BEAR RIVER BASIN
PLANNING FOR THE FUTURE

January 2004

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 and other state water plans are available online at: www.water.utah.gov.

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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, one of many in the "Utah State Water Plan" series, is intended to guide and direct water-related planning and management in the Bear River Basin 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 also made it available on the Internet. It can be accessed through the Utah State Water Plan home page at: www.water.utah.gov/planning/swp/ex_swp.htm. 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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CHAPTER 1 INTRODUCTION

The purpose of this document is to provide planners with a snapshot of the current use of water throughout the Bear River Basin, and a projection of how those uses may change over the next 20 to 50 years. Through the years it is anticipated that social, technologic and economic changes will all have an impact on the basin's water-related issues and concerns. Consequently, the state water-planning process and the basin-planning process have been dynamic in nature and, as such, plans will be re-written as necessary to ensure that the information they contain is current and accurate.

The Bear River Basin has a plentiful water supply and is one of the few areas in the state with a significant amount of developable water. It is anticipated that Bear River water will eventually be developed to satisfy growing needs for areas within and outside the basin. Growth along the Wasatch Front has planners projecting a need to import Bear River water within the next couple of decades. Most communities within the basin have adequate water to meet their projected needs for at least the next twenty years. However, it is possible that industrial, commercial and even agricultural growth could necessitate the development of new sources of water within the basin. Additionally, several communities will need to augment existing supplies within the next decade or two. Regardless of whether the pressure for new water development comes from within or outside of the basin, or whether it results from municipal, industrial, or some other use, a long-term planning effort is needed in the Bear River Basin to assure the use of valuable resource reflects local and statewide concerns.


Hyrum Reservoir at Sunset

CHAPTER 2 WATER SUPPLY

The average annual precipitation for the basin is 22 inches per year. Within the Utah portion of the basin (3,381 square miles) this produces roughly 4 million acre-feet of water. It is estimated that about 60 percent of that is used by the native vegetation and natural systems. The remaining 1,572,000 acre-feet of basin yield manifests itself in surface and subsurface flow working its way toward the Great Salt Lake. Agricultural water depletions (unrecoverable uses) are estimated to be 295,000 acre-feet. Municipal and industrial uses in the basin deplete roughly 21,000 acre-feet. With other minor gains and losses, the estimated total annual average outflow into the Great Salt Lake from the Bear River is 1,200,000 acre-feet.

Assuming full development by Idaho and Wyoming, and taking into consideration current uses and existing water rights, there remains an average annual developable flow of about 250,000 acre-feet for Utah, principally available in the winter and spring. Because of the natural variability of the river's annual flow, the development of a firm yield of 250,000 acre-feet will require new storage. There may be options to develop some of this water through the use of existing reservoirs, but ultimately the development of 250,000 acre-feet will require the construction of a new reservoir(s) and/or other water development options such as aquifer storage and recovery.

In 1991 the Utah State Legislature passed the Bear River Development Act, directing the Utah Division of Water Resources to develop 220,000 acre-feet of Bear River water. The act allocates 60,000 acre-feet to Bear River Water Conservancy District, 60,000 acre-feet to Cache County, 50,000 acre-feet to Jordan Valley Water Conservancy District, and 50,000 acre-feet to Weber Basin Water Conservancy District. The development approach currently being considered is to: 1) modify the existing operation of Willard Bay by agreement with Weber Basin Water Conservancy District; 2) connect the Bear River with a pipeline and/or canal to Willard Bay from a point near the Interstate 15 crossing of the Bear River near Elwood 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 as the demand for additional water continues to increase.

The State Engineer's office, through its Interim Cache Valley Ground-Water Management Plan will allow an additional 25,000 acre-feet per year of ground water withdrawals in the Cache Valley. As this water is developed, the effect of such development on the hydrologic system will be evaluated to determine if additional withdrawals can be allowed.

CHAPTER 3
POPULATION AND WATER USE TRENDS AND PROJECTIONS

The Utah portion of the basin has a current population of 136,097 (2000 US Census), which is projected to increase to 203,705 by 2020 and to 297,597 by 2050. This is a total increase of nearly 50 percent or just over 2 percent per year over the next 20 years, and a total increase of 119 percent or approximately 1.6 percent annually over the next 50 years.

With a few exceptions, most industries have shown growth in the past decade. However, manufacturing accounted for nearly half the basin's personal income in 1987, but has dropped to about 40 percent in the past ten years, while the Service, Retail Trade, and Transportation and Utilities sectors now constitute a larger part of the basin's economy. Agriculture and agricultural-related services remain at about four percent of the basin's total economy.

Cache Valley

Agricultural use continues to be the major use of water in the Bear River Basin. During the past few decades, heavily populated portions of the state have experienced declining agricultural use corresponding to an increasing municipal and industrial (M&I) use. However, in the Bear River Basin the conversion of agricultural land to urban use has been minimal and has not had a measurable impact upon agricultural water use. The conversion of agricultural land to urban has resulted in a net loss of dry-farm land but not in a loss of irrigated acreage. It is unlikely this trend will be reversed any time soon.

Significant population growth is projected throughout the basin during the next 20 years. However, most of the basin's municipalities have existing water supplies that are sufficient to meet the projected future demand. Despite having adequate water supplies, many towns in the basin will reach or exceed the limits of their reliable system/source capacity within the next 20 years. For many of these towns, water conservation is a reasonable and economic means of postponing the inevitable cost of system improvements by 10 years or more with effective water conservation efforts.

For many communities throughout the basin, the big problem is not actually water supply but some deficiency in their water delivery system. For Logan, Nibley, Paradise, Cornish, Tremonton, North

Garland, and West Corinne the problems exist now. These systems are already operating at the limits of their reliable system/source capacity. For these communities, infrastructure improvements are already needed. For other communities like Lewiston, Millville, Clarkston, Amalga, Smithfield, and Newton, planning efforts now and water conservation strategies implemented over the next 20 years can reduce or delay the need for expensive infrastructure improvements

CHAPTER 4
WATER CONSERVATION

A statewide goal has been established to reduce the 1995 per capita water demand within public community systems by at least 25 percent before 2050. The primary objective and resultant benefit of water conservation is the reduction of water demand, thus allowing existing water supplies to last longer. In addition, water conservation has a number of important secondary benefits. Water conservation can: delay capital investments to upgrade or expand existing water and wastewater 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 through improved efficiencies; and reduce stream diversions, enhancing water quality as well as environmental and recreational functions.

The Governor's Water Conservation Team's web site (www.conservewater.utah.gov) is hosted by the Utah Division of Water Resources. This informative web site contains many features that are designed to help Utahns use water inside and outside their homes wisely.

CHAPTER 5
WATER TRANSFERS AND EFFICIENT MANAGEMENT OF DEVELOPED SUPPLIES

The efficient use of existing developed water supplies is an important element in successfully meeting Utah's future water needs. As competition for limited water supplies increases, the value of the existing water supplies also increases. This economic incentive leads to the transfer of water from one use to another. The agriculture industry uses about 94 percent of the presently developed water in the basin. Municipal and industrial (M&I) uses account for the other six percent. Over the next 50 years this ratio is expected to change to an 89 percent to 11 percent split as M&I uses grow.

Most existing M&I systems have sufficient supplies to take them well beyond the year 2020 and many beyond 2050. Where existing supplies are inadequate to address the growth of the next 20 years, there are developable ground water and/or surface water sources. However, the development of surface water sources will likely require storage, making new water expensive. In those cases, agricultural water transfers may prove to be a less expensive alternative when compared to reservoir construction. In Box Elder County, the Bear River Water Conservancy District has acquired agricultural water in the Bothwell Pocket and is converting this water to M&I use over time to meet the growth that is projected within the district.

There is potential for additional agricultural water transfers to account for at least some of the basin's new municipal and industrial water demand, over the next 20 to 50 years. There is also a limited potential for improved agricultural water use efficiency to increase agricultural productivity and improve water quality.

Accurate measurement of water use is essential to proper management and conservation efforts. Most of the basin's community water systems are metered. However, there are properties, such as city parks, golf courses, and cemeteries, which lack meters. Other management tools that could play an

Harvesting Alfalfa in Box Elder County

important role in the future of the basin include water reuse, conjunctive use, aquifer storage and recovery, and cooperative water operating agreements.

Chapter 6. Water Development

Generally speaking, existing water supplies are adequate throughout the basin for at least the next couple of decades. However, on a micro scale some of the basin's systems are hard pressed, even now, to provide adequate flows during periods of peak demand. Consequently, many local water providers are continually investigating potential system upgrades and, in some cases, additional water development options.

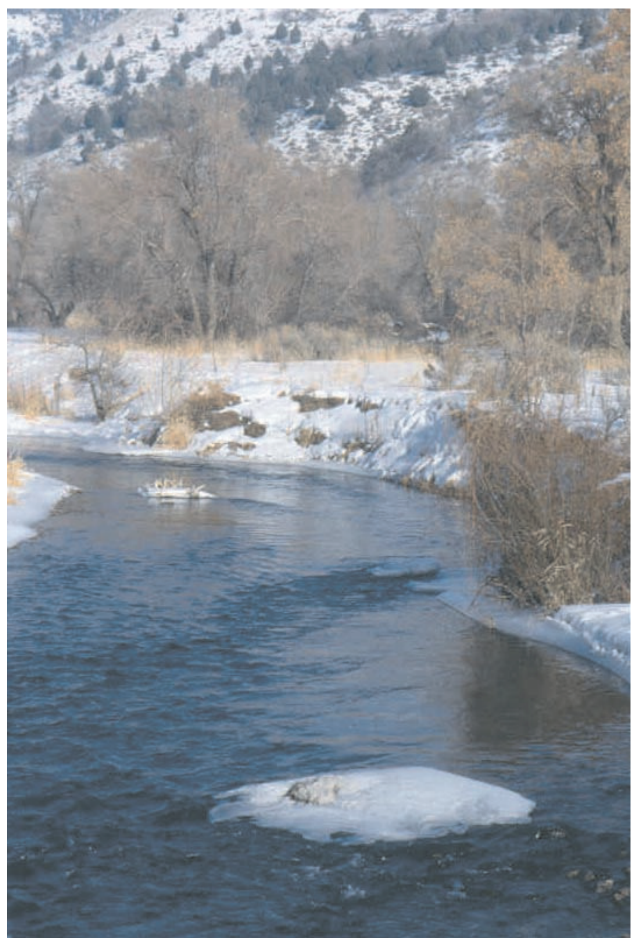
As growth takes place over the next couple of decades, local water suppliers will continue to develop available water sources. In Cache County, this will mean additional ground water development by existing municipal water purveyors. In Box Elder County, where ground water supplies are not so abundant, local water purveyors (primarily Bear River Water Conservancy District) will probably have to be a bit more creative in providing for future water needs. To hold costs down, the district and other water providers will likely continue to acquire existing water rights through the willing buyer/willing seller process and develop whatever ground water supplies might be available.

The Division of Water Resources estimates there are approximately 250,000 acre-feet of Bear River water that can economically be developed. Just how much is actually developed will be a function of many factors. Without a doubt, the biggest deciding factor will be how much reservoir storage is built. Depending upon a number of factors (such as the demand pattern), about 60,000 acre-feet of water can be developed from the Bear River without any new reservoir storage. The next 100,000 acre-feet of developed water will require the construction of storage capacity at a 1-to-1 ratio (or 100,000 acre-feet of storage yields 100,000 acre-feet of water). The next 50,000 acre-feet of storage will yield 25,000 acre-feet of water. After that, every 1,000 acre-feet of yield will require 4,000 acre-feet of storage. Consequently, to develop 250,000 acre-feet of water will require 400,000 acre-feet of storage (about the equivalent of Jordanelle Reservoir). See Figure 13.

In 1991 the Utah Legislature directed the Division of Water Resources to investigate the Honeyville and Barrens reservoir sites. With growing concern about the possible environmental and social impacts of those two reservoir sites, the 2002 Legislature rescinded the directive to consider the Honeyville and Barrens sites, and added a directive for the division to investigate the Washakie site.

Chapter 7 Water Quality, The Environment and Other Considerations

Although there are portions of Box Elder County and West Cache Valley where ground water quality is relatively poor, much of the ground water in the basin is of good quality, and suitable for potable use with little or no treatment. The quality of surface water varies through a wide range due to natural



Blacksmith Fork

effects and human activity. In the upper basin, where the Bear River enters Utah from Wyoming, water quality is considered good. Water temperatures are low, as are TDS (total dissolved solids), alkalinity, hardness and sulfates. The quality deteriorates gradually as the river flows downstream. Return flow from irrigated land, sediment, animal wastes, municipal and industrial wastewater, natural saline springs, agricultural chemicals, and increasing water temperatures all combine to cause water quality problems in the lower basin. In general, each tributary stream shows a similar pattern of downstream deterioration, although some are much better than others.

In the lower Bear River Basin, water quality problems arise primarily from high phosphorus and total suspended sediment concentrations. In particular, dissolved phosphorous contributes to the eutrophication of existing reservoirs. Eutrophication causes diminished recreational and fishery benefits, and the algae produced in a eutrophic reservoir also greatly increase the cost of treatment for municipal use.

Other impacts on fisheries arise when state water quality standards for dissolved oxygen and ammonia are not met. This is especially true in the Spring Creek portion of the Little Bear River drainage. High sediment loads in the Cub River and the mainstream of the Bear River also restrict fisheries. Violations of coliform limits have occurred throughout the basin but were most severe in the Spring Creek subdrainage and indicate a potential public health problem.

The Division of Water Quality is responsible for implementing the Total Maximum Daily Loads (TMDL) program in Utah. In cooperation with other state, federal and local stakeholders the Division of Water Quality has contracted with the Bear River RC&D and the Bear River Water Conservancy District to develop and implement the TMDL program for the Bear River Basin.

Some of the basin's riparian zones adjacent to streams and rivers have been impacted by construction and stream bank modification or channelization as a result of urban growth and agricultural practices. Riparian zones and flood plains need to be preserved and protected because they represent important habitat for wildlife, help improve water quality and buffer the population from flooding.

Historically, impacts to the main stem of the Bear River from urban growth have been relatively insignificant. This is because in the upper portion of the basin above Bear Lake, there are only two small communities directly on the Bear River. A few of the Bear River’s tributaries, however, have experienced impacts associated with urban growth and will undoubtedly experience more impacts in the future. Most notable of these is the Logan River, which flows through Logan. Also, the Little Bear River, near Hyrum and Smithfield and Summit Creek near Smithfield represent a potential for urban growth to impact riparian and flood plain corridors. In Box Elder County, growth around Bear River City and Corinne are areas of concern. In these areas it will be important for county and city planners to insure that urban growth does not negatively impact the riparian and flood plain corridors.

1

INTRODUCTION

The Utah State Water Plan provides the direction for establishing and implementing state water policies and recommendations. As a part of the state water planning process, detailed plans are prepared for each of the state's eleven hydrologic basins. This Bear River Basin Plan has been prepared at a reconnaissance level, and gives a general assessment of water related problems, issues, and concerns within the basin. Previous water related studies conducted by state and federal agencies have provided important background information in the preparation of this report. It should be stressed that basin planning is a continuous process, and that the basin plans are intended to be flexible enough to allow for future revisions. Indeed, this Bear River Basin Plan reflects changes in approach to Bear River development since the plan was first published in 1992.

The Bear River Basin has a plentiful water supply and is one of the few areas in the state with a significant amount of developable water. It is anticipated that Bear River water will eventually be developed to satisfy growing needs for areas within and outside the basin. Growth in Salt Lake, Weber and Davis Counties has planners projecting a need to import Bear River water within the next 20 to 30 years. Most communities within the basin have adequate water to meet their projected needs for at least the next twenty years, although several communities will need to augment their supplies. It is also possible that industrial, commercial and even some agricultural growth could necessitate the development of new sources of water within the basin. Regardless of whether the pressure for new water development comes from within or outside of the basin, or whether it results from municipal, industrial, or some other use, a long-term planning effort is needed in the Bear River Basin. This planning effort will assure the future development of this valuable resource reflects local and statewide concerns for the watershed, the environment, as well as meet the water needs of a growing state.

Bear River Below Cutler Reservoir

This document is not a plan for the construction of any particular project. Rather, it is a document that identifies the basin's current and projected water use and related issues. The purpose of this document is to provide planners with a snapshot of the current use of water throughout the basin, and a projection of how those uses may change over the next 20 to 50 years. It will discuss water quality, environmental and other issues associated with the current and projected water uses and will identify methods of dealing with increasing water demands, including potential development projects.

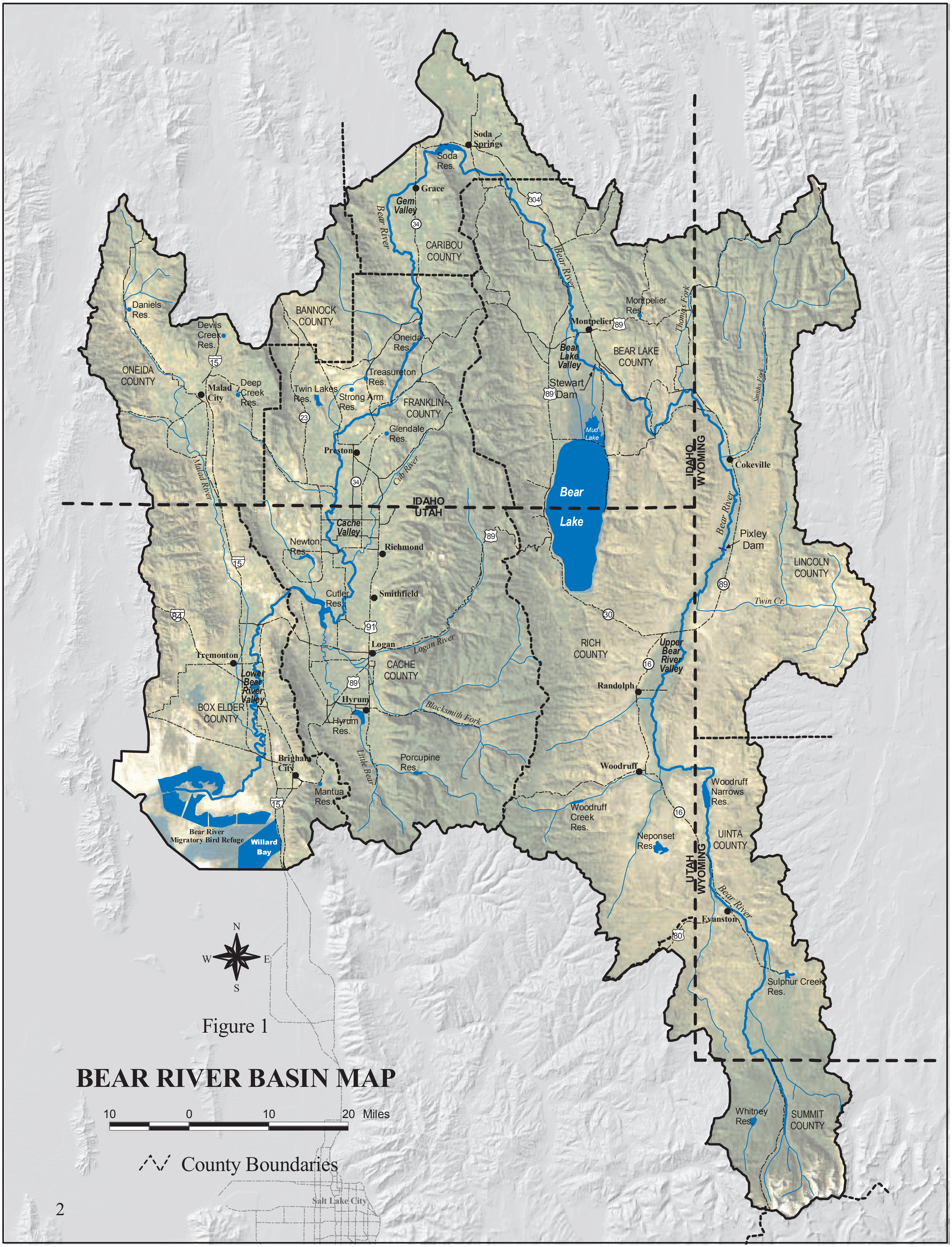


Figure 1

BEAR RIVER BASIN MAP

Ultimately, local authorities and citizenry will have the final say on development and use of the Bear River's considerable resources. It is intended that this document will assist local planners with their efforts to effectively manage the Basin's water resources.

PURPOSE OF THE PLAN

In 1990 the Division of Water Resources published a State Water Plan. This plan provided a broad overview of the state's water resources and projected needs. The State Water Plan was followed by a series of river basin plans, which reflected the plan's format but provided much more detail.

The Bear River Basin was the first of the state's eleven basins to be evaluated in detail, with a basin plan published in 1992. The plan has proved to be a valuable document to the division, other state agencies, and to many of the local city and county planners in the Bear River Basin. Through the years it is anticipated that social, technologic and economic changes will all have an impact on the basin's water-related issues and concerns. Consequently, the state and basin water-planning processes have been dynamic in nature and, as such, the plans are updated as necessary to ensure that the information contained in each plan is current and accurate. The Utah State Water Plan was rewritten in May 2001, with the publication of *Utah's Water Resources: Planning for the Future*. The *Bear River Basin: Planning for the Future* follows the format of that document in terms of chapter headings, sub-headings, figures and tables.

The Bear River Basin Plan has been rewritten for a number of reasons. Although it has only been 10 years since the Bear River Basin Plan was published, considerable growth and change have occurred in the basin. Information from many studies and publications during that same period of time should be included in the basin plan to better define the current and projected water supply, uses, plans and issues. Also the original Bear River Basin Plan did not address secondary water use as thoroughly as subsequent basin plans for other areas of the state.

This new document will address these topics as well as other changes in management of the Bear River. The past decade has seen a growing concern for water quality, recreational, and environmental issues. These issues play an ever-increasing role in the management of the river, the reservoirs, and the basin's other natural resources. These changing attitudes are reflected in the Bear River Commission, in the FERC dam re-licensing process, and in PacifiCorp's (formerly Utah Power and Light) management of releases from its reservoirs.

Although this document replaces the 1992 document as the Bear River Basin Plan, there is a valuable collection of pertinent data and useful information that will not entirely be revisited here. While this report will update population projections, land use, water supply, and management practices, much of the detailed information included in the 1992 Bear River Basin Plan is unchanged and will not be reprinted in this document. Some of these items include:

- a detailed description of the basin topography, geology, soils, and climate;
- an inventory of potentially irrigable lands in the basin;
- a detailed description of the state and federal regulatory agencies and their responsibilities; and
- a description of the state and federal water-funding programs.

The 1992 Bear River Basin Plan is no longer in print, but it can be accessed on the Internet at the following address: http://www.water.utah.gov. Once there click the "River Basin Plans" subheading of the "Planning Programs" button.

PLANNING PROCESS

By the conclusion of the review and approval process, four drafts of this document will have been prepared. These are: (1) In-House, (2) Committee, (3) Advisory, and (4) Public review drafts. After this process, the final report will be distributed to the public for its information and use. Public involvement is an important part of the planning process, and is necessary in assessing actual viewpoints and conditions in the basin. The opportunity for public discussion and input has been, and will continue to be, provided at the local, state, and federal levels as plan formulation moves through various phases.

Description of the Basin

The Bear River Basin is in northern Utah, southeastern Idaho, and southwestern Wyoming. The basin covers approximately 7,500 square miles of mountain and valley land, including approximately 3,300 square miles in Utah, 2,700 square miles in Idaho, and 1,500 square miles in Wyoming.

The Bear River Basin is in the northeastern portion of the Great Basin. The Great Basin is unusual in that it is entirely enclosed by mountains, thus forming a huge bowl with no external drainage outlet. The Bear River empties into the Great Salt Lake, a remnant of ancient Lake Bonneville, which at one time occupied a large portion of the eastern Great Basin. The Bear River is the western hemisphere's largest stream that does not reach the ocean.

As shown in Figure 1, the headwaters of the Bear River are in Summit County, Utah on the north slope of the Uinta Mountains, approximately 60 miles due east of Salt Lake City. The Bear River follows a 500-mile circuitous route, crossing the Utah-Wyoming state line three times before flowing into Idaho, then turning south and returning to Utah and ultimately flowing into the Great Salt Lake, less than 100 miles from its headwaters.

For the first 20 miles of its course the Bear River flows down the north slope of the Uinta Mountains. As it crosses the Utah-Wyoming state line the river enters a series of five major valleys that extend along its course: Upper Bear River Valley, Bear Lake Valley, Gem Valley, Cache Valley, and Lower Bear River Valley. The arable lands throughout the basin are situated in the valleys along the main stem of the river and its tributaries. The elevations of these arable valleys range from 4,200 feet above sea level at Bear River Bay to 7,800 feet in the Upper Bear River Valley near Evanston, Wyoming. These valleys are separated by narrow canyons or gorges and bordered by jagged, sharply rising mountain ranges, which reach elevations in excess of 10,000 feet above sea level. Among the 9,000 to 13,000 foot peaks in the upper reaches of the river, numerous small lakes in glacially carved cirque basins serve as catchment areas for precipitation, most of which falls as snow.

Historic Development of the River

The earliest water users in the Bear River Basin were irrigators in the Lower Bear River Valley and in Cache Valley. Consequently, they hold the earliest water rights. The management of the river is accomplished with delivery of irrigation water as the primary objective. One of the earliest efforts by irrigators to provide late-season irrigation water was to put Bear Lake to work as a storage reservoir.

Bear Lake is near the mid-point of the river's course from the Uinta Mountains to the Great Salt Lake. A few miles after entering Idaho, the Bear River flows westward into Bear Lake Valley. Bear Lake, at the south end of this valley, is about 20 miles long and seven miles wide. Historically, the river did not naturally flow into the lake. The feasibility of diverting water from Bear River into Bear Lake was presented in the Department of Agriculture Bulletin No. 70 in 1898. This was seen as a viable solution to overly abundant natural flows in the early summer followed by late summer low flows, inadequate for irrigation. In 1902 Telluride Power (predecessor to Utah Power and Light) began constructing inlet and outlet canals in an effort to divert Bear River water into the lake for later release during the agricultural growing season. In 1914 the Lifton pumping plant was constructed, at the north end of the lake, to pump water from Bear Lake into the outlet canal. These improvements and later modifications have created an active storage capacity of 1,452,000 acre-feet in Bear Lake and the ability to regulate the flow of the river.

Between 1904 and 1912, Telluride Power constructed five hydroelectric power plants below Bear Lake. These power plants at Soda, Grace, Cove, Oneida, and Cutler generate power from run-of-the-river flows. Between 1912 and 1916, Utah Power and Light entered into water-delivery contracts with the major irrigation companies along the Bear River. Releases from Bear Lake today are made to accommodate the irrigation demands in Cache and Box Elder counties in Utah and in Franklin and Caribou counties in Idaho with power generation as a secondary benefit.

2

WATER SUPPLY AND MANAGEMENT

The Bear River's average annual inflow to the Great Salt Lake is nearly 1.2 million acre-feet (1941-1990). Some of this water can be developed to meet future needs within the basin, as well as some needs outside the basin in Salt Lake, Davis and Weber counties.

CLIMATE, PRECIPITATION AND EVAPORATION

The Bear River Basin is typical of mountainous areas in the West, with wide variations in temperature between summer and winter and between day and night. The high mountain valleys experience long, cold winters and short, cool summers. The lower valleys are warmer, but have more variance between maximum and minimum temperatures. As elevations in the basin vary from 4,200 to 13,000 feet, precipitation also varies from 10 to 65 inches. Figure 2 shows a detailed picture of the basin's average annual precipitation. Precipitation in the lower basin during the May-September growing season is only 5 to 6 inches, compared to a crop water requirement of 20 to 30 inches.

The National Weather Service has 18 climatological stations located throughout the Utah portion of the basin. These have varying lengths of record. Data from these stations are listed in Table 1. Mean annual temperatures vary from a high of 52.9^{o} F in Tremonton to a low of 37.0^{o} F at the Uintalands Weather Station. The record high temperature for the basin was 110^{o} F in Corinne, and the record low was -47^{o} F in Woodruff. Precipitation results primarily from two major storm patterns: (1) frontal systems from the Pacific Northwest during winter and spring; and (2) thunderstorms from the south and southwest in the late summer and early fall. These storm patterns are influenced by the topography of the basin. As storm clouds rise over mountains, the amount of precipitation increases significantly with elevation. The difference in elevation between valleys and mountains also impacts the number of frost-free days. While the valley locations can experience as many as 189 frost-free days (Tremonton), the upper elevations receive as few as 33 days (Hardware Ranch).[1]

The Bear River in the Uinta Mountains

AVERAGE ANNUAL WATER SUPPLY

Surface Water

Figure 3 shows schematically the annual flow of the Bear River throughout its length, as well as tributary inflows, diversions, and ground water inflows based on 1941-90 data.[2] The width of the bands representing the Bear River main stem and tributaries are proportional to the average annual

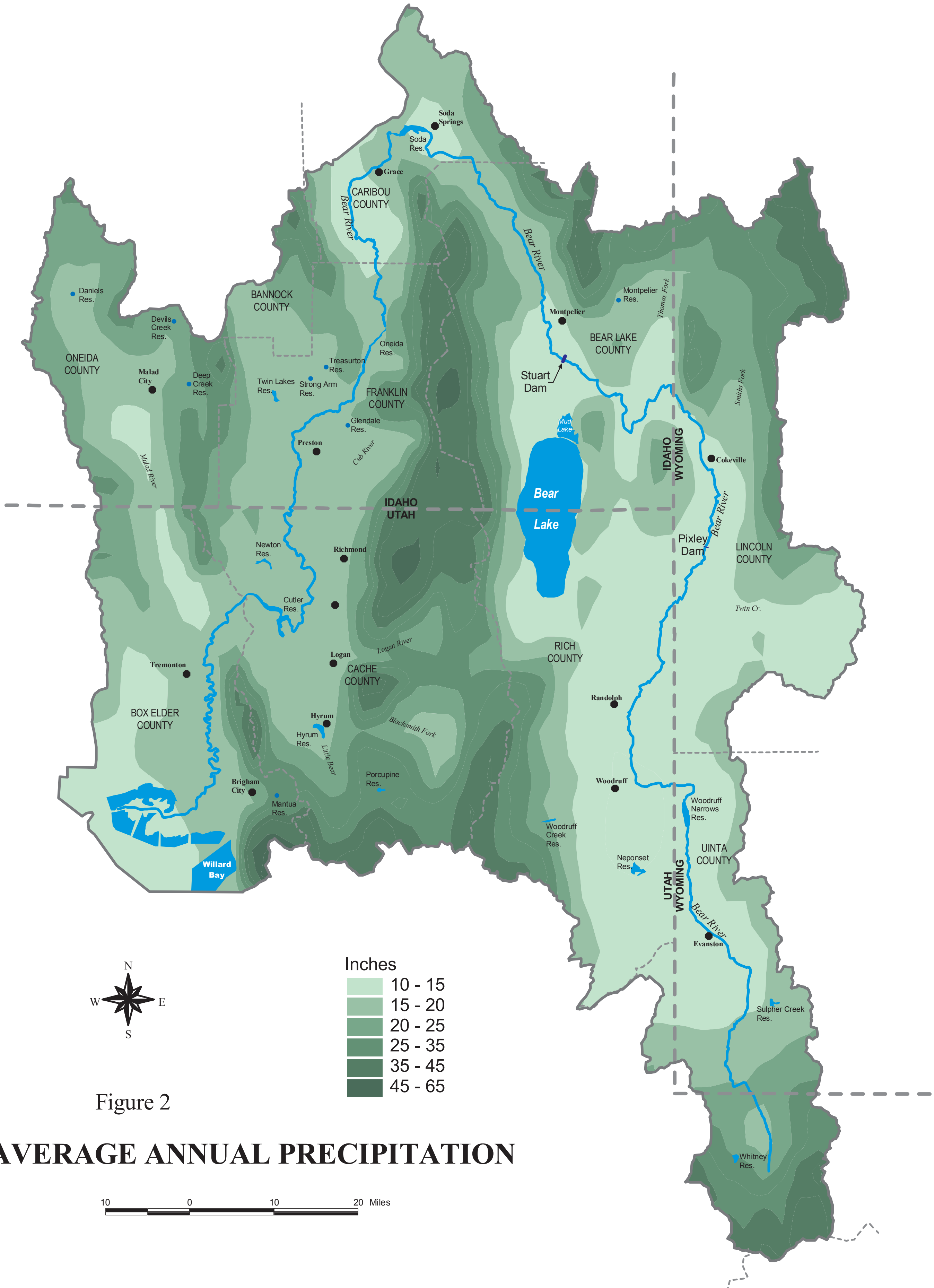


Figure 2

AVERAGE ANNUAL PRECIPITATION

TABLE 1
Climatological Data

Station	Temperature (Average Max and Min.) January Max (°F)	January Min. (°F)	July Max. (°F)	July Min. (°F)	Mean Ann. (°F)	Record Max. (°F)	Record Min. (°F)	Precipitation Snow (in.)	Precipitation Mean Ann. (in.)	Evap. Ave. Ann. (in.)	Frost Free Days
Box Elder Co.											
Cutler	29.4	13.6	89.1	61.1	49.3	107	-22	36.8	19.0	42.3	165
Plymouth	NR	NR	NR	NR	NR	NR	NR	26.2	9.8	48.8	NR
Tremonton	35.8	22.0	90.9	69.1	52.9	105	-11	24.4	17.9	40.6	189
Bothwell	NR	NR	NR	NR	NR	NR	NR	33.9	12.97	NR	NR
Corinne	33.5	14.4	90.5	56.9	48.7	110	-32	34.5	17.7	47.3	139
Brigham City	36.1	18.7	92.9	61.8	51.4	105	-16	63.9	19.3	46.0	162
Cache Co.											
Richmond	31.4	13.1	90.0	52.9	46.6	104	-28	69.4	19.5	45.3	121
Logan (KVNU)	30.8	11.3	89.3	54.4	46.4	104	-30	25.4	16.6	44.4	132
Logan (USU)	31.7	15.5	86.7	59.2	47.8	102	-25	68.7	19.5	40.9	158
Logan (Exp. St.)	33.5	14.7	88.7	54.4	47.4	99	-27	17.3	16.6	44.3	133
Logan (5 SW)	31.3	8.7	87.6	51.7	45.2	102	-44	50.9	18.2	43.7	118
Hardware Ranch	34.9	5.3	84.9	40.6	41.2	100	-43	64.9	17.4	44.2	33
Trenton	30.8	10.2	87.4	50.1	44.8	105	-44	52.0	17.7	44.8	112
Rich Co.											
Laketown	32.0	10.7	83.1	47.7	42.2	96	-37	42.5	12.2	40.5	85
Randolph	25.9	-0.2	80.6	43.2	38.4	92	-43	34.2	11.2	40.2	50
Woodruff	28.5	2.4	81.7	44.0	39.0	94	-47	42.3	9.0	40.0	56
Bear Lake	31.7	12.0	84.6	49.6	44.6	92	-25	41.1	14.0	42.0	109
Summit Co.											
Uintalands	32.7	6.6	73.9	41.8	37.0	85	-33	224	22.9	34.7	53

NR – no record
Source: *Utah Climate*, Utah Climate Center, USU (period of record: 1948-92)

flow in acre-feet. Main stem gaging stations are indicated by rectangles while diversions from the Bear River and from tributaries are represented by arrowheads. Bear Lake inflows and outflows are similarly shown. For most of the canals only the average annual depletion figure is shown. For these canals it is assumed that return flows occur reasonably close to the diversion. In some instances, however, such as the Twin Lakes Canal and the West Cache Canal, water is diverted upstream of the gage but the return flows are below the gage. In order to balance the figures from gage to gage it is necessary, at these locations, to show and use the actual diverted flows. Consequently, for some of the canals the average annual diversion figure is shown in parenthesis below the average annual depletion figure. Where both figures are shown the average annual diversion figure is the one that has been used to calculate streamflows.

The Logan River is the largest tributary to the Bear River. Blacksmith Fork and the Little Bear River join the Logan River before it enters Cutler Reservoir. The next largest tributary is Smiths Fork in Wyoming. Others are the Cub River and the Malad River in Idaho and Utah; Mink Creek and Soda Creek in Idaho. Major diversions are the Last Chance Canal in Idaho, West Cache Canal in Idaho, the Bear River Canal Company's West Side and East Side canals in Utah, and the Bear River Migratory Bird Refuge in Utah. A significant quantity of return flow and ground water flows to the river system in Cache and Box Elder counties.

Figure 3

BEAR RIVER FLOW CHART

TABLE 2
Stream Gage Records

Gaging Station On Bear River	Station Number	Drainage Area (square miles)	Period of Record	Instantaneous Extremes		Average Annual Runoff (1,000 acre-feet)	
				Min. (cfs)	Max. (cfs)	1941-90	Period of Record
Near Ut-Wy State line	10011500	172	1942-2002	7	3,230	140	142
Near Woodruff	10020300	784	1961-2002	0	3,820	163	173
Near Randolph	10026500	1,616	1943-1992	2	3,630	150	150
Smiths Fork, Wy[a]	10032000	165	1942-2002	21	2,100	142	140
At Wy-Id State Line	10039500	2,486	1937-1995	24	4,880	325	315
At Harer, Id.	10044000	2,839	1913-1986	26	5,140	393	393
Rainbow Inlet	10046000	-	1922-2002	0	4,950	304	272
Bear Lake Outlet	10059500	-	1922-2002	1	3,080	332	301
Pescadero	10068500	3,705	1921-2002[b]	23	4,280	466	444
Alexander	10079500	4,099	1911-2002	14	4,740	588	539
1Below Oneida Res.	10086000	4,456	1921-2002	3	5,480	681	623
At Id.-Ut. State line	10092700	4,881	1970-2002	48	4,870	746	834
Logan River[a]	10109000	214	1896-2002	50	2,000	156	182
Near Collinston	10118000	6,267	1889-2002	10	14	1,095	1,165
Near Corinne	10126000	7,029	1949-2002[b]	47	14	1,232	1,293

Source: USGS Water Resource Data[2] [a] tributary stream [b] not a continuous record

The Bear River modeling done in 1992 with 1941-1990 data is still an accurate representation of average conditions in the Bear River Basin. A comparison of the 1941-1990 stream-flow data with the current period of record data is included in Table 2. Dry years between 1991 and 1995 have reduced average annual flows at several locations, particularly the diversions to Bear Lake at the Rainbow inlet and the releases from Bear Lake. The flow at the Idaho/Utah state line was also adversely affected by the dry years, whereas average flows near Collinston and Corinne have remained relatively unchanged.

Bear River above Corinne in flood stage (circa 1983)

A summary of streamflow records for the Bear River is also shown in Table 2. The locations of gaging stations are shown in Figure 4. Except for the Rainbow Inlet Canal, the Bear Lake Outlet Canal, and the Logan River gages, all streamflow records in Table 2 are from mainstem gaging stations. They are listed in downstream order, beginning with the Bear River crossing of the Utah-Wyoming state line, and ending with the last gaging station on the river, near Corinne, before the river enters the Bear River Migratory Bird Refuge.

Available Water Supply

By combining the climatological data with the streamflow data, an accurate snapshot of the water supply within the Bear River Basin can be produced. Table 3 presents a water budget for the Utah portion of the basin. The average annual precipitation for the basin is 22 inches per year. Within the Utah portion of the basin (3,381 square miles) this produces roughly 4 million acre-feet of water. It is estimated that about 1,903,000 acre-feet (48 percent) of that is used by the native vegetation and natural systems. The remaining 2,097,000 acre-feet of basin yield manifests itself in surface and subsurface flow working its way toward the Great Salt Lake.

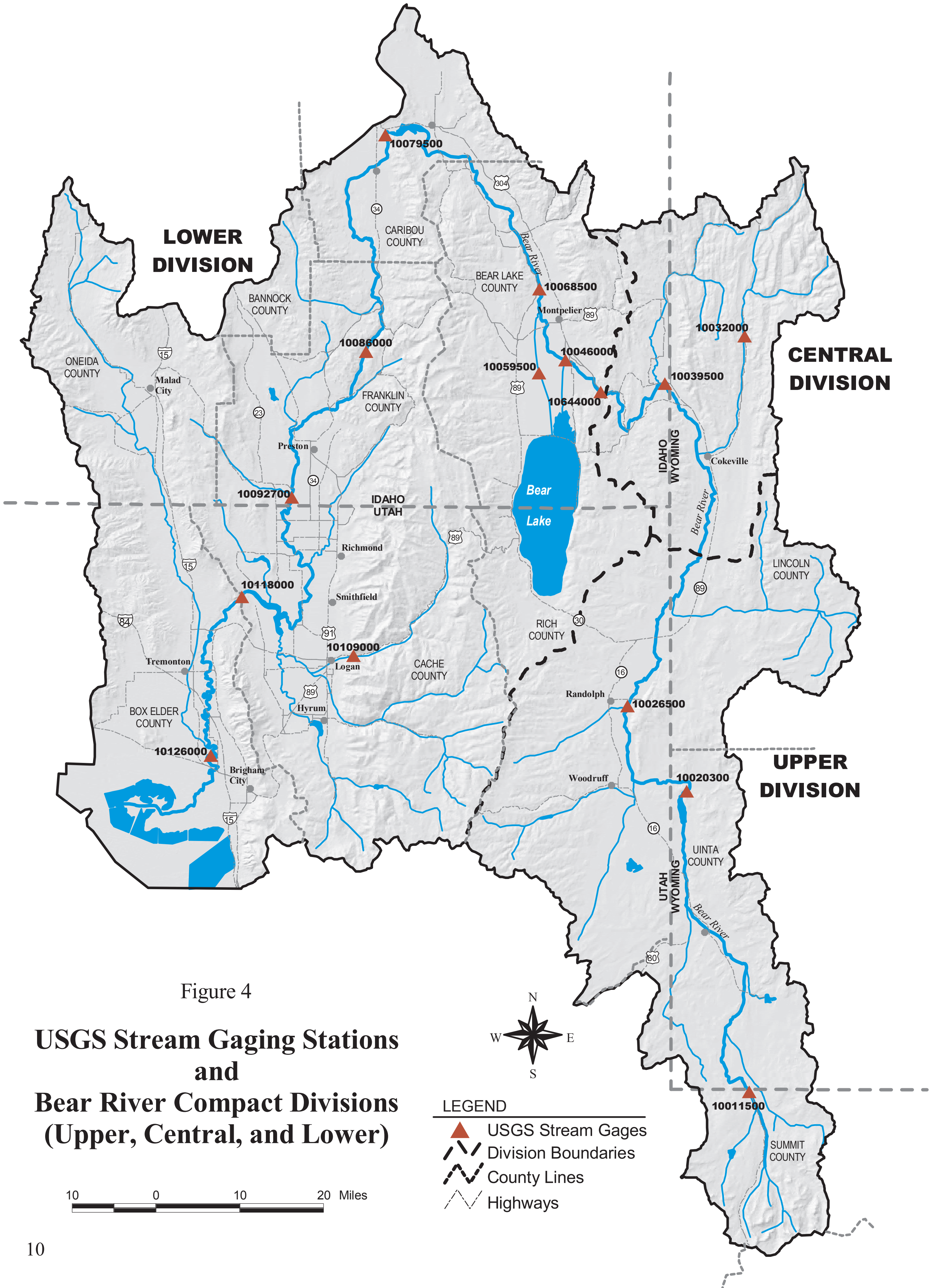


Figure 4

USGS Stream Gaging Stations and Bear River Compact Divisions (Upper, Central, and Lower)

TABLE 3
Estimated Water Budget
for the Utah Portion of the Bear River Basin

Category	Water Supply (acre-feet)
Total Precipitation	4,000,000
Used by vegetation and natural systems	1,903,000
Basin Yield	2,097,000
Agricultural Depletions	536,000
M&I Depletions	21,000
Wetland/Riparian Depletion & Reservoir Evaporation	340,000
Flow to Great Salt Lake	1,200,000

Source: *Utah Water Data Book* (1961-1990 average annual supply and present depletions) [3]

Agricultural water depletions (unrecoverable uses) are estimated to be 536,000 acre-feet. Municipal and industrial uses in the basin deplete roughly 21,000 acre-feet. It is estimated that the losses in the basin's wet and open water areas, including evaporative losses in the Bear River Migratory Bird Refuge, are 340,000 acre-feet. The estimated total annual average outflow into the Great Salt Lake from the Bear River is 1,200,000 acre-feet.

An average annual flow of 1,200,000 acre-feet from the Bear River into the Great Salt Lake can give the misleading impression that there actually are 1,200,000 acre-feet of water available for development. In reality, water rights held by the Bear River Migratory Bird Refuge account for a great deal of this water and necessitate that much of it continue to flow to the refuge. Additionally, the Bear River Compact designates how the developable waters of the river are to be allocated among Idaho, Utah, and Wyoming. Assuming full development by Idaho and Wyoming and taking into consideration current uses and existing water rights, there remains an average annual developable flow of about 250,000 acre-feet for Utah. The water that is available for development is winter and spring flow. Because of the natural variability of the river's annual flow, the development of a firm yield of 250,000 acre-feet will require new storage.

Logan River

To provide a dependable water supply of this undeveloped flow will require new storage approximately equal to the amount of water to be developed. There may be options to develop some of this water through the use of existing reservoirs, but ultimately the development of 250,000 acre-feet will require the construction of a new reservoir(s) and/or other water development options such as aquifer storage and recovery.

Ground Water

In 1994 the U.S. Geological Survey (USGS) published *Hydrology of Cache Valley, Cache County, Utah and Adjacent part of Idaho, with Emphasis on Simulation of Ground-Water Flow.*[4] The study showed a close regional hydrologic connection between ground water, springs and streams. This led the State Engineer's Office to adopt its Interim Cache Valley Ground-Water Management Plan in September 1999. The plan points out that much of the developable water in the basin is available only during winter and spring runoff. During peak demand periods of most years, principal water sources are fully appropriated and there is insufficient flow in surface sources to meet the demand of all existing surface water rights. Consequently, the plan limits the development of new ground water rights in order to maintain the reliability of existing surface water rights. The plan states, "The limiting factor regarding ground water development in Cache Valley is not the amount of water which is physically available within the aquifers, but rather the amount of ground water which can be withdrawn without impairing prior rights."[6] New appropriations must show either no impact to existing water rights or a plan to compensate or mitigate the impacts to existing water rights. Ground water may also be developed by filing a change application on existing surface water rights.

Estimates of ground water recharge and discharge from the USGS ground water study are given in Table 4. Based upon the USGS ground water study and other available data the State Engineer's office, through its Interim Cache Valley Ground-Water Management Plan will allow an additional 25,000 acre-feet per year of ground water withdrawals in the Cache Valley. As this water is developed, the effect of such development on the hydrologic system will be evaluated to determine if additional withdrawals can be allowed.

TABLE 4

Cache Valley Ground Water Recharge and Discharge

Recharge	Acre-Feet
Infiltration of precipitation	90,000
Seepage from streams	1,000
Seepage from canals	86,000
Other forms of recharge (bedrock)	46,000
Total	223,000
Discharge	
Seepage to streams	70,000
Spring Discharge	58,000
Evapotranspiration	36,000
Seepage to Reservoirs	31,000
Withdrawals from wells	28,000
Total	223,000

Source: Interim Cache Valley Ground-Water Management Plan, State Engineer's Office.

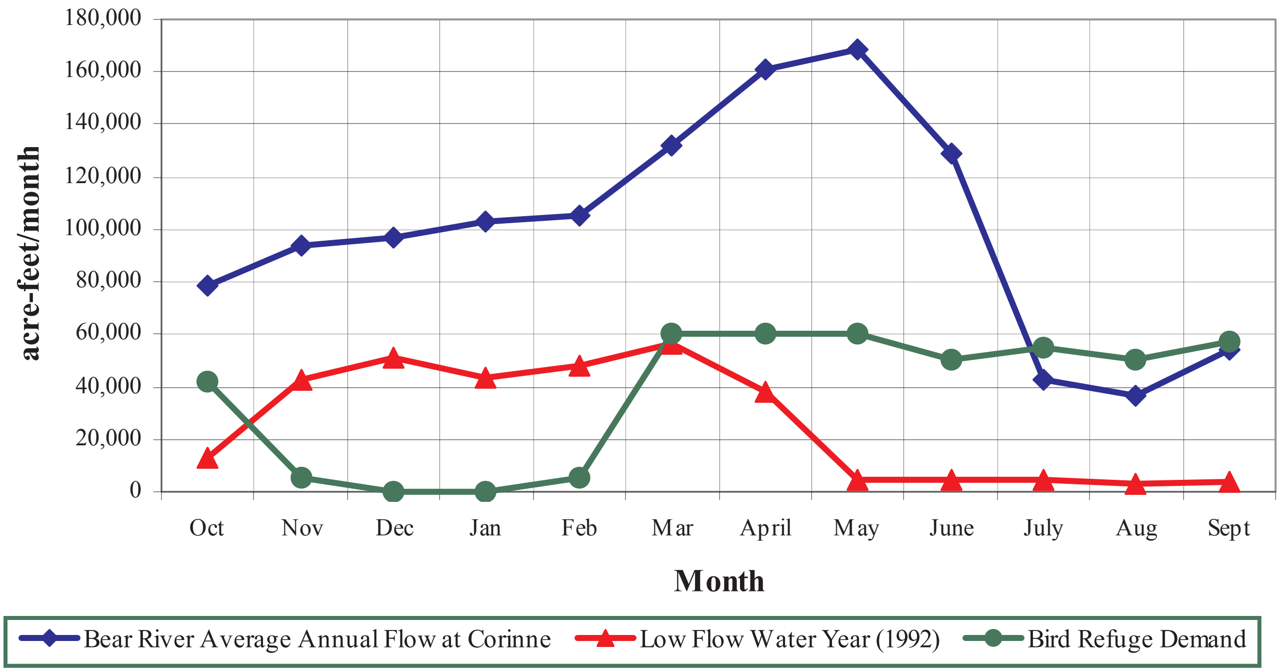
DEVELOPABLE SUPPLY

On an average annual basis, 1.2 million acre-feet of water flows past the Corinne gaging station and into the Bear River Migratory Bird Refuge. The 50-year interval of 1941-90 is a fairly representative base period for streamflow averages and other hydrologic computations. This period of record includes weather cycles with both extremely high and low water years. Assuming full development by Idaho and Wyoming, and taking into consideration current uses, the Bear River was modeled for this period of record (1941-90). The modeling reveals, that depending upon the amount of reservoir storage built, between 60,000 and 250,000 acre-feet of water can be developed in the state of Utah. Unfortunately, in dry years, there is very little developable flow and it is primarily limited to the winter flows and spring runoff. In wet years the developable flow can be significantly higher than the average annual flow. Consequently, the development of a firm yield will require the construction of reservoir storage. The relationship between the developable yield and the needed reservoir storage will be discussed in more detail in Chapter 6 Water Development.

Figure 5 compares the average annual flow of the Bear River at the Corinne gaging station (blue line) with the record low flow water year of 1992 (red line) and the demand for water at the Bear River Migratory Bird Refuge (green line). The average monthly flow at the Corinne gage rises from 80,000 acre-feet per month in October to just over 100,000 acre-feet per month in February. With the spring runoff, the flow at Corinne rises on average to 160,000 acre-feet per month in May. Through June the flow drops off dramatically to an average annual flow of about 40,000 acre-feet per month in July and August before increasing slightly in September. The lowest annual flow on record at the Corinne gage was the 1992 water year. Flows that year started at 13,000 acre-feet/month in October and then ranged between 40,000 and 60,000 acre-feet/month during the winter months of November through March, before dropping off significantly in April and settling below 5,000 acre-feet/month throughout the entire summer.

Below the Corinne gage the only significant water use is at the Bear River Migratory Bird Refuge. The bird refuge's water demand is also shown in Figure 5 and reflects the refuge's water right and desired delivery pattern. The bird refuge's water needs are fairly insignificant during the winter

Figure 5
Bear River Flows at Corinne vs Downstream Demand



months of November through February. From March through September the bird refuge's water needs hover around 60,000 acre-feet per month (1,000 cfs). As can be seen in Figure 5, the average annual flow of the river in July, August, and to some extent September, is inadequate to meet the needs of the refuge. During dry years, however, the flow of the river is inadequate to meet the bird refuge's need for more than half of the year.


The Bear River just north of the Bird Refuge

Recognizing the need to supplement the river's flow during the summer months, the U.S. Fish and Wildlife Service is currently working with the Bureau of Reclamation to explore the possibility of enlarging Hyrum Reservoir to meet summer needs at the Bear River Bird Refuge. Surplus runoff in the spring months would be stored in Hyrum Reservoir and released in the late summer months to increase the refuge's late summer water supply and help mitigate against the possible outbreak of botulism and other ill effects the refuge suffers as a result of low flows. The possibility of enlarging Hyrum Reservoir will be discussed in more detail in Chapter 6, Water Development.

The developable flow of the Bear River is represented, in Figure 5, by the area between the blue line (flow at Corinne) and the green line (demand at the Migratory Bird Refuge). During dry years the developable flow is considerably less and is represented as the area between the red line (record low flow) and the green line. But even during the driest year on record the Bear River has water available for development from November through February if storage is available. However, the need for storage is attested to by the lack of late summer flows and the significant reduction in the volume of flow in dry years.

TABLE 5
Bear River Development Act Allocations
(acre-feet)

Bear River Water Conservancy District	60,000
Jordan Valley Water Conservancy District	50,000
Weber Basin Water Conservancy District	50,000
Cache County	60,000
Total	220,000

Source: Bear River Development Act – 1991

In 1991 the Utah State Legislature passed the Bear River Development Act. The act directs the Utah Division of Water Resources to develop 220,000 acre-feet of Bear River water and allocates that water as shown in Table 5. The approach currently being considered is to: 1) modify the existing operation of Willard Bay by agreement with the Weber Basin Water Conservancy District; 2) connect the Bear River with a pipeline and/or canal to Willard Bay from a point near the Interstate 15 crossing of the Bear River near Elwood 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 as the demand for additional water continues to increase..

More than likely, the construction of a dam in the Bear River Basin will ultimately hinge on the needs of the basin's residents to develop their own allocated portion of the Bear River. The Bear River Water Conservancy District and the Cache County water users have allocations of 60,000 acre-feet each. Some of that water could possibly be developed without additional storage. However, the development of a firm yield, particularly during periods of drought when new water sources will most likely be needed, will require some form of storage.

Water Rights

The State Engineer (Utah Division of Water Rights) is presently adjudicating water rights in Box Elder County to define surface and ground water rights that are held for various uses under decrees, claims, and applications. Proposed Determinations have been completed for Cache and Rich counties. Several applications to develop large additional amounts of water have been filed in the lower basin. Any water development on the Bear River or its tributaries must conform to established water rights as well as the Bear River Compact. Table 6 lists each of the water rights areas and sub-areas within the basin along with a statement of the current status and general policy.

The Dietrich Decree was filed on July 14, 1920, in District Court of the United States for Idaho, eastern Division. The decree quantified and prioritized water rights for irrigation and power on the Bear River in Idaho. It also granted Utah Power and Light (now PacifiCorp) the right to divert 5,500 cfs of Bear River water into Bear Lake and 500 cfs from the Bear Lake and Mud-Lake tributaries. Non-consumptive rights were also granted for power purposes at the downstream hydropower projects.

On February 21, 1922, the Kimball Decree was filed in Utah District Court in Cache County. The Kimball Decree quantified and prioritized water rights on the Bear River in Utah. It also recognized Utah Power and Light's right to divert Bear River Water and store it in Bear Lake as well as non-consumptive rights for power purposes.

Bear River Compact

In 1958 the Bear River Compact was ratified by Congress and signed by the President of the United States. The compact provided for: (1) apportionment of Bear River flows between the states of Utah, Wyoming and Idaho; (2) allocation of upstream storage above Bear Lake; (3) establishment of an irrigation reserve in Bear Lake and; (4) a review of the compact provisions every 20 years.

TABLE 6
GENERAL STATUS OF WATER RIGHTS
BEAR RIVER BASIN

AREA	SUBAREA	STATUS AND GENERAL POLICY
21	Summit County	Status: Revised Proposed Determination published in 1962. Policy: Only domestic filings for in-house use are approved.
23	Laketown	Status: Proposed Determination published in 1965. Policy: Canyon areas are fully appropriated. Springs and streams are closed to new appropriations of both ground water and surface water.
	Southeast	Status: Proposed Determination published in 1966. Policy: Canyon areas are fully appropriated. Springs and streams are closed to new appropriations of both ground water and surface water.
	Woodruff Creek	Status: Proposed Determination published in 1966. Policy: Canyon areas are fully appropriated. Springs and streams are closed to new appropriations of both ground water and surface water.
	Northeast	Status: Proposed Determination published in 1965. Policy: Canyon areas are fully appropriated. Springs and streams are closed to new appropriations of both ground water and surface water.
	Big Creek, Randolph Creek & Otter Creek	Status: Proposed Determination published in 1966. Policy: Canyon areas are fully appropriated. Springs and streams are closed to new appropriations of both ground water and surface water.
25	Logan River	Status: Proposed Determinations published in 1974 & 1976. (3 books) Policy: Canyon areas closed. For most areas ground water is open to single family domestic applications. All applications are subject to the Cache Valley Ground water Management Plan implemented Sept. 1, 1999.
	Richmond (High Creek)	Status: Proposed Determination published in 1977. Policy: Canyon areas closed. For most areas ground water is open to single family domestic applications. All applications are subject to the Cache Valley Ground water Management Plan implemented Sept. 1, 1999. The Cove Area is closed to all but domestic application.
	Lewiston, Clarkston, & Newton	Status: Proposed Determination published in September 15, 1979. Policy: Canyon areas closed. For most areas ground water is open to single family domestic applications. All applications are subject to the Cache Valley Ground water Management Plan implemented Sept. 1, 1999.
	Blacksmith Fork	Status: Proposed Determination published in October 1, 1967. Policy: Canyon areas closed. For most areas ground water is open to single family domestic applications. All applications are subject to the Cache Valley Ground water Management Plan implemented Sept. 1, 1999.
	South Fork & East Fork	Status: Proposed Determination published in 1953. Policy: Canyon areas closed. For most areas ground water is open to single family domestic applications. All applications are subject to the Cache Valley Ground water Management Plan implemented Sept. 1, 1999.
29	Brigham City & Deweyville	Status: Proposed Determination published in October 1, 1990. Policy: Areas tributary to Black Slough are closed. All appropriations except .015's* are subject to the revised Bear River Compact.
	Willard	Status: Proposed Determination published on August 24, 1960. Policy: Area closed if springs lie down gradient. All appropriations except .015's* are subject to the Amended Bear River Compact.
	Portage Creek	Status: Proposed Determination published in September 5, 1991. Policy: All appropriations except .015's* are subject to the revised Bear River Compact.
	Thatcher Penrose	Status: Proposed Determination published on August 24, 1960. Policy: All appropriations except .015's* are subject to the revised Bear River Compact.
	Plymouth	Status: Proposed Determination published on August 24, 1960. Policy: All appropriations except .015's* are subject to the revised Bear River Compact.

* This is a single-family residential water right of .015 cubic feet per second.

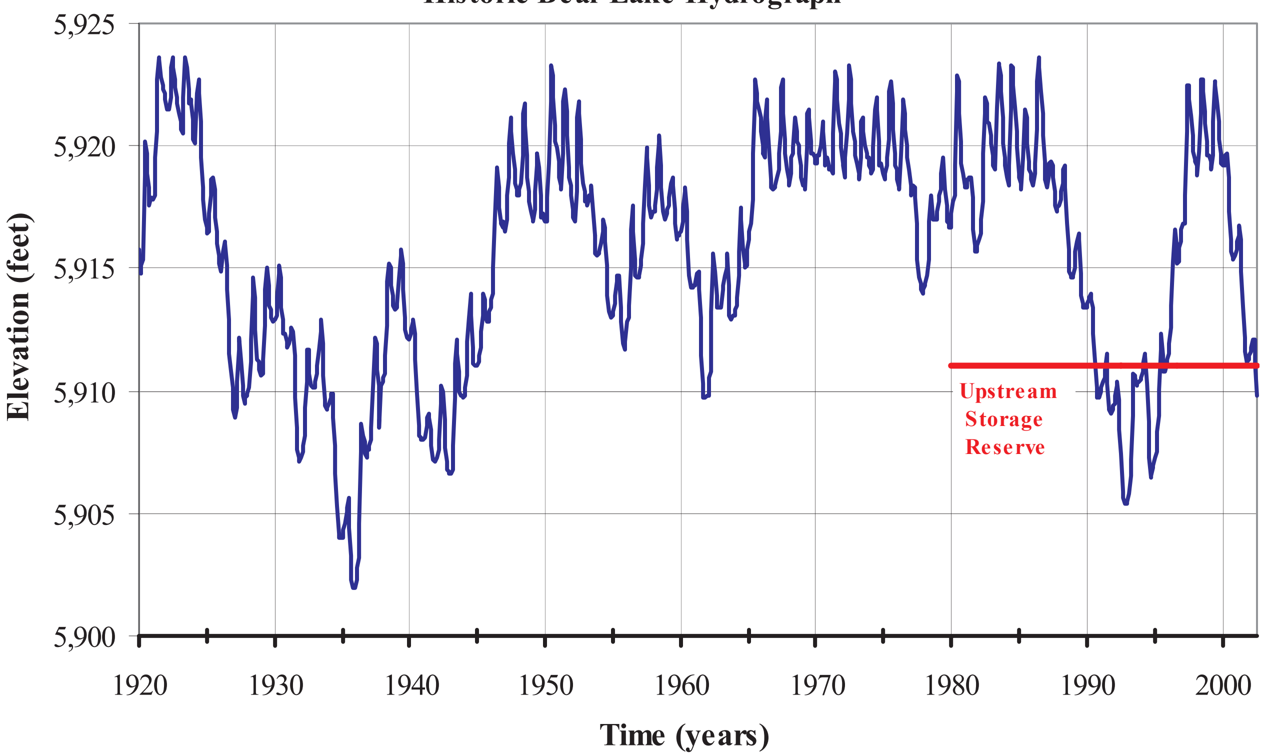
In 1980 the Bear River Compact was amended[7] to allow additional storage above Bear Lake. It also set restrictions on the additional upstream storage when the elevation of Bear Lake was below elevation 5911. The Bear River Compact also established criteria for adjusting the irrigation reserve as upstream storage increased. Prior to the Operational Agreement for PacifiCorp's Bear River System, signed in 2000, the irrigation reserve elevation was the management tool use to regulate non-irrigation releases from the lake. When the elevation of Bear Lake was below the irrigation reserve no water could be released from the lake solely for purpose of generating power. Currently, the lake is managed using a target elevation. A more detailed explanation of the current method of managing the lake will follow.

In 1994 Cutler Reservoir was relicensed by FERC for continued use as a hydropower facility. The relicensing process for Soda, Cove and Oneida hydropower plants is currently underway and scheduled for completion in 2003.

In 1995 the Bear Lake Group, a consortium of landowners, recreational and environmental interest groups filed a lawsuit against the U.S. Army Corps of Engineers and the Environmental Protection Agency. This lawsuit challenged the issuance of permits allowing PacifiCorp to dredge the channel to the Lifton pump station. In April of 1995, a Bear Lake Settlement Agreement was signed by the interested parties, the Last Chance Canal Company, the West Cache Canal Company, the Bear River Canal Company, the Idaho Pumpers Association, Bear Lake Watch, Emerald Beach, Bear Lake East and PacifiCorp. As part of the Settlement Agreement, PacifiCorp agreed not to dredge in 1995 and the Bear Lake land owners and special interest groups agreed to drop the pending law suit. All parties agreed to form a new Bear Lake Preservation Advisory Committee that would meet annually in an attempt to negotiate resolutions to disagreements between the parties that would otherwise result in litigation.

In April 2000, PacifiCorp signed an operational agreement with the states of Utah, Idaho and Wyoming to continue operating Bear Lake as it has been done historically. Water will be released from

Figure 6
Historic Bear Lake Hydrograph



Bear Lake only for flood control and to meet downstream irrigation contractual requirements. Once water is released for irrigation or flood control, power can be generated at the various downstream hydropower plants as a secondary benefit. Bear Lake will now be managed by use of a target elevation rather than an irrigation reserve. PacifiCorp's Target Elevation (PTE) will be set on March 31 of each year. The PTE may range from as low as 5916 feet during high runoff conditions to 5920 feet during projected low runoff conditions. Under normal conditions the PTE will be set at 5918. Generally, if Bear Lake's elevation is higher than the PTE at the end of the irrigation season, releases are scheduled to lower Bear Lake to the PTE by March 31 of the following year. Conversely, if Bear Lake is below the PTE at the end of the irrigation season, releases are curtailed until such time as the lake is predicted to reach the PTE or until such time as high snowpack and runoff forecasts during the following winter months require PacifiCorp to make releases for flood control.

NOTES

1. *Utah Climate*, Gaylen L. Ashcroft, Donald T. Jensen, Jeffrey L. Brown, (by Utah Climate Center, 1992).
2. *The Water Resources Data Utah*, Water Year 1990, U.S. Geological Survey Water Data Report UT-90-1
3. *The Utah Water Data Book*, Division of Water Resources, August 1997.
4. *Hydrology of Cache Valley, Cache County, Utah and Adjacent parts of Idaho, with Emphasis on Simulation of Ground-Water Flow*,
5. Bjorklund, L.J. and McGreevy, L.J., 1971, *Ground-water resources of Cache Valley, Utah and Idaho*: Utah Department of Natural Resources Technical Publication No. 36.
6. *Interim Cache Valley Ground-Water Management Plan*, Utah Division of Water Rights, p2
7. *Bear River Compact As Amended and By Laws of Bear River Commission*, December 22, 1978.

3

POPULATION AND WATER-RELATED TRENDS AND PROJECTIONS

DEMOGRAPHICS AND ECONOMIC TRENDS AND PROJECTIONS

Approximately seven percent of Utah's population resides in the three Bear River Basin counties of Rich, Cache and Box Elder. The Utah portion of the Basin has a current population of 136,097 (2000 US Census), which is projected to increase to 203,705 by 2020 and to 297,597 by 2050. This is a total increase of nearly 50 percent or just over 2 percent per year over the next 20 years, and a total increase of 119 percent or approximately 1.6 percent annually over the next 50 years.

During the past ten years, the population projections for Utah's cities and counties have been modified several times to reflect the state's ever-changing growth trends. The Bear River Basin's actual population increase during the past eight years has exceeded the Governor's Office of Planning and Budget (GOPB) projections used in the 1992 Bear River Basin Plan. At that time, Cache County's 1990 population of 70,183 was projected to increase to 77,900 by 2000 and 107,200 by 2020. The 2000 U.S. Census put Cache County's population at 91,391. At the present time the GOPB's projected population for Cache County for 2020 is 137,966 and 203,285 by 2050. Likewise, Box Elder County's 1990 population was projected to increase from a population of 36,485 in 1990 to 40,500 in 2000 and 46,300 in 2020. The 2000 U.S. Census put Box Elder County's population at 42,745. At the present time Box Elder County is projected to grow to a population of 63,388 by 2020 and to 91,526 by 2050. Population estimates for Rich County have the current population of 1,961 and a projected increase to 2,351 by 2020 and to 2,786 by 2050.

Current GOPB population estimates and projected population figures for the basin's towns and cities are given in Table 7. The population projections for each of the basin's three populated counties are graphically depicted in Figure 7. The principal cities in the basin and their 2000 population estimates include Logan (42,670); Brigham City (17,411); Smithfield (7,261); North Logan (6,163); Hyrum (6,316); and Tremonton (5,592). (See Table 7)

Table 8 compares the results of the most recent economic survey (1997) of the basin with the 1987 economic survey used in the 1992 Bear River Basin Plan. No significant changes occurred in the past decade, but some trends emerged. With a few exceptions, most industries have shown growth in the past decade. However, manufacturing accounted for nearly half the basin's personal income in 1987, but has dropped to about 40 percent in the past ten years, while the Service, Retail Trade, and Transportation and Utilities sectors now constitute a larger part of the basin's economy. Agriculture and agricultural-related services remain at about four percent of the basin's total economy.

Figure 7
Population Trends and Projections

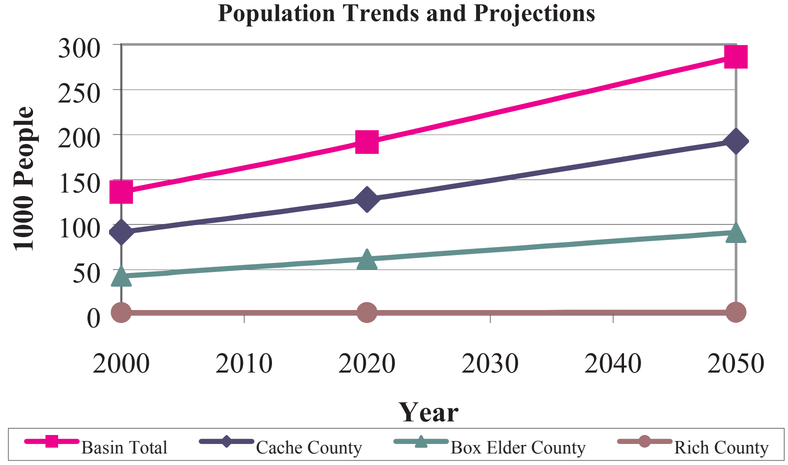


TABLE 7
POPULATION PROJECTIONS
Bear River Basin

Cities/Towns Box Elder County	Water Conservation Plan	2000[1]	2020[2]	2050[2]
Bear River City	N/A	750	1,112	1,606
Brigham City*	Yes	17,411	25,821	37,281
Corinne*	N/A	621	921	1,330
Deweyville	N/A	278	412	595
Elwood	N/A	678	1,005	1,452
Fielding	N/A	448	664	959
Garland*	Yes	1,943	2,881	4,160
Honeyville*	N/A	1,214	1,800	2,599
Howell Town	N/A	221	328	473
Mantua	N/A	791	1,1173	1,694
Perry *	N/A	2,383	3,534	5,103
Plymouth	N/A	328	486	702
Portage	N/A	257	381	550
Snowville	N/A	177	262	379
Tremonton*	Yes	5,592	8,293	11,974
Willard*	Yes	1,630	2,417	3,490
Total for Incorporated Cities and Towns		**34,722**	**51,490**	**74,347**
Balance of the County		**8,023**	**11,898**	**17,179**
Box Elder County Total		**42,745**	**63,388**	**91,526**
Cache County				
Amalga	N/A	427	587	950
Clarkston	N/A	688	826	1,530
Cornish	N/A	259	257	576
Hyde Park*	Yes	2,955	3,787	6,573
Hyrum*	Yes	6,316	8,457	14,049
Lewiston	No	1,877	2,457	4,175
Logan*	Yes	42,670	59,587	87,166
Mendon*	N/A	898	1,782	1,997
Millville*	N/A	1,507	1,973	3,352
Newton	N/A	699	1,045	1,555
Nibley*	Yes	2,045	4,238	4,549
North Logan*	Yes	6,163	9,043	12,555
Paradise	N/A	759	1,093	1,688
Providence*	Yes	4,377	13,512	17,888
Richmond*	Yes	2,051	2,592	4,562
River Heights	Yes	1,496	1,657	3,328
Smithfield*	No	7,261	12,601	16,899
Trenton	N/A	449	595	999
Wellsville*	Yes	2,728	3,574	6,068
Total for Incorporated Cities and Towns		**85,625**	**129,643**	**190,459**
Balance of the County		**5,766**	**8,323**	**12,826**
Cache County Total		**91,391**	**137,966**	**203,285**
Rich County				
Garden City*	Yes	357	428	507
Laketown	N/A	188	225	267
Randolph*	N/A	483	579	686
Woodruff	N/A	194	233	276
Balance of the County		**739**	**886**	**1,050**
Rich County Totals		**1,961**	**2,351**	**2,786**
Basin Totals		**136,097**	**203,705**	**297,597**

* Incorporated Cities and Towns N/A: Not Applicable (less than 500 connections)
Source: 1) U.S. Census Bureau, ''National Census 2000''
2) ''2003 Baseline, UPED Model System,'' Governor's Office of Planning and Budget

New homes adjacent farm land west of Tremonton

LAND USE

Land-use data for the Utah portion of the basin, collected in 2003, is presented in Table 9. The table gives a county-by-county summary of the basin's irrigated croplands by crop for 2003. Grain accounted for 16 percent of the county's total irrigated lands, while alfalfa accounted for 30 percent. The 2003 land-use survey identified 298,896 acres of irrigated ground and 152,983 acres of non-cropland agricultural lands, including idle and fallow ground. A total of 451,879 acres of agricultural lands were identified.

WATER USE TRENDS AND PROJECTIONS

Agricultural use continues to be the major use of water in the Bear River Basin. During the past few decades, heavily populated portions of the state have experienced declining agricultural use corresponding to an increasing municipal and industrial (M&I) use. However, in the Bear River Basin the conversion of agricultural land to urban and the increasing use of water for M&I purposes has not resulted in reduced agricultural water use. The abundant supply of water in the basin has meant that it has not been necessary to convert agricultural water supplies to M&I uses. The conversion of agricultural land to urban has resulted in a net loss of dry-farm land but not in a loss of irrigated acreage. It is unlikely that this trend will be reversed any time soon.

Drinking Water

Significant population growth is projected throughout the basin during the next 20 years. However, most of the basin's municipalities have existing water supplies that are sufficient to meet the projected future demand. Although existing M&I water supplies appear adequate throughout much of the Bear River Basin, some systems currently have or will have problems in the near future. Some communities, such as Logan and Nibley in Cache County and Tremonton, North Garland and West Corinne in Box Elder County, are already operating at or near the limits of their reliable system/source

TABLE 8

Personal Income and Earnings (Million $)[a]

	Box Elder		Cache		Rich		Total			
Industry	1987	1997	1987	1997	1987	1997	1987	%	1997	%
Manufacturing	333	433	126	292	[b]	0.2	459	49%	726	41%
Government	32	58	123	226	2.5	4.5	158	17%	289	16%
Services	29	59	78	216	0.7	2.8	108	11%	277	16%
Retail Trade	24	62	38	97	0.4	1.2	62	7%	159	9%
Construction	19	33	36	73	0.3	0.7	55	6%	106	6%
Agriculture and Ag Services	18	32	18	30	4.2	3.4	40	4%	65	4%
Transportation and Utilities	7	22	16	41	0.5	0.3	24	2%	63	4%
FIRE[c]	5	11	13	27	[b]	[b]	18	2%	37	2%
Wholesale Trade	8	13	8	23	[b]	[b]	16	2%	35	2%
Mining	0	1	0	0	0.4	0.7	1	0%	2	0%
Total	475	724	456	1,025	9.0	13.8	940	100%	1,762	100%

[a] Source: *Utah Economic and Business Review* Volume 59 Numbers 3 and 4 March/April 1999
[b] Not shown to avoid disclosure of confidential information
[c] Financial, Insurance, and Real Estate

TABLE 9
Irrigated and Non-Irrigated (Dry) Agricultural Ground by Crop Type
Utah portion of the Bear River Basin

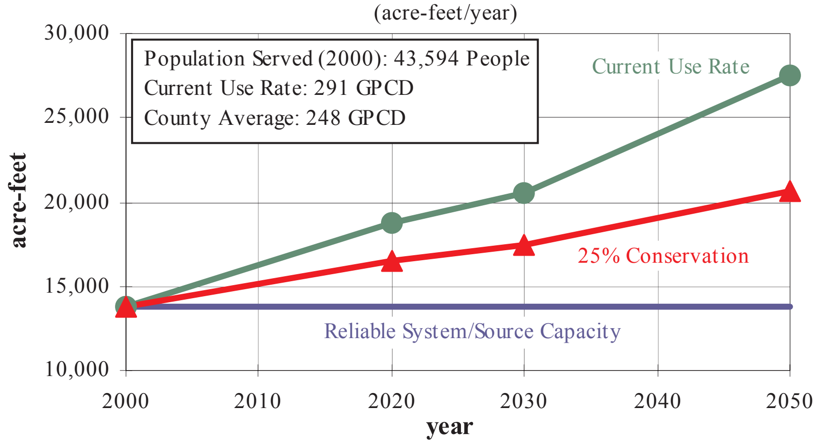
Crop	(Acres, by County) Box Elder	Cache	Rich	Summit	Total
Irrigated Cropland					
Alfalfa	28,057	52,922	9,019	0	89,998
Grain	26,316	19,958	1,905	0	48,179
Corn	13,374	7,259	11	0	20,644
Orchards/Fruit	1,157	38	0	0	1,195
Onions	1,223	0	0	0	1,223
Vegetables	286	113	0	0	399
Potatoes	0	46	0	0	46
Berries	0	0	52	0	52
Beans	0	10	0	0	10
Other Horticulture	59	101	0	0	160
Sorghum	2,235	960	0	0	3,195
Pasture	14,303	16,055	14,752	3,294	43,824
Sub-Irrigated Pasture	18,971	9,348	15,038	467	69,011
Grass/Hay	5,329	5,387	29,884	0	40,600
Sub-irrigated Grass/Hay	0	71	32	0	103
Grass Turf	682	182	0	0	864
Total Irrigated Cropland	**111,992**	**112,450**	**70,693**	**3,761**	**298,896**
Non-Irrigated Agricultural Land					
Alfalfa	1,603	6,883	641	0	9,127
Grains/Beans/Seeds	15,297	21,894	15,408	0	52,599
Pasture	14,676	5,636	13,491	1,406	35,209
Safflower	494	5,845	0	0	6,339
Fallow	7,021	6,126	138	0	13,285
Idle	14,381	20,317	1,567	159	36,424
Total Non-Irrigated Land	**53,472**	**66,701**	**31,245**	**1,565**	**152,983**
Total Agricultural Land	**165,464**	**179,151**	**101,938**	**5,326**	**451,879**

Source: *Water Related Land-use Inventories*, Bear River Basin (unpublished), Utah Water Resources, (2003 data)
Note: This table does not include irrigated lands in Idaho nor irrigated ground within the boundaries of the Bear River Migratory Bird Refuge.

capacity. Other communities, such as Garland and Brigham City in Box Elder County and Lewiston, Amalga and Newton in Cache County, will reach the limits of their reliable system/source capacity by 2020. Supply vs. demand graphs (Figures 8 through 13) have been included here to show the inter-relationships between each town's existing system's reliable system/source capacity (the blue line) and the projected demand for the next 50 years. Each figure includes a pair of future demand lines. The green line shows the community's projected water needs based upon its current use rate, while the red line shows the reduction in demand if 25 percent conservation is achieved by 2050. Similar figures have been prepared for each of the basin's municipalities and are included in the appendix.

New Homes in Cache Valley

Figure 8
Logan City
Existing Supply vs Demand
(acre-feet/year)



Reliable system/source capacity is a term used here to quantify how much water can be delivered by the existing community water system. As the term implies, delivery limits may be a result of inadequate infrastructure (system) or insufficient supply (source). For some communities, improving system capacity may simply mean replacing a pump, whereas for another community it could entail locating and developing a new water source, building a larger storage tank, and enlarging mainline pipes. This report will not go into the detail of identifying the specifics of each system's limitations, nor identify possible remedies. The intent here is to compare each community water system's existing reliable system/source capacity to its projected future demand and thereby show when problems will likely arise. It is important to understand that the reliable system/source capacity is a theoretical number based upon supplying adequate flow during periods of peak demand. Consequently, it is possible for a system to deliver more total water than the calculated reliable system/source capacity. When this happens the system will function adequately much of the time. But during periods of peak demand, usually in the morning or early evening during the summer months, the system pressure will drop, resulting in delivery problems. Such reductions in system pressure have serious implications including potential water contamination and reduced fire fighting capabilities.

Many communities in the state have initiated water conservation plans in an effort to reduce the rate of consumption of M&I water supplies. The Division of Water Resources has encouraged communities to develop water conservation plans, and has required the existence of such a plan whenever state money has been used to assist in project development. Since water supplies are plentiful throughout most of the basin, often there seems to be little incentive for communities to develop and adhere to a water conservation program. However, there is considerable incentive when one considers the infrastructure needs and capital expense associated with increasing system capacity to meet future demands. It is hoped that communities will recognize the potential for water conservation efforts not only to stretch existing supplies but also to delay the need for expensive capital improvements.

As can be seen in Figure 8, Logan City's water system is currently operating at its reliable system/source capacity. This means there is already a need for some form of infrastructure improvement or additional water source. Logan's current total

Figure 9
Nibley
Existing Supply vs Demand
(acre-feet/year)

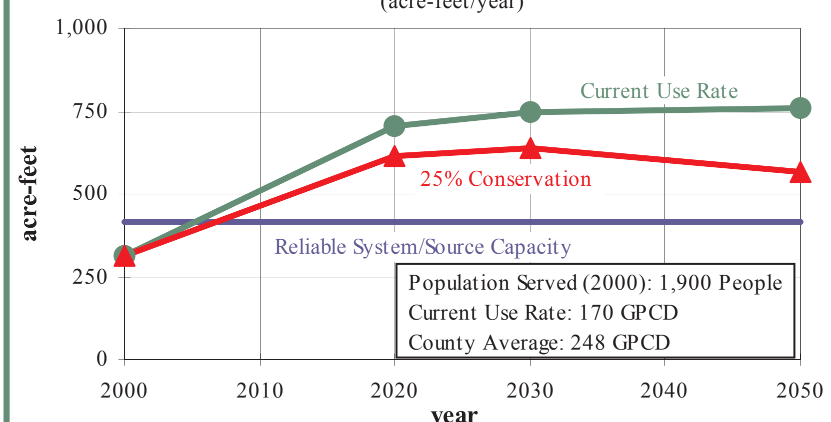
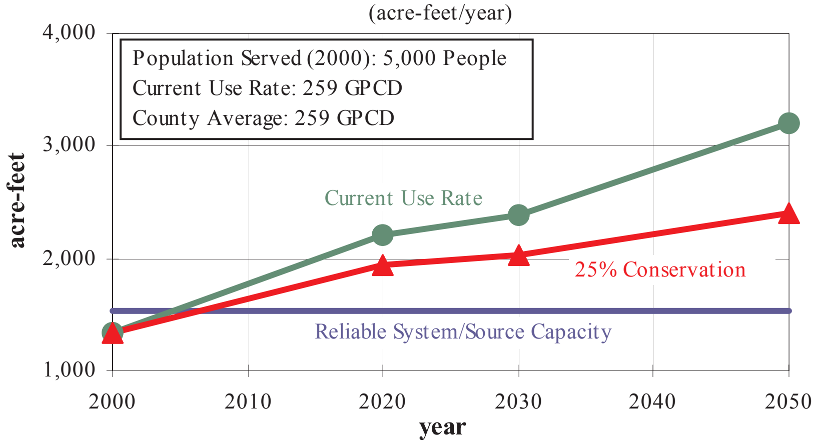


Figure 10
Tremonton
Existing Supply vs Demand
(acre-feet/year)



M&I use is 291 gallons per capita per day (GPCD), a rate which is about 17 percent higher than the county-wide average of 249 GPCD. The Current Use Rate line shows what Logan's future water needs will be if the residents continue to use water at the current rate of 291 GPCD. For comparison the 25 percent conservation line shows how future demand will be impacted if Logan's residents can achieve 25 percent water use reduction by the year 2050.

The town of Nibley (current population 1,900) is presently operating near the reliable system/source capacity of the town's water system (See Figure 9). At the present time, Nibley is only using 170 GPCD, approximately 68 percent of the countywide average. In addition to being near the limits of its reliable system/source capacity, Nibley is also faced with the probability of exceeding its existing water supply within the next 20 years. From Figure 9 it can be seen that 25 percent water conservation will do little to address either of these immediate problems for the town. At the present time Nibley is in need of additional water supplies and infrastructure improvements.

In Box Elder County, Tremonton's situation is almost identical to Logan's (Figure 10). The city's existing water system is operating near the limits of its reliable system/source capacity. Tremonton's total M&I use is currently 259 GPCD, within five percent of the countywide average of 249 GPCD.

North Garland (Figure 11) is currently using 283 GPCD, which is slightly higher than the countywide average. However, North Garland is currently operating at the limit of the system's reliable system source capacity.

Despite having adequate water supplies, many towns in the basin will reach or exceed the limits of their reliable system/source capacity within the next 20 years. For many of these towns, water conservation is a reasonable and economic means of delaying the inevitable cost of system improvements. Figure 12 and Figure 13 show two towns, Brigham City in Box Elder County and Lewiston in Cache County, which will reach the limits of their system's capacity around 2012 if water conservation efforts are not undertaken. As shown by the graphs, however, both of these towns could delay necessary infrastructure improvements to their systems a few years through water conservation efforts.

At its current total M&I per capita use rate (285 gallons per capita day), Brigham City will reach the

Figure 11
North Garland
Existing Supply vs Demand
(acre-feet/year)

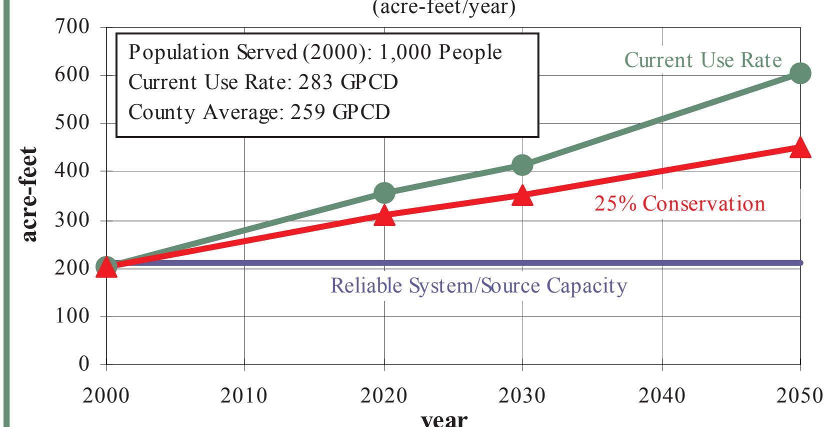
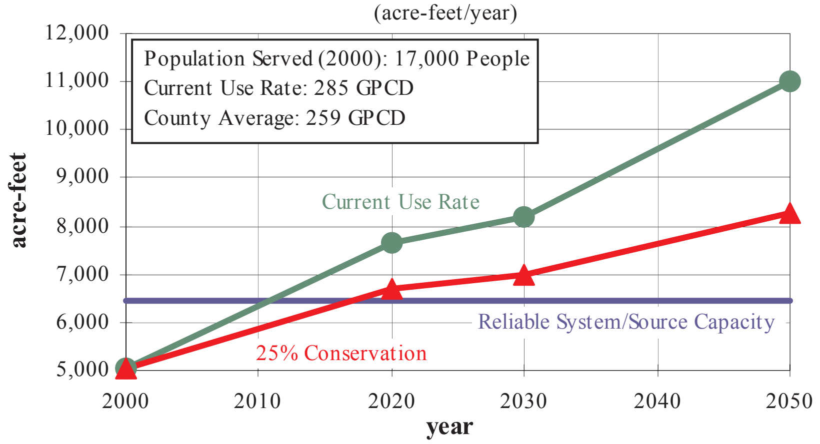


Figure 12
Brigham City
Existing Supply vs Demand
(acre-feet/year)



limits of its reliable system/source capacity around 2012 (See Figure 12). With the rapid growth rate projected for Brigham City, water conservation will only delay the need for system improvements a few short years.

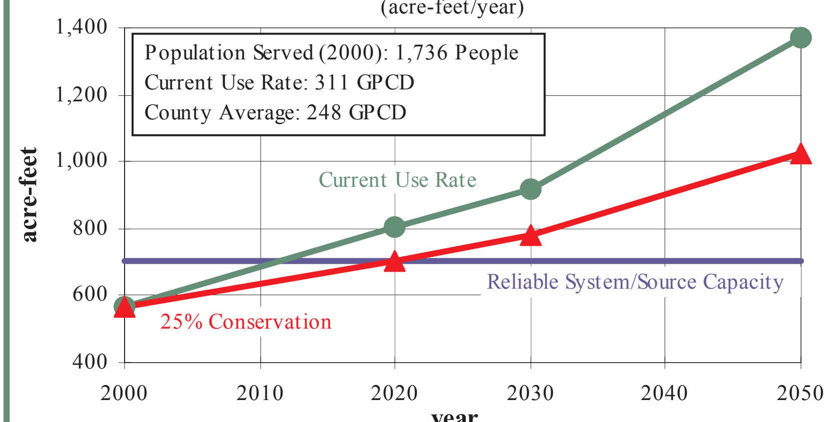
For Lewiston, with a current total M&I use rate of 311 gallons per capita-day, the system's reliable system/source capacity will be exceeded in about 2012. With water conservation that date can be moved back to about 2020. For Lewiston, as with Brigham City, the implication is that the life of the existing system could be prolonged by 8-10 years through conservation.

The impacts predicted by the supply vs. demand graphs are summarized for all communities in Table 10, which compares each water system's reliable system/source capacity to the community's predicted future water demand. Future water demands were calculated by multiplying the projected population, by the current use rate. The 25 percent conservation line assumes a water conservation reduction of 12.5 percent by 2020, and a 25 percent reduction by 2050. Through the use of color shaded cells Table 10 shows which communities are most likely to have problems with reliable system/source capacity over the next 50 years.

Table 10 shows that most communities in the basin have sufficient water supplies through the year 2020. In Box Elder County four communities will need to address system deficiencies by 2020. Through water conservation efforts alone one of these communities, Mantua, could reduce the impact of future demand enough to reduce or delay the need for infrastructure improvement beyond the year 2020. The four communities, Brigham City, North Garland, Tremonton, and West Corinne will face significant system deficiencies and will need to implement some system improvements in addition to any water conservation measures. These communities are all within the Bear River Water Conservancy District service area, and could obtain additional water through the district. Several more communities in Box Elder County will face system deficiencies by the year 2050. The communities of Brigham City, Elwood, Garland, Harper Ward and Corinne could meet their needs through 2050 through water conservation alone.

In Cache County several communities (Amalga, Lewiston, Logan, Millville, Newton, Nibley, and Smithfield) will face water system deficiencies by 2020. By 2050 several more Cache County communities (Benson, Clarkston, Cornish, Hyrum,

Figure 13
Lewiston City
Existing Supply vs Demand
(acre-feet/year)



Lewiston, Paradise and Providence) will also face delivery problems. Although all of these communities will benefit from water conservation, most will have to address their future water needs with more than just water conservation. For many communities throughout the basin, the big problem is not actually water supply but some deficiency in their water delivery system. For Logan, Nibley, Paradise, Cornish, Tremonton, North Garland and West Corinne the problems exist now. These systems are already operating at the limits of their reliable system/source capacity. For these communities, infrastructure improvements are already needed. For other communities like Lewiston, Millville, Clarkston, Amalga, Smithfield, and Newton, planning efforts now and water conservation strategies implemented over the next 20 years may postpone the need for expensive infra-

TABLE 10

PROJECTED CULINARY M&I DEMAND AND SUPPLY FOR PUBLIC COMMUNITY WATER SYSTEMS

Bear River Basin (Box Elder County)

(acre-feet /year)

Name	Reliable System/ Source Capacity	2020			2050		
		Population	Demand*	Surplus Deficit ()	Population	Demand*	Surplus Deficit ()
Box Elder County							
Acme Water Co. (Bear River City)	391	1,112	253	138	1,606	313	78
Beaver Dam Water Co.	163	61	17	146	61	14	149
Bothwell Cemetery and Water Corp.	174	529	169	5	562	177	(3)
Brigham City Municipal Water	6,473	25,821	6,678	(205)	37,281	8,265	(1,792)
Cedar Ridge Subdivision	150	100	19	131	100	16	134
Coleman Mobile Home Court	17	48	10	7	48	9	8
Corinne City Corp.	235	921	115	120	1,330	142	93
Deweyville Municipal Water System	202	412	90	112	595	111	91
Elwood Town	384	1,005	260	124	1,452	322	62
Five C's Trailer Court	17	50	7	10	50	6	11
Garland City Corp.	908	2,881	672	236	4,160	832	76
Harper Ward*	100	150	17	83	150	17	83
Honeyville Municipal Water System	1,186	1,800	629	557	2,599	778	408
Hot Springs Trailer Court	25	110	14	11	110	12	13
Mantua Culinary Water System	323	1,173	280	43	1,694	346	(23)
Marble Hills Subdivision	142	136	29	113	136	25	117
Perry City Water System	1,394	3,534	666	728	5,103	825	569
Plymouth Town	397	486	106	291	702	132	265
Portage Municipal Water System	94	381	67	27	550	83	12
Riverside – North Garland Water *	212	1,933	312	(100)	3,262	451	(239)
South Willard Culinary Water	367	392	101	266	629	139	228
Sunset Park Water Co.	13	35	11	2	35	10	3
Thatcher-Penrose Service District*	553	926	184	369	1,137	194	359
Tremonton Culinary Water*	1,535	8,293	1,937	(402)	11,974	2,398	(863)
Ukon Water Co.*	200	1,031	127	73	1,411	150	50
West Corinne Water Co	967	1,852	1,165	(198)	2,274	1,226	(259)
Willard Municipal Water System	847	2,321	667	180	3,490	859	(12)
County Totals		**57,493**	**14,603**	**2,866**	**82,501**	**17,851**	**(382)**

Dark Green Surplus/Deficit Cell indicates that without conservation the existing Reliable System/Source Capacity will be inadequate.

Red Surplus/Deficit Cell indicates that even with conservation the existing Reliable System/Source Capacity will be inadequate.

* These communities also receive water from the Bear River Water Conservancy District

TABLE 10 (continued)
PROJECTED CULINARY M&I DEMAND AND SUPPLY
FOR PUBLIC COMMUNITY WATER SYSTEMS
Bear River Basin
(acre-feet /year)

Name	Reliable System/ Source Capacity[1]	2020			2050		
		Population	Demand*	Surplus Deficit ()	Population	Demand*	Surplus Deficit ()
Cache County							
Amalga Municipal Water System	559	587	649	(90)	950	900	(341)
Benson Water Culinary District	147	577	105	42	1,048	164	(17)
Clarkston Municipal Water System	471	826	387	84	1,530	615	(144)
Cornish Municipal Water System	99	257	85	14	576	162	(63)
Goaslind Spring Water Works Co.	401	60	11	390	60	9	392
High Creek Culinary Water System	64	85	19	45	85	16	48
Hyde Park Culinary Water System	1,244	3,787	467	777	6,573	695	549
Hyrum City Water System	4,771	8,457	2,703	2,068	14,049	3,848	923
Lewiston Culinary Water System	705	2,457	705	0	4,175	1,026	(321)
Logan City Water System	13,758	59,587	16,455	(2,697)	87,166	20,632	(6,874)
Mendon Culinary Water System	294	1,782	204	90	1,997	196	98
Millville City Water	454	1,973	390	64	3,352	568	(114)
Newton Town Water	158	1,045	171	(13)	1,555	218	(60)
Nibley City	406	4,238	617	(211)	4,549	567	(161)
North Logan Culinary System	2,986	9,043	1,275	1,711	12,555	1,517	1,469
Paradise Town	190	1,093	160	30	1,688	212	(22)
Providence City Corp. Water	3,748	13,512	2,972	776	17,888	3,373	375
Richmond City	919	2,592	448	471	4,562	676	243
River Heights City Water System	1,208	1,657	573	635	3,328	987	221
Smithfield Municipal Water System	2,311	12,601	2,052	259	16,899	2,359	(48)
South Cove Water Supply	182	73	19	163	202	16	166
Trenton City	577	595	96	481	999	138	439
Wellsville City	4,022	3,574	583	3,439	6,068	848	3,174
County Totals		**130,458**	**31,145**	**8,529**	**191,854**	**39,743**	**(69)**
Rich County							
Garden City Water System	771	428	418	353	507	424	347
Laketown City Water System	235	225	194	41	267	198	37
Mountain Meadow Park Imp. Dist.	325	120	14	311	139	14	311
Randolph City	276	579	280	(4)	686	284	(8)
Woodruff Culinary Water System	52	223	45	7	276	46	6
County Totals		**1,585**	**951**	**708**	**1,875**	**966**	**693**

Dark Green Surplus/Deficit Cell indicates that without conservation the existing Reliable System/Source capacity will be inadequate.
Red Surplus/Deficit Cell indicates that even with conservation the existing Reliable System/Source capacity will be inadequate.

*Calculated demand for 2020 and 2050 include 12½ percent and 25 percent conservation respectively.

1 Reliable system source capacity represents the volume of water, which when divided by the average annual per capita use, gives the population that can reliably be served by the existing system under peak day demand conditions.

Source: *2001 M&I Water Supply Bear River Report*, Utah Division of Water Resources, April, 2001.

structure improvements to the '20s and '30s.

In Rich County no communities appear to have a serious water system deficiency. Randolph is currently operating at the limits of its system's reliable system/source capacity. However, the city's current water-use rate is more than twice the county average. Water conservation efforts alone would resolve any delivery problems Randolph might face over the next 50 years.

Secondary Water

A secondary (or dual) water system supplies non-potable water for uses that do not require high quality water, principally for watering lawns and gardens. The major purpose of a secondary water system is to reduce the overall cost of water treatment by using cheaper untreated water where appropriate, and preserving higher quality water for domestic use. Secondary systems are most suitable for areas where it is economically feasible to construct a separate storage and distribution system in addition to the potable (drinking) water system. Installing secondary systems is generally more feasible in developing areas. This allows secondary lines to be placed at the same time as other infrastructure, greatly reducing costs and inconvenience to homeowners.

Although secondary systems free up higher quality water supplies for culinary uses, people tend to use more water with them than if they are watering lawns with the drinking water system. This is because secondary systems are not metered, so people pay a flat fee for as much water as they want rather than paying for what they actually use.

An economical meter is not yet available that can withstand the severe conditions of a secondary system. Secondary water is often laden with suspended grit and organic material, which wears away and clogs moving parts. Also, secondary systems are drained in the fall and left dry through the winter months. This results in a buildup of organic material, which hardens and impedes the free movement of the meter parts when the system is then refilled.

The Logan River above 1st Dam

Further research into the development of a meter, so that water users can be billed according to their use, is encouraged. Another solution that may work in some instances is the installation of filters to remove grit and organic material at the head of the systems. This would help reduce clogs and wear and tear on moving parts, but does not solve the problems associated with the draining of the system during the winter months.

In the Bear River Basin, the total secondary use, including commercial and institutional uses, is about 5,200 acre-feet per year (See Table 11). This represents about 13 percent of the basin's total residential water use. Percentage-wise the Bear River Basin has one of the lowest rates of secondary water use in the state.

TABLE 11
Secondary (Non-Potable) Water Use Within Public Community Systems
Bear River Basin

County	Residential Use (Ac-Ft/year)	Commercial Use (Ac-Ft/year)	Institutional Use (Ac-Ft/year)	Industrial/ Stockwater Use (Ac-Ft/year)	Total Secondary Use (Ac-Ft/year)
Box Elder	754	186	594	0	1,535
Cache	2,392	173	907	0	3,472
Rich	21	138	28	0	186
Total	**3,167**	**497**	**1,529**	**0**	**5,193**

Source: *Municipal & Industrial Water Supply Studies: Bear River Basin*, Utah Water Resources, 2001

Table 12 shows the current use rate of treated drinking water and untreated secondary water for each of the basin's communities.

Currently the statewide average municipal and industrial water use is 293 gallons per capita-day (GPCD). Including the secondary water use the Bear River Basin's average is virtually the same at 292 GPCD. These numbers include indoor and outdoor residential, commercial, institutional and industrial uses. These per capita use numbers vary widely from town to town and can be used as an indicator of where water conservation might be beneficial. However, the numbers cannot be used as the sole indicator of where water supplies are being wasted. The town of Amalga, for instance, has a total residential use of 1,144 GPCD which includes 880 GPCD of industrial water use, primarily at the

TABLE 12
Municipal and Industrial Water Use
Bear River Basin (Box Elder County)

Community	Service[1] Population (2000)	Culinary Water Use		Secondary Water Use (GPCD)		Total M & I Use (GPCD)
		(Ac-ft/yr)	(GPCD)	Residential	Other	
Box Elder County						
Acme Water Co. (Bear River City)	820	212.9	231.8	34	49	314.4
Beaver Dam Water System	61	18.7	273.7	0	0	273.7
Bothwell Cemetery and Water Corp.	400	116.6	260.2	37	28	325.2
Brigham City Water System	17,000	5,024.9	263.9	5	16	284.9
Cedar Ridge Subdivision	100	21.4	191.0	0	0	191.0
Coleman Mobile Home Court	48	3.8	70.7	93	47	210.2
Corinne City Water System	646	91.7	126.7	76	50	252.3
Deweyville City Water System	350	86.6	220.9	34	64	318.6
Elwood Town Water System	625	184.6	263.7	28	0	291.7
Five C's Mobile Home Park	50	6.5	116.0	0	0	116.0
Garland City Water System	1,680	448.2	238.2	7	6	251.5
Harper Ward Water System[2]	150	16.9	100.6	182	0	322.0
Honeyville City Water System	1,250	498.7	356.1	0	24	379.7
Hot Springs Trailer Court	110	13.7	110.7	0	11	121.8
Mantua Town Water System	708	193.3	243.7	3	8	254.4
Marble Hills Subdivision	136	32.1	210.7	0	0	210.7
Perry City Water System	2,000	431.3	192.5	74	6	272.9
Plymouth Town	400	100.0	223.2	0	0	223.2
Portage Town Water System	250	50.3	179.6	107	0	287.1
Riverside-North Garland Water System[2]	1,100	203.3	165.0	35	83	282.9
South Willard Water Company	264	73.1	247.2	18	0	265.1
Sunset Park Water Co.	35	8.8	224.4	0	0	224.4
Thatcher-Penrose Service District[2]	700	159.2	203.0	50	0	252.7
Tremonton City Water System[2]	5,000	1,334.7	238.3	0	20	258.7
Ukon Water Co. [2]	920	129.8	125.9	149	51	326.1
West Corinne Water Co.	1,345	967.1	641.9	14	2	657.6
Willard City Water System	1,535	503.6	292.9	10	4	306.9
County Totals	**37,683**	**10,931.8**	**259.0**	**18**	**18**	**295.4**

Source: *Municipal & Industrial Water Supply Studies: Bear River Basin*, Utah Water Resources, 2001.
GPCD - Gallons per Capita Day

1. Service population is reported by the water purveyor and may differ significantly from the 2000 census numbers shown in Table 8.
2. These communities also receive water from the Bear River Water Conservancy District.

TABLE 12 (continued)
Municipal and Industrial Water Use
Bear River Basin (Cache and Rich Counties)

Community	Service[1] Population (2000)	Culinary Water Use		Secondary Water Use (GPCD)		Total M & I Use (GPCD)
		(Ac-ft/yr)	(GPCD)	Residential	Other	
Cache County						
Amalga Municipal Water System[2]	410	518.4	1,128.7	16	0	1,144.8
Benson Water Improvement District	560	116.6	185.9	77	0	263.1
Clarkston Municipal Water System	670	359.1	478.5	0	0	478.5
Cornish Municipal Water System	250	94.3	336.7	11	21	368.8
Goaslind Spring Water Works Co.	60	6.2	92.2	89	0	181.5
High Creek Water System	85	26.4	277.3	11	0	287.8
Hyde Park Water System	3,000	423.1	125.9	56	8	190.1
Hyrum City Water System	6,185	2,258.5	326.0	110	14	450.2
Lewiston City Water System	1,736	568.9	292.5	14	4	310.8
Logan City Water System	43,594	13,757.7	281.7	0	10	291.3
Mendon City Water System	804	104.7	116.2	160	29	305.0
Millville City Water System	1,350	305.2	201.8	23	20	244.8
Newton Town Water System	690	129.3	167.3	111	34	312.2
Nibley City	1,900	316.0	148.5	22	0	170.4
North Logan City Water System	6,400	1,031.2	143.8	24	9	176.6
Paradise Town Water System	645	107.7	149.1	260	36	444.8
Providence City Water System	4,610	1,159.0	224.4	14	0	238.2
Richmond City Water System	1,938	383.1	176.5	67	18	261.5
River Heights City Water System	1,480	576.2	347.5	7	2	357.0
Riverside Culinary Water Co.	90	19.6	194.4	0	0	194.4
Smithfield City Water System	7,420	1,381.1	166.2	34	30	230.3
South Cove Water Works	73	11.9	145.5	73	49	267.8
Trenton City Water System	500	92.4	165.0	104	11	279.3
Wellsville City Water System	3,000	559.2	166.4	30	0	195.9
County Totals	**87,450**	**24,305.8**	**248.1**	**24**	**11**	**283.0**
Rich County						
Garden City Water System[3]	225	251.4	997.4	6	546	1,549.0
Laketown City Water System[3]	340	236.6	624.2	36	14	674.6
Mountain Meadow Imp. District	80	16.3	181.9	0	0	181.9
Randolph City	500	276.2	493.1	0	32	525.2
Woodruff Town Water System	140	43.1	274.8	29	26	329.0
County Totals	**1,285**	**823.6**	**572.2**	**17**	**111**	**700.5**
Basin Totals/Averages	**126,418**	**36,061.2**	**255.0**	**22**	**15**	**291.7**

Source: *Municipal & Industrial Water Supply Studies: Bear River Basin*, Utah Water Resources, 2001
GPCD - Gallons per Capita Day
1. Service population is reported by the water purveyor and may differ significantly from the population numbers shown in Table 7.
2. High per capita use includes commercial water use at the cheese factory.
3. High per capita use is a result of high influx of seasonal tourism

town's cheese factory. Garden City and Laketown also have high per capita water use. For both of these communities though, these high numbers are a result of a seasonal influx of temporary residents and tourist.

Agriculture

The 1986 land-use data used in the 1992 Bear River Basin Plan identified the basin's total cultivated ground as 420,000 acres. Of that total, 301,700 acres were irrigated and 118,300 acres were non-irrigated cropland. Land-use data collected in 1996 identified 306,390 acres of irrigated ground and 110,803 acres of non-irrigated agricultural ground for a total of 417,193 acres of cultivated ground.

Land use inventory data collected in 2003 put the current total irrigated acreage within the Utah portion of the Bear River Basin at 298,896 acres with 152,983 acres of non-irrigated lands for a total of 451,879 acres of agricultural ground. The data shows a basin-wide reduction in irrigated acres of less than one percent over the past seventeen years.

The 1992 Bear River Basin Plan also showed Bear River water was used to irrigate 60,000 acres in Wyoming and 190,000 acres in Idaho. No effort has been made in this update to evaluate how much ground is now irrigated in these states.

Table 13 compares the water-related land use data of 1986 with the data collected in 1996 and the land-use data collected most recently during the summer of 2003. Percentage-wise the biggest change (a 41.6 percent increase) in irrigated cropland has been in Summit County where just over 1,100 acres of additional surface- and sub-irrigated pastureland has been identified. The data also shows a reduction in irrigated cropland of 2,743 acres (3.7 percent) in Rich County.

In Cache County the irrigation cropland reduction of 7,364 acres (6.2 percent) over the past seventeen years corresponds well with the increased population of 35,000 persons. The implication for Cache County seems to be that population growth and urban development occurs hand-in-hand with agricultural reductions, as irrigated cropland is converted to housing lots along with commercial and industrial development.

Corinne Canal

In Box Elder County urban growth appears to have had a less significant impact upon existing agriculture. Although the data shows an increase of 6,195 acres (5.9 percent) over the past seventeen years, the increase is attributable to the identification of sub-surface irrigated pasture that was initially identified as dry pasture in the 1986 survey. In reality, surface irrigation in Box Elder County has remained fairly consistent through all three surveys.

TABLE 13
Irrigated Cropland by County
Bear River Basin

County	1986	1996	2003	Increase (%)
Summit	2,655	3,129	3,761	41.6
Rich	73,436	72,377	70,693	-3.7
Cache	119,814	119,772	112,450	-6.2
Box Elder	105,797	111,112	111,992	5.9
Basin Total	301,702	306,390	298,896	-0.9

Source: Bear River Basin Water Related Land Use Inventories, Division of Water Resources, January, 1991 & Unpublished 1996 and 2003 land-use data

Environment

The Bear River Basin has no regulated instream flow requirements. The hydro-power plant at Cutler Dam was relicensed by FERC in April of 1994, but the new license did not stipulate any instream flow requirement associated with the operation of the Reservoir. The re-licensing process for the Soda, Grace-Cove, and Oneida projects is currently underway and scheduled for completion in 2004.

Although the basin has no instream flow requirements, the larger streams have some flow present throughout the year. With the exception of small reaches of the Blacksmith Fork, which are seasonally dewatered by hydroelectric developments, the entire length of Blacksmith Fork River and Logan River are Class I and/or Class II fisheries from their respective headwaters to the canyon mouths. With no significant upstream storage and few diversions, these streams are some of the highest quality trout fisheries in the state.

Bear River Migratory Bird Refuge

The Bear River Migratory Bird Refuge is located 15 miles west of Brigham City, Utah, and covers 74,000 acres of marshes, uplands and open water. Established in 1928 on the delta of the Bear River in the Great Salt Lake, the refuge attracts thousands of migratory ducks, swans, geese, shorebirds and other fowl. The site of the refuge has long been a popular stopping spot for migratory fowl. Botulism outbreaks at this location predate the existence of the bird refuge, which has suffered significant losses of birds to botulism in recent years. Botulism outbreaks typically occur in the late summer and early spring. The severity of the outbreaks appears to be influenced by the availability of water to flush the marsh system. The refuge's water right entitles it to a flow of 1,000 cfs up to a total use of 425,771 acre-feet per year. But mid-July through September flows in the river are often significantly less than 1,000 cfs. To mitigate this problem, the refuge has expressed interest in enlarging Hyrum Reservoir. Additional storage at Hyrum Reservoir would provide the refuge with late season flows that could be used to flush the ponds and hopefully reduce late summer botulism outbreaks.

Recreation

The Bear River Basin has numerous large reservoirs and streams that offer many water-related recreation opportunities. All the lakes and reservoirs are used for fishing, and some of the larger ones, such as Bear Lake, Hyrum, Newton and Mantua, are popular with boaters. The upper end of Cutler Reservoir is a marshland inhabited by waterfowl and navigable by canoe or a small motorboat.

Recreational water use continues to grow in the state. From 1959 to 1998, the number of registered boats in the state multiplied just over nine times[1].

Bear Lake Marina

The number of fishing licenses sold for the same period increased nearly three times[2]. Expectations are that both will continue to grow at these rates.

According to surveys done by the Division of Parks and Recreation, 95 percent of those boating at Bear Lake and Hyrum Reservoir were from Utah. The surveys also reveal that, although the number of boats grows steadily, the majority of boaters at Bear Lake and Hyrum reservoirs do not yet consider the lakes overly crowded. They did feel that limits on the number of boats out on the water should be established at Hyrum Reservoir, but not at Bear Lake. Most felt if they were not able to get their boat on the water at their first choice destination, there would still be nearby alternatives[3].

Conflicts have already surfaced between recreational use and traditional agricultural, M&I, and hydropower production. One of the natural results of reservoirs being used at their design limits is that average water levels will be lower, at the end of summer than at the beginning. Boaters at Hyrum Reservoir are concerned with the fluctuating water levels and would like to see the water level maintained at a higher level[3]. Fully utilizing the reservoirs not only reduces useable surface areas but also increases the distance to the water.

Bear Lake's water levels are controlled by the stipulations of the Bear River Compact, the 1995 settlement agreement and contracts between Utah Power and Light (now PacifiCorp) and their contracts with water users in Idaho and Utah. This has been a sore spot with property owners and recreational enthusiasts who desire a more stable lake level. Although the level of the lake fluctuates as PacifiCorp meets its downstream contracts, efforts have been made in recent years to include the homeowners and recreationists in discussions about operation of the lake.

Recreational water use has long been important in Utah and has been planned into many water projects. Recreational users are becoming more vocal in expressing their wishes. Where possible, it is important to include these users in discussions regarding new water projects or changes in the operation of existing ones. By so doing, and by everyone participating constructively, solutions to the increasingly complex situations now arising can be created.

NOTES

1. Utah Division of Parks and Recreation, State of Utah: Strategic Boating Plan, April 2000

2. Utah Division of Wildlife Resources, license sales records

3. Utah State University Institute for Outdoor Recreation and Tourism and Utah Division of Parks and Recreation: A Summary Report: 2001 Utah State Park Boater Intercept Survey, March 2002

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WATER CONSERVATION

The Bear River Basin's cities, towns and industries generally enjoy an adequate water supply. Even as far ahead as the year 2050, most municipalities in the basin have enough water to meet their projected water needs or have an option available to acquire the needed water. For many of these communities the question has not been "When to develop and implement a water conservation plan?" but "Why?"

Drought conditions plaguing the northern portion of the state since 1999 have served as a wake-up call for many Bear River Basin communities and agricultural water users. Water conservation by municipalities in the basin should be implemented as a way of life or an ethic, not merely as a drought-mitigation tool.

THE BENEFITS OF WATER CONSERVATION

The primary objective and resultant benefit of water conservation is the reduction of water demand, thus allowing existing water supplies to last longer. In addition, water conservation has a number of important secondary benefits. Water conservation can:

- Delay capital investments to upgrade or expand existing water and wastewater 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 through improved efficiencies;
- Reduce stream diversions, enhancing water quality as well as environmental and recreational functions; and
- Improve water levels in reservoirs for recreational use

UTAH'S WATER CONSERVATION EFFORT

A statewide goal has been established to reduce per capita water demand within public community systems by at least 25 percent before 2050. To guide the management of water development projects, the Board of Water Resources has issued a policy statement supporting conservation and the "wise use" of water. The Board's policy requires communities petitioning them for project funding to: (1) develop a water conservation plan, (2) establish a time of day watering ordinance, and (3) develop a progressive water rate structure.

Water Conservation Plans

The state's Water Conservation Plan Act requires all water conservancy districts and water retailers serving more than 500 connections to prepare Water Management and Conservation Plans. These were to be submitted to the Division of Water Resources by April 1999 and are to be updated every 5 years. These plans should present effective water conservation measures that can be employed to reduce municipal water use. Leak detection programs are recommended to find other unmetered water that is lost in the system. For most communities, unmetered losses will probably go unchecked as long as the existing supplies are adequate. Competent planning helps water system managers foresee the crises and reduce system losses through metering and system maintenance. Also, programs that improve the efficient use of water on large landscapes, such as parks, schools, and cemeteries, can realize significant water reductions through careful planning and management without sacrificing aesthetic appeal.

Governor's Water Conservation Team

The Governor's Water Conservation Team's web site (www.conservewater.utah.gov) is hosted by the Utah Division of Water Resources. This informative web site contains many features that are designed to help Utahns use water inside and outside their homes wisely. Some of the web site's features include: a monthly lawn watering recommendation, a customizable landscape watering guide, a comprehensive list of tips, a water conservation events calendar, and copies of the team's radio and TV ads promoting conservation.

Studies

The Utah Division of Water Resources conducts studies to assess water demand so that baselines can be established and progress towards the state's water conservation goals can be tracked. A multi-family residential water demand analysis is also being conducted to determine how water is used indoors in apartments, condominiums and other multi-family settings. These numbers will be beneficial because they can be used to generalize indoor water consumption rates.

A wide range of water conservation methods have been employed in various regions of the arid western United States. The practices used in other western states are often applicable to Utah. Studies are underway to test the adaptability of specific practices to Utah conditions. For example, the division has an irrigation controller study underway. The new controller has been installed in a few homes in the Salt Lake Valley to assess its water saving capabilities. The controller incorporates evapotranspiration (ET) rates into each irrigation zone's specific parameters, and recalculates an efficient irrigation schedule each time it receives the localized evapotranspiration rate from a satellite. This study will make it possible for the division to predict water savings from the installation of ET-based irrigation controllers.

A 1995 publication of the Utah Water Conservation Advisory Board offered a number of programs and suggestions for effectively conserving M&I water. These recommendations include: 1) development of water management and conservation plans by major water provider agencies, 2) reduction of water use by replacing high water consuming landscaping with xeriscaping or landscaping with reduced water needs, 3) better overall management of water intensive businesses and large conveyance systems, and 4) implementation of incentive based water pricing policies.

Water Conservation Measures

An effective water conservation program should contain a variety of water-saving measures, including incentive pricing, ongoing leak detection and repair programs, commercial and residential water use audits, and an effective water metering program. But the most effective residential water use program that can be implemented in the basin, and throughout the state, is to decrease the over-watering of residential, commercial and institutional landscapes. Most Utah residents over-water their landscapes by 20-50 percent. Local water conservation programs should emphasize the reduced use of water on landscapes.

Indoor Conservation

Since lawns and gardens are dormant during the winter months, Utahns have ample opportunity to focus on indoor water conservation. Residents can install water-saving toilets and showerheads, and check plumbing for leaks. Newer large appliances, such as washing machines and dishwashers are designed to use less water than older models. Even so, automatic dishwashers and washing machines should be run only for full loads. Residents can also avoid running faucets unnecessarily for shaving, brushing teeth, or rinsing vegetables, dishes, and other items.

Outdoor Conservation

Outdoor landscape irrigation accounts for about two-thirds of all residential water use. This water can be supplied by either the culinary water system or a secondary water system. Secondary supplies reduce the demand for the more expensive culinary quality water, thereby reducing overall water costs. However, the use of secondary water does not reduce overall water use. In fact, the availability of un-metered, low cost, secondary water often results

Brigham City home with low-water use landscaping

in over-watering of the landscape. It is also recommended that, whenever feasible, secondary water systems should be metered.

Regardless of the cost, many people tend to over-water lawns and gardens as much as 50 percent. Studies have revealed that automated home sprinkler systems with timers result in the greatest over-watering of landscapes. Homeowners, who water by hand, dragging a hose and sprinkler, tend to water only the areas that need to be watered. Homeowners that have an in-ground sprinkler system that is manually operated tend to water only when the lawn appears to need water. However, many home owners with fully automated sprinkler systems tend to set the timer to provide enough water for the hottest days of the summer and then leave the system at that setting for much of the year.

Educating homeowners to periodically adjust their irrigation system's application rate to coincide with seasonal weather changes can achieve significant water savings. Perhaps a more effective measure is to replace the system controller with a more sophisticated device capable of automatically adjusting the application rate to reflect seasonal-changing landscape water needs. Conservation measures that do not require the homeowner to adjust their habits are easier to implement and are more effective. Irrigation controllers linked with a local weather station that automatically adjust application rates to the water requirements of the landscape are a good way to implement water efficiency practices without changing personal water use habits. These types of measures are called "hard fixes", and also include replacing or repairing broken sprinkler heads, improving system uniformity, or maintaining proper irrigation pressures.

Water conservation can also be achieved by changing residential landscaping paradigms. Grass areas should be designed so they are easy to care for, will actually be utilized, and can be irrigated efficiently. The Utah State University Extension Service has information on low water consuming plants and vegetation that in many instances offer a suitable alternative to grass. Individuals interested in implementing any of these types of water conserving landscapes can get ideas from the Center for Water-Efficient Landscaping at Utah State University, the demonstration landscapes at the Greenville Farm Demonstration Garden (1800 North 800 East, Logan), the Utah State Botanical Gardens in Kaysville, or the Jordan Valley Water Conservancy District in the Salt Lake Valley.

The Division of Water Resources encourages water conservation through low water-use landscaping often referred to as xeriscape. Principles of xeriscape include limiting lawn areas, grouping plants with similar water needs, using plants adapted to local climate conditions, irrigating only when needed, watering during morning or evening hours, mowing the lawn at a longer length, and improving soils in shrub and garden areas by using mulches.

Metering

Accurate measurement of water is an important part of any pricing structure and encourages conservation in several ways. Not only is each user assured a fair and equitable distribution of resources, but it is also a more business-like way to operate a system and maintain records. When users pay according to the quantity of water they actually use, there is a built-in incentive to conserve.

Most community water systems are metered. However, properties such as city parks, golf courses, and cemeteries often are not. Metering all connections is an essential component in assessing the costs within a water system. Metering can also aid in water accounting, and can detect losses within the system. (See Chapter 5 for a discussion of metering secondary water systems.)

Incentive Pricing

Pricing policies are a means of reducing per capita water use. Uniform rate structures (a constant price for each unit of water) provide little incentive for consumers to conserve unless the price is set at a high level. Decreasing block rate structures (lower unit prices for larger volumes used) provide an incentive to increase use. "Take or pay" contracts, which provide water purveyors with a guaranteed revenue stream, do not promote conservation below the contracted amount of water. Increasing block rate structures provide a greater conservation incentive for consumers. Under this pricing policy, consumers experience an increasing unit price for higher water consumption. To be effective, the increase in price between blocks must be substantial.

Table 14 shows water rates for selected communities in the Bear River Basin. Communities such as Millville City and North Logan City show strong economic pricing policies, completely separating any variable water use from the base rate. Doing this allows the water agency to cover fixed costs through fixed charges on the water bill, and charge for variable use from per-unit charges on the bill. This type of rate structure allows a more accurate cost-of-service accounting and stabilizes revenue.

Assuming an average family of four and using the respective per capita use rates (See Table 12), the price per 1000 gallons of water for the selected communities of Table 15 range between $0.51 per 1000 gallons (Hyrum City) to $1.91 per 1000 gallons (North Logan City), with the average rate price of $.97 per 1000 gallons. See Table 15 for a detailed summary of the ratepayers cost per 1000 gallons for the selected communities. These numbers reflect average per capita water use and as such are representative of water use during the spring and autumn months of the year. Summertime water use rates, with heavy outdoor watering would be higher, while water use rates during the winter months would be lower.

Including more blocks within a rate structure is better economically and politically, as the consumer using large amounts of water will be paying the costs associated with that level of use. However, the increase between blocks must be substantial to encourage efficient water use. The increase from Block 2 to Block 3 in Providence City's pricing structure, from $0.65 per thousand gallons to $1.15 per thousand gallons, is a level of increase found effective in influencing water use. Inconsequential rate increases among blocks will have no significant effect on water consumption.

Setting water prices to encourage more efficient water use requires consideration of several principles. They are as follows:

TABLE 14
Water Rates for Selected Communities
All quantities measured in thousands of gallons (Gal)

Agency	Base Rate	Limit	Block 1	Limit	Block 2	Limit	Block 3	Limit	Block 4	Limit
Garland City	$12.75	15	$0.50	Unit	-	-	-	-	-	-
Hyde Park City	$26.00	10	$0.50	50	$1.00	Unlim	-	-	-	-
Hyrum City	$ 8.00	10	$0.45	50	$0.65	Unlim	-	-	-	-
Logan City	$ 8.95	3	$0.55	Unlim	-	-	-	-	-	-
Millville City	$17.00	0	$0.60	Unlim	-	-	-	-	-	-
Newton Town	$15.50	20	$0.30	Unlim	-	-	-	-	-	-
North Logan City	$ 7.11	0	$1.57	Unlim	-	-	-	-	-	-
Perry City	$15.50	15	$0.95	Unlim	-	-	-	-	-	-
Portage	$15.00	Unlim	-	-	-	-	-	-	-	-
Providence City	$19.25	10	$0.40	40	$0.65	60	$1.15	Unlim	-	-
Richmond City	$19.60	10	$0.72	Unlim	-	-	-	-	-	-
River Heights	$22.20	8	$0.40	108	$0.45	208	$0.50	308	$0.55	408
Smithfield City	$ 8.00	6	$0.50	Unlim	-	-	-	-	-	-
South Willard	$22.00	17	$0.75	Unlim	-	-	-	-	-	-
Tremonton City	$13.00	13	$1.13	Unlim	-	-	-	-	-	-

- **Encourage lower water use without causing a shortfall in system revenues**. To avoid revenue shortfalls, the rate structure should provide a consistent base charge that is set to cover all fixed cost -- those costs that do not vary with the amount of water delivered. It will cover all debt service, insurance, personnel, etc. that must be paid regardless of how much water is taken from the system. All customers pay this charge whether they use any water or not. Variable costs - those costs that vary with the amount of water delivered - should be covered by the volume charge, or what is often called the overage rate. Revenue from this part of the rate structure will vary with the amount of water delivered to customers and should cover the costs of all energy, treatment chemicals, etc. used in delivery of the water.

- **Identify water waste, reward efficient use and penalize excessive use**. In larger communities with more sophisticated billing and a customer relation's staff, water use targets can become part of the conservation program with the combination of available weather station technologies and computer billing programs. With targets in place for each customer, water over-use is readily identified, as are exemplary water efficient behaviors.

- **Produce additional revenue from penalty rates that can be used to fund needed water conservation programs and capital improvements**. Water conservation comes at a cost. This cost can be added to the commodity portion of the rate, raising the price of each unit of water delivered to the customer's meter. Additional revenue generated by the penalty portions of the rate structure should be placed in a dedicated account and used to pay for water conservation programs, new wells, storage tanks, and other capital improvements as needed.

- **Communicate through a water bill the cost of wasted water directly to the customer**. The ideal water bill would present the following information with each issuance: a target usage based on weather, landscaped area, and indoor water use; the amount of water delivered above (or below) the target use; and the rate (price) charged for the target usage and any excess. With this information, the customer is equipped with the information needed to make informed decisions about such things as landscape changes, spraying the driveway, washing the car, filling the pool, and long showers.

- **Provide a person or staff member to respond to customer calls for help in reducing water usage.** Individual home owners who desire

TABLE 15

Rate-payers cost per 1000 gallons for Selected Communities

Agency	Use Rate (GPCD)	Monthly Use*	Base Rate	limit	Block 1 Rate	Block 1 Usage	Block 1 cost	Total Bill	Cost per 1000 Gallons
Garland City	251	30.1	$12.75	15	$0.50	15.1	$7.55	$20.30	$0.67
Hyde Park City	190	22.8	$26.00	10	$0.50	12.8	$6.40	$32.40	$1.42
Hyrum City	450	54.0	$8.00	10	$0.45	44.0	$19.80	$27.80	$0.51
Logan City	292	35.0	$8.95	3	$0.55	32.0	$17.60	$26.55	$0.76
Millville City	245	29.4	$17.00	0	$0.60	29.4	$17.64	$34.64	$1.18
Newton Town	312	37.4	$15.50	20	$0.30	17.4	$5.20	$20.72	$0.55
North Logan City	177	21.2	$7.11	0	$1.57	21.2	$33.28	$40.39	$1.91
Perry City	273	32.8	$15.50	15	$0.95	17.8	$16.91	$32.41	$0.99
Portage	287	34.4	$15.00	Unlim	-	-	-	$15.00	$0.87
Providence City	238	28.6	$19.25	10	$0.40	18.6	$7.44	$26.69	$0.93
Richmond City	261	31.3	$19.60	10	$0.72	21.3	$15.34	$34.94	$1.12
River Heights	357	42.8	$22.20	8	$0.40	34.8	$13.92	$36.12	$0.84
Smithfield City	230	27.6	$8.00	6	$0.50	21.6	$10.82	$18.80	$0.68
South Willard	265	31.8	$22.00	17	$0.75	14.8	$11.10	$33.10	$1.04
Tremonton City	258	31.0	$13.00	13	$1.13	18.0	$20.34	$33.34	$1.08
Average									$0.97

*Monthly Use (in 1000 gallons) = Use Rate x 4 people x 30 days / 1000 gallons to stay within their targets and request assistance can be given a soil probe and taught to properly irrigate their lawns and gardens through home water use audits. Trained irrigation specialists can provide water audits for golf courses, school grounds, and other large areas.

Water rates can be structured in several ways, each of which upholds the above principles in whole or in part. A series of three tables is use to demonstrate two common rate structures and one that is relatively new to system managers and customers in Utah.

The seasonal block rate structure increases the price of water during times of higher demand when most peaking problems and wear and tear on the infrastructure occur. Salt Lake City Public Utilities implemented a seasonal block rate in 1994 for the summer months of June, July and August, and has continued this program with great success. Table 16 shows an example of seasonal rate structures.

Table 16
Seasonal Block Rate Structure
All quantities are measured in thousands of gallons (Kgal)

Month	Usage	Base Rate	Regular Rate $.70	Seasonal Rate $1.00	Total
Jan	9	$10.00	$6.30	-	$16.30
Feb	10	$10.00	$7.00	-	$17.00
Mar	11	$10.00	$7.70	-	$17.70
Apr	30	$10.00	$21.00	-	$31.00
May	45	$10.00	$31.50	-	$41.50
Jun	58	$10.00	-	$58.00	$68.00
Jul	63	$10.00	-	$63.00	$73.00
Aug	60	$10.00	-	$60.00	$70.00
Sep	34	$10.00	$23.80	-	$33.80
Oct	20	$10.00	$14.00	-	$24.00
Nov	10	$10.00	$7.00	-	$17.00
Dec	9	$10.00	$6.30	-	$16.30
TOTALS	**359**	**$120.00**	**$124.60**	**$181.00**	**$425.60**

The increasing block rate structure is more complex, but simple to administer if the water supplier has adequate computer billing software. Table 17 shows how this rate structure works in a hypothetical family for one year.

The seasonal block and increasing block rates can be constructed to encourage efficient water use without causing a shortfall in revenue. This can be accomplished by setting the base charge to consistently cover fixed costs and setting the commodity charge to cover variable costs.

However, neither rate structure has the ability to identify wasteful or inefficient behaviors. In both situations it is possible to create a water bill that will educate the customer regarding how much water is being used. A charge for each overage may encourage more efficient use. Both rate structures can be supported by staff who respond to customer calls for help in reducing water use.

The ascending block rate provides a water use target for each customer based on size of landscaped area, number of people, and plant water needs measured by weather stations. Irrigation application efficiency is also accounted for in setting the targets. Table 18 shows how this rate structure works in a hypothetical family for one year.

TABLE 17
Increasing Block Rate Structure
All quantities are measured in thousands of gallons (Kgal)

Month	Usage	Base	Overage 0 – 10 $0.70	Overage 10 - 20 $.90	Overage Over 20 $1.00	Total
Jan	9	$10.00	$6.30	-	-	$16.30
Feb	10	$10.00	$7.00	-	-	$17.00
Mar	11	$10.00	$7.00	-	-	$17.00
Apr	30	$10.00	$7.00	$9.00	-	$26.00
May	45	$10.00	$7.00	$9.00	$25.00	$51.00
Jun	58	$10.00	$7.00	$9.00	$38.00	$64.00
Jul	63	$10.00	$7.00	$9.00	$43.00	$69.00
Aug	60	$10.00	$7.00	$9.00	$40.00	$66.00
Sep	34	$10.00	$7.00	$9.00	$14.00	$40.00
Oct	20	$10.00	$7.00	$9.00	-	$26.00
Nov	10	$10.00	$7.00	-	-	$17.00
Dec	9	$10.00	$6.30	-	-	$16.30
TOTALS	**359**	**$120.00**	**$82.60**	**$63.00**	**$160.00**	**$425.60**

TABLE 18
Ascending Block Rate Structure
Usage and Target Usage measured in thousands of gallons (Kgal)

Month	Usage	Base	Target Usage	Et.[1]	Rate 1[2] @ $.80	Rate 2[3] @ $1.00	Rate 3[4] @ $2.00	Rate 4[5] $4.00	Total
Jan	9	$10.00	10	0	$7.20				$17.20
Feb	10	$10.00	10	0	$8.00				$18.00
Mar	11	$10.00	10	0	$8.00	$1.00			$19.00
Apr	30	$10.00	28	2.0	$22.40	$2.00			$34.40
May	45	$10.00	39	3.3	$31.20	$6.00			$47.20
Jun	58	$10.00	47	4.2	$37.60	$9.40	$3.20		$60.20
Jul	63	$10.00	50	4.6	$40.00	$10.00	$6.00		$66.00
Aug	60	$10.00	47	4.2	$37.60	$9.40	$7.20		$64.20
Sep	34	$10.00	30	2.3	$24.00	$4.00			$38.00
Oct	20	$10.00	19	1.0	$15.20	$1.00			$26.20
Nov	10	$10.00	10	0	$8.00				$18.00
Dec	9	$10.00	10	0	$7.20				$17.20
Totals	**359**	**$120.00**	**321**	**21.6**	**$246.40**	**$42.80**	**$16.40**		**$425.60**

Days in Billing Period = 30 Appl. Effic. = .65 Indoor use = 70 gpcd Irr. Area = .21 ac. Family Size = 5
1) Estimated Evapotranspiration in inches
2) Conservative or efficient Use
3) Normal Use
4) Inefficient Use
5) Irresponsible Use

Commercial Water Conservation

Water conservation within commercial organizations is also essential, and can provide the business with extra revenue formerly wasted on excess water use. Some commercial endeavors, such as laundries, have already implemented water conservation to reduce energy costs. Often businesses hire a landscape contractor to maintain their grounds. Frequently there is a lack of communication between the business owner and the landscaper. Consequently commercial sites are often over-watered by a significant amount. Water pricing incentives would likely further motivate commercial businesses to re-evaluate their water conservation efforts.

Industrial Water Conservation

Water pricing incentives will likely have a positive impact upon discretionary water use within industries that receive water from public water systems. Making production processes more water-efficient can also save large amounts of discretionary water.

Education

An effective water conservation program requires an active water education component. Since everyone is a water user, water education is directed at changing individual attitudes and habits. Every public agency or private organization concerned with planning, developing or distributing water can make a difference through efforts in this regard. In Utah, water conservation materials are regularly mailed to schools, water-user organizations and individuals upon request. These materials are part of a water education program sponsored by the Division of Water Resources. Other conservation objectives of the division's education program include water-efficient landscaping, proper gardening techniques, and the promotion of more efficient appliances such as low-flow toilets and low-flow showerheads. Assistance in implementing conservation-oriented water rate structures is also available. Water education programs will continue to be directed at students in elementary and secondary schools through a consortium of public education and water agencies throughout the state.

5

WATER TRANSFERS AND EFFICIENT MANAGEMENT OF DEVELOPED SUPPLIES

The efficient use of existing developed water supplies is an important element in successfully meeting Utah's future water needs. As competition for limited water supplies increases, the value of the existing water supplies also increases. This economic incentive leads to the transfer of water from one use to another. This chapter discusses the transfer of agricultural water to higher value uses 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.

AGRICULTURAL WATER TRANSFERS

The agriculture industry uses about 94 percent of the presently developed water in the basin. Municipal and industrial (M&I) uses account for the other six percent. Over the next 50 years agricultural uses are expected to drop to 89 percent and M&I uses to increase to 11 percent.

To date, not a lot of agricultural water has been converted to M&I use. Although there will be more in the future it is estimated that less than 5 percent (or 42,000 acre-feet) of the agricultural water would be converted over the next 50 years. The amount of agricultural water transferred to M&I use in the Bear River Basin will not be nearly as large as it will on the Wasatch Front. Most existing M&I systems in the basin have sufficient supplies to take them well beyond the year 2020 and many beyond 2050. Where existing supplies are inadequate to address the growth of the next 20 years, there are developable ground water and/or surface water sources. However, the development of surface water sources will likely require storage, making the new water expensive. In those cases, agricultural water transfers may prove to be a less expensive alternative compared to reservoir construction. In Box Elder County, the Bear River Water Conservancy District has acquired agricultural water in the Bothwell Pocket with the plans to convert this water to M&I use over time to meet the growth that is projected within the district.

Canal Maintenance in Box Elder County

AGRICULTURAL WATER-USE EFFICIENCY

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 are: (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 agricultural water-use efficiency, it will likely be difficult to gain the needed support of irrigators. Increasing agricultural productivity should be a high priority of any efficiency project. If a project fails to benefit the farmers who are expected to implement it, it will be difficult for the project to succeed.

Proper implementation of agricultural water-use efficiency typically increases crop yields 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 maximize crop yields. This process may lead to increased depletions and ultimately reduce the return flow or ground water recharge as the crops use more water if greater productivity occurs.

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 less adsorbed phosphate fertilizer and insecticides 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.

Reduced Water Diversions

Reducing water diversions may be a benefit of agricultural water-use efficiency. Increased flows and improved quality in streams contribute to the health of riparian and wetland ecosystems, as well as fish and wildlife. However, for many irrigation systems, the water savings from on- and off-farm improvements will likely be stored in reservoirs for later use or used to satisfy any water deficiencies within the system. As a consequence, the full benefits of reduced diversions often affect only nearby stream segments and not the entire river system.

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 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 through seepage, evaporation, and transpiration from vegetation along the banks. 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, to an on-demand scheduling, 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 training

Flood Irrigation

Sprinkler Irrigation

personnel, but can realize substantial improvements in water 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 for these methods depends upon local soils and topography, along with the farm economics and the type of crops to be grown.[1,2,3] At the present time there are very few places in the basin where drip irrigation would be practical.

Other technologies, such as laser land leveling and advances in surface irrigation hydraulics, make it possible for traditional surface (flood) irrigation to be as efficient and in some cases even more efficient than sprinkler irritation. With proper management laser land leveling can result in practically no tailwater runoff (return flows) and greatly reduce deep percolation.

Secondary or "Dual" Systems

Secondary water systems, also known as "dual" water systems, provide untreated water for outdoor uses, primarily lawn watering and gardening. These systems free up existing treated water for culinary uses. However, they do require the construction of an additional water conveyance infrastructure, and can be expensive, and consequently are less likely to be installed in developed areas of existing communities. In areas of new construction where an adequate secondary water supply exists, secondary systems are usually economical to install. Secondary water systems may also prove economical as a retrofit if the construction costs are less than the cost of enlarging the M&I system to meet future needs and the costs associated with treating the water to drinking water standards.

While there may be an economic incentive for building secondary water systems based on the cost of high quality treated water conserved, studies have shown that "secondary" systems do not promote overall water conservation. Since secondary water is seldom metered, consumers tend to use more of it when watering their lawns. Secondary systems should be metered when water quality allows. The development of a new inexpensive secondary water meter is needed and would enable the metering of secondary water systems and the implementation of pricing structures that would help control use.

Measurement

Measurement or metering of flows is important in both the agricultural setting and the urban setting. Accurate measurement of water use encourages conservation in several ways. Not only is each user assured a fair and equitable water distribution and a corresponding financial assessment, but it is also a more business-like way to operate a system and maintain records. When users pay according to the quantity of water they actually use, there is a built-in incentive to conserve, whether the use is irrigation, municipal, or industrial. Accurate metering can also help to identify and quantify system losses. Most community water systems are metered. However, there are properties, such as city parks, golf courses, and cemeteries, which may not be metered.

WATER REUSE

One effective method of conserving existing water supplies is to establish a system of reuse. To some extent, current water supplies are reused as return flows from irrigation fields and effluent from wastewater treatment plants flows back into the natural waterways and aquifers. Many communities in the United States have safely and successfully used reclaimed wastewater for numerous purposes, including:

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

No direct reuse of wastewater for drinking water use has been attempted in the United States, except in emergency situations. However, reuse of wastewater for industrial, agricultural and other uses such as golf course watering is becoming more common. In the future, water reuse may become a more valuable tool in meeting our future water needs.

The Division of Water Quality regulates water reuse in Utah. The rules and conditions under which wastewater can be reused is set forth in Title R317-1-4 of the Utah Administrations Code. Currently there are no reuse projects in the Bear River Basin.

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.

In some parts of the world, rainwater is collected and used to water lawns and garden areas. In some instances, even gray water (household water from tubs and sinks but not toilets) is collected for use outdoors. These rather extreme forms of water conservation may one day have an application in the basin, but at the present time water supplies are abundant enough and inexpensive enough to render these approaches economically unviable. At the present time and given the present cost of water, a collection system for either rainwater or gray water would, by far, exceed the cost of the water saved.

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.[4] 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:[5] 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 suppliers. In particular, managers should assess the value of ground water in optimizing storage capacity, enhancing transmission capabilities, and improving water quality of the system.

AQUIFER STORAGE AND RECOVERY

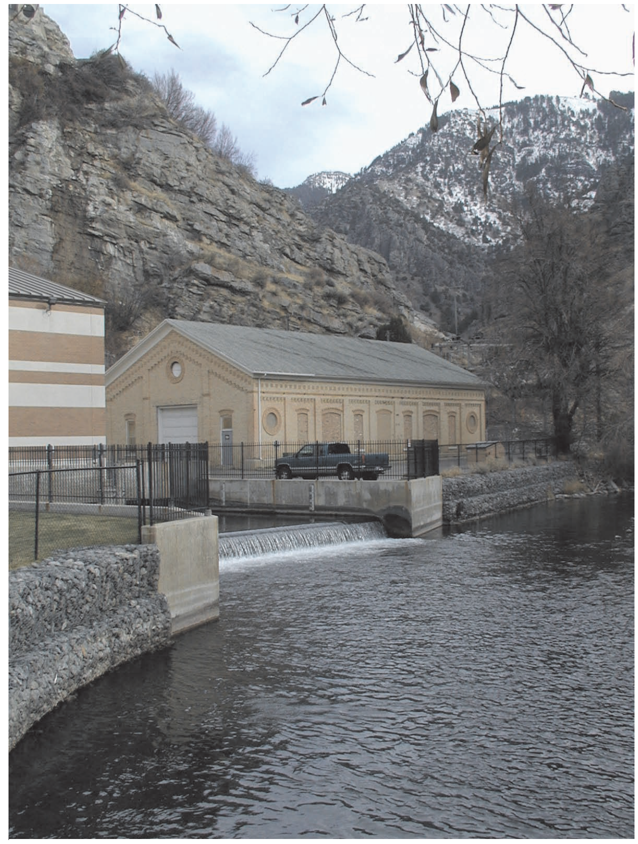
Another possible means of developing surface water and storing it for future M&I use is aquifer storage and recovery (ASR), also known as artificial ground water recharge. The approach with ASR is to use a primary ground water aquifer to store water supplies. Some utilities use ASR to store treated surface water during periods of low water demand, and provide the recovered water later to meet peak daily, short-term or emergency demands. Many communities have found ASR systems to have numerous advantages. These include[6]:

- 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 evaporation and vulnerability to contamination.

Aquifer storage and recovery requires minimal structural elements and 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. Aquifers also provide a water quality benefit since they have a natural ability to filter sediment and remove some biological contaminants. Unit costs for ASR facilities average about $400,000 per million gallons per day (mgd) or $360 per acre-foot per year.

To maintain ground water quality, it is necessary to treat surface water to drinking water standards before injecting it into a primary drinking water aquifer. Any entity using ASR is required to comply with regulations established and administered by the Division of Water Quality. They also need to file water right applications with the Division of Water Rights.

Brigham City initiated a pilot study ASR program in 1998. The program proved very successful and has continued since that time. Brigham City's primary water source consists of six springs in Mantua. The water from these springs is collected and delivered by pipe to the town of Brigham City about three and a half miles down canyon. During the winter months the flow from the springs exceeds the towns water needs. The excess flow during the winter season is chlorinated and injected into the local ground water aquifer. This chlorination provides some conditioning of the poor quality native ground water, increasing its value for M&I use. This is a great secondary benefit of the ASR project. At the present time Brigham City injects about 1.5 million gallons per day (4.6 acre-feet/day) for 180 days. During the summer, months the city then withdraws 800 gallons per minute (3.5 acre-feet /day) from the aquifer. Because the collection and delivery system was already in place, the project was started with a relatively low capital



Logan City Power Plant

cost of about $165,000. There may be other opportunities in the basin for ASR to enhance M&I supplies, particularly in the Box Elder County area.

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, adjoining water systems are interconnected 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 in this way are:

- 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 manager 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.

NOTES

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

2. 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.

3. Merriam, J.L. and J. Keller, *Farm Irrigation System Evaluation: A Guide for Management*, (Logan: Utah State University, 1978), 271.

4. Gorelick, S. M<. (ed.), *Conjunctive Water Use: Understanding and Managing Surface Water-Ground water Interactions*, Int. Assoc. Hydrol. Sci. Publ., (1986), 156&547.

5. 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.

6. 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.

6

WATER DEVELOPMENT

Generally speaking, existing water supplies are adequate throughout the basin for at least the next couple of decades. Throughout Cache County, the water supply should take them well into the 2040s, while Box Elder County's present supply should meet the county needs through 2025. However, these projections are based upon a countywide condition for average water years and average yearly demand. On a micro scale and during drought conditions, some systems are hard pressed even now to provide adequate flows during periods of peak demand. Consequently, many local water providers are continually investigating additional water development options.

As growth takes place over the next couple of decades, local water suppliers will continue to develop available water sources. In Cache County, this will mean additional ground water development by existing municipal water purveyors. In Box Elder County, where ground water supplies are not so abundant, local water purveyors (primarily Bear River Water Conservancy District) will probably have to be a bit more creative in providing for future water needs. To hold costs down, the Bear River Water Conservancy District and other Box Elder County water providers will likely continue to acquire existing high quality ground water rights through the willing buyer/willing seller process and develop whatever additional ground water along the east side of the county that might be available.

Hyrum Reservoir

BEAR RIVER DEVELOPMENT PROJECT

Development of the Bear River has been studied for many years. In the 1950s, the Bureau of Reclamation identified and studied several potential reservoir sites on the lower Bear River and its tributaries. During the high precipitation and runoff years of the early 1980s, the Utah State Legislature directed the Utah Division of Water Resources to investigate controlling the level of the Great Salt Lake through storage and diversion of water from the Bear River.

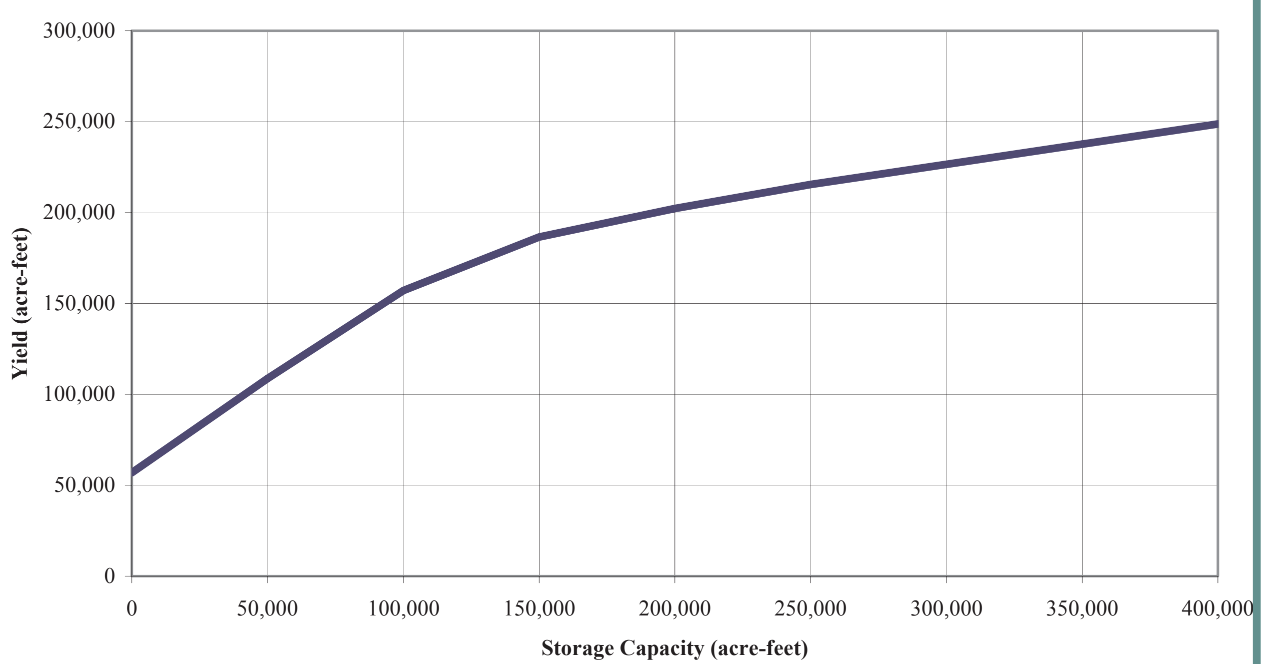
In 1991 the Legislature passed the Bear River Development Act. The Act directs the Division of Water Resources to develop 220,000 acre-feet of the Board of Water Resources water rights in the Bear River and its tributaries, and allocated the water as follows: 50,000 acre-feet each to Jordan Valley Water Conservancy District and Weber Basin Water Conservancy District; 60,000 acre-feet to Bear River Water Conservancy District, and 60,000 acre-feet to water users in Cache County. The division is to plan, construct, own, and operate reservoirs and facilities on the river as authorized and funded by the Legislature and to contract the developed water to these four entities as specified in the Act.

Based on revised estimates of water needs, public input, and cost analysis, the Utah Board and Division of Water Resources' current plan for Bear River development is as follows: (1) develop an agreement with the Weber Basin Water Conservancy District to store surplus Bear River Water in Willard Bay, (2) connect the Bear River with a pipeline and/or canal to Willard Bay from a point near the Interstate 15 crossing of the Bear River near Elwood 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 as the demand for additional water continues to increase.

Parts 1 through 3 would be timed to deliver water to the Wasatch Front within the next two decades (based on contracts with Jordan Valley Water Conservancy District and Weber Basin Water Conservancy District and legislative approval). In all likelihood, part 4, the construction of a reservoir in the Bear River Basin, would not be carried out until the Bear River Water Conservancy District and/or Cache County water users need additional water.

The division estimates there are approximately 250,000 acre-feet of Bear River water that can be developed. Just how much water is actually developed will be a function of many factors. Without a doubt, the deciding factor will be how much reservoir storage is built. Other factors include: where the storage is located, what the demand pattern is like, and whether or not any water will be stored in Willard Bay. Figure 14 shows the relationship between the developable Bear River yield and the reservoir storage needed. The assumptions made in developing this figure are: Willard Bay is used to store flows from the Bear River, and a delivery reliability of 90 percent (a full supply in nine years out of ten) is acceptable. The graph shows that about 60,000 acre-feet of water can be developed from the Bear River without any new reservoir storage if water can be stored in Willard Bay. The next 100,000 acre-feet of developed water will require the construction of storage capacity at a 1-to-1 ratio (or 100,000 acre-feet of storage yields

Figure 14
Developable Bear River Yield vs Storage Capacity
(assuming use of Willard Bay and 90% reliable supply)



100,000 acre-feet of water). The next 50,000 acre-feet of storage will yield 25,000 acre-feet of water. After that, every 1,000 acre-feet of yield will require 4,000 acre-feet of storage. Consequently, to develop 250,000 acre-feet of water will require about 400,000 acre-feet of storage (about the equivalent of Jordanelle Reservoir).

In the 1991 Bear River Development Act, the Utah Legislature specifically directed the Division of Water Resources to investigate the Honeyville and Barrens reservoir sites. With growing concern about the possible environmental and social impacts at those two sites, the 2002 Legislature rescinded the directive to consider the Honeyville and Barrens sites and added a directive for the division to investigate the Washakie Site.

Washakie Reservoir

The Washakie Reservoir site is located just south of the Utah-Idaho state line between the I-15 freeway and the Union Pacific Railroad line. The reservoir is an off-stream site and would be contained on the north, west and south sides by a long dike. Originally investigated by the division in 1983, the site was not as economically favorable as several other sites in the basin. Now, however, with fewer impacts upon the environment, the site is considered by many to be the most favorable in the basin. The size of the reservoir would be determined by the height of the dike. To date the maximum capacity the division has investigated is 185,000 acre-feet. Through exchanges upstream water users could enjoy the storage benefits of Washakie.

Washakie Reservoir Basin

WEATHER MODIFICATION

Over the years, local sponsors and the Utah Division of Water Resources have been involved with numerous cloud seeding programs designed to increase the winter precipitation within different areas of the state. This is done on a cost-sharing basis with the local sponsors. Local sponsors initiate the project and apply to the division for funding assistance as part of the state's cloud seeding project. Nationally, studies indicate winter seeding projects generally increase the winter precipitation by 14 to 20 percent. Economic analysis of this sort of increase in precipitation shows the benefits from the extra water far outweigh the operational costs of seeding.

Cloud seeding in the East Box Elder/Cache County Project area is sponsored by the Bear River Water Conservancy District and Cache County. The East Box Elder/Cache County Project area has been in operation since 1989. Target and control regression analyses show a December-February precipitation average increase of 20 percent and an April 1 snow water content average increase of 18 percent. The net cost of the increased water is about $1 per acre-foot.

With the cost being so reasonable, it makes sense to consider weather modification as a viable source of water development in the Bear River Basin. Existing cloud seeded areas of Wellsville Mountains, Bear River Range, and north-western Uinta Mountains account for only about six percent of the basin's total area. While these areas do represent the most mountainous portions of the basin, and hence the most productive areas for cloud seeding, there is still potential for cloud seeding in other areas of the basin.

The existing cloud seeding coverage of the eastern Uinta Mountains could be expanded to include the entire Bear River Basin watershed within the Uinta Mountains. This effort could be coordinated with interested parties in the Uintah Basin to include expansion of coverage into the upper Duchesne drainage as well.

The Thomas Fork and Smith's Fork area of Wyoming was cloud seeded as a test area in 1955 through 1970, 1980 through 1982, and 1989 through 1990. An evaluation of snow pack during those years indicated an increase in snow pack of 11 percent. Even though the topography of the test area is not as extreme as the Wellsville Mountains or the Bear River Range, the results were consistent with those realized elsewhere in the country. This is a strong indication that cloud seeding in these other areas of the basin would be just as successful as it has been elsewhere.

The cloud seeding of the Bear River Range could be expanded into Rich County to include the eastern slopes of this range. This area is the rain shadow side of the mountain, however, and may not yield as great an increase in snow pack as experienced on the western slope.

UPGRADING AND ENHANCING EXISTING INFRASTRUCTURE

M&I studies done by the division show that most drinking water systems in the basin 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 statewide survey of drinking water systems conducted by the Utah Division of Drinking Water, 91 percent of the respondents indicated the overall physical condition of their system would need to be upgraded within the next 15 years; and 31 percent of the respondents indicated their present system was deficient, particularly with respect to its ability to maintain minimum fire flows[1]. There is good reason to believe that within the Bear River Basin the percentage of systems in need of upgrades or system enhancements is similar to the statewide numbers. Indeed, data submitted by the basin's water purveyors, and published in the Municipal and Industrial Water Supply Studies for the Bear River Basin[2] indicate many systems within the basin have an adequate water supply but suffer some limitation to the system's reliable capacity. Solutions to these problems include: developing additional water sources, deepening a well or increasing a pump size, replacing existing piping with new and enlarged piping, or adding more reservoir storage.

NOTES

1. Utah Division of Drinking Water, 1999 Survey of Community Drinking Water Systems, (Salt Lake City: Department of Environmental Quality, 2000), Appendix 11, 1 and 2. An annual survey prepared in cooperation with the Division of Water Rights and the Division of Water Resources.

2. Municipal and Industrial Water Supply Studies: Utah Bear River Basin, Utah Department of Natural Resources, Division of Water Resources, April, 2001

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WATER QUALITY, THE ENVIRONMENT AND OTHER CONSIDERATIONS

Water supply decisions can 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.

WATER QUALITY

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.

Water Quality Concerns in the Bear River Basin

Although there are portions of Box Elder County and West Cache Valley where ground water quality is relatively poor, much of the ground water in the basin is of good quality, and suitable for potable use with little or no treatment. Essentially all of the municipal, industrial, and domestic water in the basin comes from high-quality ground water sources. Between 1997 and 1999 the Utah Division of Water Quality analyzed the general chemistry and nutrients for 163 wells in Cache Valley. The concentrations of total dissolved solids ranged from 178 to 1,758 mg/l, averaging 393 mg/l valley wide. Nitrate concentrations in Cache Valley's principal aquifer ranged from less than .02 to 35.77 mg/l. Seven of the 163 wells yielded water samples that exceeded the ground water quality standard of 10 mg/l for nitrate. High nitrate levels could be attributed to contamination from septic tank systems, feed lots and/or fertilizer.[1]

The quality of surface water varies through a wide range due to natural effects and human activity. In the upper basin, where the Bear River enters Utah from Wyoming, water quality is considered good. Water temperatures are low, as are TDS (total dissolved solids), alkalinity, hardness and sulfates. But the quality deteriorates as the river flows downstream. Return flow from irrigated land, sediment, animal wastes, municipal and industrial wastewater, natural saline springs, agricultural chemicals, and increasing water temperatures all

Cutler Reservoir with its adjacent wetlands in the center of Cache Valley

combine to cause water quality problems in the lower basin. In general, each tributary stream shows a similar pattern of downstream deterioration, although some are much better than others.

In the lower Bear River Basin, water quality problems arise primarily from high phosphorus and total suspended sediment concentrations. In particular, dissolved phosphorous contributes to the eutrophication of existing reservoirs. Eutrophication causes diminished recreational and fishery benefits, and the algae produced in a eutrophic reservoir also greatly increase the cost of treatment for municipal use. Other impacts on fisheries arise when state water quality standards for dissolved oxygen and ammonia are not met. This is especially true in the Spring Creek portion of the Little Bear River drainage. High sediment loads in the Cub River and the mainstream of the Bear River also restrict fisheries. Violations of coliform criteria have occurred throughout the basin but were most severe in the Spring Creek subdrainage and indicate a potential public health problem.

Total Maximum Daily Load Program

The Federal Clean Water Act of 1972 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 achievements 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 non-point sources.

A TMDL is a calculation of the maximum amount of a pollutant that a water-body can receive and still meet water quality standards for its designated beneficial use. In other words, a TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. The calculation includes a margin of safety to ensure that the water-body can be used for the purposes the state has designated. The calculation also accounts for seasonable variation in water quality. The Clean Water Act, Section 303, establishes the criteria for setting water quality standards and the TMDL programs.

The state is responsible to set water quality standards for each of its water-bodies (creek, river, pond, lake, reservoir, etc.) by identifying the uses associated with it. Examples of designated uses are: drinking water supply, contact recreation (swimming) and aquatic life support (fishing). The state then uses scientific criteria to establish water quality standards for that water-body based upon its designated use. An impaired water-body is one which has had a measured pollutant exceeding the water quality standard associated with the designated use. The current goal is to establish TMDL’s for all of the state’s impaired water-bodies by 2015.

The Division of Water Quality is responsible for implementing the TMDL programs in Utah. In cooperation with other state, federal and local stakeholders the Division of Water Quality has contracted with the Bear River RC&D and the Bear River Water Conservancy District to develop and implement the TMDL program for the Bear River Basin.

A Bear River Tri-State Water Quality Task Force has been created and includes Division of Water Quality personnel from each of the three states through which the Bear River passes. The primary function of this task force is to improve water quality in the Bear River and its tributaries. From its creation, one of the task force's primary goals has been to build consistency in water quality standards across state lines. The task force provides a valuable forum for coordinating Utah, Idaho and Wyoming’s individual TMDL efforts to insure that the final product is consistent across state lines.

Table 19 provides a list of the water-bodies in the Bear River Basin that have been identified as impaired in the state's assessment report issued by the Utah Division of Water Quality. Throughout the drainage, including the Malad River sub-drainage, manure management is a critical issue. Runoff from fields spread with manure during the winter and direct runoff from feedlots are serious problems. Point sources also contribute substantially to nutrient loadings. Sediment problems arise from exposed banks, irrigation return flows and severely degraded riparian areas. The resulting high phosphorus loads and reduced dissolved oxygen counts are the most common pollutant problems in the Bear River Basin.

TABLE 19
Impaired Waterbodies in the Bear River Basin
(Impaired use class in bold)

Waterbody	Pollution Parameter	Use Class
Bear River & tributaries From Cutler Reservoir to the Great Salt Lake	Total Phosphorus	2B, 3B, 3D, 4
Bear River from Utah/Wyoming border to Utah/Wyoming border	Dissolved oxygen	2B, 3A, 4
Saleratus Creek &tributaries from confluence with Woodruff Creek to headwaters	TDS, Temperature, Dissolved oxygen	2B, 3A, 4
Spring Creek from confluence with Little Bear River to headwaters	Fecal coliform, Ammonia, Temperature, Total Phosphorus Dissolved oxygen	2B, 3A, 3D, 4
Hyrum Reservoir	Total Phosphorus Dissolved oxygen	2A, 2B, 3A, 4
Newton Reservoir	Total Phosphorus Dissolved oxygen	2B, 3A, 4
Porcupine Reservoir	Temperature	2B, 3A, 4
Tony Grove Lake	Dissolved oxygen	2B, 3A, 4

Beneficial Use Classifications for Water In The State of Utah	
Class 1	Protected for use as a raw water source for domestic water
Class 2	Protected for Recreational use and aesthetics Class 2A – Protected for primary contact recreation such as swimming. Class 2B – Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3	Protected for use by aquatic wildlife Class 3A – Protected for cold water species of game fish and other aquatic life. Class 3B – Protected for warm water species of game fish and other aquatic life Class 3C – Protected for non-game fish and other aquatic life Class 3D - Protected for waterfowl, shorebirds, and other water-oriented wildlife.
Class 4	Protected for agricultural uses including irrigation of crops and stockwatering.
Class 5	The Great Salt Lake. Protected for primary and secondary contact recreation, aquatic wildlife and mineral extraction

It is predicted that with a medium to high level of remediation effort, phosphorus loads can be reduced substantially, and the TMDL targets could be met in the Bear River.[2]

Preservation and Restoration of Riparian and Flood Plain Corridors

Some of the basin's riparian zones adjacent to streams and rivers have been impacted by construction, stream bank modification or channelization as a result of urban growth and agricultural practices. Riparian zones and flood plains need to be preserved and protected because they represent important habitat for wildlife, help improve water quality and buffer the population from flooding.

Historically, impacts to the main stem of the Bear River from urban growth have been relatively insignificant. This is because, with the exception of Evanston, Wyoming in the upper portion of the basin, there are no urban settings directly on the Bear River. A few of the Bear River's tributaries, however, have experienced impacts associated with urban growth and will undoubtedly experience more impacts in the future. Most notable of these is the Logan River, which flows through Logan city. Also, the Little Bear River (near Hyrum) and Summit Creek (near Smithfield) have the potential for urban growth to impact riparian and flood plain corridors. In Box Elder County, growth around Bear River City and Corinne are also areas of concern. In these areas it will be important for county and city planners to insure that urban growth does not negatively impact the riparian and flood plain corridors.

Within the Bear River Basin, some cattle management practices have had a significant impact upon riparian lands. In some areas inadequate fencing has allowed cattle direct access to the stream. This practice has resulted in trampled and degraded stream banks and adjacent riparian zones. An increased awareness of this problem has resulted in several fencing and re-vegetation projects with very favorable results. There is still room, however, for further water quality improvements through fencing and other cattle management practices.

Stockwater pond in Box Elder County

Storm Water Runoff

In urban areas, storm water runoff is a water quality problem. As the storm water and snow-melt runs off streets, parking lots, driveways and industrial areas, the water picks up salt, gasoline, oil and residue of numerous other harmful chemicals and pollutants. This water then flows into receiving waters without treatment. In some cases, these flows are detained for a brief period in a retention basin whose primary function is to attenuate the flood effects. Recent EPA regulations require many communities to detain and address pollutants in this water.

In rural settings, as growth occurs, agriculture canals are often used to convey storm water runoff. This can be a financial boon for some communities faced with the burden of developing infrastructure to accommodate storm water runoff. However, serious potential flooding problems can result from this situation. Canals are managed to deliver agricultural water. Consequently, it is possible for an unexpected storm to occur while the canal is full of water. This can result in flooding and even a possible breach of the canal creating even more significant flooding and a potential liability situation for the canal owner, the municipality or other local governments involved.

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 U.S. Environmental Protection Agency (EPA) has 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. The second phase of the storm water regulations went into effect in the year 2003 and requires many smaller communities to seek a storm water discharge permit. Under the second phase of storm water regulations, requirement for a storm water discharge permits will not be based solely on community size, but instead on a complex matrix of parameters which will include the sensitivity of the receiving waters and the potential downstream water uses.

The Utah Division of Water Quality is working closely with affected communities to help them comply with these new regulations. The communities in the Bear River Basin that will be required to obtain storm water discharge permits are Brigham City, Hyde Park, Logan, Millville, Nibley, North Logan, River Heights, Smithfield and Providence.

Nutrient-Loading

Nutrient over-enrichment continues to be one of the leading causes of water quality problems in the Bear River Basin. Although these nutrients (nitrogen and phosphorus) are essential to the health of aquatic ecosystems, excessive nutrients can result in the growth of aquatic plants and algae, leading to oxygen depletion, increased fish and macroinvertebrate mortality, and other water quality and habitat impairments.

The Bear River's water quality suffers primarily from high phosphorus and high sediment loads. The sediment load is mentioned here because one of the potential sources of phosphorus in the basin is the erosion of soils with high phosphorus content. It is believed that stabilizing stream banks and reducing erosion in the basin can have a positive impact in reducing the overall phosphorus load. The primary causes of high phosphorus loads, however, are believed to be wastewater treatment plant effluent, return flows from agriculture (particularly cattle waste runoff from feedlots and pasturelands) and runoff from heavily fertilized lawns and landscapes. Much of the efforts resulting from the TMDL process will be directed at reducing the phosphorus loads from these sources.

Concentrated Animal Feedlot Operations

Another concern receiving national and local attention is the impact which animal feedlot operations 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 animal feedlot operations and the relative lack of stringent regulations to control the majority of these operations, the EPA and the U.S. Department of Agriculture and Food 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, wool growers, and representatives from the turkey, poultry and hog industries, prepared a Utah Animal Feeding Operation and Concentrated Animal Feeding Operation 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.[2]

Septic Tank Densities

In the rural areas of the basin, where advanced wastewater treatment systems have not been constructed, individual septic tank systems are used to dispose of domestic wastes. As the population in these 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 in Cache Valley currently range from 26 to 145 acres per septic system for the designated communities. The countywide average is 72 acres per septic system.[3] Septic tank densities are a significant concern in Cache Valley and could soon become a problem elsewhere in the basin. Septic tanks for summer home developments are also a concern, as they are commonly located in sensitive watershed areas. Unless alternative wastewater treatment systems are built, there may be restrictions placed on future 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 Non-point Source Pollution Plan to better handle non-point sources of pollution, which are believed to be responsible for 95 percent of the state's remaining water quality impairments. 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 that provides valuable guidelines and rules to help communities protect their water sources.

A Tri-State Water Quality Task Force has been established to plan and implement water quality improvement projects. This task force consists of representatives from the Department of Environmental Quality for each of the three states along with representatives from Idaho Fish and Game, Utah Division of Wildlife Resources, Wyoming Fish and Game, U.S. Fish and Wildlife Service, Utah Division of Water Resources, Utah Division of Water Rights, U.S. Natural Resources Conservation Service, PacifiCorp Power Company, Bear River Water User's Association, U.S. Forest Service, U.S. Environmental Protection Agency, U.S. Department of Agriculture, and other local interest groups. This task force meets quarterly and is currently working to insure that the TMDL process and water quality standards are consistent throughout the Bear River Basin and particularly across state boundaries. The task force has sponsored and continues to sponsor water quality projects within the basin.

THE ENVIRONMENT

Endangered Species

The U.S. Fish and Wildlife Service (FWS) has jurisdictional responsibility over wildlife issues with national implication, such as migratory birds or threatened and endangered species. The FWS administers and operates the Bear River Migratory Bird Refuge at the mouth of the Bear River in Box Elder County.

Table 20 lists the species considered threatened or endangered which reside in the Bear River Basin. The list changes over time as various species are added when they become threatened or removed from the list as they recover. When any activity is planned which may impact a threatened or endangered species, it is the responsibility of the project sponsor to take actions to protect them.

TABLE 20
Threatened and Endangered Species
Bear River Basin

Gray Wolf	*endangered
Whooping Crane	endangered
Black-footed Ferret - Unconfirmed	*endangered
Lahontan Cutthroat Trout	threatened
Bald Eagle	threatened
Maguire Primrose	threatened
Brown Grizzly Bear	*threatened
Canada Lynx - Possible	threatened
Fat-whorled Pondsnail	candidate
Yellow-billed Cuckoo	candidate

*Considered by U.S. Fish and Wildlife Service to no longer occur in Utah.

The FWS compiles lists of native animal and plant species for review and possible addition to the list of threatened and endangered species. Such species are generally referred to as candidates. While these species presently have no legal protection under the Endangered Species Act, it is prudent to consider impacts to these species as well. From a planning perspective, it is prudent to consider the possibility that a candidate species could, in the near future be added to the list of threatened and endangered species. The candidate species listed for the Bear River Basin are the Fat-whorled Pondsnail and the Yellow-billed Cuckoo.

Wetlands

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 storm water management, and afford unique opportunities for recreation, education and research. In addition, they provide many benefits to wildlife species.

The Wetlands definition currently accepted by the Corp of Engineers and the EPA is found in the 1987 Corp of Engineers Wetlands Delineation Manual. Under these guidelines, three criteria must be met to define an area as a wetland: (1)

Wetlands adjacent Cutler Reservoir

hydrophytic vegetation; (2) hydric soils; and (3) wetland hydrology. Wetlands are defined as:

"Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegitation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."[4]

Instream Flow Maintenance

Over the past several decades, instream flow maintenance has had more and more of an effect on water resources development and management. The advantages of maintaining year-round minimum flows in natural streams in the Bear River Basin are: (1) protection of existing fish populations; (2) maintenance of riparian vegetation, for stream bank stability and resistance to erosion; (3) maintenance of favorable conditions of flow in stream channels; (4) esthetic enjoyment and recreational use by people; and (5) normal daily use by birds, animals and aquatic organisms and plants.

Releases from Bear Lake for irrigators in Box Elder County have helped to insure instream flows for much of the main stem of the Bear River through the late summer season and early fall. Many of the Bear River's tributary streams, however, are dewatered through this period as flows are diverted for irrigation of farmland.

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.

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 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. Lands currently designated as wilderness within the Bear River Basin are identified in figure 15.

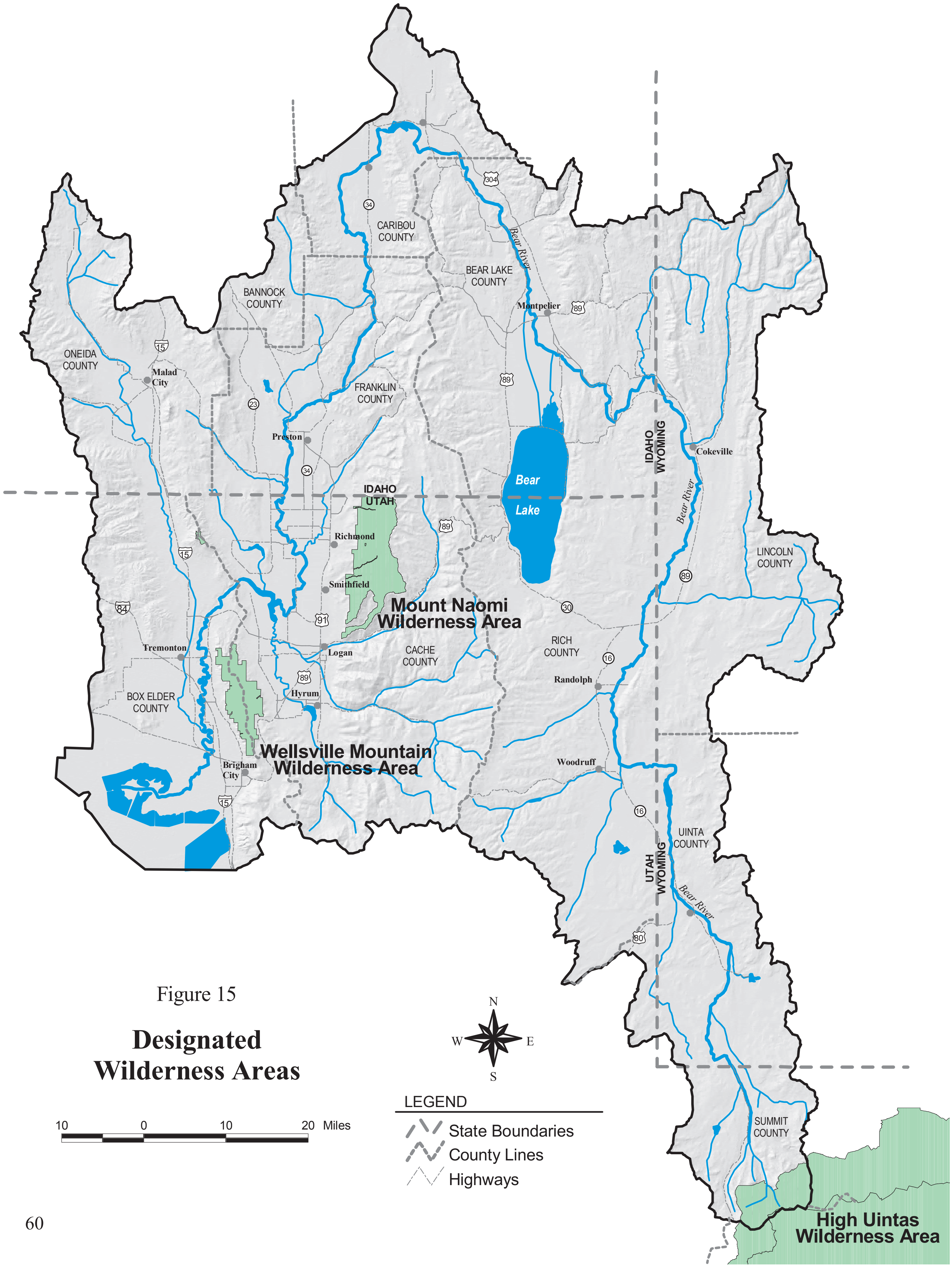


Figure 15

Designated Wilderness Areas

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." 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 the Bear River Basin with the Wild and Scenic River designation. In recent years, however, national forests and other federal agencies have made inventories of Utah streams for consideration as wild and scenic rivers.

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, these federal agencies 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, non-declining 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. Federal agencies should practice responsible watershed management that will help ensure a continued high quality, non-declining supply of water to meet the state's increasing needs.

NOTES

1 Geology of Northern Utah: Utah Geological Association Publication 27, Utah Geological Survey, US Geological Survey, Rocky Mountain Foundation, American Association of Petroleum Geologists, (September 11, 1999).

2 Utah State Department of Environmental Quality Web Page: waterquality.utah.gov/watersheds/bear/water_quality.htm

3 Ground-Water Quality Classification and Recommended Septic Tank Soil-Absorption-System Density Maps, Cache Valley Utah, by Mike Lowe, Janae Wallace, and Charles E. Bishop, Environmental Sciences Program, Utah Geologic Survey (June, 2002)

4 U.S. Army Corps of Engineers, 1987. Wetlands Delineation Manual, Environmental Laboratory, Department of Army, Waterways Experiment Station, Corps of Engineers,

Vicksburg, Mississippi, p. 13.

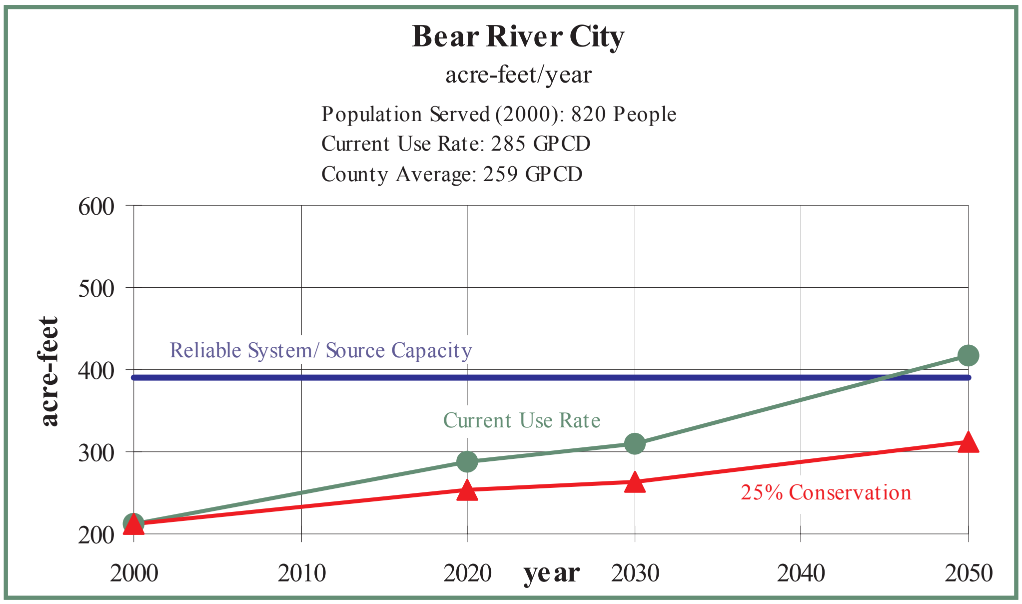
APPENDIX

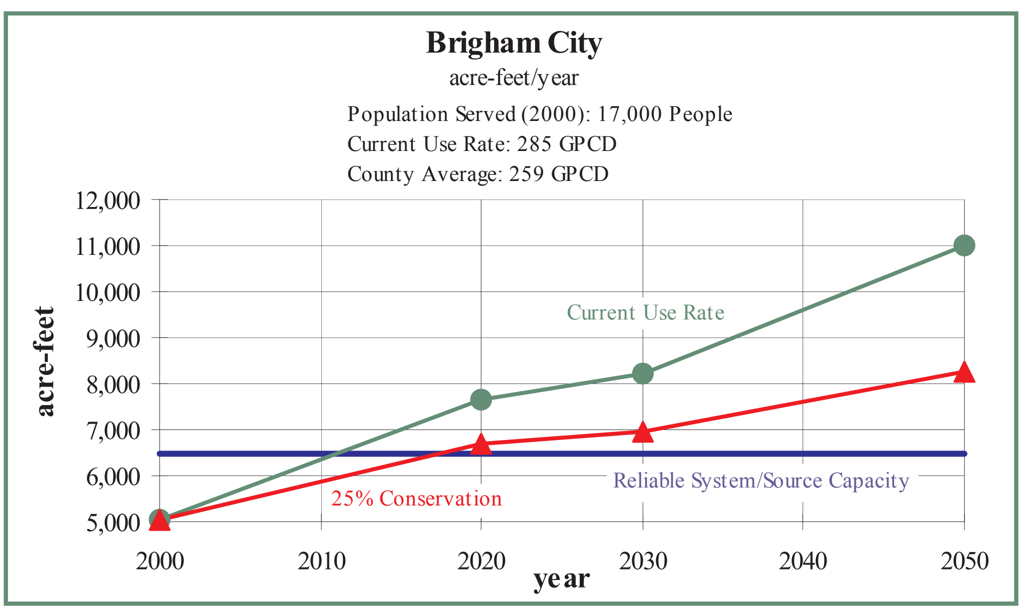
<u>Water Supply vs. Demand Graphs</u>

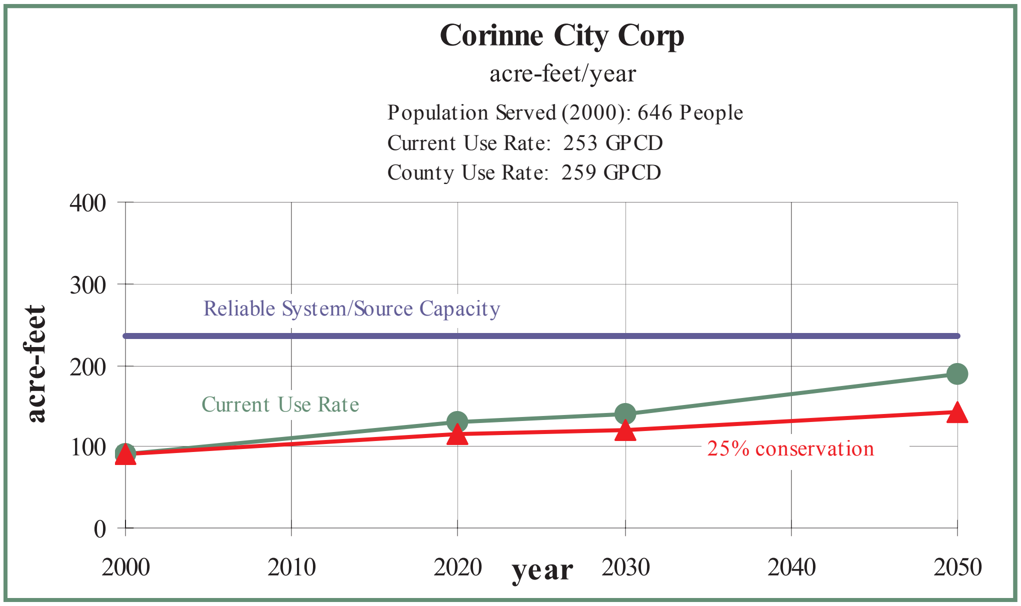
The following Water Supply vs Demand Graphs are presented alphabetically by county.

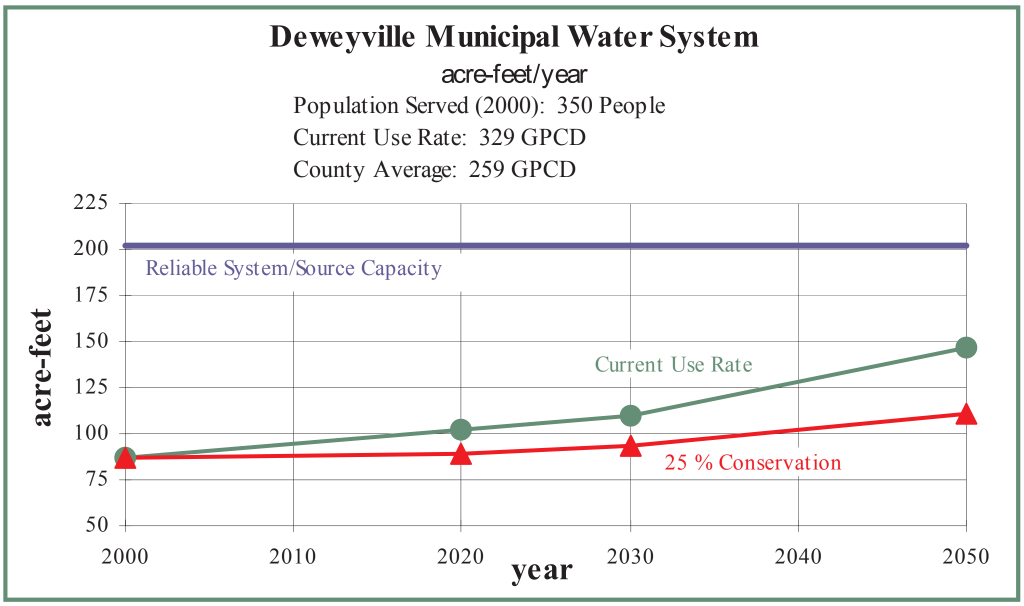
These graphs show the inter-relationships between each town's existing system's reliable system/source capacity and its projected demand for the next fifty years. Each figure includes a pair of future demand lines. The green line shows the community's projected water needs based upon its current use rate, while the Red line shows the reduction in demand if twenty-five percent conservation is achieved by the year 2050. The system's existing reliable system/source capacity is shown in blue. Also shown on each figure is the population served in 2000, the current use rate in gallons per capita day, and for comparison the county average per capita use rate

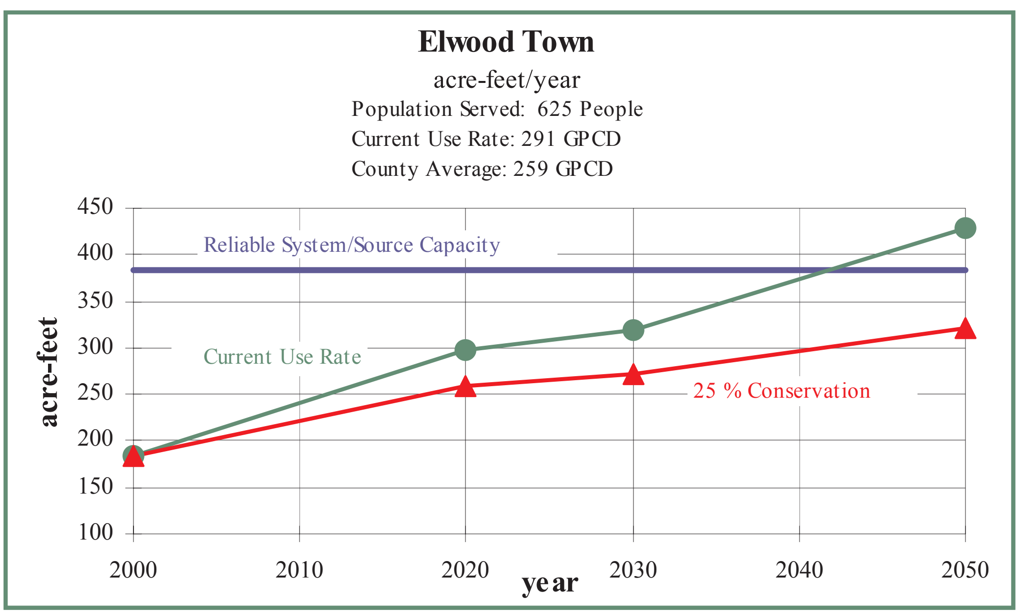
Box Elder County Communities:

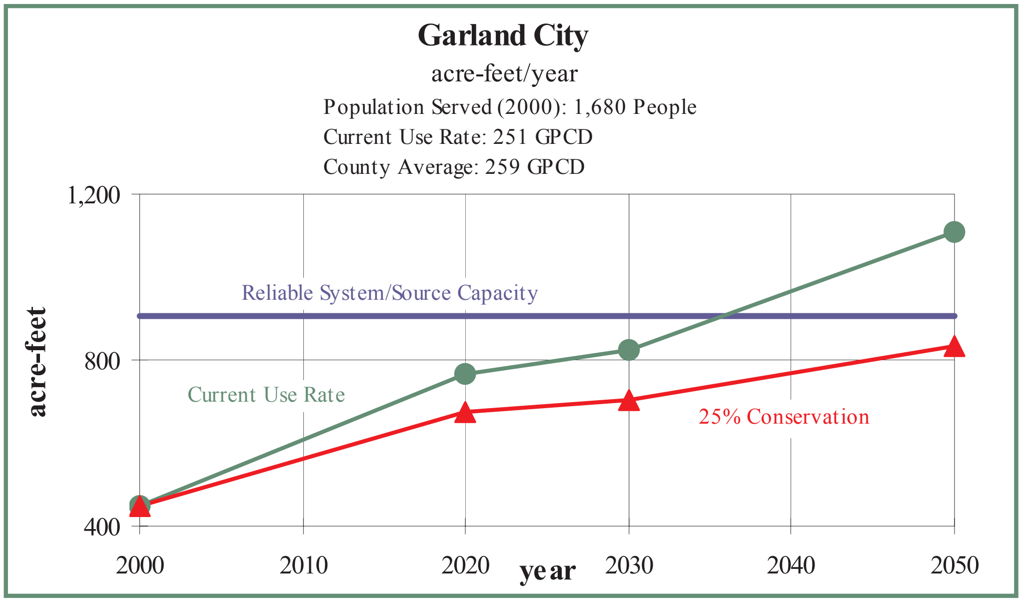


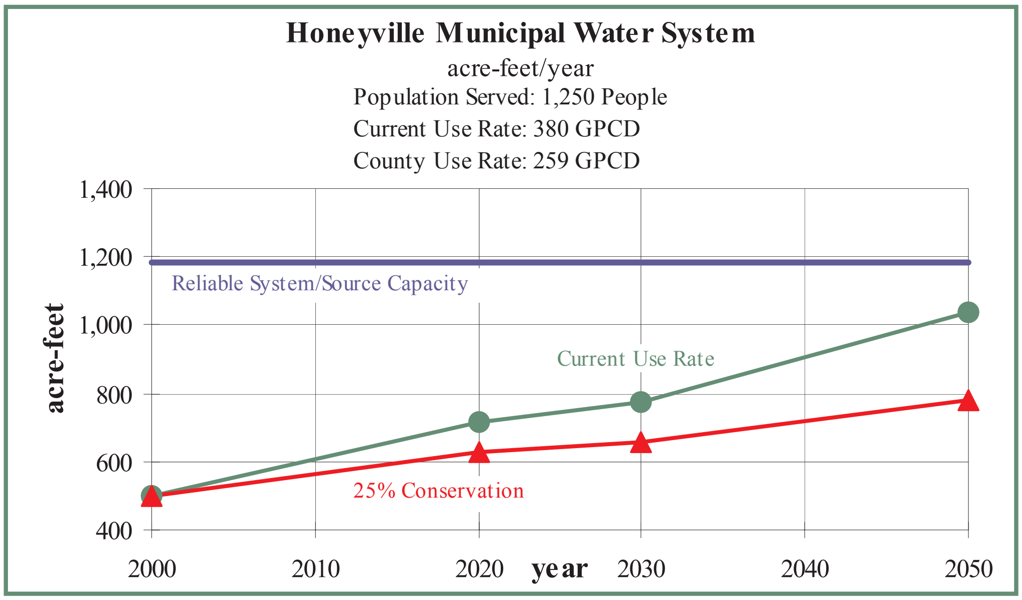


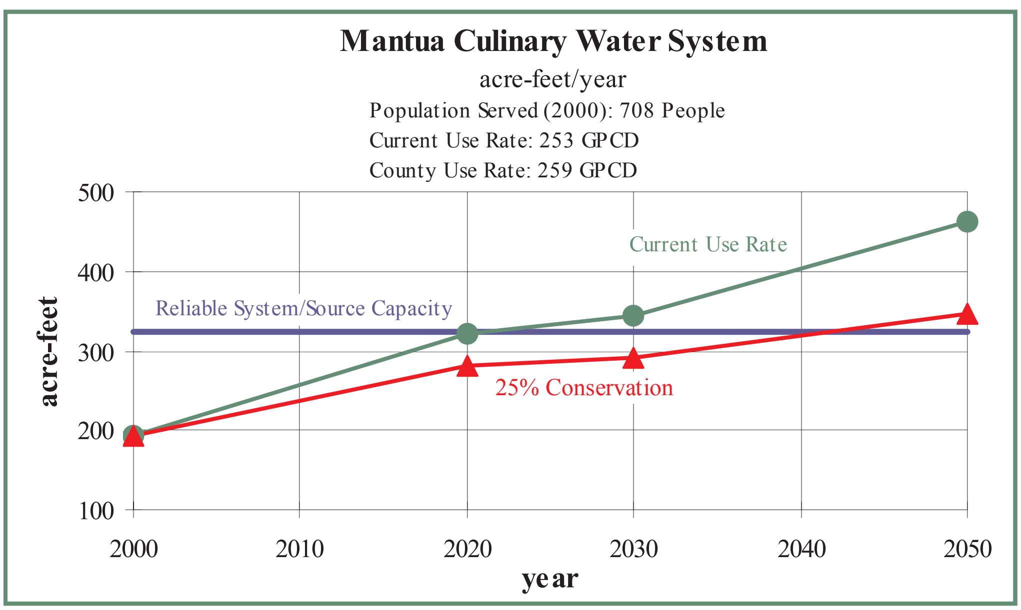

Corinne City Corp
acre-feet/year
Population Served (2000): 646 People
Current Use Rate: 253 GPCD
County Use Rate: 259 GPCD
acre-feet
400
300
200
100
0
Reliable System/Source Capacity
Current Use Rate
25% conservation
2000
2010
2020
2030
2040
2050
year

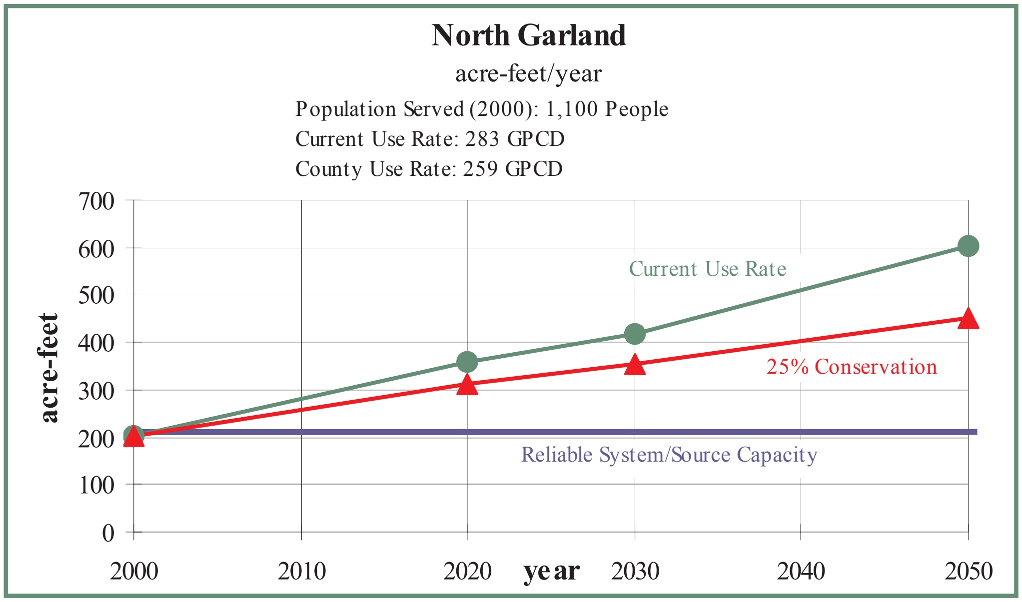

Deweyville Municipal Water System
acre-feet/year
Population Served (2000): 350 People
Current Use Rate: 329 GPCD
County Average: 259 GPCD
acre-feet
225
200
175
150
125
100
75
50
Reliable System/Source Capacity
Current Use Rate
25 % Conservation
2000
2010
2020
2030
2040
2050
year

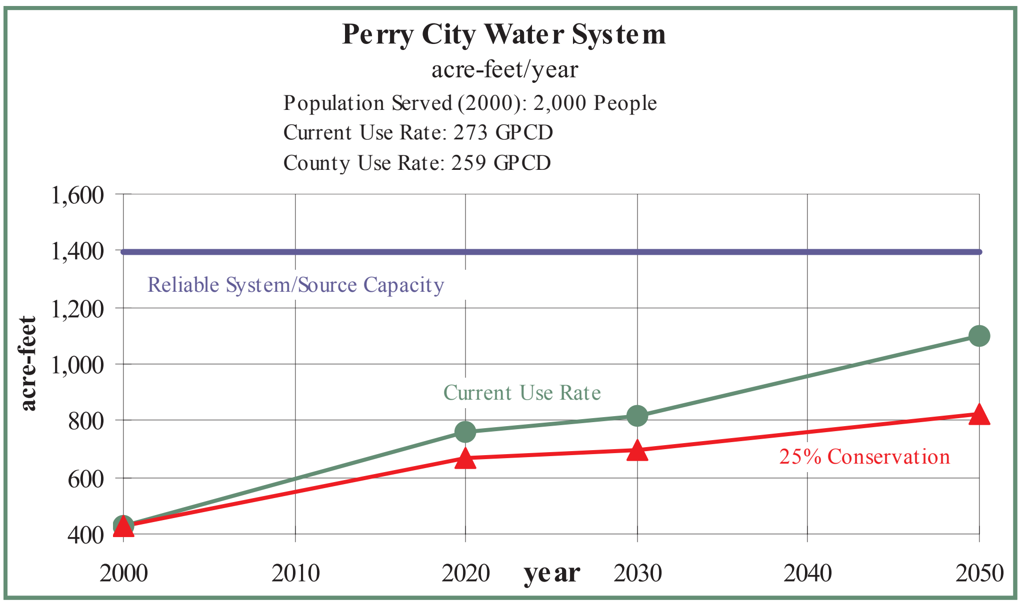

Elwood Town
acre-feet/year
Population Served: 625 People
Current Use Rate: 291 GPCD
County Average: 259 GPCD
acre-feet
450
400
350
300
250
200
150
100
Reliable System/Source Capacity
Current Use Rate
25 % Conservation
2000
2010
2020
2030
2040
2050
year

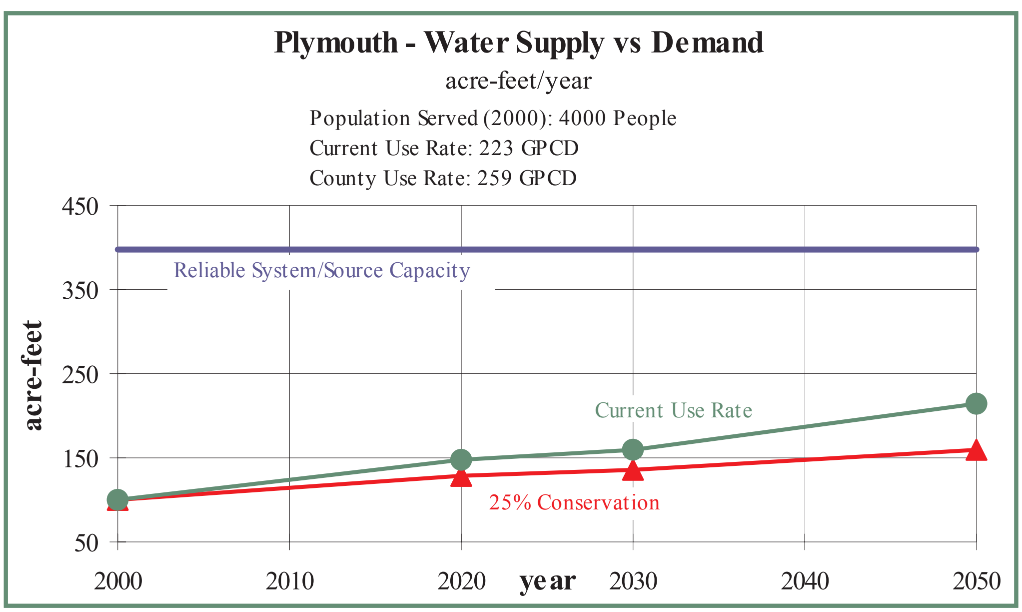

Garland City
acre-feet/year
Population Served (2000): 1,680 People
Current Use Rate: 251 GPCD
County Average: 259 GPCD
Reliable System/Source Capacity
Current Use Rate
25% Conservation
acre-feet
year
1,200
800
400
2000
2010
2020
2030
2040
2050

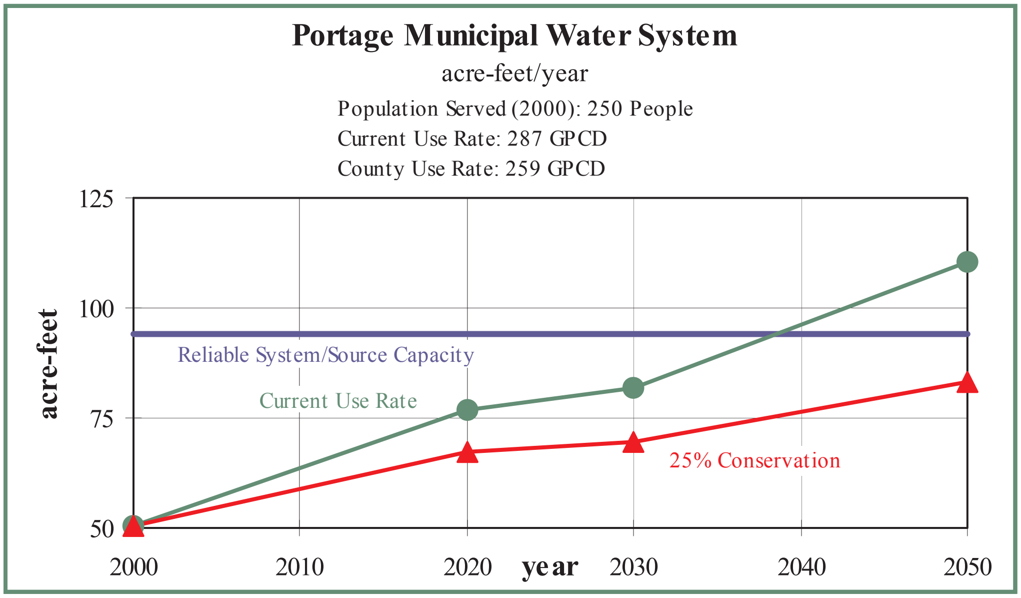

Honeyville Municipal Water System
acre-feet/year
Population Served: 1,250 People
Current Use Rate: 380 GPCD
County Use Rate: 259 GPCD
Reliable System/Source Capacity
Current Use Rate
25% Conservation
acre-feet
year
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050

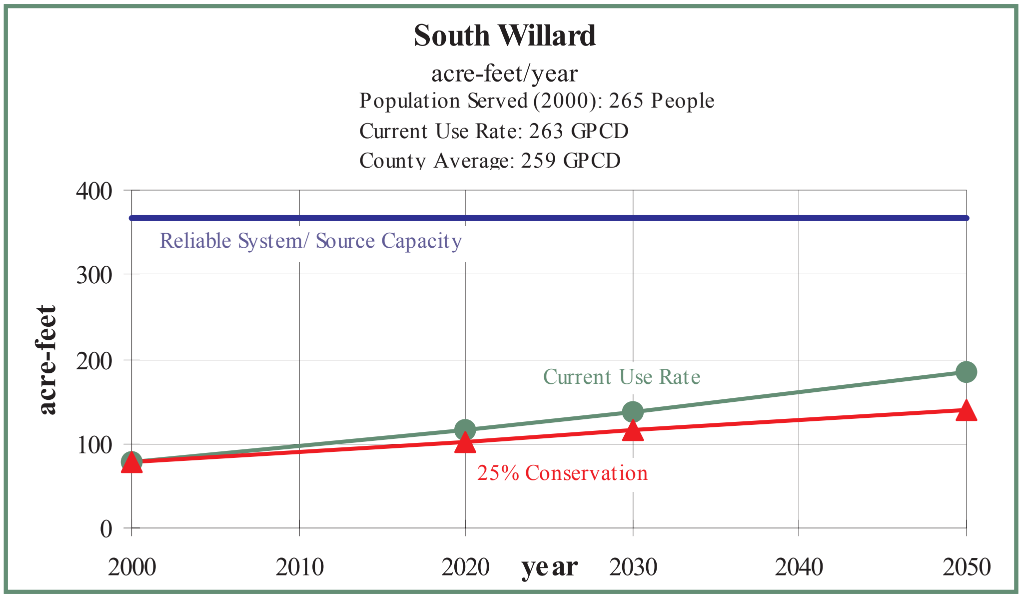

Mantua Culinary Water System
acre-feet/year
Population Served (2000): 708 People
Current Use Rate: 253 GPCD
County Use Rate: 259 GPCD
Current Use Rate
Reliable System/Source Capacity
25% Conservation
acre-feet
year
500
400
300
200
100
2000
2010
2020
2030
2040
2050

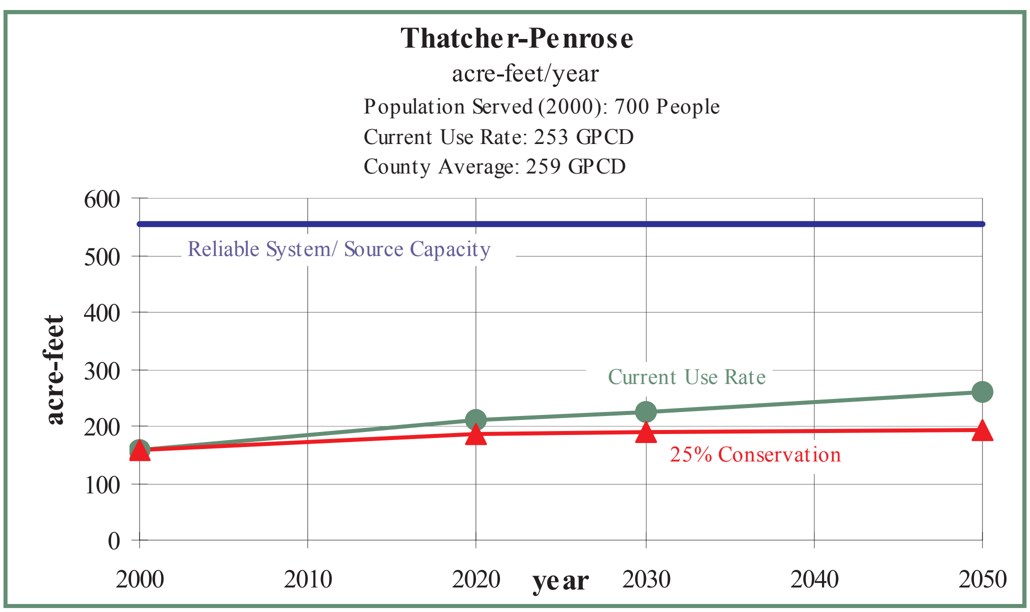

North Garland
acre-feet/year
Population Served (2000): 1,100 People
Current Use Rate: 283 GPCD
County Use Rate: 259 GPCD
acre-feet
year
Current Use Rate
25% Conservation
Reliable System/Source Capacity
700
600
500
400
300
200
100
0
2000
2010
2020
2030
2040
2050

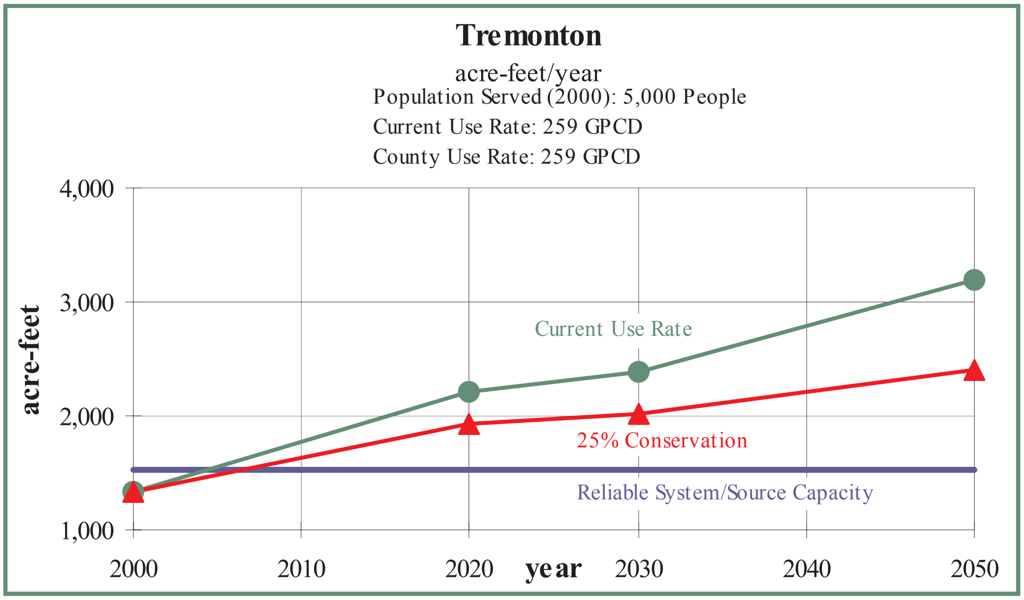

Perry City Water System
acre-feet/year
Population Served (2000): 2,000 People
Current Use Rate: 273 GPCD
County Use Rate: 259 GPCD
acre-feet
year
Reliable System/Source Capacity
Current Use Rate
25% Conservation
1,600
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050

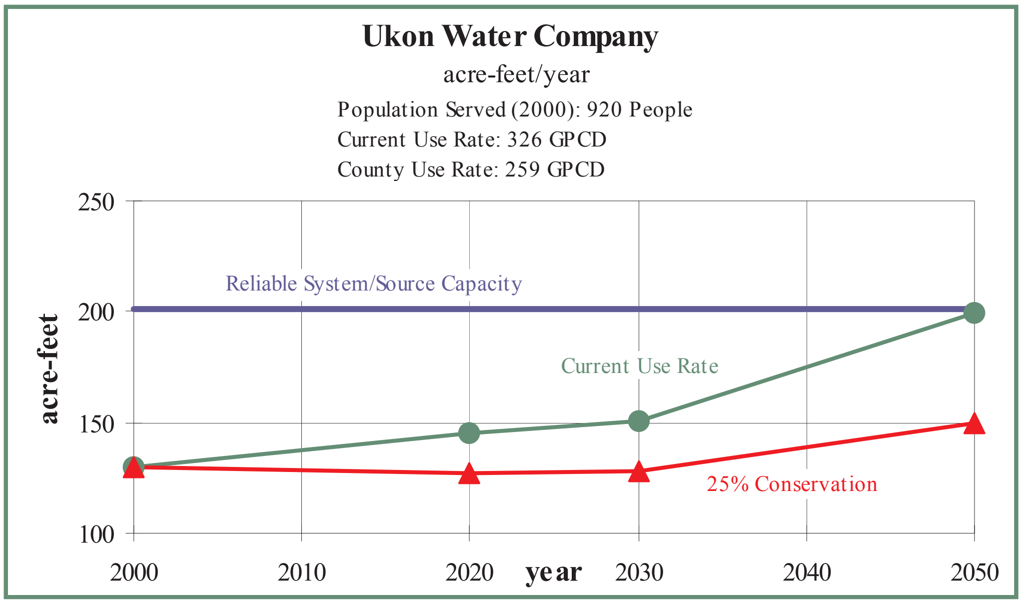

Plymouth - Water Supply vs Demand
acre-feet/year
Population Served (2000): 4000 People
Current Use Rate: 223 GPCD
County Use Rate: 259 GPCD
acre-feet
year
Reliable System/Source Capacity
Current Use Rate
25% Conservation
450
350
250
150
50
2000
2010
2020
2030
2040
2050

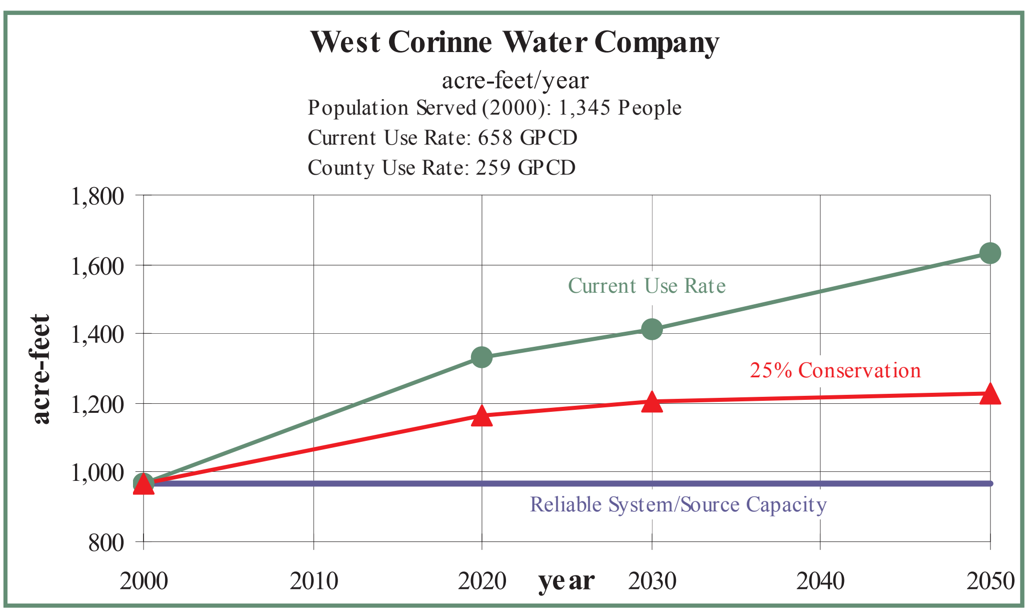

Portage Municipal Water System
acre-feet/year
Population Served (2000): 250 People
Current Use Rate: 287 GPCD
County Use Rate: 259 GPCD
125
100
75
50
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

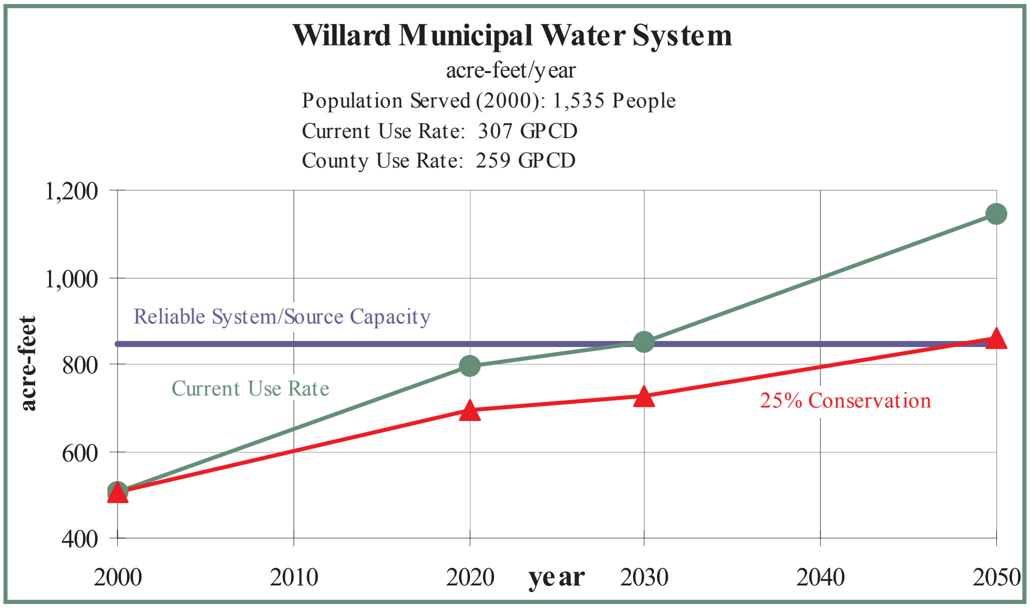

South Willard
acre-feet/year
Population Served (2000): 265 People
Current Use Rate: 263 GPCD
County Average: 259 GPCD
400
300
200
100
0
acre-feet
Reliable System/ Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050


Thatcher-Penrose
acre-feet/year
Population Served (2000): 700 People
Current Use Rate: 253 GPCD
County Average: 259 GPCD
600
500
400
300
200
100
0
acre-feet
Reliable System/ Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

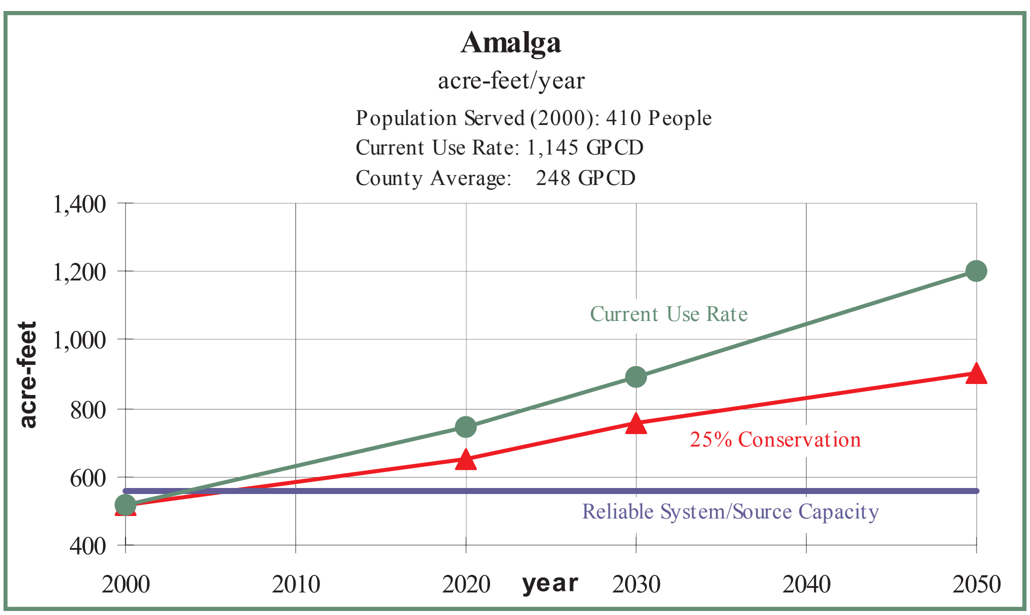

Tremonton
acre-feet/year
Population Served (2000): 5,000 People
Current Use Rate: 259 GPCD
County Use Rate: 259 GPCD
4,000
3,000
2,000
1,000
acre-feet
Current Use Rate
25% Conservation
Reliable System/Source Capacity
2000
2010
2020
year
2030
2040
2050

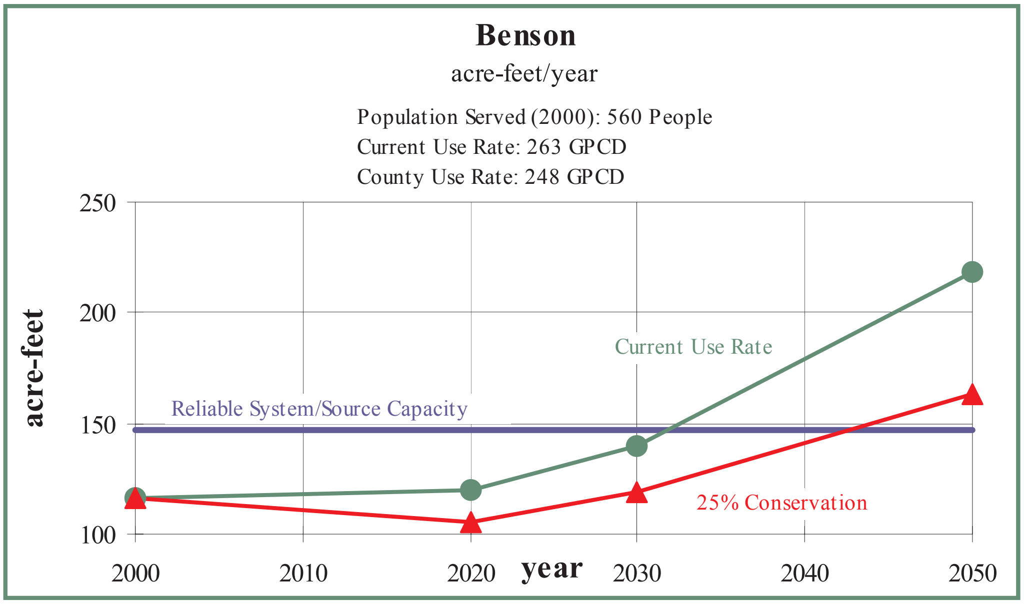

Ukon Water Company
acre-feet/year
Population Served (2000): 920 People
Current Use Rate: 326 GPCD
County Use Rate: 259 GPCD
250
200
150
100
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

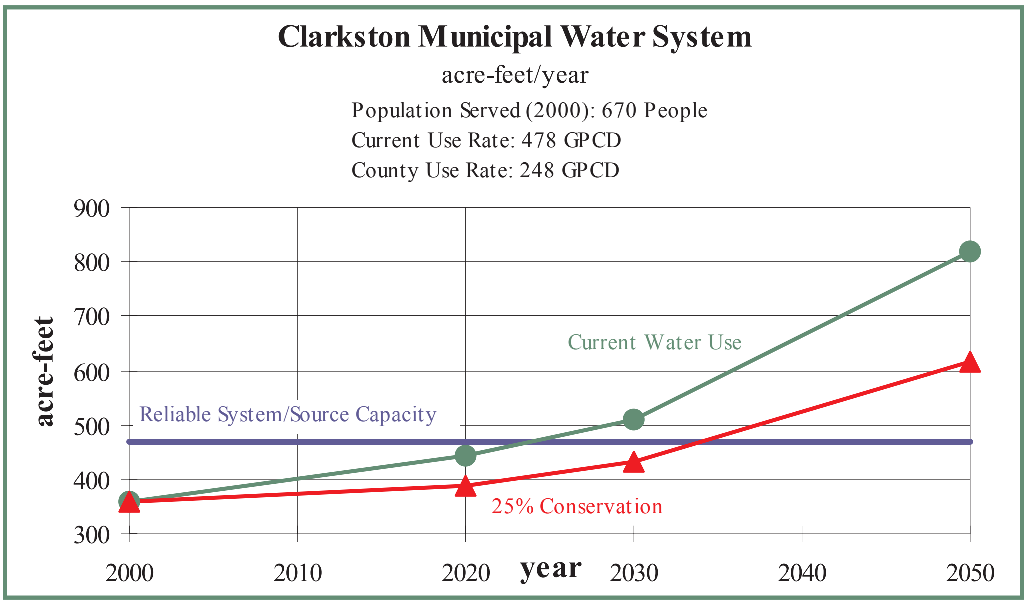

West Corinne Water Company
acre-feet/year
Population Served (2000): 1,345 People
Current Use Rate: 658 GPCD
County Use Rate: 259 GPCD
1,800
1,600
1,400
1,200
1,000
800
acre-feet
Current Use Rate
25% Conservation
Reliable System/Source Capacity
2000
2010
2020
year
2030
2040
2050

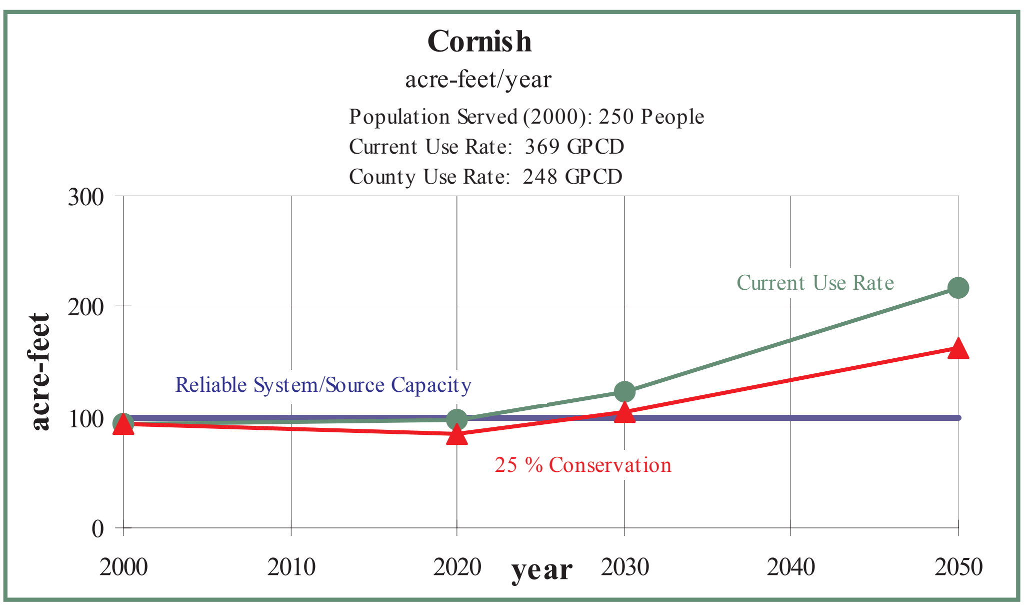


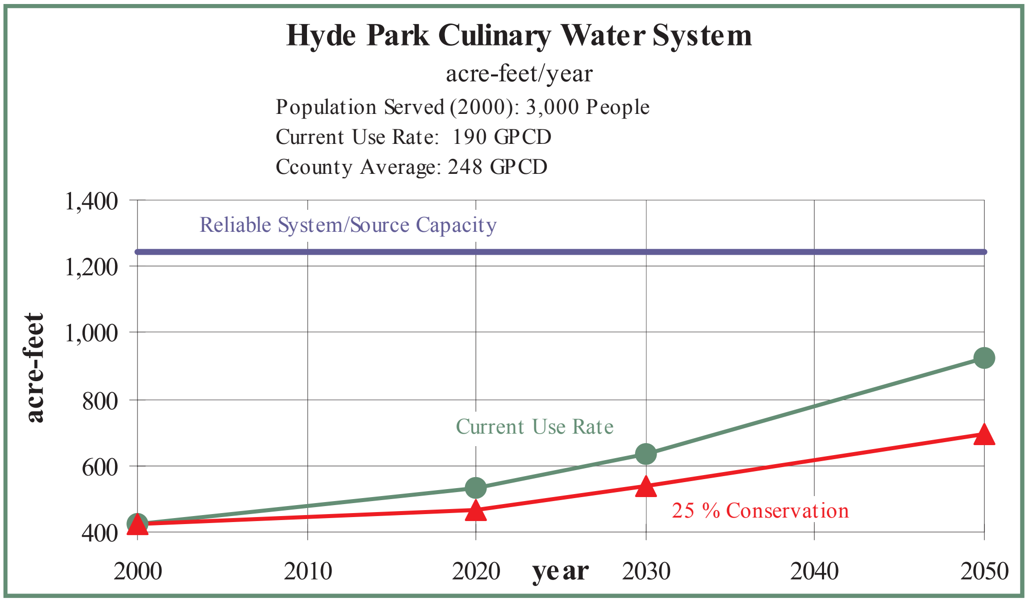
Cache Valley Communities:

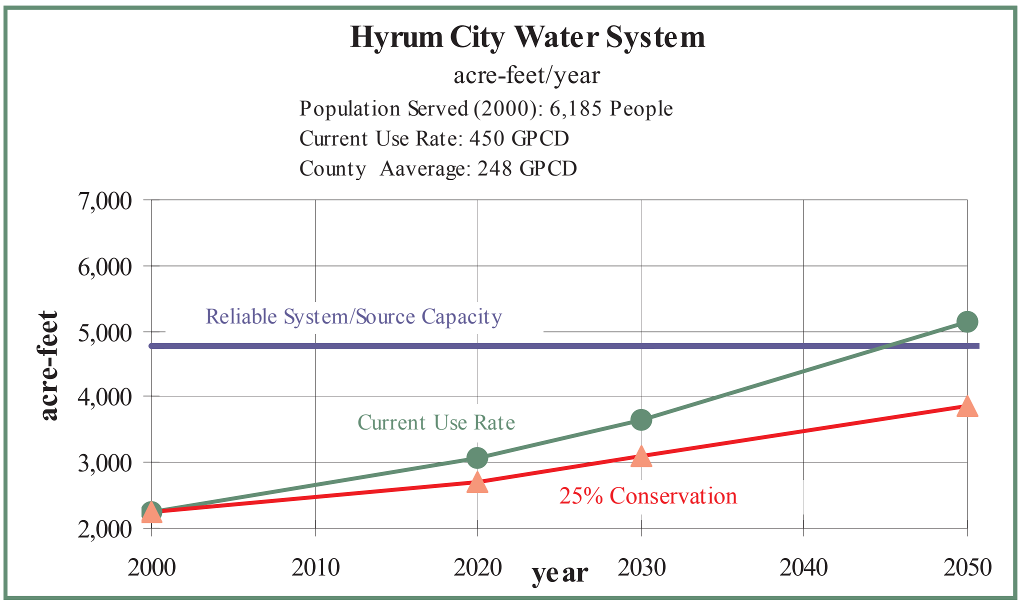



Benson
acre-feet/year
Population Served (2000): 560 People
Current Use Rate: 263 GPCD
County Use Rate: 248 GPCD
250
200
150
100
acre-feet
Current Use Rate
Reliable System/Source Capacity
25% Conservation
2000
2010
2020
year
2030
2040
2050

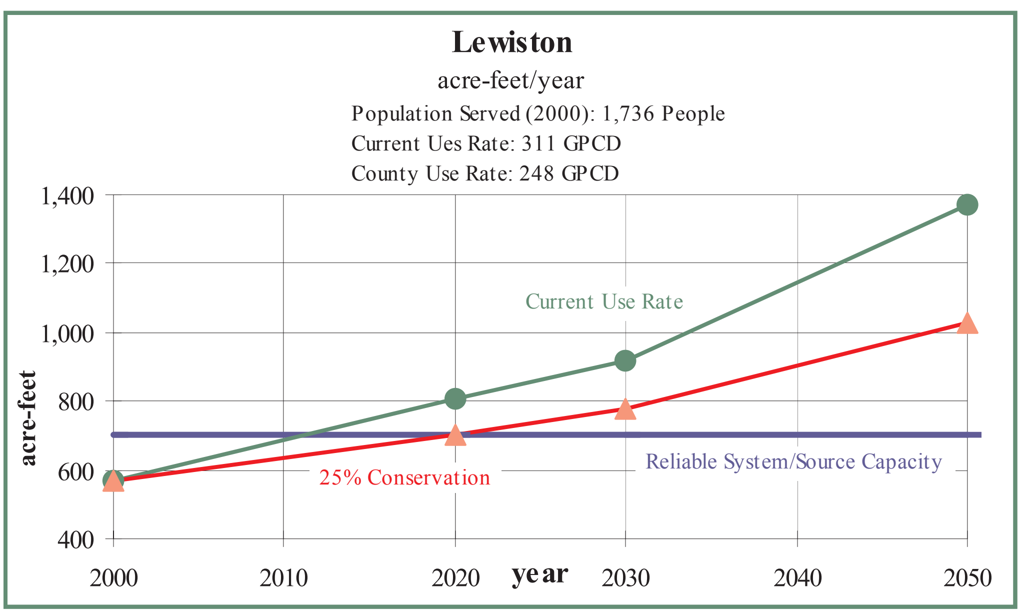

Clarkston Municipal Water System
acre-feet/year
Population Served (2000): 670 People
Current Use Rate: 478 GPCD
County Use Rate: 248 GPCD
900
800
700
600
500
400
300
acre-feet
Current Water Use
Reliable System/Source Capacity
25% Conservation
2000
2010
2020
year
2030
2040
2050

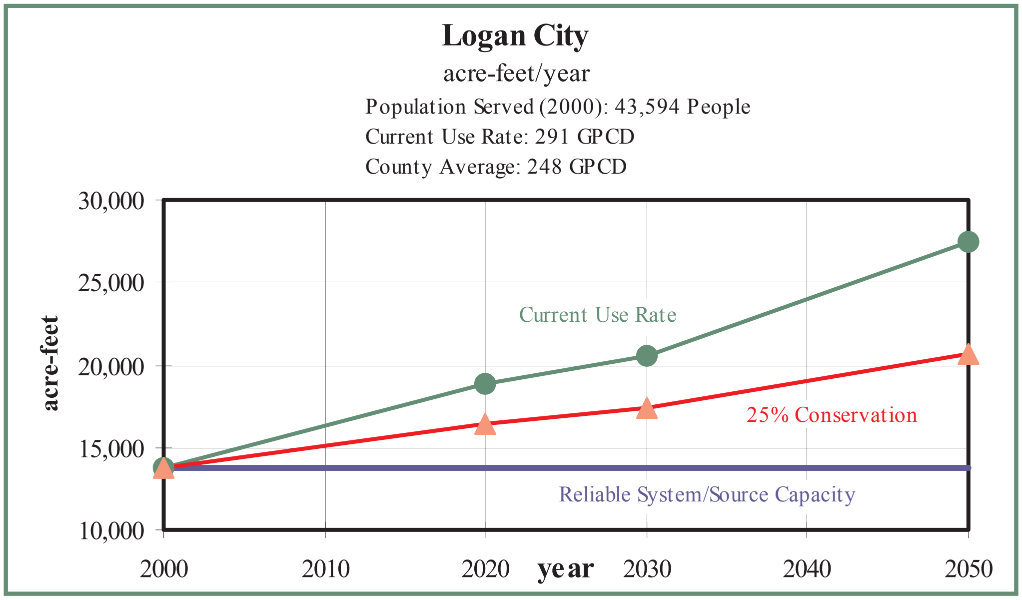

Cornish
acre-feet/year
Population Served (2000): 250 People
Current Use Rate: 369 GPCD
County Use Rate: 248 GPCD
300
200
100
0
acre-feet
Current Use Rate
Reliable System/Source Capacity
25 % Conservation
2000
2010
2020
year
2030
2040
2050

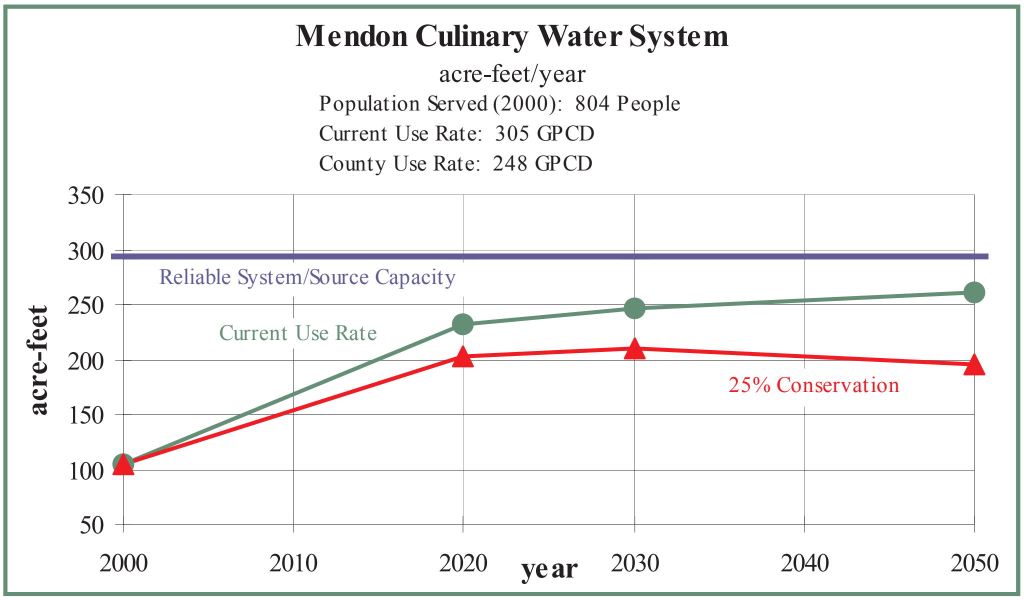

Hyde Park Culinary Water System
acre-feet/year
Population Served (2000): 3,000 People
Current Use Rate: 190 GPCD
Ccounty Average: 248 GPCD
Reliable System/Source Capacity
Current Use Rate
25 % Conservation
acre-feet
year
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050

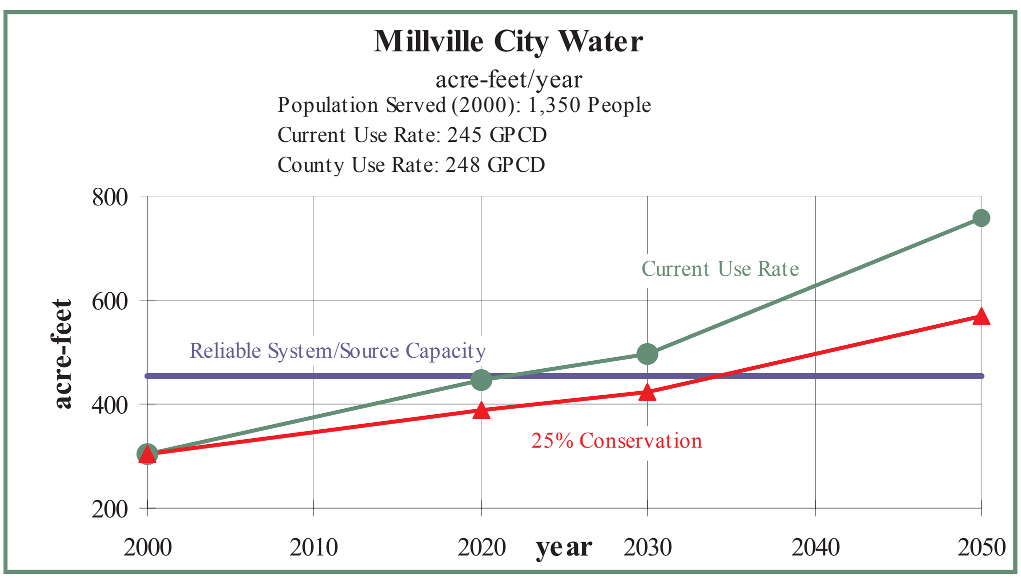

Hyrum City Water System
acre-feet/year
Population Served (2000): 6,185 People
Current Use Rate: 450 GPCD
County Aaverage: 248 GPCD
Reliable System/Source Capacity
Current Use Rate
25% Conservation
acre-feet
year
7,000
6,000
5,000
4,000
3,000
2,000
2000
2010
2020
2030
2040
2050

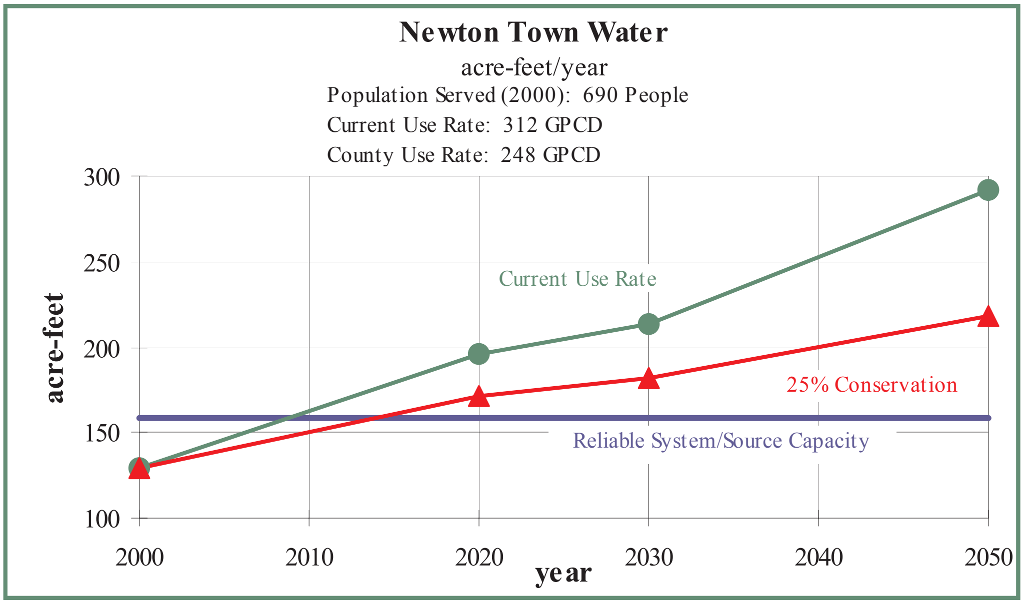
v

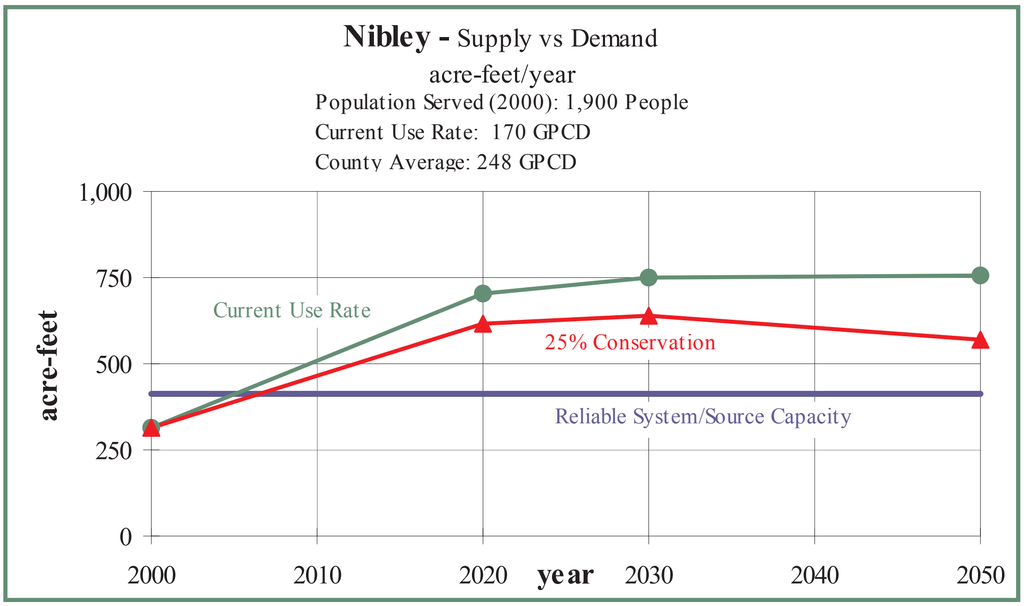

Lewiston
acre-feet/year
Population Served (2000): 1,736 People
Current Ues Rate: 311 GPCD
County Use Rate: 248 GPCD
Current Use Rate
Reliable System/Source Capacity
25% Conservation
acre-feet
year
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050

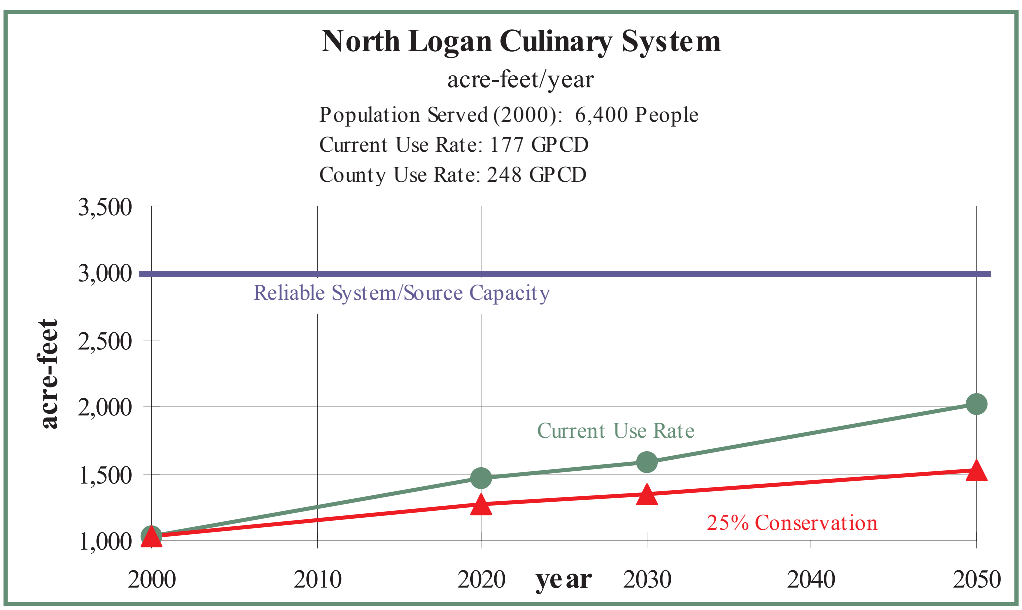

Logan City
acre-feet/year
Population Served (2000): 43,594 People
Current Use Rate: 291 GPCD
County Average: 248 GPCD
30,000
25,000
20,000
15,000
10,000
acre-feet
Current Use Rate
25% Conservation
Reliable System/Source Capacity
2000
2010
2020
year
2030
2040
2050

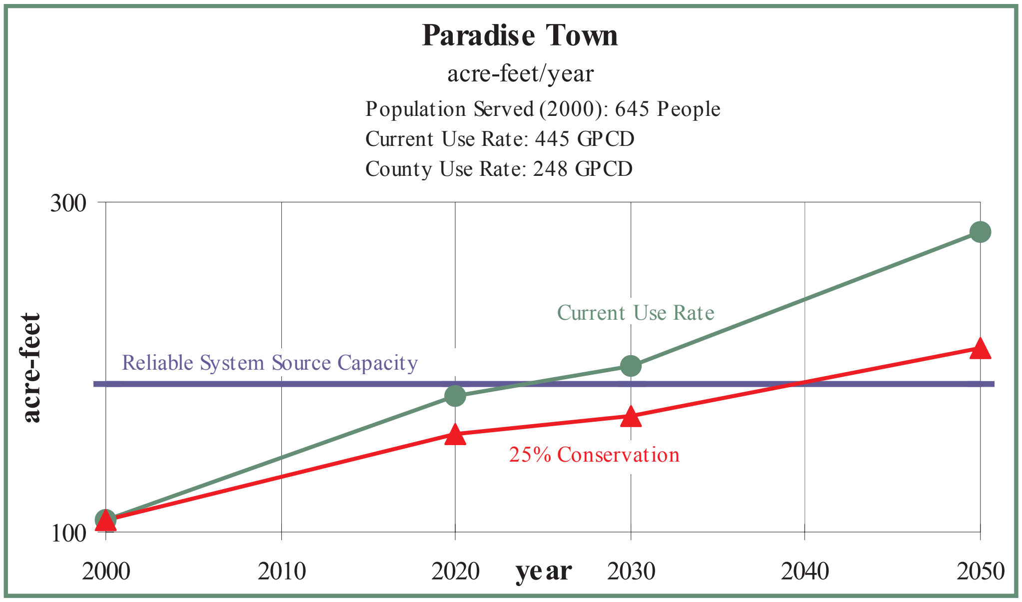

Mendon Culinary Water System
acre-feet/year
Population Served (2000): 804 People
Current Use Rate: 305 GPCD
County Use Rate: 248 GPCD
350
300
250
200
150
100
50
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

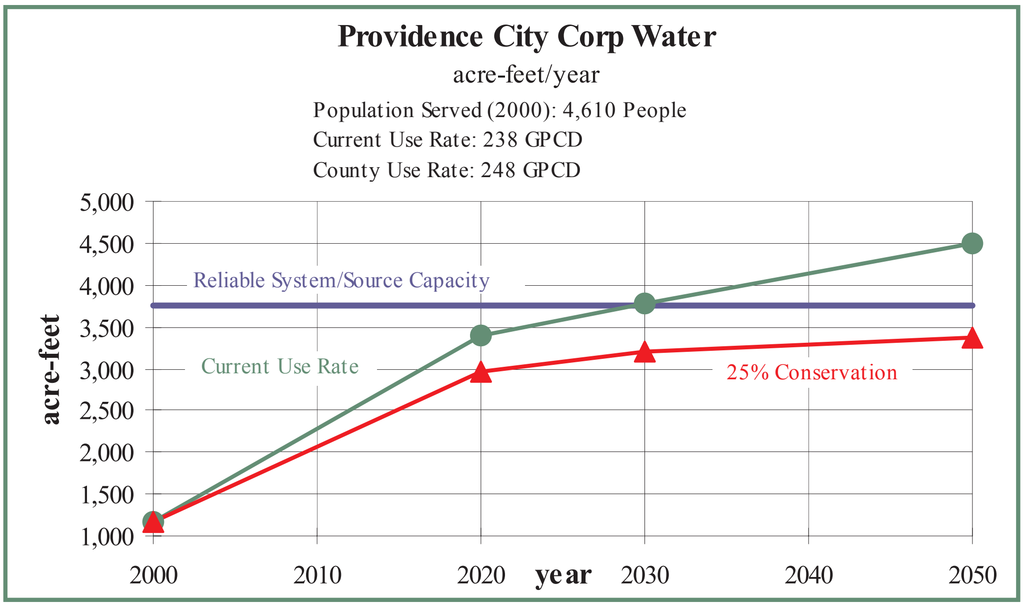

Millville City Water
acre-feet/year
Population Served (2000): 1,350 People
Current Use Rate: 245 GPCD
County Use Rate: 248 GPCD
800
600
400
200
acre-feet
Current Use Rate
Reliable System/Source Capacity
25% Conservation
2000
2010
2020
year
2030
2040
2050

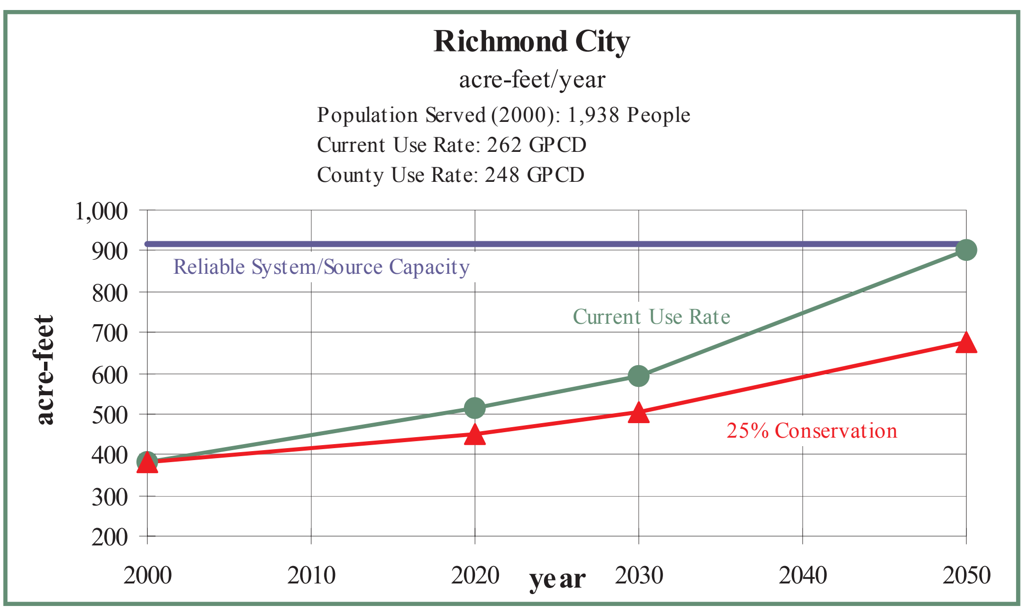

Newton Town Water
acre-feet/year
Population Served (2000): 690 People
Current Use Rate: 312 GPCD
County Use Rate: 248 GPCD
acre-feet
300
250
200
150
100
Current Use Rate
25% Conservation
Reliable System/Source Capacity
2000
2010
2020
2030
2040
2050
year

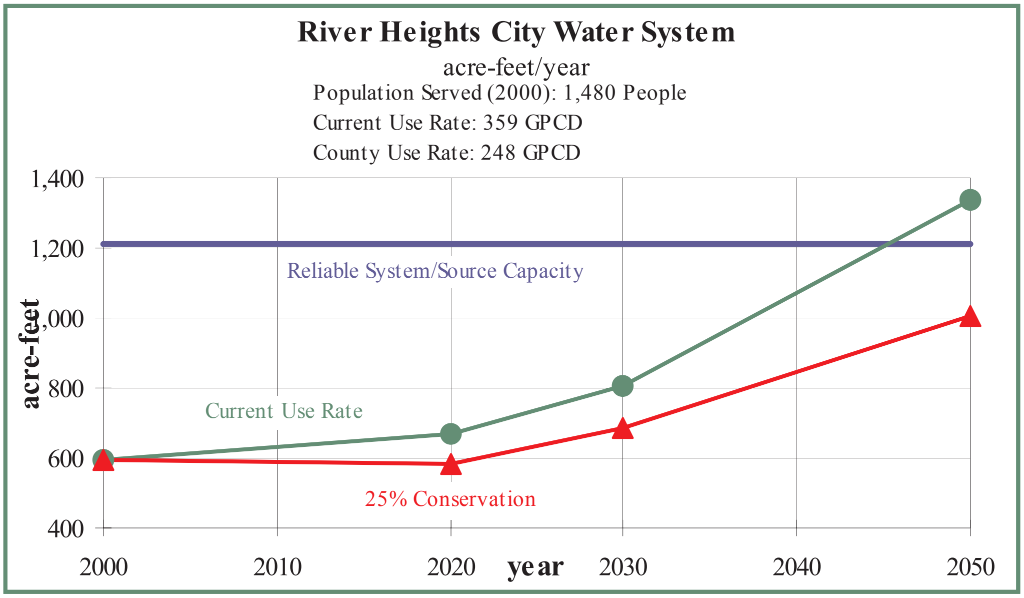

Nibley - Supply vs Demand
acre-feet/year
Population Served (2000): 1,900 People
Current Use Rate: 170 GPCD
County Average: 248 GPCD
acre-feet
1,000
750
500
250
0
Current Use Rate
25% Conservation
Reliable System/Source Capacity
2000
2010
2020
2030
2040
2050
year

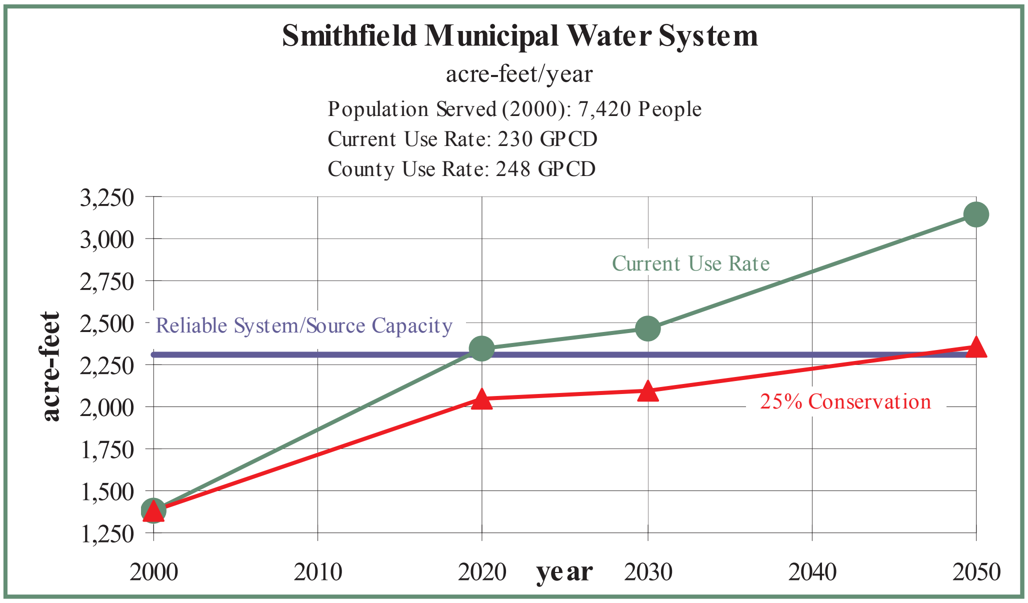

North Logan Culinary System
acre-feet/year
Population Served (2000): 6,400 People
Current Use Rate: 177 GPCD
County Use Rate: 248 GPCD
acre-feet
3,500
3,000
2,500
2,000
1,500
1,000
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
2030
2040
2050
year

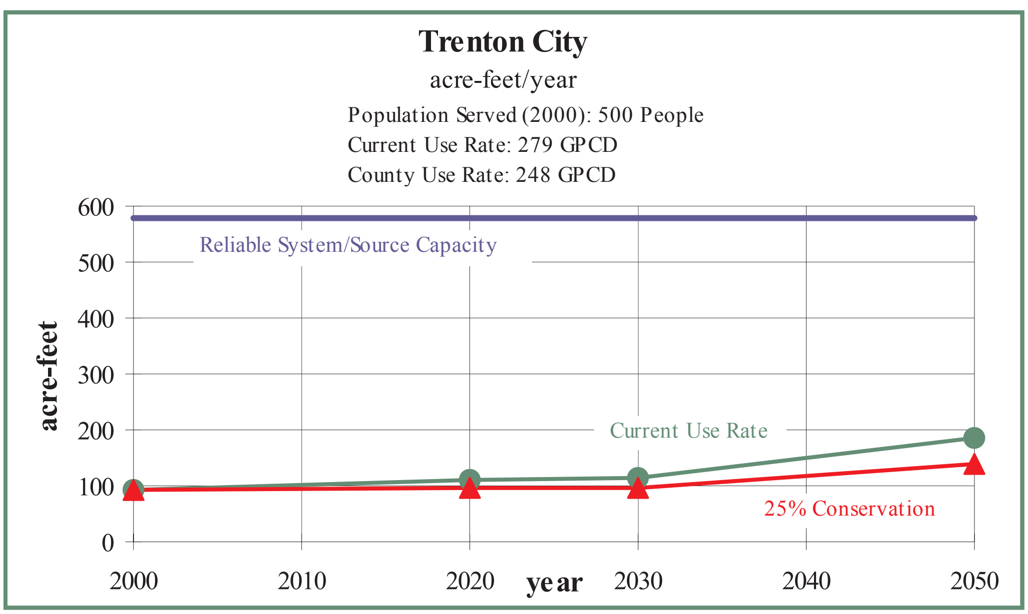

Paradise Town
acre-feet/year
Population Served (2000): 645 People
Current Use Rate: 445 GPCD
County Use Rate: 248 GPCD
300
100
acre-feet
Reliable System Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

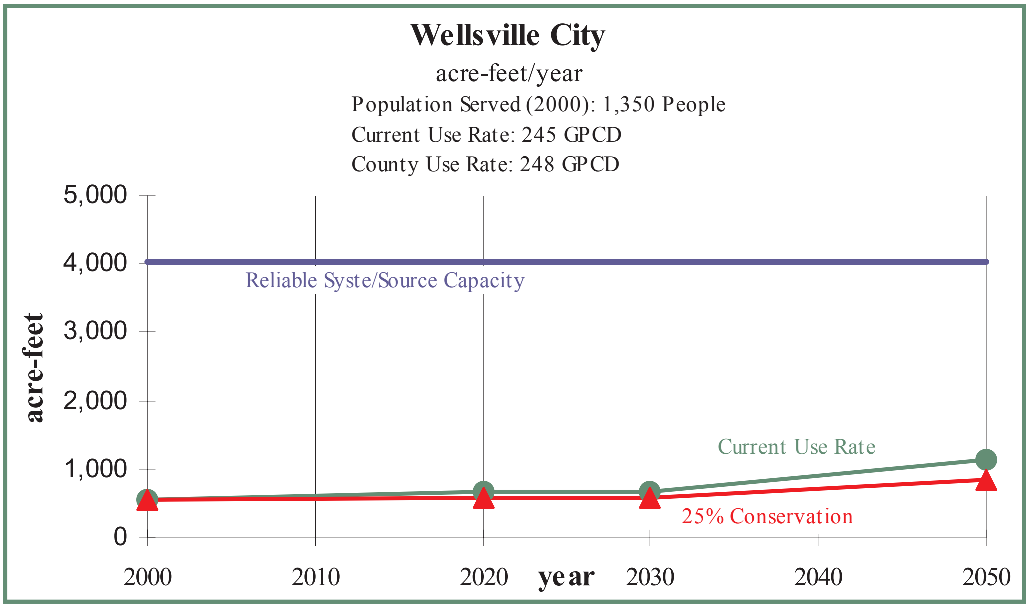

Providence City Corp Water
acre-feet/year
Population Served (2000): 4,610 People
Current Use Rate: 238 GPCD
County Use Rate: 248 GPCD
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050


Richmond City
acre-feet/year
Population Served (2000): 1,938 People
Current Use Rate: 262 GPCD
County Use Rate: 248 GPCD
1,000
900
800
700
600
500
400
300
200
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

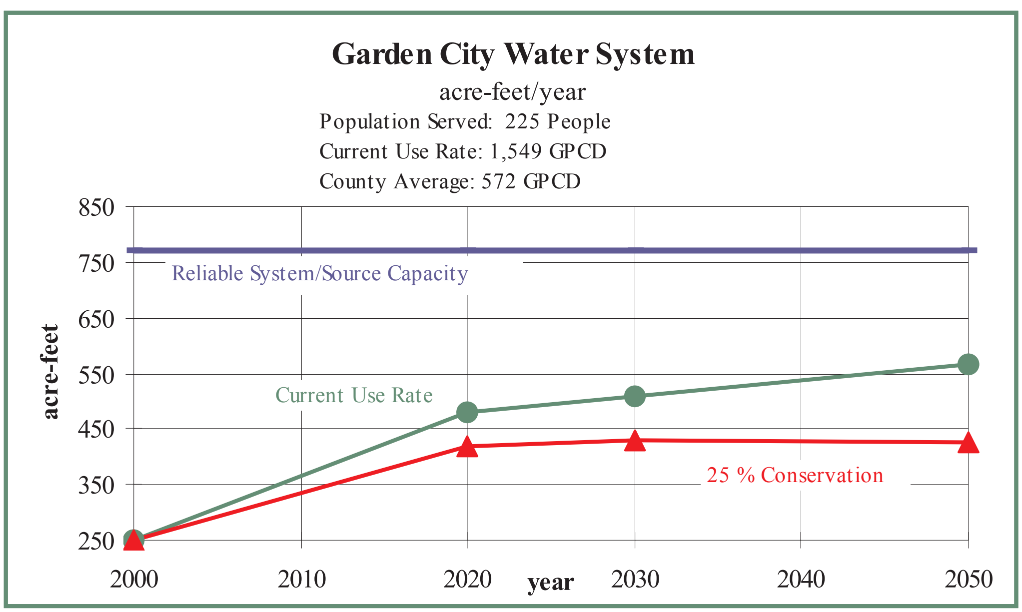

River Heights City Water System
acre-feet/year
Population Served (2000): 1,480 People
Current Use Rate: 359 GPCD
County Use Rate: 248 GPCD
1,400
1,200
1,000
800
600
400
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

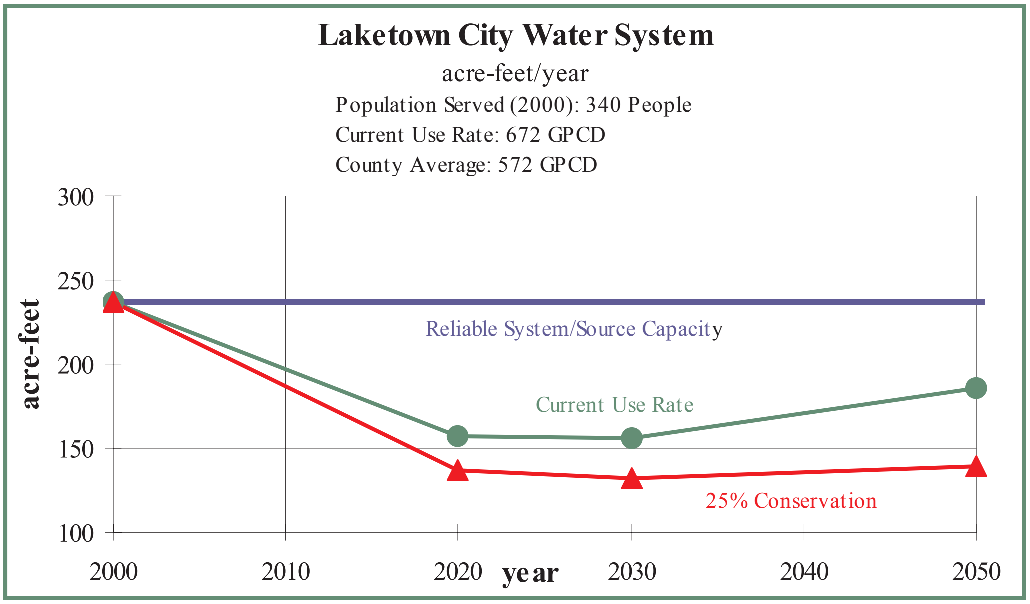

Smithfield Municipal Water System
acre-feet/year
Population Served (2000): 7,420 People
Current Use Rate: 230 GPCD
County Use Rate: 248 GPCD
3,250
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
acre-feet
Current Use Rate
Reliable System/Source Capacity
25% Conservation
2000
2010
2020
year
2030
2040
2050

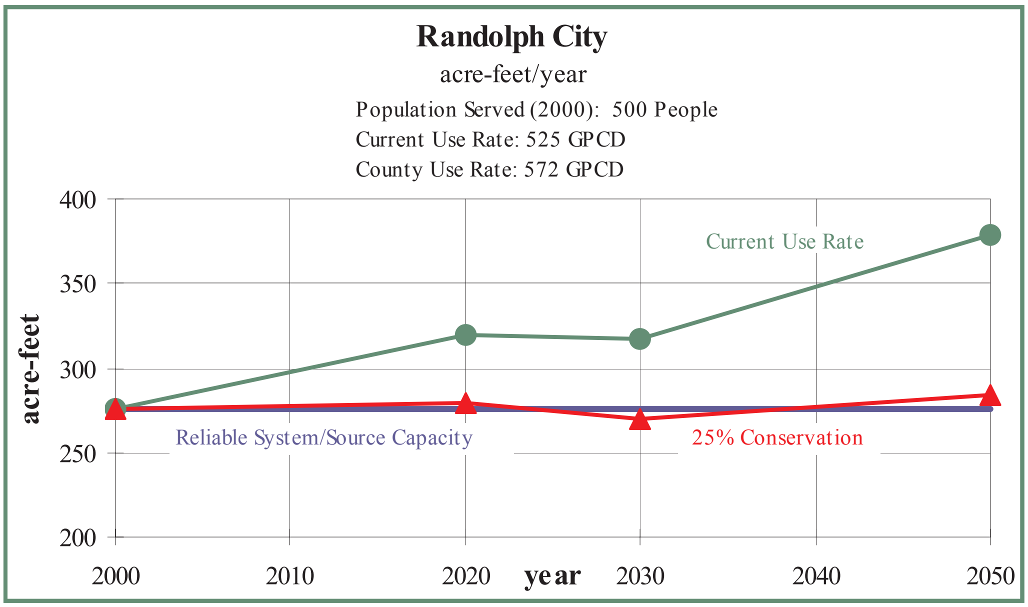

Trenton City
acre-feet/year
Population Served (2000): 500 People
Current Use Rate: 279 GPCD
County Use Rate: 248 GPCD
600
500
400
300
200
100
0
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050

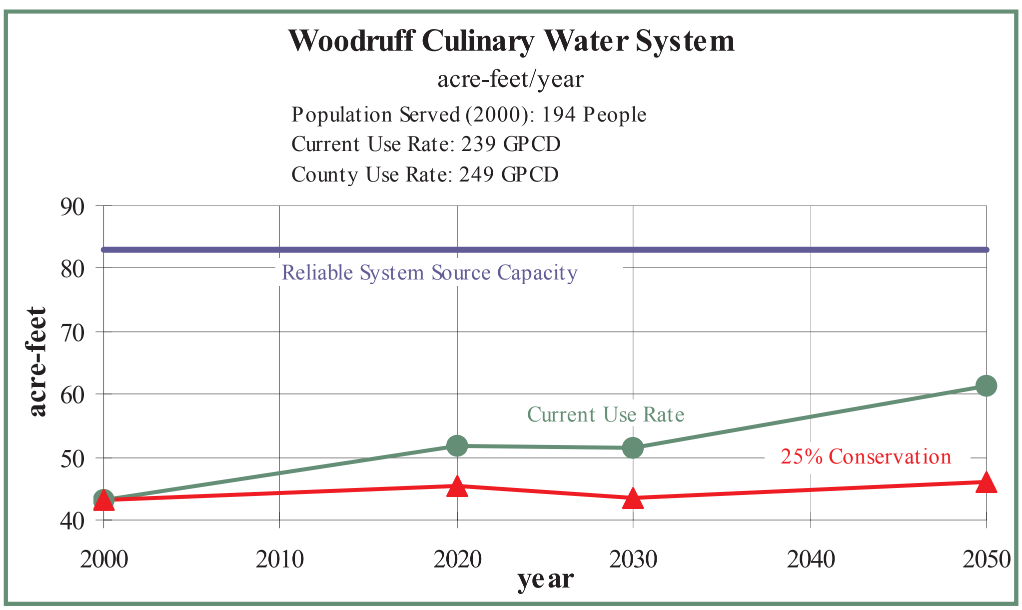


Rich County Communities:




Laketown City Water System
acre-feet/year
Population Served (2000): 340 People
Current Use Rate: 672 GPCD
County Average: 572 GPCD
300
250
200
150
100
acre-feet
Reliable System/Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
year
2030
2040
2050


Randolph City
acre-feet/year
Population Served (2000): 500 People
Current Use Rate: 525 GPCD
County Use Rate: 572 GPCD
400
350
300
250
200
acre-feet
Current Use Rate
Reliable System/Source Capacity
25% Conservation
2000
2010
2020
year
2030
2040
2050


Woodruff Culinary Water System
acre-feet/year
Population Served (2000): 194 People
Current Use Rate: 239 GPCD
County Use Rate: 249 GPCD
90
80
70
60
50
40
acre-feet
Reliable System Source Capacity
Current Use Rate
25% Conservation
2000
2010
2020
2030
2040
2050
year

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 thatreaches 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
Bear River Basin—Planning for the Future

Prepared by the Division of Water Resources with valuable input from the State Water Plan Coordinating Committee:

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