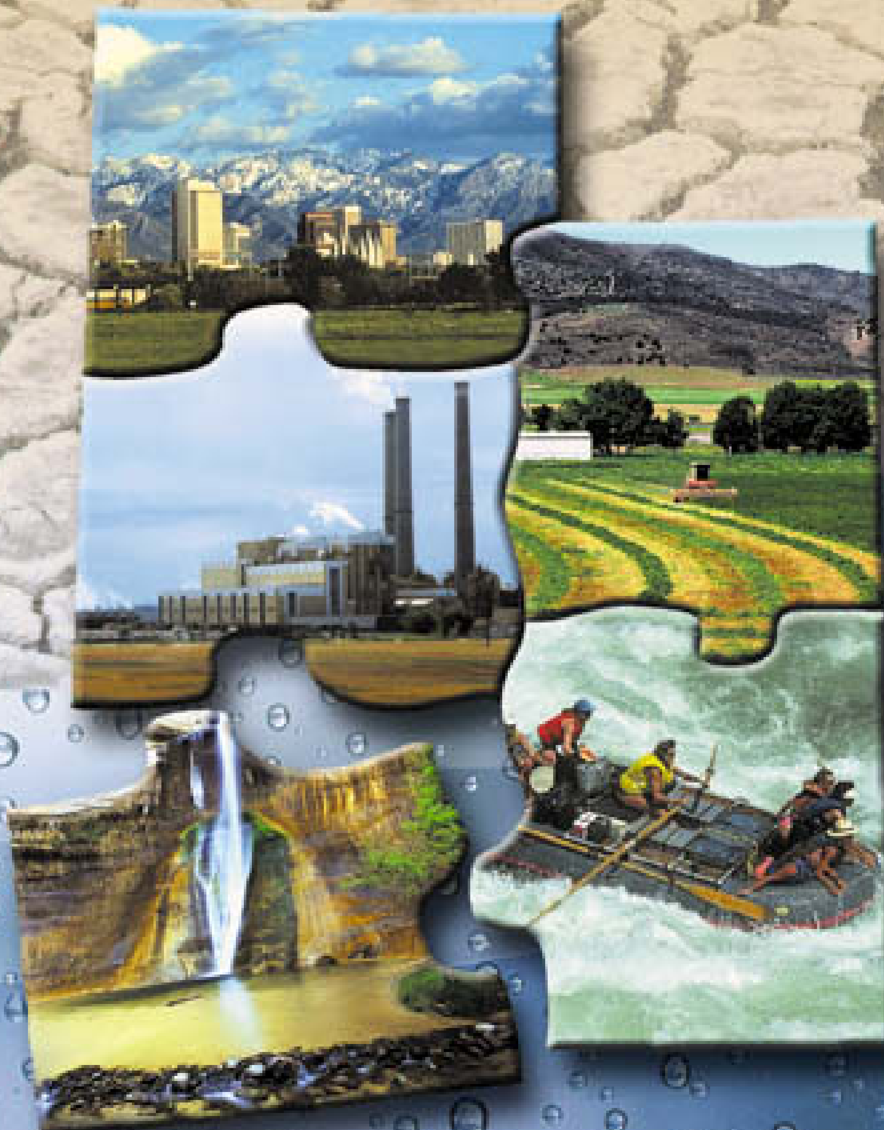
Utah's Water Resources
Planning for the Future

May, 2001

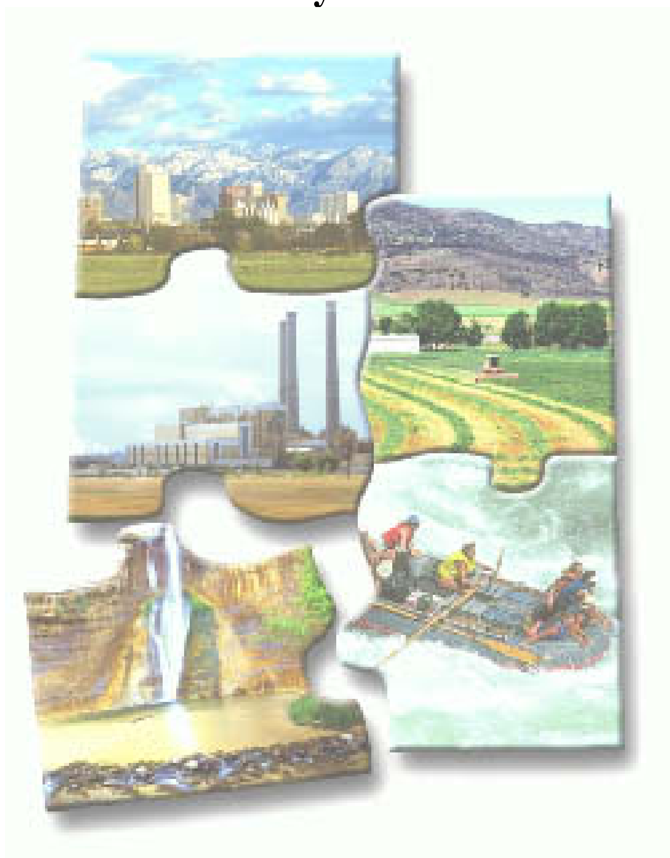


STATE OF UTAH
NATURAL RESOURCES
Division of Water Resources

UTAH STATE WATER PLAN

UTAH'S WATER RESOURCES
PLANNING FOR THE FUTURE

May 2001



Prepared for:
The people of Utah
Under the direction of the Board of Water Resources

By:
The Division of Water Resources

With valuable input from the
State Water Plan Coordinating Committee:

Department of Natural Resources, Division of Water Rights, Division of Parks and Recreation, Division of Wildlife Resources, Department of Environmental Quality, Division of Drinking Water, Division of Water Quality, Department of Agriculture and Food, Governor's Office of Planning and Budget, Division of Comprehensive Emergency Management, Utah Water Research Laboratory

UTAH STATE WATER PLAN

This document is also available online at: www.nr.state.ut.us/wtrresc/waterplan/.

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PREFACE

One of the major responsibilities of the Utah Division of Water Resources is comprehensive water planning. Over the past decade and a half, the division has prepared a series of documents under the title "Utah State Water Plan." This included a statewide water plan and an individual water plan for each of the state's eleven major hydrologic river basins. The preparation of these plans involved several major data collection programs as well as extensive inter-agency and public outreach efforts. Much was learned through this process; state, local, and federal water planners and managers obtained valuable information for use in their programs and activities, and the public received the opportunity to provide meaningful input in improving the state's water resources stewardship.

This document is the latest in the "Utah State Water Plan" series and is intended to guide and direct Utah's water-related planning and management into the next century. It summarizes key data obtained through the previous water planning documents, introduces new data where available, and addresses issues of importance to all future water planning efforts. Where possible, it identifies water use trends and makes projections of water use. The document also explores various means of meeting future water demands and identifies important issues that need to be considered when making water-related decisions. Water managers and planners will find the data, insights and direction provided by this document valuable in their efforts. The general public will discover many useful facts and information helpful in understanding Utah's water resources. Both audiences should appreciate the real-life, Utah examples highlighted in sidebars and photographs. Although the use of technical words is avoided wherever possible, an extensive glossary illuminates exact usage of terminology that may be unfamiliar.

In addition to the printed form of this document, the Utah Division of Water Resources has made an interactive version available on the Internet. This can be accessed through the Utah State Water Plan home page at: www.nr.state.ut.us/wtrresc/waterplan/. This web page allows the document and other water planning documents to be viewed by the largest audience possible, thus facilitating better planning and management at the state and local level. It also provides a convenient mode for readers to provide comment and feedback to the division regarding its water planning efforts.

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EXECUTIVE SUMMARY

Utah's water resources play an integral role in the life of every Utahn. From a morning shower to a weekend trip down the Colorado River, water is interwoven into nearly every activity. Use of Utah's water resources has allowed the rugged landscape to be settled, has provided Utahns with numerous employment and recreational opportunities, and has made possible a high quality of life. The far-reaching vision of Utah's leaders, coupled with modern engineering technology, has allowed Utah's water supply to be harnessed and used on a large scale. Water has been made so readily available, in fact, that its relative scarcity in Utah's semi-arid climate is often overlooked. This reality must be fully recognized and appropriate decisions made in order to provide sufficient water for Utah's future population.

Utah's Water Resources: Planning for the Future emphasizes the importance of careful planning and wise management in meeting future needs. It estimates Utah's available water supply, makes projections of water need, explores how these needs will most efficiently be met, and discusses other important values, including water quality and the environment. This document will be a useful guide and reference to local water planners and managers as they strive to meet the many water challenges facing Utah. It will also be of help to those in the general public who are interested in making greater contributions to water-related decisions being made by local, state and federal government officials.

The following paragraphs summarize the main points of each chapter:

CHAPTER 1
INTRODUCTION: WATER RESOURCES IN UTAH

Utah's diverse and striking landscapes and its rich cultural history owe their existence to the presence of water resources. Water is the medium that shaped many of Utah's unique natural features. It is the ingredient that caused its communities to blossom in the desert. Utah's natural beauty and the strength of its communities have combined to form a desirable quality of life for its residents. These conditions have contributed to Utah's rapid growth in the past and they will likely continue to do so in the future.

In order to meet future needs brought about by growth, Utah must promote effective water conservation and water management technologies. This, along with carefully planned water developments, will secure sufficient water for the future.

Utah's institutional structure is well prepared for the challenges at hand. Through careful coordination and cooperation, Utah's water needs will be provided for and the integrity and beauty of the environment will be preserved.

The vision of Utah's leaders has provided sufficient water for present needs. Continued vision and careful planning will assure these needs are met for future generations. (Photo of downtown Salt Lake City from City Creek Canyon.)

CHAPTER 2
WATER SUPPLY

Except for its neighbor to the west, Nevada, Utah receives less annual average precipitation (13 inches) than any of the 50 states. The average precipitation in the United States is close to 30 inches, more than double that of Utah. If not for its mountains, which capture moisture from passing storm systems and release it throughout the year, Utah would be one vast desert.

While most of Utah's available water supply (7.3 million acre-feet per year) is already used, the Division of Water Resources estimates that 790,000 acre-feet per year can yet be developed based on current legal, political, economic and environmental constraints. Much of this developable water supply (420,000 acre-feet per year) is located in the Colorado River drainage, away from the large population centers along the Wasatch Front. The Bear River drainage, with approximately 250,000 acre-feet per year of developable water available to Utah, represents the most significant source of water available to these areas.

CHAPTER 3 POPULATION AND WATER USE TRENDS AND PROJECTIONS

Good employment opportunities, a pleasant climate, beautiful scenery, and a broad range of other opportunities will continue to drive growth and prosperity in Utah. By 2050, Utah's population is expected to more than double to about five million. Assuming that current per capita use rates remain steady, this population growth will increase municipal and industrial (M&I) water diversions from current levels of about 900,000 acre-feet per year to over 1.9 million acre-feet per year.

Despite the rapid growth in urban water demands, agricultural irrigation will continue to be the primary use of Utah's developed water supply. These diversions will slowly decline from current levels near 4.6 million acre-feet per year to about 4.2 million acre-feet per year as growth in the M&I sector displaces traditional agricultural uses.

In addition to the changes in agricultural and M&I water demands, environmental and recreational uses of Utah's water will continue to play important roles in the future. Pressure to use water to sustain important environmental values and recreational purposes will increase.

CHAPTER 4 WATER CONSERVATION

Implementing effective water conservation measures and programs is critical to satisfying Utah's future water needs. The state recognizes the importance of water conservation and has implemented requirements for water retailers and conservancy districts with more than 500 connections to prepare water conservation plans and submit them to the Division of Water Resources with updates every five years. This requirement covers a total of 150 utilities serving approximately 93 percent of Utah's population. As of May 2001, 99 water suppliers and conservancy districts had complied with the legislation and submitted a plan to the Division of Water Resources.

The Division of Water Resources has also set an M&I water conservation goal to reduce the per capita demand on public water supplies 25 percent by the year 2050. This equates to an annual volume of about 400,000 acre-feet. This goal will be achieved as water suppliers implement various conservation measures and programs that have proved effective. Among these are incentive pricing, outdoor watering and landscape guidelines and ordinances, water audits, meter installation on all water connections, rebates and other incentive programs, and leak detection and repair programs. In addition to these measures, a strong water conservation education program is key to long-term success.

Much of Utah's public water supply is used to irrigate residential landscapes. Conservation measures such as incentive pricing can be effective at reducing water consumption.

CHAPTER 5 WATER TRANSFERS AND EFFICIENT MANAGEMENT OF DEVELOPED SUPPLIES

As competition for limited water supplies increases, the value of those supplies also increases. This economic incentive can lead to the outright transfer of water from one use to another, or it can encourage other water management strategies to be employed that maximize the benefits provided by existing uses. Major sections within this chapter are as follows:

- <u>Agricultural Water Transfers</u>: converting agricultural water to M&I uses as the associated land changes from agricultural to urban.
- <u>Agricultural Water-use Efficiency</u>: implementing improved operating practices and irrigation technology to improve water use efficiency.
- <u>Conjunctive Use</u>: using surface and ground water

supplies together instead of separately to optimize beneficial use.

- <u>Aquifer Storage and Recovery</u>: storing excess surface water in ground water reservoirs and retrieving it later.
- <u>Secondary Water Systems</u>: piping untreated water separately for use on outdoor landscapes, thereby preserving treated water for potable purposes.
- <u>Cooperative Water Operating Agreements</u>: contractual agreements between water suppliers to better meet needs within each system, often using facilities and resources jointly to meet peak or emergency demands.
- <u>Water Reuse</u>: recycling effluent from wastewater treatment facilities.

Chapter 6
Water Development

Water developments will continue to play an important role in meeting Utah's future water needs. These developments will be based on sound engineering, economic and environmental principles.

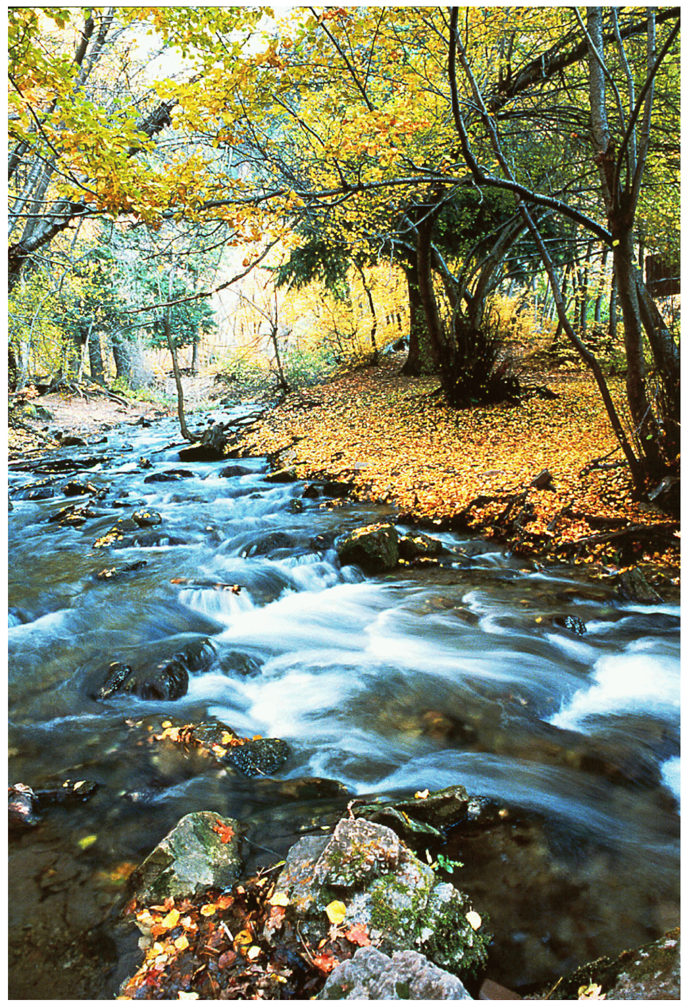
The completed Central Utah Project will help meet the needs of the Wasatch Front. The Bear River Project and Lake Powell Pipeline, currently in the feasibility stages, are two major projects that are being investigated to help meet the M&I needs of the Wasatch Front, and Washington and Kane counties, respectively. Numerous smaller projects will also be needed to satisfy the demands of growth in other areas.

One option that has long been recognized as a means of enhancing the water supply is a form of weather modification known as cloud seeding. Areas in Utah that actively practice cloud seeding have realized a 7-20 percent increase in April 1 snow water content, and a combined total increase in runoff of approximately 13 percent. The estimated cost of water developed in these areas by cloud seeding is about one dollar per acre-foot.

In addition to new projects and weather modification, much of the existing infrastructure is old and not of sufficient capacity to meet projected needs. These systems will need to be upgraded and expanded as necessary. Water-related funding should keep pace with these needs so systems can operate efficiently and provide necessary safety to customers.

Chapter 7
Water Quality, the Environment and Other Considerations

Effectively meeting Utah's water needs involves more than providing adequate water supplies and delivery systems. Values such as water quality and the environment must also be carefully considered. Water managers and planners need to implement policies and strategies that address these sensitive and often controversial subjects. This includes educating the public and seeking their input in the decision-making process. Effectively addressing these and other topics will allow Utah's population to grow without unnecessarily degrading our natural resources.



Water quality and environmental values will continue to play important roles in water resource decisions. Addressing these topics effectively will allow Utah's population to grow and the many benefits provided by precious water resources to be sustained. (Photo of Mill Creek in Salt Lake County courtesy of the Utah Travel Council and Frank Jensen.)

Water quality topics that are of particular concern include: implementing the Environmental Protection Agency's new Total Maximum Daily Load (TMDL) rules; maintaining the integrity of riparian and flood plain corridors amidst increasing development pressure; regulating storm water discharges within urban areas; analyzing and controlling the effects of nutrient loading on Utah's rivers and water bodies; managing animal feedlot operations; and dealing with high septic tank density problems.

Environmental topics include: protecting and restoring endangered species to sustainable populations; preserving wetlands from loss or degradation; maintaining instream flows for fish and wildlife, recreational and other purposes; and analyzing the impacts of wilderness and wild and scenic river designation on the ability to access and use certain water resources.

Other considerations that are briefly discussed in this chapter include land management and water yield, reserved water rights, and the Colorado River. Careful consideration of these and other issues at the local level will help assure the success of local projects.

CHAPTER 8
CONCLUSION: PUTTING THE PIECES TOGETHER

The responsibility for making many decisions regarding water resources resides with local leaders. These leaders can improve this decision-making process by educating the public and seeking their participation in water-related discussions. The role of government agencies is important in helping local leaders meet the many challenges they face as they try to satisfy the needs of the growing population within their communities. Government agencies can provide valuable technical, financial and other types of assistance which are not always possible at the local level. These agencies should be involved in the early stages of local water projects to avoid conflicts and setbacks that could have otherwise been avoided.

The future of Utah and its precious water resources is bright. Through cooperation with state, federal and local interests, local leaders will be able to meet the growing water needs within their communities while preserving the quality and integrity of their natural surroundings.

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INTRODUCTION: WATER RESOURCES IN UTAH

A Vision of Utah's Water Future: Supporting Growth and Preserving Our Environment and Culture

The future of Utah's water resources is bright. Through cooperation, conservation and good management, the high quality of life that past water supplies have provided Utah's citizens will be maintained for generations to come. This will require a major conservation effort, a shift in water-use patterns, as well as continued investments in infrastructure and water developments.

The greatest increase in future water demands will be the result of population growth. These water needs will occur primarily in the municipal and industrial sector, of which residential use is a significant component. Although these urban water demands will drive many future water decisions, Utah need not forsake its rural heritage to satisfy these needs. The conversion of agricultural water supplies to municipal and industrial uses as farm land is urbanized will occur to satisfy some future water needs, particularly along the Wasatch Front. However, because these conversions will not always be sufficient to satisfy future demands, other means of securing adequate water supplies are necessary.

The greatest increase in future water demands will be the result of population growth in Utah's urban centers. (Photo of Salt Lake City courtesy of Utah Travel Council and Frank Jensen)

In order to meet all demands on Utah's water resources, a cooperative effort is needed to better use existing water supplies. Utah must promote water conservation measures and innovative water management technologies. Although this effort will forestall the need for costly new water developments, these measures alone will not satisfy all of Utah's future needs. Therefore, new water development will be needed. The timing and size of this development will depend on the ability of water conservation and other water-saving strategies to reduce water demand.

In order to meet future needs, Utah must promote water conservation and water management technologies. This, along with carefully planned water developments, will secure sufficient water for the future.

In addition to securing adequate water for the future, water planners and managers need to expand their planning and management efforts to effectively address water quality, environmental and other values. Water agencies and institutions must fully integrate strategies and policies into their operations to address these issues. An important aspect of this endeavor will be to coordinate federal and state water resources efforts with localized needs. Proper coordination will allow solutions to be tailored to local conditions and help maintain a constructive and open dialog among all water resources stakeholders.

Purpose of this Document

The purpose of *Utah's Water Resources: Planning for the Future* is to describe the current status of Utah's water resources and evaluate the demands that will be placed upon them in the future. This involves quantifying available water supply, estimating current and future uses, and identifying ways to obtain new water supplies and manage existing supplies to satisfy future needs. This plan presents the state's position on water development, water conservation, environmental issues affecting water resources and water quality. A main goal of this document is to help water managers, planners, legislators and other parties formulate the management strategies and policies needed to direct their efforts into the new century. This document should also be a valuable resource for those in the general public interested in contributing to water-related decisions at all levels of government.

The Significance of Water Resources to Utah

Utah's diverse and striking landscapes were created by numerous geologic forces. The forces of water, in particular, carved much of its natural beauty. Glaciers, prehistoric lakes, rain, rivers and streams have all contributed to the formation of the dramatic landscapes we call Utah. Today, water resources continue to shape and sustain Utah's environment. The natural interaction between water and land is central to many ecosystems. Lakes, rivers, streams and associated wetlands are literally the life blood of Utah's environment.

Native inhabitants of Utah depended upon water resources and associated habitat and wildlife to sustain their way of life. Some of these American Indians even dammed and diverted water for small-scale irrigation. Later, with the arrival of white settlers, Utah's water resources were increasingly utilized. The arid climate and rugged terrain were new to these settlers. Not only was harnessing the available water resources essential for the growth of life sustaining crops, but it was necessary to grow the attractive trees and decorative plants they desired in their immediate surroundings. To them, making the desert "blossom as the rose" represented an ideology, a literal fulfillment of prophecy. The success of these determined pioneers at irrigating and settling the West helped form the foundations upon which the government's future reclamation and settlement policies were formed.

The quality of life that Utah's citizens now enjoy is in large part due to the community efforts and perseverance of these early settlers and the insightful planning of the generations that followed. A well-established infrastructure, coupled with the diversity and ease of access to its natural wonders, makes Utah a particularly desirable place to live. These conditions have contributed to Utah's rapid growth in the past and will continue to do so in the future. As a result of this growth, the strains placed upon Utah's water resources will continue to intensify.

Water resources are an integral part of Utah's many striking landscapes. The close proximity of Utah's communities to this diversity is one of the key reasons for Utah's rapid growth. (Photos courtesy of Tom Till. Photo on the left, "The Subway," Zion N.P.; top, Gunnison Butte and Christmas Meadows; and bottom, LaSal Mountains and Lake Powell.)

STATE WATER PLANNING: FULFILLING A STEWARDSHIP

Accommodating Utah's growing water needs and preserving its unique environment and culture presents an important challenge to Utah's leaders. Successfully fulfilling this stewardship is critical to Utah's future prosperity and welfare. Utah's long history of water management and planning activities, as well as its institutional structure, will enable state and local leaders to effectively meet this challenge.

Utah's Water Planning History

Organized water resources management and planning activities have a longer history in Utah than in most other western states. Beginning in 1847 with the settlement of the Salt Lake Valley, groups were sent out by Brigham Young, president of The Church of Jesus Christ of Latter-day Saints, to settle what would later become the state of Utah and the surrounding region. Because of the harshness of the terrain and climate, the success of these communities relied heavily on reliable water sources. Before settlement of any area occurred, an advance company was typically sent to survey the land and identify potential water supplies. Once a promising site was located, a group of settlers was organized and leaders appointed. These leaders organized water development crews and oversaw water appropriations for the benefit of the entire community.

Gradually, government entities assumed a larger role in water resources management and planning. Today, Utah has an established legal and institutional structure to guide the comprehensive planning and management of its water resources (see sidebar).

In the early 1960s, the state began to focus more attention on preparing a statewide water plan to guide Utah's water resources development through the end of the century. In 1963, the Utah Water and Power Board along with Utah State University published a document entitled, "Developing a State Water Plan: Utah's Water Resources–Problems and Needs–a Challenge." This document initiated a statewide reconnaissance of Utah's water resources and provided a significant building block for future state water planning. With the creation of the Board of Water Resources and Division of Water Resources in 1967, Utah's dedication to comprehensive water planning was again emphasized.

Utah Government's Role in Water Resources

The following list chronicles the gradual evolution of the state's role in water resources planning and management since statehood.

1897	The Office of the State Engineer (later renamed the Division of Water Rights) was established to oversee water appropriations.
1903	The Water Code became part of Utah law and the doctrines of "Prior-Appropriation" and "Beneficial Use" were officially adopted.
1921	The Utah Water Storage Commission was created to oversee important water developments and obtain the necessary water rights.
1935	Ground water was added to the state water code.
1947	The Utah Water and Power Board was created to continue the mission of the Utah Water Storage Commission, which was discontinued in 1941.
1953	The Bureau of Water Pollution Control was created.
1963	Specific legislation was passed directing the Water and Power Board to develop a state water plan.
1967	The Water and Power Board was renamed the Board of Water Resources, and the Division of Water Resources was created.
1979	The Bureau of Drinking Water and Sanitation was created.
1991	The Department of Environmental Quality was created. As part of this department, the Division of Drinking Water and the Division of Water Quality were formed, replacing the Bureau of Drinking Water and Sanitation and the Bureau of Water Pollution Control.

Between 1972 and 1985, the Division of Water Resources continued its comprehensive water planning effort and published a series of documents entitled, "The State of Utah Water."[1] These reports provided refined water supply and use estimates. They also explored a wide range of possible uses of Utah's remaining unused water supplies including the potential to redistribute water resources through large scale interbasin transfers and the development of water resources for mineral extraction.

The 1990 State Water Plan and Subsequent River Basin Plans

A landmark publication that resulted from state water planning efforts was the 1990 *Utah State Water Plan*. This document was a comprehensive water plan and resource inventory for the state and provided a basis for more detailed planning at the hydrologic river basin level. Subsequent plans for each of the state's basin plan areas, shown in Figure 1, have been completed.[2] These river basin plans inventory basin water supplies, provide present and future water use information, and address problems and issues facing local water resources stakeholders. These plans are being used by local and statewide planners to make informed water resources decisions.

The Current Plan

As part of the state water planning effort that produced the 1990 *Utah State Water Plan*, a list of guiding principles was created. Since that time, these principles have been updated and revised to reflect the changing needs of state water planning. The following guiding principles were used to develop this document:

- All waters, whether surface or subsurface, are held in trust by the state as public property and their use is subject to rights administered by the State Engineer.
- Water rights owners are entitled to transfer their rights under free market conditions. Any change in place or nature of use is subject to approval by the State Engineer.
- The state of Utah's role is to set policy, provide assistance and protect statewide water resource interests.
- The responsibility for making many local decisions regarding water resources resides with local leaders.
- Educating the public on water resources issues and seeking their input in the decision-making process is vital to effective planning, management and development.
- Long-term water planning will help ensure sufficient water supplies when and where needed for Utah's growing population.
- Local, state and federal water resources planning and management activities should be coordinated to effect cooperation and minimize duplication.
- The maintenance of water quality within the state's water quality standards will help sustain all present and future uses of Utah's water resources.

FIGURE 1
Basin Plan Areas and Hydrologic River Basins

*See note (3) at end of chapter.

- Water conservation and efficient management of existing water supplies are needed to help satisfy future water demands in the most economical and timely fashion.
- Water development, based on sound engineering, economic and environmental principles, will help meet future water needs.
- Recreation, aesthetic and environmental uses of water should be included in water planning, management and development activities.

Water development will be needed to meet future demands. This development will be based on sound engineering, economic and environmental principles. (Photo of Adams Reservoir reconstruction near Kaysville.)

This document is Utah's guide for the stewardship of its water resources. The state recognizes the urgent need to implement effective water conservation measures. These, coupled with other innovative water management technologies, must be implemented to safeguard the ability of existing water supplies and new developments to meet future needs and lessen impacts of drought. The state will continue to develop water supplies, as necessary, to meet projected water needs.

Water quality, environmental and other values need to be properly addressed in order to make good water-related decisions.

In order to make good water development and management decisions, water quality, environmental and other values need to be properly addressed. The state must assume a leading role in handling these unique challenges and assist local stakeholders in formulating working solutions that are in compliance with state and federal laws. Coordination and cooperation between local, state and federal stakeholders, on these and other issues, will help meet the water needs of Utah's citizens in an efficient and timely manner.

NOTES

[1]There are six documents referred to by this note that were prepared by the Division of Water Resources, these are: *The State of Utah Water* (1972), *The State of Utah Water (1975), The State of Utah Water (1978), State of Utah Water (1980), State of Utah Water* (1982), *State of Utah Water (1985)*, (Salt Lake City: Department of Natural Resources).

[2]The 11 river basin plans prepared by the Division of Water Resources are: *Bear River Basin* (1992), *Kanab Creek/Virgin River Basin* (1993), *Cedar/Beaver Basin* (1995), *Weber River Basin* (1997), *Jordan River Basin* (1997), *Utah Lake Basin* (1997), *Sevier River Basin* (1999), *Uintah Basin* (1999), *West Colorado River Basin* (2000), *Southeast Colorado River Basin* (2000), & *West Desert Basin* (2001), (Salt Lake City: Department of Natural Resources). A full-text version of each report is available over the Internet at the division's website: www.nr.state.ut.us/wtrresc/planning/swp/ex _swp.htm.

[3]In order to consolidate the discussion of Lake Powell and avoid mixing political subdivisions on either side of the Green and Colorado rivers, the West Colorado and Southeast Colorado river basin plans were written based on a non-hydrologic boundary. The Division of Water Resources continues to collect and report data based on hydrologic boundaries, to which all numbers in this document conform.

2

WATER SUPPLY

Utah receives an average of 13 inches of precipitation annually. With the exception of its neighbor to the west, Nevada, this is the lowest annual precipitation received by any of the 50 states (see Figure 2). Due to other climatological factors, only a small portion of this precipitation makes its way into Utah's waterways and aquifers. The result is a water supply that is limited. In addition these climatological factors vary significantly from year to year resulting in a water supply that is not only limited, but also unpredictable.

> **Except for its neighbor to the west, Nevada, Utah receives less annual average precipitation than any of the 50 states.**

This chapter discusses how climate influences Utah's water supply and expresses the available water supply in terms of long-term averages. The portion of this supply that is still available for development is then estimated. Finally, the chapter concludes with a brief discussion of drought and flooding to put in perspective the constant variability of the water supply.

CLIMATOLOGICAL INFLUENCES

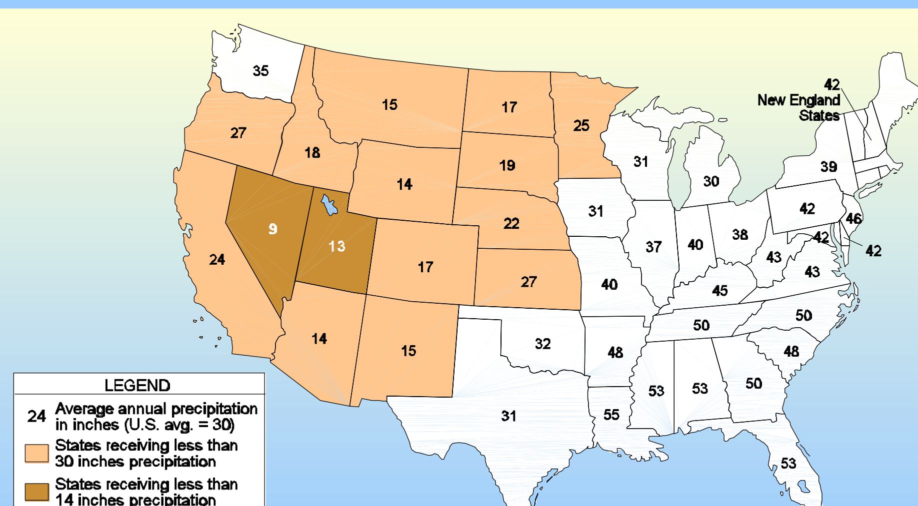
Utah's overall climate is classified as semiarid. This means that in much of the state, the little precipitation that does fall simply returns to the atmosphere through evaporation. Although this classification is convenient, one need not look farther than Utah's pristine mountain tops and rugged desert canyons to realize the state is really a combination of several very different microclimates. Atop many of Utah's mountain ranges, the cool summer air and lush meadows stand in striking contrast with the dry desert heat and desert vegetation of the valley bottoms. Many such variations occur over just a few miles, further emphasizing the climatic diversity.

Although differences in latitude play a part in the diversity of Utah's smaller microclimates, the determining factor is elevation. Precipitation and temperature vary almost in proportion to changes in elevation. Precipitation rises with increases in elevation from a low of about five inches in the lowlands to more than 60 inches on some peaks (see Figure 3). Temperature is similarly governed by elevation, with a typical 3 degrees Fahrenheit decrease for every 1,000 foot rise.[1]

Precipitation

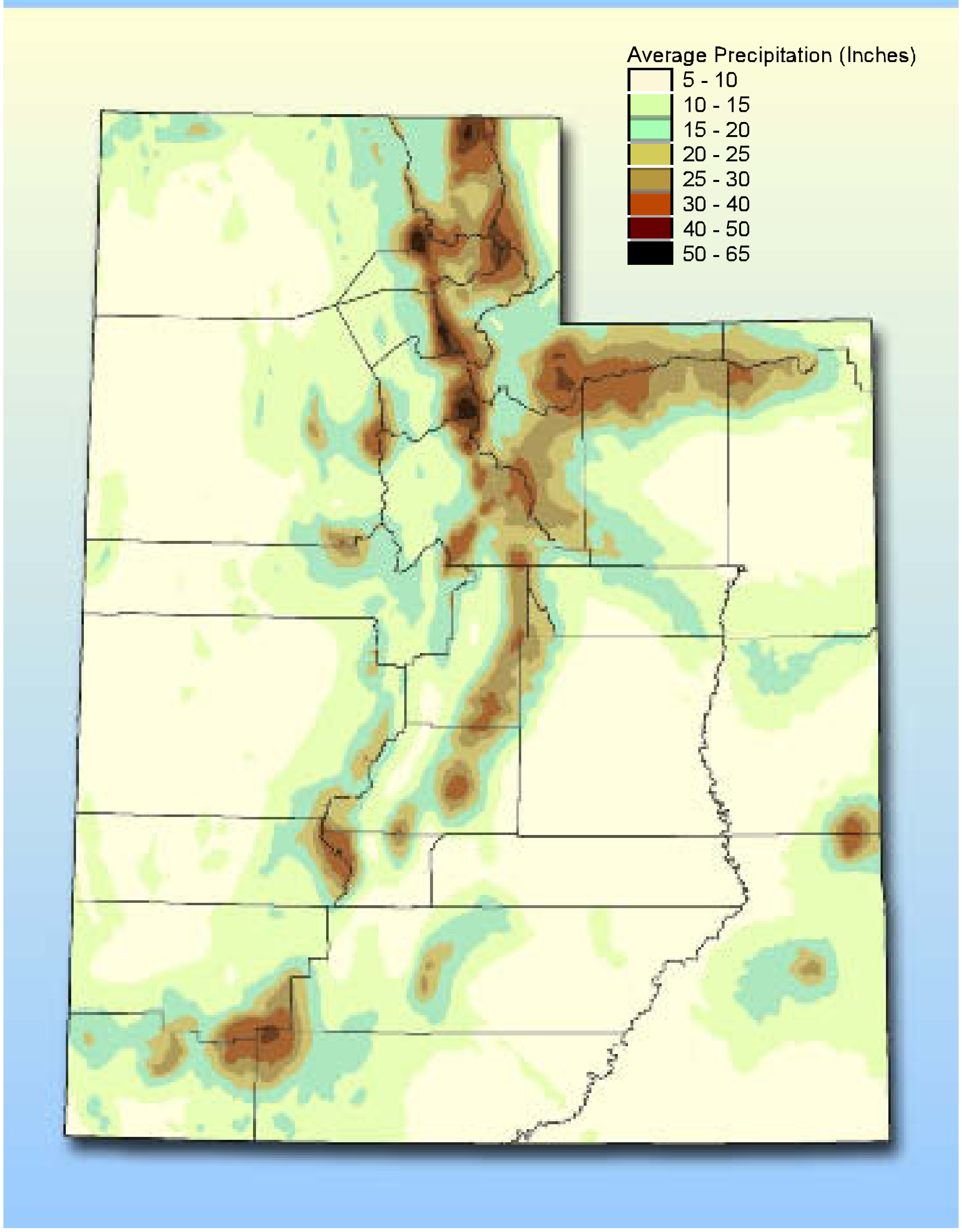
Most of the precipitation falls on the mountainous regions as snow. This snow is extremely important to Utah's water supply because it functions as a storage reservoir, releasing the water into streams and aquifers as temperatures rise. Depending on surface conditions of the soil and the rate of melting, the precipitation that is not evaporated or transpired through vegetation flows

FIGURE 2
Average Annual Precipitation in the United States



(Source: U.S. Weather Bureau, 1961-1990 period of record) directly into streams or it seeps into the soil. While the portion of the precipitation that makes its way to surface waterways moves very quickly, the portion that percolates into the ground moves much more slowly. Topography, soil characteristics, geologic configurations and other factors affect the path and movement of this ground water. At some lower elevation, it may come to the surface as a natural spring or seep, discharge into a lake or river, or become part of the aquifer storage in the lower valleys.

FIGURE 3
Average Annual Precipitation in Utah



Although precipitation varies significantly from region to region throughout the state, it averages about 13 inches or 61.5 million acre-feet per year (an acre-foot is enough to cover an acre of land with one foot of water, or to satisfy the needs of a family of four for one year). Table 1 lists the average annual precipitation values for each of the state's 11 hydrologic river basins. As shown, the Weber River Basin receives the highest amount of precipitation, about 26 inches per year. The West Desert and West Colorado River basins receive the least, about 10 inches per year. It comes as no surprise that the majority of the state's population (about 89 percent) is located in the five basins receiving the most precipitation.

Evaporation and Transpiration

Precipitation is the process that moves water from the atmosphere to the surface of the earth. Evaporation returns some of this water to the atmosphere through vaporization directly from the surface of the Earth; transpiration returns water to the atmosphere through skin and plant tissue. The rates at which evaporation and transpiration occur are highly dependent upon climatological factors such as temperature, humidity and wind.

Approximately 87 percent, or 53.8 million acre-feet, of the precipitation falling on Utah each year is removed by the natural environment through evaporation and transpiration before it reaches a stream or aquifer where it can be used. An additional 7 percent, or 4.0 million acre-feet per year, is removed by the environment through evaporation from open water bodies or transpiration from riparian and wetland vegetation after it reaches areas where it can be used. Three-fourths of this, or 3.0 million acre-feet per year, evaporates from the Great Salt Lake.

Not only do climatic conditions influence the amount of water Utah receives, but they also determine the amount of this water that is consumed. In most of the non-mountainous areas of the state, the potential for evaporation and transpiration far exceed normal precipitation. If not for Utah's many mountains, which cool the air and capture water from passing storm systems, Utah would basically be one vast desert.

TABLE 1
Average Annual Precipitation by Basin

Basin	Avg. Precipitation (inches/yr)*
Weber River	26
Jordan River	23
Bear River	22
Utah Lake	22
Kanab Creek/Virgin River	17
Uintah	15
Sevier River	14
Cedar/Beaver	13
Southeast Colorado River	11
West Colorado River	10
West Desert	10
STATE AVERAGE†	**13**

* Values based on the 1961-1990 period of record.
† Average is calculated by weighted land areas.

Average Annual Water Supply

Surface Water

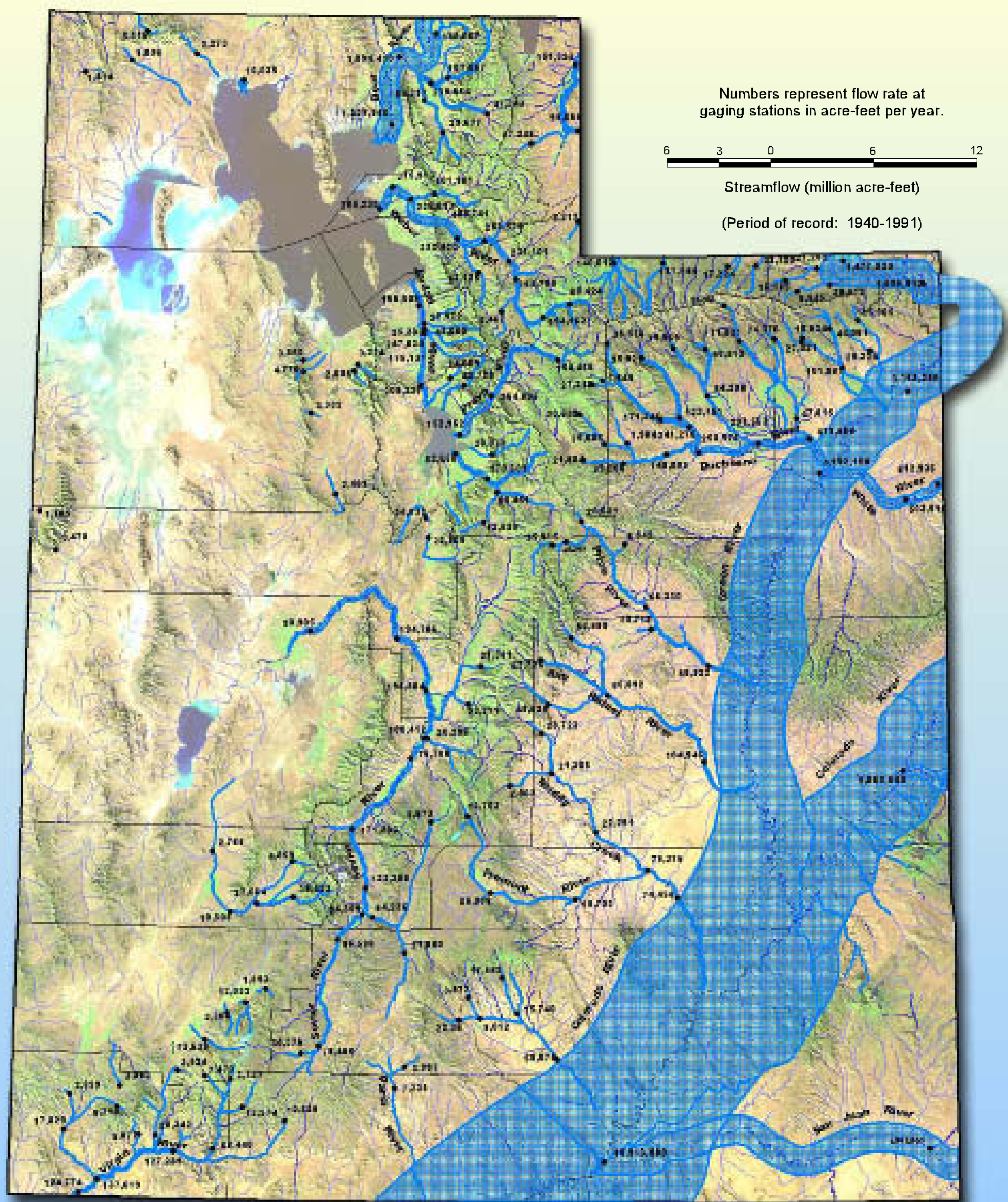
The portion of precipitation not initially evaporated or transpired by vegetation eventually makes its way into streams and other surface water-bodies, or percolates into the ground water. Surface water can be quantified

Due to little precipitation, vegetation is sparse in vast portions of Utah. (Photo of Colorado Plateau near Canyonlands National Park courtesy of Patrick Cone.)

at gaging stations on stream segments. The U.S. Geological Survey, in cooperation with other federal and state entities, monitors an extensive network of gaging stations throughout the country and takes measurements on many of Utah's important streams and rivers. Figure 4 shows the flow for gaged streams and rivers throughout Utah based on the 1941 to 1990 period of record. The thickness of the shaded blue lines represents the average annual flow in acre-feet per year of each stream segment.

As evident in Figure 4, the Colorado River and its tributaries, the Green and San Juan rivers, are the largest rivers in Utah. The Duchesne and White rivers, tributary to the Green River, are also significant rivers in Utah. These rivers are located in some of the most sparsely populated areas of the state. The bulk of Utah's population lives near the smaller Bear, Weber, Jordan, Provo, Sevier and Virgin river systems, which are located in the north, central, and southwestern portions of the state.

FIGURE 4
State of Utah Average Annual Streamflow



Ground Water

Detailed estimates of developed ground water supply exist for all the areas of the state with significant ground water development. Figure 5 shows the location of these areas ranked according to amount of historical withdrawal. Table 2 lists the average annual ground water withdrawals in each of the areas, based on well data available for the years of 1989 to 1998. According to these estimates, an average of 851,000 acre-feet of ground water is withdrawn annually in Utah. Most areas are pumping ground water at or below estimated annual recharge values. Thus, any excess recharge typically becomes part of a surface water system and is measured by stream gages. The Beryl-Enterprise area is one area pumping ground water in excess of natural recharge (ground water mining or overdraft). This overdraft is resulting in an average drop in water level of about 1.2 feet per year.[2]

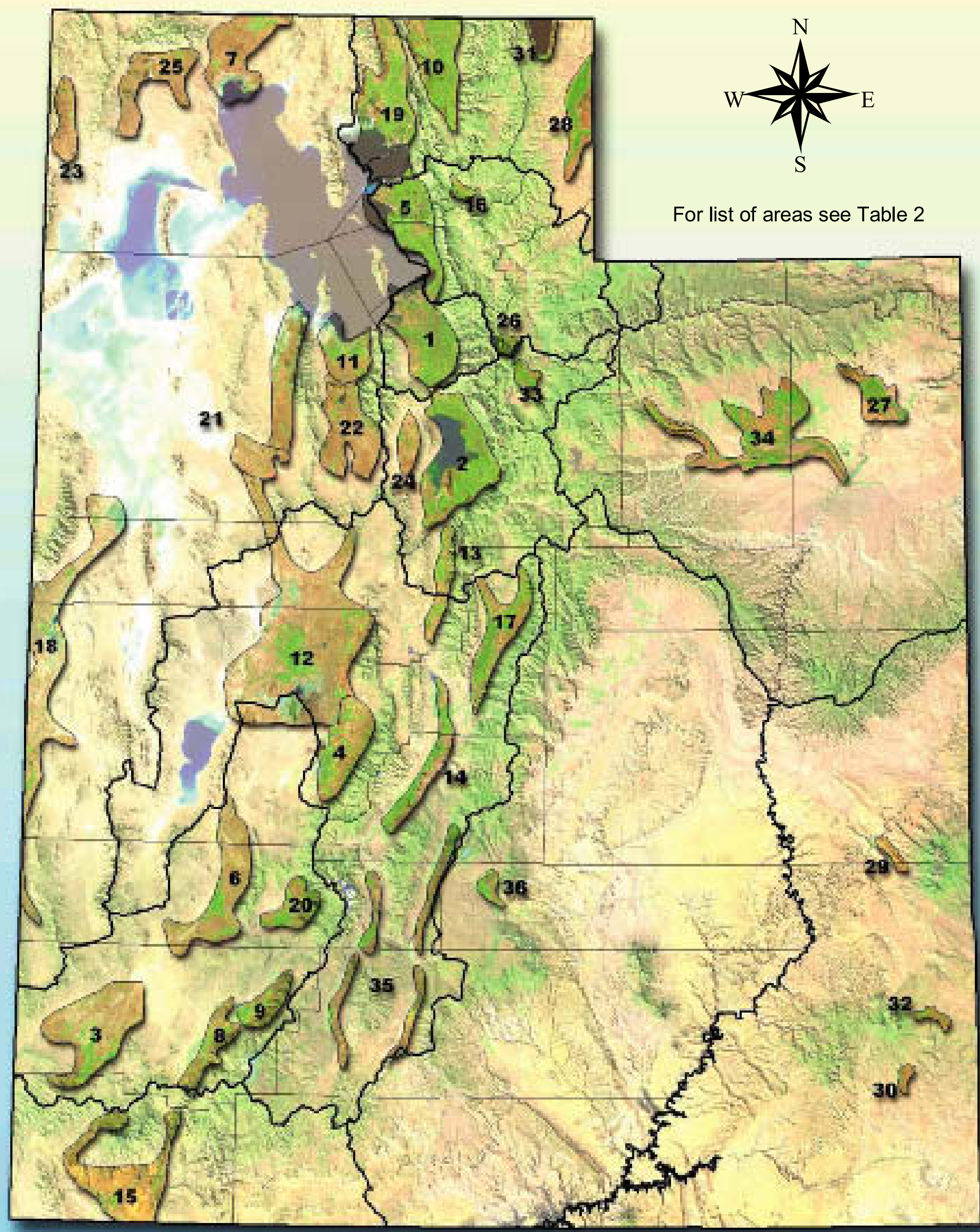
It is estimated that outside of these developed ground water basins, additional water is available. However, due to remote location, depth of water table, water quality uncertainties, water rights issues, potential overdraft and other questions, it is unlikely that very much of this storage will be used.

TABLE 2
Areas of Significant Ground Water Development in Utah

No. in Fig. 5	Area	'89-98 Avg. (af/yr)†	No. in Fig. 5	Area	'89-98 Avg. (af/yr)†
1	Salt Lake Valley	133,000	20	Beaver Valley	8,000
2	Utah and Goshen valleys	108,000	21	Dugway, Skull Valley, Old River Bed	6,000
3	Beryl-Enterprise area	80,000	22	Rush Valley	4,000
4	Pahvant Valley	80,000	23	Grouse Creek Valley	4,000
5	East Shore area	60,000	24	Cedar Valley, Utah County	3,000
6	Milford area	49,000	25	Park Valley	3,000
7	Curlew Valley	36,000	26	Park City area	*
8	Cedar Valley, Iron County	33,000	27	Vernal area	*
9	Parowan Valley	29,000	28	Upper Bear River Valley	*
10	Cache Valley	28,000	29	Spanish Valley	*
11	Tooele Valley	27,000	30	Blanding area	*
12	Sevier Desert	25,000	31	Bear Lake Valley	*
13	Juab Valley	21,000	32	Monticello area	*
14	Central Sevier Valley	19,000	33	Heber Valley	*
15	Central Virgin River area	17,000	34	Duchesne River area	*
16	Ogden Valley	13,000	35	Upper Sevier valleys	*
17	Sanpete Valley	12,000	36	Upper Fremont River	*
18	Snake Valley	10,000		Total of other areas (*)	42,000
19	Malad-lower Bear River	9,000		**STATE TOTAL**	**851,000**

* Less than 3,000. See "Total of Other Areas (*)" for combined total.
† (Source: Tables 1, 2 & 3 in, *Ground-Water Conditions in Utah: Spring of 2000*, Cooperative Investigations Report No. 41. U.S. Geological Survey, Utah Division of Water Resources and Utah Division of Water Rights.)

FIGURE 5
Areas of Significant Ground Water Development in Utah



(Adapted from: Figure 1, in *Groundwater Conditions in Utah: Spring of 2000.* Cooperative Investigations Report No. 41, U.S. Geological Survey, Utah Division of Water Resources and Utah Division of Water Rights.)

Available Water Supply

The combination of all the climatological data with the streamflow and ground water data presented to this point yields a snapshot of the water supply in Utah. This snapshot is contained in Table 3, which shows the disposition of the average annual precipitation that falls on Utah (61.5 million acre-feet). After the initial evaporation and transpiration from vegetation and natural systems (53.789 million acre-feet), approximately 13 percent (7.711 million acre-feet) makes its way into Utah's river and aquifer systems each year. This is called the "Basin Yield." Due to the Colorado River Compact, which decreases Utah's entitlement to Colorado River water by 819,000 acre-feet per year, and the Bear River Compact, which increases Utah's entitlement to Bear River water by 284,000 acre-feet per year, this amount is reduced by 535,000 acre-feet annually (row four).

TABLE 3
Estimated Statewide Water Budget

Row	Category	Water Supply (acre-feet/yr)*
1	Total Precipitation	61,500,000
2	Used by vegetation and natural systems†	53,789,000
3	*Basin Yield*	*7,711,000*
4	Interstate Compact Decreases	(535,000)
5	Ground Water Mining Increases & Other Inflow	135,000
6	*Available Supply*	*7,311,000*
7	Agricultural Depletions	2,175,000
8	M&I Depletions	443,000
9	Great Salt Lake	3,000,000
10	Other Depletions‡	998,000
11	*Yield that flows out of state*	*695,000*

* Values based on 1961-1990 period of record.
† See evaporation and transpiration discussion on pages 8-9.
‡ Wetland and riparian depletion and reservoir evaporation.

Row five shows a 135,000 acre-feet per year increase to the water supply. Of this, 100,000 acre-feet is inflow from Nevada into the West Desert. The remaining 35,000 acre-feet is due to ground water mining in the Beryl-Enterprise area. Since mining ground water has the net effect of increasing the annual water supply, it is also added to the basin yield to obtain the actual water supply that is available for use in Utah. This value is shown in row six and is approximately 7.311 million acre-feet per year. Table 4 breaks down this estimate by hydrologic river basin.

Currently, annual agricultural depletions amount to 2.175 million acre-feet (row seven of Table 3) and annual municipal and industrial (M&I) depletions amount to 433,000 acre-feet (row eight), or 30 and 6 percent of Utah's available water supply, respectively. Great Salt Lake evaporation and other depletions combine to deplete another 3.998 million acre-feet per year (rows nine & ten), or 55 percent. This leaves about 695,000 acre-feet, less than 10 percent of the available supply, that flows out of the state.

TABLE 4
Estimated Water Supply by Basin

Basin	Water Supply (acre-feet/yr)*
Bear River	2,106,000
Jordan River & Utah Lake	1,278,000
Weber River	1,046,000
Sevier River	819,000
Uintah	688,000
West Colorado River	446,000
West Desert	329,000
Kanab Creek/Virgin River	247,000
Cedar/Beaver	216,000
Southeast Colorado River	136,000
TOTAL	**7,311,000**

* Values based on 1961-1990 period of record. For developable supplies, see Table 5.

Developable Water Supply

Table 5 shows a breakdown of the estimated developable[3] water supply in Utah by hydrologic river basin. Notable sources of developable supply exist in the Upper Colorado River and Bear River, with a statewide total of about 790,000 acre-feet. Most of the developable supply in these areas represents available surface water.

TABLE 5
Estimated Developable Water Supply by Basin

Basin	Developable Supply (acre-feet/yr)*
Upper Colorado River†	420,000
Bear River	250,000
Jordan River & Utah Lake	50,000
West Desert	25,000
Weber River	25,000
Kanab Creek/Virgin River‡	20,000
Sevier River	0
Cedar/Beaver	0
TOTAL	**790,000**

* Values based on the 1961-1990 period of record.
† Includes the West Colorado River, Southeast Colorado River and Uintah basins, and represents Utah's remaining Colorado River Compact depletion allocation.
‡ Does not include Sand Hollow Project, which is now under construction.

In the Upper Colorado River Basin, which encompasses the Uintah, West Colorado River and Southeast Colorado River basins, the 420,000 acre-feet per year shown represents a net depletion of surface water flows in the Colorado River and its tributaries, and is Utah's remaining Colorado River Compact allocation. This amount is what the Division of Water Resources estimates as the potential for development of the state's remaining Colorado River allocation. In the Bear River Basin, about 75,000 acre-feet per year could be made available without building additional storage reservoirs by utilizing Willard Bay more efficiently. The remaining 175,000 acre-feet per year would require additional on or off-stream storage. In the Jordan River & Utah Lake basins, the 50,000 acre-feet per year represents mainly surface water development from existing storage in Utah Lake and a small amount of additional ground water development.

In the Kanab Creek/Virgin River Basin, the 20,000 acre-feet per year represents 16,000 acre-feet of potential ground water development and 4,000 acre-feet of surface water storage. Half of the 25,000 acre-feet shown for the West Desert area represents surface water flows that leave the northwest portion of the state into the Columbia River Basin. The other half represents potential ground water development in and around existing communities. Most of the 25,000 acre-feet per year shown for the Weber River Basin represents potential ground water development.

Although the 790,000 acre-feet of water shown is listed as developable, applications to appropriate most of these waters have already been filed with the State Engineer. The Board of Water Resources holds senior water right applications for much of the Bear River water shown, as well as a significant portion of the Upper Colorado River Basin water shown. These rights are being held in trust for the benefit of the citizens of Utah and will be used as needed projects are identified.

Variability of Water Supply

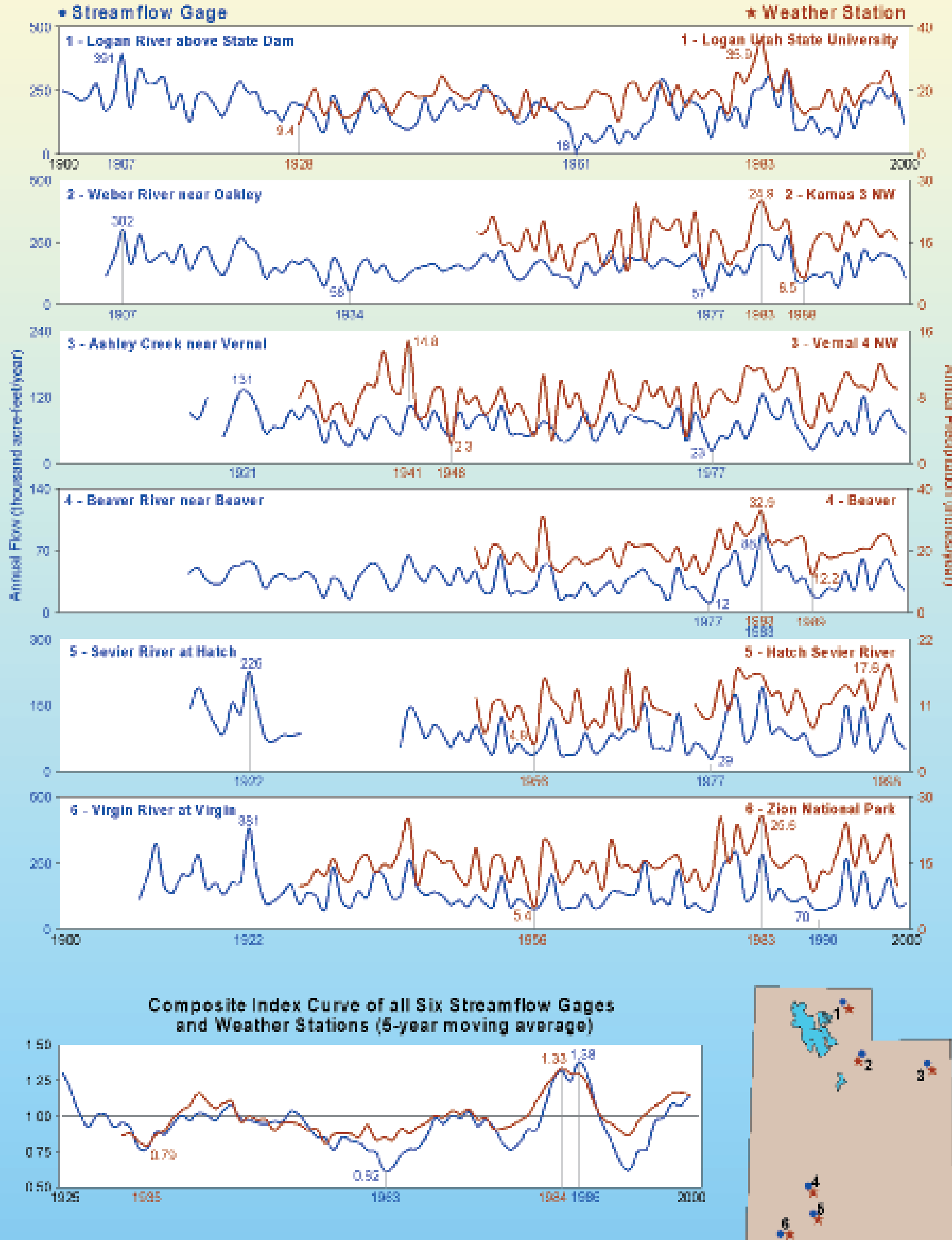
The discussion to this point has focused on Utah's average annual water supply. Actual water supply conditions rarely match these averages. In fact, it is not unusual to experience water supply conditions in extreme excess or deficit of the average. Often these variations occur in prolonged wet and dry cycles.

Figure 6 shows the variability of annual streamflow and precipitation at several locations throughout Utah. The red lines show annual precipitation in inches per year and the blue lines show annual streamflow in acre-feet per year. A composite index curve is also shown indicating the wettest and driest five year periods.

Utah's water supply is not always dependable. Drought is a constant threat.

The cyclic nature of water supply conditions in Utah is evident from the figure. For example, the prominent peak in precipitation and streamflow that occurred in northern Utah during the early 1980s, and which occurred to a lesser degree in southern Utah, depicts one of the wettest periods on record. This period, which produced some of the state's worst recorded flooding, was immediately followed by one of the driest periods on record (1987-1992). This figure also shows differences between northern and southern Utah.

FIGURE 6
Water Supply Variability of Selected Areas in Utah



The variability of the water supply emphasizes the importance of water storage reservoirs to Utah. Without the benefits of storage, the effects of prolonged drought periods would be severely felt, as would the effects of flooding during wet periods. Instead, storage reservoirs allow much of the excess flows available during wet years to be captured and held in storage for possible use in subsequent dry years.

Utah's variable water supply emphasizes the important role of water storage development. Storage reservoirs allow excess flows to be captured and held for use in subsequent dry years.

Drought and flooding, although extremes, are not abnormalities; they are part of the natural cycle. Effective water resource planning includes measures to prevent or minimize the effects of these natural events. Local entities should take advantage of normal years to plan for mitigating and responding to these eventualities.

Too much water can also cause problems, as demonstrated by this photo of City Creek running down State Street in Salt Lake City during the spring of 1983.

NOTES

[1]A more detailed discussion of climatological factors influencing Utah's water resources is found in the Utah Water and Power Board and Utah State University publication, *Developing a State Water Plan: Utah's Water Resources-Problems and Needs, a Challenge* (Salt Lake City: Department of Natural Resources, 1963), 3-5.

[2]The long-term decline in the ground water levels of the Beryl-Enterprise area is clearly documented in a joint study of the U.S. Geological Survey, Utah Division of Water Rights, and Utah Division of Water Resources, *Ground-water Conditions in Utah: Spring of 2000*, Cooperative Investigations Report No. 41, (Salt Lake City: USGS). The 1.2 foot drop cited is the average yearly decline in the water table since 1980 of the wells listed on pages 107-109 of this document.

[3]*Developable* in this document refers to the amount of water that the Division of Water Resources estimates can be developed based on current legal, political, economic and environmental constraints.

—··3··—

POPULATION AND WATER USE TRENDS AND PROJECTIONS

The 21st Century: A Promising Era of Growth and Prosperity

Utah enters the 21st century with bright prospects for continued prosperity and a high standard of living. Liveable communities, education and employment opportunities, a pleasant climate, beautiful scenery, and a broad range of recreational opportunities will encourage our children to stay and others to move to the state. As a result, Utah's population growth is expected to continue well into the foreseeable future.

> **Good employment opportunities, a pleasant climate, beautiful scenery and a broad range of other opportunities will continue to drive growth and prosperity in Utah.**

With such growth comes an abundance of issues and challenges. How infrastructure will be planned and resources managed are important issues that will need to be effectively resolved. One certainty is that additional water will be required for municipal and industrial (M&I) purposes. This water will be made available through conservation, agricultural conversion, management strategies and water development.

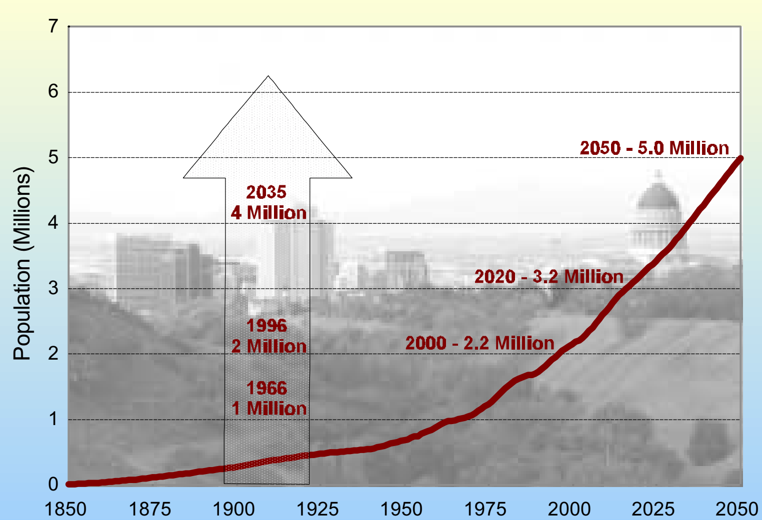
Economic/Employment Trends and Projections

Employment opportunities directly influence population growth. Utah's population and economic growth rates are projected to continue to out-pace most of the nation through the year 2020. An increasingly diversified economy will help sustain economic growth. In 1994, the total number of people employed in Utah reached one million. Total employment is expected to double to about two million by the year 2020. Agricultural employment is the only sector expected to decrease. Metal mining and refining as well as military employment are expected to remain relatively constant. Other employment sectors will grow at varying rates. These trends apply throughout the state, with total employment for each county expected to rise.

Population Trends and Projections

Since Mormon settlers first began arriving in the Salt Lake Valley in 1847 until now, the state's population has grown steadily. With exception of the Great Depression and the recession of the late 1980s, this growth has occurred at a rate at least 1 percent every year, with an annual average of nearly 4 percent. In 2000, Utah's population was about 2.2 million. By 2020, the population is expected to increase to 3.2 million, and by 2050 it could more than double to about 5.0 million (see Figure 7).

FIGURE 7
Population Trend and Projection



(Source: Utah Governor's Office of Planning and Budget)

The 2000 Census ranks states by growth rate. The five fastest growing states in the nation are all located in the West; these are: (1) Nevada, (2) Arizona, (3) Colorado, (4) Utah and (5) Idaho. The only state bordering Utah not in the top five is Wyoming (32). Utah's growth has historically been high due to its rapid natural increase–the result of the nation's highest fertility rate and the nation's third highest life expectancy.[1] In the 1990s, this rapid natural increase combined with good economic conditions to increase Utah's growth.

Over the years, the rate of migration into and out of Utah has varied. In the mid-1980s, when California and national economies improved relative to Utah's, there was a net out-migration and the state's annual growth rate declined to about 0.7 percent. In the late-1980s, the state's economy started to recover, and job growth rates in Utah exceeded those in California and the nation resulting in a net in-migration to the state.

Utah's population is distributed as shown in Figure 8. Most of the population currently lives in the area along and around the Wasatch Front. This area, known as the Greater Wasatch Area, extends roughly 50 miles north and 70 miles south of Salt Lake City (Brigham City to Nephi) and extends approximately 30 miles west and 30 miles east (Tooele to Park City). About 82 percent of Utah's population is located in the Greater Wasatch Area and other urban areas of the state. This ranks Utah as the sixth most urbanized state in the nation, behind other western states such as California, Nevada and Arizona.[2]

Greater Wasatch Area

The majority of Utah's future growth is projected to occur in the Greater Wasatch Area. Through extensive research and involvement of the public, the Quality Growth Efficiency Tools (QGET) Technical Committee and Envision Utah have gathered information about what residents of this area value and how they think growth should be accommodated.[3] Based on this information, several issues were identified that need to be addressed in order to protect the environment and maintain economic vitality and quality of life. Improving air quality, increasing transportation options, and conserving and maintaining availability of water resources are some of the issues.

To address this and the other issues, Envision Utah developed specific quality growth strategies that seek to bring about change through means other than regulatory authority. Several of the strategies that influence water use include:[4]

< promoting walkable development (encouraging new and existing developments to include a mix of uses with a pedestrian-friendly design);

< fostering transit-oriented development (housing and commercial development that incorporates and encourages various forms of transportation);

< preserving open spaces by including open areas in new development and providing incentives to reuse currently developed land; and

< restructuring water bills to encourage water conservation.

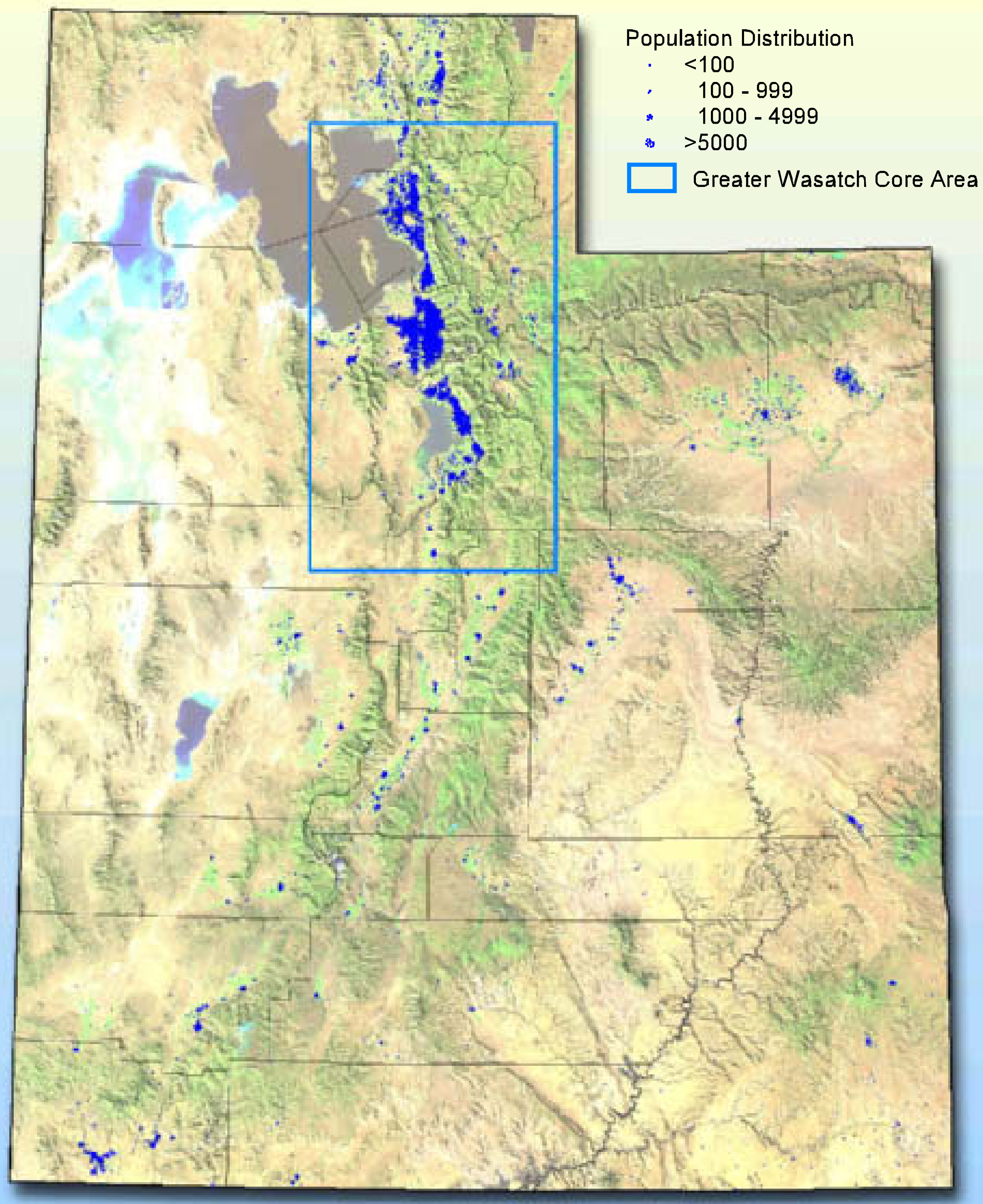
If future growth follows these strategies, the potential for water savings will be significant. A trend away from dispersed development toward more concentrated population centers would result in reduced lot sizes and lower per capita water use. By 2020, Envision Utah estimates that average lot sizes would decline from 0.32 acres to 0.29 acres and per capita water use would decline about 6 percent in the Greater Wasatch Area under the quality growth strategy.[5]

Rural Areas

In rural areas, there are numerous communities ranging from just a few homes to populations of several thousands. Some of these communities are growing rapidly, others very slowly, and a few are declining. Some are actively trying to attract businesses that would provide jobs and help their economies. If successful, these communities could grow more rapidly than anticipated.

Many rural areas in Utah share some of the same concerns that QGET and Envision Utah have identified for the Greater Wasatch Area. These and other areas will benefit from the insights and strategies provided by this cooperative venture to ensure quality growth in Utah. In addition to this effort, the Governor's Rural Partnership Office, in cooperation with local groups, has created a program specifically designed to assist rural communities with their unique growth related challenges. The goal of this program, entitled "21st Century Communities," is to provide planners and leaders in rural communities with the training, guidance and tools that will help them succeed in their planning efforts.

FIGURE 8
Utah's Population Distribution and the Greater Wasatch Area



Source: 1990 U.S. Census

Water and Limitations on Growth

In most areas, water will not be a limiting factor of population growth. This does not mean that each community presently has ample water for its needs or the system capacity to deliver it. Rather, it means that in most places water could be made available if the necessary water transfers, agreements and infrastructure were in place.

PRESENT AND FUTURE USES OF UTAH'S WATER RESOURCES

Agricultural irrigation is, and will continue to be, the primary use of developed water in Utah. Other uses include municipal and industrial (M&I), environmental and recreational. Increasing competition between these uses will continue to shape and reform the way Utah's water resources are utilized. M&I water use will experience the greatest increases because of anticipated population growth.

More concern is being expressed about the environment than ever before and, with it, an awareness of societal effects on ecosystems. Properly balancing water management and environmental concerns will allow future M&I demands to be met without compromising the quality of life that comes with healthy ecosystems. Recreational use of lakes and streams will also increase and must be considered.

Increasing municipal and industrial water demands will play a prominent role in shaping the way Utah's water resources are utilized in the future.

Agriculture

In recent years, the state's economy has become more reliant upon tourism, recreation, services and technology for its economic base. However, agriculture continues to be an important part of the rural economic picture. The state has about 1.5 million irrigated acres and an additional half a million acres of dry-crop land. Most of this agricultural land is devoted to raising feed for the livestock industry, but there are a steady number of acres raising row crops and a variety of fruits and specialty items.

The trend along the Wasatch Front has been a decrease in agricultural land as the growing population has converted farms to residential and commercial areas. In rural areas, agriculture growth has slowed tremendously and is remaining fairly steady. Table 6 shows present and projected agricultural land acreage and associated water use. The Jordan River, Utah Lake and Weber

TABLE 6
Present and Projected Irrigated Land and Agricultural Water Use by Basin

Basin	(acres)*			(acre-feet/yr)†		
	2000	2020	2050	2000	2020	2050
Sevier River	300,700	299,900	298,200	767,000	765,000	760,000
Bear River	291,700	286,600	277,400	858,000	843,000	816,000
Uintah	198,300	197,800	197,000	745,000	744,000	741,000
Utah Lake	146,800	132,200	101,100	523,000	471,000	360,000
Weber River	117,400	103,800	88,000	322,000	283,000	240,000
Cedar/Beaver	95,000	94,300	92,500	268,000	266,000	261,000
West Desert	86,200	85,100	82,900	204,000	202,000	196,000
West Colorado River	83,600	83,500	82,900	284,000	283,000	281,000
Jordan River	20,500	8,100	0	85,000	38,000	0
Kanab Creek/ Virgin River	19,100	17,700	14,500	92,000	85,000	70,000
Southeast Colorado River	18,600	18,500	18,200	73,000	73,000	72,000
TOTAL	**1,377,900**	**1,327,500**	**1,252,700**	**4,221,000**	**4,053,000**	**3,797,000**

* Acres were developed using a geo-spacial model and are based on land-use surveys conducted by the Division of Water Resources, population densities, and population estimates from the Governor's Office of Planning and Budget.

† Water use values were derived from previous water budgets conducted by the Division of Water Resources.

Agricultural water use is expected to slowly decline as urban growth continues. In most cases the water will be converted to municipal and industrial uses. (Photo of a new residential development near an alfalfa field in South Jordan.)

River basins are all projected to experience a significant reduction in agricultural land over the next couple of decades due to urban growth.

In other basins, such as the Sevier, the Cedar/Beaver and the Kanab Creek/Virgin River, the existing water supply has nearly been fully developed and there is little water left for future agricultural development. In the Southeast Colorado River, Uintah, West Desert, and the West Colorado River basins, many localized areas have been fully developed, but there are a few areas where water could be developed and used for agricultural expansion. However, due to federal environmental regulation and economic conditions, it is unlikely that significant new agricultural land will be developed in the future.

In recent years, there has been a strong interest in preserving open spaces and other values associated with agricultural lands. This is especially true in urban areas where these desirable lands are rapidly disappearing. The state, conservation groups, agricultural interests and others have shown strong support for preserving open spaces for future generations. Through conservation easements and other means, some of these resources have been protected from development pressures. If this trend continues, more lands will be preserved.

Municipal and Industrial

Estimates of present municipal and industrial water use by basin have been made and are shown in Table 7. Projections of water use in 2020 and 2050, based on present use rates and future population, are also shown. These estimates show the largest volume increases in M&I water demand will occur in the Greater Wasatch Area which includes the Jordan River Basin and portions of the Weber River, Utah Lake, West Desert and Bear River basins. The largest percentage increase in M&I water demand is expected to occur in the Kanab Creek/Virgin River Basin, where demand is expected to more than quadruple.

A study by the Division of Water Resources collected detailed M&I water use data in Utah. Table 8 contains the per capita use rates of public community and secondary water systems obtained by this study.

TABLE 7
Present and Projected Total M&I Water Use by Basin

Basin	(acre-feet/yr)		
	Present*	2020†	2050†
Jordan River	332,000	449,000	650,000
Weber River	170,000	267,000	358,000
Utah Lake	134,000	232,000	383,000
Bear River	50,000	71,000	103,000
West Colorado River	51,000	55,000	62,000
Sevier River	48,000	55,000	64,000
Kanab Creek/Virgin River	42,000	86,000	183,000
West Desert	24,000	35,000	53,000
Uintah	24,000	27,000	31,000
Cedar/Beaver	20,000	33,000	51,000
Southeast Colorado River	9,000	10,000	12,000
TOTAL	**904,000**	**1,320,00**	**1,950,00**

* The exact year of the data shown varies from 1992 to 1998, see Division of Water Resources, *Municipal and Industrial Water Supply and Uses*, (Salt Lake City: Department of Natural Resources, 2000).
† Projections represent future demands based on current use rates and future population projections from the Governor's Office of Planning and Budget. Actual demands will likely be less, depending on the level of conservation that can be achieved.

TABLE 8
Public Community System and Secondary System Water Use (gpcd)

Water Use	Basin: Utah Lake (1993,98)	West Desert (1996)	SE Colorado (1996)	Bear River (1998)	Uintah (1995)	Jordan River (1995)	Weber River (1992)	West Colorado River (1996)	Sevier River (1996)	Cedar/ Beaver (1994)	Kanab Crk./Virgin River (1997)	TOTAL/ AVERAGE
Potable Uses:												
Residential	144	151	157	183	161	202	114	186	171	219	209	**169**
Commercial*	24	16	35	28	22	38	27	25	30	22	93	**34**
Institutional†	36	58	18	18	30	57	49	29	44	20	22	**45**
Industrial	13	16	4	26	26	19	6	9	22	10	5	**14**
Total Potable	**217**	**241**	**214**	**255**	**239**	**316**	**196**	**249**	**267**	**271**	**329**	**262**
Non-potable Uses:												
Residential	41	9	31	22	38	6	115	91	87	64	46	**44**
Commercial	8	0	0	4	0	2	5	0	0	5	17	**5**
Institutional	5	34	41	11	27	4	10	26	21	42	48	**10**
Industrial‡	1	0	0	0	0	0	0	0	0	0	0	**0**
Total Non-Potable	**55**	**43**	**72**	**37**	**65**	**12**	**130**	**117**	**108**	**111**	**111**	**59**
TOTAL	**272**	**284**	**286**	**291**	**304**	**328**	**326**	**366**	**375**	**382**	**440**	**321**
Total Use by Category:												
Residential	185	160	188	205	199	208	229	277	258	283	255	**213**
Commercial	32	16	35	32	22	40	32	25	30	27	110	**39**
Institutional	41	92	59	29	57	61	59	55	65	62	70	**55**
Industrial	14	16	4	26	26	19	6	9	22	10	5	**14**

* Commercial uses are those associated with small business operations. For example, retail businesses, restaurants and hotels.
† Institutional uses are those associated with various public agencies and institutions such as parks, cemeteries, recreational areas and golf courses.
‡ Less than 0.5 gpcd used in Sevier and Uintah counties.

Water used by self-supplied industries, private domestic systems and non-community systems is not shown. The total per capita use rates vary substantially by basin, with a low of 272 gpcd in the Utah Lake Basin to a high of 440 gpcd in the Kanab Creek/Virgin River Basin. The statewide average is 321 gpcd. Of this amount, approximately 66 percent (or 213 gpcd) is residential use.

Figure 9 shows how Utah's per capita water use of public supplies compares with the rest of the nation. As would be expected, due to outdoor watering needs, many western states are among the highest water users. Nevada and Utah, the two driest states, rank number one and two, respectively, in per capita water use of public supplies.

Environmental interests will continue to play an important role in how Utah's water resources are used. (Photo of Calf Creek Falls near Escalante courtesy of Max Bertola.)

Environment

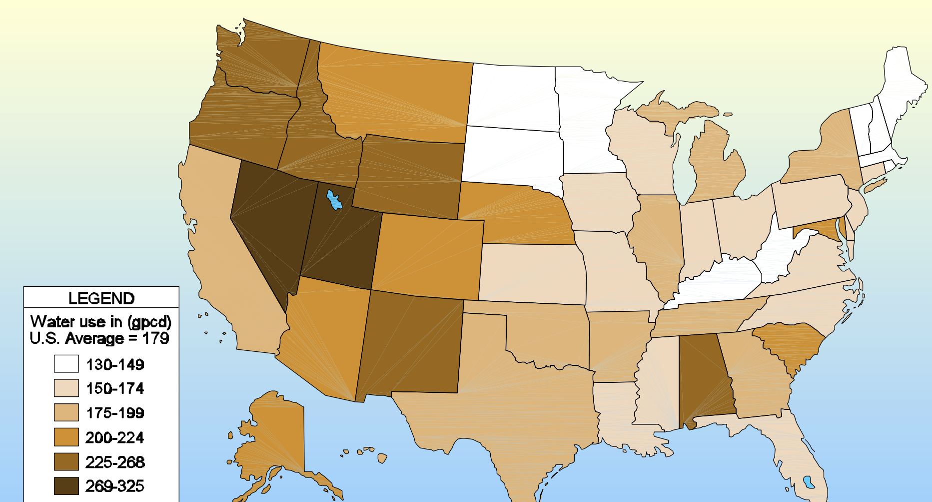
The environmental movement has had a profound influence on water resources planning, development and management. As environmental awareness increases, so will the pressure to use water to preserve and restore the environment. As the population continues to grow, and our understanding of the effects of growth on the environment increases, the public will need to be willing to make needed changes in lifestyle to accommodate growth. In general, the environmental movement will assist water managers in their efforts to promote water conservation, utilize efficient water management technologies and improve water quality.

Recreation

Today, recreation is an important component of water use and development projects. Some of the most popular recreation activities in Utah are associated with waterways. These activities include boating, rafting, kayaking, swimming and stream fishing.

The Green and Colorado rivers in Utah are internationally recognized recreation and scenic treasures. Tourists travel thousands of miles to these rivers to float white water stretches, fish blue-ribbon trout streams, or participate in other recreational opportunities. Flaming Gorge and Lake Powell National Recreation areas also generate millions of visitor days from in- and out-of-state visitors. The state also has parks and rec-

FIGURE 9
Per Capita Water Use of Public Water Supplies in the United States



(Source: USGS, *Estimated Use of Water in the United States in 1995*.)

reational facilities on many reservoirs including Deer Creek, East Canyon, Echo, Jordanelle, Pineview, Quail Creek, Rockport, Willard Bay and others.

In recent years, Utah Lake and the Great Salt Lake, as well as the Jordan and Bear rivers, have all benefitted from water quality management efforts that make them more appealing to the public for recreational purposes. The Jordan River has benefitted from a coordinated state, federal and local effort to establish a parkway that will ultimately traverse the entire length of the river. A few problems that are foreseen affecting recreation are:

< A growing population will increase the use of existing recreational facilities.
< Less than adequate boat ramps and parks.
< An effective decrease of reservoir surface areas as the reservoirs' operating conditions approach their intended use patterns.
< Increasing financial strain on managing entities.

Recreation on or near Utah's waterways is very popular. (Photo courtesy of Patrick Cone.)

As reservoirs reach full utilization, recreation activities may be adversely impacted. (Photo courtesy of Utah Division of State Parks and Recreation.)

NOTES

[1]These and other interesting vital statistics are available from National Center for Health Statistics, *National Vital Statistics Report*, (Hyattsville: 1998), Vol 47, No. 9.

[2]QGET Technical Committee, *QGET Data Book, Third Edition*, (Salt Lake City: Governor's Office of Planning and Budget, 1998).

[3] The QGET Technical Committee consists of representatives from state and local governments, and the private sector. It was formed in 1995 by the Governor of Utah to analyze growth-related issues including transportation, air quality, land use, water availability and infrastructure costs (web page: www.governor.state.ut.us/dea/qget/1.htm). Envision Utah is a unique and dynamic partnership that brings together citizens, business leaders and policy-makers from public and private circles. It was formed in 1997 and has as its objective to develop a broadly supported growth strategy–a common vision for our future, and our children's future–to guide the businesses, residents and government bodies of Utah into the 21st century (web page: www.envisionutah.org).

[4]Governor's Office of Planning and Budget, *Strategy Analysis: QGET Quality Growth Efficiency Tools*, (Salt Lake City, 2000), 49, 50.

[5]Governor's Office of Planning and Budget, 33.

4

WATER CONSERVATION

Due to past water management and development activities, Utah's cities, towns and industries generally enjoy an adequate supply of water. In the future, however, the demands for water imposed by a growing population will exceed presently developed supplies available for municipal and industrial (M&I) purposes. Implementing effective water conservation is a critical component in satisfying Utah's future water needs. The focus of this chapter is water conservation in the M&I sector. Water conservation as it relates to agriculture is discussed in Chapter 5.

Implementing effective water conservation measures and programs is critical to satisfying Utah's future water needs.

THE BENEFITS OF WATER CONSERVATION

Besides the obvious advantage of decreasing water demand and allowing existing water supplies to last longer, water conservation has a variety of important benefits. Water conservation can:

- delay expensive capital investments to upgrade or expand existing water facilities;
- reduce sewage flows, delaying the need for more wastewater treatment facilities;
- conserve energy as less water needs to be treated, pumped and distributed to the consumer;
- lessen the leaching of chemicals and sediments into streams and aquifers because of improved urban irrigation efficiencies; and
- reduce stream diversions, enhancing water quality, environmental and recreational functions.

UTAH'S WATER CONSERVATION EFFORT

In order to receive the full benefits of water conservation, Utah needs to implement water conservation measures and programs now, rather than wait for a crisis. State and local leaders recognize the importance of water conservation to effective resource planning and management. They also recognize the need for local water planners and managers to customize their water conservation objectives to local needs and circumstances. This is evident in the legislative requirement for water retailers and conservancy districts to prepare individual water conservation plans. In order to meet the future water needs of its growing population, particularly in urban areas, Utah will need to continue to refine and improve its water conservation plan require-

Central Utah Water Conservancy District's Water Conservation Credit Program

The Central Utah Project Completion Act requires the Central Utah Water Conservancy District to prepare a Water Management Improvement Plan. This plan includes the establishment of a district-wide water conservation goal and the establishment of a Water Conservation Credit Program. In 1995, the district implemented this credit program, fulfilling the conditions of the Act that require the district to develop a continuous process for the identification, evaluation and implementation of water conservation measures.

The water conservation credit program is the mechanism by which the district allocates $50 million in federal funds for the implementation of conservation measures. This money is distributed to projects that meet certain criteria including a requirement of a 35 percent cost share from local sources.

Originally, the Act required a savings of 30,000 acre-feet of water per year, but after detailed study the district decided a goal to conserve a total of 49,622 acre-feet of water per year by the year 2013 was appropriate. As of June 2000, 108 applications for funding have been received with 36 approved for funding and in various stages of construction. Current annual conservation totals 18,600 acre-feet per year, with an anticipated total conservation of 68,500 acre-feet per year.

The credit program is exceeding expectations, clearly indicating the likelihood of water conservation success elsewhere in the state if funding is made available.

(Source: Central Utah Water Conservancy District) ments and actively promote research and implementation of effective water conservation programs and measures.

Utah's Water Conservation Goal

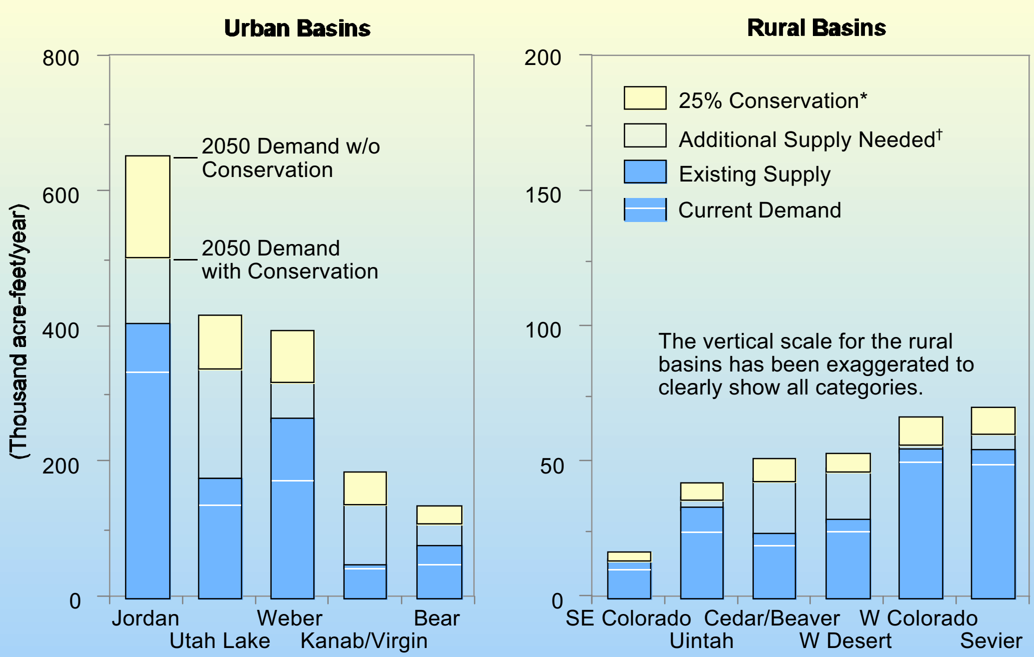
The goal of the state is to conserve water wherever possible. Because most new water demands will be the result of an increasing population, the state has developed a specific goal to conserve water use directly linked to population growth. This goal is to reduce per capita water demand from public community systems by 12.5 percent by 2020 and a total of 25 percent before the year 2050. This is equivalent to a total decrease in demand of about 400,000 acre-feet per year by the year 2050.

Figure 10 illustrates the important role that 25 percent conservation can play in reducing M&I water demands throughout Utah by the year 2050. For example, without water conservation, it is estimated that the Jordan River Basin would experience an increase above current demand of about 320,000 acre-feet per year by 2050. With conservation, this increase is cut nearly in half. The figure also shows that most basins still have a fairly large gap, representing additional needed water supply, even after conservation. Although it may be possible to achieve more than 25 percent conservation, it is likely that most of these additional needs will be met by a combination of agricultural water conversions, improved management of existing supply and water development.

Water Conservation Plans

In 1998 and 1999, the Utah Legislature passed and revised the Water Conservation Plan Act. This act requires conservancy districts and water retailers with more than 500 connections to prepare a water conservation plan and submit it to the Division of Water Resources. This requirement covers systems that service about 93 percent of Utah's population. As of June 2001, 99 out of 150 water retailers and conservancy districts who were supposed to submit plans have done so. These plans are to be updated and resubmitted every five years. State water funding boards have further stipulated that a plan must be in place prior to any funds being awarded. The legislation also directs the

FIGURE 10
Meeting Total M&I Demand in 2050 by Basin

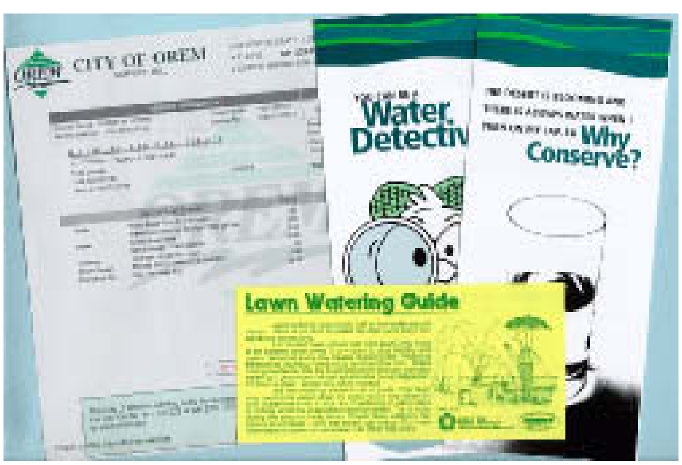


* Represents 25% conservation of public community systems' supply.
† Represents the absolute minimum additional supply needed to meet future demands.

Board of Water Resources to study ways to implement the plans, develop recommendations on implementation, and report to the Legislature.[1]

This legislation has given water conservation increased emphasis to many water providers as well as significant media coverage throughout the state, and has created a foundation upon which the state can build a successful water conservation framework. This framework took initial shape in the recommendations that the Board of Water Resources made to the Legislature in November 1999. Some of these recommendations are summarized below:[2]

- Educate the public on the importance of using Utah's water resources more efficiently. This includes providing adult education opportunities to teach homeowners and landscape contractors how to design and care for water-efficient landscapes and disseminating information through the media on weather factors affecting lawn and garden water use.
- Provide programs for training and licensing landscape and irrigation contractors and managers to assure that large urban irrigation systems are properly installed and operated.
- Provide incentives for more efficient water use by using a volume rate structure with discounts for efficient use as well as penalty charges for water wasted. Such a rate structure should be supported by trained staff and appropriate tools to assist water wasters in reducing use.
- Encourage monthly meter reading and billing by all water retail providers. Water bills should have an education component that assists consumers in reducing their use.
- Support existing water audit programs and encourage more active participation in such programs. This involves providing state support to train and test irrigation water auditors and collecting data to track the effectiveness of such programs.
- Encourage water conservancy districts and water retailers to fund rebates to encourage replacement of old, high-flow toilets and other high water use appliances in the home.
- Study the feasibility of tax incentives for water intensive industries and businesses as well as homeowners, for finding ways to improve water use efficiency.



Water bills should contain detailed information about actual water use and other educational materials that promote efficiency.

Funding for Research and Implementation

Funding for research and implementation of local water conservation programs and measures is needed to complement the requirements of the water conservation plans. Accurate and reliable results of water conservation measures in Utah need to be collected in order to determine those measures that will most likely produce positive results. This will encourage a broader acceptance of water conservation by local decision-makers and allow for a better allocation of resources to achieve water conservation goals.

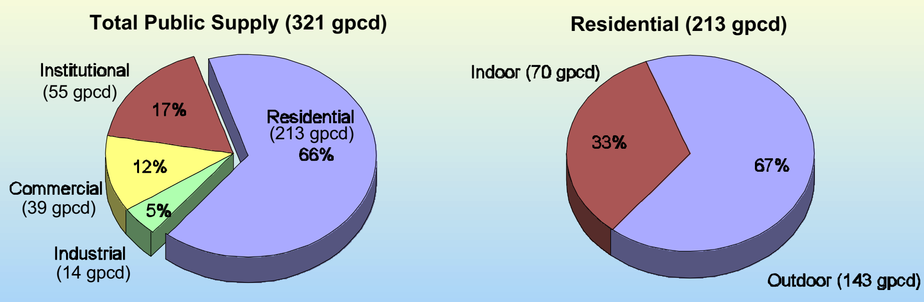
Baseline Water Use Rates

One data need that is critical for a water provider to monitor the success of water conservation measures is the determination of an accurate baseline water use. This typically includes all M&I uses except for self-supplied industries, private domestic, and other non-community systems. This baseline is usually expressed as gallons per capita per day (gpcd).

The Division of Water Resources has determined the total per capita water use of all public water supplies, including secondary water, to be approximately 321 gpcd. Only Nevada (the driest state in the U.S.) uses more water per capita. While Utah's relatively high per capita water use is often compared to the national average of approximately 179 gpcd, a more appropriate comparison would be against other Rocky Mountain states. This average is approximately 245 gpcd.[3]

Figure 11 breaks down Utah's total per capita use of public supplied water into residential, commercial,

FIGURE 11
Breakdown of Public Supply Water Use Including Secondary Water



(Source: Division of Water Resources, *Municipal and Industrial Water Supply and Uses*, 2000.)

institutional and industrial components. Residential use is by far the largest component at about 66 percent or 213 gpcd. As shown on the right, an estimated 143 gpcd, or 67 percent of this amount, is used outdoors and 70 gpcd (33 percent) is used indoors. Institutional uses, which include schools, churches, parks, cemeteries and city-owned properties, are about 55 gpcd. Commercial uses are approximately 39 gpcd and industrial uses (public supplied only) are approximately 14 gpcd.

Although these statewide values provide useful information for comparison purposes, individual communities should establish their own baseline use rates. This will assist these communities in setting appropriate goals and monitoring the progress toward reaching those goals through the various conservation measures and programs they decide to implement.

WATER CONSERVATION MEASURES

An effective water conservation program contains a variety of water-saving measures with emphasis on reducing outdoor use. The following paragraphs discuss some of the measures that will most likely result in positive reductions in water demand.

Incentive Pricing

Much research and experimentation have been done in the area of water pricing as an incentive to reduce water use. Nearly all the literature agrees that a properly designed water rate structure is an essential element of an effective water conservation program. If water prices are too low, then the signal sent to the consumer is that the resource is abundant and they need not conserve.[4]

In an era where developable water supplies are reaching their limits and economic and environmental concerns make further development less desirable, it makes sense to reflect these conditions in water rate structures. Yet, many water providers continue to use structures that do little to promote efficiency.

Table 9 lists average water prices of several cities in Utah and the western United States. As shown, Utah's rates are among the lowest in the West and are well below the national average. Some reasons that may help explain why Utah's rates are lower include the following: much of Utah's population

TABLE 9
Water Prices of Various Western Cities

City	Estimated Cost per 1,000 gallons
Reno	$3.39
Seattle	$2.30
Los Angeles	$2.22
Park City, UT	$2.20
Tucson	$1.81
Boise	$1.68
Las Vegas	$1.65
Phoenix	$1.61
Albuquerque	$1.41
Denver	$1.14
Sandy, UT	$0.99
Salt Lake City	$0.87
Provo, UT	$0.75
Sacramento	$0.75
AVERAGE	**$1.63**
Utah Average	$1.15
National Average	$1.96

(Out-of-state values adapted from, "Western States Water Newsletter," dated, December 31, 1998. In-state values taken from Utah Division of Drinking Water, *1999 Survey of Community Drinking Water Systems*, 2000, Appendix 7, 1-6.)

is located near mountain watersheds which have been easily harnessed to gravity feed a significant portion of the state's water needs; ground water use has been managed well with typical pump-lifts that are reasonable and have remained fairly steady; and, property taxes are used to pay a portion of the water costs.

Whatever the reasons for Utah's lower rates, simply raising water prices is not the solution. Instead, water pricing strategies that "reward" high water use with lower or static rates, should be replaced with pricing structures that discourage waste and reward efficiency. Rate structures must also be designed to avoid capital shortfalls as customers succeed in conserving water. Some of these effective rate structures, including increasing block, seasonal and ascending block rates, are discussed briefly below.

Increasing Block Rates

The increasing block rate is currently used by many water systems in Utah. It typically has a base charge of $5 to $20 which must be paid whether or not any water is used. A fixed amount of water is usually made available as part of this base charge. The price of subsequent increments of water supplied then increases in a step-wise fashion. This rate structure encourages efficiency only if the steps in the incremental price are sufficient to discourage excessive use.[5] Separating the base charge from any water actually delivered allows the water supplier to better reflect the actual costs of providing water service. The base charge is set to cover the fixed costs of providing service while the overage charges are set to cover the actual costs of delivery.

Seasonal Rates

This rate structure has a base charge much the same as the increasing block rate. The main difference is that instead of rate increases depending solely on the volume of water used, rates are set according to seasons. The price for each unit of water delivered in winter is lower than for water delivered in the summer. The summer price is set strategically to encourage consumers to be more conscious of irrigation habits during the months when peak demands often strain the delivery system. If desired, a spring and fall use rate can also be applied. This helps reflect the rising and falling costs associated with typical use patterns of a water supply system. It also helps water suppliers better communicate to consumers that irrigation water needs typically diminish during the spring and fall months and, therefore, sprinkler timers should be adjusted accordingly.

Ascending Block Rates

This rate structure requires that a target use be established for each customer. This target is based on the water needs of the landscape and the number of people in the home or business. Landscape water need is determined by using evapotranspiration rates for turf grass from local weather stations and landscape size. Then, each unit of water is priced in such a way so as to reward the consumer for using less than the target range and penalize them for using amounts that exceed the target range. Penalties are assessed by using a sequentially higher rate, typically doubling with each volume increment in excess of the target.[6]

A properly designed and implemented water rate structure is an essential element of any water conservation program.

Because of the effort required to obtain and maintain accurate data on all customers, the ascending block rate requires more staff and capital resources. However, it is also the most effective in providing an incentive to use water efficiently. Table 10 shows an annual summary of a customer's bill using an ascending block rate structure. Careful examination of this bill shows how the customer is charged for inefficient use of water throughout the irrigation season and the wasteful use of water in the months of September and October, two months where many people forget to turn back their automatic sprinkler timers.

Implementing incentive pricing structures, such as those outlined above, must be done carefully to be successful. A successful rate structure has the following characteristics:

< encourages more efficient water use without causing a shortfall in system revenue;
< provides for the identification of waste, rewards efficient use and penalizes excessive use;
< produces revenues from penalty rates that are used to fund water conservation programs;
< is supported by a water bill that clearly communi-

TABLE 10
Example Summary of a Customer's Ascending Block Rate Bill

Month	Usage (1000 gal.)	Base Charge	Target Use	Irrig. Req.* (in.)	Overage Rate per 1,000 gal. Conserv Use† $0.75/k	Normal Use‡ $1.10/k	Ineff. Use§ $2.20/k	Wasteful Use~ $4.40/k	Irrespons Use** $8.80/k	TOTAL
January	10	$10.00	15.00	0.0	$7.50					**$17.50**
February	10	$10.00	15.00	0.0	$7.50					**$17.50**
March	18	$10.00	15.00	0.0		$16.50	$6.60			**$33.10**
April	35	$10.00	29.75	0.2		$32.73	$11.55			**$54.28**
May	48	$10.00	39.50	2.0		$43.45	$18.70			**$72.15**
June	58	$10.00	45.60	3.9		$50.16	$27.28			**$87.44**
July	73	$10.00	48.92	4.7		$53.81	$52.98			**$116.79**
August	68	$10.00	45.60	3.9		$50.16	$49.28			**$109.44**
September	62	$10.00	33.44	1.7		$36.78	$62.83	$52.10		**$161.71**
October	50	$10.00	29.75	0.2		$32.73	$44.55	$23.65		**$110.93**
November	14	$10.00	15.00	0.0		$15.40				**$25.40**
December	10	$10.00	15.00	0.0	$7.50					**$17.50**
Totals	**456**	**$120.00**	**347.56**	**16.6**	**$22.50**	**$331.72**	**$273.77**	**$75.75**	**$0.00**	**$823.73**
									Average cost per 1,000 gallons	$1.81

* Irrigation requirement for turf grass of a typical Wasatch Front resident.
† Total gallons used are less than 75 percent of target use.
‡ Total gallons used up to 100 percent of target use.
§ Gallons used between 100 percent and 150 percent of target use.
~ Gallons used above 200 percent of target use.

cates the cost of wasted water to the responsible person; and

< is supported by a person or staff who can respond to customer calls for help in reducing usage.

Water suppliers throughout the state are beginning to recognize the importance of water pricing in managing rising water demands. West Jordan City, located in the Salt Lake Valley, plans to implement an ascending block rate structure. The city believes that this measure is a key element in reaching its goal to reduce water demand 15 percent in five years.

Outdoor Watering Guidelines and Ordinances

If residential outdoor conservation were practiced, the potential savings would be great since it makes up the biggest part of residential use (approx. 67 percent). The Division of Water Resources estimates that the water needed to produce a healthy lawn on a typical residential landscape could be reduced 25 percent by following two simple steps. These are: (1) Watering to meet the consumptive use--the amount of water needed by a plant to produce maximum growth; and (2) Maintaining a sprinkler uniformity of about 60 percent.[7] Consumptive use values are readily available for most areas of the state. Not only will watering to meet the consumptive use conserve water, but it also produces a healthier and better-adapted turf. Average residential sprinkler uniformities have been found to be about 54 percent. Increasing these to at least 60 percent can be achieved by designing sprinkler systems properly and by inspecting and maintaining performance regularly.

If a homeowner were to implement additional outdoor watering guidelines, overall water consumption could be reduced beyond 25 percent.[8] Other guidelines include setting watering durations to suit different soil types, using several short durations (cycling) to water deeply while avoiding runoff, and watering flower and shrub areas less than turf areas. Another method that has proven effective in reducing water consumption is simply confining watering to times during the day that minimize evaporation, between 6 p.m. and 10 a.m., for example. After unsuccessfully attempting to reduce water use in its secondary water system by limiting watering to certain days, the Bountiful Sub-Conservancy District found that an ordinance restricting watering to the hours between 6 p.m. and 10 a.m. was the most effective method. By doing this, the district immediately reduced water consumption by about 17 percent.[9]

The potential savings and relatively unobtrusive nature of irrigation guidelines and ordinances make such measures extremely attractive. The immediate reduction in peaking loads that can be produced will not only conserve water but delay the need for system upgrades and expansion that are dictated by peak system demands. Any comprehensive water conservation program should seriously consider such measures.

Landscape Guidelines and Ordinances

The types of plants that make up a landscape and the total area that requires landscaping can have a significant impact on overall water consumption. Replacing typical turf grass and other water-loving vegetation with native or low water-use plants significantly reduces outdoor water needs; hard-scaping a portion of the landscape eliminates the need for water. If the low water-use vegetation is irrigated using efficient irrigation practices, outdoor water use can be reduced above and beyond the percentage mentioned previously. Not only do water-wise landscapes conserve water, but they consume less amounts of chemicals, require less maintenance than typical turf, and add interest and color to the ordinary landscape.

Changing the way people landscape so that it more closely matches the stresses of Utah's semiarid climate is an important aspect of long-term water conservation. Demonstration gardens and public education programs that communicate efficient landscaping techniques, as well as ordinances that promote more "natural" landscaping practices, are important components of an outdoor water conservation program. These measures could become a way of life in the future as demands for limited water supplies continue to rise.

A water-conserving landscape, often referred to as Xeriscape, incorporates wise irrigation practices and proper plant selection to produce an aesthetically beautiful landscape that is in harmony with the local climate. (Photos of commercial and residential Xeriscapes courtesy of Xeriscape Design, Salt Lake City.)

Commercial and Residential Water Audits

A water audit is becoming a commonly used tool to help consumers reduce their water use. A complete water audit consists of an indoor and outdoor component. Indoors, a typical audit involves checking the flow rates of appliances and identifying leaks, and if necessary, replacing basic fixtures with low-flow devices and making other recommendations. Outdoors, an audit measures the uniformity and precipitation rate of an irrigation system, identifies problems, and suggests how to improve system efficiency and water according to actual plant requirements.

Beginning in 1999, the Jordan Valley Water Conservancy District (JVWCD), in cooperation with the Central Utah Water Conservancy District (CUWCD) and Utah State University Extension Service initiated a free "water check" program. This water check is basically a simplified outdoor water audit for residents. The slogan for the program is "Slow-the-Flow, Save H_20." Advertised through local media and at community events, the program allows residents throughout the Salt Lake Valley to improve their outdoor watering habits. During the spring of 2000, the program was extended to include residents of Utah County. Plans to expand into Davis County are underway.

The JVWCD, CUWCD and Utah State University Extension Service are collecting data on audited residences. This data is already providing valuable information on outdoor water use. The data will also be used to monitor and evaluate the performance of the program.

Installation of Meters on All Water Connections

In order to effectively bill customers according to the amount of water they use, their connection must be metered. Frequently reading meters is also important. In Utah, communities currently meter most potable (drinking) water connections. However, secondary water is largely not metered due to unfavorable meter performance in untreated water systems. All connections, including secondary, should be metered. Not only will metering these connections immediately enhance water providers' ability to conserve water resources, but it will allow them to more accurately distribute the actual costs of water service among its many customers.

Retrofit, Rebate and Incentive Programs

It has long been known that the largest indoor consumption of water occurs at the toilet. This fact prompted legislation to replace toilets, which typically consume 3.5 to 7.5 gallons per flush, with low-flow devices that consume 1.6 gallons. Since 1992, Utah law requires the installation of these toilets in new construction and since 1994, federal law prohibits the manufacture of old-style toilets. This change reduces indoor residential water consumption in new construction by an estimated six gpcd[10], but does not affect homes constructed prior to 1992 unless old toilets are replaced. Retrofitting old-style toilets and other water intensive appliances with newer water efficient designs is recognized by many utilities as an effective way to produce water savings. This is accomplished by retrofitting programs or rebates which provide an incentive for residents to remove their old appliances. Because it is fairly easy to estimate the water savings that retrofit, rebate and incentive programs are likely to produce, these programs are a popular method used to help reach water conservation goals.

Leak Detection and Repair Programs

In some water systems, the best way to conserve water may be to discover and repair leaks within the distribution system. Leak detection and repair programs often receive substantial capital investment because the results of such efforts can be clearly quantified. However, if a thorough investigation determines that leaks are not a big problem (typically less than 10 percent),

In some water systems, finding and repairing leaks may be the most desirable conservation alternative. Water savings from such measures are relatively easy to quantify.

Typical Water Use Within the Home

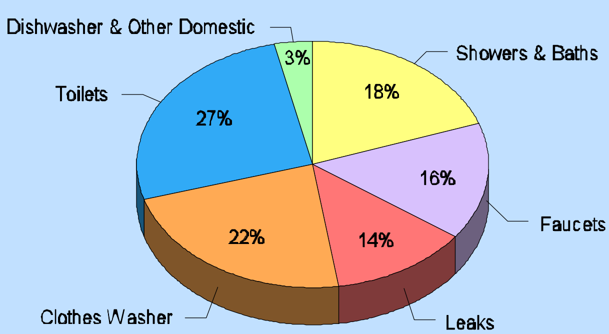
The typical U.S. residence consumes about 69 gallons per person per day inside the home. This is approximately equivalent to one completely full bathtub.

As indicated by the accompanying chart, approximately 27 percent of all the water used indoors goes down the toilet. The clothes washer uses another 22 percent for a total of nearly 50 percent of indoor water use from just two household appliances. Showers and baths consume about 18 percent, and faucets another 16 percent. Leaks account for a significant 14 percent.

Surprisingly, only 3 percent of water used indoors is used by the dishwasher or other domestic purposes such as cooking and cleaning. Despite this fact, 100 percent of water supplied inside the home must meet stringent drinking water standards.

The American Water Works Association (AWWA) estimates that a comprehensive program to install water efficient plumbing fixtures within the home and fix leaks could reduce total indoor water consumption by as much as 30 percent.

(From Mayer, Peter W. et. al., *Residential End Uses of Water*, [AWWA Research Foundation, 1999], xxvi.)



such programs may not yield savings as significant as other conservation measures. Water utilities should carefully weigh the costs of infrastructure repair and replacement against all possible conservation measures in order to determine which will most economically attain the desired objectives.

Water Conservation Education: Critical to Long-Term Success

A well-organized water conservation education program, which complements the implementation of specific conservation measures, is crucial to sustainable demand reduction. The often-cited water conservation efforts of Tuscon, Arizona, which achieved a 27 percent reduction in demand over a five-year period (1974-1979), is mainly attributed to a comprehensive water education program.[11] An effective conservation program helps citizens alter their water use habits. If the general populace does not permanently change how it uses water, many conservation successes can easily be erased as old habits recur. Evidence of this is the immediate rebound of water consumption that occurs after the effects of a drought dissipate and media attention to local water scarcity subsides.

Water managers can partially overcome this problem by providing conservation education materials on an ongoing basis through the customer's monthly water bill. In addition to the common conservation pamphlets and articles, the following information could be provided:

- A comparison of current year versus prior years water usage, similar to that shown on many electric bills.
- The amount of water used and the costs incurred in each step of the rate schedule.
- Instruction on appropriate biweekly changes in automatic timer settings during the irrigation season.
- Phone numbers, Internet addresses and other references that may help the customer conserve water.

While Utah water providers have been slow to implement conservation measures, they have long recognized the need for education programs which include conservation awareness. Utah's effort began in the early 1980s when the Division of Water Resources (DWRe) and the newly formed International Office for Water Education at Utah State University began to solicit the support of water conservancy districts, the Utah State Office of Education and others to sponsor an ongoing water education program for school children. This program functioned well for many years.

The state of Utah continues to support water education and has a goal to develop water conservation and education materials that expand awareness of water issues beyond the classroom to the general public. The DWRe works closely with the State Office of Education to provide professional training and resources focused on teaching water-related subjects in the core science curriculum for elementary grades K-6. This training is delivered through workshops sponsored by the Office of Education and the division's web site. The DWRe also works closely with water conservancy districts and cities in supporting their outreach activities through water fairs, a poster contest and an annual recognition banquet.

NOTES

[1]For further detail concerning this legislation, see State of Utah Legislature, *Utah Code 73-10-32*, as amended by Chapter 19, 1999, General Session, (Salt Lake City: Utah Legislature, 1999). The *Utah Code* is available over the Internet at: www.le.state.ut.us/~code/code.htm.

[2]Utah Board of Water Resources, *Implementing Water Conservation Plans of Water Conservancy Districts and Water Retailers*, a report presented to the Natural Resources, Agriculture, Environment Interim Committee of the Utah Legislature, (Salt Lake City: Division of Water Resources, 1999).

[3]The 245 gpcd cited is the average of the following western states: Arizona, Colorado, Idaho, New Mexico, Nevada, & Wyoming; and is derived from U.S. Geological Survey, *Estimated Use of Water in the United States in 1995*, USGS Circular Survey No. 1200, (Washington, D.C.: U.S. Dept. of the Interior, 1998), 20-23.

[4]Martin, William E., et. al, *Saving Water in a Desert City*, (Washington, D.C.: Resources for the Future, 1984), 3. Mr. Martin is a former member of Tuscon, Arizona's city government. During his tenure as a city official, difficult decisions were made which laid the groundwork for the city's well publicized water conservation efforts.

[5]Summers, Lyle, *Incentive Pricing for Efficient Water Use in Urban Utah*, Draft, January 14, 1999. Prepared for the Utah Water Conservation Forum, (Salt Lake City: Division of Water Resources, 1999), 7.

[6]Ibid.

[7]Utah Division of Water Resources, *Identifying Residential Water Use: Survey Results and Analysis of Residential Water Use for Thirteen Communities in Utah*, (Salt Lake City: Division of Water Resources, 2000), 27.

[8]A possible reduction in outdoor water use of 50 percent is cited in numerous documents, among which the following is an excellent source of Utah specific information: Keane, Terry, *Water-wise Landscaping: guide for water management planning*, (Logan: Utah State University Extension Services, 1995), 1. This document is available on the Internet at the USU Extension Service's web page: www.ext.usu.edu/publica/natrpubs.htm.

[9]Utah Division of Water Resources, *An Analysis of Secondary Water Use in Bountiful, Utah*, a non-published report, (Salt Lake City: Division of Water Resources, 1995), 1&4.

[10]Utah Division of Water Resources, 2000, 9.

[11]Martin, 4-5.

5

WATER TRANSFERS AND EFFICIENT MANAGEMENT OF DEVELOPED SUPPLIES

Using existing developed water supplies efficiently is an important element in successfully meeting Utah's future water needs. As competition for limited water supplies increases, the value of those supplies also increases. This economic incentive can lead to the outright transfer of water from one use to another, or it can encourage other water management strategies to be employed that maximize the benefits provided by existing uses. Accordingly, this chapter discusses agricultural water transfers as well as the following water management strategies: agricultural water-use efficiency, conjunctive use of surface and ground water, aquifer storage and recovery, secondary water systems, cooperative water operating agreements and water reuse.

> As competition for limited water supplies increases, the value of those supplies also increases. This competition provides an incentive to employ new management strategies that better utilize existing supplies.

Many areas in the state could experience increased benefits from their presently developed water supplies if they were to implement one or more of these management strategies. Where appropriate, state and federal agencies should promote these strategies by emphasizing them as alternatives to be explored in the planning stages of local projects.

AGRICULTURAL WATER TRANSFERS

Agriculture uses about 80 percent of the presently developed water supply.[1] Municipal and industrial (M&I) use account for the remaining developed water supply. Existing developed supplies for agriculture represent a significant source of water to meet future M&I demands, especially in basins where urbanization is replacing irrigated farmland.

The extent to which agricultural water will be converted to meet other needs depends on state agricultural policy, the proximity of growth to irrigated lands, and the relative value of the land and water to be exchanged. Another factor contributing to the extent to which such transfers will meet future needs is the amount of water that can actually be converted. Agricultural to M&I water transfers are typically not a one-to-one conversion, because the traditional use of agricultural water in the state is seasonal while M&I water use is year-round. Under these circumstances, it is difficult to predict to what extent future needs can be met by agricultural water transfers. Nevertheless, it is anticipated that these transfers will play a significant role in many areas of the state. To this end, this section discusses three forms of agricultural water transfers: land and water conversions, water rights sales and water leases.

Land and Water Conversions

As Utah's communities grow, this growth often occurs on adjacent irrigated agricultural land. This is especially true in the Greater Wasatch Area where nearly every city is constrained on one or more sides by geographical features such as mountains, rivers and lakes that prohibit development. The value of this adjacent agricultural land, and the water associated with it, has led to a growing trend of land and water conversions from agriculture to M&I.

When a piece of irrigated farm land changes from agriculture to urban use, the city may require the agricultural water rights associated with the land to be transferred to the municipality as a condition of approving the development. The amount of water required per acre of land for irrigated agriculture is about the same as the water required for urban development on the same acre.

Many municipalities in Utah follow this land and water conversion approach. Consequently, much of the increased water supply requirements brought on by growth in Utah can be satisfied by the conversion. However, in some areas, the quality of the water used for agriculture is such that its conversion to M&I use may not be economically feasible. In these areas, other options will play a bigger role.

Water Rights Sales

Another common form of water transfer is a simple water right sale. Unlike a land and water conversion, a water right sale involves the transfer of a water right from one user to another, separate from any land use considerations. In agriculture, such a transfer requires retiring (taking out of production) agricultural lands and changing the place and purpose of the associated water rights.

Water rights sales take advantage of available mechanisms to legally move water from one area to another. Such transfers generally result in a shift of available water supplies from lower-valued to higher-valued uses, thus producing an increase in the economic value of the water.

One of the most visible water rights sale to ever take place in Utah occurred in the Delta area in 1981. In this transfer, California and Utah power suppliers purchased 20 percent of the water shares from the Delta, Melville, Abraham and Deseret Canal Companies, as well as the Central Utah Water Company, in the Lower Sevier River Basin. These power suppliers then used most of the water in the production of power at the Intermountain Power Plant, located north of Delta.

Water Leases

Another type of transfer is a conditional or "dry year" transfer. Conditional transfers are temporary water leases that are contingent upon certain conditions. Such transfers often have arrangements that define an "interruptible supply" that may periodically be used, under certain conditions such as a drought or other emergency, by another user.[2] Leasing irrigators' surface water rights was used extensively in California to stave off the effects of the 1987-1992 drought.

AGRICULTURAL WATER-USE EFFICIENCY

Since irrigated agriculture is the largest user of water in Utah, many have suggested that using water more efficiently in agriculture is the main solution to meeting future water needs. With the exception of water quality improvements, most benefits of agricultural water-use efficiency (increased stream flows, for instance) do not extend far beyond the farm. In fact, many agricultural water-use efficiency projects result in a net increase in water depletions to the system. This occurs because the water that is "saved" is often stored in upstream reservoirs, which allows it to be released to meet late-season shortages.

This section discusses the major benefits of agricultural water-use efficiency, investigates some of the complexities that must be carefully considered in order for an efficiency project to be successful, and explores some of the irrigation methods that can be employed to increase agricultural water-use efficiency.

The Benefits of Water-Use Efficiency

The two major benefits of agricultural water-use efficiency: (1) increased agricultural productivity and (2) improved water quality. In some instances, a third benefit of reduced stream diversion may also be realized. A short discussion of these benefits follows.

Increased Agricultural Productivity

Unless increasing the productivity of farms is a central focus of agriculture water-use efficiency, it will likely be difficult to gain the needed support of irrigators. Increasing agriculture productivity should be a high priority of any efficiency project. It could be argued that if a project failed to benefit the farmers who are expected to implement it, it has missed the boat.

Proper implementation of agriculture water-use efficiency typically provides increases in crop yields of 15 to 30 percent. Usually, irrigation system improvements first focus on the conveyance network, followed by on-farm improvements. A combination of both is necessary to achieve the higher yields. This process usually increases depletions and ultimately reduces the amount of return flow or ground water recharge.

Improved Water Quality

Improved irrigation efficiency can alleviate water quality problems. Reduced conveyance seepage losses will result in less salt pickup during subsurface transport. Reduced tailwater runoff (return flows) from irrigated fields will result in less soil erosion and fewer adsorbed phosphate fertilizer being transported to downstream water bodies. Reduced deep percolation losses below the crop roots will also result in less transport of nitrate fertilizer to the ground water and less salt pickup.

Improving water quality in the Colorado River is the major impetus for ongoing agriculture water-use efficiency projects in the Upper Colorado River Basin. Many irrigated valleys in the Colorado River Basin are underlain by the highly saline Mancos Shale formation, from which many of the soils are derived. During the irrigation season, conveyance seepage losses and deep percolation losses move downward through the soil profile, then across the top of the Mancos Shale, all the time taking salts into solution before returning to the river channel downstream.

In the Uinta Basin and the Price-San Rafael areas (part of the Uintah and West Colorado River basin planning areas), sprinkle irrigation is being employed to decrease deep percolation losses as part of the Colorado River Salinity Control Program. Thus far, the Uinta Basin Unit's efficiency improvements have resulted in a salt load reduction to the Colorado River of over 100,000 tons per year. Overall irrigation efficiency has improved from 20-25 percent to about 65 percent. In the Price-San Rafael areas, the increased efficiency projects will also result in an increased depletion of at least 25,000 acre-feet per year.

<u>*Reduced Water Diversions*</u>

Reducing water diversions may be a benefit of agricultural water-use efficiency. Increased and better quality flows in streams contribute to the health of riparian and wetland ecosystems, as well as fish and wildlife; it may also free up water for other uses. However, for many irrigation systems, most of the water savings from on- and off-farm improvements will first result in satisfying any deficiencies in water to the immediate farmers and then to individual farmers downstream. As a consequence, the full benefits of reduced diversions often affect only nearby stream segments, and not the entire river system. This is especially true during the peak irrigation demand season (mid-June to mid-August), and also often late in the irrigation season when most farms in Utah suffer from a lack of a reliable supply.

Water Rights, Supply and Other Considerations

Water rights may often be the determining factor in determining the appropriateness of a water-use efficiency project. In a basin that is over-appropriated (more paper water rights than actual supply), any water savings resulting from agricultural efficiency improvements are simply consumed by lower-priority water rights holders. Although this can result in increased agricultural productivity, it typically results in greater depletions, poorer water quality and reduced end-of-system stream flows.

Changing on-farm application of water from flood irrigation to pressurized sprinkler irrigation can greatly improve application efficiency.

Water-use efficiency can also disrupt the timing of water deliveries, and thus the storage of excess supplies, to downstream users. The Sevier River Basin is an example of a river system where it has been argued for years that improving agricultural water-use efficiency in one area of the basin may result in adverse impacts to other users by altering the timing of return flow. Irrigators in this basin rely heavily on a delicate balance of return flows and slow releases of deep percolation–the so-called "inefficiencies" of upstream irrigators–to supply downstream farms with adequate water.

Irrigation Efficiency Methods

Once the appropriateness of efficiency measures in an area is determined, actual implementation of these measures can proceed. A host of irrigation efficiency technologies exist, for almost any imaginable situation. Typical irrigation systems in Utah include storage reservoirs, conveyance through open canals or distribution piping, and on-farm application facilities and equipment. These systems can "lose" between 20 and 65 percent of the water diverted into them to seepage and evaporation, although losses are typically between 35

The combination of laser land-leveling and recent advances in surface irrigation provide a hydraulic performance comparable to sprinkle irrigation. (Photos of laser land-leveling equipment [above] and surface irrigation of a leveled field [below] courtesy of Wynn Walker, Utah State University.)

and 55 percent. Clearly, technology or management improvements can result in an increase of total system efficiency and a reduction in water loss.

The effectiveness of canal operations can be improved by moving from a fixed rotation schedule, which supplies water to irrigators at pre-specified times regardless of need, to an on-demand scheduling approach which supplies water when an irrigator requests. The amount of available storage dictates the degree to which on-demand scheduling can be implemented.

Automated canal operations, utilizing a network of water level and flow measurement devices as well as gate control mechanisms, provide the capability to monitor and manage entire irrigation systems through telemetry and computerized equipment. Remotely operated systems usually require considerable investments in technology and personnel, but can realize substantial improvements in water use efficiency for large irrigation systems.

Many on-farm application technologies also exist which have the potential to improve irrigation application efficiency. For example, pressurized irrigation can be employed, such as sprinkle irrigation (designed for 80 percent irrigation application efficiency) or trickle (drip) irrigation (designed for 95 percent application efficiency). The appropriateness of these methods depends upon local soils and topography, along with the farm economics of the crops to be grown.[3,4,5]

Other technologies, such as laser land-leveling and advances in surface irrigation hydraulics, make it possible for traditional surface (flood) irrigation to be just as efficient. Laser land-leveling results in practically no tailwater runoff (return flows) and greatly reduces deep percolation.

Conjunctive Use of Surface and Ground Water Supplies

In areas where available water resources have been nearly fully developed, optimal beneficial use can be obtained by conjunctive use of surface water and ground water supplies. This involves carefully coordinating the storage, timing and delivery of both resources. Surface water is used to the fullest extent possible year round, while ground water is retained to meet demands when streamflows are low.[6] Generally, the total benefit from a conjunctively managed basin will exceed that of a basin wherein the resources are managed separately. Additional benefits of conjunctive use may include:[7]

- better management capabilities with less waste;
- greater flood control capabilities;
- greater control over surface reservoir releases; and
- more efficient operation of pump plants and other facilities.

In evaluating alternatives for conjunctive use, water managers should view ground water as more than a supplement to surface supplies. In particular, managers should assess the value of ground water in optimizing storage capacity, enhancing transmission capabilities, and improving water quality of the system.

Where infiltration basins are not feasible, pumps can be used to inject water directly into the receiving aquifer. In some cases, the same pumps can also be used to recover the storage.

Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is a form of conjunctive use where excess water is stored underground in a suitable aquifer and recovered later as needed. Some water utilities use ASR to store treated surface water during periods of low water demand, and provide the recovered water later to meet peak daily, short-term, or emergency demands.[8] Others may store it for use during periods of water deficits.

Many communities have found ASR systems to have numerous advantages; these include:[9]

- Enhanced reliability of existing water supplies as aquifer storage provides a back-up supply during emergencies such as chemical spills or broken pipelines.
- Increased flows in streams to support fish, riparian habitat and aesthetic purposes during periods of low summer flow.
- Decreased vulnerability to evaporation and contamination than is typical with a surface reservoir.

Unlike surface water storage, aquifer storage requires minimal structural elements. This is an attractive benefit considering the difficult political and environmental challenges facing many surface water storage projects. Aquifers are also much more efficient water transmission mechanisms. An aquifer has the ability to convey water from the point of recharge to any point of use near the aquifer without the extensive canals, piping and appurtenances required by surface water distribution systems. Aquifers also provide a water quality benefit since they have a natural ability to filter sediment and remove some biological contaminants.

Along with the difficulties of building surface storage, water supply costs are a driving force for implementation of ASR. Unit costs for ASR facilities generally range from about $200,000 to $600,000 per million gallons per day (mgd) of recovery capacity, with an overall average of about $400,000 per mgd (or $357 per acre-foot per year). This can be less than the cost of some other water supply alternatives. The Jordan Valley Water Conservancy District's ASR project (see sidebar) has experienced a unit cost near the average of $400,000 per mgd.

Although the advantages of conjunctive use and ASR are numerous, they may also have disadvantages. These include possible disruption of return flows and springs, damage to riparian and wetland vegetation, and possible

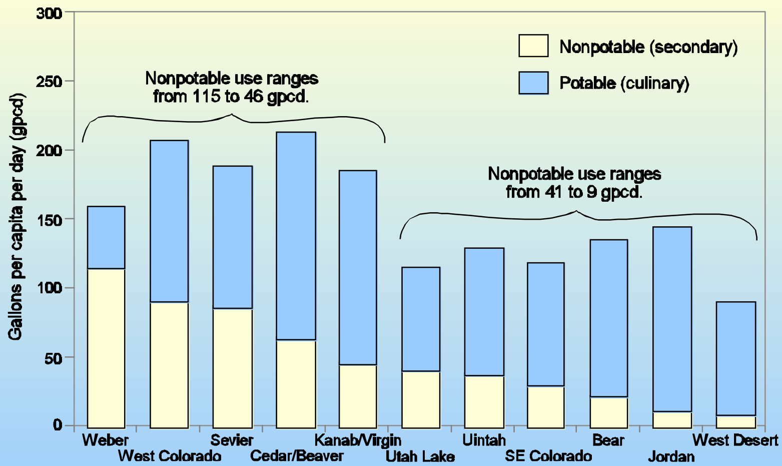
Aquifer Storage and Recovery Demonstration Project

The Jordan Valley Water Conservancy District (JVWCD) recently completed facilities for an artificial ground water storage and recovery project. Under the current operation of this project, which was built using federal funds through the Central Utah Project Completion Act Groundwater Program and local sources, JVWCD treats excess runoff from local streams and Deer Creek Reservoir, injects it into the semi-confined aquifer beneath the Salt Lake Valley from November thru May, and then recovers the injected water to satisfy late summer peak demands from July to September.

The average capacity of the 12 million dollar plus demonstration project is approximately 5,800 acre-feet per year. Because the State Engineer currently limits full recovery of water injected into the aquifer to the same year in which it was injected (any carry-over storage is subject to a 10% reduction each year it is stored in the aquifer), the options for long-term storage are presently limited. However, even with these restrictions the JVWCD could potentially store up to 33,000 acre-feet in the aquifer for future use. This water could then be used to mitigate the effects of drought and manage other common shortages.

This project allows JVWCD to capture high quality runoff that would otherwise go unused, increases the peak demand delivery capacity within Salt Lake County, and is a critical element in the effort to stabilize the declining ground water aquifer in the southeastern portion of the valley.

FIGURE 12
Residential Outdoor Water Use in Utah by Basin



(Source: Division of Water Resources, *Municipal and Industrial Water Supply and Uses, 2000.*)

water use than a typical potable (culinary) water system. Figure 12 breaks down residential outdoor water use by basin into potable and nonpotable (secondary) components. As shown, the five basins with the highest overall per capita use are also the five basins with the highest residential outdoor per capita use of nonpotable water. This indicates that consumers use more water outdoors in basins where inexpensive unmetered secondary water is available than consumers in other basins. One way to deal with this over-use is to meter the water and charge according to an incentive pricing rate structure. Conventional meters plug up and wear out quickly on secondary systems. Filtering the water to a level where conventional meters will function properly or using a meter under development that can function in such condition should be considered.

cost increases. Water managers should fully investigate all aspects of proposed projects to avoid potential problems.

Secondary Water Systems

A secondary (or dual) water system supplies nonpotable water for uses that do not have high water treatment requirements, such as residential landscape irrigation. A secondary system's major purpose is to reduce the overall cost of providing water by using cheaper, untreated water for irrigation and preserving higher quality water for drinking water uses.

Secondary systems are most suitable for areas where it is economically feasible to construct a separate distribution system in addition to the required potable (drinking) water system. Installing secondary systems is generally more feasible in rural areas or areas that are under development. This allows secondary lines to be installed at the same time as other infrastructure, greatly reducing costs and inconvenience to homeowners. The Weber River Basin has long recognized the value of secondary systems. Many communities within this basin require secondary systems be installed as a part of new development.

Although secondary systems do free up treated water supplies for drinking water purposes, it is important to recognize that they generally result in higher overall

Cooperative Water Operating Agreements

Temporary localized water shortages may occur as the result of system failures or as a result of growth that approaches the limits of the water system or supply. A cooperative approach to water resource and system management at the local and regional level can help water managers prevent shortages better and cope with them if they do occur. This is often accomplished without committing the large sums of money to capital expenditures for new supplies that would otherwise be required. In its simplest form, connections are installed between adjoining water systems and an agreement is made regarding the transfer of water between them.

Some of the many benefits to water suppliers who cooperatively operate their water systems at a local and regional level are:[10]

- Greater flexibility in meeting peak and emergency water demands.

- Better scheduling options associated with regular maintenance and repair programs.
- Decreased capital costs as construction of new projects can be delayed.
- Increased opportunities for joint improvement projects as cooperative relationships are formed and resources more fully utilized.

At an institutional level, the managers of the cooperating systems must agree on such things as water transfer strategies, plans for interconnections, water conservation enforcement policies and emergency management plans. Perhaps the most significant institutional challenge is to remove the psychological hurdle of taking water from one system and giving it to another. To do this, education of the public on the concept and benefits of a regional, cooperative approach to system management will often be necessary. The Utah Division of Drinking Water is working towards this goal by helping small local water systems consolidate their water treatment operations.

WATER REUSE

Water has always been used and reused (or recycled) by humans as a natural part of the hydrologic cycle. The return of wastewater to streams and rivers, and the reuse of these waters by downstream users, is not new. In this document, "water reuse" refers to the direct use of wastewater, which involves the application of some degree of treatment, and the planned use of the resulting effluent for a beneficial purpose.

Reuse Options

Many communities in the United States have safely and successfully used reclaimed wastewater for numerous purposes, including:

- <u>Landscape irrigation</u>: reclaimed sewage effluent can be used to irrigate parks, golf courses, highway medians and residential landscapes.
- <u>Industrial process water</u>: industrial facilities and power plants can use reclaimed water for cooling and other manufacturing processes.
- <u>Wetlands</u>: reclaimed water can be used to create, restore and enhance wetlands.
- <u>Commercial toilet flushing</u>: reclaimed water can be used to flush toilets in industrial and commercial buildings including hotels and motels.

Reuse in Utah

The *Utah Administrative Code*, Title R317-1-4, provides regulations that must be followed for reuse of treated wastewater. In addition to specifying water quality standards for certain types of reuse, state rules require anyone intending to reuse to provide:

- A description of the source, quantity, quality, and use of the treated wastewater to be delivered; the location of the reuse site; and how the requirements of this rule would be met.
- A description of the water rights for the use of the treated effluent, including evidence that the State Engineer has been notified and has agreed that the treatment entity has the right to use the water for the intended use.
- An operation and management plan that includes: a copy of the contract with the user, if other than the treatment entity; a labeling and separation plan for the prevention of cross connections between reclaimed water distribution lines and potable water lines; schedules for routine maintenance; a contingency plan for system failure or upsets; and a copy of the contract covering how the requirements of this rule will be met if the water will be delivered to another entity for distribution and use.

Table 11 contains a list of existing or proposed water reuse projects in Utah compiled by the Division of Water Quality. Most of these projects are type 2 reuse which do not involve potential contact with the general public. Type 1 reuse, which requires more stringent treatment due to potential human contact, is being used in Tooele for a broad range of uses and is proposed for use on a new golf course in the Salt Lake Valley. St. George is also considering type 1 reuse.

The appropriateness of any individual reuse project will depend upon the effect that it will have on existing water rights. Often, downstream users depend upon the wastewater effluent to satisfy their rights. The effects on downstream water rights need to be addressed as part of the feasibility of any reuse project.

Gray Water Reuse and Rainwater Harvesting

Gray water reuse is a form of water recycling that is often spoken of as a potential conservation measure. Gray water is typically what goes down the bathtub drain, bathroom sink or out of the washing machine.

TABLE 11
Existing and Proposed Water Reuse Projects in Utah

Project	Approx. Flow (mgd)	Begun Service	Description and Type of Reuse
Ash Creek Special Service District	1.00	1986	Aerated lagoon wastewater facility with winter storage. Type 2 reuse - alfalfa production.
Blanding City	*	*	Facultative lagoon system with winter storage. Type 2 reuse - alfalfa production.
Cedar City	4.40	1996	Trickling filter plant. Type 2 reuse - applied to pasture land and native vegetation.
Central Valley Water Reclamation Facility (SLC)	N/A	future	Secondary treatment facility. Type 1 reuse - future irrigation of a new golf course.
Francis Town	0.25	1985	Facultative lagoon with winter storage. Type 2 reuse - alfalfa production.
Heber Valley Special Service District	2.50	1982	Facultative lagoon system with winter storage. Type 2 reuse - alfalfa production.
Long Valley Sewer Improvement District	*	*	Facultative lagoon with winter storage. Type 2 reuse - alfalfa production.
Roosevelt City	N/A	N/A	Facultative lagoon system with winter storage. Type 2 reuse - alfalfa production.
Santaquin City	0.37	1995	Facultative lagoon with winter storage. Type 2 reuse - alfalfa production.
St. George City	N/A	future	Secondary treatment facility. Type 1 reuse - various uses being considered.
Tooele City	2.25	2000	Oxidation ditch plant with winter storage. Type 1 reuse - presently irrigates golf course and county recreation property with plans to irrigate residential landscapes.

* Lack of water has prohibited reuse application to date. N/A Exact value or date not available.

The effluent from the toilet, kitchen sink and dishwasher is typically not suitable for home recycling. Gray water systems are usually installed on a house-by-house basis and not at the community level. However, gray water systems have been known to be installed in large hotels as the water supply for flushing toilets. A well-designed gray water system has the potential to reduce household water use by up to 30 percent.

Gray water is not without its problems. It contains organic matter, pathogens, detergents, and salts, and without disinfection, is only suitable for subsurface irrigation. Some gray water systems provide disinfection, and other very short-term storage; these systems are more expensive, but can be set up to run recycled water to surface irrigation and toilets. Because of health concerns, the cost of installing a recycling system, difficulties in retrofitting existing homes to separate gray water, and regulatory concerns, gray water reuse will likely not see widespread application in Utah within the next 50 years.

Rainwater harvesting for nonpotable outdoor use is generally easier and less problematic than using gray water, and therefore, could see more widespread application. All that is needed are rain gutters and storage tanks large enough to capture the volume of precipitation that could be expected at the bottom of each downspout. A simple screen placed at the inlet can even filter off shingle grit, leaves and other matter. The water "harvested" in this manner could then be used to water flower-beds, shrubs, gardens and even indoor plants.

NOTES

[1]When environmental depletions are included (natural depletions not caused by human activities), agricultural and M&I depletions amount to less than half of the available water supply, or 30 and 6 percent, respectively.

[2]U.S. Bureau of Reclamation, "Institutional Water Management Measures." Retrieved from the Internet web page: 209.21.0.235/programs/modelplan/rra/watermgt_measures/institutional_ measures.htm, June 1999.

[3]Israelsen, O.W., and V.E. Hansen, *Irrigation Principles and Practices*, (New York: John Wiley and Sons, Inc., 1962), 447.

[4]Jensen, M.E. (ed.), *Design and Operation of Farm Irrigation Systems.* ASAE Monograph No. 3. (St. Joseph, MI: American Society of Agricultural Engineers, 1980), 829.

[5]Merriam, J.L. and J. Keller, *Farm irrigation system evaluation: A guide for management*, (Logan: Utah State University, 1978), 271.

[6]Gorelick, S. M. (ed.), "Conjunctive Water Use: Understanding and Managing Surface Water-Groundwater Interactions," *Int. Assoc. Hydrol. Sci. Publ*., (1986), 156&547.

[7]Hall, W., notes on Integrated River Basin Planning and Management prepared for the Central Water Commission, Government of India, the U.S. Agency for International Development, and Harza Engineering Company, in support of the Integrated Water Resources Planning Project, (New Delhi, India, 1990), 120.

[8]Pyne, R.D.G., P.C. Singer, and C.T. Miller, "Aquifer Storage and Recovery of Treated Drinking Water," (1999). Retrieved from the AWWA Research Foundation's Internet webpage: www.awwarf.com/exsums/ 90689.htm.

[9]City of Salem, Oregon, "Salem Oregon's Aquifer Storage and Recovery System." Retrieved from the Internet web page: www.open.org/~spubwork/water/asr.html.

[10]Tao, P., "Managing Water Shortage by Regional Cooperation and Conservation," in Austin, T.A. (Ed.), *National Water Conference*. Proceeding of the Specialty Conference, University of Delaware, Newark, July 17-20, 1989.

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WATER DEVELOPMENT

Since the beginning of Utah's pioneer settlement, water development has played an indispensable role. From the first diversion of Salt Lake Valley's City Creek in 1847 to the large scale projects of the 20th century, developing Utah's waters has been a mainstay of civilization. Although the past few decades have brought about significant changes and challenges for water resource planners and managers, water development will continue to play an important role in Utah's future. These challenges will be effectively met as decision-makers carefully consider all the engineering, economic, legal and environmental issues associated with each water project.

Water developments will continue to play an important role in meeting Utah's future water needs.

This chapter outlines some large water projects currently under construction or being investigated in Utah. This chapter also discusses a few small projects being planned by local entities, water development through weather modification, and infrastructure and funding needs.

WATER DEVELOPMENT PROJECTS

Figure 13 shows the location and general features of three of Utah's largest water development projects: the Central Utah Project, which is mostly complete with portions under construction and reevaluation; and the Bear River Project and the Lake Powell Pipeline, which are in the investigation stages.

Central Utah Project

Work on the Central Utah Project (CUP) began in the 1950s under the U.S. Bureau of Reclamation. Since 1992, the Central Utah Water Conservancy District (CUWCD), with oversight by the U.S. Department of the Interior (DOI), has been in charge of this project. The remaining features, the Uintah and Upalco units and portions of the Bonneville Unit, have undergone numerous studies and changes over the past several years in attempts to reach agreeable compromises among all the involved parties. The state of Utah supports the CUP and is working to help find such compromises.

The CUWCD has conducted numerous studies and worked with all interested parties since 1992 to reach an agreement on the Uintah and Upalco units. Thus far, the parties have not been able to come to an agreement. There are no active negotiations among the parties at this time, and it appears these units will be de-authorized. These projects were to develop flows of the Lake Fork and Yellowstone rivers and the Whiterocks and Uinta rivers for supplemental irrigation of non-Indian lands. They were also to provide water for municipal and industrial uses and instream flows for recreation and fish and wildlife.

Surface water reservoirs, such as Smith & Morehouse Reservoir shown above, are a familiar element of many water developments.

Section 203(a) of the Central Utah Project Completion Act (CUPCA) provides authorization for Uinta Basin Replacement Projects. The CUWCD and DOI have been working with the Moon Lake Water Users Association, the Duchesne County Water Conservancy District and other interested parties to develop a project. In February 2001, they released a Draft Environmental Assessment on the proposed Uinta Basin Replacement Project for public review and comment.

FIGURE 13
Major Future Water Development Projects in Utah

The proposed replacement project will double the size of Big Sand Wash Reservoir to 24,000 acre-feet, move water presently stored in four lakes in the Uinta Wilderness Area to the enlarged Big Sand Wash Reservoir, and provide instream flows in the Lake Fork River from Moon Lake to a new diversion about two miles upstream from the confluence with Pigeon Water Creek. The proposed project will also provide 7,500 acre-feet of storage space for new irrigation and M&I water for the Roosevelt area and 4,500 acre-feet of storage space for the high mountain lake water.

Two of the six Bonneville Unit Systems which provide a critical link to the Wasatch Front area have yet to be completed. These are the Diamond Fork System and the Utah Lake Drainage Basin Delivery System (Utah Lake System), the name given to the replacement project for Spanish Fork Canyon-Nephi Irrigation (SFN) System. The Diamond Fork System will convey water from Strawberry Reservoir to the mouth of Diamond Fork Canyon. The last segment of the Diamond Fork System is currently under construction and is scheduled for completion by June 2004. This system must be completed before the CUWCD can bring the full transbasin diversion of Bonneville Unit water from Strawberry Reservoir.

In March 1998, a Draft Environmental Impact Statement (DEIS) for the SFN System and the remaining section of the Diamond Fork System was released for public review and comment. Because of the significant issues raised by the Environmental Protection Agency, the Strawberry Water Users Association, and the Division of Water Quality on the DEIS, planning for the SFN System was discontinued.

Scoping for the Utah Lake System, as well as planning, environmental reviews, and obtaining a Record of Decision from the Secretary of the Interior, will likely take until 2004. How exactly the project water will be allocated is not known. Final design and construction of the project will probably require eight to ten years.

Bear River Development

In the Bear River Development Act, passed by the Legislature in 1991, the Division of Water Resources is directed to develop the surface waters of the Bear River and its tributaries. The act also allocates water among various counties and provides for the protection of existing water rights. The act allocates a total of 220,000 acre-feet of water annually as follows: the Jordan Valley Water Conservancy District and Weber Basin Water Conservancy District are entitled to 50,000 acre-feet each; and the Bear River Water Conservancy District and Cache County entities 60,000 acre-feet each. The total cost of the project is estimated to be between $130-260 million, depending upon which dam site is chosen. If the project is constructed, the state of Utah will be obligated to construct diversion and, if necessary, storage and delivery facilities to move the water as far south as Willard Bay. All other required conveyance and treatment systems will be the responsibility of the contracting entities.

Based on revised water need estimates, public response and cost analysis, the division's current plan is as follows: (1) modify the existing operation of Willard Bay by agreement with the Weber Basin Water Conservancy District to use it as a reservoir to store Bear River water, (2) connect the Bear River with a pipeline or canal to Willard Bay from a point near Interstate 15 and the crossing of the Bear River in Box Elder County, (3) construct conveyance and treatment facilities to deliver water from Willard Bay to the Wasatch Front, and (4) build a dam in the Bear River Basin. While parts (1) through (3) would be timed to deliver water to the Wasatch Front by about 2015, part (4) would be carried out when the Bear River Water Conservancy District or Cache County water users need additional water. If an agreement with the Weber Basin Water Conservancy District to share Bear River water in Willard Bay cannot be reached, part (4) may occur sooner.

Lake Powell Pipeline

Since the late 1980s, Washington County has experi enced the most rapid growth rate in Utah and one of the most rapid in the nation. Even though this high growth rate began to decline in 1996, it is expected to remain among the fastest growing areas in Utah through the first half of the century. Washington County Water Conservancy District estimates that presently developed supplies will sustain growth through about 2015. To meet growth beyond that point, it has a number of development proposals it hopes to implement over the next 50 years.

The Lake Powell Pipeline project would pump water out of Lake Powell and convey it 120 miles overland to the St. George and Kanab areas. (Photo of Lake Powell courtesy of Tom Till.)

The largest of the proposals being investigated is piping Colorado River water into the area from Lake Powell, 120 miles away. Under the proposal, 70,000 acre-feet of water would be delivered to Washington County and approximately 10,000 acre-feet to Kane County. The estimated total cost of this project is about $257 million, with a total unit cost of $256 per acre-foot. If the cost to treat and deliver the water for M&I uses is also included, the unit cost works out to be $414 per acre-foot.[1] Although the water is not expected to be needed until about 2030, the district is working to obtain the necessary water rights, easements and rights-of-way.

Other Local Projects

There are numerous other water development projects under construction or investigation throughout Utah. Many of these are listed and explained in more detail in the river basin plans prepared over the last decade by the Division of Water Resources.[2] These projects range from rehabilitation or expansion of existing infrastructure that fully develop exising water rights to entirely new projects that develop additional water supplies.

The Duchesne and Uintah County Water Conservancy districts are investigating a number of projects within their service areas, that, if built, would develop over 100,000 acre-feet of water and cost more than $250 million. These projects would fill a variety of environmental and human needs including instream flows, fish conservation pools, flood control, secondary irrigation, municipal and industrial uses, and crop irrigation.

Power Generation

The western states' power crisis that began in 2000 has many regional and local power suppliers in Utah looking to increase their power generation capacities. This will enable them to meet future demands and meet current peak demands without having to rely on the wholesale market.

Utah's 2000 power requirement averaged about 3,000 megawatts. With the state's invitation to high-tech companies to locate in Utah, this requirement could easily double to as high as 6,100 megawatts by the year 2010. With or without these high-tech companies, Utah's power demand is expected to increase substantially over the next several decades as the population continues to grow.

Water use associated with power generation varies depending upon the size and the type of power plant. Coal-fired plants use between 15 and 25 acre-feet per year per megawatt of generating capacity. Most of this water is used for cooling the steam returning from the turbines. Newer plants, with natural gas-fueled jet-type engines, use between two and three acre-feet per year per megawatt. This water is used to reduce exhaust emissions and provide cooling. Some plants utilizing diesel or natural gas-fueled piston engines have self-contained cooling systems and use no water at all.

Expansion of several existing coal-fired plants is being investigated. These proposed expansions are expected to use an additional 20,000 acre-feet per year, most of which has already been acquired. New natural gas generation facilities being proposed have the potential to use another 1,000 acre-feet. Beyond these proposed plants, if new plants continue to be natural gas-fired, or hydroelectric, the requirement for additional water will be relatively small. However, if coal becomes the preferred fuel, the water requirements would be significant.

WEATHER MODIFICATION

Weather modification, or cloud seeding, has long been recognized as a means to enhance existing water supplies. Cloud seeding assists nature in the formation of precipitation, by providing droplet-forming nuclei at the proper times and places.

In mountainous regions like Utah, clouds form as moist air rises and cools during its passage up and over mountain ranges. By nature, many of these clouds are highly inefficient at releasing precipitation, retaining more than 90 percent of their moisture. Cloud seeding can greatly improve this precipitation efficiency. A schematic drawing of the process for seeding mountain clouds is shown in Figure 14. Typically, silver iodide is released into the air from strategically placed ground generators to produce artificial ice nuclei. Aircraft seeding is also used, but is much more expensive. The nuclei form ice crystals that attract moisture from the surrounding air, forming droplets large enough to fall to the ground as snow.

The first cloud seeding project in Utah ran from 1951 to 1955 in the central and southern portion of the state.

FIGURE 14
Cloud Seeding Process

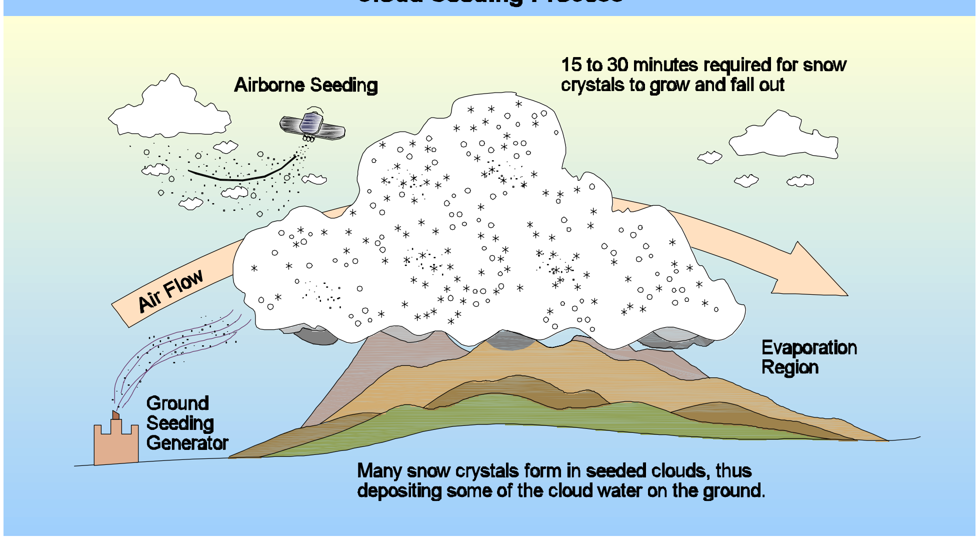
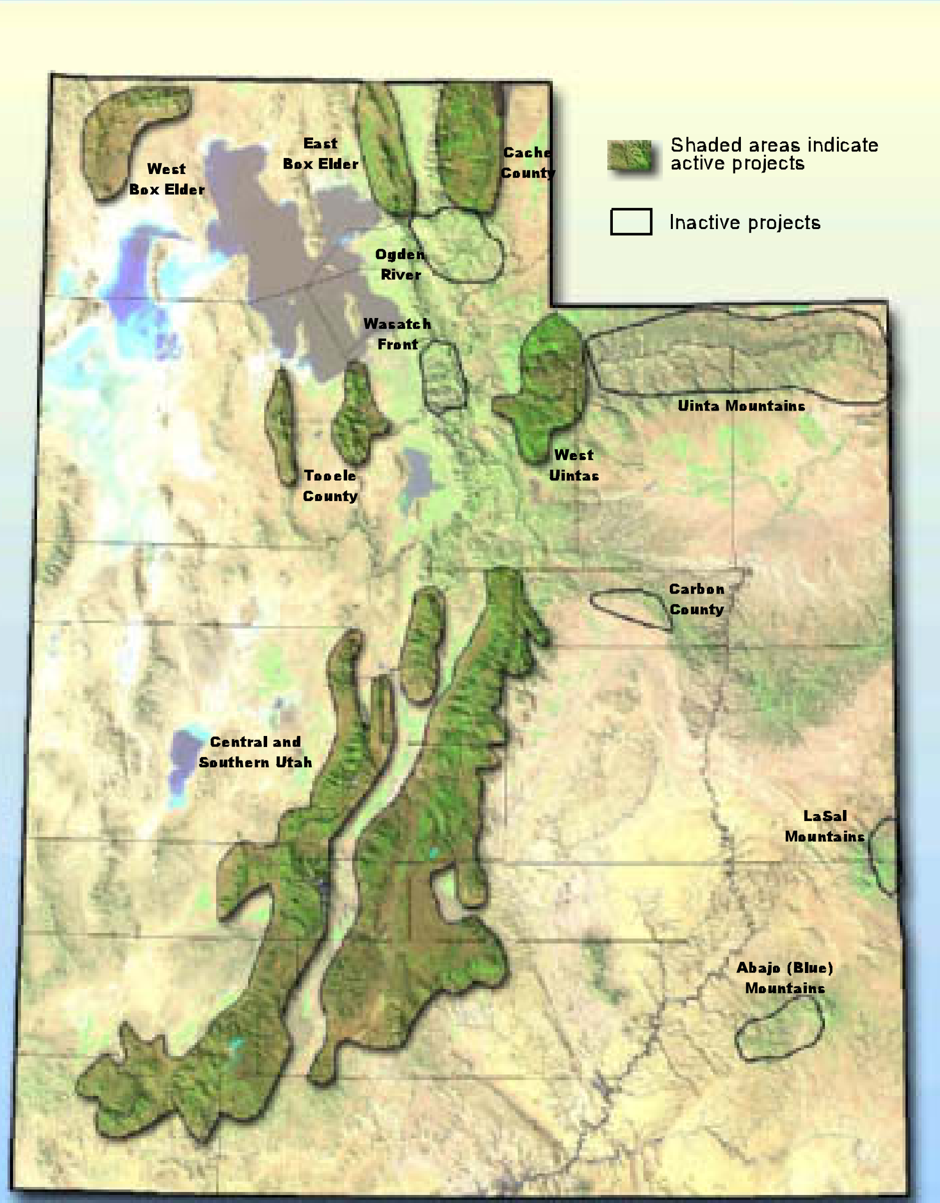


FIGURE 15
Cloud Seeding Project Areas



Source: TRC North American Water Consultants

Cloud seeding began again in central and southern Utah in 1973 and has continued to the present. Also in 1973, the Legislature passed the Utah Cloud Seeding Act. This law provides for licensing cloud seeding operators and permitting cloud seeding projects by the Utah Division of Water Resources. The act states that, for water right purposes, all water derived from cloud seeding will be treated as though it fell naturally. Since 1976, the state, through the Board of Water Resources, has shared the cost of cloud seeding projects with local entities.

Utah cloud seeding project areas are shown in Figure 15. In water year 2000 there were four active project areas in Utah. These were the Central and Southern Utah, Tooele County, West Box Elder County, and the East Box Elder/Cache county areas. The West Uintas project became active again in water year 2001.

A study conducted by the Division of Water Resources estimates that these areas have realized a 7-20 percent increase in April 1 snow water content. This translates into an increase in estimated average annual runoff of about 250,000 acre-feet, 13 percent above historical runoff in these areas. The division estimates the cost of water developed from cloud seeding these areas to be about one dollar per acre-foot.

Precipitation data from a number of cloud seeding projects have been examined for evidence of downwind effects. Results from these analyses show a slight increase in precipitation in areas up to 90 miles downwind from the project area. No decrease in precipitation has been detectable farther downwind from any long-term project.

Cloud seeding is most effective when it is continued over several years. This increases soil moisture, provides greater groundwater and spring flows, and sustains base flows in streams and rivers. Seeding only in dry periods will not be as effective because of the lack of seedable storm systems.

Upgrading and Enhancing Existing Infrastructure

The river basin plans, with a few exceptions, show that the drinking water systems in the state have sufficient water to meet needs through at least 2020. Although they have sufficient water rights, many do not have the capacity or facilities to actually divert and deliver this water.

In a 1999 survey of drinking water systems conducted by the Utah Division of Drinking Water, 91 percent of the respondents indicated that the overall physical condition of their system would need to be upgraded within the next 15 years, and 31 percent of the respondents indicated that their present system was deficient, particularly with respect to its ability to maintain minimum fire flows.[3] Solutions to these problems include additional sources, new and enlarged piping, more storage reservoirs, and additional or larger water treatment facilities.

In a 1999 survey, 91 percent of drinking water systems in Utah indicated that they will need system upgrades within the next 15 years. (Photo of water tank above Rockville Cemetery.)

The survey also revealed that 38 percent of systems do not collect enough revenue from water bills to meet the usual operation and maintenance expenses of their system, and only 30 percent of the systems collect sufficient funds to cover the costs of future improvements.[4]

Funding

Water projects have become increasingly complex and expensive. The developable water is now farther away and deeper in the ground, and the available dam sites need more work to make them suitable. Projects in or near urban areas must work around existing features and pay a higher price for land purchases, easements and rights-of-way. Environmental considerations also add to project costs, as habitat and species protection must be considered in project planning, construction and operation.

Ultimately water users must bear these increased costs. The water funding programs administered by state and federal governments have been important in developing water projects and infrastructure. These programs are generally low-interest loans that, when repaid, fund other water projects through a revolving fund.

Notes

[1]Boyle Engineering Corporation, *Water Supply Needs for Washington and Kane Counties & Lake Powell Pipeline Study*, (St. George, 1998), 12. Prepared for Washington County Water Conservancy District and the Utah Division of Water Resources.

[2]Copies of basin plans can be obtained by contacting the Division of Water Resources or over the Internet at the following address: www.nr.state.ut.us/wtrresc/planning/swp/ex_swp.htm.

[3]Utah Division of Drinking Water, *1999 Survey of Community Drinking Water Systems*, (Salt Lake City: Department of Environmental Quality, 2000), Appendix 11, 1&2. An annual survey prepared in cooperation with the Division of Water Rights and the Division of Water Resources. This survey, and the data it contains, is available on the Internet at the Division of Drinking Water's web site: www.deq.state.ut.us/eqdw.

[4]Ibid.

7

WATER QUALITY, THE ENVIRONMENT AND OTHER CONSIDERATIONS

If the state of Utah is to effectively meet its future water needs, it will involve more than simply providing adequate water supplies and delivery systems. Water supply decisions can greatly impact water quality, the environment, recreation, downstream water users and many other aspects of society. Water planners and managers need to be aware of these impacts and develop plans and strategies that fully consider them in order to make effective decisions.

> **Effectively meeting Utah's water needs involves more than providing adequate water supplies and delivery systems. Water quality, the environment and other issues must also be considered.**

This chapter discusses in detail the importance of water quality and the environment to the management of Utah's water resources. Other considerations such as land management and water yield, reserved water rights, and the Colorado River are also briefly discussed.

WATER QUALITY

About the middle of the 20th Century, the federal and state governments began to recognize the need to monitor and control the growing problem of water pollution. In 1953, the state Legislature established the Water Pollution Control Committee and the Bureau of Water Pollution Control. Later, with the passage of the federal Clean Water Act in 1972 and the federal Safe Drinking Water Act in 1974, strong federal emphasis was given to preserving and improving water quality. Today, the Utah Water Quality Board and Division of Water Quality and the Utah Drinking Water Board and Division of Drinking Water are responsible for the protection, planning and management of water quality in the state of Utah.

As a result of these state agencies, and the emphasis of the federal government on water quality, we enjoy much safer water systems than Utah's early settlers. However, due to the magnitude of growth and development that is projected to occur and the increase in water pollution that this growth will bring, Utahns will continue to face water quality challenges. Water resource planners and managers need to be increasingly aware of these problems and work closely together to satisfy future water quality needs.

Water Quality Concerns in Utah

Some of the water quality concerns that are of particular importance to the future of Utah's water resources are discussed briefly below:

Total Maximum Daily Load Program

Section 303 of the Clean Water Act directs each state to establish water quality standards to protect beneficial uses of surface and ground water resources. The Act also requires states to monitor water quality to assess achievement of these standards. Where water quality is found to be impaired, each state must then establish a total maximum daily load (TMDL) for each pollutant that contributes to the impairment. A TMDL sets limits on pollution sources and outlines how these limits will be met through implementation of best available technologies for point sources and best management practices for nonpoint sources.[1]

The U.S. Environmental Protection Agency (EPA) is responsible to assure that states comply with the Clean Water Act. Because of the complexity, controversy and cost of determining and implementing TMDLs, states have been hesitant to pursue aggressive programs. As a result, many states and the EPA are being sued by various activists for failure to comply with the law. Consequently, the EPA is becoming more aggressive with its TMDL program requirements. These requirements include the charge for states to provide some "reasonable assurance" of achievement as part of the TMDL. This and other changes will impact water resources activities in Utah. For example, changes to the National Pollution Discharge Elimination System (NPDES) will allow EPA to require certain dischargers causing significant water quality problems, who were previously unregulated, to obtain an NPDES permit. This is expected to impact certain concentrated animal feed-lot operations and aquatic animal production facilities.[2]

The Division of Water Quality is responsible to implement TMDL programs in Utah. In cooperation with state, federal and local stakeholders, the division is organizing and facilitating locally led watershed groups to establish TMDLs. Water managers and planners in Utah need to be familiar with water quality regulations, and actively participate in the development and implementation of TMDLs. This participation will help assure that the calculation of a TMDL includes an appropriate margin of safety that accommodates future development and growth.

Flood plain development disturbs valuable riparian habitat, diminishing important water quality and flood prevention functions. (Photo courtesy of Utah Division of Wildlife Resources)

Preservation and Restoration of Riparian and Flood Plain Corridors

Many riparian zones adjacent to Utah's streams and rivers have been severely impacted and construction has occurred in their corresponding flood plains. As urban growth expands, additional riparian and flood plain corridors are in jeopardy. Stream bank modification and channelization (often referred to as habitat modification) are the cause of many water quality impairments to Utah's streams. In 1998, the Division of Water Quality estimated that habitat modification was the cause of nearly 16 percent of Utah's stream water quality impairments.[3] Riparian zones and flood plains need to be preserved and protected because they help improve water quality and buffer the population from flooding.

Storm Water Discharge Permitting

Discharge of storm water runoff from industrial and urban landscapes into streams and rivers is a significant point source of pollution. Runoff and erosion from construction sites is also a contributor to this problem.

To address this concern the EPA initiated a two phase process for implementation of storm water management regulations. During the first phase of the process, most industries, as well as cities with more than 100,000 people, were required to obtain storm water discharge permits. Construction activities that disturbed more than five acres were also required to obtain a permit in order to provide sediment and erosion control.

In November of 1999, the EPA began implementing the second phase of the storm water regulations, requiring all communities in the nation's "urbanized areas" to develop storm water management plans by early 2003. In Utah, these new regulations affect cities in Cache, Weber, Davis, Salt Lake and Utah counties, which, based on the 1990 census, the EPA has declared urban. The second phase regulations will also affect all construction sites larger than one acre.

The Utah Division of Water Quality is working closely with affected communities to help them comply. Although Park City, as well as the surrounding area, is not yet affected by the new regulations, it is believed that after the 2000 census this area will also be declared urban and, therefore, be required to comply with the new regulations.

Nutrient Loading

Nutrient over-enrichment continues to be one of the leading causes of water quality impairment in the United States. Although these nutrients (nitrogen and phosphorus) are essential to the health of aquatic ecosystems, excessive nutrient loads can result in the growth of aquatic weeds and algae, leading to oxygen depletion, increased fish and macroinvertebrate mortality, and other water quality and habitat impairments.[4]

Nutrients enter waterways primarily through wastewater treatment plant effluent. Return flows from agriculture and runoff from heavily fertilized urban lawns and landscapes also contribute to total nutrient loading. Proper application of fertilizer on agricultural and urban landscapes and further treatment of wastewater effluent would be necessary to significantly reduce nutrient loads.

Concentrated Animal Feedlot Operations

Another concern receiving national and local attention is the impact animal feedlot operations (AFO) and concentrated animal feedlot operations (CAFO) have on water quality. These operations, where large numbers of animals are grown for meat, milk or egg production, can increase the biological waste loads introduced into rivers, lakes, and surface or ground water reservoirs. Animal manure contains nutrients, pathogens and salts. Because of the water quality problems created by CAFOs and the relative lack of stringent regulations to control the majority of these operations, the EPA and the U.S. Department of Agriculture recently developed a joint national regulation strategy.

The Utah Division of Water Quality, working together with the Utah Farm Bureau Federation, Utah Association of Conservation Districts, Dairy Association, Cattleman's Association, Woolgrowers, and representatives from the turkey, poultry and hog industries, prepared a Utah AFO and CAFO strategy that will satisfy the EPA's requirements. The Utah strategy has three primary goals: (1) to restore and protect the quality of our water for beneficial uses, (2) to maintain a viable and sustainable agricultural industry, and (3) to keep the decision making process on these issues at the state and local level.

Utah's strategy calls for a commodity-group assessment of all livestock operations. Following this assessment, a general permit will be issued covering all CAFOs with 1,000 animal units or more or smaller facilities with significant water pollution problems. The strategy provides a five-year window for facilities to make voluntary improvements. After this "grace" period, the initial focus of more stringent regulatory action will be directed toward those facilities located within priority watersheds with identified water quality problems.[5]

Septic Tank Densities

In many rural areas of Utah, where advanced wastewater treatment systems have not been constructed, individual septic tank systems are used to dispose of domestic wastes. As the population in such areas grows, the density of septic tanks typically increases. This threatens water quality by placing increasing demands on the environment's natural ability to dissipate the pollutants created.

Septic tank densities are of particular concern in the growing areas of Iron, Morgan, Summit, Wasatch, Washington and Weber counties. Septic tanks for summer home developments are also a concern in many other Utah counties, as they are commonly located in sensitive watershed areas. Unless alternative wastewater treatment systems are built, there may be restrictions placed on further development in these areas in the form of septic tank density regulations.

Water Quality Protection and Improvement Programs in Utah

Many state and federal programs are in place to improve the nation's and Utah's water quality. The Utah Pollutant Discharge Elimination System (UPDES) closely regulates point sources of pollution. This system has brought about significant improvement to water quality over the past 30 years and continues to play a valuable role. The Division of Water Quality is currently preparing a Nonpoint Source Pollution Plan to better handle nonpoint sources of pollution, which are believed to be responsible for 95 percent of the state's remaining water quality impairments.[6] The division will integrate this plan with the TMDL requirements using a watershed based approach. This approach seeks the participation and involvement of local stakeholders.

The Utah Division of Drinking Water is responsible for protecting Utah's drinking water sources. To accomplish this task, the division has implemented a drinking water source protection program which provides valuable guidelines and rules to help communities protect their water sources. The award winning efforts of the Salt Lake Valley Groundwater Protection Coalition is one example of the early successes of this source protection program.

The Salt Lake Valley Groundwater Protection Coalition

Most of the cities in the Salt Lake Valley have banded together with water improvement and conservancy districts, other water utilities, and an engineering consultant to form the Salt Lake Valley Groundwater Protection Coalition. Following guidelines set by the Division of Drinking Water, the Coalition has established a comprehensive program aimed at protecting the ground water underlying the Salt Lake Valley, Utah's most densely populated area.

This program includes a hydrologic model of the valley's ground water aquifer that is used to predict the movement of ground water and help pin-point sensitive recharge areas. The program also includes an effective public awareness campaign that educates citizens on the proper disposal of toxic chemicals and other pollutants. Furthermore, the program makes information available to developers, through city zoning commissions, on the best places to locate sensitive commercial ventures such as gas stations. This information helps cities avoid contamination of ground water often caused by such activities.

The quality of the coalition's program has received national attention. In 1997 it received the national grand award by the American Academy of Environmental Engineers. The EPA's Region VII office recognized the coalition's program in 1998 with the Environmental Achievement Award for its outstanding achievement in drinking water source protection. The program was again honored in 1999 by the American Consulting Engineers Council, receiving one of only 16 national honor awards for ground water protection.

The coalition is pleased that its program has made a difference in the protection of Utah's water resources and hopes to expand and improve the program in the future.

(From a personal communication with Brian Harris, Coalition team leader and staff member of the Jordan Valley Water Conservancy District, June 21, 1999.)

In order to comply with an agreement between the United States and Mexico to control the salinity of Colorado River water, the federal government implemented the Colorado River Salinity Control Program. This program's aim is to decrease salinity in the Colorado River by improving agricultural water use efficiency and reducing deep percolation. This program has had tremendous success in Utah due to the willingness of local sponsors to participate. Utah encourages further funding and participation in this program.

Coordination and Cooperation: Key to Effective Water Quality Management

Effective management of water quality requires significant coordination and cooperation. Water development or management activities that will impact water quality need to be properly coordinated with the appropriate agencies so that water quality impacts can be minimized or avoided. The public also needs to be integrated into the process so that its needs and concerns can be properly addressed.

The Division of Water Quality has recognized the importance of working together with all the stakeholders and has established a watershed-based approach to help fully achieve its water quality objectives. In 1996, the division produced a publication entitled, "Utah Watershed Approach Framework," outlining how the approach is to be implemented.

The state of Utah hopes that a spirit of cooperation and the participation of more water resources stakeholders will increase the effectiveness of efforts to achieve water quality objectives. Such an effort is especially crucial in meeting water quality standards outlined in TMDLs. The formation of localized groups provides federal and state agencies with the choice opportunity to coordinate their management plans with the local stakeholders and other concerned agencies.

The Environment

For much of the 20th century, water management activities in the United States focused mainly on the development and control of the nation's water resources. This was done in an attempt to bring growth and prosperity to vast regions of the continent. This was particularly true in the West where Utah and other states enthusiastically welcomed many federally-funded water projects.

With the construction of large dams on the Colorado River came a host of unconsidered and unforeseen environmental impacts. Mitigating these impacts continues to this day. (Photo of Glen Canyon Dam courtesy of Patrick Cone.)

At that time, environmental values associated with water resources were not well understood. Since the 1970s, however, the arena in which water managers and planners operate has undergone enormous change. These environmental values are now better understood and there is an effort throughout the country to protect the environment from further unnecessary degradation and mitigate or restore areas impacted from past actions.

Amid this growing environmental movement, Utah's population continues to grow and the competition for finite water resources among various users continues to increase. Experienced water planners and managers may feel frustrated in their attempts to meet these growing needs because environmental concerns have made the implementation and management of needed water development projects difficult, if not impossible. The challenge for water planners and managers today is to integrate environmental policies and strategies into their operations in order to provide balanced and comprehensive solutions to water supply problems.

Water Resources and the Environment: A Relationship in the Balance

Over the years, there has been little cooperation between the environmental community and natural resources managers in obtaining balanced solutions to environmental problems. Typically, these interests have been characterized as enemy forces brought to the negotiation table out of necessity, unwilling to bend or compromise their respective agendas. This unhealthy decision-making environment rarely produces satisfactory solutions. To effectively handle these problems, both sides need to understand and balance the water needs of the environment with those of a growing population.

It is important to recognize that continued population growth will create a need for future water developments in Utah. Whether these will be new developments or upgrades of existing developments, the environment will be affected. While some development may harm the delicate balance that is important to a healthy, functional ecosystem, other developments may actually enhance certain aspects of the ecosystem, creating valuable habitat and benefitting wildlife.

Whether good or bad, changes to the environment will occur. It is the responsibility of water managers and planners to minimize the impacts that water developments have on the environment.

Important Environmental Values Affecting Water Resources in Utah

In Utah, environmental values have either already profoundly influenced water resources planning and management or have the potential to do so. These include endangered species, wetlands, the Great Salt Lake, instream flow maintenance, Wilderness designation, and Wild and Scenic River designation. Each is discussed briefly below.

<u>Endangered Species</u>

As of the year 2000, 29 plant species and 20 animal species in Utah were listed as threatened, endangered or candidate species. At least one could be found in each of Utah's 29 counties. Of the state's nine endangered animal species, seven were fish whose numbers have reached critical levels due to altered flow patterns, water temperatures and human-introduced predatory species.

The Endangered Species Act (ESA) of 1973 gives the U.S. Fish and Wildlife Service the power to recover and conserve all forms of plants and animals found to be threatened or in danger of extinction. As such, the ESA is one of the nation's broadest and most powerful environmental laws. It has also been controversial and the source of intense public debate involving three premises important to state and local government officials. These premises are private property rights, state primacy and natural resource protection.

The Utah Department of Natural Resources is currently engaged in cooperative efforts with local governments, private property owners and federal agencies to balance species protection with development of natural resources, including water. These efforts attempt to provide affected parties with protection against uncertainty, regulatory delays and the high cost of federal threatened or endangered species recovery programs.

Two such recovery programs that affect water resources in Utah, are the Upper Colorado River Endangered Fish Recovery Program and the San Juan River Basin Recovery Implementation Program. These programs aim to protect and recover several native Colorado River fish species that have become endangered due to human activities, while allowing for continued water development of the river. Utah is a funding partner on the Upper Colorado River program. Strong support for these programs exists from both the environmental and water communities, as they protect the fish and the interests of water users. The outlook for the success of both programs is promising, fish numbers are increasing and habitat improvements appear to be helping to create sustainable fish communities. Continued funding is necessary if all the program's goals and objectives are to be achieved.

<u>*Wetlands*</u>

Wetlands are defined by the Clean Water Act as "those areas that are inundated or saturated by surface or

Wetlands are vital habitat for a variety of animal species. Migratory birds are frequent visitors to Utah's wetlands. (Photo courtesy of Tony Morgan.)

ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."[7] Wetlands are among the most biologically productive natural ecosystems in the world. Wetlands provide many benefits to the people of Utah; they provide natural flood protection, improve water quality, assist in stormwater management, and afford unique opportunities for recreation, education and research.

Approximately 50 percent of Utah's wetlands are lo cated around the Great Salt Lake. The state's remaining wetlands are found scattered throughout the West Desert and high mountain meadows and valleys, and adjacent to rivers, streams and lakes. Most of the Great Salt Lake wetlands are located between the lake and the Wasatch Front, which is the most populated area in the state. These wetlands are widely recognized for their significance; they form an important part of one of the nation's most significant migratory bird routes. The state is working closely with local and federal agencies to assure that wetlands are protected as the needs of Utah's growing population are accommodated.

Riverton City's Secondary Water System

Riverton City has recognized the value of wetlands to its water management programs. It has recently installed a secondary water system which incorporates wetlands as part of the delivery system.

This system uses canal water from Utah Lake, drainage water from Rose Creek, and ground water from shallow wells to provide the citizens of Riverton City with untreated water for outdoor irrigation instead of high quality drinking water.

The project includes 10 acres of constructed wetlands including pond-like and riparian wetlands. The ponds act as holding cells for a maximum daily delivery capacity of 12 million gallons. It is expected that filtering the water through these wetlands will decrease the total dissolved solids of the water as well as control odor, both problems that have limited the use of Utah Lake water in the past.

(From, *Water Conservation Credit Program*, Central Utah Water Conservancy District, March 1998.)

The Great Salt Lake

The Great Salt Lake is one of Utah's natural wonders, and is also recognized internationally as a resource of particular significance. It is an important economic, educational and recreational resource. The lake also influences the climate of a major segment of the Wasatch Front and is a potential flood hazard. All this emphasizes the need to better understand the Great Salt Lake ecosystem, in particular, the impacts that existing developments have had on the lake. This increased understanding will allow future resource decisions to be made wisely.

The Utah Department of Natural Resources has prepared a comprehensive management plan for the Great Salt Lake. The general objectives of the plan are to protect and sustain the lake and its resources, and "to provide for reasonable beneficial uses of those resources, consistent with their long-term protection and conservation."[8] This plan will help foster greater coordination of lake management efforts of various agencies and lead to better understanding of the Great Salt Lake ecosystem.

Instream Flow Maintenance

Over the past several decades, instream flow maintenance has had more and more of an affect on water resources development and management. Previously undervalued instream uses of water for recreation, ground water recharge, and fish and wildlife habitat, are now recognized alongside agricultural irrigation, domestic consumption, and industrial and energy production as beneficial uses of water resources in most states. Further emphasis to instream flows is given by our society's relative wealth of leisure time which has increased interest in white water kayaking, rafting, and canoeing, as well as fishing and hiking.[9]

Legislative action was taken to maintain instream flows in Utah in the late 1980s with an instream water rights provision added to the *Utah Code*[10], and again in the early 1990s as an integral part of the Central Utah Project Completion Act (CUPCA). The provisions of these two legislative actions are detailed in the following sections.

Instream Water Rights

The ability to obtain instream water rights in Utah lies exclusively with the Division of Wildlife Resources and the Division of Parks and Recreation. The *Utah Code* allows these two state agencies to file changes on perfected water rights in order to provide instream flows in designated reaches of streams. These flows may be acquired for preservation and enhancement of fisheries, the natural stream environment, or public recreation. Acquisition of such water rights is dependent upon legislative appropriations and a willing seller, unless the water right is previously owned by the agency or is gifted or deeded to it.

The *Utah Code* also authorizes the State Engineer to reject an application to appropriate water or to change use of a water right if, in the State Engineer's judgment, approval would unreasonably affect public recreation or the environment by decreasing instream flows. In this sense, an instream water right is not the only way that instream flows can be protected. In addition to actual instream water rights, numerous instream flow requirements exist around the state. These minimum flows are typically part of an agreed project operation or permit requirement, much like those instream flows

Designation of stream segments with outstanding scenic and wilderness values as "Wild and Scenic" should be done in the spirit of the Wild and Scenic River legislation. (Photo of Stevens Arch above the Escalante River courtesy of Tom Till.)

discussed below as part of the Central Utah Project (CUP).

Central Utah Project
In order to gain approval for the CUPCA and receive needed funding to complete the CUP, several key environmental items, including instream flow maintenance, were added to the legislation. These instream flows differ from the instream water rights discussed previously in that the water left in the stream to maintain minimum flows is not an actual water right. Rather, it is an instream flow agreement. This means that water rights will be purchased from willing sellers and project reservoirs and diversion structures will be operated in a manner that will maintain minimum instream flows.

Wilderness Designation

Wilderness designation of Utah lands has been the subject of heated debate since the early 1980s. Wilderness proponents have concluded that a significant portion of the federal lands in the state qualify for designation as wilderness. State and local leaders are deeply concerned by the potential impacts that such broad-sweeping designations will have on state and local resources.

Wilderness is believed by many to be the most restrictive federal land management designation. As such, development within these areas becomes very difficult, if not impossible. Use of existing water supplies and facilities would also be restricted to prior uses, thus prohibiting some changes or upgrades needed to meet future needs. Access for maintenance would also be restricted. Careful consideration of all impacts should be made before designating areas as wilderness or wilderness study areas. Current and potential uses of water needs must be considered when evaluating the impact of wilderness designation.

Wild and Scenic River Designation

The Wild and Scenic Rivers Act (WSRA) of 1968 states that, "certain selected rivers of the nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."[11] Designation of a stream or river segment as "wild and scenic" would prevent construction of flow modifying structures or other facilities on such river segments. The area for which development is limited along a wild and scenic river varies from river to river but includes at least the area within one-quarter mile of the ordinary high water mark on either side of the river.

Currently there are no rivers in Utah with the Wild and Scenic River designation. Although a 30-mile section of the Colorado River (upstream of its confluence with the Dolores River) was designated for special study, it was never designated as part of the Wild and Scenic River System. In recent years, however, national forests and other federal agencies have made inventories of Utah streams for consideration as wild and scenic rivers. Environmental groups have compiled similar lists with literally thousands of miles of rivers for consideration. These include portions of the Green, Colorado, Logan and Weber rivers as well as their tributaries, including the North Fork of the Duchesne River.

Before designating streams and rivers as "wild and scenic," state, federal and local agencies should assure that all the potential water management and other resource impacts such designation would have far into the future are assessed. They must also ensure that designation is done in the spirit of the WSRA and not simply used as a tool to impede water and other important resource development.

Incorporating Policies and Strategies to Address Environmental Values

Effectively managing Utah's water resources amidst the often opposing demands for its use is a daunting task facing the state's water managers and planners. The success of such efforts will rely heavily on the incorporation of policies and strategies that address the many sensitive and controversial environmental values discussed in this chapter.

Educating the public concerning future water needs, water management and the environment is a crucial element in obtaining a proper balance in the decision-making process. An educated public is more likely to participate in water management discussions and make meaningful contributions to the debate. Increased public participation also fosters greater support for water management programs and objectives.

OTHER CONSIDERATIONS

In addition to water quality and environmental values, there are many other considerations that must be considered in order to make good water-related decisions. The remainder of this chapter discusses some of the more significant of these considerations.

Land Management and Water Yield

The federal government, primarily the U.S. Forest Service and the Bureau of Land Management, administers about two-thirds of the land area in the state of Utah. More significantly, they own and manage the headwaters of almost all the watersheds from which the state's surface water supply is derived and the state's population is dependent. Utah is concerned about the ability of these lands to yield a high quality, nondeclining supply of water to its communities for agricultural, M&I and other uses.

Since the 1920s, federal agencies have been very successful in suppressing natural fire. Consequently, there has been a buildup in standing vegetation (biomass) on these lands. This well documented phenomenon may be reducing overland flow of runoff and increasing losses to evapotranspiration, which will ultimately reduce water yields from historical levels. Additionally, this buildup of biomass will also increase the probability of catastrophic fire, which can result in serious flash flood flows. Such flows can carry huge loads of sediment and debris into streams and rivers, as well as water storage and distribution features, seriously disrupting natural and man-made water systems. Federal agencies should practice responsible watershed management that will help ensure a continued high quality, nondeclining supply of water to meet the state's increasing needs.

Reserved Water Rights

Among the unknowns that could affect Utah's water future is the quantification of federal reserved water rights. These rights are associated with federal land reservations including Indian reservations, national parks and monuments, and national forests. While some reserved water right claims have been settled in the state, most have not. Many remain unsettled because of questions related to quantification methodology, a lack of funding, and potential conflicts with existing water rights. Additionally, the federal government is not required to identify and quantify its reserved water rights until a general water rights adjudication is done for the river basin in which the claims are located.

The Winters doctrine, *Winters vs. United States* (207 U.S. 564 [1908]), and subsequent cases, form the basis for defining federal reserved water rights on Indian and other federal reservations. It states that when the federal government reserves land from the public domain, water rights are implicitly reserved of sufficient quantity to meet the primary purposes for which the reservation was established. Generally, quantifying a federal reserved right requires specifying: (1) the amount of water claimed, (2) the water sources, (3) the primary purposes of the reservation for which the water is needed (in the case of Indian reservations, the practicably irrigable acreage), and (4) the priority date of the claim.[12]

As of early 2001, the only Indian reserved water right claim in Utah that has been completely settled is that of the Shivwits Band of the Paiute Indians in Washington County. Under the settlement agreement, the Shivwits Band will receive 4,000 acre-feet of water per year. Half of this will be delivered by the existing Santa Clara Project; the other half will be provided by the future St. George Reuse Project (1,900 acre-feet) and increased production of wells on the reservation (100 acre-feet).

Claims of the Northern Ute Indian Tribe of the Uintah and Ouray Indian Reservation in Duchesne, Uintah and Grand counties are also on the table. Although Congress has passed a final compact agreement, the Northern Ute Indian Tribe and the state of Utah have yet to ratify the compact. The claims of the Navajo Indian Tribe in southern San Juan County will also likely be brought to the table in the future.

Other recent discussions of reserved rights in Utah involved non-Indian rights for national parks and monuments. These claims are usually for instream flows and non-consumptive resource protection, and generally do not involve large amounts of water. Recently, the reserved water rights claim for Zion National Park was successfully negotiated by local water officials, the state and federal agencies. Other possible non-Indian claims for water may be for some wilderness areas, wildlife refuges and national forests, although the extent of such claims has not been resolved. The concern with these types of claims is the effect they will have on existing water users and future water development, since the priority date of the reserved water rights is the date that the reservation was created and generally precedes many established water rights.

Utah's current position regarding the interplay between federal and state water rights is one of negotiation rather than litigation.[13] It is the state's hope that this approach to negotiation will continue to bear fruit. A spirit of cooperation will help solve the difficulties that will arise in trying to settle these claims.

Colorado River

Beginning with the 1922 Colorado River Compact, there have been several actions that have allocated the waters of the Colorado River. Collectively these are known as the "Law of the River." Accordingly, Utah's allocation is approximately 1.73 million acre-feet per year. In view of the fact that these actions were negotiated during a period of above normal precipitation, a more realistic analysis leaves Utah's share at about 1.37 million acre-feet per year.

Current depletions to Utah's Colorado River allocation add up to about 950,000 acre-feet per year. Much of this is diverted from tributaries to the Colorado River. The biggest users are agricultural interests in the Uintah Basin and Carbon, Emery and Wayne counties. Water is also exported to the Wasatch Front by the Bonneville Unit of the Central Utah Project; two of Utah's first large-scale water projects, the Provo River and Strawberry projects; and several other smaller diversions.

Utah has an estimated 420,000 acre-feet per year of its Colorado River water that it can yet use. Projections are that annual demand will continue to increase such that about 194,000 acre-feet could remain unused in 2020 and about 43,000 acre-feet would remain unused in 2050. Steady increases in M&I uses, settlements of reserved water right claims, along with a handful of small agricultural irrigation projects, will contribute to this reduction.

Many battles have been raged over the Colorado River, giving credence to the saying that is common in the West: "Water is more valuable than gold." (Photo of sandstone reflection on water courtesy of Tom Till.)

Notes

[1]U.S. EPA, "Total Maximum Daily Load (TMDL) Program." Retrieved from EPA's Internet web page: www.epa.gov/owow/tmdl/intro.html, March 2000.

[2]Ibid.

[3]Utah Division of Water Quality, *Utah Water Quality Assessment Report to Congress 1998*, (Salt Lake City: Dept. of Environmental Quality, 1998), 12, 40&42.

[4]U.S. EPA, "National Nutrient Assessment Strategy: An Overview of Available Endpoints and Assessment Tools," 12-28. Retrieved from the EPA's Internet web page: www.epa.gov/owowwtr1/NPS/proceedings/overview.html, on June 1999.

[5]Utah Department of Agriculture and Food, "Animal Feeding operations... A Utah Strategy: How Will it Affect You?" A brochure prepared in cooperation with EPA, USDA, NRCS, Utah Department of Environmental Quality, Utah Association of Conservation Districts, and USU Extension, (Salt Lake City: 1999).

[6]Utah Division of Water Quality, 1998, 40.

[7]U.S. Environmental Protection Agency, *America's Wetlands - Our vital link between land and water*, (Washington D.C.: EPA, Office of Wetlands, Oceans and Watersheds, Wetlands Division (4520F)).

[8]Utah Department of Natural Resources, *Great Salt Lake Comprehensive Management Plan and Decision Document*, (Salt Lake City: 2000), 1-2.

[9]Whipple, William Jr., *Water Resources: A New Era for Coordination*, (Reston, Virginia: ASCE Press, 1998). This document, published by the American Society of Civil Engineers, provides valuable insights into the changing field of water resources and the associated challenges facing water resource planners and managers.

[10]Utah Legislature, *Utah Code 73-3-3*, as amended by Chapter 208, 1992 General Session, (Salt Lake City: Utah Legislature, 1992).

[11]U.S. Congress, *Wild and Scenic Rivers Act*, P.L. 90-542, as amended, 16 U.S.C. 1271-1287, (Washington D.C.: Government Printing Office, 1986).

[12]Utah Agricultural Experiment Station, *Wilderness Designation in Utah: Issues and Potential Impacts*, Research Report #151, January 1995.

[13]State of Utah, Memorandum from Michael M. Quealy, Assistant Attorney General, to Jim Alder, "Legal Counsel to the Western States Water Council,"October 22, 1998.

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CONCLUSION: PUTTING THE PIECES TOGETHER

One of the guiding principles behind the preparation of *Utah's Water Resources: Planning for the Future* is that the responsibility for making many water-related decisions resides with local leaders. Amidst the many issues now facing these leaders, successfully meeting the future water needs of their communities has become a complex and perhaps a frustrating endeavor. To better address these challenges, local decision-makers need to adopt a balanced viewpoint and perspective of the issues. Obtaining this perspective involves educating the public on current water resources issues and seeking their input in the decision-making process. The state of Utah wants these communities to succeed, and, as stated in another of the guiding principles, has defined its role as follows: "The state of Utah's role is to set policy, provide assistance and protect statewide water resource interests." Working together with the public and government agencies with water-related responsibilities, local leaders will have the tools and the support needed to meet the future needs of their communities.

The responsibility for making many water-related decisions resides with local leaders.

This chapter looks briefly at the important roles of local stakeholders and government agencies with regards to Utah's water resources. Successfully fulfilling these roles will assure a bright and prosperous future for Utah and its natural beauty.

LOCAL STAKEHOLDERS: THE RESOURCES' BEST STEWARDS

Stakeholders in the water resources arena are any individuals or organizations that have an interest or role in water management activities. This includes people who live, work or recreate within the management area as well as local, state and federal agencies. Local stakeholders need to play an important role in the planning and decision-making process within their communities. They are the ones who depend upon the water and other resources for their livelihoods and without whose support water management activities are largely unsuccessful. These individuals are also the ones most likely to be stewards over their resources. Not doing so may impair their ability to sustain themselves and future generations.

Although local stakeholders are key players in water resources planning and management, they often lack the financial resources, technical data, and knowledge of regulation required to identify and implement all elements of an effective water resource management plan. Therefore, some sort of state and federal government role is necessary.

Involving all local stakeholders through public meetings or other means is essential to effective resource management.

THE ROLE OF GOVERNMENT: PROVIDING DIRECTION AND ASSISTANCE

State and federal agencies are important contributors to effective water resources planning and management. These agencies can offer valuable technical and financial resources that can assist local decision-makers make their planning and management efforts more effective.

State and federal agencies possess a wealth of technical data and knowledge regarding water resources and associated issues. These agencies need to continue to make this information readily available to local stakeholders who have neither the time nor the resources to collect and research such information. This allows them to make educated decisions based on sound scientific facts. State and federal agencies can foster a spirit of cooperation by attending local planning activities and meetings. Active participation by these agencies will also help ensure that local plans comply with state and federal laws and regulations.

MEETING THE CHALLENGES OF THE FUTURE THROUGH COOPERATIVE EFFORTS

In the Governing 2000 Conference, Governor Michael O. Leavitt addressed the challenges facing information technology in state government with the following words: "Fight it and perish, accept it and survive, or lead and prosper." The same could be said of the challenges now facing Utah's water industry.

Water resource challenges are complex–solutions generally involve many stakeholders and often stir emotional public debate and scrutiny. Water planners and managers must rise to the occasion and resolve these problems with care and deliberation. The timing and size of needed new water developments must be carefully balanced against the ability of water conservation and efficient management of existing water supplies to meet future needs. Water quality needs, environmental values, and other issues must be understood and properly considered. Doing this, and cooperating with federal, state and local interests in the planning and decision-making process, will enable local leaders to meet the future water needs of their communities while preserving the aesthetic and ecological integrity of the environment around them.

With appropriate attention given to all the issues, Utah's population can grow in harmony with its diverse wildlife and breathtaking landscapes. (Photo from Capitol Reef National Park near visitor center courtesy of Patrick Cone.)

GLOSSARY

Acre-Foot (ac-ft) - The volume of water it takes to cover one acre of land (a football field is about 1.3 acres) with one foot of water; 43,560 cubic feet or 325,850 gallons. One acre-foot is approximately the amount of water needed to supply a family of four with enough water for one year (assuming a use rate of 225 gpcd).

Animal Feedlot Operations (AFO) - A lot or facility where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period; and where crops, vegetation, forage growth, or post-harvest residues are not sustained over any portion of the lot or facility in the normal growing season.

Aquifer - A geologic formation that stores and/or transmits water. A confined aquifer is bounded above and below by formations of impermeable or relatively impermeable material. An unconfined aquifer is made up of loose material, such as sand or gravel, that has not undergone settling, and is not confined on top by an impermeable layer.

Beneficial Use - Use of water for one or more of the following purposes including but not limited to, domestic, municipal, irrigation, hydro power generation, industrial, commercial, recreation, fish propagation, and stock watering; the basis, measure and limit of a water right.

Commercial Use - Water uses normally associated with small business operations which may include drinking water, food preparation, personal sanitation, facility cleaning and maintenance, and irrigation of landscapes.

Concentrated Animal Feedlot Operations (CAFO) - An animal feedlot operation (see above) where more than 1,000 animal units are confined, or 301 - 1,000 animal units are confined and waters of the United States pass through the facility or the operation discharges via a man-made device into waters of the United States. Also, AFOs can be designated as CAFOs on a case-by-case basis if the NPDES permitting authority determines that it is a significant contributor of pollution to waters of the U.S.

Conjunctive Use - Combined use of surface and ground water systems to optimize resource use and minimize adverse effects of using a single source.

Conservation - According to Webster's Dictionary, conservation is the act or process of conserving, where conserve is defined as follows: (1) To protect from loss or depletion, or (2) to use carefully, avoiding waste. In this document, the second definition is used exclusively. However, in the water resources field the first definition is also used. Using the first definition, constructing a reservoir to capture excess runoff in order to more fully utilize the water is also considered conservation.

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.

Culinary Water - See "Potable Water."

Depletion - The net loss of water through consumption, export and other uses from a given area, river system or basin. The terms consumptive use and depletion, often used interchangeably, are not the same.

Developable - That portion of the available water supply that has not yet been developed but has the potential to be developed. In this document, developable refers to the amount of water that the Division of Water Resources estimates can be developed based on *current* legal, political, economic and environmental constraints.

Diversion - 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. This is often referred to as withdrawal.

Drinking Water - See "Potable Water."

Dual Water System - See "Secondary Water System."

Efficiency - The ratio of the effective or useful output to the total input in a system. In agriculture, the overall water-use efficiency can be defined as the ratio of crop water need (minus natural precipitation) to the amount of water diverted to satisfy that need.

Eutrophication - The process of increasing the mineral and organic nutrients which reduces the dissolved oxygen available within a water body. This condition is not desirable because it encourages the growth of aquatic plants and weeds, is detrimental to animal life, and requires further treatment to meet drinking water standards.

Evapotranspiration - The scientific term which collectively describes the natural processes of evaporation and transpiration. Evaporation is the process of releasing vapor into the atmosphere through the soil or from an open water body. Transpiration is the process of releasing vapor into the atmosphere through the pores of the skin of the stomata of plant tissue.

Export - Water diverted from a river system or basin other than by the natural outflow of streams, rivers and ground water, into another hydrologic basin. The means by which it is exported is sometimes called a transbasin diversion.

Gallons per Capita per Day (gpcd) - The average number of gallons used per person each day of the year for a given purpose within a given population.

Ground Water - Water which is contained in the saturated portions of soil or rock beneath the land surface. It excludes soil moisture which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

Hydrology - The study of the properties, distribution, and effects of water in the atmosphere, on the earth's surface and in soil and rocks.

Incentive Pricing - Pricing water in a way that provides an incentive to use water more efficiently. Incentive pricing rate structures include a base fee covering the system's fixed costs and a commodity charge set to cover the variable costs of operating the water system.

Industrial Use - Use associated with the manufacturing or assembly of products which may include the same basic uses as a 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 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.

Instream Flow - Water maintained in a stream for the preservation and propagation of wildlife or aquatic habitat and for aesthetic values.

Mining - Long-term ground water withdrawal in excess of natural recharge. (See "Recharge," below.) Mining is usually characterized by sustained (consistent, not fluctuating) decline in the water table.

Municipal Use - This term is commonly used to include residential, commercial and institutional water use. It is sometimes used interchangeably with the term "public water use," and excludes uses by large industrial operations.

Municipal and Industrial (M&I) Use - This term is used to include residential, commercial, institutional and industrial uses.

Nonpoint Source Pollution (NPS) - 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.

Nutrient Loading - The amount of nutrients (nitrogen and phosphorus) entering a waterway from either point or nonpoint sources of pollution. Nutrients are a byproduct of domestic and animal waste, and are present in runoff from fertilized agricultural and urban lands. Nutrients are not typically removed from wastewater effluent, and if present in excessive amounts result in growth of aquatic weeds and algae.

Phreatophyte - A plant species which extends its roots to the saturated zone under shallow water table conditions and transpires ground water. These plants are high water users and include such species as tamarisk, greasewood, willows and cattails.

Point Source Pollution - Pollutants discharged from any identifiable point, including pipes, ditches, channels and containers.

Potable Water - Water meeting all applicable safe drinking water requirements for residential, commercial and institutional uses. This is also known as culinary or drinking water.

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.

Public Water Supply - Water supplied to a group through a public or private water system. This includes residential, commercial, institutional, and industrial purposes, including irrigation of publicly and privately owned open areas. As defined by the State of Utah, this supply includes potable water supplied by either privately or publicly owned community systems which serve at least 15 connections or 25 individuals at least 60 days per year.

Recycling - See “Reuse.”

Recharge - Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gain from precipitation, or artificially as the result of man’s influence. Artificial recharge can occur by diverting water into percolation basins or by direct injection into the aquifer with the use of a pump.

Residential Use - Water used for residential cooking; drinking; washing clothes; miscellaneous cleaning; personal grooming and sanitation; irrigation of residential lawns, gardens, and landscapes; and washing automobiles, driveways, etc.

Reuse - The reclamation of water from a municipal or industrial wastewater conveyance system. This is also known as recycling.

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.

Safe Yield - The amount of water which can be withdrawn from an aquifer on a long-term basis without serious water quality, net storage, environmental or social consequences.

Secondary Water System - Pressurized or open ditch water delivery system 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.

Self-supplied Industry - A privately owned industry that provides its own water supply.

Stakeholders - Any individual or organization that has an interest in water management activities. In the broadest sense, everyone is a stakeholder, because water sustains life. Water resources stakeholders are typically those involved in protecting, supplying, or using water for any purpose, including environmental uses, who have a vested interest in a water-related decision.

Total Maximum Daily Load (TMDL) - As defined by the EPA, a TMDL “is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. [Its] calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality.” The TMDL must also provide some “reasonable assurance” that the water quality problem will be resolved. The states are responsible to implement TMDLs on impaired water bodies. Failure to do so will require the EPA to intervene.

Water Audit - A detailed analysis and accounting of water use at a given site. A complete audit consists of an indoor and outdoor component and emphasizes areas where water could be used more efficiently and waste reduced.

Water Yield - The runoff from precipitation that reaches water courses and therefore may be available for human use.

Watershed - The 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.

Wetlands - Areas where vegetation is associated with open water and wet and/or high water table conditions.

Withdrawal - See “Diversion.”

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UTAH STATE WATER PLAN
Utah's Water Resources: Planning for the Future

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