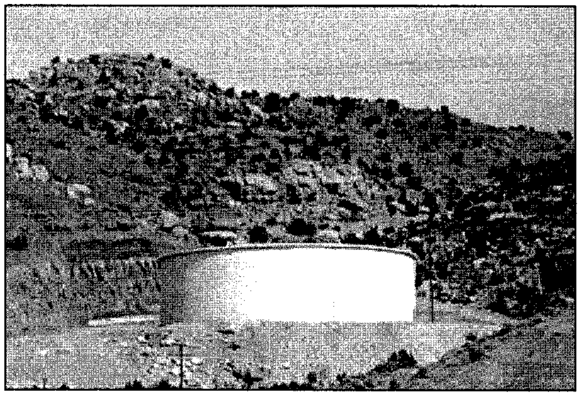
is closed to development of new domestic wells, sources to meet the future demand will have to come from existing rights.

Estimates of culinary water use by 2020 were based on population projections. The culinary water diversions were projected to increase from 14,320 acre-feet in 1996 to 21,850 acre-feet by 2020. Depletions increased from 7,160 acre-feet in 1996 to 10,930 acre-feet by 2020. This is an increase of 53 percent in 24 years.

11.6 ALTERNATIVE SOLUTIONS

The location and type of development occurring will dictate how culinary water is provided for expanding populations. The needed water will come from springs and wells. Construction of water treatment plants as a precondition to the use of surface water supplies is possible but this source is unlikely because of cost. The increased use of private domestic wells for single residences is possible under the present moratorium with the purchase of existing water rights. This will likely result in conversion of a small quantity of agricultural water rights to culinary water purposes.

There is another possibility for providing a water supply for domestic wells. This would be establishment of a water bank where water could be stored in upstream reservoirs to replace groundwater used for domestic purposes. This stored water could come from water rights of owners who may have surplus water or who may have land to retire. A long-term lease would be required for any water put in such a water bank.



Richfield City water storage tank

Table 11-2
PUBLIC COMMUNITY SYSTEMS CULINARY WATER SUPPLY AND USE-1996

Water Supplier	Population Served	Total Connect	Reliable Source (ac-ft)	M&I Use (ac-ft)	Per Capita Use (gpcd)	System Capacity (ac-ft)
GARFIELD						
Antimony	215	120	287	62	257	124
Hatch	110	88	145	51	410	61
Panguitch	1,500	845	1,762	391	233	770
Garfield County Total	1,825	1,053	2,194	504	247	955
JUAB						
Eureka	640	315	155	68	95	78
Levan	564	257	1,048	491	777	- 491
Juab County Total	1,204	572	1,203	559	415	569
MILLARD						
Delta	2,998	1,022	1,768	1,177	350	1,177
Deseret-Oasis SS	491	138	679	135	246	295
Country Estates	72	18	30	8	100	15
Kanosh-Paiute Indian Res.	50	14	NA	13	223	NA
Lynndyl	150	67	1,161	49	290	498
Oak Meadows Subdivision	60	14	81	16	241	35
Sherwood Water Company	54	58	48	16	266	21
Fillmore	2,300	884	4,173	907	352	1,768
Hinckley	680	238	573	211	277	247
Holden	500	217	484	201	360	205
Kanosh	450	236	672	285	565	285
Leamington	250	85	181	89	318	89
Meadow	250	159	540	148	528	224
Oak City	650	236	1,395	331	455	583
Scipio	375	153	478	144	343	201
Millard County Total	9,330	3,539	12,263	3,730	357	5,643
PIUTE						
Circleville	500	261	766	236	421	236
Greenwich Waterworks Co	65	19	149	14	196	14
Junction	150	129	181	53	314	53
Kingston	145	67	193	33	201	33
Marysvale	310	220	223	115	332	115
Piute County Total	1,170	696	1,512	451	344	451
SANPETE						
Axtell	155	83	242	54	309	54
Centerfield War&Imp	800	342	724	445	496	445
Ephraim	3,300	961	3,627	820	222	1,593
Fairview	1,300	505	727	209	143	337

Table 11-2 Continued - -
PUBLIC COMMUNITY SYSTEMS CULINARY WATER SUPPLY AND USE-1996

Water Supplier	People Served	Total Connect	Reliable Source (ac-ft)	M&I Use (ac-ft)	Per Capita Use (gpcd)	System Capacity (ac-ft)
Fayette	195	63	177	89	408	89
Fountain Green	950	273	294	295	277	295
Gunnison	2,000	543	2,122	419	187	949
Heartland Mobile Home Pk	30	12	48	3	101	24
Manti	2,500	855	2,524	482	172	1,140
Maryfield	500	157	154	76	136	76
Moroni	2,000	416	1,089	203	90	557
Mt. Pleasant	2,333	1,060	1,840	432	165	836
Spring City	900	345	555	109	108	272
Sterling	350	116	234	53	135	110
Wales	200	90	130	31	139	61
Sanpete County Total	17,513	5,821	14,487	3,720	190	6,838
SEVIER						
Annabella	700	253	724	115	148	335
Aurora	993	315	453	170	152	208
Austin Come S.D.	142	45	89	36	223	39
Brooklyn Tapline Co.	160	50	NA	52	290	NA
Central Valley	741	136	360	114	137	168
Cove S.D.	130	42	257	75	516	107
Elsinore Town	750	303	683	530	631	530
Glenwood	437	155	181	122	249	122
Joseph	450	146	408	120	238	178
Koosharem	400	168	445	80	178	200
Monroe	1,606	688	1,289	628	349	628
Redmond	850	267	935	245	258	405
Richfield	6,800	2,247	2,419	2,077	273	2,077
Salina	2,200	924	905	793	322	793
Shadow Mnt. Estates Subdiv.	37	13	58	9	205	26
Sigurd	385	159	715	161	373	302
South Monroe	42	14	NA	31	650	NA
Sevier County Total	16,823	5,925	9,921	5,358	284	6,118
BASIN TOTAL	47,865	17,606	41,580	14,322	267	20,574

Source: Municipal and Industrial Water Use Inventory, Division of Water Resources.

Section 12 Sevier River Basin
WATER QUALITY

Tables

Figures

section Twelve Sevier River Basin- State Water Plan

Water Quality

Good quality water is an indicator of a healthy, well-managed environment.

12.1 INTRODUCTION

Utah was introduced to maintaining high quality water resources with introduction of the Utah Water Pollution Control Act of 1953. This was reinforced by the Federal Water Pollution Control Act of 1972.. In 1984, the governor of Utah issued an executive order to prepare and implement a groundwater protection plan. It is evident water quality is an important aspect of our lives. This section describes the existing levels of water pollution in the Sevier River Basin. Sources of pollution are identified, problems and solutions are discussed and recommendations are given for water quality management and improvement.

12.2 SETTING

The highest water quality is found in the upper reaches of the Sevier River, its tributaries and the streams flowing into Pahvant Valley. As the water flows downstream, the quality deteriorates.

The Division of Water Quality is currently conducting surface- water quality studies and the results will be published in 1999. Selected parts of this plan will be included in the report by the Division of Water Quality.

The U.S. Geological Survey, in cooperation with the Division of Water Rights, has conducted groundwater studies throughout the Sevier River Basin (See Section B, Bibliography). One series were water supply papers published during the 1960s and early 1970s. The latest series of technical publications were published during the 1980s and 1990s. Both surface and groundwater quality measurements were taken during the course of these studies. The results are summarized in this section and Section 19, Groundwater. The water quality measurement units are shown in this section as mg/L (milligrams per liter) while those reported in the original document, if different, follow in parenthesis. See Section A, Acronyms, Abbreviations and Definitions for a definition of water quality terms.

Surface water quality measurements were taken in the Upper Panguitch Valley area during 1988-89.[60] The following is the average of the measurements of total dissolved-solids (specific conductance) collected: Sevier River near Hatch, 190 mg/L (322 µS/cm); Sevier River above McEwen Diversion, 310 mg/L (525 µS/cm); Sevier River near Circleville, 285 mg/L (480 µS/cm); East Fork Sevier River below Deer Creek, 305 mg/L (520 µS/cm); and East Fork Sevier River near Kingston, 255 mg/L (430 @/cm).

Surface water quality data were collected in the Central Sevier Valley area in August and October 1988.[39] The averages of the measurements of total dissolved-solids (specific conductance) were: Sevier River above Clear Creek, 283 mg/L (480 µS/cm); Sevier River east of Richfield, 552 mg/L (935 µS/cm);and Sevier River at Sigurd, 590 mg/L (1,000 µS/cm). Samples taken in the northern Sevier Valley during August 1988 showed total dissolved- solids for the Sevier River west of Salina, 915 mg/L (1,550 µS/cm); Sevier River south of Redmond, 1,040 mg/L (1,763 µS/cm); and Sevier River below San Pitch River, 1,103 mg/L (1,870 µS/cm). Except for Clear Creek, the dissolved-solids concentrations of inflows to the river were higher than those of the river itself.

During studies carried out by the U.S. Geological Survey[76] in Sanpete Valley during the years 1988-89, the following surface water quality data were collected: San Pitch River below Milbum, 448 mg/L (760 µS/cm); San Pitch River west of Chester, 767 mg/L (1,300 µS/cm); San Pitch River near Manti, 1,100 mg/L (1,865 µS/cm); and San Pitch River below Gunnison Reservoir, 920 mg/L (1,560 µS/cm). The latter reading reflects the inflow from Six Mile Creek into Gunnison Reservoir.

Surface water quality data collected on Chicken Creek during September 1992 indicate increases in chemical constituents as the water moves downstream.[55] Sample analyses indicate the following: Chicken Creek about 3 miles above Levan, 263 mg/L (445 μS/cm) and Chicken Creek near Levan, 545 mg/L (925 μS/cm). A sample in November 1993 at Chicken Creek Reservoir outlet showed 780 mg/L (1,320 μS/cm).

Water quality data were collected on the lower Sevier River during the 1980s. These data show water quality near Lynndyl averaged 1,162 mg/L (1,970 @/cm) with an average of 442 cfs during May and June 1982. In 1988, the water quality was 1,025 mg/L (1,737 μS/cm) with a flow of 281 cfs and 2,340 mg/L (3,966 μS/cm) with a flow of 29 cfs.

Data on the lower Sevier River were also collected in May 1964.[32] These surface water quality data, given as total dissolved-solids (TDS), for selected locations are: Sevier River near Juab, 1,560 mg/L; Sevier River near Lynndyl, 1,540 mg/L; Canal A at DMAD Reservoir, 1,230 mg/L; Sevier River below Gunnison Bend Reservoir, 1,150 mg/L; and Sevier River near Hinckley, 2,730 mg/L.

The U.S. Geological Survey took water samples in 1985 as part of a study of the Pahvant Valley.[58] The surface water quality was as follows: Chalk Creek (upper), 240 mg/L (410 μS/cm); Chalk Creek (lower), 435 mg/L (740 μS/cm); Meadow Creek, 275 mg/L (470 μS/cm); and Corn Creek, 395 mg/L (670 μS/cm).

Similar data taken during the 1960s showed the total dissolved solids for Chalk Creek near Fillmore, 180 mg/L and for Corn Creek near Kanosh, 234 mg/L.[43] This indicates the water quality is deteriorating.

These data clearly show the deterioration of water quality as the Sevier River flows from the upper reaches in Panguitch Valley until it enters the Delta area. Many of the contaminants are the result of deep percolation and return flows from irrigation where salts are leached from the soil profiles. There is considerable contamination from leaching of salts found in the Arapien shale formation which is at or near the surface in the Central Sevier Valley, along the western part of Sanpete Valley, and in southern Juab Valley. This formation is the source of supply for the rock salt mines near Redmond.

Figures 12-1 through 12-5 show the total dissolved-solids (TDS) and specific conductance for selected stations along the Sevier River for the period 1971-91. Figure 12-6 shows the station near Lynndyl for the period 1951-91. The stations in the upper Sevier River show a constant or slight increase in contaminants. Stations in the lower Sevier River show a decrease in contaminants. It is possible this may reflect a change in irrigation management practices in the upper Sevier River or a change in the volume of flows or a combination of both.

Additional information on groundwater quality can be found in Section 19, Groundwater.

12.3 ORGANIZATIONS AND REGULATIONS

Water quality is important to all users. Leadership in maintaining water quality rests with local governments along with assistance from state and federal regulatory agencies and programs.

12.3.1 Local

The Central Utah District Public Health and the Southwest Utah District Public Health departments are involved in water quality matters in the Sevier River Basin. The Six-County Association of Governments and the Panoramaland Resource Conservation and Development Council are currently participating with the Division of Water Quality in a study of the Sevier River Basin. The area in Garfield County is included through a cooperative agreement with Color County Resource Conservation and Development Council. This study will provide water quality data along with information on improvement and management.

City, town and county governments have the responsibility to follow and enforce state laws and regulations in operation of their facilities. They take an active role in protecting wells, springs,

Figure 12-I
SURFACE WATER QUALITY - SEVIER RIVER AT HATCH
Sevier River Basin

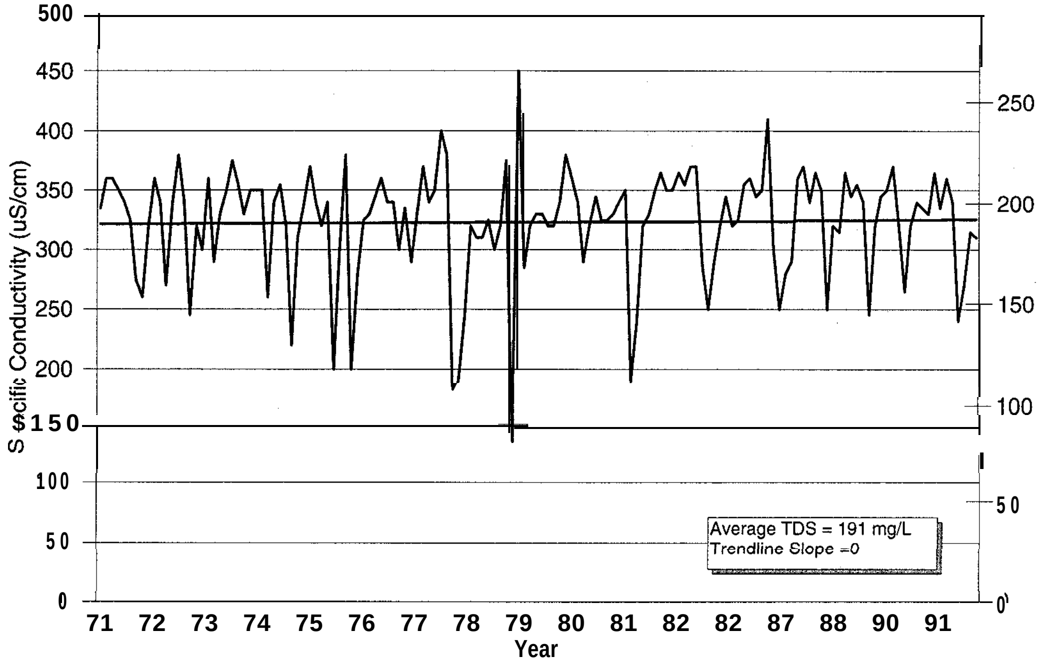


Figure 12-2
SURFACE WATER QUALITY - EAST FORK SEVIER RIVER NEAR KINGSTON
Sevier River Basin

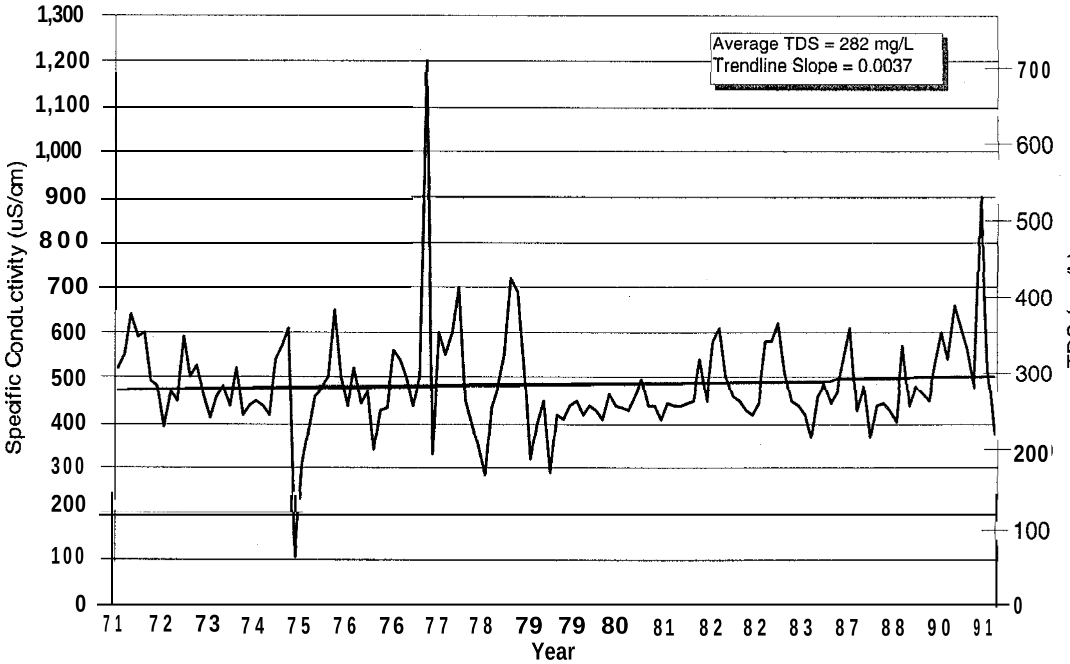


Figure 12-3

SURFACE WATER QUALITY - SEVIER RIVER ABOVE CLEAR CREEK

Sevier River Basin

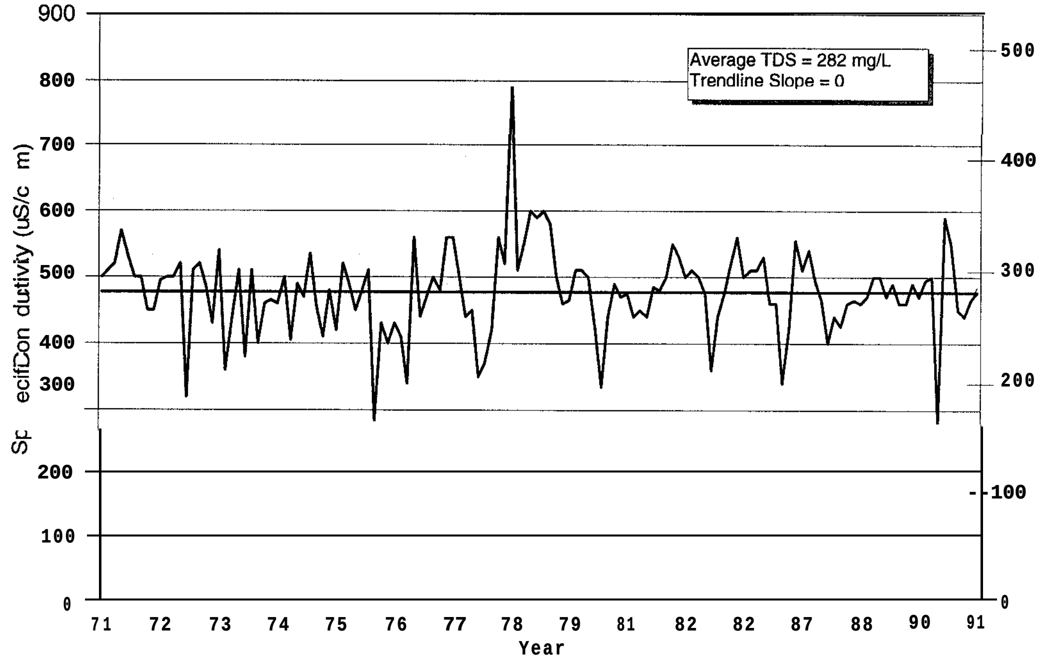


Figure 12-4

SURFACE WATER QUALITY - SEVIER RIVER BELOW SAN PITCH RIVER

Sevier River Basin

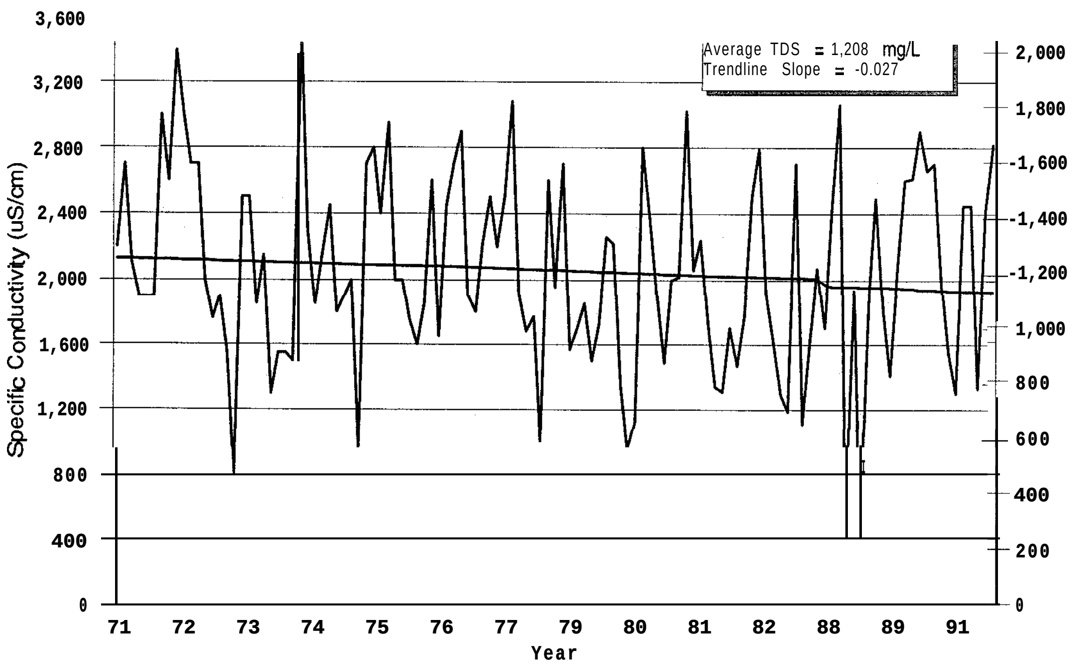


Figure 12-5
SURFACE WATER QUALITY - SEVIER RIVER NEAR JUAB
Sevier River Basin

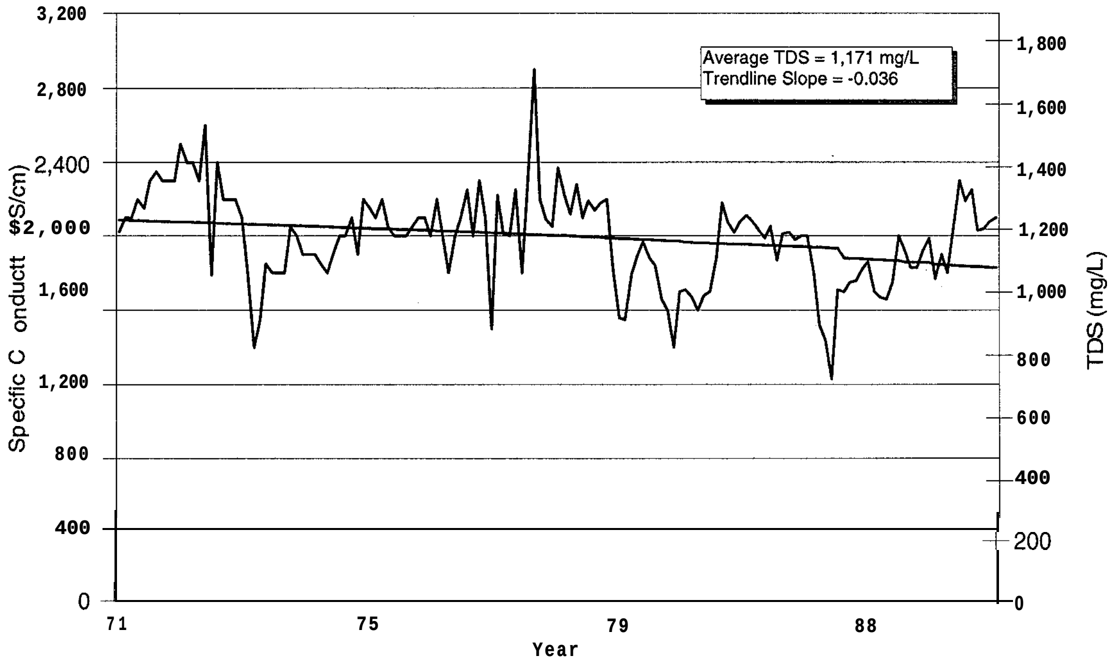
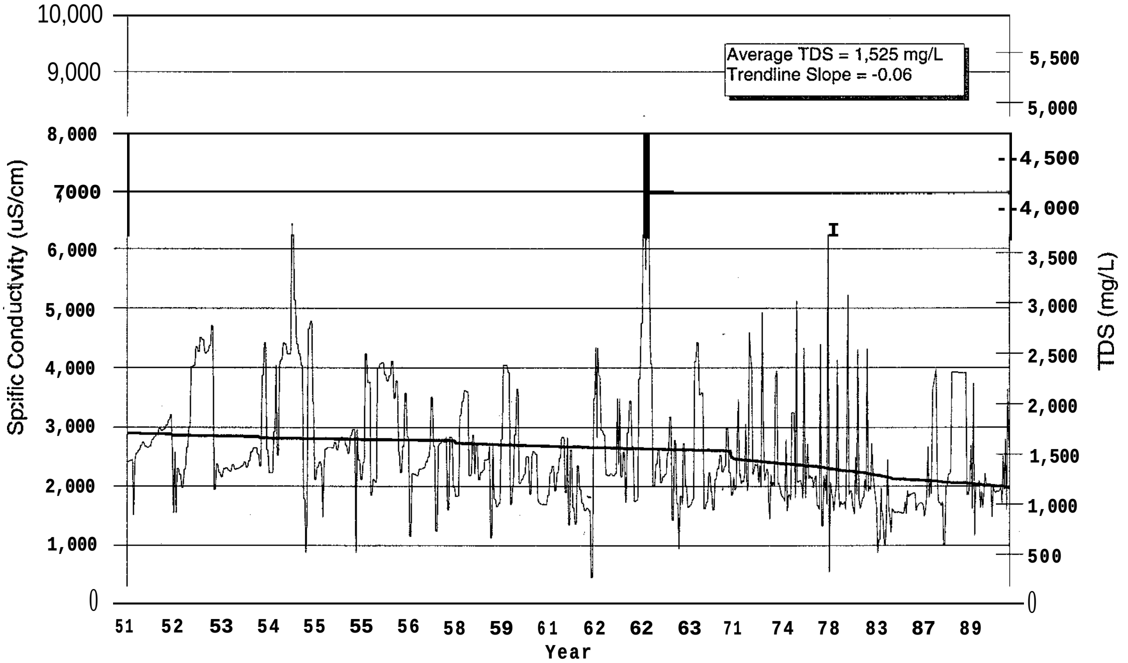


Figure 12-6
SURFACE WATER QUALITY - SEVIER RIVER NEAR LYNNDYL
Sevier River Basin



and recharge areas, and in treating waste water. Table 12-1 shows the community wastewater treatment facilities.

12.3.2 State

The Division of Water Quality (DWQ) is responsible for adopting, enforcing and administering state and federal water quality regulations. This includes the Utah Water Quality Act and the federal Clean Water Act. They are charged to maintain acceptable levels of water quality for a growing population. Increasing numbers of people also bring more recreational activity with added potential for pollution of surface steams and reservoirs as well as groundwater. This will require water quality agencies and water rights administrators to correlate their activities to assure state surface water and groundwater standards are met.

The Clean Water Act gives responsibility to the Department of Environmental Quality for the enforcement of regulations dealing with point and nonpoint source discharges. The Division of Water Quality is responsible for administration of the National Pollutant Discharge Elimination Systems (NPDES). They are also responsible for implementing the Nonpoint Source (NPS) Program. The agricultural portion of the NPS program is carried out by the Utah Department of Agriculture and Food under contract with the Department of Environmental Quality.

Limits on loading rates or discharge of various pollutants are established by the state as part of the discharge permits with consideration given to Environmental Protection Agency (EPA) 5guidelines. Municipal wastewater treatment facilities and industries discharging pollutants into Utah waters are issued a Utah Pollutant Discharge Elimination System (UPDES) permit, These permits are valid for five years and must be renewed with a reevaluation of pollutant limitations.

Enforcement of NPDESAJPDES permit requirements is accomplished by effluent monitoring programs supervised by DWQ. Currently, three municipal wastewater facilities and seven industrial waste water facilities have discharge permits. See Table 12-2 for a list of permitees.

Most of the communities use septic tanks to dispose of wastes. This is becoming a problem in some areas because of pollution buildup where septic tanks are more concentrated. Communities with septic tanks for waste disposal are shown in Table 12-3.

The Division of Water Quality developed a "Ground Water Quality Protection Strategy" for the state of Utah based on an executive order by the governor in 1984. Groundwater discharge permits are required for activities with the potential for pollution. The DWQ has also established classifications for surface water in Utah based on beneficial uses. To help control water quality, the streams, reservoirs and lakes are assigned standards for maximum contaminant levels according to four major beneficial use designations. These uses are; 1) As a source for drinking water, 2) for swimming and indirect contact recreation, 3) stream/lake/wetland dependent fish and wildlife, and 4) agriculture. Table 12-4 shows the current beneficial use water quality classes and other pertinent information for the water storage facilities. Table 12-5 shows the use classification of streams.

Clean Lakes Projects are in various stages of implementation by the Division of Water Quality (DWQ). Phase I Clean Lakes Program studies have been implemented for Navajo Lake and

Cattle along Otter Creek

Table 12-1
COMMUNITY WASTEWATER TREATMENT FACILITIES

County/Facility	Disposal Method	Capacity	Receiving Point Discharge
Garfield			
Panguitch	Sewage Lagoons	N A	N A
Juab			
Eureka	Aerated Lagoon	N A	N A
Millard			
Brush Wellman			
Delta	Total Containment Lagoon	N A	NA
Fillmore	Total Containment Lagoon	N A	N A
Hinckley	Total Containment Lagoon	N A	N A
IPP	Total Containment Lagoon w/Aeration	N A	N A
Sanpete			
Centerfield	Collection System-Evaporation Ponds		N A
Ephraim [a]	Total Containment Lagoon		NA
Fountain Green [b]	Total Containment Lagoon		N A
Gunnison	Total Containment Lagoon		N A
Manti [c]	Total Containment Lagoon		N A
Moroni	Activated Sludge	1.1 mg x daily flow [e]	**0.6** mgd
Mt. Pleasant [d]	Total Containment Lagoon	N.A	N A
Spring City	Lagoon	**20** acres [f]	60 gpm
Sevier			
Aurora	Total Containment Lagoon	N A	N A
Redmond	Total Containment Lagoon	N A	N A
Richfield	Total Containment Lagoon	N.A	N A
Salina	Intermittent Discharge Lagoon	**98** acres [f]	**0.57** mgd
Total			

[a] 20 homes use septic tanks
[b] 3 homes use septic tanks
[c] 20 percent use septic tanks
[d] 10 percent use septic tanks
e Design capacity
f Surface area

Source: Division of Water Quality

Table 12-2
POINT SOURCE DISCHARGE PERMITS

Permitee	Receiving Water
Eureka Lagoons	Eureka Lagoons
Moroni WWTP	San Pitch River
Road Creek FH-Burrville	Burr Creek
Road Creek FH-Deans #1	Piped to #2
Road Creek FH-#2	Canal, ditches to Otter Creek
Spring City Lagoons	Unnamed Streams
Trophy FH	Cove River Canal
UDWR FH-Fountain Green	Silver Creek
UDWR FH-Glenwood	Glenwood Spring Creek
UDWR FH-Mammoth	Mammoth Creek

Otter Creek Reservoir. Phase I and II studies have been completed for Panguitch Lake.

The Utah Department of Agriculture and Food, Environmental Quality Section, carries out the agricultural portion of the nonpoint water pollution control and prevention program administered by the Department of Environmental Quality/Division of Water Quality. This program is funded by EPA grants and matching funds from state and local agencies and private sources. The program includes watershed management projects, groundwater monitoring, and information and education. Public information programs include newsletters, brochures, videos and slide shows. These are also extended to public schools and adult education.

12.3.3 Federal

Congress passed the federal Water Pollution Control Act in 1972 to establish regulatory programs to improve the quality of the nation's waters. In 1977, the act was amended and became known as the Clean Water Act (CWA). Additional amendments were made in 1987.

The CWA amendments provided regulations to deal with the growing national toxic water pollution problem and to further refine the EPA's enforcement priorities. The amendments substantially increased EPA's authority to enforce all water quality regulations associated with new federal mandates to clean up the nation's streams, rivers, reservoirs and lakes.

In the mid-1950s, the federal government began offering funding programs to state water pollution control agencies to help in the ongoing construction of wastewater facilities. These early grants provided funding to pay for 30 to 55 percent of the total construction costs. This source of funds, along with monies provided through the Utah Water Pollution Control Act, helped finance most wastewater treatment facilities. More than $5.86 million in grants and loans were spent to construct or enlarge wastewater treatment and collection facilities in the Sevier River Basin.

Federal public works expenditures drastically decreased by 1990 and most grant programs for

Table 12-3
COMMUNITIES WITH SEPTIC TANKS

County/Community	County/Community
GARFIELD	**SANPETE**
Antimony	Axtell
Hatch	Fairview
JUAB	Heartland Mobile Home Park
Levan	Mayfield
MILLARD	Sterling
Deseret-Oasis SS	Wales
Kanosh-Paiute Indian Reservation	**SEVIER**
Lynndyl	Annabella
Oak Meadows Subdivision	Austin Community SSD
Sherwood Water Company	Brooklyn Tapline Company
Holden	Central Valley
Kanosh	Cove SSD
Learnington	Elsinore Town
Meadow	Glenwood
Oak City	Joseph
Scipio	Koosharem
PIUTE	Monroe
Circleville	Shadow Mnt Estates Subdivision
Greenwich Waterworks Co	Sigurd
Kingston	South Monroe
Marysville	

Source: Division of Water Quality and Division of Water Resources

Table 12-4
SURFACE STORAGE CLASSIFICATIONS

Name	Capacity (acre-feet)	2A	2B	3A	3B	4	Trophic Status
		Beneficial Use Classes					
Barney Lake	200		x	x		X	60.70
Big Lake	1,115		x	x		X	NA
DMAD	10,990		X		x	x	60.55
Fairview Lake #2	2,200		x	x		X	39.25
Gunnison Bend	5,000		X		x	x	55.04
Gunnison	20,264		X		x	x	56.81
Koosharem	7,470		x	x		X	65.86
Lower Box Creek	340		x	x		X	74.28
Manning Meadow	996		x	x		X	50.17
Navajo Lake	11,700		x	x		X	39.71
Nine Mile	3,500	X		X		X	53.10
Otter Creek	52,495		x	x		X	55.23
Palisade Lake	1,728	x	x		x	x	39.61
Panguitch Lake	23,730		x	x	x	x	52.67
Pine Lake	1,100		x	x		X	19.66
Piute	71,826		x	x		X	45.54
Redmond Lake	1,200		X		x	x	70.71
Rex	975		x	x		X	50.21
Sevier Bridge	236,145		X		x	x	52.19
Tropic	3,600		x	x		X	39.12

Trophic Status Index (TSI)[37] refers to the nutrient status, biological production and morphological characteristics of the water. TSI less than 40 = Oligotrophic, TSI 40 to 50 = Mesotrophic, TSI over 50 = Eutrophic.
The lower the index number, the better the water.
Note: See Table 12-4 for beneficial use class definitions.
Source: Division of Water Quality.

Table 12-5
STREAM CLASSIFICATIONS

Stream	Use	Classifications			
Sevier River and tributaries from Gunnison Bend Reservoir to Annabella Diversion except the following tributaries:	2B		3B		4
Oak Creek	2B	3A			4
Round Valley Creek & tributaries	2B	3A			4
Chicken Creek	2B	3A			4
San Pitch River & tributaries from confluence with Sevier River to U-132 crossing except the following tributaries:	2B		3C	3D	4
Twelve Mile Cr & trib from USFS bdy to hdwtr	2B	3A			4
Six Mile Creek & tributaries	2B	3A			4
Manti Creek & tributaries	2B	3A			4
Ephraim Creek & tributaries	2B	3A			4
Oak Creek & trib from USFS bdy to hdwtr	2B	3A			4
Fountain Green & trib fr USFS bdy to hdwtr	2B	3A			4
San Pitch R & trib from U-132 cross to hdwtr	2B	3A			4
Sevier River and tributaries from Annabella Diversion to headwaters	2B	3A			4
Monroe Creek and tributaries	2B	3A			4

Class 1 Culinary raw water source
Class 1C Domestic use with prior treatment
Class 2 Instream recreational use and aesthetics
Class 2A Primary human contact-swimming
Class 2B Secondary human contact-boating, wading etc.
Class 3 Instream use by aquatic wildlife
Class 3A Habitat maintenance for cold water game fish, water related wildlife and food chain organisms
Class 3B Habitat maintenance for warm water game fish, water related wildlife and food chain organisms.
Class 3C Habitat for non game, water related wildlife and food chain organism.
Class 3D Habitat for water fowl, shore birds, water related wildlife, and food chain organisms.
Class 4 Agricultural-livestock and irrigation water.
Class 5 Great Salt Lake general use-primary and secondary human contact, water related wildlife, and mineral extract.
Class 6 General use restricted and/or governed by environmental and health standards and limitations.
Source: Division of Water Quality.

construction and upgrades were eliminated. Today, federal wastewater treatment funding is only available through revolving loan programs administered by the Division of Water Quality. Total expenditures are over $21.29 million for wastewater assistance in the Sevier River Basin.

Federal standards for solid waste and hazardous material are set forth under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), often called the Super Fund. These standards are regulated by EPA. Local health department monitoring programs are also used to verify compliance. In addition, the Corps of Engineers is involved in water quality issues.

12.4 WATER QUALITY PROBLEMS

Water quality problems can be caused by one or more of several sources. These are described below.

Pollution from natural geologic sources is almost impossible to control. This was highlighted by a letter to the editor from a New York City woman who thought all the erosion at Bryce Canyon was awful and something should be done to stop it. Geologic pollution becomes more evident as the high quality of water from the upper watersheds deteriorates as it flows downstream.

Point sources of pollution are usually from municipal and industrial facilities. Table 12-2 lists the point sources where discharge permits have been issued and discharges are monitored by the Division of Water Quality.

Other sources of pollution include contaminants from man-caused nonpoint sources. Runoff from pastures, over-inigation of agricultural croplands and abuse of the upper watersheds pollute water supplies. There are concerns about contamination from sewer lagoons and concentrations of septic tanks in the valley areas (Table 12-3). Septic tanks in summer home concentrations are becoming a problem in upper watershed areas such as along the Wasatch Plateau and on Cedar and Monroe Mountains.

12.4.1 Surface Water Quality Problems

The surface water quality is excellent to good in the upper reaches of the Sevier River and its tributaries as indicated by samples taken during 1988-89. As the water moves downstream and is diverted and used, the quality deteriorates. The Sevier River contains dissolved-solids less than 300 mg/L until it reaches the Sevier Valley area. East of Richfield the water contains 552 mg/L (935 μS/cm)and at Sigurd it was 590 mg/L (1,000 μS/cm) in 1988. The total dissolved-solids (TDS) south of Redmond were 1,040 mg/L (1,763 μS/cm) and were 1,103 mg/L (1,870 μS/cm) below the confluence with the San Pitch River. The San Pitch River has only 1,050 mg/L (1,780 μS/cm) below Gunnison Reservoir although it reached 1,100 mg/L (1,865 μS/cm) west of Manti.

The water salinity increases as the Sevier River reaches areas where the Arapien shale influences the water quality. This geologic formation is high in salts which are readily leached as water moves over and through this formation. The Arapien shale is a large contributor of salts to the Sevier River system in central Sevier Valley and Sanpete Valley. Brine and Lost creeks contribute high concentrations of TDS although loadings are low because stream flows are small, generally less than 0.5 c.f.s.

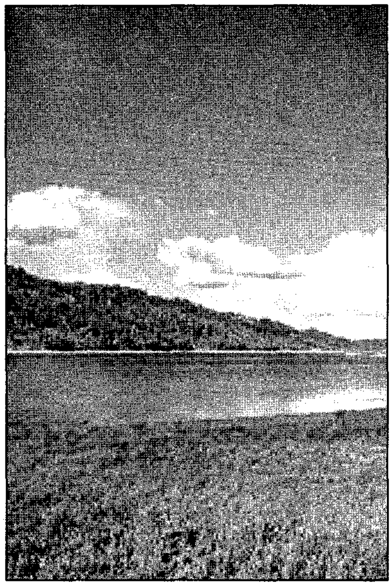
Chicken Creek flows are less than 1,000 mg/L where they enter Juab Lake. There are flows with high TDS but the flows are low, making the total loading small.

Water salinity measurements taken near Lynndyl in May and July 1982 averaged 1,162 mg/L (1,970 μS/cm) with flows averaging 442 cfs. Measurements at Hinckley in 1964 showed 2,730 mg/L. The water salinity in the lower reaches of the Sevier River reflects the accumulation of contaminants throughout the system.

The major water quality problems are the increases in total dissolved-solids as the water flows downstream. There are two main sources of pollutants. These are geologic and man-caused. The geologic will be difficult to control. It may be possible to modify or dilute the salt inputs at some locations. The man-caused problems are usually from irrigation water leaching into the groundwater reservoirs. This water moves

downstream and reappears as return flow. As a result, the water quality deteriorates in the downstream reaches. See Figure 12-7.
Water quality problems are described below for the Clean Lakes Projects. These projects are Navajo Lake, Otter Creek Reservoir and Panguitch Lake.

The water quality problem in **Navajo Lake** is caused by the growth of macrophytes (vegetative bodies) associated with the sediments.[37] This problem is increased by the penetration of light to the lake bottom. These large mats of organic material cause high pH values and reduce dissolved-oxygen resulting in anoxic or low oxygen conditions, especially during the winter months when ice covers the lake. Navajo Lake is considered oligotrophic. Concentrations of hydrogen sulfide also occur during the winter period as the macrophytes decompose. There is at least a partial fish-kill every year. Pollution is produced by livestock grazing and by wastes and litter from recreation activities.



Navajo Lake

Phosphorus concentrations have been a problem in **Otter Creek Reservoir** although there has been a decline in recent years.[37] Also, high algae production and macrophytes have caused excessive pH values. The reservoir was eutrophic with atrophic status index (TSI) over 50 but has recently been classed as mesotrophic (TSI 40-50). The high level of nutrients has produced large blue-green algal blooms along with macrophytes. Also, low dissolved-oxygen levels develop when the organic materials decompose. The extensive production of the macrophytes restricts boating and impairs the fishery. Nonpoint sources of pollution include sedimentation and nutrient loading from grazing, pesticides and fertilizers from cropland and wastes/litter from recreation.

Both total phosphorus and dissolved oxygen in **Panguitch Lake** have exceeded state water quality standards.[37] As a result, it is considered eutrophic and nitrogen limited. Historically, there have been blue-green algal blooms and summer oxygen deficits in the reservoir bottom waters which have contributed to some fish kills although none have occurred recently. These problems are caused by litter and human wastes from recreation and by increased sedimentation from over-grazing and denuding the soil through timber harvesting and wildfires.

12.4.2 Groundwater Problems

The groundwater reservoirs are a vital part of the Sevier River system. This is a large resource that once contaminated, is extremely difficult if not impossible to reclaim. With this in mind, it would seem important to install a groundwater quality monitoring network to detect any changes caused by outside sources.

Many potential sources of groundwater pollution exist. These include contaminants from agricultural operations, various types and methods of waste disposal, toxic spills, leaking underground tanks and operations such as mining, and oil and gas exploration.

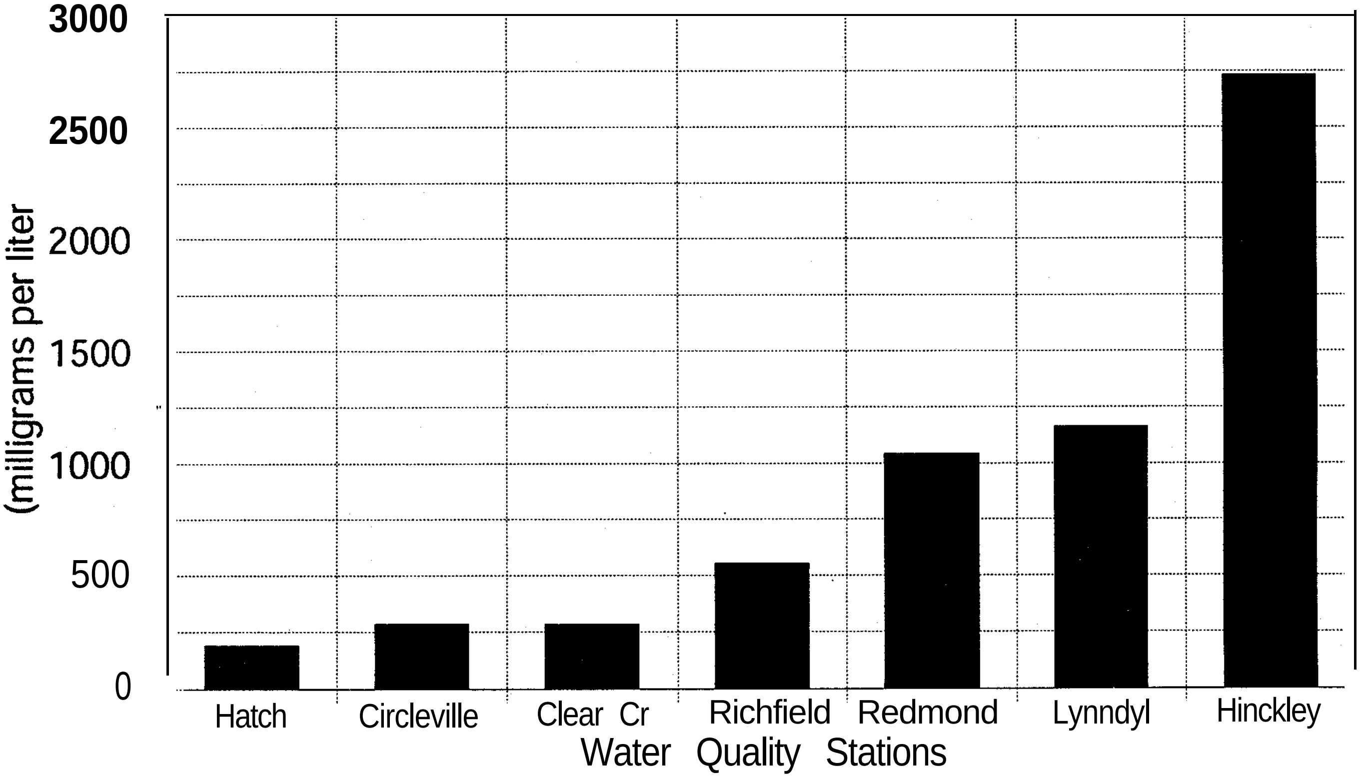
Groundwater recharge areas consist of both consolidated rock and alluvium. These areas are critical to water quality as the salts leached from them determine the constituents contaminating the groundwater. In potential recharge areas where the aquifer is exposed, it can be contaminated by precipitation and pollutants left in or on the land that are leached into the groundwater. High quality alluvial aquifers are especially vulnerable to pollution by the activities of people.

Individual septic tanks are ineffectively managed at the present time. Although construction according to local health department specifications is required, there is not much control over individual operation and many septic tanks fail over time. With increasing growth in rural areas, use of septic tanks is increasing. This

Figure 12-7

WATER QUALITY

Sevier River



is compounding the problem of existing concentrations of septic tanks, such as in the Monroe area or in the Duck Creek-Swain Creek area on the upper Asay Creek drainage. There have been few advances to customize septic tank design to the hydro geologic setting or aquifer type. It is now a "one-size-fits-all" approach.

The groundwater quality varies throughout the basin. Like surface water, the groundwater quality is highest in the upper reaches along the Sevier River and its tributaries and decreases downstream. The same is true in each individual groundwater reservoir where the water quality decreases in a downstream direction.

The total dissolved-solids concentrations (specific conductance)were sampled in **Panguitch Valley** during 1988-89 in the valley-fill aquifers.[60] Wells sampled ranged from 159 mg/L (270 μS/cm) to 443 mg/L (750 μS/cm) with an average of 293 mg/L (497 μS/cm). Spring samples were 242 mg/L (410 μS/cm) to 425 mg/L (720 μS/cm) with an average of 317 mg/L (538 μS/cm). Mammoth Spring was 100 mg/L (170 μS/cm).

Groundwater quality seemed to be better in the **East Fork of the Sevier River.**[60] The one well tested was 226 mg/L (383 μS/cm) in the East Fork of the Sevier River. The wells in Grass Valley averaged 153 mg/L (260 μS/cm).

Circleville Spring in the **Circle Valley** subbasin showed 86 mg/L TDS.[39] Water from one well about 2 miles northeast of Circleville was 473 mg/L TDS. A well north of Marysvale has calcium and chloride as the predominate ions with TDS of 1,955 mg/L (3,310 μS/cm). In general, the groundwater in the Junction-Marysvale subbasin is of good quality with less than 295 mg/L (500 μS/cm).

Groundwater in the Sevier-Sigurd portion of **the Sevier Valley** subbasin was measured by specific conductance methods.[39] From these measurements, the total dissolved-solids (TDS) in the Joseph area along the Sevier River were 342 mg/L (580 μS/cm). They were about 428 mg/L (725 μS/cm) about 2 miles northwest of Monroe. Downstream to about 2-1/2 miles SSE of Richfield, groundwater quality ranged from 218 mg/L (370 μS/cm) to 437 mg/L (740 μS/cm). In the area east of Richfield, groundwater quality was 861 to 2,148 mg/L (1,460 to 3,640 μS/cm). Wells in the Vet-million area showed 251 to 885 mg/L (425 to 1,500 μS/cm). Data from the Sigurd area indicated values ranged from 466 to 702 mg/L (790 to 1,190 μS/cm). As can be seen, the groundwater quality varies from area to area but declines in a downstream direction. Water tends to be of higher quality away from the Sevier River.

The north portion of the Sevier Valley subbasin in the Aurora-Salina area north to Gunnison has water with TDS about twice that in the Sevier-Sigurd portion. In the Aurora-Salina area, values range from 590 mg/L (1,000 μS/cm) to 1 ,180 mg/L (2,000 μS/cm).

Sanpete Valley groundwater total dissolved-solids (TDS) range from about 500-600 mg/L in the Fairview-Mt. Pleasant area to over 1,000 mg/L below Chester and toward Gunnison Reservoir.[76] The Fountain Green-Moroni area groundwater is in the 500-700 mg/L range although Big Springs is 245 mg/L. Nitrate concentrations are a problem in some areas. See Section 19.2.6 for more information.

The **southern Juab Valley** groundwater around Levan flows from the mouths of Chicken and Pigeon creeks to Chicken Creek Reservoir[59] (Juab Lake). The TDS in the groundwater was 623 mg/L at a well about one mile north of Levan and 3,180 mg/L in a spring at the northeast end of Chicken Creek Reservoir.

The **Sevier Desert** contains two aquifers, one shallow (less than 500 feet below the land surface) and one deep (over 800 feet below the land surface). The water quality was about 200 mg/L TDS in the Lynndyl-Delta area in the deep aquifer.[26] In the southwestern part of the area toward Sevier Lake, dissolved- solids exceed 10,000 mg/L in the shallow aquifer.

Dissolved-solids in **Pahvant Valley** range from 300 mg/L to over 6,000 mg/L.[36] Water in the eastern part of the valley have dissolved-solids less than 1,000 mg/L while the rest of the valley ranges from 1,000 to 5,000 mg/L although some areas west of Kanosh are over 6,000 mg/L. More information can be found in Section 19, Groundwater.

12.5 ALTERNATIVE WATER QUALITY IMPROVEMENTS

Navajo Lake, Otter Creek Reservoir and Panguitch Lake are being studied under the Clean Lakes Program. These water bodies exhibit problems and these studies will determine how best to improve the water quality.

The water quality problem in Navajo Lake is caused by macrophytes or aquatic plants growing in the lake.[37] When this biological community overpopulates as it has in Navajo Lake, it interferes with the lake habitat and recreational uses. A Clean Lakes Phase I Program is being conducted to determine possible solutions. The study will cost $60,000.

Otter Creek Reservoir and Panguitch Lake water quality problems are caused by eutrophication.[37] This natural aging process is characterized by increased nutrient concentrations and sedimentation rates. These water bodies are being studied under Clean Lakes Program, Phase I grants of nearly $50,000 for Panguitch Lake and $100,000 for Otter Creek Reservoir.

As of 1997, the Otter Creek Watershed has received $375,000 of Clean Water Act, Section 3 19 Nonpoint Source Program funds. These funds have been and will continue to be used to implement best management practices (BMPs) which will improve water quality within the watershed. The types of BMPs installed in the watershed include, rangeland treatment, irrigation improvement, riparian enhancement and stream bank stabilization. Division of Water Quality monitoring activities within the Otter Creek watershed include chemical, physical and biological monitoring. These monitoring programs will document water quality before and after implementation of BMP's.

Some correctional measures have been implemented in the Panguitch Lake watershed under the Clean Lakes Program, Phase II . These are intended to control agricultural waste from grazing livestock and recreational waste and litter from getting into the lake.

Landfill locations can be controlled by elected officials and government agencies working together. They should be located in areas where surface water or groundwater will not become contaminated through leaching or runoff. Agricultural BMPs and good land management practices, in the valley croplands and the upper watersheds, will help control nonpoint pollution. Also, controls on construction and other land surface disturbances will reduce pollution.

Over-irrigation is contributing to pollution by leaching chemicals out of the soil and into the groundwater reservoirs. Technology is available to reduce this type of pollution. The use of pesticides is also suspected to contribute to the problem. Better control would help reduce pollution from this source.

In some areas, grazing or other causes have depleted the land cover and the riparian vegetation. Efforts to reestablish range and riparian vegetation will reduce erosion and the resulting pollution. See watershed inventories and restoration in Section 10.

Some time in the future, sewage treatment plants may become an alternative in the larger communities. Treatment of waste water and releasing it back into the system could increase the available water supply where the current method of using sewage lagoons, evaporates most of the water into the atmosphere. Funds could be made available through the Water Quality Board's revolving loan fund and from grants available from other sources.

The Division of Water Quality is conducting a water quality study in the Sevier River Basin. This study should update current data and discuss alternatives for water quality improvements.

Section 13 Sevier River Basin
DISASTER AND EMERGENCY RESPONSE

Tables

Figure

Section Thirteen Sevier River Basin- State Water Plan

Disaster and Emergency Response

Disasters are always traumatic experiences for those affected. Preparedness is the key to alleviating these experiences.

13.1 INTRODUCTION

This section discusses flood hazard mitigation and disaster response activities. It also describes predisaster or immediate actions needed to protect water and water-related resources in the Sevier River Basin. It describes programs and mechanisms now in place along with those needed. After the fact reactions are more inefficient and require more time, money and other resources. It also portends loss of life and threatens the health and welfare of those affected.

Most water-related emergency situations are naturally caused although man often increases the magnitude. They vary from disastrous flooding to extreme drought. Man-caused emergencies include oil and chemical spills and other polluting activities that threaten water supplies. Some disasters result from a combination of natural forces and man's activities.

13.2 BACKGROUND

Natural disasters and other emergencies are a part of the area's history. Floods have been a perennial problem. Earthquakes and other natural disasters have occurred less frequently and have caused only minimal damage.

The first recorded flood in the Sevier River Basin occurred at Manti from Manti Creek on August 1, 1852. The most damaging flood in Manti resulted from a cloudburst on July 11, 1899. As reported in the Deseret Evening News, ". . . The two city creeks overflowed . . . poured a muddy deluge filled with floating driftwood, debris, haystacks, and bridges . . . haystacks, hen coops, and stables were swept away. . . sickly people had to be rushed from their homes . . . " This flood warned the west of the results of nearly 50 years of over-grazing.

A life was lost in August 1889 in Wood Canyon near Mayfield. "The main stream was directed against the Jorgensen home within which were Mrs. Jorgensen and six children. Mr. Jorgensen arrived and left his buggy and team on high ground . . . His oldest boy came out to help with the horses . . . the other five children were floating around on a lounge in 3 feet of water and his wife holding up a cupboard to steady herself and also to prevent it from falling on the children. Mr. Jorgensen broke a window to make an exit for the water. He then saw . . . the buggy and horses rolling over and over. The boy . . . was drowned and also cattle and horses."

A large flood at Mt. Pleasant interrupted the Pioneer Day celebration on July 24, 1946. It was reported, ". . . The force of this mortar like mud with its accompanying load of rocks and logs was such that boulders up to 10 feet in diameter were moved . . . " This was the most destructive flood in the basin until the area-wide flooding along the Sevier River in 1983.

The "Floods of the '80s" in the Sevier River Basin began near the end of May 1983 with a sudden rise in temperature that started melting a record high snowpack. Flood damages were recorded throughout the basin. Total damages are unknown but probably exceed $50 million not including loss of a railroad and considerable damage to the natural resources. The D&RGW Railroad spur from Thistle to Marysvale was destroyed to the point it was not rebuilt. Upper watersheds will require decades to return to pre-flood conditions. Irrigation facilities throughout the basin were damaged or destroyed. The DMAD Reservoir dam spillway failed requiring breaching of Gunnison Bend Reservoir dam. As a result, the town of Deseret was inundated with up to five feet of water.

Flooding continued during the spring and early summer of 1984 causing less damages than during the previous year but still probably exceeding $15 million. Sevier Lake filled up to the shoulders of U.S. Highway 6-50, something that hasn't occurred in recent memory. People were fishing from boats in the fresh water of the Sevier River flowing into the lake, a strange sight in a remote desert area. Dead sheep along the lake shore demonstrated the fallacy of drinking the salty lake water.

Historically, floods in the basin have claimed six lives. There may be more. Most communities are susceptible to flooding as they were usually located at the mouths of canyons with perennial streams. Because of this, flooding has become an ongoing problem.

Earthquakes have occurred periodically and are associated with three major faults. The Sevier and Paunsaugunt faults run north-south the entire length of the basin. The Elsinore fault is shorter, primarily located in Sevier Valley. The Elsinore fault is the most active but there is no record of excessive damage. Major fault lines are shown on Figure 13-l.

All levels of government have statutory authority to carry out disaster related programs. However, no one entity has all of the necessary authority to implement actions to mitigate and respond to disasters. This lack of an umbrella of authority is discussed in the *Utah State Water* Plan-1990 See Section.3, Introduction; Section 13, Disaster and Emergency Response; and Section 16, Federal Water Planning and Development.

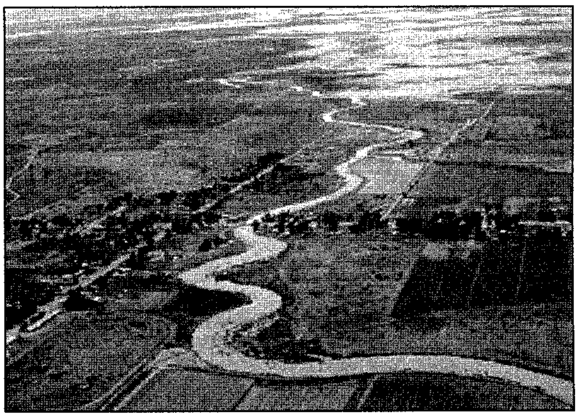
13.3 ORGANIZATIONS AND REGULATIONS

Local government has the primary responsibility to initiate action in response to a disaster or emergency. If the town or city impacted cannot handle the emergency situation, they call on the county for assistance. The county can call for assistance from the state who turns to the federal government when necessary.

13.3.1 Local

When an emergency occurs, local governments are required by the Division of Comprehensive Emergency Management to carry out the following tasks to provide an effective first response:

- Prepare an emergency operations plan for the coordination of local and county emergency responses, and link it to potential assistance from appropriate federal and state agencies.
- Provide necessary resources (including special supplies and equipment) to support emergency relief operations and list these resources. Procedures to be followed for obtaining assistance and use of resources in the emergency operation plans should be included.
- Assign and train personnel needed to carry out disaster relief functions.
- Provide the State Disaster Coordinating Officer with copies of current emergency operations plans.
- Recommend changes to state and local emergency disaster relief procedures and assigned functions as needed.



Flooding near Deseret

Cities and counties have primary responsibility for disaster response as stated in Titles 10 and 17 of *Utah Code Annotated, 1953, as amended.* Most local governments have delegated disaster responsibilities to specific individuals. Table 13-1 shows the position responsible for disaster response in each county.

13.3.2 State

The Division of Comprehensive Emergency Management (CEM) provides a statewide system

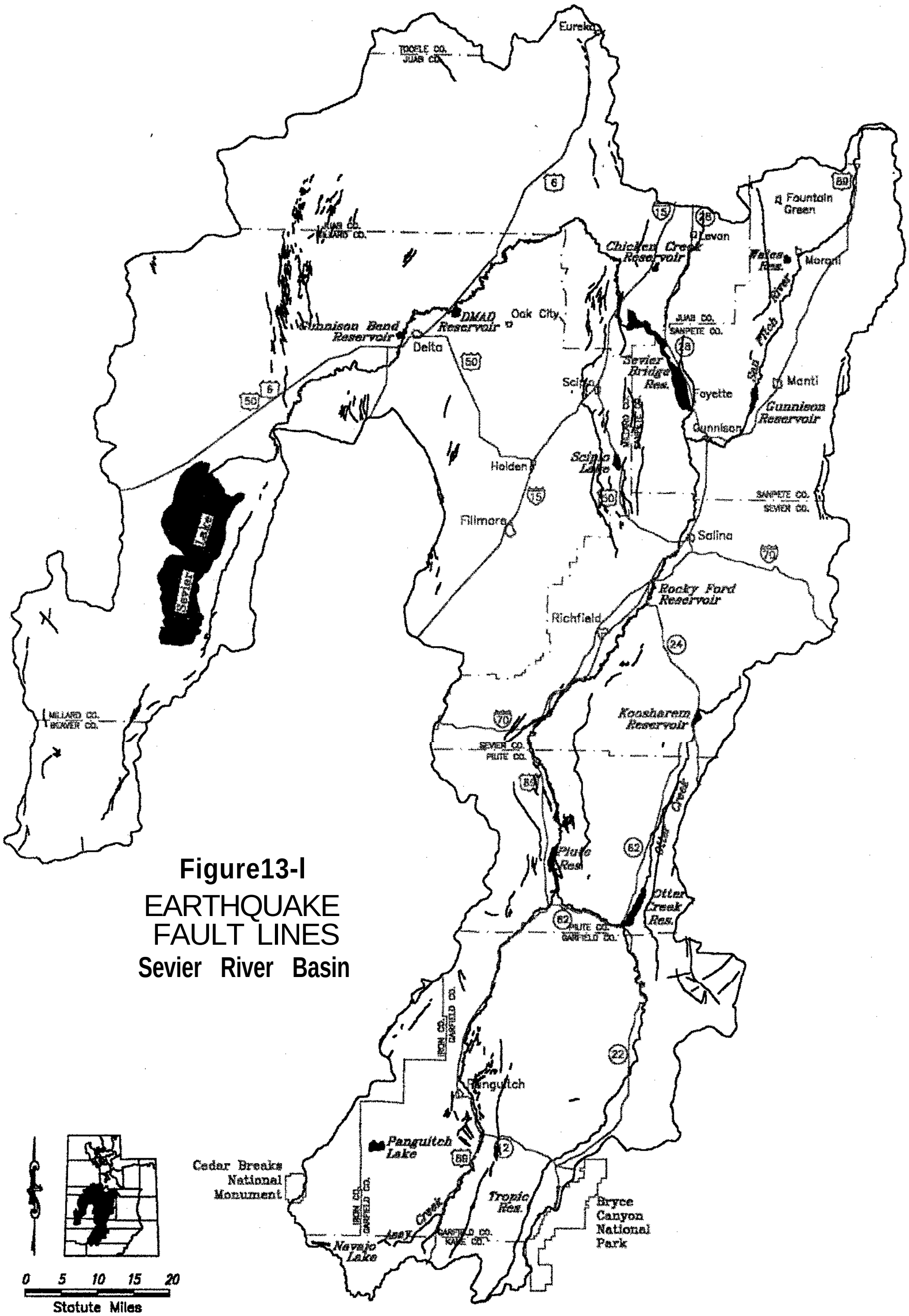


Figure13-l
EARTHQUAKE
FAULT LINES
Sevier River Basin

Table 13-1 DISASTER RESPONSE RESPONSIBILITY	
County	Responsible Position
Garfield	Sheriff-Director, Garfield Co. Emergency Services
Iron	Sheriff-Director, Iron Co. Civil Defense
Juab	Director, Juab Co. Emergency Services
Kane	Director, Kane Co. Emergency Services
Millard	Sheriff-Director, Millard Co. Emergency Services
Piute	Sheriff-Director, Piute Co. Emergency Services
Sanpete	Director, Sanpete Co. Civil Defense
Sevier	Director, Sevier Co. Emergency Services

or plan encouraging and assisting counties and cities with activities relating to emergencies and disasters. They are responsible for assisting towns, cities and counties prepare emergency response and management plans, comprehensive in scope but allowing effective and close cooperation with state and federal agencies in the event of a disaster beyond local capabilities. CEM also works closely with other state and federal agencies to assure needed resources reach areas seriously affected by a major disaster. This is done primarily through the Inter-Agency Technical Team (IAT) consisting of technical experts from virtually every discipline relating to water and natural resources representing many state and federal agencies. CEM's hazard mitigation officer is coordinator for IAT and may be contacted at 538-3400 for assistance.

When the extent of the disaster or emergency is beyond local capability, the governor, at his discretion, can declare a "state of emergency" and provide state assistance. The governor may also request federal assistance if deemed necessary. At this time, the State Disaster Coordinating Officer (SDCO) assumes all responsibility for distributing both state and federal assistance to alleviate local disasters. This is carried out in cooperation with local disaster officials.

The SDCO also serves as the governor's primary point of contact for all disaster coordination and related correspondence between the federal, state and local disaster management officials.

13.3.3 Federal

The President of the United States may declare that a major disaster has occurred at any time, usually at the governor's request. At this time, federal assistance is provided for disaster response, recovery, preparedness and mitigation through the Federal Emergency Management Agency (FEMA). This assistance is distributed under the direction of the federal coordinating officer designated by FEMA and the SDCO.

Other federal agencies also have disaster related assistance programs. Most of these can be invoked under agency policies and guidelines even though a presidential disaster declaration does not exist. These are generally coordinated through state and local officials. Specific programs are provided by agencies such as the Corps of Engineers, Farm Service Agency, Natural Resources Conservation Service and Civil Air Patrol.

The National Flood Insurance Program (NFIP) is administered by FEMA. This program requires flood insurance on all development in the flood plains as determined by topographic surveys. Lack of flood insurance denies use of any federal or federally insured monies for development in flood plains.

13.4 FLOOD PROBLEMS

The Sevier River Basin is impacted by three types of storms: general winter storms, general summer storms and summer thunderstorms. At times, rain on snowpack or frozen ground cause floods.

13.4.1 River and Stream Flooding

Long-term floods produced by snowpack melt resulted in the 1983-85 events, particularly on the Sevier River mainstem. Tributary drainages are subject to flooding from cloudburst storms on a more frequent basis. Generally, floods resulting from these high-intensity thunderstorms occur most often and do the most damage. Nearly all tributaries have produced one or more flash floods in the past. Higher risk flood-prone communities include Panguitch, Monroe, Manti and Fillmore. Flood peaks for selected locations are shown in Table 5-2.

Manmade and natural obstructions in flood plain areas can affect flooding, These restrict flood channels and can cause overbank flows.

Flood plain maps have been prepared for many communities. Maps for Panguitch, Richfield, Salina and Manti are shown as examples on Figures 13-2 thru 13-5. The FEMA flood plain boundaries shown are approximate and those living outside the boundaries should not assume they are without risk from flooding. There are communities that do not participate in the National Flood Insurance Program, some because they are outside the flood plains.

13.4.2 Upper Watersheds and Floods

The major flood source areas are upper watersheds in poor hydrologic condition. This is caused by improper practices that use land beyond its capability. These uses may take a variety of federal agencies to assure needed resources reach areas seriously affected by a major disaster. This is done primarily through the forms such as over-grazing, poor location of roads and trails, cross-country use of vehicles, timber harvesting and mining. Erosion problems are discussed in more detail in Section 10, Agricultural Water.

13.5 DROUGHT PROBLEMS

The climatological history of the Sevier River Basin reveals a cyclic pattern of wet and dry periods. The wet and dry peaks seem to occur at varying magnitudes about every 10 to 30 years. Extreme droughts have occurred during the periods 1934-36, 1955-57, 1960-65, 1977 and during the late 1980s and early 1990s.

Droughts generally do not have large impacts on public water supplies from springs and wells unless they last for an extended period. However, culinary water use increases during time of drought unless restrictions are applied. Surface water flows are usually impacted from the beginning of the drought. Only the larger reservoirs store more than one years supply.

The hot, dry summers make regular irrigation of crops necessary. By mid-season, stream flows are low and in some cases, nonexistent. As a result, crops suffer. In the higher elevations, rangeland production of feed for wildlife and livestock is reduced.

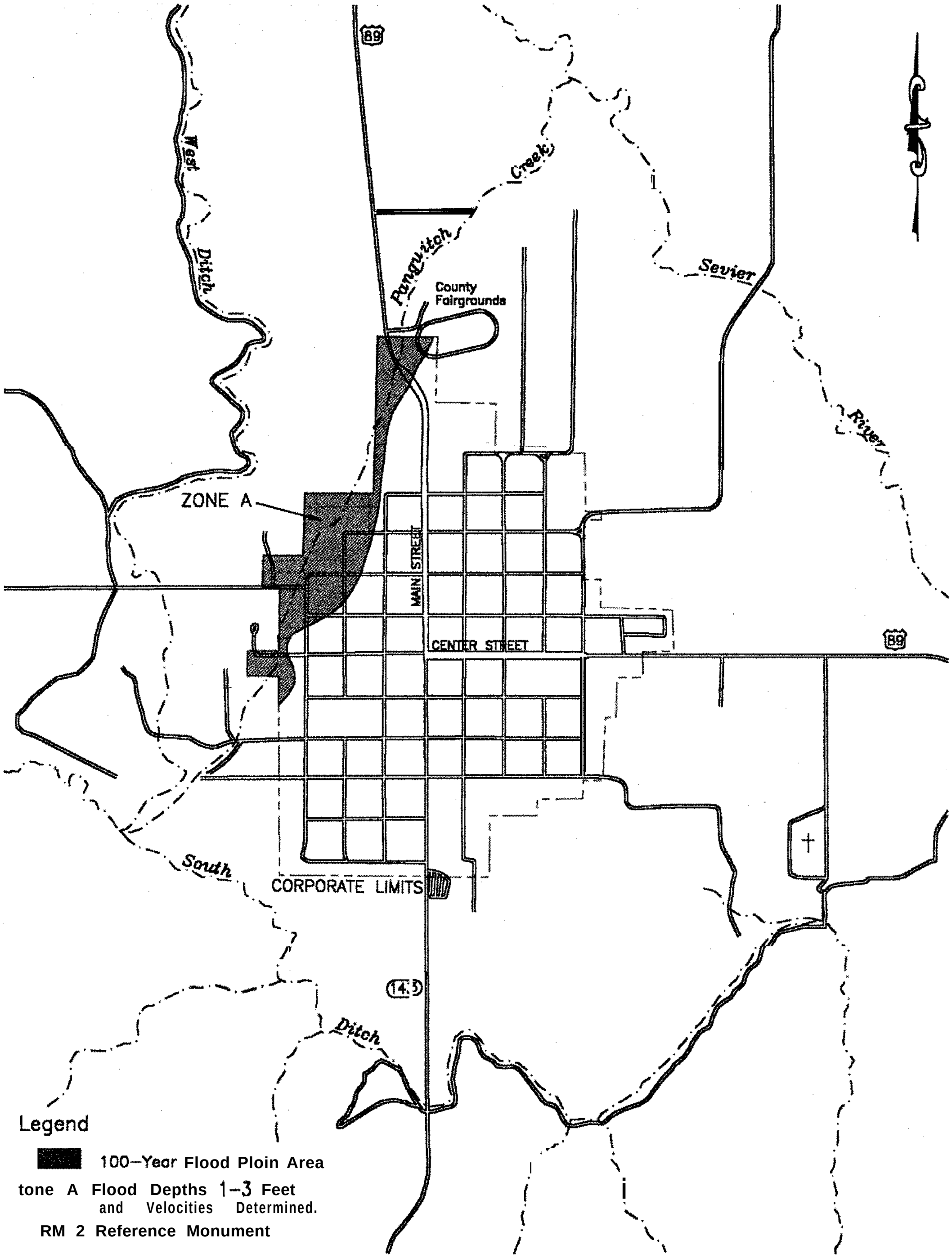
13.6 OTHER WATER-RELATED EMERGENCY PROBLEMS

There are other disasters that can affect the water resources. These include earthquakes, land slides and structural failures.

There is greater potential damage from an earthquake than from any other kind of natural disaster. Three major normal faults traverse the basin in a north-south direction. These are the Paunsaugunt fault, Sevier fault and Elsinore fault. Although the Paunsaugunt and Sevier faults are the biggest, the Elsinore fault is the most active. Earthquakes can disrupt sources of culinary water supplies as well as delivery systems, creating potential danger to the health and welfare of local residents.

Mudslides do not create a large potential danger. The most noticeable evidence of recent mudslides is on the steep west face of the Gunnison Plateau caused by the extreme wet years of 1983-84. Mudslides could disrupt irrigation water delivery systems and drinking water supplies, dam rivers, and damage drinking water tanks.

The major potential structural failures would be the overtopping or breaching of a reservoir dam. This type of failure could be caused by flood flows through a reservoir exceeding the emergency spillway capacity or by an earthquake.



Legend

100–Year Flood Ploin Area

tone A Flood Depths 1–3 Feet and Velocities Determined.

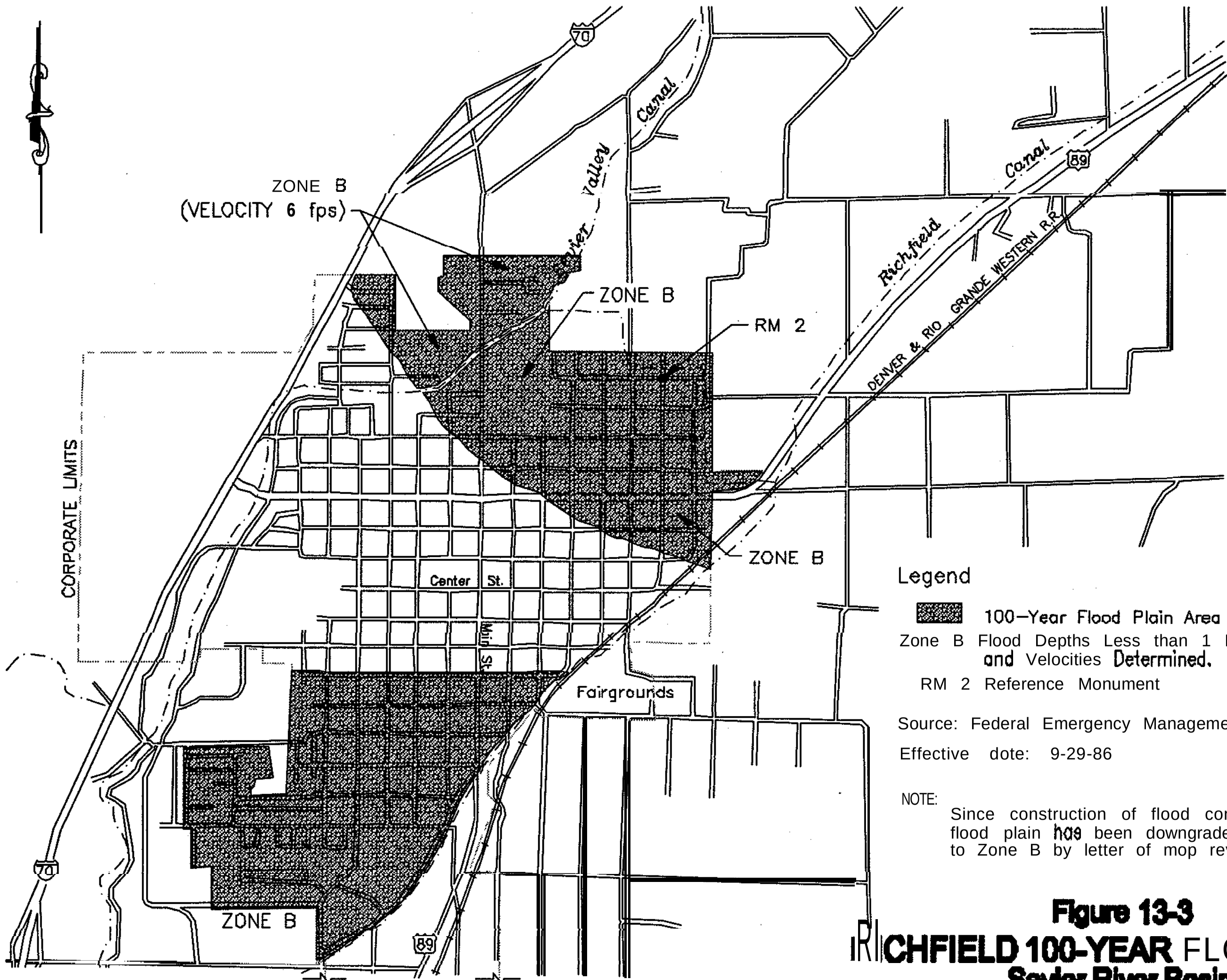
RM 2 Reference Monument

Source: Federal Emergency Monogement Agency (FEMA)
Effective date: 8–28–79

Figure 13-2

PANGUITCW IOO-YEAR FLOOD PLAIN

Sevier River Basin



Legend

100–Year Flood Plain Area

Zone B Flood Depths Less than 1 Foot and Velocities Determined.

RM 2 Reference Monument

Source: Federal Emergency Management Agency (FEMA)

Effective dote: 9-29-86

NOTE: Since construction of flood control structures, flood plain has been downgraded from Zone A to Zone B by letter of mop revision.

Figure 13-3
RICHFIELD 100-YEAR FLOOD PLAIN
Sevier River Basin

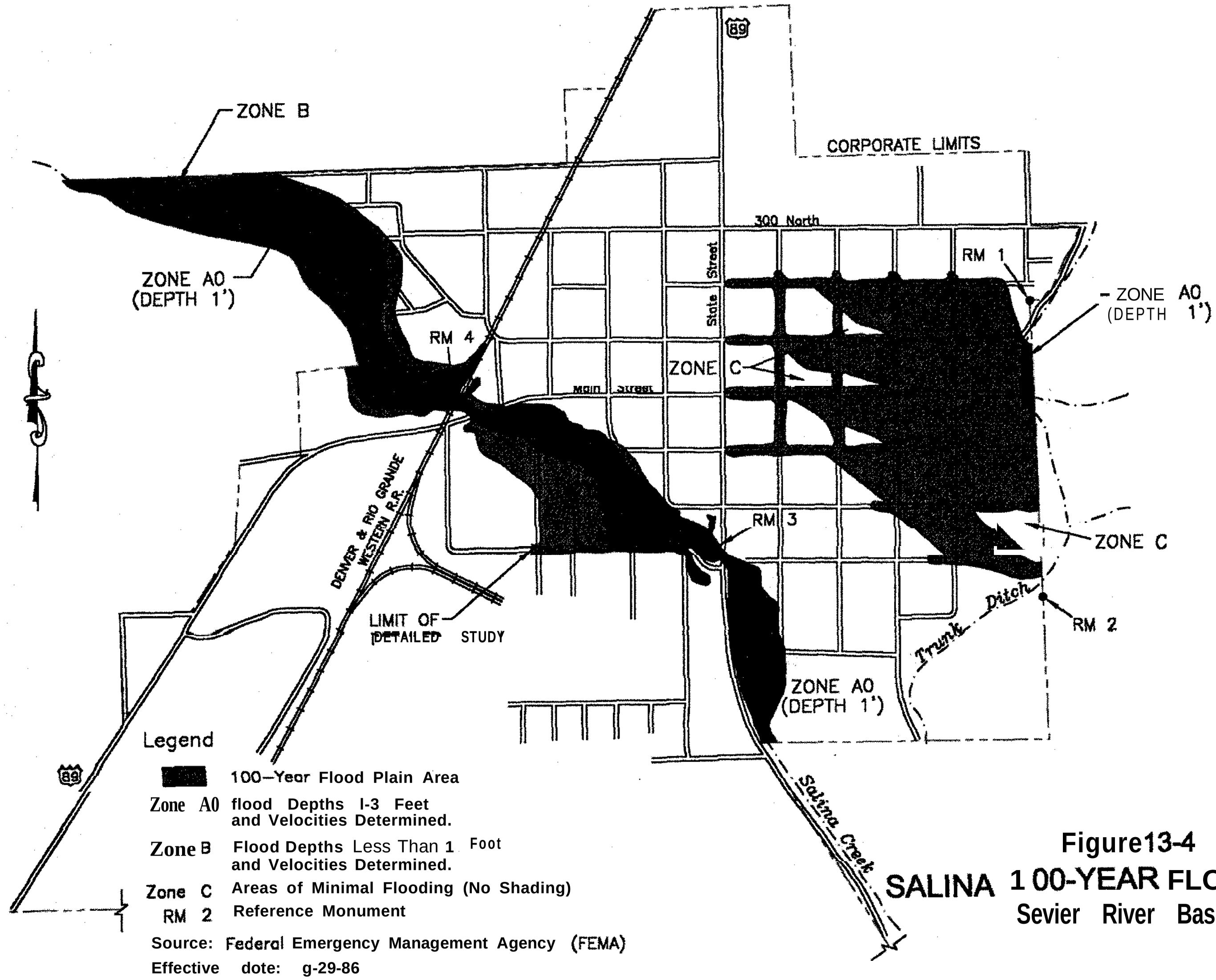
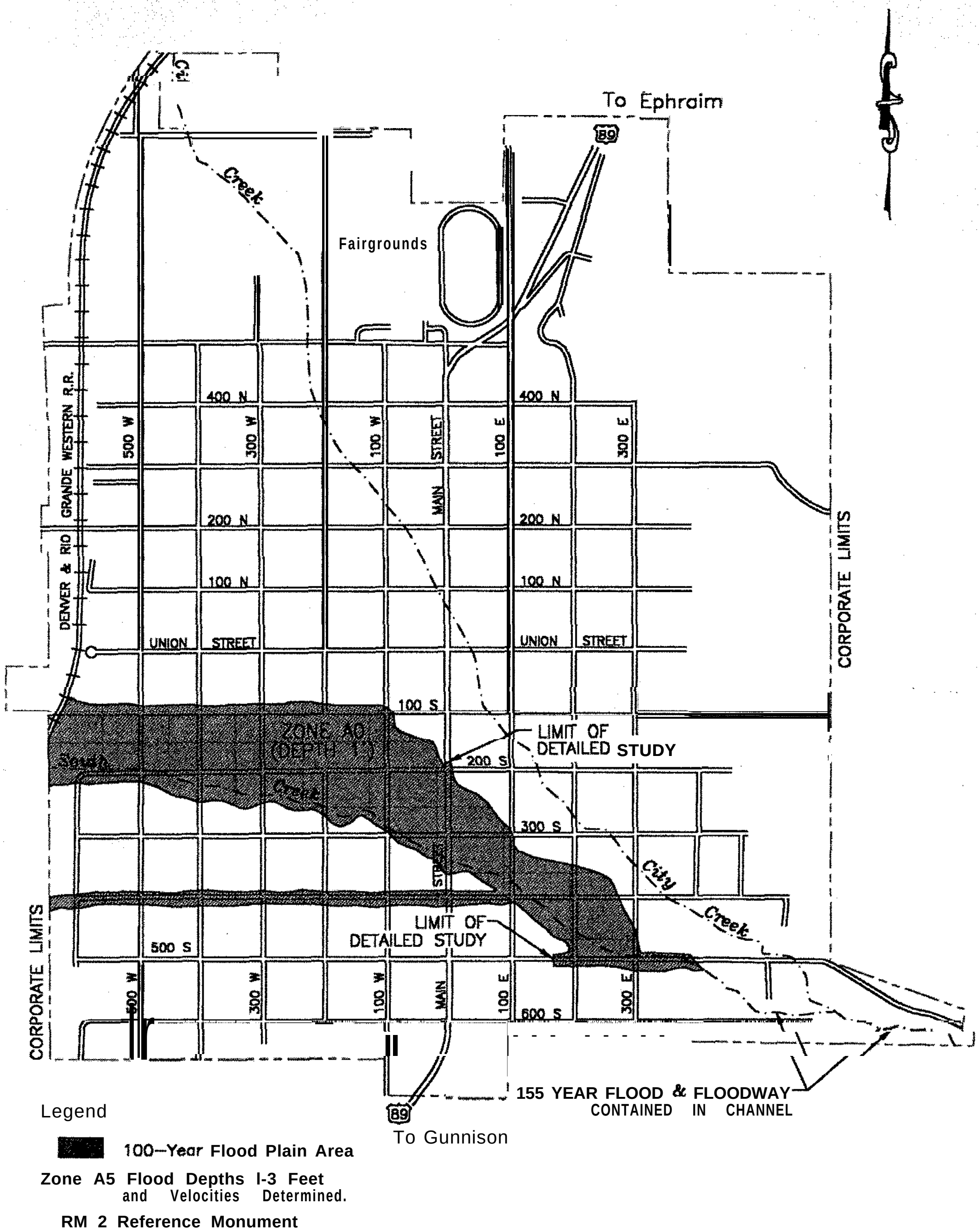


Figure13-4
SALINA 100-YEAR FLOOD PLAIN
Sevier River Basin



Source: Federal Emergency Management Agency (FEMA)
Effective date: 8–4–87

Figure 136
MANTI 100-YEAR FLOOD PLAIN
Sevier River Basin

13.7 FLOOD PREVENTION AND DROUGHT CONTROL ALTERNATIVES

For the most part, only the larger storage reservoirs would have appreciable effect on reducing flood flows in major drainages although most reservoirs would have some effect. Most of the reservoirs on tributary drainages can provide some flood control. Flood control reservoirs or flood channel facilities should be considered on tributary drainages where downstream flood damage potential is great. Examples of existing flood control structures are those above Monroe, Richfield, Glenwood, Mt. Pleasant and Kanosh. Others could be added or improved above Manti, Levan and Fillmore.

Investigation of the upper watershed areas could determine the effects of installing nonstructural measures such as vegetative improvement to reduce floods.

Flood plain management may be one of the most viable alternatives to reduce flood damage. Refer to Section 13.9.1 for further discussion of flood plain management.

There are also additional ways to reduce the impact of flooding. Canal and river banks can be strengthened along critical sections. Narrow bridges or other constrictions that would be overloaded can be modified or replaced to decrease the risk of damage from high flows.

Drought impacts can be reduced when the volume of precipitation is increased by weather modification through cloud seeding. However, this requires the right conditions to be most effective. During prolonged periods of drought, it may not be possible to significantly increase the precipitation although it is a viable alternative on a long-range continuing basis. This will maintain the upper watershed soil moisture at a higher level which will tend to moderate the effects of drought. Good management of the upper watersheds is one of the best alternatives to alleviate the impacts of drought.

The current Utah Drought Response Plan was prepared in 1990. The Division of Comprehensive Emergency Management is updating this plan.

13.8 DISASTER RESPONSE ALTERNATIVES

It is always more effective to have plans and/or facilities in place prior to any disaster response requirements. There are several actions that could be put in place to alleviate emergency situations. Suggested actions include the following:

- Development of disaster response plans (Emergency Operations Plans) by individual communities,
- Investigation and construction of water storage and floodwater prevention projects,
- Continuation of cloud seeding programs,
- Family emergency plans, and
- An assessment of sediment/debris flows that could be expected after wildfires.

All of the major reservoirs have disaster response plans in place. In addition, real-time stream gaging stations could be used as an early-warning system for flood situations. These are remote controlled so they can be easily accessed.

Disaster Response Plans or Emergency Operation Plans (EOP) help communities increase their ability to respond to disasters and emergencies. These plans should be prepared ahead of time allowing counties, cities and towns to coordinate efforts and define responsibilities. Decisions should be made on leadership positions and activation of response activities.

All of the counties have EOPs in place. These plans identify hazards in the counties. They also address disruption, contamination or exceptional shortfall in water supplies that can occur during emergency situations. When this happens, water deliveries need to be prioritized to ensure critical needs are met first.

The Division of Comprehensive Emergency Management (CEM) suggests all residents prepare a 72-hour emergency survival kit. This will allow time for relief efforts to reach most residents. Families should have their own emergency plan outlining each member's responsibility during a disaster. Emergency preparedness drills will familiarize family members of their duties and will help ensure the safety of each.

Flood control measures are implemented at the local level. However, CEM coordinates the resources of many local, state and federal agencies. The following steps are used to prepare for floods:

- Coordinate state resources to make them available to counties,
- Evaluate flood risks in local areas,
- Coordinate Army Corps of Engineers and other agency activities and put them in touch with local officials,
- Provide an interagency technical assistance team to evaluate threat and risk of flooding, and
- Coordinate emergency response.

Hazard mitigation may include structural and non-structural activities as they relate to flood prevention. Continued active involvement in the National Flood Insurance Program (NFIP) is essential to ensure adequate flood plain management objectives are in place to reduce flood losses. Hazard mitigation plans should be implemented by communities to deal with specifically identified potential disasters, such as flooding, earthquakes and toxic spills.

13.9 ISSUES AND RECOMMENDATIONS

There is one policy issue. It discusses flood plain management.

13.9.1 Flood Plain Management

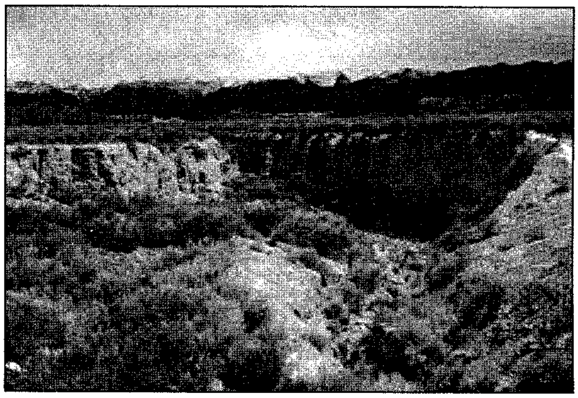
Issue - Some local governments do not have or have out dated flood plain management plans.

Discussion - Many communities are located near the mouths of canyons with perennial streams. These canyons can produce devastating floods causing property damage, loss of life and endangering the health and welfare of the residents. Most of these floods are caused by cloudburst storms which produce high flows. There have been numerous floods of this type recorded from Sevier River tributaries. The prolonged flooding during 1983-84 caused considerable damage on the Sevier River mainstem.

The NFIP was established to reduce large federal outlays for disaster relief. Its purpose is to: 1) Reduce flood loss, 2) prevent unwise development in flood plains, and 3) provide affordable flood insurance to the public.

In order to qualify under the NFIP, communities must pass ordinances regulating development in flood plains. This is required if any federal or federally insured funds are used for construction. The CEM coordinates the NFIP. They can assist local participating communities in the implementation of the flood plain objectives defined by NFIP. Table 13-2 shows the status of the NFIP.

Recommendation - Nonparticipating entities should become qualified to participate in the National Flood Insurance Program. The Division of Comprehensive Emergency Management should assist.



Floods have damaged Danish Wash

Table 13-2
NATIONAL FLOOD INSURANCE PROGRAM COVERAGE

Participating Communities

Communities	Policies	Communities	Policies
Garfield		Fairview	0
Unincorporated	1	Gunnison*	1
Hatch	2	Manti	2
Panguitch	3	Mt. Pleasant	17
Juab		Moroni	0
Levan	2	Spring City	0
Piute		**Sevier County**	
Unincorporated	0	Unincorporated	8
Circleville	0	Annabella	11
Junction	0	Aurora	1
Marysvale	0	Elsinore	5
Millard		Glenwood	6
Unincorporated	0	Joseph	0
Fillmore*	0	Koosharem*	0
Holden	1	Monroe	2
Kanosh*	0	Redmond*	0
Oak City*	0	Richfield*	2
Sanpete		Salina	5
Unincorporated	2	Sigurd	1
Ephraim	0		

Non-Participating Communities

Communities	Communities
Garfield	**Piute**
Antimony	Kingston
Juab	**Sanpete**
Eureka	Centerfield
Millard	Fayette
Delta	Fountain Green
Hinckley	Sterling
Leamington	Wales
Lynndyl	**Sevier**
Scipio	All communities participate

* NSFHA - No Special Flood Hazard Areas (designated 100 year floodplains)- flood insurance available.

Section 14 Sevier River Basin FISHERIES AND WATER-RELATED WILDLIFE

Tables

Fisheries And Water-Related Wildlife

Diverse fish and wildlife species are found from alpine environs to the vast dry desert areas and from mountain streams to valley reservoirs.

14.1 INTRODUCTION

This section describes the fisheries and other water-related wildlife in the Sevier River Basin. It also discusses associated problems and presents alternatives to improve this resource. All forms of wildlife depend on water at some time. The multifaceted recreational opportunities provided by wildlife and fishing can be enjoyed by all ages regardless of their situation.

Fishing is clearly dependent on a quality aquatic habitat. However, the quality of the riparian zone also impacts amphibians, birds, mammals, leeches, mollusks and insects. Riparian vegetation provides food, cover and nesting sites for wildlife and helps determine water temperature, which in turn may determine fish species, composition and population size along with influencing the available nutrients. Water development for various uses impacts the historic hydrologic regimes and associated riparian communities which effects fisheries and wildlife resources.

For these reasons, it is important to understand the relationship of fisheries and wildlife to other water-related resources uses.

The quality of the environment contributes to the health, well-being and quality of life of the local residents.

14.2 SETTING

A wide diversity of fish, wildlife and plant species are found in the basin; interacting together to contribute to a functioning ecosystem. There are 92,000 acres of wetlands, riparian vegetation and open water areas. About 50 percent of the riparian and open water areas are located in Millard and Sanpete counties. Management areas such as Manti Meadows and Topaz Slough provide habitat for waterfowl.

Fishing is a popular pastime on the lakes, reservoirs and streams, particularly in the upper reaches of the river and tributary systems. In the lower areas, flat water-based recreation becomes more popular.

14.2.1 Wildlife Species

Early settlers reported big game was scarce although furbearers, waterfowl and predators were abundant, and fish were found in good supply. The few deer were intensively hunted for meat and hides. By the turn of the century, big game was so scarce the sight of a deer or other game animal was a rarity. Through passage and enforcement of laws, big game is abundant today, as is small game, waterfowl and many other wildlife species.

The traveler, local or distant, is often delighted to see ground squirrels, chipmunks and perhaps a lumbering porcupine. Walking through the forest, one is likely to hear the scolding of the red squirrel and in the vicinity of Navajo Lake may even observe the unique flying squirrel. High on the talus slopes of mountains, pika abounds; their chipping mixed with the whistle of yellow-bellied marmots. It may take more effort to see a kit fox on the desert or a coyote, cougar or eagle. The Utah prairie dog, a threatened species, is also found in the Sevier River Basin. Song birds brighten the day with their music while water-fowls bring a feeling of restlessness during their migrations. Many waterfowl and shorebirds use the Sevier River and lakes for resting and feeding during spring and fall migrations. The wide variety of wildlife present, offers many recreational opportunities such as hunting, wildlife viewing, photography and backyard bird feeding. Thousands of snow geese use Gunnison Bend Reservoir as a spring staging area every year, attracting numerous visitors. Each spring the Utah Division of Wildlife Resources (DWR) sponsors a "Snow Goose Day" at Gunnison Bend Reservoir.

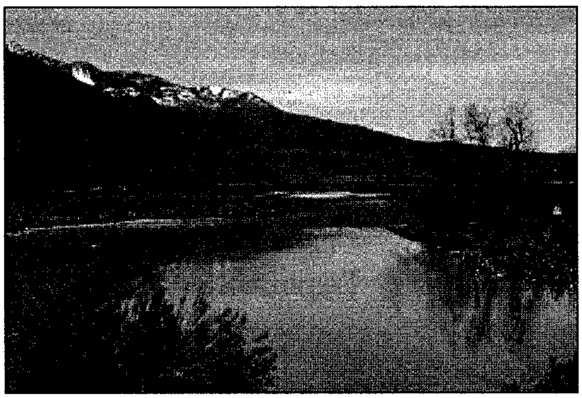
Migratory waterfowl hunting occurs along the rivers and streams. Geese are also found in nearby feeding areas, often cultivated lands where grain is grown. Hunting for pheasants is a popular sport. This takes place in the irrigated areas, although nearby riparian vegetation also provides hunting. Chukars are hunted in the dry foothills and grouse in the uplands and mountain areas.

The Endangered Species Act (ESA) does not apply directly to non-federal water-related activities by any agency under a federal permit or license. Owners and operators of non-federal projects are not affected as long as the normal and ongoing operations do not result in the taking of one of these species. The criteria for threatened and endangered status and category designations are explained in Section 16, Federal Programs and Development. Species classified for official listing are shown in Table 16-2.

In the event federal permits are required to develop a water resource or make revisions to existing ones, the Fish and Wildlife Service will review the project. The scope and overall intent of the proposed project or change will be assessed to decide the effect on fish and wildlife in the immediate area. Endangered plants are treated differently than endangered animals on private property. Threats to endangered plants will not stop development activities in an area where federal permits are not required although the ESA provides some protection where plants are not under federal jurisdiction. If listed plants are removed, destroyed or damaged on state or private land in violation of state law or criminal trespass law, it is also a violation of the ESA. The Fish and Wildlife Service and Division of Wildlife Resources makes every effort to work with private landowners to conserve listed and candidate species.

There are three springsnails species in the Sevier River Basin that are found in only one other spring in the entire world. They are found in the springs below Johns Valley groundwater reservoir on the East Fork of the Sevier River, in the central Sevier River area, and in the San Pitch River. A less restricted species occurs in several locations in the Otter Creek drainage. See Table 14-1 for a selected list of wildlife species that occur in the Sevier River Basin.

The Utah prairie dog, bald eagle and peregrine falcon are federally listed threatened or endangered species known to occur in the basin. The upper part of the basin is considered to be within the range of the federally listed endangered Southwestern willow flycatcher. The habitat most commonly utilized by the flycatcher is multi-storied, dense, riparian vegetation. Proper management of this riparian vegetation could greatly improve habitat for these high-interest species. They are judged to be in danger of extinction throughout a significant part of their range and as such, are protected by federal and state laws and regulations.


Heppler Pond provides waterfowl habitat

14.2.2 Fisheries

Prior to about 1870, the Bonneville cutthroat was the only trout found in the Sevier River Basin. This native species was found in moderately large populations throughout the Sevier River and its tributaries. Diaries of early settlers indicated loading pack horses with native trout. After 1870, stocking of Yellowstone cutthroat and rainbow trout started and was increased in the early 1900s. Fishing soon became a pastime of many with license sales multiplying lo-fold within 50 years. The fishing in the Sevier River main stem was reduced to practically nothing by the 1950s and is limited to nonexistent at the present time.

Many streams and reservoirs suitable for planting are stocked each year with fingerlings and catchable-sized fish. Management of wild-fish waters also helps assure natural reproduction to sustain the fishery. Fish populations in wild-fish waters are especially sensitive to alterations and impacts to their habitat.

Table 14-1 WILDLIFE SPECIES		
BIG GAME	SMALL GAME	FURBEARERS
antelope	cottontail rabbit	beaver
elk	jack rabbit-nongame	mink
moose		muskrat
mountain goat		
mule deer		
CARNIVORES	WATERFOWL	GAME BIRDS
badger	var. species of	blue grouse
black bear	coots	chukar
bobcat	cranes	Merriam turkey
cougar	ducks	mourning dove
fox	geese	ring-necked pheasant
skunk	herron	ruffed grouse
weasel	rails	sage grouse
	snipe	
NONGAME BIRDS	GAME FISH	NONGAME FISH
bald eagle	black bass	carp
golden eagle	brook trout	dace, spp.
ferruginous hawk	catfish	leatherside chub
peregrine falcon	cutthroat trout	minnow
red-tail hawk	German brown trout	mountain sucker
rough-legged hawk	perch	redside shiner
Southwestern willow flycatcher	pike	sculpin, spp.
	rainbow trout	Utah chub
	walleye	Utah sucker
	white bass	

The Division of Wildlife Resources has purchased all the water rights to establish conservation pools in Pine Lake and Manning Meadow Reservoir. There are three state, and five private fish hatcheries. The state fish hatcheries are located on Mammoth Creek in Garfield County, below Glenwood Springs east of the town of Glenwood in Sevier County and below Big Springs west of Fountain Green in Sanpete County. Two of the private fish hatcheries are located between Richfield and Glenwood south of SR-119. These are the Trophy Fish Ranch near the point of Bull Claim Hill and the Hydeaway at the Hepler Ponds. The other three are located in Grass Valley, two near Koosharem and the other near Burrville.

Cutthroat, brook and rainbow trout are found in the cold mountain streams and lakes and German brown trout in some valley streams. Some streams no longer support abundant fish populations because of silt loads, fluctuating water levels, loss of instream structures, unstable streambeds, streamflow diversions, and degradation of riparian vegetation.

Downstream, fishing changes more to a warm water fishery. Principal species are German brown trout, carp, suckers and channel catfish. Walleye, small mouth bass, yellow perch and northern pike also occur in the lower reservoirs and river.

Physical data for the larger lakes and reservoirs are shown in Table 14-2. See Table 12-4 for additional data.

Classes of Lakes - Class I lakes are large bodies of water that satisfy heavy fishing pressure.

Table 14-2
RESERVOIR PHYSICAL DATA

Reservoir/Lake	Elevation (feet)	Surface area (acres)	Maximum depth (feet)	Aquatic Use (Class)
Barney Lake	10,050	20	16	3A
Big Lake	9,330	120	NA	3A
Chicken Creek	5,050	510	8	3C, 3D
DMAD	4,665	1,200	24	3B
Fairview Lake #2	8,975	105	40	3A
Fool Creek #1	4,805	1,200	20	3C, 3D
Gunnison	5,390	1,285	28	3c
Gunnison Bend	4,620	705	24	3B
Koosharem	6,995	310	20	3A
Lower Box Creek	8,465	50	23	3A
Manning Meadow	9,750	NA	49	3A
Navajo Lake	9,035	715	24	3A
Nine Mile	5,400	215	36	3A
Otter Creek	6,370	2,520	37	3A
Palisades Lake	5,870	65	31	3A
Panguitch Lake	8,210	1,250	66	3A
Pine Lake	8,190	75	20	3A
Piute	5,995	2,510	66	3A
Redmond Lake	5,110	160	10	3B
Rex	7,250	45	38	3A
Sevier Bridge	4,980	10,905	74	3B
Tropic	7,835	180	30	3A

Productivity is such that it supports a high fish population in good condition of one or more species of game fish. Natural reproduction and/or stocking of small fish maintains an excellent sport fishery.

Class II lakes are also important because of their recreational value. Productivity is such that it supports a high fish population in good condition of one or more species of game fish. Coldwater lakes in this class require stocking of small fish to maintain good fishing. Some Class II lakes are smaller and may have lower aesthetic ratings or biological deficiencies.

Class III lakes and reservoirs are often attractions for out-of-state anglers but normally provide angling for those who reside within 50 miles. Some are in areas where there is little fishing but may be very important locally. These key lakes and reservoirs should be enhanced for fishery production if possible.

Class IV, V, and VI lakes and reservoirs contribute little to the fishery resource. Some provide fishing where little fishery exists except when stocked with catchable trout.

Most streams have been classified for fish habitat to assist in management decisions. The classification for selected streams is shown in Table 14-3.

Classes of Streams - Class I streams are top quality fishing waters. They should be preserved and improved for fishery and similar recreational uses. These streams are generally outstanding in natural beauty and are of a unique type. Their productivity supports high fish populations of one or more species of the more desirable game fish in good condition. Natural reproduction or the stocking of small fish maintains an excellent sport fishery.

Class II waters are of great importance to the fishery. These are productive streams with high aesthetic value and should be preserved. Fishing and other recreational uses should be the primary consideration. They are moderate to large in size and may have some human development along them. Many Class II streams may be comparable to Class I except for size.

Class III streams are the most common and support the bulk of stream fishing pressure. These streams provide fair to good fishery habitat and aesthetics. Water developments involving Class III waters should be planned to include fisheries as a primary use, and fishery losses should be minimized and enhanced when possible.

Class IV streams are typically poor in quality with limited fishery value. Fishing should be considered a secondary use. A few provide an important catchable fishery in areas where no other fishery exists. Water development plans should include proposals to enhance fisheries values where feasible.

Class V streams are now practically valueless to the fishery resource. Other water uses should take preference over fisheries use in planning water development.

Class VI streams are those stream channels which are dewatered for significant time periods during the year. Many of the stream sections could support good to excellent fish populations if appropriate minimum flows could be provided.

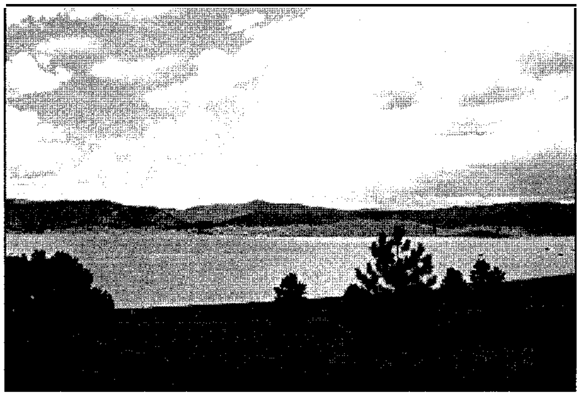
14.2.3 Wildlife Habitat

Habitat is the most important factor in maintaining healthy and self sustaining populations of fish and wildlife. Habitat is influenced by the overall condition of the ecological system and the level and type of human activities. Nature's abundance of water along with a favorable climate have created an exceptional ecosystem for a wide variety of fish and wildlife. Healthy riparian zones provide habitat as well as travel and migration corridors, winter cover, and food supply for resident species. Streams flowing off the surrounding mountain sides are often dewatered in the lower stretches, reducing wildlife habitat and watering sources.

Construction of water storage facilities has expanded and diversified recreational fishing and hunting opportunities for people. At the same time, the increased demand for water and building of communities has been in direct conflict with the needs of many fish and wildlife species.

14.3 ORGANIZATIONS AND REGULATIONS

Local, state and federal agencies have a part in passing and enforcing laws to regulate management of water facilities affecting wildlife. Private organizations work with public entities to protect fish and wildlife habitat.



Panguitch Lake provides prime fishing

14.3.1 Local

Irrigation companies control most of the water facilities affecting fish and wildlife. The impact may be either direct or indirect. Early irrigation rights holders were not required to leave water in the streams during times of low flow. As a result, there are no instream flow water rights in the Sevier River mainstem. The only exception is Manning Creek which is owned by the Division of Wildlife Resources.

There are several wildlife groups active in the Sevier River Basin. They are involved in the policy making process by providing local input to the Regional Advisory Council, which makes recommendations about regulations to the Wildlife Board.

Table 14-3
STREAM CLASSIFICATION FOR FISH HABITAT

Stream Reach	Use Class	support Status	Stream Reach	Use Class	Support Status
Asay Creek	3A	u-PS,l-NS	Salina Cr, hdwtr to USFS bd	3A	PS
Duck Creek	3A	F S	Salina Cr, USFS bdy to SR	3 B	PS
Mamoth Creek	3A	u-FS,1-NS	San Pitch R, hdwtrs to U132	3A	NA
Panguitch Cr, ab Pang L	3A	F S	San Pitch R, U132 to Svr R	3C-3D	NA
Panguitch Cr, blw Pang L	3A	u-PS,m-FS,1-NS	San Pitch R, east side trib	3A	NA
Sevier, Piute R to hdwts	3A	N S	Ivie Creek	3A	u-FS, I-NS
Bear Creek	3A	NS"	Chicken Cr, hdwtr to Levan	3A	NA
EF Sevier R, ab Tropic R	3A	F S	Chicken Cr, Levan to Svr R	3 B	NA
EF Sevier R, TR to Johns V	3A	N S	Deep, Little Salt, Chris	3A	NA
Deer & Antimony Creeks	3A	F S	Creeks above USFS bdy		
EF SR, Johns V to Piute R	3A	PS	SR, Svr Brdg to Gnnsn Bnd R	3 B	PS
Otter C ab Koos R & Gmwh C	3A	F S	Tanner, Cherry, Judd Creeks	3A	NA
Box Creek	3A	PS	Fool Cr, hdwtrs to USFS bdy	3A	NA
Otter Cr, Otter R to Kshm R	3A	N S	Fool Cr, USFS bdy to mouth	3 B	NA
SR, Piute Res to Clear Cr	3A	PS	Oak Cr, hdwtrs to USFS bdy	3A	F S
SR, Clr Cr to Annabella Div	3A	NS	Oak Cr, USFS bdy to mouth	3 B	N S
SR, Annbll Div to Vrmllm Dm	3 B	N S	Goose Cr, hdwtr to USFS bdy	3A	no trout
Beaver & Deer Creeks	3A	F S	Goose Cr, USFS bdy to mouth	3 B	no trout
Manning3& Monroe Creeks	A	F S	3 Pioneer Cr, hdwt to USFS bd	A	F S
SR, Vrmln Dm to Rcky Fd Res	3 B	PS	Pioneer Cr, USFS bd to mouth	3 B	N S
SR, Rcky Frd Rs to Salilna C	3A	PS	Chalk Cr,hdwtrs to USFS bd	3A	F S
SR. Slna Cr to Svr Brdg Res	3 B	PS	Chalk Cr, USFS bdy to mouth	3A	N S
Willow Cr, hdwt to USFS bdy	3A	F S	Meadow Creek, abv diversion	3A	PS
Lost Cr, hdwtrs to USFS bdy	3A	F S	Corn Creek, above diversion		PS
Lost Cr, USFS bdy to SR	3A	PS			

[a] No trout to maintain an important 3C fishery.

Note: FS • Fully Supportive
PS • Partially Supportive
NS • Nonsupportive

Some NS streams flows are inadequate for trout.

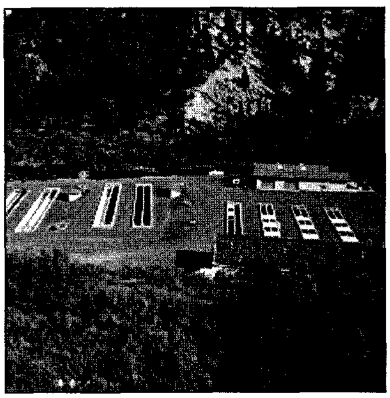
Stream Class:

3A • Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.
3B • Protected for warm water species of game fish and other warm water aquatic life. including the necessary aquatic organisms in their food chain.
3C • Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.
3D • Protected for waterfowl, shore birds and other water-oriented wildlife not included in class 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

14.3.2 State

The Division of Wildlife Resources (DWR) responsibility for the management, protection, propagation and conservation of the state's wildlife resources. Planning for wildlife habitat needs is recognized as an integral part of basin water planning. Fishing, hunting and non-game wildlife activities contribute financially to the economy and these need to be considered.

The DWR will assume the lead role in determining potential impacts (positive and negative) to wildlife resources from water development projects. DWR will assess plans and identify benefits and adverse impacts, recommend possible mitigation and minimization of impacts, and if this is not possible, suggest project termination. DWR also provides factual information regarding consequences of unmitigated and mitigated impacts to wildlife resources.


Mammoth Fish Hatchery

Title 73-3-3 of the ***Utah Code Annotated*** allows the division to file for minimum instream-flow water rights. They can also file requests for permanent changes in the operation of certain streams and rivers to preserve critical fish habitat and to provide permanent enhancement of the state's stream and river fisheries. Water releases from reservoirs could be used to provide instream flows. Filing for instream flows could affect water rights in some areas. Currently, there are no instream flow rights except Manning Creek.

14.3.3 Federal

The Fish and Wildlife Service (FWS) is charged with carrying out the Fish and Wildlife Coordination Act. This act requires consultation between FWS and state agencies on specific activities. FWS is also charged with administering and regulating the Endangered Species Act. All federal agencies are charged with using their authorities to further the purposes of the act by carrying out programs for the conservation of threatened and endangered species.

14.4 PROBLEMS AND ISSUES

The following are problems and issues.

- Instream flows are critical for maintaining the fishery resources, aquatic and wetland habitats.
- There is a need to manage the riparian vegetation along the river and stream banks and the open water shore lines.
- Erosion is affecting water quality and degrading fish habitat where there is severe loss and degradation.
- Over-grazing by livestock and wildlife induces erosion of the upper watersheds and degrades the habitat, deposits sediment in the stream and river fisheries, reduces the water quality and prevents percolation into the groundwater, thus lowering spring flows. The problem of over-grazing of valley bottoms and along streams and rivers should be addressed where needed.
- Draining and development of wetlands should be approached with caution and mitigated where feasible.
- Consideration should be given to restoring meanders in the Sevier River through Sevier Valley to improve wildlife habitat and improve river hydrology. Any action taken should consider any adverse impacts such as increased water use by riparian vegetation and reduced channel capacity to carry flood flows.
- Actions should be taken to preserve habitat for threatened and endangered species as well as for state sensitive species.

Many people are attracted to live and play in this area because of the unique year-round attractions and facilities. This results in more pressure on the environment as a whole and on the water resources in particular. Many of the canyons and lakes are heavily used in the summer for recreational pursuits. Many summer homes are being constructed in the upper watershed areas and towns and businesses are expanding as the population continues to grow. All of these and other activities tend to degrade the environment, making it more susceptible to deterioration of fish and wildlife habitat.

Conflicts are going to increase in the future due to finite water resources and expanding population. Some groups are advocating preserving all resources from all development and use. At the same time, others depend on these and other resources for their livelihood.

Most of the perennial streams are either captured in storage reservoirs or are diverted for irrigation during the growing season. Some stream channels are enlarged by erosion from cloudburst floods, loss of riparian vegetation and wildlife and livestock trampling.

Water quality is a problem in many reaches of the Sevier River. Streambank erosion, lack of riparian vegetation and increasing amounts of dissolved-solids are destroying the fisheries.

Other areas are damaged by ATV travel. This can cause a reduction in vegetation and associated wildlife values, loss of streambank stability, and siltation.

14.5 ALTERNATIVE SOLUTIONS

There are alternatives for using the resources so negative impacts can be avoided. ATV trails can provide control of this increasing activity. The Paiute ATV Trail in Sevier, Millard and Piute counties is a good example.

Riparian areas are important wildlife habitat for many species. These areas generally offer all four major habitat components: food, water, cover and living space. The linear lines of the riparian areas increase the “edge” between contrasting vegetation types. These are the zones of different types of vegetation that line streams at varying distances from stream banks. Different species use different vegetative types. These areas need to be protected.

Riparian areas can be protected from livestock and wildlife use by providing water upland from stream banks. Options include upstream ponds, horizontal wells, and wind power or solar energy to pump water to upland areas within the constraints of existing water rights. In the worst areas, fencing can be used to control access.

Another technique to assist with acceleration of regrowth on riparian areas is construction of instream structures. These include small impoundments or low head dams (much like those built by beavers), rock weirs, streambank protection, building up water tables, vegetative plantings and/or anchoring trees or rocks to streambanks to prevent further erosion. Some of these practices may be met with resistance from irrigation companies because it may impact their water rights.

Many of the poor cold water fisheries can be improved. Some of the waters are similar to the section of the East Fork of the Sevier River south of Antimony in Black Canyon. Electroshocking surveys here on August 10, 1995 indicates the potential for cold water fisheries in other waters of the Sevier River Basin. See Table 14-4.

Table 14-4
BLACK CANYON ELECTROSHOCKING SURVEY RESULTS

Location	Survey Length	Catchable Size Trout	Comment
At Osiris	0.1 mile	59 brown & 5 rainbow	4 brown, 19 rainbow, and 2 cutthroat, 6"-8"
1.5 mi below Osiris	0.1 mile	37 brown 4 rainbow, & 3 cutthroat	
2 mi below Osiris	0.1 mile	24 brown, 4 rainbow, & 3 cutthroat	suckers, sculpin & minnows were common

Note: Number of catchable size trout (8 inches or larger) captured in one pass on August 10, 1995.
Source: Division of Wildlife Resources, Southern Region.

Section 15 Sevier River Basin
WATER-RELATED RECREATION

Tables

Section Fifteen Sevier River Basin - State Water Plan

Water Related Recreation

Water is often the focal point for outdoor recreation whether it is flat-water for boating, streams for fishing, or just enjoying the changing reflections or soul-quieting music of rippling water.

15.1 INTRODUCTION

This section describes most of the water-related recreational facilities and resources found in the Sevier River Basin. Some of the data presented is from the Utah State Comprehensive Outdoor Recreation Planning (SCORP)[15] process. This process provides information for the preparation of a priority list of key water-related recreational and environmental issues to be addressed in the future. Information includes consumer or participant's expressions of outdoor recreation needs, issues and alternative solutions. The Utah SCORP also provides general guidelines for future leisure investments and suggests actions and responsibilities for attaining outdoor recreation needs. The SCORP is required by the federal government for states to receive grants for acquisition and development of outdoor recreation facilities by federal, state and local government sponsors. Public demand for outdoor recreation facilities and access are considered in the plan.

More than 370 projects have been funded in Utah since the Land & Water Conservation Fund program was initiated in the late 1960s; water features have always been a high priority amenity or site feature. The following tabulation is a breakdown of total project cost for 32 Land & Water Conservation Fund matching-grant projects.

Garfield County	3 projects	$97,700
Juab County	2 projects	$253,300
Millard County	6 projects	$642,700
Piu te County	4 projects	$76,000
Sanpete County	9 projects	$540,700
Sevier County	8 projects	$510,500

15.2 SETTING

The numerous reservoirs, clear streams, alpine scenery and red rock plateaus are prime recreational attractions. In contrast, there are historic mining remains, broad expanses of desert vistas and constantly moving sand dunes. These resources attract recreationists who enjoy horseback riding, fishing, boating and water skiing, sightseeing, sand dune buggying and ATV touring. As can be seen, there is a broad resources base supporting recreation. It seems the most popular recreation activities are associated with water.

The major public land managers are the Bureau of Land Management, Forest Service, National Park Service and Utah School and Institutional Trust Lands Administration. These four agencies control about 77 percent of the total area. These public lands also contain many of the water-related recreational settings.

Private ownership of many of the storage reservoirs make up a substantial part of the water-related recreation areas.

In addition, the Division of Parks and Recreation manages six state parks containing 1,656 acres. The Division of Parks and Recreation also has responsibilities for enforcing the boating laws on all waters in the area; e.g., Gunnison Bend Reservoir and Panguitch Lake. The division also provides custodial management of Fort Deseret south of Delta, and provides cooperative OHV management in the Sand Dunes and Oasis areas.

The National Park Service manages Bryce Canyon National Park and Cedar Breaks National Monument, two scenic splendors lit up with colors so rich and glowing they awaken even the most apathetic enthusiasm. The Bureau of Land Management administers the Little Sahara Recreation Area, an area of moving, shifting sands. Here sand dune buggying has become a popular pastime.

Other points of interest include the Old River Bed north of Delta where the Sevier Lake Basin drained into ancient Lake Bonneville, Tintic mines and

Eureka Mining Museum, Sugarloaf (Pahvant Butte volcano) near Fillmore and Cedar Grove near Koosharem where the peace treaty with the American Indians was signed.

One can go from the colorful vistas of the Markagunt and Paunsaugunt plateaus down their gentle slopes with the ponds and lakes fed by cool mountain streams, through the forests of pine and aspen, past the rugged mountains with their snow-capped peaks and into the broad river valleys with their green expanses of cultivated crops. From here, one can travel through fertile lands and on to the broad, blossoming river delta and then into the simmering desert with its barren mountains and vast expanse, ending in a broad, dry playa. Each of these areas has their own unique beauty and provide experiences for even the most discriminating recreationist.

Byways include SR-143 from Brian Head-Cedar Breaks to Panguitch Lake, SR-14 from US-89 at Long Valley Junction to Navajo Lake and on to Cedar City, SR-12 from south of Panguitch to Bryce Canyon and to Torrey via Escalante and Boulder, and SR-31 from Fair-view to the Skyline Drive and to Huntington. Several back ways provide access to points of interest around the basin.

15.3 ORGANIZATIONS AND REGULATIONS

Management of recreational facilities and activities is usually by local, state or federal government agencies. Many of these facilities or activities are water-related.

153.1 Local

Most of the basin is covered by two multi-county planning districts (MCDs). The Central (Six County AOG) Multi-County Planning District (MCD) covers the entire basin except Beaver, Garfield, Iron and Kane counties. These counties are covered by the Southwest MCD. A small part of Tooele County is part of the Wasatch Front Regional Council.

Each of the MCDs collects data to prepare brochures and guide material to attract and assist visitors to the area. These organizations are formed and staffed under the direction of the several county commissions. MCDs are also called "area associations of government" or AOGs--they often provide technical services, clearing houses for grant programs and other advocacy roles for local government.

Other local organizations are also involved in promoting recreational activities. These include county, city and town governments; and to some degree, state and regional tourism organizations.

15.3.2 State

The Division of Parks and Recreation has responsibility for conserving Utah's rich natural resources heritage while making recreational opportunities available to all users. By statute, they are the "recreation authority" for the state (see *Title 63-1 I -1 7.1, UCA, as amended).* Their mission is to "enhance the quality of life through parks, people and programs." Within this context, the division manages six state parks in the Sevier River Basin. They also coordinate four grant funding-programs, manage the OHV program, oversee the boating and trail programs, and prepare the Statewide Comprehensive Outdoor Recreation Plan (SCORP)[15]. The division operates under the general guidelines of their 1996 system plan: <u>Frontiers 2000: A System Plan to Guide Utah State Parks and Recreation into the 21st Century</u> (pp.39). Fifteen major issues have been identified by planning participants. Among these issues are boating, participating in the state water planning process, planning, public safety on Utah's waters, establishing boat carrying capacities on lakes and reservoirs, boating education, personal water craft training and certification, general training, and generally enforcing the state boating laws.

15.3.3 Federal

Federal agencies with responsibilities to provide and conserve recreational opportunities include the Bureau of Land Management, Forest Service and National Park Service. Each operates under the regulations peculiar to that agency. Most federal recreational activities are not water-oriented, but many are located on or near small streams, lakes, and riparian areas.

15.4 OUTDOOR RECREATIONAL FACILITIES AND USE

All levels of government and the private sector provide recreational opportunities and facilities. Some of the most used recreational facilities are water-related, either directly or indirectly. There is a very broad spectrum of recreational uses.

15.4.1 City and County Recreational Facilities

City and county recreational facilities range from golf courses and ball diamonds to picnic areas, all using water for large grass areas or minor amounts for culinary needs. Swimming pools and ice skating rinks are direct users of water. Water skiing and boating are popular water-based activities on a few privately-owned reservoirs.

Other recreation pursuits do not require much water for direct use. One of these is the Paiute ATV Trail. ATV activities are sponsored by local committees and travel councils and funded by the State Parks OHV Grants Program--matched by federal dollars. The consortium of state, federal and local groups and businesses promote the virtues of the 200-mile loop Paiute ATV trail that traverses three mountain ranges, through rugged canyons and desert areas. There are numerous side trips to enjoy other activities making a total of more than 300 miles of roads and trails. This trail also has access to the Great Western Trail which will eventually run from Canada to Mexico along the Skyline Drive on the eastern boundary of the basin.

15.4.2 State Parks

The Division of Parks and Recreation manages the following six state parks: Fremont Indian (889 acres) and Territorial Statehouse (2.4 acres) Parks and Museums, Otter Creek (80 acres), Palisade (79 acres), Piute (40 acres), and Yuba (120 acres plus 445 acres leased from BLM) State Parks. These parks cover about 1,656 acres. Surface-water areas are not included as they are generally under other ownership. Otter Creek, Palisade, Piute and Yuba state parks offer fishing, boating and water skiing. Clear Creek is a popular amenity running through Fremont Indian State Park and Museum. All parks have water-related recreational facilities except Territorial Statehouse State Park and Museum. Fremont Indian State Park and Museum have campgrounds, trails and guided interpretive trails. All of the parks are popular with visitation increasing nearly 25 percent in the last 10 years. Visitation for each of the parks is listed in Table 15-1 along with the water-related facilities available. The 364,000 guests in 1977 generated about $5.8 million in economic activity and about $363,600 in sales tax revenue.

The recreational demand at Yuba State Park is several times the capacity of existing facilities, especially on the holiday weekends of Memorial Day and Labor Day. To compound the problem, part of the area around Yuba Lake (Sevier Bridge Reservoir) is in private ownership and no facilities are available. The other major land owner is the Bureau of Land Management. The Division of Parks and Recreation has secured $300,000 in state funds for improvements. These funds were matched by more than $300,000 of federal funds to provide access, day use areas, and control fencing. This has been an excellent state, federal and local government partnership. The elevation of the reservoir makes it an early season boating destination for thousands of boaters along the Wasatch Front.

The regulations at Yuba Lake are an example of limits or boating caps that have been instituted on six reservoirs in the state, including Jordanelle, Quail Creek and Deer Creek reservoirs (state parks) during 1996. More than 5,000 more boats were sold in 1996 than in 1995. Most of these are personal watercraft (PWC). These are fast, fun, and sometimes a nuisance to other park users. They are also more affordable to the average middle income family and are easier to store and tow. This increase in PWCs will result in more cautious management of water bodies and a need for education and greater courtesy by PWC users. More than 2,441 students have been trained and certified statewide on PWCs as of December 1996. In addition, 12,980 students have been trained and certified on OHV's.

15.4.3 Federal Recreation Areas

Bryce Canyon National Park, Cedar Breaks National Monument and Little Sahara Sand Dunes Recreation Area are the major developed federal facilities. These federal recreational facilities are shown in Table 15-2. Visitation at these three important recreation areas generate more than 1.42 million visits each year, spending more than $38 per person or in excess of $54 million in state and local

Table 15-l
STATE PARKS VISITATION AND FACILITIES-1997

Park	Visitation (1000)	Water Area (acres)	Overnight (number)	Elevation (feet)
Fremont Indian	100	stream	31	5,900
Otter Creek	21	3,120	30	6,400
Palisade	103	60	53	5,800
Piute	30	3,360	Undev.	5,900
Territorial State House	40	-0-	-0-	5,100
Yuba	70	10.900	27	5.500

economic activity; and at least $3.4 million in tax revenues (conservative estimate without multipliers).

There are many campgrounds and picnic areas located in the Dixie, Fish Lake, Manti-La Sal and Uinta national forests. Recreational activity is measured in "recreational visitor days (RVD)." Dixie has use at 0.305 acres per RVD; Fish Lake has less intense use at 1.117 acres per RVD. For comparison, the Wasatch National Forest is at an intensity of 0.321 acres per RVDs. Many of these local facilities are near mountain lakes, reservoirs and streams. Other facilities include cabin accommodations near Navajo Lake and Panguitch Lake.

15.5 RECREATIONAL ACTIVITY PROBLEMS AND NEEDS

The Division of State Parks and Recreation is in the process of conducting a series of public opinion surveys associated with state parks and the Utah SCORP (Statewide Comprehensive Outdoor Recreation Plan). The 1992 survey helped determine the recreational problems and needs in the Sevier River Basin.

- Enhancing winter outdoor recreation opportunities: access, facilities, programs

Table 15-2
FEDERAL PARKS, MONUMENTS AND RECREATION AREAS

Name	Visitation (1000)	Type	Overnight Facilities	Elevation (feet)
Bryce Canyon N.P.	950	Scenic	Lodge, Camp	8,000
Cedar Breaks N.M.	220	Scenic	RV, Camping	10,000
Little Sahara R.A.	243	OHV	RV. Camping	5.000

- Need for Outdoor Recreation ethics--among OHVers, bikers, and littering campers and fishermen:
- Develop stable funding sources for acquiring lands and developing outdoor recreation and tourism facilities;
- Provide more water-based recreation opportunities: access to lakes, reservoirs, streams;
- Provide information facilities for travelers and tourists--get them off the freeways and into the area;
- Provide improved quality and accessible hunting and fishing opportunities:'areas being closed off by private development and federal regulations;
- Provide recreation planning assistance to local government and businesses: grants, data base, programs;
- Complete reasonable development of existing parks: renovation where facilities are run down; provide at least a basic level for visitor services in local, state and federal park and recreation areas. (Utah SCORP, 1992, p. 93)

Recent reservoir user surveys have been conducted by the Division of Parks and Recreation during the years 1996-1997. Each reservoir park site has different characteristics, but there are some common findings and concerns by reservoir park users:

- Respondent parties expend between $90 to $230 per visit on food, lodging, gas, recreation equipment, and equipment rentals--usually in parties of two adults and more than two children.
- Location, facilities and affordability are primary attractions to park users.
- Major needs include maintenance of facilities (clean and green), trails, rentals (jet skis or boats), shade and water access--including beaches.
- Depending on the park, and its level of development--the provision and maintenance of beaches and rest rooms ranked very high.
- The most popular activities were camping, boating, waterskiing. This depends upon the quality and character of the resource in question.

One other problem is the transfer of exotic species from one water body to another, either directly by fishermen or by water craft. There is the potential for introducing undesirable species.

The numbers of personal water craft are increasing. They are becoming a problem in many areas such as Yuba Lake on holiday weekends where there are large crowds. In shallow water areas, such as Gunnison Bend Reservoir, they disturb waterfowl. There is also a danger of hitting objects, such as fences, that are covered during high water.

15.6 NEEDED RECREATION OPPORTUNITIES

A 1991 and 1995-statewide survey revealed public attitudes and desires regarding state parks and outdoor recreation in general:

- Needs for the counties in the drainage included developed camping opportunities; improved fishing (access, quality, habitat); improved hunting (access, quality of big game and upland game); golf courses (varied between counties); primitive camping (only basic, if any development); picnicking facilities; trails; OHV staging areas and trails; mountain bike trails; equestrian facilities (corral, hitching, loading, watering, staging areas); backways and byways (less developed roads for sightseeing, and paved roads with good signs, beautiful vistas and access to quality recreation areas).
- Respondents did not want state parks over-developed or privatized; basic services; don't sell for private development; charge more fees to secure development funds; tell users how funds are spent--let them see what they are paying for.
- Users want stable sources of funding for parks so future uses can be planned for and implemented.
- Park users are not averse to park closure once capacity is reached to assure quality

- experience and protection of a sustainable resource. (USU, 1995)

15.7 ISSUES AND RECOMMENDATIONS

There are two major issues. These are outdoor ethics and comprehensive planning.

157.1 Outdoor Ethics

Issue - Many conflicts are exacerbated by unethical behavior in recreational settings.

Discussion - As the use of flat-water facilities increase, boating and water skiing accidents are becoming more commonplace. There often appears to be no concern by boaters for each other's safety or for respecting others' recreation experience, particularly where water-skiing is involved.

Some areas are so popular, especially on holiday weekends, facilities are overcrowded to the point security personnel are required to maintain a semblance of order. This is especially true at Yuba Lake State Park. To complicate the problem, three ownerships are involved. There is private land, Division of State Parks and Recreation facilities and lands administered by the Bureau of Land Management. Waste disposal facilities are especially overloaded to the point it is dangerous to people's health and welfare.

Programs such as TREAD LIGHTLY, CAPTAIN SAFE'TE (boating safety), hunter education and off-highway vehicle training are helping make everyone aware of the problems. Education and enforcement programs need to be continued and even increased in the future.

In some situations, it would be desirable to provide areas for specific activities such as bird watching, fishing only or quiet areas.

Recommendation - The Division of Parks and Recreation should organize groups with a cross-section of recreators and managers to obtain ideas and support for recreational safety and to determine ways to reduce conflict.

157.2 Comprehensive Planning

Issue - Efficient allocation of resources can best be achieved through comprehensive planning.

Discussion - The Division of Parks and Recreation is in the process of preparing comprehensive management plans for all the areas it manages in the Sevier River Basin. The objective is to make all state parks more attractive and better able to meet the needs of the recreating public.

Recommendation - The Division of Parks and Recreation should continue to prepare and update management plans to achieve and balance the use of water resources for recreation.

Little Sahara sand dunes

Section 16 Sevier River Basin
FEDERAL WATER PLANNING AND DEVELOPMENT

Tables

Federal Water Planning and Development

Federal involvement at the local level is becoming more oriented towards management, conservation and preservation of natural resources with fewer programs promoting natural resources development.

16.1 INTRODUCTION

This section provides a brief description of each agency's programs and how they impact the resources of the Sevier River Basin. Although the activities of federal agencies are changing, many programs are still available to the local people for their betterment and the enhancement of their resources. This section gives an insight to the program functions and how they can be accessed. This will also help improve the working relationships between the individuals, local entities, and state and federal governments.

16.2 BACKGROUND

With the continual downsizing of the federal government in the natural resources fields, there are decreases in both financial and technical assistance in most agency programs. This process passes more responsibility to local and state governments to carry out many of these programs without providing funding. Additionally, federal standards for resources uses are higher, adding to the total cost.

16.3 FEDERAL PROGRAMS

There are 13 federal agencies with jurisdiction over programs affecting the resources of the Sevier River Basin. The agencies and their programs are briefly described below.

16.3.1 Bureau of Land Management

The Federal Land Policy and Management Act gives the Bureau of Land Management (BLM) authority to inventory and comprehensively plan for all public lands and resources under its jurisdiction. They are also responsible for managing the wilderness study areas and wild and scenic and recreational rivers. There are no wild and scenic and recreational rivers in the Sevier River Basin.

Parts of three wilderness study areas (WSA) are in the Sevier River Basin. There is one potential study area not included in the Environmental Impact The three WSAs are all in the House Range on the western boundary of the basin and could conceivably be joined and designated as one which would increase the total acreage. These are managed for multiple use but new development is not allowed. The WSAs and their location and areas are shown in Table 16-1. The BLM also manages the Little Sahara Recreation Area located just west of U.S. Highway 6 between Eureka and Delta. See Section 3 for land areas.

Water has become a major determinant of resource management alternatives. Quality and quantity of water are major elements of resource management plans (RMP) as BLM manages riparian habitats of streams, lakes, reservoirs and ponds. After public participation, RMPs become management plans for resources on BLM lands. The Cedar, Beaver, Garfield, Antimony Resource Management Plan has been completed. Others are in the preparation process. The Bureau of Land Management is participating in a water quality study in the Sevier River Basin.

16.3.2 Bureau of Reclamation

Five categories of water resources programs are administered by the Bureau of Reclamation (BR). They are: investigation, research, loans, service and grants, all requiring close cooperation with the concerned citizens.

<u>Investigation Programs</u> - The BR conducts research on water project design, construction and materials. Research is also carried out on atmospheric management as well as geothermal and solar power. Most programs are conducted in

Table 16-1 WILDERNESS STUDY AREAS		
WSA	Location	Area (acres)
Rockwell[a]	T. 13 S.R. 5 W. Just west of Little Sahara Recreation Area	9,150
Swazy Mt.	T. 15 & 16 S., R. 13 W. 40 miles NW of Delta	49,500
Howell Pk.	T. 17 S., R. 13 W. 40 miles West of Delta	24,800
Notch Pk.	T. 19 S., R. i3 W. 45 miles S of W of Delta	51,130

a Rockwell WSA was not included in final EIS.

cooperation with other entities. Currently, the BR is assisting water users along the Sevier River with real-time river and canal flow data using solar operated gages.

Research Programs - The BR conducts research on water-related design; construction; materials; atmospheric management; and wind, geothermal and solar power. Most programs are conducted in cooperation with other entities.

Loan Programs - BR has recently reassessed its loan programs and concluded they need major redirection. As a result, BR is no longer accepting applications for loans.

Service Programs - Service programs are designed to provide data, technical knowledge and expertise to state and local government agencies. They aim to avoid duplication of special service functions. Local governments pay for these services.

Grant Programs - The BR is involved in water management and conservation under Section 2 10, PL 97-293 (Reclamation Reform Act) and the Reclamation Act of 1902, as amended. Through a memorandum of understanding with the Utah Division of Water Resources, the BR established cost reimbursement funds to be used for public water conservation education, training, and management plan preparation. In some cases, the Division of Water Resources is required to provide matching funds.

Expected benefits include technical assistance for willing water user groups. Classroom teachers will be trained in the use of Project WET (Water Education for Teachers) materials. Public education activities will be conducted and public information materials will be produced under the program.

16.3.3 Cooperative State Research, Education and Extension Service

This agency has responsibility for all agricultural cooperative research programs. It is also assigned all agricultural-related cooperative education and extension programs.

16.3.4 Corps of Engineers

If local entities are unable to deal with a large water resources problem, they may petition their congressional representatives for assistance from the Corps of Engineers (COE) under the Civil Works-General Investigation Authority. They may request assistance with smaller problems directly from the local COE office under the Continuing Authorities Program. This allows the

COE to investigate the economic, technical, social and environmental acceptability of environmental restoration, flood control, and streambank protection projects. When the directive covers an entire river basin, the COE studies it as a unit and prepares a comprehensive plan. Close coordination is maintained with local interests, the state and other federal agencies.

The COE also has emergency assistance authorities. Requests for emergency assistance should be made through the Utah Division of Comprehensive Emergency Management.

The Redmond Channel Improvement Project on the Sevier River near Redmond was authorized by the Corps of Engineers at the request of Sevier County in 1944 and completed in 195 1. It consisted of channel improvements and facilities to improve the river carrying capacity. The project also protects the community of Redmond and about 3,000 acres of adjacent farmland. A recent follow up study was underway to consider restoring some of the wetlands and riparian habitat. There is no current activity on the study.

Reconnaissance studies of the Sevier River and its tributaries were conducted to determine if improvements for flood control and related purposes would be economically and environmentally justified. Initially, more than 100 communities were evaluated and the most serious were evaluated in detail. Although flood threats were found to be serious, federal participation in further studies or projects was not economically justified. The study was completed in March 1994.

16.3.5 Environmental Protection Agency

Environmental Protection Agency programs include drinking water under the Safe Drinking Water Act and water pollution control under the Clean Water Act.

The Safe Drinking Water Act increased the number of regulated drinking water contaminants. It added new required treatment methods and made other revisions. The 1996 amendments to the Safe Drinking Water Act created several new programs and included a total authorization of more than $12 billion nationwide in federal funds for various drinking water programs and activities. Refer to Section 11, Drinking Water for more information.

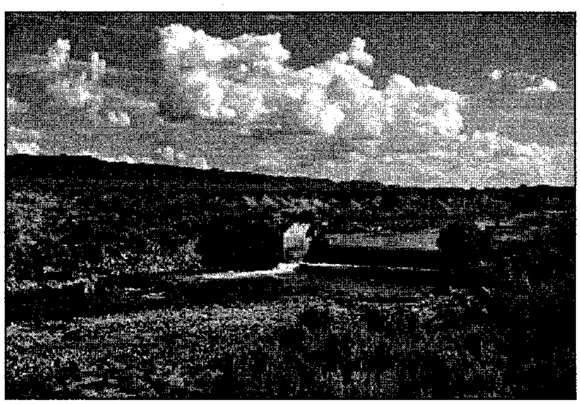
Important aspects of the Clean Water Act include the National Pollutant Discharge Elimination System (NPDES) Section 402, regulating the discharge of point sources of pollutants to waters of the United States. Construction grants originally provided funds for needed municipal wastewater treatment facilities. This was phased out in 1990 and replaced with a revolving loan fund managed by the states.

Water quality management planning and nonpoint source pollution control, Section 604(b), provides funds to states to carry out water quality management planning. Section 3 19 of the act authorizes funding for implementation of nonpoint source pollution control measures under state leadership.

16.3.6 Farm Service Agency

The Farm Service Agency (FSA) administers farm commodity, crop insurance, and conservation programs for farmers and ranchers. They also administer the farm ownership and operating loans formerly provided by the Farmers Home Administration. FSA's programs include the Agricultural Conservation Program (ACP), Emergency Conservation Program (ECP) and the Conservation Reserve Program (CRP).

The ACP is a comprehensive program designed to reduce soil erosion, mitigate water pollution, protect and improve cropland and pasture condition, conserve water, preserve and enhance wildlife habitat, and where possible, encourage conservation of energy. Projects are



Diversions are built with federal help

evaluated at the local level on a case-by-case basis to determine consistency with the overall ACP objectives. The ACP is administered by state and local committees that are made up of local farmers and ranchers.

The ECP provides emergency cost-share funding for various farm related disasters. These include but are not limited to excessive wind erosion, floods and extreme drought conditions. Millions of dollars were provided for farmers and ranchers during the flooding of 1983-84.

The CRP was established to encourage farmers, through contracts and annual payments, to reduce soil erosion. In addition, CRP eligibility has been expanded to promote preservation and maintenance of wetlands, wildlife habitat and water quality.

The USDA Natural Resources Conservation Service and Forest Service and the Utah Division of Forestry, Fire and State Lands provide technical program guidance. Educational support is provided by Utah State University-Cooperative Extension Service.

16.3.7 Federal Emergency Management Agency

Federal Emergency Management Agency (FEMA) programs are directed toward disaster preparedness, assistance and mitigation. They provide technical assistance, loans and grants.

Presidential Declared Disaster - After the President declares a major disaster, usually following a governor's request, grants are available to state and local governments for mitigation. FEMA provided about $9.35 million for mitigation within the Sevier River Basin during the flooding of 1983-84.

Assistance Grants - FEMA can provide matching grants to help the state develop and improve disaster preparedness plans, and develop effective state and local emergency management organizations. Also, grants are available to develop earthquake preparedness capabilities.

Flood Plain Management - Technical assistance can be provided to reduce potential flood losses through flood plain management. This includes flood hazard studies to delineate flood plains, advisory services to prepare and administer flood plain management ordinances, and assistance in enrolling in the National Flood Insurance Program. FEMA can also help with the acquisition of structures in the flood plain subjected to continual flooding.

16.3.8 Fish and Wildlife Service

The Fish and Wildlife Service (FWS) carries out mandates of the Endangered Species Act, Fish and Wildlife Coordination Act, Clean Water Act and Migratory Bird Treaty Act. There are no land or water areas in the Sevier River Basin directly managed by FWS.

The FWS compiles lists of animal and plant species native to the United States. These lists are reviewed for possible addition to the List of Endangered and Threatened Species. Candidate Species are those for which FWS has sufficient information on biological threats and vulnerability to support addition to the list. Species considered threatened or endangered in the Sevier River Basin are shown in Table 16-2. These lists change over time as species are added when they become threatened or are removed when they recover. When any activity is planned, which may affect a threatened or endangered specie, it is the responsibility of the sponsor to take actions to protect them.

Endangered Species Act Section 7 consultation is required of any federal agency to insure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. The Fish and Wildlife Coordination Act requires consultation with the Fish and Wildlife Service and the Utah Division of Wildlife Resources where waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted or otherwise controlled or modified by any agency under a federal permit or license.

The Endangered Species Act also prohibits the "taking" of a protected species. "Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempting to engage in any such conduct. This can include habitat modification or degradation where it kills or

Table 16-2 LISTED, PROPOSED, THREATENED AND ENDANGERED SPECIES	
Common Name	Scientific Name
Endangered Suecies	
black-footed ferret	Mustela nigripes
least chub	Iotichthys phlegethontis[a]
peregrine falcon	Falco peregrinus
southwestern willow flycatcher	Empidonax traillii extimu
autumn buttercup	Ranunculus aestivalis
Threatened Species	
bald eagle	Haliaeetus leucocephalus
Mexican spotted owl	Strix occidentalis lucida
Utah prairie dog	Cynomys parvidens
heliotrope milkvetch	Astragalus montii
Jones cycladenia	Cycladenia humilis va. jonesii
last chance townsendia	Townsendia aprica
Ute ladies'-tresses	Spiranthes diluvialis
Candidate Suecies	
spotted frog	Rana luteiventris
aquarius paintbrush	Castilleja aquariensis

[a] Proposed to be listed as endangered.

injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding or sheltering. Any unpermitted activity on any land resulting in "take" of federally listed species constitutes violation of Section 9 of the Endangered Species Act. Section 404 permitting under the Clean Water Act, as administered by the Corps of Engineers, calls for FWS to respond to impacts to wetlands and on threatened or endangered species. Under the Migratory Bird Treaty Act, all birds are protected except English sparrows, starlings and pigeons.

16.3.9 Forest Service

Forest Service water-related programs include watershed management, special use authorization for water development projects, and coordination with local, state and federal agencies. There are parts of four national forests in the basin: Dixie, Fish Lake, Manti-La Sal and Uinta (See Section 3 for history and area). They also manage wilderness areas on national forest lands. There are no national forest wilderness areas in the Sevier River Basin. Studies are being conducted on the Fish Lake National Forest to increase runoff. See Section 10.5, Agricultural Development, for more information. The Forest Service is also participating in a water quality study in the Sevier River Basin.

Watershed Management - Watershed protection insures activities do not cause undue soil erosion and stream sedimentation, reduce soil productivity or otherwise degrade water quality. Water yields can be impacted as a result of snowpack changes from timber harvest procedures. Harvest procedures should use well-planned layout and design for the best impact. Potential snowpack increases may approach one-half acre-foot per acre for some treated areas. Multiple-use considerations and specific onsite conditions may limit actual increases.

Special Use Authorization - Construction and operation of reservoirs, conveyance ditches, hydropower facilities and other water developments require special use authorization and an annual fee. The authorization contains conditions necessary to protect all other resources use. Coordination of water developments by others require communication early in the planning process to guarantee environmental concerns are addressed. Resource Management Plans have been prepared for all the national forests in the basin.

16.3.10 Geological Survey

The U.S. Geological Survey (USGS), through its Water Resources Division, investigates the occurrence, quantity, quality distribution and movement of surface water and groundwater. It also coordinates federal water data acquisition activities. This is accomplished through programs supported by the USGS, independent of or in cooperation with other federal or nonfederal agencies.

The USGS cost-shares with various state and local agencies. Programs include water quality and water level changes in the groundwater aquifers. They also read and evaluate surface water stream gauges. The USGS cooperative program currently maintains 13 gaging stations in the Sevier River Basin (See Figure 5-l).

16.3.11 National Park Service

The National Park Service (NPS) promotes and regulates use of national parks, monuments and similar reservations to "conserve the scenery, natural historic objects and wildlife. The NPS also provides for the enjoyment of these resources in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The long-range objectives of the NPS are as follows:

1. To conserve and manage the parks for their highest purpose; the natural, historical and recreational resources.
2. To provide the highest quality of use and enjoyment by increased millions of visitors.
3. To develop the parks through inclusion of additional areas of scenic, scientific, historical and recreational value.
4. To communicate the cultural, natural, inspirational and recreational significance of the American heritage.

In fulfillment of these objectives, NPS performs the following functions.

- Manage the 35,240 acres in Bryce Canyon National Park, 2 1,020 acres in the Sevier River Basin.
- Manage the 6,300 acres in Cedar Breaks National Monument, 940 acres in the Sevier River Basin.
- Conduct the recreational aspects of water project implementation studies.
- Conducts congressionally authorized Wild and Scenic River and National Historic and Scenic Trail studies.
- Through cooperative agreements, administers recreation lands under the jurisdiction of other federal agencies.
- Provides professional and administrative support to the national, regional and park advisory boards.

16.3.12 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) provides technical and financial assistance to conserve soil, water and related resources on non-federal land through local soil conservation districts. In addition to working with individual landowners and units of government, NRCS administers several other programs.

Soil surveys describe an area's soils, uses and management. These surveys are carried out on private, state and, by cooperative agreements, on federal lands administered by the-Bureau of Land Management. Soil surveys have been published for four areas, field mapping completed for two areas and soil surveys are being conducted in one area. Refer to Figure 3-6.

The snow survey program provides for and coordinates snow surveys and prepares forecasts of seasonal water supplies. This is a cooperative program with state and other federal agencies for the benefit of water users. There are 13 snow courses and 14 snotel sites located throughout the Sevier River Basin. See Section 3.3.2 and Figure 3-3.

The Watershed Protection and Flood Prevention Act (PL 83-566) provides technical and financial assistance at the request of local sponsors and in cooperation with local, state and federal agencies to prevent erosion, reduce flood damages, improve irrigation systems and control water pollution. The Pleasant Creek Watershed Project at Mt. Pleasant (1958) was one of the initial eleven pilot projects approved nationally. The Mill Canyon-Sage Flat (1961) and Glenwood (1975) projects have been completed and the Monroe-Annabella Project is almost complete.

The Resource Conservation and Development (RC&D) program provides assistance to government and nonprofit organizations in multi-jurisdictional areas. Beaver, Garfield, Iron and Kane counties in the upper Sevier River Basin are located in the Color Country RC&D Project area. The project coordinator is located in Cedar City. There is a project coordinator for the Panoramaland RC&D Project (Six-County area) located in Richfield. An application is on file for project development funding.

The Emergency Watershed Program provides technical and financial assistance to agricultural oriented organizations to relieve eminent hazards to life and property. More than four million dollars were expended in the Sevier River Basin during the floods of 1983-84.

16.3.13 Rural Development

Rural Development provides financial assistance for water and waste disposal facilities in rural areas and towns of up to 10,000 people. Priority is given to public entities in areas smaller than 5,500 people to restore, improve or enlarge a water supply or waste disposal facility. Eligibility for loans and grants requires water or waste disposal systems must be consistent with state and subdivision development plans and regulations. Rural Development also makes loans for resource conservation and development projects. Projects have been funded consisting of grants and/or loans in the towns of Circleville, Kingston, Marysvale, Centerfield, Fountain Green and Sterling.

All water based recreation is popular

16.4 FEDERAL CONCERNS

The biggest concern in natural resources planning is the lack of coordination between local, state and federal officials during the planning and implementation of various programs, activities and projects. There is a need for more coordination concerning the use of public lands.

In order to meet this need. The River Basin Coordinating Committee (RBCC) has been formed. This committee includes all federal and state resources agencies and meets quarterly to ensure projects and activities are coordinated at the technical level. Final decisions are made by the Natural Resources Coordinating Committee.

Section 17 Sevier River Basin
WATER CONSERVATION

Tables

Water Conservation

Water shortages, environmental issues, social values and competing uses have made users more aware of the need to use water wisely.

17.1 INTRODUCTION

This section discusses ways to conserve water and presents the value of making everyone aware of how to use it wisely. Conservation has been a way of life for many generations in Utah. When the early settlers carried water for household use, they learned to appreciate how far it was to the creek. The degree of conservation was determined by the number of trips one was willing to make.

Present day shortages caused by droughts, system failures or pollution episodes can be alleviated by having a plan to conserve water and stretch supplies to meet priority demands. It is important to recognize that significant water use reductions can be achieved when people understand the reasons to conserve. The public has demonstrated a willingness to temporarily reduce water use during times of drought. By educating the public on the benefits of implementing long-term water conservation efforts, and how to do it, people will be more likely to accept these programs and will provide support and funding necessary to implement them.

When water is inexpensive and plentiful, conservation is not popular, especially if additional costs are involved. During times of drought and where there is good reason, the public will respond over the short-term to a request to conserve.

Residents in the Sevier River Basin have always been aware of the limited water supply. Although developments of water resources for agriculture are expensive, developing water of high quality for culinary use is more expensive. These costs will increase in the future. Now is the time to consider the place of more water conservation.

17.2 BACKGROUND

To understand water conservation programs, there is a need to recognize the difference between diversions and depletions. Manmade diversions for irrigation, municipal, industrial and domestic uses must be sufficient to provide the water depleted along with any conveyance and delivery losses en route to the point of use. Most of these losses become return flow and are available for rediversion at some other point. Depletions consist of the water put to a use and consumed, and unavailable for return to the system. If a system were 100 percent efficient, diversions and depletions would be equal.

A well-managed conservation program for all public water uses may postpone or reduce the need for building new facilities and finding additional supplies. The most effective program combines incentives to conserve with conservation measures designed into the construction and operation of water supply systems.

Effective conservation programs combine activities designed to reduce the demand for water with measures to improve the efficiency of delivery systems. Demand reduction should include educating customers on improving irrigation practices, in-home use and landscape designs. Demand reduction is also more achievable with a pricing schedule that provides customers an incentive to use water more efficiently. Delivery efficiency can be improved by system audits and installing new meters and other facilities to reduce measurable losses.

Water quality is important in any water management program. If the goal is to conserve high quality water for meeting culinary growth demand, then providing a separate irrigation pipe network to substitute untreated water for lawn and garden irrigation can be a logical solution. The total amount of water may be about the same, however, this saves the high quality water for culinary purposes and may reduce total costs.

The goal of a conservation measure may be aimed at either diversions, depletions, or both. This applies to both municipal and industrial water and to agricultural water.

17.2.1 Agricultural Water

Crop production is the largest use of water. Other large users include several large dairies and beef feedlots throughout the basin, a turkey processing plant in Moroni and a mushroom production facility near Fillmore.

Agricultural water users have been implementing conservation measures and facilities over the years. The measures include land leveling, on-farm and off-farm ditch and canal lining, sprinkler irrigation systems and gated pipe.

Farmers have been installing sprinkler irrigation systems to replace flood irrigation systems. Some of these systems serve lawns and gardens, such as the one in Glenwood, as well as agricultural land. There are many projects where canal lining and both pressure and gravity pipelines have been installed.

Exchanging a low-efficiency irrigation system for one more efficient may reduce the amount of water diverted while maintaining the amount of water depleted. This will leave more water in the stream for diversion downstream and will improve water quality. If the more efficient system increases crop depletion by providing a full water supply, return flows will be reduced even though diversions may also be reduced, although to a lesser extent.

There is a delicate balance within one or a group of irrigation systems where a change in either the supply, diversion or use will affect the others. Farmers who have sufficient supplies to meet crop requirements usually have no incentive to increase efficiency. However, improved efficiency can reduce costs. Saved water cannot be used to irrigate new land nor can it be sold to others if downstream water rights may be adversely affected. Saved water may be transferred to other uses and/or place of use if the appropriate laws and regulations are followed.

Water budgets prepared during 1989-90 indicate an overall irrigation efficiency of about 50 percent within each water-budget area. Current irrigation practices allow room for improvement in distribution and application efficiencies. The most widespread and effective conservation practice is scheduling irrigation based on the crop's need. This includes determining the crop consumptive use and irrigating to replenish the root-zone supply before the plant is stressed.

17.2.2 Municipal and Industrial Water

High quality municipal and industrial water is in short supply in some communities. Future growth will impact the current supply and the cost of developing additional water.

Culinary diversions can be reduced if users install water saving devices in the home. Installation of in-home water saving devices has been slow coming but it is now required by law. More lawn sprinkling systems are being installed but are often operated for convenience rather than to save water. Ordinances requiring watering only between the hours of 6:00 p.m. and 10:00 a.m. have been effective in reducing water use. Depletions can be reduced by using low water-using landscapes. The culinary water use in 1996 was 267 gallons per capita day (gpcd) with 50 percent used indoors.

Some cities and towns, such as Centerfield, are moving toward secondary systems to supply lawn and garden and some industrial uses with untreated quality water. Many of these systems are being converted to pipelines but there are still open ditch systems. This reserves the high quality water for culinary use. Secondary water use in 1996 was 153 gpcd compared to 56 gpcd statewide. The statewide use is low because nearly 60 percent of the state population used more culinary water for outside use; secondary water use was only about 12 gpcd. There are 12 communities in the basin where culinary water use is more than 400 gpcd.

Water rates (prices) may provide a strong incentive to use municipal water more

Table 17-1
WATER RATES FOR SELECTED COMMUNITIES IN THE SEVIER RIVER BASIN

City/Town	Base Rate ($)	Base Allocation (gallons)	First Overage ($)	For- gallons	Second Overage ($)/1,000 gallons	For- gallons	Third Overage ($)/1,000 gallons
Central	20	0					
Central WWC	15	30,000	.34	All			
Delta	14	8,000	.40	All			
Deseret-Oasis SSD	22	10,000	1.00	All			
Eureka	8.75	10,000	2.50	All			
Fillmore	12	10,000	.35	All			
Gunnison	13.50	15,000	.65	All			
Joseph	14.50	25,000	1.00	All			
Kanosh	11	20,000	.25	All			
Lynndyl	18	10,000	.75	All			
Milford	16	10,000	.50	All			
Monroe	17	20,000	1.00	All			
Oak City	16	1,000	.30	20,000	.35	60,000	.60
Panquitch	16	15,000	.60	All			
Richfield	13.50	15,000	.35	50,000	.45	All	
Salina	17	7,500	.75	All			
Spring City	20	10,000	.45	15,000	1.00	All	

productively. Historically, rates have been low in this basin. Current rates are shown for 1997 in Table 17-1 for cities and towns where annual data is available.

Most communities provide little incentive for conservation with volume charges of less than $0.75 per 1,000 gallons. Only Deseret-Oasis SSD, Eureka, Joseph, Monroe and Spring City charge $1 .OO per 1,000 or more per 1,000 gallons.

Most industries provide their own water supply. In these cases, they tend to conserve water to reduce operation costs in order to be more competitive. It is not anticipated there will be large increases in industrial water demands.

17.3 WATER CONSERVATION OPPORTUNITIES

There are several methods and/or programs to conserve water. These include well-designed and operated systems and installation of water saving devices and practices. Structural and nonstructural means can be used to accomplish water conservation.

One program designed to promote water conservation was developed under the Central Utah Project Completion Act (CUPCA) Section 207. This program, the Conservation Credit Program, is administered by the Central Utah Water Conservancy District (CUWCD). Manti Irrigation Company has obtained $9.1 million for installation of a sprinkler irrigation system. This will conserve water for other uses. Also, a provision in Section 206 under CUPCA allows water users in Sevier River Basin counties belonging to the CUWCD to draw on taxes collected to construct water development projects. Both of these programs are based on a 35 percent cost-share by the water users. There are seven other applications for project funds in Sanpete County and one application from Garfield County.

The largest demand for additional water supplies will come from the municipal and industrial sector. This will also be the most costly whether it comes from groundwater or spring development. There may be a need for surface-water treatment facilities in the future.

Effective conservation should concentrate on reducing demand. For example, if the daily use per capita were reduced by 50 gallons per capita day, there would be an annual savings of more than 300 acre-feet or a constant flow of nearly 200 gallons per minute. At $100 per acre-foot development cost, this would be $30,000 per year.

Planting low water-using vegetation has the greatest potential for culinary water saving, especially where new construction is involved, and/or no secondary water is available. Outdoor use can be reduced by as much as 50 percent. Lawn watering guides can also show how to conserve water. Opportunities exist for reducing inside water use as well. Legislation requires water-saving fixtures such as low-flush toilets and low-flow shower heads in new construction or when old ones are replaced. The most effective way to establish a culinary water conservation program is under the direction of managers and elected officials responsible for public water supplies.

Agriculture provides the best opportunity for conservation of the largest volume of water. Farmers have been installing sprinkler irrigation systems at an increasing rate and finding them cost effective, especially where gravity pressure can be used. There is still room for improvement in distribution and on-farm irrigation efficiencies. Although this may be a water savings at the local level, it does not save water for the Sevier River Basin as a whole. Irrigation companies can reduce loss in distribution systems but the best method is by individual farmers increasing their on-farm efficiency.

An important element of any long-term water conservation program is public education. This can result in a public realization of the value of wasted water and reduced revenue and can build more public support for these programs. A big part of a public education program is simply just teaching how life works and how we depend on water for sustenance.

17.4 ISSUES AND RECOMMENDATIONS

There is considerable population growth in some areas which makes conservation an important component of the plans for meeting future needs. Four policy issues are discussed below.

17.4.1 Community Water Management and Conservation Plans

Issue - Most communities do not have plans for improving the efficiency of water use in meeting future growth demands.

Discussion - Developing additional sources of water for residential use is costly due to additional restrictions on development. Conserving high quality water sources to serve portions of future growth will be increasingly competitive with the development of new supplies.

The 1997 Water Conservation Plan Act requires all conservancy districts and water retailers to prepare water conservation plans. These are to be submitted to the Division of Water Resources by April 1, 1999.

Water suppliers need to identify conservation goals in relation to supplies and demands. Alternatives to provide water to meet projected demands, including education and incentive pricing, should be identified. The Division of Water Resources has recently completed an inventory of present supplies, system capacities and has estimated projected demands. Refer to Section 11 for data on these items. This can be the basis for preparing a water supply and use plan with conservation as an important component. The plan should also look at including fringe areas in the public water system service area. In some cases, this will reduce the need for additional domestic wells.

Recommendation - Water management and conservation plans should be developed by all cities and towns.

17.4.2 Secondary Water Systems

Issue - Secondary water systems can reduce the demand for high quality water.

Discussion - Supplies of high quality culinary waters are limited and treating lower quality surface water is costly. For these reasons, public water suppliers should consider delivering low-quality water for outside uses. A large portion of existing municipal supplies are used for home landscape irrigation as well as large lawn areas such as parks, schools and churches where there is no need for water meeting culinary standards.

To meet future demands, supplies presently used by agriculture could be converted to secondary uses and eliminate the need to find more costly sources of higher quality water. Secondary water uses should be metered so their use can be controlled. This will delay or, in the case of some slower growing communities, may eliminate the need for developing more municipal water for many years, thus reducing future financial outlays.

Recommendation - Cities and towns should determine the feasibility of constructing secondary water systems.

Alternative landscaping conserves water

17.4.3 Water Conserving Landscaping

Issue - The use of water-conserving landscapes can reduce the need for limited supplies.,

Discussion - Landscapes use a major portion of the culinary water in most communities. Extensive turf, such as in yards, school grounds, park and golf courses has become the normal landscaping practice. Research reveals that most of these turf areas are over-watered, wasting up to 50 percent of the water applied.

More efficient irrigation and reduced turf acreages can conserve water and still maintain appealing, attractive landscapes. Use of more efficient methods such as sprinkler and drip irrigation systems should be considered. The total amount of water applied per irrigation depends on the time and rate of application. Most residential water users are not aware of the amount of water required or how much is applied. Evaporation losses can be minimized by irrigating between the hours of 6:00 p.m. and 10:00 a.m. A study of the Bountiful area for a lo-year period before and a S-year period after watering was restricted to nighttime hours showed a 17 percent decrease in water use.

Water efficient landscaping uses a combination of native plants, low water using exotic or imported plants, mulched flower beds, hardscaping (decks, patios and rock gardens) and smaller selective turf areas to achieve a pleasing mix. Correctly designed landscaping can also meet the needs for recreation and entertainment areas along with beautification. This can reduce water use up to 50 percent of the amount required for a typical monoculture of turf grass. A list of low water using plants applicable to the Sevier River Basin can be obtained from nurseries and landscape designers in the area. In addition, the Division of Water Resources and Utah Extension Service have similar information available.

New residential construction lends itself best to low water using landscapes. Installation is more expensive than the current typical landscaping, but it will achieve an aesthetic, functional design. Installation costs can be recaptured through more economical operation and maintenance outlays. Replacing existing landscaping can be very costly; however, it does provide an opportunity to redecorate the outside areas while conserving water. Feasibility will depend on the cost of water and individual desires. Communities can take the lead by determining the amount of water uses on parks, golf courses and other large areas and demonstrate how water can be conserved. Water pricing (rate schedules) can also be designed to encourage use of low water-using landscapes.

Recommendation - Communities, especially the county seats, should determine current water use on large turf areas, install model water conserving landscape demonstration projects on city or county property and consider adopting a landscape ordinance.

17.4.4 Water Pricing

Issue - Some public water pricing programs can provide incentives for more efficient water use.

Discussion - A pricing strategy may be among the most powerful conservation tools at a water utility's disposal. Cities and other water suppliers are finding certain rate schedules can give an incentive to modify water use and customer behavior and meet conservation goals. Those responsible for maintenance of large areas of turf should be billed for the cost of water, even if it is the municipality. This would bring about recognition of the cost of water.

Conservation rate structures should have the following characteristics:

Equity - Each customer group will be treated the same, or must feel they are doing no more or no less than any other customer group. Each customer group may be assigned a goal which defines the upper limit of efficient water use. For residential customers, the goal is based on the number of people per household served and outdoor water needs.

Revenue Stability - This will avoid the decrease in revenue that traditionally accompanies conservation actions by customers. To avoid the negative impacts of the rise and fall of revenues directly linked to water sales, 100 percent of the fixed cost of a water system may be recovered with a basic charge. This charge is paid by all customers regardless of usage. Charges for water delivered through each meter are calculated separately. Revenue from metered sales must be sufficient to cover costs that vary with the amount of water used. With all fixed costs covered by a basic fee and variable system costs covered by metered sales revenue, revenue fluctuations from water use during droughts and periods of wet weather have fewer adverse consequences

Credibility - Success of any rate structure rests on the perception by customers that the system is credible and based on scientific-principles. The rate structure should be based on defensible information that is logical, simple and is credible in the eyes of the customers. Credibility is gained by providing customers accurate data on water needs based on lot size and people served, along with continuous education about rates, incentives, penalties and the need for water efficiency.

Building a Conservation Ethic - Utah's water supply and growth analysis by the Division of Water Resources shows conservation must be practiced now to delay expensive new water investments in the short term and chronic shortages in the future. Setting customer goals and providing pricing incentives that convey a clear conservation message builds a water efficiency ethic among customers. Through continuing education, customers generally understand that wasted water is expensive water. A rate structure with steep price increases above a base rate sets a price on inefficient water use. The combination of an equitable, logical and credible rate structure with price incentives to achieve goals, starts the process of building a long-term water conservation ethic.

Focusing efforts on helping culinary water users achieve low bills along with keeping rates as low as possible addresses the most fundamental issue in the minds of customers. While introduction of a conservation rate structure may increase phone calls and visits from customers, it increases the opportunity for culinary water providers to impact customers in a positive way. Customer calls can provide valuable information for correcting account information on number of people served and the landscaped area. This also provides opportunities for explaining how the customer can improve landscape watering or indoor water-use practices.

The impact of a well thought out conservation rate-structure by public water suppliers may save up to 15 percent for residential users and up to 45 percent for landscape irrigation.

Recommendation - Most local water providers should adopt new water-rate schedules that encourage water conservation.

Section 18 Sevier River Basin
INDUSTRIAL WATER

Tables

Industrial Water

Industries use a small but important part of the water resources.

18.1 INTRODUCTION

The generation of electrical power has become an important part of our society. In the Sevier River Basin, the current uses of water for power production are small but may increase in the future. Other industrial uses are for manufacturing and processing along with uses for culinary supplies. It is important to have suitable water available if industry is to come into the basin. This section discusses the present uses of water for industrial purposes and presents possibilities for future expansion.

18.2 SETTING

The total self-supplied industrial water use in the Sevier River Basin is 25,120 acre-feet annually. This includes 7,120 acre-feet of potable and 18,000 acre&feet of non-potable water. Industrial water use is primarily for power generation. The largest industrial water user is the coal-fired Intermountain Power Project (IPP) north of Delta. This power-generation facility uses surface water (non-potable) and potable water. This water was purchased from agricultural users and converted to industrial use. Power production capacity is currently rated at about 1.8 gigawatts (GW). This is about 60 percent of the original planned capacity. The balance was not built as the projected demand for energy did not materialize. The deregulation of electric power rates would also affect operations at the IPP plant.

Hydroelectric power plants have been built and are operating on 12 sites throughout the Sevier River Basin. Utah Power built one site with a capacity of 100 kw on Panguitch Creek but it is not operating. There are a total of 23 sites for small hydroelectric power plants if additional capacity is needed in the future. The present and potential hydroelectric power plants are shown in Table 18-l.

Additional industrial users are discussed below. Most of these use water only for culinary purposes. However, in some cases, water is used for aesthetics such as lawns and landscaping. All of these uses are generally minor.

The existing mining industries divert varying amounts of water. Coal mining in Salina Canyon is a major activity. Mining of gypsum near Sigurd has been in operation since the 1940s. The gypsum is used to make wall board in a plant at the site. A new plant near Richfield produces high grade gypsum used in the production of food and pharmaceuticals. This product is shipped all over the nation. The cement manufacturing plant in Leamington Canyon is about 15 years old. A beryllium processing plant is located near Lynndyl. Sawmills are located at Gunnison, Vet-million, Ephraim and Fairview. There are a number of sand and gravel and ready-mix concrete plants in all areas of the basin. Industrial water use is shown in Table 18-2.

18.3 PROJECTED INDUSTRIAL WATER DEVELOPMENT

Industrial requirements for water are not expected to increase significantly. The only exception would be expansion of the Intermountain Power Project if there is an increased demand for power.

The coal mining operation in Salina Canyon has reserves for up to 60 years. Annual production may increase. This could also produce more water. It is anticipated the major increases in water use will come from light industry.

Table 18-1
HYDROELECTRIC POWER PLANTS

Name/County	Stream	On Line	Capacity Installed (kw)	Potential (kw)	Owner.
Garfield					
Panguitch Lake	Panguitch Cr	No	0	148	W Panguitch Irr & Res Co
Panguitch	Panguitch Cr	No	100	NA	Utah Power
Juab					
Sevier Bridge	Sevier River	No	0	2,075	Delta Land & Water, et al
Levan	Cobble Cr	Yes	100	100	Levan
Levan	Pigeon Cr	Yes	200	200	Levan
Millard					
Lake Cr	Lake Cr	No	0	581	Otter Creek Res Co
Scipio Lake	Round Valley Cr	No	0	159	Piute Res & Irr Co
Piute					
Otter Cr	Otter Cr	No	0	655	
Piute	Sevier River	No	0	1,230	
Sanpete					
Ephraim No. 1 Ph	Ephraim Cr	Yes	150	150	City of Ephraim
Ephraim No. 2 Ph	Ephraim Cr	No	200	200	City of Ephraim
Fairview Upper	Cottonwood Cr	No	100	NA	Fairview City Corporation
Fountain Green	Big Spring	Yes	320	320	Utah Power
Gunnison	San Pitch Res	No	0	487	Gunnison Irr Co
Highland (9mi Res)	Nine Mile Cr	No	0	120	Highland Canal Co
Lwr Fairview Ph	Cottonwood Cr	No	100	100	Fairview City Corporation
Lwr Mt Pleasant	Pleasant Cr	Yes	150	754	Mt Pleasant City Corporation
Lwr Manti Ph	Manti Cr	Yes	120	1,109	Manti City L&P
Mt Springs Ph	Manti Cr	Yes	400	+25,000	Manti City L&P
Spring City	Oak Cr	Yes	380	380	Spring City Corporation
Uppr Mt Pleasant	Pleasant Cr	Yes	175	470	Mt Pleasant Corporation
Sevier					
Lower Monroe Ph	Monroe Cr	Yes	100	121	Monroe City Corporation
Three Creeks Res	Sevier River	No	0	120	Rocky Ford Canal Co
Upper Monroe Ph	Monroe Cr	Yes	125	10,660	Monroe City Corporation
Burrville Irr Co	Burr Cr	Yes	25	25	Burrville Irr Co

Table 18-2
INDUSTRIAL WATER USE

County	Public System	Potable Self-Supplied	Non-potable Self-Supplied	Total
	(acre-feet)			
Garfield	20	-o-	-0-	20
Juab	neg	90	-0-	90
Millard	260	6,390	18,000	24,650
Piute	50	-o-	-o-	50
Sanpete	460	530	-0-	990
Sevier	380	110	-0-	490
Total	1,170	7,120	18,000	26,290

Section 19 Sevier River Basin
GROUNDWATER

Tables

Figures

Groundwater

Groundwater is an important component of the total water resources.

19.1 INTRODUCTION

This section describes the groundwater resources for the Sevier River main stem, Pahvant Valley, Round and Scipio Valleys, and the Levan-Mills area. The main stem groundwater is more critical because of the interrelationship of water flows from area to area. Groundwater data for Little Valley, Dog Valley and Tintic Wash Valley are negligible concerning storage, withdrawal and quality. There is some potential for development in these areas.

Groundwater is not visually discernable in place and as a result, is difficult to quantify. The determination of groundwater quality is more easily defined.

Groundwater is used primarily for irrigation. Other uses include public water supplies, domestic water and stock water. Springs have often been the first to be developed by the settlers for household and miscellaneous uses. It wasn't until about 1900 that wells were first used to supply irrigation water. In about 1915, artesian wells were drilled in Flowell, west of Fillmore and by 1920, they supplied about 10 percent of the irrigation water in that area.

All water quality data are presented first in milligrams per liter and second as it was reported in the original study report. See Appendix A, Acronyms, Abbreviations and Definitions for specific definitions of water quality units of measurements.

19.2 GROUNDWATER GEOLOGY AND RESERVOIR CHARACTERISTICS

The Sevier River main stem is characterized by a series of groundwater basins or reservoirs along the river system, each separated from the one upstream by a relatively impermeable, underground geologic restriction. These are shown, along with others around the basin, in Figure 19-l. A typical groundwater reservoir cross-section on the Sevier River is shown in Figure 19-2. The U.S. Geological Survey has estimated the groundwater reservoirs above Sevier Bridge Reservoir contain more than five million acre-feet of water in the upper 200 feet of alluvial fill. See Table 19-1 for data on the groundwater reservoirs. They are supplied by water from several sources; the river and irrigation canals as they traverse the valley, deep percolation from irrigation and precipitation, and groundwater tributary inflow.

The functions of the groundwater reservoirs above Sevier Bridge Reservoir are an integrated part of the operation of the Sevier River system. When a groundwater reservoir is full, it spills over the geologic restriction and contributes to the downstream flow of the river. The soil profile in the lower elevation land areas in each basin becomes saturated when the groundwater reservoir is full, enabling high water-using vegetation (phreatophytes) to grow.

Conversely, as the supply of water declines or when large volumes of water are pumped for an extended period of time, the wet areas are dried up with a subsequent decrease in consumptive use. When this happens, some of the water which normally drains to the river as return flow percolates downward to refill the groundwater reservoir, reducing the downstream river flow.

Return flows are important to the regimen of the Sevier River. Analysis has shown about 50 percent of the total tributary inflow and river diversions reappear as surface water for rediversion downstream. Much of the diverted water percolates down through the root zone and

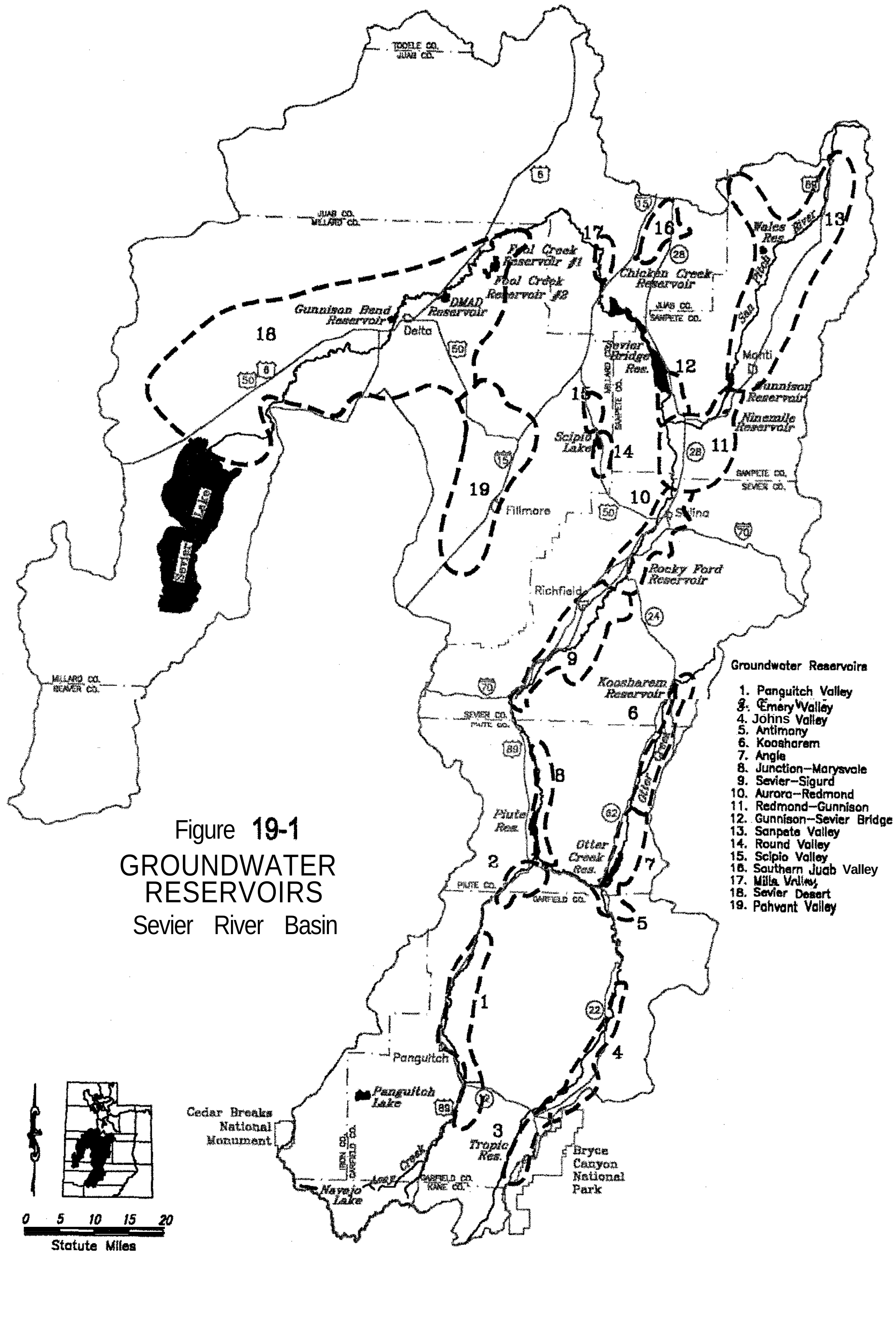


Figure 19-1
GROUNDWATER RESERVOIRS
Sevier River Basin

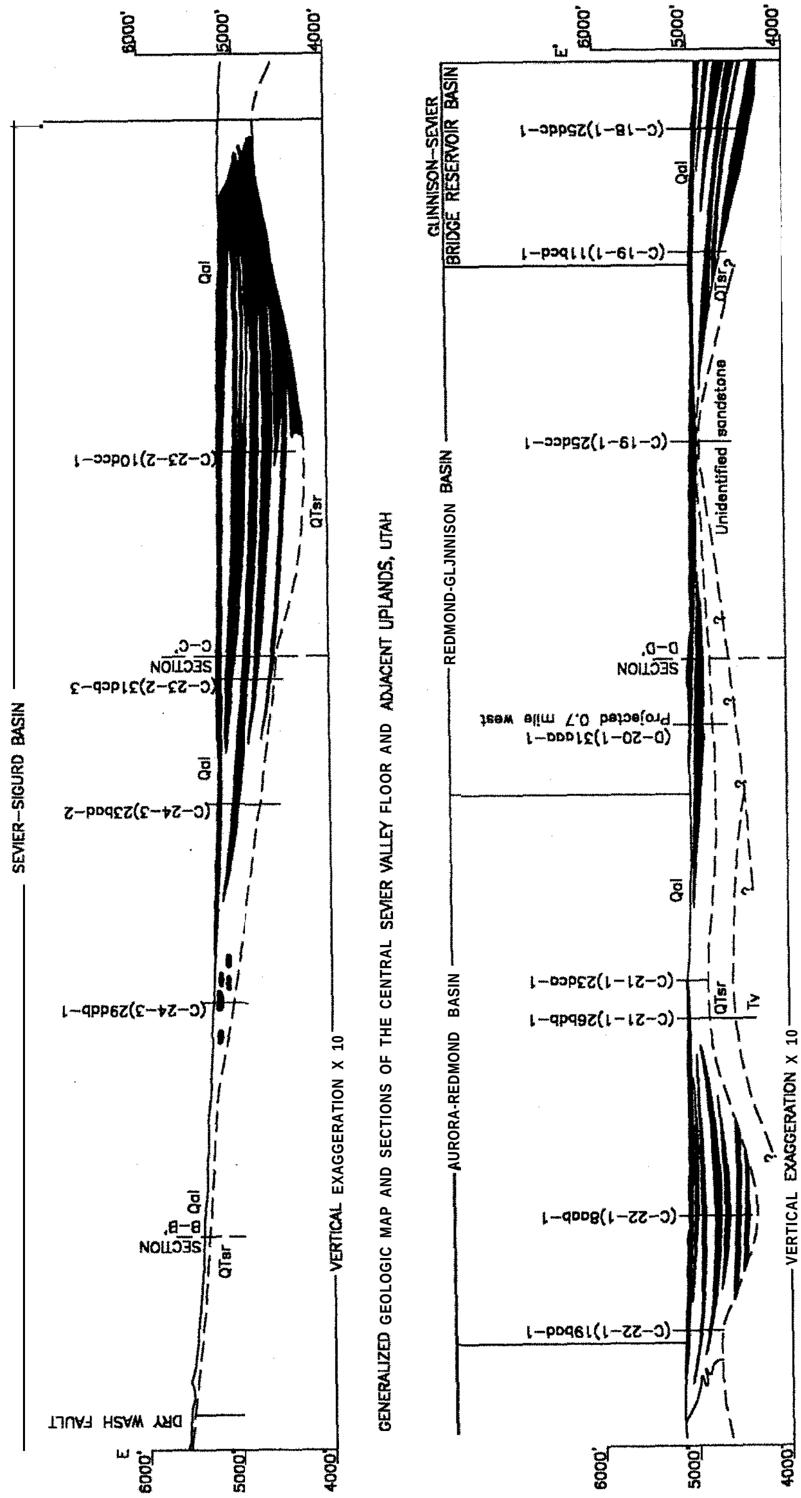


Figure 19-2
GROUNDWATER RESERVOIR X-SECTION
Sevier River Basin

Sand and Gravel

Silt and Clay

Source: USGS Water Supply Paper 1787

Table 19-l
SEVIER RIVER GROUNDWATER RESERVOIRS

Reservoirs	Storage (1,000 acre-feet)	Withdrawals (acre-feet/year)	Water Quality
Panguitch Valley	570	100	Very good
East Fork Valley[a]	90	120	Good
Grass Valley[b]	150	1,700	Good
Circle Valley	210	220	Good
Junction-Maryavale	30	Neg	Good
Sevier-Sigurd	800(3,000[c])	12,100	Good-fair
Aurora-Redmond	200	400	Good-fair
Redmond-Gunnison	150	4,500	Fair
Gunnison-Sevier Bridge	300	3,900	Fair-poor
Sanpete Valley	3,000	6,300	Good
Subtotal-above S.B.Reservoir	5,500		
Round Valley	d	2,800	Very Good
Scipio	d	100	Good
Southern Juab Valley	d	8,300	Good-fair
Mills	d	Neg.	Good-poor
Sevier Desert	200,000 e	31,000	Good-poor
Pahvant Valley	1,000	84,000	Good-poor
Total	206,500	155,540	

Source: U.S.G.S. studies during 1960s; Water Supply Papers, 1787, 1794, 1836, 1854 and 1896.
[a] Includes Emery Valley, Johns Valley and Antimony Subbasins.
[b] Includes Koosharem and Angle Subbasins.
[c] U.S.G.S. study 1986-90 published as Technical Publication 103.
[d] Storage estimates were not made.
[e] Technical Publication 79.

usually becomes a part of the groundwater reservoir. This water surfaces at the geologic restrictions on the lower end of the groundwater reservoir and becomes downstream surface-water flows.

Many irrigation companies, particularly in Circle Valley, the lower Sevier Valley, Sanpete Valley and the Mills area depend on return flows for water to divert into their systems. Also, a large share of the water stored in Sevier Bridge Reservoir comes from return flows.

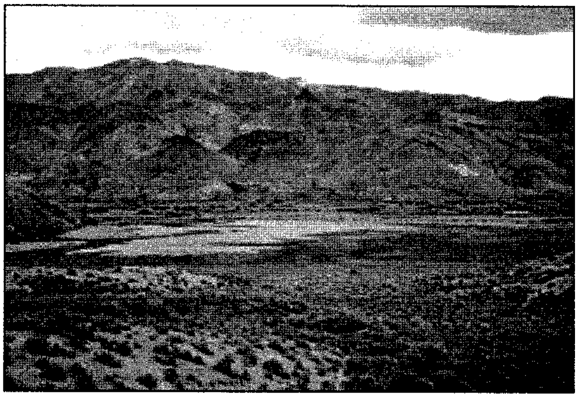
Model studies have indicated even though water is pumped, the reduction in groundwater basin outflow is less than the volume of withdrawals. This pattern is essentially the same in all of the groundwater reservoirs.

Groundwater movement in the valleys is continuous but with less short-term fluctuation than surface-water flows. Transwatershed groundwater flow is also important along the lower reaches of the Sevier River. The entire outflow from Scipio Valley is groundwater flowing through a system of en echelon faults and solution channels in the Flagstaff limestone to feed Mohlen and Blue springs on the Sevier River just below Yuba Dam. About 80 percent of the groundwater outflow from the Levan area becomes the surface water supply for the Mills area.

There is also groundwater flow out of and into the basin.[63] There is groundwater outflow of 6,800 acre-feet from the East Fork of the Sevier River into the Kanab Creek-Johnson Wash drainages. Groundwater outflows from the South Fork of the Sevier River are about 14,600 acre-feet to the Virgin River drainage on the south and to drainages along the Hurricane Cliffs from Cedar City to Paragonah. The groundwater outflow from Pahvant Valley to Clear Lake Spring was measured at 14,900 acre-feet during the period 1960-64 and 16,000 acre-feet during 1969-8 1.[40]

There is 6,700 acre-feet of groundwater inflow from the west side of the Gunnison Plateau near Nephi into the San Pitch River drainage. Nearly 11,000 acre-feet of groundwater flows from the Awapa Plateau in the Fremont River drainage into Antimony Creek.

The groundwater reservoirs are discussed in the following subsections. Most of the data comes from technical publications by the U.S. Geological Survey (USGS) and the Division of Water Bights and from USGS water supply papers and basic-data reports.



Groundwater supplies Taylor Pond

19.2.1 Panguitch Valley Basin[12,60]

Panguitch Valley groundwater reservoir is located between the mouth of Mammoth Creek and the head of Circleville Canyon. The Sevier fault forms the eastern boundary. The valley alluvial fill is about 830 feet thick. Panguitch Valley groundwater reservoir was formed by a geologic restriction of volcanic rock on the north between the Sevier Plateau on the east and the southern Tushar Mountains on the west. The Sevier River flows through this restriction into Circleville Canyon, a steep-sided gorge about five and one-half miles long.

The Wasatch (Claron) formation in the Markagunt Plateau is the predominant producer of groundwater and therefore influences the water quality in Panguitch Valley. The dominant ions are calcium, bicarbonate and magnesium. Sodium concentrations increase north of Panguitch because of the presence of volcanic rocks west of the valley. The groundwater in the northern end of Panguitch Valley has a lower concentration of dissolved-solids than the southern part. This is because the high-quality deep groundwater is forced up at the geologic restriction.

The surface water dissolved-solids concentrations ranged from 18.5 mg/L at Hatch to 318 mg/L at the confluence of Bear Creek and the Sevier River. Evidence indicates the surface water and groundwater are comparable in quality except in the valley mouth.

Groundwater was sampled during the early 1960s.[12] Data indicates the total dissolved solids in the Hatch area were about 175 mg/L. This increased to about 400 mg/L near Panguitch but dropped to about 250 mg/L east of Spry and 200 mg/L at the valley mouth.

Panguitch Valley stores about 570,000 acre-feet of water in the top 200 feet of alluvium. Annual pumpage was estimated at 49 acre-feet in 1962. There were 120 wells drilled between 1963 and 1989 with current withdrawals for public, domestic and livestock use of about 100 acre-feet. There are no large irrigation wells.

A model study by the U.S. Geological survey investigated the impact of increased groundwater use.[60] The study determined it may be possible to develop up to an additional 3,600 acre-feet of groundwater. This would take water away from some of the phreatophytes and partially dry up some of the wetter areas. There would also be some decrease in the flow of springs, streams and existing wells. After one year of increased use, return flows would decrease by about 500 acre-feet from predevelopment flows and by about 2,000 acre-feet after 12 years.

19.2.2 Circle Valley Basin[12,60]

The Circle Valley Basin is located between the mouth of Circleville Canyon and a bedrock restriction west of Kingston. The basin was formed by en echelon faulting in the surrounding volcanic rocks. It is bounded on the east by the Sevier Plateau and on the west by the southern

Tushar Mountains. The alluvium is estimated to be 680 feet thick.

The Circle Valley groundwater quality is indicated by a well about 2 miles northeast of Circleville where the dissolved-solids concentrations are 473 mg/L. Circleville Spring, about 5 miles northwest of the well, has dissolved-solids concentration of 85 mg/L. This indicates the difference between valley fill groundwater quality and water issuing from volcanic rocks.

Groundwater storage is estimated at 210,000 acre-feet in the upper 200 feet of alluvium. Annual pumpage was about 540 acre-feet in 1962, 500 acre-feet of which was for irrigation. There were 13 wells drilled between 1963 and 1989. Groundwater withdrawals from wells is now about 223 acre-feet per year, 200 acre-feet from two irrigation wells. The use of one large well producing 500 acre-feet in 1962 was discontinued.

19.2.3 East Fork Valley Basin [12,60]

The East Fork Valley subbasins are between Tropic Reservoir and the upper end of Kingston Canyon. There are three separate basins in this reservoir system formed by two bedrock restrictions. Annual withdrawals from wells are estimated at 124 acre-feet, mostly for public water supplies in Emery Valley.

Emerv Vallev Subbasin - Emery Valley Subbasin covers about 12,000 acres between Tropic Reservoir and Flake Mountain. Part of the subbasin is bounded by a fault on each side. The valley was formed from an eroded horst. The maximum known thickness of the alluvial aquifer is 66 feet.

Johns Valley Subbasin - Johns Valley Subbasin lies between Flake Mountain and the head of Black Canyon and covers about 30,000 acres. The volcanic bedrock at the head of Black Canyon extends out from the Aquarius Plateau and the Sevier Plateau, restricting the groundwater outflow and forming the groundwater reservoir. The maximum known thickness of the valley alluvium is 360 feet. The groundwater reservoir contains about 90,000 acre-feet of water.

Small flows running through these two subbasins tend to infiltrate into the water table and eventually feed the groundwater reservoir. This supplies the dense stands of Artemisia tridentata (big sagebrush) and Chrysothamnus spp. (rabbit brush). As a result, only large flows contribute to the downstream supply of the East Fork of the Sevier River. For this reason, the Tropic and East Fork Irrigation Company is required to release the Otter Creek Reservoir Company storage rights in large volumes. This insures more of the released flows reach Otter Creek Reservoir. This was a source of contention between the two companies in past years but has been resolved by an operations agreement.

The only available water quality data is from Tom Best Spring with dissolved-solids concentrations of 233 mg/L. This spring is on the west slopes of the valley which are made up of volcanic rocks.

Antimonv Subbasin - Antimony Subbasin includes about 6,000 acres between the mouth of Black Canyon and the upper end of Kingston Canyon. This area is bounded by the volcanic bedrock of Black Canyon, Sevier Plateau, Aquarius Plateau, the bedrock at the head of Kingston Canyon and the Grass Valley subbasin. The maximum known thickness is 201 feet of alluvium.

19.2.4 Grass Valley Basin [12,60]

The Grass Valley subbasins cover the area between the low divide separating Otter Creek from Peterson and Lost creeks on the north and the head of Kingston Canyon on the south. It includes the Koosharem and Angle subbasins. The Grass Valley groundwater reservoir contains about 150,000 acre-feet of water. The annual withdrawals from wells are estimated at 1,700 acre-feet, mostly flowing wells for irrigation and livestock use.

Koosharem Subbasin - The Koosharem Subbasin runs from the divide above Koosharem Reservoir to the bedrock restriction below Greenwich, covering about 30,000 acres. It is bounded by the Sevier Plateau on the west and the Awapa and Fish Lake plateaus on the east. It is a graben with a maximum thickness of 770 feet of alluvium.

The water quality was tested in one well just north of Koosharem. The dissolved-solids concentration was found to be 148 mg/L.

Angle Subbasin - The Angle Subbasin covers about 20,000 acres between the bedrock restriction forming 'The Narrows" above Angle and the head of Kingston Canyon. It is a graben formed by the Paunsaugunt fault and Awapa Plateau on the east and the Sevier Plateau and an unnamed fault on the west. The maximum known thickness of alluvium is 490 feet.

19.2.5 Central Sevier Valley Basin[39,79]

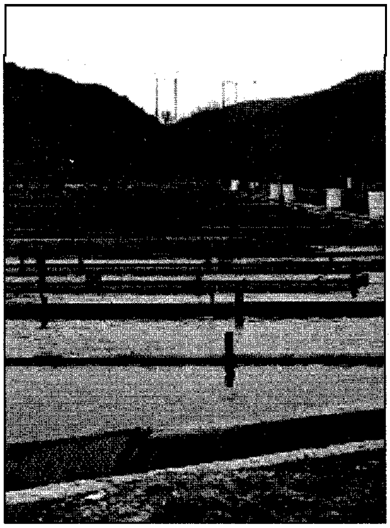
The Central Sevier Valley is made up of five groundwater basins: Junction-Marysvale, Sevier-Sigurd, Aurora-Redmond, Redmond-Gunnison and Gunnison-Sevier Bridge Reservoir. (Figure 19-1).

The Central Sevier Valley is a synclinal trough modified by a graben formed by the two largest faults in the area: the Sevier fault on the east and Elsinore fault on the west. The Tushar fault is present in the southern part of the valley. These faults are probably responsible for the springs along the east and west edges of the valley such as Bamson Springs, Black Knoll Spring, Cove Spring, Glenwood Springs, Richfield Spring and Redmond Lake Spring. The five groundwater basins have been formed by faulting, volcanism, intrusions and stream action. The Sevier River has deposited more than 800 feet of alluvium in some areas, forming the groundwater reservoirs.

The groundwater quality generally decreases as the water moves from the Junction area to Sevier Bridge Reservoir although there is good quality water at various locations throughout this reach. About 60 percent of the samples in the Sevier to Redmond area tested less than 590 mg/L (1,000 µS/cm) while only about 25 percent in the Redmond to Sevier Bridge Reservoir area was less.

Part of this increased contamination comes from over irrigation and precipitation and part comes from the Arapien shale. Groundwater satisfies all types of uses including culinary, irrigation, industrial, stock water, recreation and environmental demands.

Groundwater in the Central Sevier Valley Basin is less suitable for culinary water supplies than in upstream areas. Only half of the wells tested did not exceed the recommended drinking water standards. Public water supplies in the Redmond-Gunnison basin are less likely to meet the higher domestic water standards. The majority of the samples tested were classed as very hard.



Supplied by alluvial springs

Hardness is also a measure of the suitability of water for domestic purposes. Water from unfaulted Tertiary volcanic rocks was softer than from any other formation.

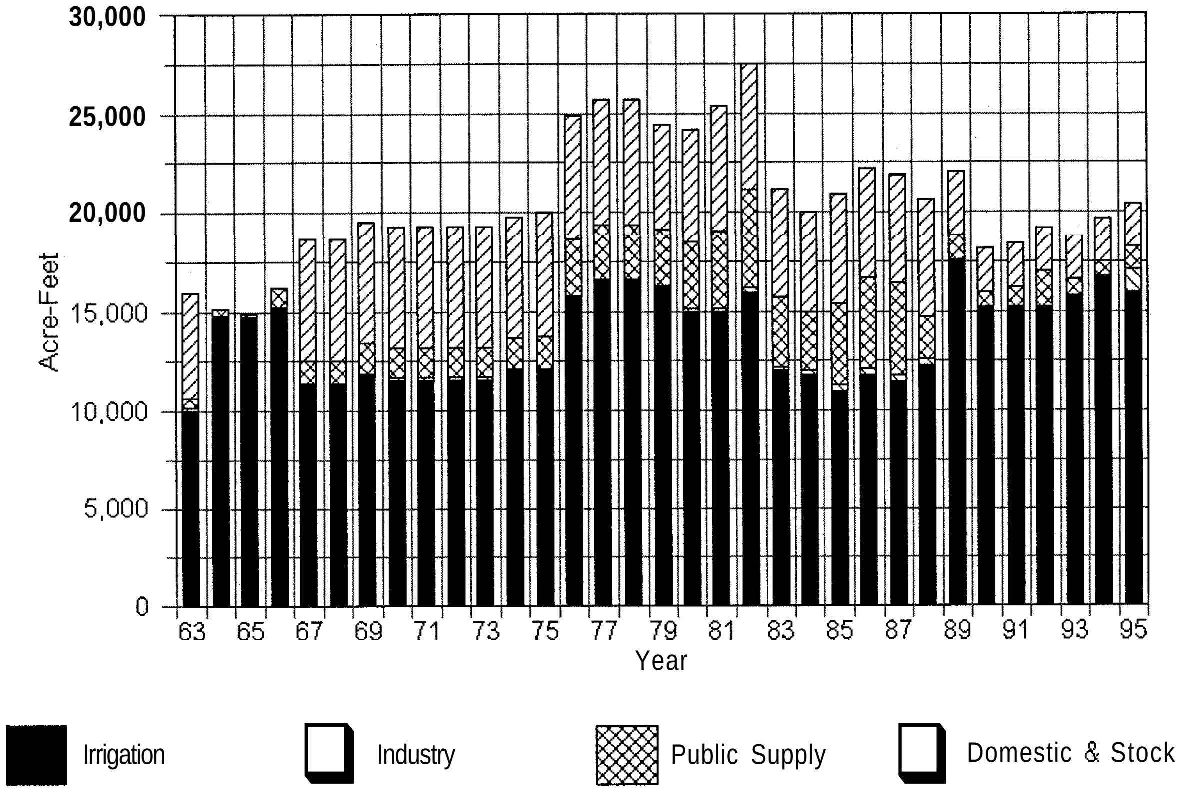
Irrigation water quality is classified using indices of salinity (total dissolved-solids)and sodium hazard. In the Central Sevier Valley, springs provide the best quality of water for irrigation. In general, wells greater than 100 feet deep yield water of better quality for irrigation than do wells less than 100 feet deep. The majority of the wells deeper than 100 feet tested medium salinity hazard while wells less than 100 feet deep were high or very high salinity hazard. Most of the wells at all depths had a low sodium absorption ratio with the deeper wells having less sodium. Although the overall quality of water tends to deteriorate in a downstream direction, it appears good quality groundwater is available for irrigation except in the Redmond-Gunnison basin where the water is slightly to moderately saline. Groundwater withdrawals from wells during 1963-95 are shown in Figure 19-3.

Junction-Marvsvale Groundwater Subbasin[79] The Junction-Marysvale Subbasin runs from the mouth of Kingston Canyon to the head of Marysvale Canyon. The basin is divided by a bedrock restriction in the valley near Piute Dam. The area

Figure 19-3

Central Sevier Valley

ESTIMATED WITHDRAWAL FROM WELLS



above Piute Dam covers about 2,000 acres and the known depth of the alluvium is only 80 feet.

The groundwater basin below Piute Dam runs to the head of Marysvale Canyon, an area about 12 miles long and from 300 feet to 5,000 feet wide. The maximum thickness of the alluvium is not known.

The groundwater storage in the upper 100 feet of alluvium was estimated at 30,000 acre-feet in 1960.[79] The total withdrawals were small from 28 wells pumped for stock water use in 1960.

The groundwater is generally suitable for all uses as it has less than 295 mg/L (500 μS/cm). Most wells have calcium and bicarbonate as the predominant ions. Some areas produce water with a pH less than 6.0 which is unsuitable for domestic usewithout treatment. Fluoride is found in some water in excess of the recommended amount for domestic use. Local dentists have reported the incidence of tooth decay is much less here than in other areas with less concentration.

Sevier-Sigurd Groundwater Subbasin - This subbasin runs from the mouth of Marysvale Canyon near the town of Sevier to Rocky Ford Dam near Sigurd. The geologic restriction near Sigurd is formed by lava on the east and an uplifted block on the west. The graben formed basin is 25 miles long and from 2 to 5 miles wide. The alluvium increases in thickness from a feather edge at the mouth of Marysvale Canyon to 800 feet near Venice, then decreases to 280 feet west of Rocky Ford Reservoir.

The areal extent of the groundwater reservoir is about 62,000 acres and the average thickness of the water-yielding material is about 240 feet. Total groundwater storage is about 3.0 million acre-feet. (This value is from a 1986-90 U.S.G.S. study. A 1960 study indicated 800,000 acre-feet of storage in the upper 200 feet of alluvium.)

U.S. Geological Survey studies[39] have indicated increased withdrawals from wells of 25,000 acre-feet would reduce all types of discharge but the largest impact would be a reduction of return flow to the Sevier River by about 4,800 acre-feet (See Section 9.5.2). Other studies have indicated these withdrawals would have the least impact on the river if wells were drilled between Central Valley and Sigurd.

The groundwater reservoir is recharged by infiltration of precipitation, seepage from canals and the Sevier River, deep percolation from irrigation, and tributary groundwater inflow. The total recharge is estimated at 112,700 acre-feet. The recharge by components is shown in Table 19-2.

Discharge from the groundwater reservoir is by seepage to the Sevier River, evapotranspiration, springs, wells (pumped and flowing), drams and subsurface outflow. The discharge from pumped wells and evaporation occur throughout the area. The balance of the discharge is mostly in the northern half of the basin. The discharge is shown in Table 19-2.

Groundwater in the Sevier-Sigurd basin is generally suitable for all uses although there are some exceptions. The deeper wells generally produce the highest quality water. The Monroe Hot Springs and the Joseph Hot Springs are highly mineralized and are not representative of the groundwater in general. These hot springs come from the Sevier fault and from the Elsinore fault, respectively.

The water quality in the Sevier-Sigurd Subbasin generally deteriorates from south to north and is influenced by inflow from consolidated rocks and tributary streams. Calcium and magnesium bicarbonate dominate in the south half and along the west margin from Richfield to Sigurd. These come from seepage of irrigation water and inflow from consolidated-rock. Sulfate becomes more dominant east of Richfield and south of Sigurd. This water has a specific conductance 2 to 4 times that of water where bicarbonate is the anion.

Groundwater northwest of Monroe had dissolved solids of 425 mg/L (725 μS/cm). One well, two and one-half miles south -southwest of Richfield had dissolved solids between 295 mg/L and 415 mg/L (500 and 700 μS/cm) while wells closer to town and to the south were up to 2,360 mg/L (4,000 μS/cm). This difference may be the influence of higher quality water in the river as opposed to deep percolation from irrigation. Groundwater near Sigurd shows dissolved solids from 415 mg/L to 885 mg/L (700 to 1,500 μS/cm) indicating the influence of poorer quality water

Table 19-2
GROUNDWATER RECHARGE/DISCHARGE-SEVIER TO SIGURD

Source	Annual Recharge (acre-feet)
Infiltration of precipitation	2,100
Seepage from canals	8,900
Seepage from Sevier River	10,100
Seepage from tributary streams	19,200
Groundwater inflow and irrigation deep percolation	72,400
Total	112,700
Source	**Annual Discharge**
Seepage to Sevier River	47,400
Evapotranspiration	23,200
Springs	18,000
Wells	12,100
Drains	10,000
Subsurface outflow	2,000
Total	112,700

lower downstream along the Sevier River as opposed to tributary inflow sources.

Aurora-Redmond Groundwater Subbasin - This groundwater basin is nine miles long and averages three miles in width. Maximum thickness of the alluvium is 660 feet east of Aurora. This basin contains three distinct layers of clay deposited by the Sevier River and its tributaries. The clay layers were deposited in lakes or ponds created by a restriction formed by the Redmond Hills anticline. Groundwater storage is about 200,000 acre-feet in the top 200 feet of alluvium.

Recharge comes from precipitation, seepage from canals and the Sevier River, deep percolation of irrigation water and tributary groundwater inflow. Water is diverted from the Sevier-Sigurd Subbasin into the Piute and Vermillion canals, part of which is delivered to this subbasin. Groundwater inflows from Salina Creek and Lost Creek were estimated at 150 acre-feet and 75 acre-feet, respectively. These discharges produce large amounts of saline contaminants as the water moves through the Arapien shale.

The groundwater discharge is from evapotranspiration, well withdrawals, gains to the Sevier River and springs. These discharges occur throughout the basin. Well withdrawals are estimated at 400 acre-feet used for municipal and industrial, domestic and stock water supplies.

Most of the groundwater in the Aurora-Redmond Subbasin is generally suitable for all types of use. The deeper wells produce the better quality water. The wells on the east side of the basin are near the Arapien shale and as a result produce poorer quality water.

One well at the north edge of Aurora yields water at about 340 mg/L (580 µS/cm). Groundwater from a well about one and one-half miles south-southeast of Redmond is about 440 mg/L (750 µS/cm) while a well one mile west-southwest is about 710 mg/L (1,200 µS/cm). The first is near the Sevier River and the latter is near Redmond Spring.

Redmond-Gunnison Groundwater Subbasin - The Redmond-Gunnison groundwater basin is a Y-shaped depression running from the Redmond Hills northward with one branch extending northwesterly down the Sevier Valley about three miles toward Sevier Bridge Reservoir. The other branch extends about 7 miles up the San Pitch River to Gunnison Reservoir dam. The basin is 12 miles long and ranges from three to eight miles in width. The basin alluvium ranges in thickness from 250 feet thick in the Willow Creek fan to 120 feet west of Centerfield and 320 feet west of Gunnison. The basin alluvial fill stores about 150,000 acre-feet in the upper 200 feet.

Groundwater withdrawals are about 4,500 acre-feet. Of this amount, about 4,200 acre-feet is used for irrigation and the balance for municipal and industrial purposes.

The Redmond-Gunnison Subbasin groundwater is lower in quality than the upstream subbasins. Groundwater in the Axtell area and in the northwestern part of the subbasin is of quality acceptable for most uses, mostly irrigation. The remainder of the subbasin produces water with higher salinity and is unsuitable for domestic uses. This is due to mineral constituents dissolved from the Arapien shale.

One well near Axtell produces water with dissolved solids of 2,270 mg/L (3,850 μS/cm). The groundwater quality in the Gunnison area ranges from about 1,300 mg/L (2,200 μS/cm) on the east side of the valley to about 1,535 mg/L (2,600 μS/cm) on the west near the Sevier River.

Gunnison-Sevier Bridge Reservoir Subbasin - This subbasin extends from midway between Gunnison and Fayette to Yuba Dam. It is about 18 miles long and averages 3 miles in width. This groundwater reservoir is divided into two subbasins, one above and one below the Sevier Bridge Reservoir narrows which is midway between Fayette and Yuba Dam.

The alluvium was deposited by a lake formed by a bedrock restriction across the valley at the Sevier Bridge Reservoir narrows. The alluvium thickness varies from a thin veneer near the narrows to 500 feet near Fayette and 320 feet northwest of Gunnison. Little is known about the extent, thickness or characteristics of the groundwater reservoir in the lower subbasin as it is typically covered by water stored in Sevier Bridge Reservoir. The estimated groundwater in storage is 300,000 acre-feet.

Irrigation is the only suitable use for most groundwater in the Gunnison-Sevier Bridge Reservoir Subbasin because of the chemical quality. Well water from a deeper aquifer is of a higher quality. Total annual withdrawals from wells is about 3,900 acre-feet with about 3,500 acre-feet used for irrigation.

Recharge-Discharge: Aurora to Sevier Bridge Reservoir - It was difficult to determine the recharge-discharge relationships for each of the five groundwater subbasins in the Central Sevier Valley. Even a broader basis, some of the items were lacking in data. Broad estimates have been made of the recharge and discharge for the three northern subbasins; Aurora-Redmond, Redmond-Gunnison and Gunnison-Sevier Bridge Reservoir. These are shown in Table 19-3.

19.2.6 Sanpete Valley Basin[76]

Sanpete Valley is Y-shaped and about 40 miles long and up to 13 miles wide. The west branch of the Y runs from Moroni toward Fountain Green and the east branch runs up to Fait-view. The Arapien Valley extends southward from the lower end of Sanpete Valley and is about 8 miles long and one mile wide. These two valleys are bounded on the east by the Wasatch monocline. On the west, Sanpete Valley is bounded by the Gunnison Plateau and the Arapien Valley is bounded by low hills with a drainage divide on the south. The valley till thickness varies from about 100-350 feet in the Mt. Pleasant-Fait-view and Moroni- Fountain Green areas to 100-500 feet in the Ephraim-Manti area. Generally the valley fill is thicker on the west side, probably influenced by the Sevier fault. The wells on the east side of the valley are under water table conditions. The wells on the west are under artesian and water table conditions.

Most of the groundwater is stored in the alluvium in the valley fill. There is an estimated three million acre-feet of water stored in the upper 200 feet of valley fill in Sanpete Valley above the Gunnison Reservoir dam. Of this amount, about 600,000 acre-feet is in the top 30 feet of saturated material and 400,000 acre-feet is in the 30 to 50-foot zone. There is 800,000 acre-feet in the underlying 50 feet and 1.2 million acre-feet in the 100 to 200-foot zone.

Table 19-3
GROUNDWATER RECHARGE/DISCHARGE-AURORA TO SEVIER BRIDGE RESERVOIR

Source	Annual Recharge (acre-feet)
Precipitation (5%[a])	4,900
Sevier River losses	1,500
Groundwater inflow	2,400
Other recharge[b]	135,000
Total	143,800
Source	**Annual Discharge**
Evapotranspiration	24,000
Well withdrawals	7,400(8,800[c])
Discharge to Sevier River	85,000
Springs	27,000
Total	143,800

[a] Only 5 percent of the precipitation was considered effective.
[b] Other recharge includes deep percolation from irrigation, groundwater inflow-Sanpete Valley, other groundwater inflow.
[c] Separate study estimate.

Recent studies simulated increasing the present well withdrawals from 6,300 acre-feet to 18,900 acre-feet over a 5-year drought period using a recharge at 75 percent of average. Discharge as seepage to the San Pitch River decreases from 17,200 acre-feet to between 13,200 and 16,000 acre-feet. Discharge from alluvial springs decreases 3,600 acre-feet to between 2,400 and 3,100 acre-feet.

Groundwater Recharge - There are four sources where recharge to the groundwater reservoir has been estimated. These are tributaries, San Pitch River, deep percolation of unconsumed irrigation water and precipitation.

Seepage from the tributaries occurs where the streams flow across the alluvial fans. Up to 38 percent loss has been measured on Twin Creek, 10 percent on Ephraim Creek and 9 percent on Oak Creek near Spring City.

Seepage from the river varies throughout its length. There are areas of gain as well as loss. Measurements made of gaining and losing reaches determined the net recharge to the river.

Recharge from deep percolation of unconsumed irrigation water was estimated at 29,000 acre-feet or about 0.5 feet per acre. Deep percolation has decreased over the years as more sprinkler systems have been installed. Between 1975 and 1989, sprinkler irrigation increased from about 10 percent of the irrigated land to over 50 percent.

Precipitation is a significant part of the recharge to the groundwater reservoir. Based on other studies in Utah, recharge is estimated at 10 percent of the annual precipitation. The recharge to groundwater is shown in Table 19-4.

Groundwater Discharge - There are four principal sources of discharge from the groundwater reservoir. These are evapotranspiration, seepage to the San Pitch River, springs and withdrawals from wells.

The evapotranspiration rates were based on several studies in other areas and at different times in Sanpete Valley. The range in gain to the San Pitch River is from two different studies completed during October and April in two different years. The water pumped from wells indicates the high and low years over the 33-year period. The volume of water from flowing wells tends to remain constant. The discharge from springs is almost constant although some springs were not included because measurements were not available. Withdrawals from wells during 1963-95 are shown in Figure 19-4. The discharges from groundwater are shown in Table 19-4.

The groundwater is generally of better quality near the boundary between the valley fill and the mountain fronts of the Wasatch Plateau and San Pitch Mountains. This is the area where snowmelt runoff enters the valley across alluvial fans.

The concentration of total dissolved-solids (TDS) varies throughout the valley. In many areas in the central part of the valley, the TDS is less than 500 mg/L. TDS over 500 mg/L is present in the northwestern, central and extreme southern part of the basin.

Water with higher specific conductance is generally concentrated in two areas of the valley. One area is downgradient from outcrops of the Green River and Crazy Hollow formations of Tertiary age in the central part of the valley from Chester to Pigeon Hollow. This water is generally less than 200 feet below the surface. The other area is downgradient from outcrops of the Arapien shale on the west and south side of the valley from near the Point of the Mountain (Big Mountain) southward to near the mouths of Axehandle and Rock canyons.

Water from the majority of wells in the valley fill has a dissolved-solids concentration less than 600 mg/L and specific conductance less than 1,000 µS/cm. The water is composed of calcium, sodium, magnesium and bicarbonate ions which are typical of most of the groundwater from the valley fill.

The water from Big Springs west of Fountain Green is a calcium carbonate type with a dissolved solids concentration of only 255 mg/L (430 µS/cm) although Birch Spring three miles south has dissolved solids of 470 mg/L (800µS/cm). This good quality water is indicative of most of the groundwater flow through the Indianola formation. The series of springs from about Fountain Green to the Point of the Mountain are from groundwater movement through the Indianola formation from the west side of the mountain.[63] Most of these springs all have dissolved-solids less than 355 mg/L (600 µS/cm). In contrast, a spring discharging water from a fault zone southwest of Manti contains sodium bicarbonate, sulfate and chloride ions. Dissolved-solids concentrations are much higher at 1,780 mg/L.

Ground-water quality for Sanpete Valley is generally very good, although locally, elevated total dissolved-solids (TDS) and nitrate concentrations exist in the valley-fill aquifer. The Utah Geological Survey mapped water quality in the valley-fill aquifer to ascertain possible nitrate pollution documented in previous investigations. Water-well samples were collected and analyzed during the summer and autumn of 1996 and spring of 1997 to evaluate TDS and nitrate concentrations. Water wells representing a widespread geographic distribution in the valley-fill aquifer, were analyzed for nutrients (nitrate, nitrite, ammonia, and phosphate). Of those, 120 were tested for general chemistry, and 52 for organics (including pesticides).

Nitrate values range from <.02 mg/L to 45.3 mg/L. Eighty-eight percent of the wells analyzed for nitrate yielded values less than 5 mg/L. Three percent of the water wells analyzed showed high nitrate values (those which exceeded Utah drinking-water standards of 10 mg/L). Preliminary data indicate half of the high-nitrate wells are impacted by diffuse non-point sources, not nitrate plumes. Most of the high-nitrate wells are shallow (<200 feet deep) and/or in primary recharge areas. Three percent of the water wells tested for pesticides yielded values above the detection limit,

Figure 19-4

Sanpete Valley

ESTIMATED TOTAL WITHDRAWAL FROM WELLS

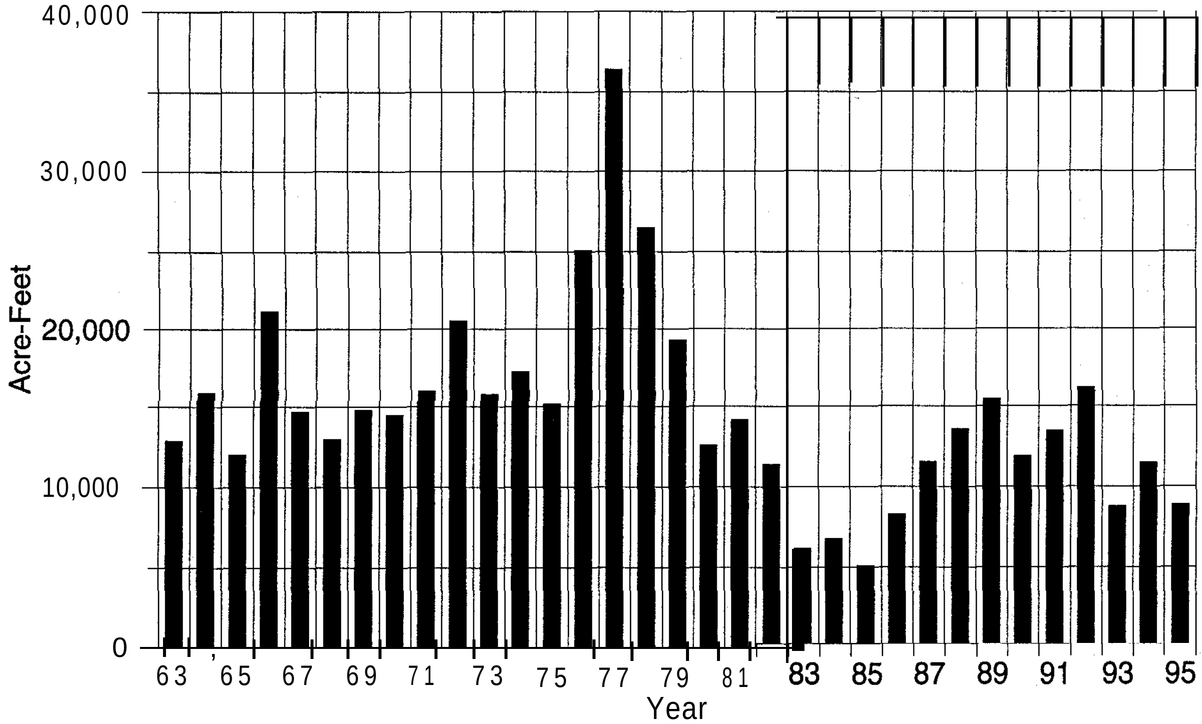


Table 19-4 GROUNDWATER RECHARGE/DISCHARGE-SANPETE VALLEY	
Source	Annual recharge (acre-feet)
Seepage from tributaries	28,500-57,000
Seepage from San Pitch River	1,500-l ,800
Deep percolation-irrigation water	29,000
Precipitation	15,000
Total (rounded)	74,000-103,000
Source	Annual Discharge
Evapotranspiration	41,000-l 16,000
Seepage to San Pitch River	18,500-80,300
Wells	
Pumped (1963-88)	1,200-12,800
Flowing (1965-657, 1989)	4,000
Alluvial springs	11,000
Total (rounded)	76,000-224,000

but at levels below Utah drinking-water standards. Total dissolved-solids concentrations determined for 70 percent of the wells tested for general chemistry are below 500 mg/L, with a range of 226-2,572 mg/L. Overall water quality in the valley-fill aquifer is Class IA (pristine drinking water), the highest quality classification for water in Utah.

Potential sources of nitrate contamination include fertilizer, manure associated with feed lots (cattle, turkeys, chickens and sheep), and septic tanks. Elevated levels of TDS concentrations in ground water are attributed to the proximity of outcrops of the Green River formation in the central part of the valley, and to the Arapien shale in the southern part of the basin.

19.2.7 Round and Scipio Valleys Subbasins"

Scipio Valley and Round Valley are graben basins, bounded on the east by the Valley Mountains and on the West by the Pahvant Range and Canyon Mountains. High angle normal faults traverse Scipio Valley in a northeasterly direction. Movement along several of these faults has exposed bedrock which forms the Low Hills. This is also the northern basin boundary making Scipio Valley a closed basin. These faults have led to solution channels which provide underground drainage out of the valley and through Little Valley. These channels provide the source of water for Mohlen and Blue springs under the Sevier River below Yuba Dam.

Round Valley Subbasin - Groundwater in Round Valley occurs mainly under artesian conditions. There are three large flowing wells that tap permeable zones in the sandstone. They discharge 1,300-1,800 gallons per minute (gpm). Groundwater also occurs under water table conditions around the edge of the valley. Water samples taken in Round Valley during 1963 were 300 mg/L (510 µS/cm) and 374 mg/L (634 µS/cm).

Scinio Vallev Subbasin - Groundwater occurrence in Scipio Valley is unusual as the water levels change abruptly near the middle of the valley. In the southern part of the valley, water levels are about l-50 feet below the land surface. The source of water is mostly seepage from Round

Valley Creek and/or irrigation water. About two miles north of Scipio, the water levels drop abruptly to more than 200 feet. The source of water is probably recharge on alluvial fans from precipitation and tributary runoff. There may be a deeper aquifer at this same level in the southern part of the valley. Samples taken during 1963 in Scipio Valley just northeast of Scipio varied from 221 mg/L (375 μS/cm) to 553 mg/L (938 μS/cm). One well six miles north of Scipio near the Low Hills contained 1,233 mg/L (2,090 μS/cm).

19.2.8 Southern Juab Valley Basin[11,55,59]

Juab Valley is a north-trending long, narrow valley divided into the northern and southern parts by the Levan Ridge, an east-west trending topographic divide which is also part of the northern boundary of the Sevier River Basin. Southern Juab Valley is bounded by the San Pitch Mountains on the east and the West Hills and South Hills on the west. This part of the valley is about 16 miles long and 2 to 6 miles wide. Juab Valley is downfaulted along the Wasatch fault on the east. Data indicates the valley is bounded on the west by inferred, smaller normal faults which intersect the Arapien shale at depth.

Chicken Creek is the primary stream supplying Southern Juab Valley with a smaller amount flowing from Pigeon Creek. These streams do not normally reach Chicken Creek Reservoir during the irrigation season except during high-runoff years because of diversions for irrigation. However, groundwater is discharged to seeps and springs near the reservoir. Chicken Creek Reservoir stores groundwater discharge and high-flow runoff. This water is used for irrigation in the Mills area, about four miles to the south.

The depth of the basin-fill deposits is not known but seismic-reflection data indicates it may be about 1,200-2,300 feet. For this discussion, the depth i.s considered to be 1,000 feet. The recharge and discharge for Southern Juab Valley was determined from average annual data based on the period 1963-93. The evapotranspiration data was based on the average irrigated acreage for 1990-92. The reason for this was because the irrigated acreage of 3,900 acres in 1969 had nearly doubled by the 1990s. In addition, 12 irrigation wells had been added in the Levan area since 1963. The annual recharge and discharge from the groundwater basin are shown in Table 19-5.

Water Quality - Groundwater entering southern Juab Valley is high in calcium and sulfate, picked up from the Arapien shale. Total dissolved-solids concentrations ranged from 623 mg/L at a well near Levan to 3,980 mg/L at a well about five. miles north of Chicken Creek Reservoir. There is a plume of groundwater extending from Chicken Creek toward Chicken Creek Reservoir where dissolved-solids concentrations are less than 1,000 mg/L. Palmer Spring, located under the northeast end of Chicken Creek Reservoir, contains 3,180 mg/L of dissolved-solids. Groundwater from the flow path supplying this spring is south of the Chicken Creek flow path and is probably less transmissive, allowing longer contact with soluble salts in the alluvium.

19.2.9 Mills Valley Subbasin”

Groundwater occurs under both water table and artesian conditions. Water table conditions occur along the margins while artesian conditions are found at depth beneath the flood plain. The supply for Chase Spring comes from alluvium or possibly from the underlying bedrock. The Meadows is a swampy area northwest of Chase Spring which contains many small springs and seeps.

Total annual groundwater discharge in the area is about 2,000 acre-feet, coming mostly from seepage from irrigation practices to the east. Two wells were sampled in 1963 within one mile of each other at depths of 359 feet and 465 feet. The deeper well contained 797 mg/L (1,350 μS/cm) while the other contained 337 mg/L (571 μS/cm). Chase Spring contained 1,127 mg/L (1,910 μS/cm).

19.2.10 Sevier Desert Basin[26,35]

The Sevier Desert area is bounded on three sides by steep, rugged mountains. These are the East Tintic Mountains and Canyon Range on the east, West Tintic, Sheeprock, Simpson, Keg and Desert mountains on the north and the Drum and Topaz mountains and House Range on the west. See Figures 3-1 and 19-1.

In the Sevier Desert, there is no distinct groundwater reservoir boundary as the water is moving across the broad delta in a west to southwesterly direction. There are two primary aquifers, one shallow and one deep.

Water enters the Sevier Desert groundwater basin from the surrounding mountains as well as the northwesterly flow from Pahvant Valley. Some of the groundwater comes from the Sevier River and there is some inflow from the Beaver River drainage. Other recharge is by infiltration of precipitation, seepage from streams, canals and reservoirs, and deep percolation of irrigation water. Recharge is estimated in Table 19-6.

Discharge from the unconsolidated basin fill is from seepage to the Sevier River, evapo-transpiration, groundwater outflow with ultimate discharge into Sevier Lake, and wells. Estimated discharge is shown in Table 19-6.

There is an area of 1.28 million acres or 2,000 square miles containing water in storage in the alluvial aquifers. Saturated deposits containing fresh water extend to a depth of about 1,300 feet near Lynndyl. The depth of the alluvium varies but it is estimated to exceed 1,000 feet in the central part of the basin. Total storage is estimated at 200 million acre-feet. Although most of the water is fresh, there is poor quality water in the low-lying central part of the basin.

The water quality varies from 200 mg/L total dissolved-solids (TDS) in a well just west of DMAD Reservoir to 49,000 mg/L TDS in a well north of Sevier Lake. The highest quality water is from wells deeper than 500 feet in the Lynndyl-Delta area. Poorer quality water comes from wells less than 200 feet deep in the southwestern part of the basin toward Sevier Lake. This is indicative of the contamination of the more shallow aquifers downstream by return flows from cropland drains and leaching of salts.

Groundwater quality has deteriorated over the years in the Leamington-Lynndyl area. Discharges have increased in concentrations of sodium and potassium from 241 mg/L to 316 mg/L and chloride from 665 mg/L to 690 mg/L. This is from poor quality water recharging the groundwater reservoir, probably deep percolation from irrigation. The area of deterioration probably extends to the west.

Groundwater withdrawals during the 1964-8 1 period averaged about 27,500 acre-feet, nearly three times the 1951-63 period average of 9,600 acre-feet. Most of the increase was from deep wells for irrigation with some use for municipal purposes. This increased use has caused a decline in the water levels of 10 to 13 feet in the shallow aquifer over several square miles in an area about four miles west of Delta. Water levels have declined up to 19 feet in the deep aquifer in an area about two miles south of Delta. There has been some decrease in the number of flowing wells. Groundwater withdrawals from wells during 1963-95 are shown in Figure 19-5.

19.2.11 Pahvant Valley Groundwater Basin[36,43,58]

The Pahvant Valley groundwater reservoir is fed by the mountain streams from the Pahvant Plateau along the east side of the valley. There is also groundwater inflow from the mountain bedrock. Most of the groundwater outflow is through the basalt flows on the west side of the valley into Clear Lake Spring. There is also groundwater movement from Pahvant Valley north toward the Sevier Desert area south of Delta.

The Pahvant Valley aquifer is made up of sands and gravels deposited during the Recent and Pleistocene ages. The aquifer materials are coarser near the mountains and become finer to the west. The beds of coarser material are interlayered with clay materials and as water moves from the mountains to the west, these confining layers create artesian conditions. The coarser beds are connected laterally and the confining beds are not perfect aquicludes so there is both horizontal and vertical movement of water. Most of the recharge percolates down as water crosses the alluvial fans in streams, irrigation ditches and from irrigated fields.

The basaltic Pahvant Flow in the western part of the valley and the basalt underlying the area west of Black Rock Volcano are both unconfined aquifers interlayered with unconsolidated deposits. The groundwater is supplied mainly by upward leakage from the artesian aquifer, percolation of irrigation water and precipitation.

Table 19-5
GROUNDWATER RECHARGE/DISCHARGE-SOUTHERN JUAB VALLEY

Source	Annual Recharge (acre-feet)
Seepage from nonirrigation-season stream flow	2,400
Seepage from canals and unconsumed irrigation water	4,300
Infiltration of precipitation	2,600
Subsurface inflow and seepage from ephemeral streams - east side	1,200
Subsurface inflow and seepage from ephemeral streams - west side	1,500
Total recharge	12,000
Source	**Annual Discharge**
Wells	
Pumped - Irrigation and public use	5,300
- Domestic and stock use	100
Flowing	900
Total wells	6,300
Springs and seeps	
Palmer Spring	700
Seepage to Chicken Creek reservoir	1,100
Total springs and seeps	1,800
Evaportanspiration	3,900
Subsurface	-0-
Total discharge	12,000

Table 19-6
GROUNDWATER RECHARGE/DISCHARGE-SEVIER DESERT BASIN

Source	Annual Recharge (acre-feet)
Stream seepage	27,000
Canal seepage	12,700
Reservoir seepage (Fool Creek Reservoir)	2,800
Irrigation water (deep percolation)	9,000
Precipitation	7,000
Groundwater tributary Inflow	18,000
Total	76500
Source	**Annual Discharge**
Seepage to Sevier River	6,500
Evapotranspiration	20,000
Groundwater outflow	31,000
Well withdrawals	31,000
Total	88,500

Estimates indicate the volume of groundwater in storage in Pahvant Valley is about 11 million acre-feet in the upper 200-500 feet of alluvium. Of this amount, less than one million acre-feet is recoverable. Prevention of long-term mining and protection of junior water rights are factors regulating recovery of groundwater. The cost of electricity is also a factor restricting pumping.

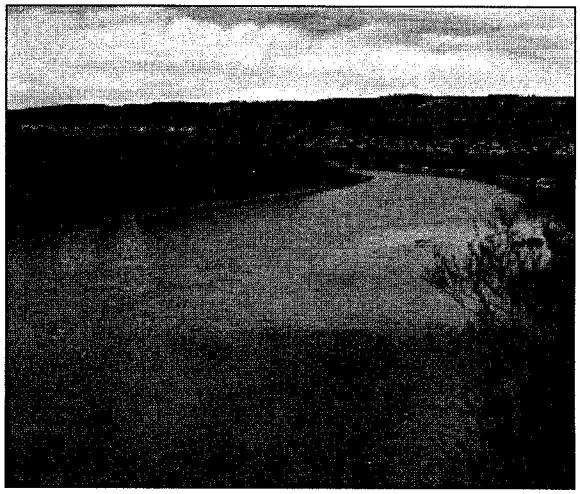
There appears to be a groundwater restriction along the western border of Pahvant Valley consisting of fine-grained silts and clays. It is unclear how groundwater moves from Pahvant Valley into Clear Lake Springs but a fault and fracture system could act as a conduit. However, flood flows leaked out of the valley relatively fast during the 1980s. Flood water from Chalk Creek flowed into "The Sink" about three miles northwest of Flowell. Flood flows from Corn Creek reached a low area about 7 miles west of Kanosh and seeped into the ground through a series of sink holes. Normally flows do not reach these areas.

Pahvant Valley is divided geologically and hydrologically into six districts. These districts are McCornick, Greenwood, Pahvant, Flowell, Meadow and Kanosh. They have all been developed to provide irrigation water. Data for these districts is shown in Table 19-7.

Recharge - Total recharge varies from year to year depending on climatic factors. During years of low precipitation, recharge is less than during wet years such as 1983-84. Total recharge was over 70,000 acre-feet in 1959. Recharge from various sources is shown in Table 19-8.

Discharge - Discharge from the groundwater reservoir is from springs, evapotranspiration, wells and groundwater outflow. Discharge is shown in Table 19-8.

The withdrawal from wells has steadily increased since the first wells were drilled near Flowell in 1915. Discharge was primarily from flowing wells until the availability of electricity in 1952. As discharge from pumped wells decreased until by 1983, it was less than 1,000 acre-feet. Flowing well discharge increased again due to increased precipitation in 1982-84 to 9,500 acre-feet in 1984, 23,000 acre-feet in 1985, and 22,000 acre-feet in 1986. During the drought of 1977, well withdrawls were 96,000 acre-feet. Since that time, total withdrawals have been less. Most of the wells are between 200 and 500 feet deep in basin fill and 100 feet to 200 feet deep in basalt aquifers.



River flow comes from groundwater

There have been water-level declines over 50 feet in some areas of Pahvant Valley from 1953 to 1980. The water levels have mostly recovered as a result of the unusually wet years from 1983-85. Withdrawals from groundwater are shown on Figure 19-6.

Water Oualitv - There is a wide range in water quality in Pahvant Valley. A well about 4 miles northwest of Holden tested 300 mg/L total dissolved-solids (TDS) while some hot springs 4 miles northwest of Kanosh contained 9,000 mg/L TDS. The eastern part of Pahvant Valley has groundwater concentrations less than 1,000 mg/L TDS while most of the remaining area has concentrations ranging from 1,000 to 5,000 mg/L TDS. The farming area west of Kanosh has the poorest quality water with TDS concentrations over 5,000 mg/L. This has been attributed to recirculation of irrigation water which may account for up to 50 percent of the pumped well water. These larger concentrations are generally sodium chloride or sodium chloride sulfate types. The quality of water as it pertains to irrigation is shown in Table 19-9.

Figure 19-5

Sevier Desert

ESTIMATED WITHDRAWAL FROM WELLS

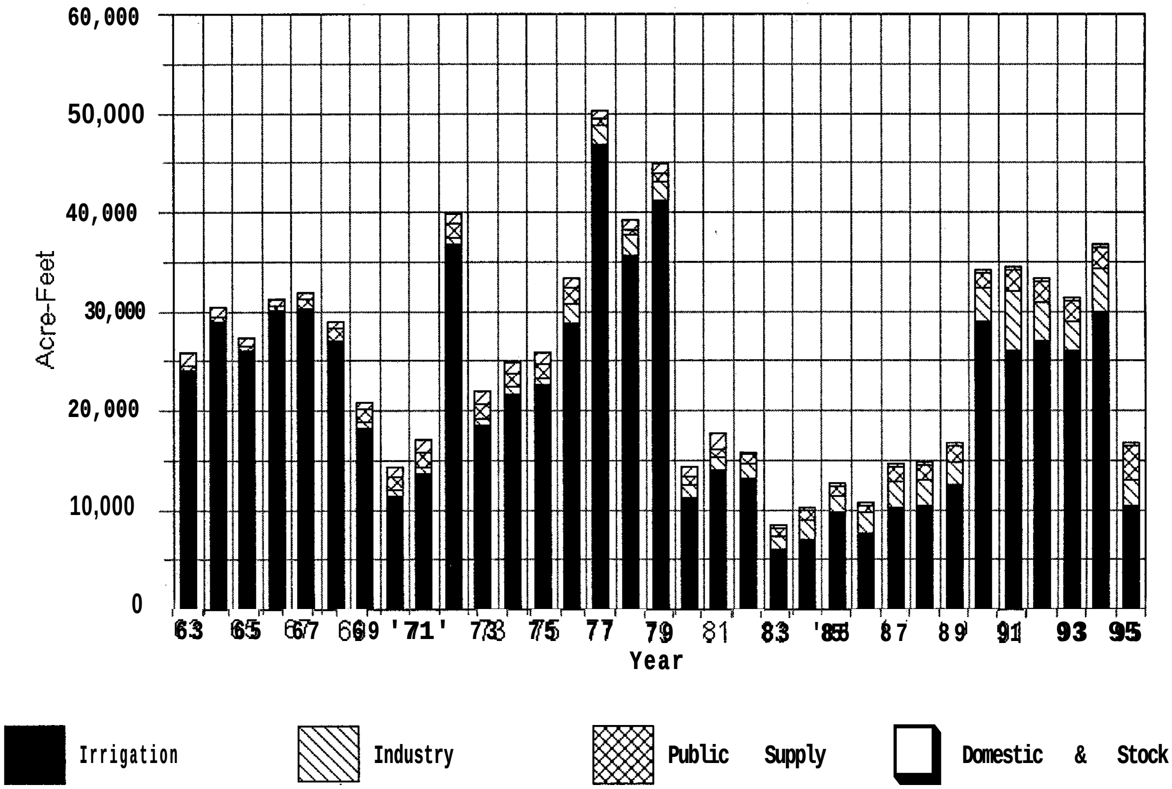


Table 19-7 PAHVANT VALLEY GROUNDWATER RESERVOIR					
District	Average Thickness (feet)	Area (acres)	Storage (1,000 ac-ft)	Withdrawals (acre-feet)	Water Quality
McCornick	27.5	17,500	1,200	NA	Good
Greenwood	300	31,000	2,300	NA	Good
Pahvant	200	9,500	480	NA	Good
Flowell					
Alluvium	500	34,500	4,300	NA	Fair-poor
Basalt	50	6,500	20	NA	Fair
Meadow	350	24,500	2,200	NA	Good-fair
Kanosh	300	14,000	500	NA	Good-poor
Total		137,500	11,000	84,000	

Source: Ground-Water Resources of Pahvant Valley, Utah, 1965.[43]

Table 19-8 GROUNDWATBR RECHARGE/DISCHARGE-PAHVANT VALLEY	
Source	Annual Discharge (acre-feet)
Seepage from streams	20,500
Central Utah Canal seepage	3,300
Irrigation water deep percolation	39,000
Precipitation infiltration	11,000
Total	73300
Source	Annual Discharge
Springs	3,500
Evapotranspiration	29,000
Wells	78,000
Total	110,500

19.3 GROUNDWATER PROBLEMS AND NEEDS

The groundwater reservoirs appear to be in stable condition with a few exceptions. This is due to the limited development allowed in most areas of the Sevier River Basin. Two exceptions are the Sevier Desert and Pahvant Valley.

In the Sevier Desert, the shallow artesian aquifer has declined up to six feet west and north of Delta and as much as nine feet between Oak City and Fool Creek Reservoirs from 1991 to 1996. During the same period, the deep artesian aquifer declined up to seven feet in a band from Oak City through the Leamington-Lynndyl area and around to the north and west of Delta to an area west and southwest of Deseret. Previously from 1963-81, the shallow artesian aquifer declined up to 10 feet west and north of Delta and over live feet between Oak City and Fool Creek Reservoirs. During this period, the deep artesian aquifer declined up to 19 feet around Delta, 11 feet south of Oasis and six feet north and west of Delta. It also declined up to eight feet in the Oak City and Learnington-Lynndyl area.

Water levels in Pahvant Valley have declined up to 14 feet around McCornick, west of Holden and about six miles southwest of Kanosh between 1991 and 1996. Levels have declined up to seven feet over the rest of the valley. Water levels in the recharge areas below the alluvial fans of Chalk and Meadow creeks have risen up to seven feet with increases up to 15 feet below the Corn Creek fan during this same period.

Water quality in the Hatton area west of Kanosh is becoming a problem. In the Kanosh farming district, the dissolved-solids concentrations have increased from 2,000 mg/L to 6,000 mg/L in some wells since the 1950s.

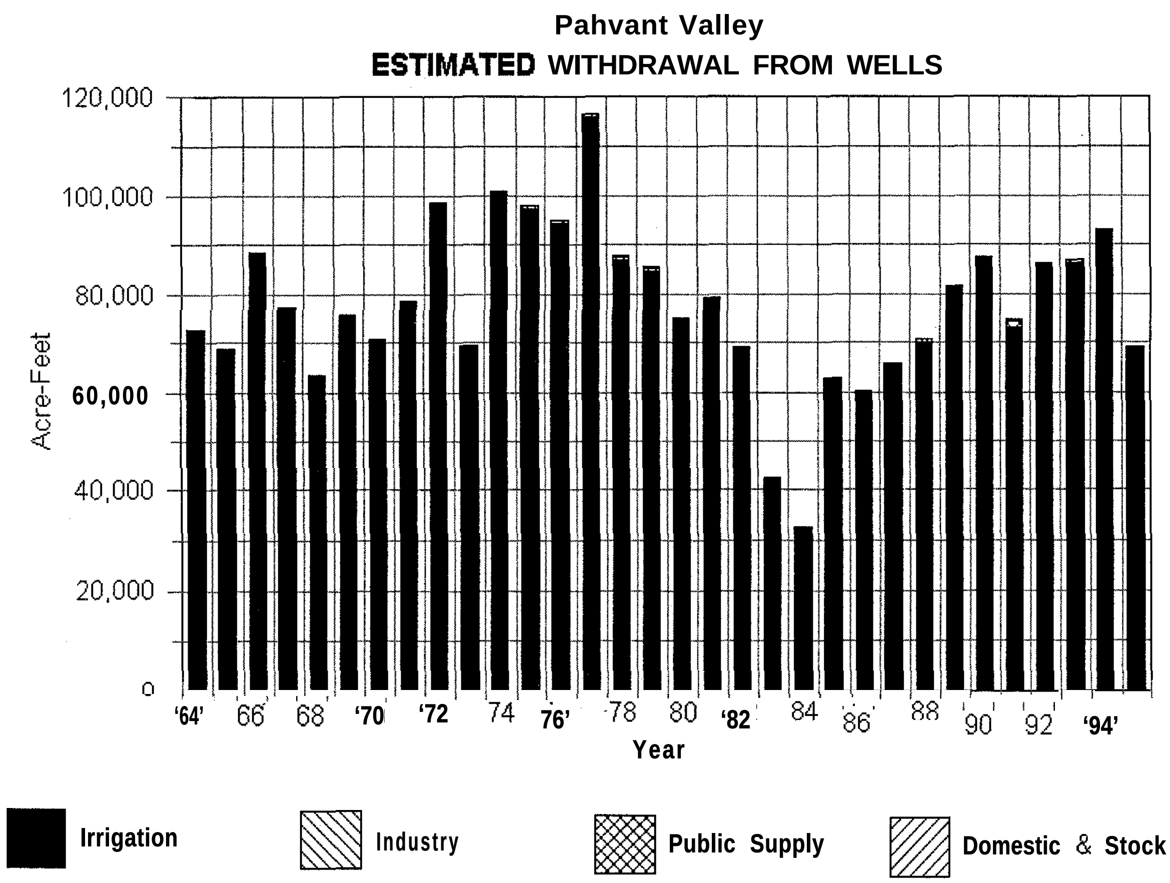
19.4 GROUNDWATER MANAGEMENT PLANS

The State Engineer is working on new groundwater management plans throughout the entire basin. Work has progressed considerably in Pahvant Valley over the last few years with restrictions on unauthorized groundwater withdrawals. In March 1997, the State Engineer closed all of the Sevier River system to additional well permits. This was ordered to stop the increased drilling of domestic wells with flows of 0.015 cfs or two acre-feet until a management strategy could be prepared. The only exception would be transferring an existing water right to a domestic well permit.

19.5 GROUNDWATER MANAGEMENT ALTERNATIVES

There are over five million acre-feet of groundwater stored in the top 200 feet of alluvium in underground reservoirs throughout the Sevier River system above Sevier Bridge Reservoir. Studies by the U.S. Geological Survey during the 1980s have indicated limited development of groundwater in some areas could take place. There would be downstream as well as within basin effects although they would vary from basin to basin. The decrease in downstream flows would be from 15 to 20 percent of the increased groundwater withdrawal. Other impacts may occur in the yields of springs and use by phreatophytes. See Section 9.5.2, Groundwater Management for more discussion.

Figure 19-6



Pahvant Valley
ESTIMATED WITHDRAWAL FROM WELLS
120,000
100,000
80,000
60,000
40,000
20,000
0
Acre-Feet
'64' 66 68 '70 '72 74 76' 78 80 '82 84 86 88 90 92 '94'
Year
Irrigation
Industry
Public Supply
Domestic & Stock

Table 19-9
QUALITY OF GROUNDWATER FOR IRRIGATION-PAHVANT VALLEY

District	Salinity Hazard	Sodium Hazard
McCornick	High	Low
Greenwood	High	Low
Pahvant	High	Low, east; High, west
Flowell[a]	Medium to High	Low
Meadow	Medium to High	Low
Kanosh	Very High	Medium to High

[a] Groundwater in the basalt aquifer has three times the concentrations as groundwater to the east.

Section A Sevier River Basin
ACRONYMS, ABBREVIATIONS AND DEFINITIONS

Section A Sevier River Basin- State Water Plan

Acronyms, Abbreviations and Definitions

A.1 ACRONYMS AND ABBREVIATIONS

Many names, titles, programs, organizations, legislative acts, measurements and activities are abbreviated to reduce the volume of words and to simplify communications. A few of the acronyms, abbreviations and definitions used in the Sevier River Basin Plan are listed below.

A.1.1 State and Local Agencies and Organizations

CEM	Division of Comprehensive Emergency Management
DWQ	Division of Water Quality
MCD	Multi-County Planning District
SDCO	State Disaster Coordinating Office
SHMT	State Hazard Mitigation Team
UWQB	Utah Water Quality Board

A.1.2 Federal Agencies

BLM	Bureau of Land Management
BR	Bureau of Reclamation
COE	Corps of Engineers
EPA	Environmental Protection Agency
FSA	Farm Service Agency
FEMA	Federal Emergency Management Agency
FWS	Fish and Wildlife Service
NRCS	Natural Resources Conservation Service
USDA	United States Department of Agriculture
USGS	Geological Survey

A.1.3 Programs/Acts

ACP	Agricultural Conservation Program
CERCLA	Comprehensive Environmental Response and Comprehensive Liability Act
CFR	Code of Federal Regulations
CRP	Conservation Reserve Program
CUP	Central Utah Project
CWA	Clean Water Act
DWSPR	Drinking Water Source Protection Rule
ESA	Endangered Species Act
ECP	Emergency Conservation Program
NAWQA	National Water Quality Assessment
NFIP	National Flood Insurance Program
NPDES	National Pollution Discharge Elimination System
RPDWS	Rules for Public Drinking Water Systems
SCORP	State Comprehensive Outdoor Recreation Plan
SDWA	Safe Drinking Water Act

UPDES	Utah Pollution Discharge Elimination System
USDWA	Utah Safe Drinking Water Act
UWPCA	Utah Water Pollution Control Act
UWQA	Utah Water Quality Act

A.l.4 Measurements

Ac-Ft	Acre-feet
CFS(cfs)	Cubic feet per second
gpcd	Gallons per capita day
gpm	Gallons per minute
MCL	Maximum contaminant level
mgd	Million gallons per day
mg/l	Milligrams per liter
µmhos/cm	Micromhos per centimeter
µS/cm	Microsiemens per centimeter
mw	Megawatt
PMP	Probable maximum precipitation
SMCL	Secondary maximum contaminant level
TDS	Total dissolved solids
TMDL	Total Maximum Daily Load

A.1.5 Miscellaneous

EAP	Emergency Action Plan
EOP	Emergency Operations Plan
FIRE	Finance, insurance and real estate
M&I	Municipal and industrial
OHV	Off Highway Vehicle
RC&D	Resource Conservation and Development
RMP	Resource Management Plan
TCPU	Transportation, communications and public utilities
WWTP	Wastewater treatment plant

A.2 WATER RESOURCE DEFINITIONS

Many terms used in the water business have different meanings depending on the source, and are sometimes confusing. Some words are used interchangeably. A few commonly used water terms are defined for use in this document.

A.2.1 Water Use Terms

Water is often said to be "used" when it is diverted, withdrawn, depleted, or consumed. But it is also "used" in place for such things as fish and wildlife habitat, recreation and hydropower production.

Commercial Use - Uses normally associated with small business operations which may include drinking water, food preparation, personal sanitation, facility cleaning and maintenance and irrigation of landscapes.

Consumptive Use - Consumption of water for residential, commercial, institutional, industrial, agricultural, power generation and recreational purposes. Naturally occurring vegetation and wildlife also consumptively use water. Water consumed is not available for other uses within the system.

Cropland Irrigation Use - Water used for irrigation of cropland. Residential lawn and garden uses are not included.

Depletion - Net loss of water through consumption, export and other uses to a given area, river system or basin, The terms consumptive use and depletion, often used interchangeably, are not the same.

Diversion/Withdrawal - Water diverted from supply sources such as streams, lakes, reservoirs, springs or wells for a variety of uses including cropland irrigation and residential, commercial, institutional, and industrial purposes. The terms diversion and withdrawal are often used interchangeably.

Industrial Use - Use associated with the manufacturing or assembly of products which may include the same basic uses as commercial business. The volume of water used by industrial businesses, however, can be considerably greater than water use by commercial businesses.

Institutional Use - Uses normally associated with general operation of various public agencies and institutions including drinking water; personal sanitation; facility cleaning and maintenance; and irrigation of parks, cemeteries, playgrounds, recreational areas and other facilities.

Municipal Use - This term is commonly used to include residential, commercial and institutional. It is sometimes used interchangeably with the term "public water use."

Municipal and Industrial (M&I) Use - This term is used to include residential, commercial, institutional and industrial uses.

Private-Domestic Use - Includes water from private wells or springs for use in individual homes, usually in rural areas not accessible to public water supply systems.

Residential Use - Water used for residential cooking; drinking; washing clothes; miscellaneous cleaning; personal grooming and sanitation; irrigation of lawns, gardens, and landscapes; and washing automobiles, driveways, and other outside facilities.

A.2.2 Water Supply Terms

Water is supplied by a variety of systems for many uses. Most water supply systems are owned by an irrigation company or a municipality, but in some cases the owner/operator is a private company, or is a state or federal agency. Thus, a "public" water supply may be either publicly or privately owned. Also, systems may supply treated or untreated water.

Culinary Water Supply - Water meeting all applicable safe drinking water requirements for residential, commercial and institutional uses. This is also known as potable water.

Municipal and Industrial (M&I) Water Supply - A supply that provides culinary/secondary water for residential, commercial, institutional and industrial uses.

Public Water Supply - Includes culinary water supplied by either privately or publicly owned community systems which serve at least 15 service connections or 25 individuals at least 60 days per year. Water from public supplies may be used for residential, commercial, institutional, and industrial purposes, including irrigation of publicly and privately owned open areas.

Secondary / Non-Potable Water Supply - Pressurized or open ditch water supplies of untreated water for irrigation of privately or publicly owned lawns, gardens, parks, cemeteries, golf courses and other open areas. These are sometimes called "dual" water systems.

A.2.3 Groundwater Terms

Aquifer - A saturated body of rock or soil which will yield water to wells or springs

Groundwater - Water which is contained in the saturated portions of soil or rock beneath the land surface. Excludes soil moisture which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

Mining; - Long-term groundwater withdrawal in excess of recharge.

Phreatophvte - A plant species which extends its roots to the saturated zone under shallow water table conditions and transpires groundwater. These plants are high water users and include such species as tamarisk, greasewood, willows, and cattails.

Recharge - Water added to the groundwater reservoir or the process of adding water to the groundwater reservoir.

Recoverable Reserves - The amount of water which could be reasonably recovered from the groundwater reservoir with existing technology.

Safe Yield - The amount of water which can be withdrawn from an aquifer on a long-term basis without serious quality, environmental or social consequences, or seriously depleting the reservoir.

Total Water in Storage - A volume of water derived by estimating the total volume of saturated aquifer and multiplying by the porosity (intergranular space containing water).

A.2.4 Other Water Terms

Some water terms are peculiar to the water industry.

Call - The ability to order a quantity or flow of water at a given time and for a given period of time.

Carriage Water - Water needed for hydraulic operation of a delivery system.

Drinking Water - Water used as a potable/culinary supply.

Export Water - A water diverted from a river system or basin other than by the natural outflow of streams, rivers and groundwater. The means by which is exported is sometimes called a transbasin diversion.

Instream Flow - Water flow maintained in a stream for the preservation and propagation of wildlife or aquatic habitat and for aesthetic values.

Non-Point Source Pollution - Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients etc., carried to lakes and streams by surface runoff.

Point Source Pollution - Pollutants discharged from any identifiable point, including pipes, ditches, channels and containers.

Potable/Culinary - Water suitable for drinking or cooking purposes. The terms culinary and potable are often used interchangeably.

Reuse - The reclamation of water diverted from a municipal or industrial wastewater conveyance system.

Riparian Areas - Land areas adjacent to rivers, streams, springs, bogs, lakes and ponds. They are ecosystems composed of plant and animal species highly dependent on water.

Watershed - The total area of land above a given point on a waterway that contributes runoff water to the flow at that point; a drainage basin or a major subdivision of a drainage basin.

Water Yield - The runoff from precipitation that reaches water courses and therefore may be available for human use.

Wetlands - Areas where vegetation is associated with open water and wet and/or high water table conditions.

Wet/Open Water Areas - Includes lakes, ponds, reservoirs, streams, mudflats and other wet areas.

A.3 OTHER DEFINITIONS

Argillic horizon - A horizon below the surface layer in which silicate clays have accumulated.

Aquic conditions - Soils that have a continuous or sufficient period time of water saturation for reducing conditions or lack of oxygen to be present.

Calcis horizon - A horizon in which secondary calcium carbonates or other carbonates have accumulated.

Mollic epipedon - A thick dark mineral surface layer having more than 50 percent base saturation, and an organi carbon content of 0.6 percent or more.

Water quality - Water qualtiy data was taken from reports and other material prepared by various agencies over different periods of time. For this reason, water quality measurements were made in different units. It has been decided to report the data in milligrams per liter with the units used during the original studies following in parentheses.

The salinity concentration of dissolved solids is given in milligrams per liter (mg/L), a unit expressing the weight per unit volume. A mg/L is equivalent to parts per million (ppm). Specific conductance is often measured in lieu of concentration of dissolved solids as it is more economical and can be done in the field. Specific conductance is a measure of the ability of the water to conduct electricity, which is a function of the dissolved solids. Specific conductance is given in micromhos per centimeter (µmhos/cm). Specific conductance is also reported in microsiemens per centimeter (µS/cm). A µmhos/cm is equal to a µS/cm. For concentrations of 100 to 5,000 µmhos/cm, specific conductance can be converted to dissolved solids by the equation: mg/L = 0.59 µmhos/cm. In all cases, the lower the number, the better the water quality.

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