Jordan River Basin
Planning for the Future

UTAH STATE WATER PLAN

Public Review Draft
March 2010

JORDAN RIVER BASIN
PLANNING FOR THE FUTURE

Public Review Draft

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By:

Utah Division of Water Resources

With input from the State Water Plan Coordinating Committee
(see inside-back cover for participating agencies)

U T A H   S T A T E   W A T E R   P L A N

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 two decades, the Division has prepared a series of documents under the title "Utah State Water Plan." This includes two statewide water plans and an individual water plan for each of the State's eleven major hydrologic river basins. Preparing these plans involves several major data collection programs as well as extensive inter-agency and public outreach efforts. Much is learned through this process. State, local, and federal water planners and managers obtain valuable information for use in their programs and activities, and the public receives the opportunity to provide meaningful input in improving the state's water resources stewardship.

This document is the latest in the "Utah State Water Plan" series and is intended to guide and direct water-related planning and management in the Jordan River Basin over the next several years. 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 within the Basin 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 the Basin's water resources. Included in this Jordan River Basin Plan are real-life examples highlighted in the text, 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 to the reader.

In addition to the printed form of this document, the Utah Division of Water Resources has made a "pdf" version available on the Internet. This can be accessed through the Division's home page at: www.water.utah.gov. This web page allows this 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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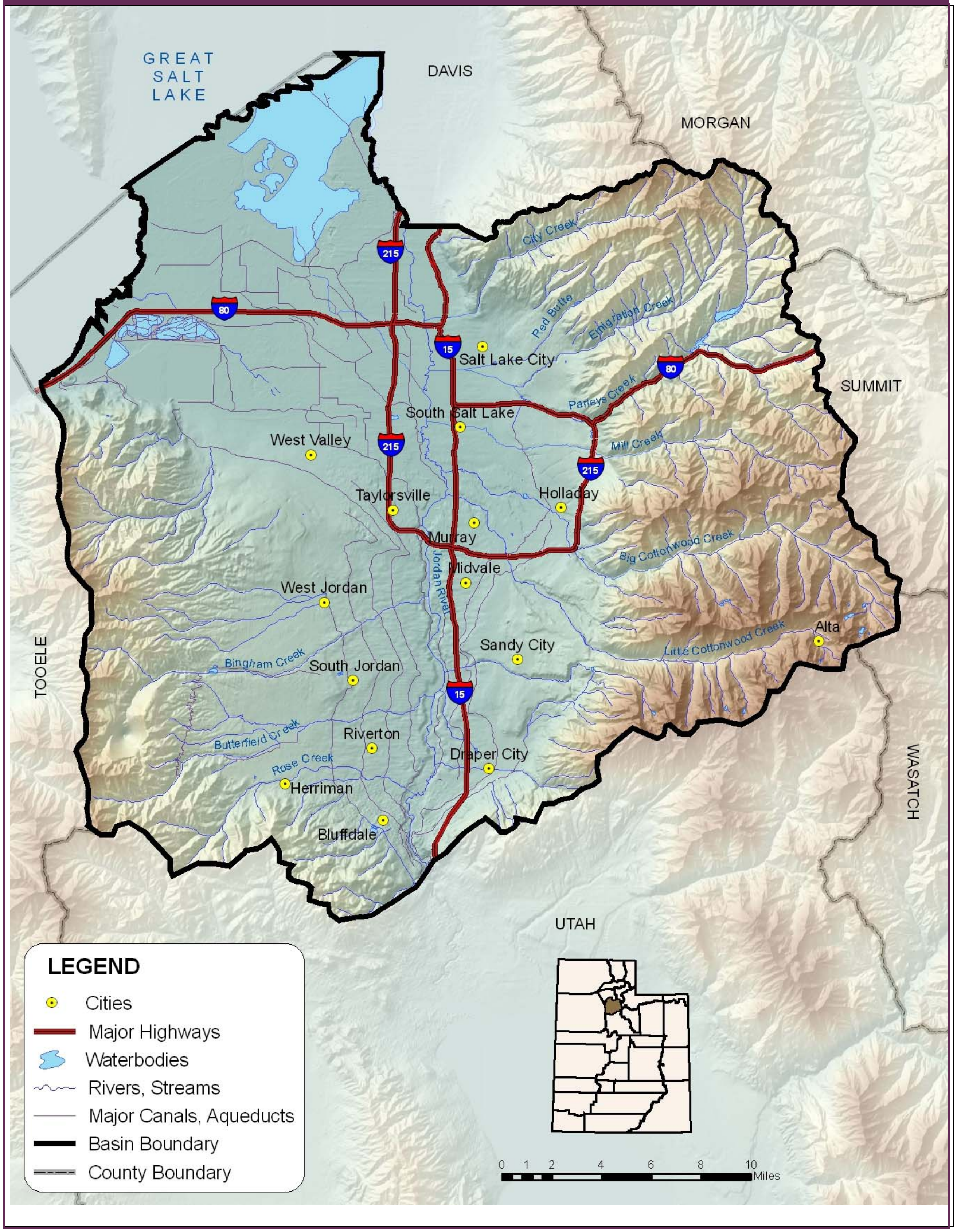
INTRODUCTION:
WATERS OF THE JORDAN RIVER BASIN

The Jordan River Basin is the State of Utah's most populous basin and comprises all but the northwest portion of Salt Lake County that lies in the Great Salt Lake. The Basin is bounded on the west by the Oquirrh Mountains, on the northeast and east by the Wasatch Range, and on the south by the Traverse Mountains (see Figure 1). The Basin receives runoff from these mountains and the entire Utah Lake Basin, which is tributary to the Jordan River. The Basin is one of Utah's wettest, receiving an average of 23 inches of precipitation annually. Despite being the State's most populous, as well as one of the State's wettest basins, the Jordan River Basin has only one significant reservoir (i.e., larger than 5,000 acre-feet) to capture and store runoff - Little Dell Reservoir (20,500 acre-feet), which was built in 1993. As a result, much of the Jordan River Basin's drinking water supply is imported from the upper basin (Utah Lake basin). But there is also water imported from the West Desert Basin, the Weber River Basin and as far away as the Uintah Basin (part of the Colorado River drainage).

The combination of relatively high precipitation, significant ground water withdrawals, and extensive importation has allowed the Jordan River Basin to support a large population and has enabled local water suppliers to satisfy the demands of growth. However, this does not imply that the basin is without problems or that continuing growth will come without challenges. Currently developed supplies are not sufficient to meet projected growth and not all streams and other water bodies in the Jordan River Basin meet Utah's water quality standards. Additionally, environmental needs and recreational demands are on the increase. This will

FIGURE 1
Jordan River Basin Map



bring greater competition for existing water supplies and ultimately require more emphasis on wise management and efficient use of all the Basin's water resources.

FUTURE VISION

In order to meet all the future water demands in the Jordan River Basin, cooperative efforts will be needed to more fully and efficiently use existing water supplies. State and local leaders must work closely with water suppliers in the Basin to continue to promote aggressive water conservation measures and additional innovative water management technologies. While this effort may delay the need for costly new water developments, these measures alone will not satisfy all future needs. The proposed Bear River Development Project will ultimately be needed. Exactly when this project will be constructed depends upon actual population growth as well as the ability of water conservation and other strategies to reduce water demand and the agreements within the basin to share resources.

In addition to securing adequate water for the future, water planners and managers need to continue to expand their efforts to effectively address water quality, the environment, and other values. Water agencies and institutions must fully integrate strategies and policies into their operations that address these issues. An important aspect of this endeavor will be to carefully coordinate Federal, State and local water resources efforts. Coordination will allow solutions to be tailored to local conditions and help maintain a constructive and open dialog among all water resources stakeholders.

Keys to assuring a productive future for the water resources of the Jordan River Basin include the following:

- Strong cooperation among all water resources stakeholders;
- Concerted effort to implement water conservation measures and practices;
- Careful application of innovative water management strategies such as water reuse, conjunctive management of surface and ground water, and cooperative agreements;
- Continued investment in infrastructure and carefully planned water developments;
- Continued investment in water quality programs; and
- Conscious effort to address environmental, recreational, and other needs.

PURPOSE OF THIS PLAN

The purpose of this document is to describe the current status of the water resources in the Jordan River Basin and estimate future demands that will be placed upon them. This involves quantifying the available water supply, quantifying current and future uses, identifying ways to manage and enhance existing supplies and developing new supplies to satisfy future needs. This document is intended to help water managers, planners, and others formulate the management strategies and policies that will secure a bright future for the Basin. In addition to presenting basic water data, this document should also be a valuable resource for those who live in the Basin or who are otherwise interested in contributing to water-related decisions.

DESCRIPTION OF BASIN

The total area drained by the Jordan River includes two of the eleven major basin planning areas as defined by the Utah Division of Water Resources - the Jordan River Basin and the Utah Lake Basin. The Jordan River Basin includes all of Salt Lake County above the shoreline of the Great Salt Lake (see Figure 1). The Utah Lake Basin consists of all lands draining to Utah Lake and to the Jordan River below Utah Lake to the Salt Lake County line. This includes most of Utah County and portions of Summit, Wasatch, Juab, Sanpete and Carbon counties. While the Jordan River and Utah Lake are hydrologically connected via the Jordan River, this report only addresses water issues specific to the Jordan River Basin.

Drainage Area and Topography

The Jordan River Basin includes all streams tributary to the Jordan River from the Salt Lake County line on the south all the way to its terminus on the north at the Great Salt Lake. In addition to these tributaries, the Jordan River receives runoff from all the streams and rivers that flow into Utah Lake.

From its outlet at Utah Lake to its terminus at the Great Salt Lake, the Jordan River is approximately 44 miles long. The Jordan River’s five largest in-basin tributaries all emanate from the Wasatch Mountains on the east side of the valley and include, in order of magnitude: Big Cottonwood Creek, Little Cottonwood Creek, Parleys Creek, Mill Creek, City Creek, and Red Butte.[1] These five streams furnish about 80 percent of the annual surface water flows that originate from within the Basin, and, when added to the other smaller streams on the east side, combine to make up 97 percent of the total tributary stream flow originating in the basin. The other three percent originates from several ephemeral streams emanating from the Oquirrh Mountains on the west side of the Salt Lake Valley.

Salt Lake County has a total area of about 805 square miles (515,200 acres). Approximately 370 square miles (about 46% of the basin) is in the extremely mountainous and heavily forested Wasatch Range, Oquirrh Mountains, and Traverse Mountains. With the exceptions of Emigration, Big Cottonwood, and Little Cottonwood canyons, the mountainous areas are almost entirely uninhabited. Although there is very little residential or agricultural land-use in the mountains, there are significant mining interests (particularly in the Oquirrh Mountains) along with large amount of recreational activity.[2]

Physiography and Geology[3]

The Jordan River Basin forms part of the eastern edge of the Basin and Range Physiographic Province bounded on the east by the Wasatch Range of the Middle Rocky Mountains. The huge fault block mountains surrounding Salt Lake Valley stand as evidence of massive earth shifts in the past. The Wasatch Fault is a constant reminder of this seismic activity. In times of greater precipitation and glacial activity, ancient Lake Bonneville covered over 20,000 square miles of north-central Utah, including the entire Salt Lake Valley, with a water level approximately 1,000 feet above the present elevation of the Great Salt Lake. As Bonneville Lake receded, it left multiple lake terraces on the lower slopes of the mountains. As a result, large deposits of sand and gravel exist on these terraces and at the mouths of canyons, while fine-grained sediments dominate the soils on the valley floor.

The Basin’s eastern edge is bounded by the Wasatch Range which rises abruptly from the Salt Lake Valley (elevation 4200) to an elevation over 11,000 feet above sea level. The Wasatch Mountains intercept the moisture-bearing westerly snow storms, providing the bulk of the valley's vital in-basin water supply. The Traverse Mountains form the Basin's southern barrier. The western edge of the Basin is formed by the Oquirrh Mountains, whose peaks rise to 9,000-10,000 feet. To the northwest lies the Great Salt Lake, and beyond that the Great Salt Lake Desert.

Soils and Vegetation[4]

The soils below elevation 5,200 feet (the highest level of ancient Lake Bonneville) have developed from alluvial sediments on flood plains, alluvial fans, and foot slope areas at the base of the mountains. Quartzite and sandstones are the predominant parent material for the alluvium and consist mainly of coarse sands and gravels, although there are areas of medium-to-fine textured topsoils. Much of the soil near the edges of the valley is medium-to-coarse textured material, deposited at the mouth of canyons as alluvial fans. The lake terraces and finer materials are widely distributed on the broader interior valley floor and were deposited during both Bonneville and post-Bonneville times. As a result, a complex pattern of highly stratified soils exists. In general, arable lands of the basin have good water transmission properties and adequate moisture-bearing capacity which, with other favorable physical and chemical properties, make them well-suited for irrigated agriculture.

The Basin’s vegetation varies markedly with elevation due to significant differences in temperature and precipitation. At the bottom of the Salt Lake Valley (elevation 4,200 feet), annual precipitation averages about 12 inches. At the top of the mountain peaks (above 11,000 feet), precipitation is greater than 60 inches, most of which falls during the winter months in the form of snow. Heavy alpine forests above about 8,000 feet give way to oaks, mountain brush, and juniper trees, then to sagebrush, sparse grasses, scattered vegetation and semi-desert conditions at lower elevations. About 30 percent of the basin is forested with either alpine, conifer, aspen, or oaks while 27 percent of the Basin is vegetated with the closely related categories of mountain-brush, juniper, sagebrush, greasewood, or native vegetation types. An additional 9 percent of the basin is classified as open water, riparian, marsh-land, or wetlands. The remainder of the Basin (34 percent) is classified as urban, residential, or agricultural.

SIGNIFICANCE OF WATER RESOURCES TO THE BASIN

Water is a central feature of the Jordan River Basin's landscape. Water originating in snowfields and lakes high in the Wasatch and Oquirrh mountains form the Jordan River's tributaries, and along with ancient glaciers have carved out the Basin's many beautiful canyons. The Jordan River itself forms a central artery through the middle of the valley on its way north from Utah Lake to the Great Salt Lake. Native inhabitants of the Jordan River Basin depended upon water resources and associated habitat and wildlife to sustain their way of life. While they often spent the hot summers outside the Basin in higher-elevation valleys, they often visited the basin's low-lying areas during the winter months. Later, with the arrival of the early pioneers, the waters of the basin were increasingly utilized.

In 1847, the Mormon pioneers arrived in the Salt Lake Valley and soon several settlements sprang up near the high quality water of the mountain streams. From the day of the pioneers first arrival, Salt Lake City and the surrounding area has been the center of Utah's population and economic activity. In addition to Salt Lake City, which is the largest city in the state, the Jordan River Basin is now home to three of the next four largest cities in the state: West Valley (2), Sandy (4) and West Jordan (5); as well as the state's fastest growing city (Herriman).[5]

In addition to the strong commercial and economic forces within the Basin, the close proximity of the population to the diverse outdoor activities in the nearby mountains and surrounding areas has contributed to the Basin's rapid growth. For these and other reasons, the Basin is expected to experience substantial population growth into the future, nearly doubling the population by 2050. While the water resources of the basin will play an important role in facilitating this growth, additional water supplies from other basins will eventually be needed to sustain the projected population.

BRIEF HISTORY OF WATER USE AND DEVELOPMENT

The history of water use and development in the Jordan River Basin goes back to the very first days of pioneer settlement and has continued virtually unabated since that time. During that time, the nature of water use in the Basin has shifted from one dominated by agricultural irrigation to one primarily for municipal and industrial purposes. While the sequence of events in the Basin's water development history are numerous and quite fascinating, only a brief summary is given here.

The Pioneer Period (1847-1880)

The first wagon train of Mormon Pioneers arrived in Salt Lake Valley on July 24, 1847. An advanced company of men arrived two days earlier to prepare land for planting crops. On the first evening after the advanced company's arrival, plans were made to plow, plant and irrigate a field of potatoes. The next day, water was diverted from City Creek and conveyed in ditches to irrigate the chosen plot of land near where the Salt Lake City and County Building now stands.[6] Numerous other fields were soon planted, and by the spring of 1848, over 5,000 acres had been brought under irrigation. By 1850, farming communities had been established on Big Cottonwood Creek, Mill Creek, Little Cottonwood Creek, Parley's Creek, Emigration Creek and along the Jordan River. During this period, many ditches and canals were constructed to divert water from streams entering the valley from the east and from the Jordan River.[7] Some of these are still in use today, such as the North Jordan Canal, the Jacob/Welby Canal, and the Utah Lake Distribution Canal.

By 1860, practically all of the waters of the mountain streams had been appropriated for agricultural uses by families dependent upon farming for their livelihood. At that time, the residents of Salt Lake City were almost entirely dependent upon City Creek and quickly recognized the need for additional water resources.

As early as 1864, Salt Lake City officials began looking into "boring artesian wells" and bringing water from the Jordan River to the city.[8]

The Growth and Expansions of Salt Lake City (1881-1929)

While there were many communities established in the Jordan River Basin during the pioneer period, the history of water development in the basin over the subsequent decades revolves largely around the municipal, industrial, and domestic needs of Salt Lake City. Although originally the nucleus of a largely agrarian society, with large lots intended to grow shade trees and vegetable gardens, the city quickly grew and became the economic, political, and cultural center of the Utah Territory and later the State of Utah. As a result, the water needs of Salt Lake City were constantly the focus of attention of local leaders.

In 1882, construction on the Jordan and Salt Lake City Canal was completed and it delivered Jordan River water to Salt Lake City.[9] While this water was adequate for irrigation of crops, it was not suitable for domestic use. However, the completion of this canal made it possible for city leaders to negotiate the State's first water exchange agreement in 1888. Per this agreement, Jordan River water was provided to local farmers in exchange for the higher-quality water they used from Emigration Canyon and Parley's Creek.[10] In addition to being suitable for domestic purposes, water from the Wasatch Mountain streams had another advantage over the Jordan River for residents of Salt Lake City -- it could be delivered by gravity to the areas being developed at the foot of the mountains and along the benches formed by Lake Bonneville. This advantage was clearly recognized and played a role in the development of Utah Lake into a storage reservoir in 1892, which made more water in the Jordan River available for exchange with water from local mountain streams. Subsequently, several new canals were constructed and Salt Lake City negotiated additional agreements with local irrigation companies to exchange this new irrigation water for water in Big Cottonwood and Little Cottonwood creeks to supply the city with needed water for domestic purposes.[11]

Despite all of these developments, the high-quality water supply available from local streams was insufficient to meet growth in Salt Lake City and was unreliable during periods of drought. From 1900 to 1920, the population of Salt Lake City more than doubled from approximately 53,500 to 118,000.[12] In an attempt to shore up the water supplies available to the city, several small reservoirs within the basin were constructed. In 1915 and 1916, two reservoirs were built near the headwaters of Big Cottonwood Creek—Twin Lakes Reservoir (934 acre-feet) and Phoebe-Lake Mary Reservoir (742 acre-feet), respectively. In 1917, Mountain Dell Reservoir, with a capacity of 955 acre-feet, was constructed up Parleys Canyon, and in 1925 the reservoir was enlarged with a concrete arch dam to a capacity of 3,514 acre-feet.[13]

In 1928, the mayor of Salt Lake City appointed a Water Supply Advisory Board to investigate future water supply options for the City. The Board investigated numerous local and non-local water sources, including:[14]

- More complete utilization of existing exchanges;
- Additional reservoir storage in Parleys, Big Cottonwood, and Little Cottonwood creeks, as well as other tributary streams;
- Water importation from the Weber River, Duchesne River, and Upper Green River watersheds; and,
- Water storage from a new reservoir on the Provo River.

The advisory board recommended that a combination of both local and non-local sources be pursued immediately. The local source recommended for development was the Argenta Dam and reservoir on Big Cottonwood Creek. The non-local source recommended for development was a combination of water to be imported from the Weber, Duchesne, and Provo River systems via tunnels and aqueducts.[15]

In order to finance Argenta Dam, approval from the taxpayers of a special bond issue was required. However, once this proposal was brought before the public, an acrimonious controversy ensued and it was voted down.[16] Although more ambitious and costly, the prospects for the non-local source recommended by the advisory board proved much brighter. With money available from the federal government through the U.S. Bureau of Reclamation (BOR), local sponsors of this project were able to convince local taxpayers that it was worth their investment.

Federal Projects and Local Water Districts (1930-Present)

Federal Projects

For many years BOR, in cooperation with the State of Utah, had been involved in the planning and development of water supplies for various sponsors throughout the State. In 1931, BOR presented the first complete report on the Provo River Project, whose concept was similar to the one proposed by Salt Lake City's Water Supply Advisory Board and would also benefit other water users in the Utah Lake and Jordan River basins.[17] Construction of the Provo River Project began in 1938 and the first water became available in 1941. Major features of the project included Deer Creek Dam and Reservoir (152,600 acre-feet); the Duchesne Tunnel (which diverts water from the Colorado River drainage into the Provo River drainage); enlargement of the Weber-Provo Canal; enlargement of the Provo Reservoir Canal; and the 42-mile Salt Lake Aqueduct (completed in 1951). This aqueduct delivers water from Deer Creek Reservoir near Heber all the way to Salt Lake City.[18]

Not long after the completion of the Provo River Project, BOR began planning an even larger importation project. This project, known as the Central Utah Project (CUP), also enjoyed strong state and local support. Construction of the Bonneville Unit of the CUP, which would provide water to the Wasatch Front, began in 1967 and initial delivery of water to Salt Lake County began in 1990. Major features of the project that have been completed to date include: Jordanelle Reservoir (capacity 320,000 acre-feet), Jordan Aqueduct, Starvation and Strawberry collections systems, and the Diamond Fork Tunnel and Pipeline. The CUP project currently provides a water supply of 84,000 acre-feet per year in times of drought and an average annual 70,000 acre-feet per year of municipal and industrial water to the Jordan River Basin.[19] An additional 30,000 acre-feet per year of water will be made available to the Jordan River Basin by 2020 when the last component of the Bonneville Unit of the CUP, the Utah Lake System, is completed.

Another federally funded project built to benefit the residents of the Jordan River Basin was Little Dell Reservoir, constructed by the U.S. Army Corps of Engineers in 1993. Little Dell Reservoir is the only large (i.e. over 5,000 acre-feet) storage reservoir physically located within the Jordan River Basin. It has a capacity of 20,500 acre-feet and provides both flood control and municipal water supply.

Local Water Districts

The Metropolitan Water District of Salt Lake City was formed in 1935 by the State Legislature as a "separate and independent" public agency. The District was formed to provide an independent agency to oversee the water supply needs of the city as well as to satisfy BOR requirements that federal projects have local sponsorship. It is the primary wholesaler of water to Salt Lake City, which has a statutory preferential right to purchase most of the District's water for use within the city. The District participated in the Provo River Project and holds shares of stock in the Provo River Water Users Association, which entitles the District to receive 61,700 acre-feet of water annually from Deer Creek Reservoir. In 1990, Sandy City formally applied for annexation into the Metropolitan Water District of Salt Lake City, renamed the Metropolitan Water District of Salt Lake City and Sandy (MWDSLS). MWDSLS's Board of Directors approved this request and increased the Board membership from five to seven members, adding two new members to represent Sandy City.[20] MWDSLS has petitioned for 20,000 acre feet of CUP Bonneville Unit Municipal and Industrial water and 8600 acre feet of CUP Bonneville Unit Utah Lake System water. Other supplies are provided by Little Dell Reservoir, the Ontario Drain Tunnel, and Little Cottonwood Creek (via Salt Lake City and Sandy City interests).

The Salt Lake County Water Conservancy District was organized in 1951 to supply water to other developing areas of the county. Water was first delivered in 1954. The District changed its name to the Jordan Valley Water Conservancy District in 1998 and is now the second largest wholesale water provider in the Basin next to MWDSLS. The District's water sources include direct flow rights in local Wasatch mountain streams as well as water supplies developed by the Provo River and Central Utah projects in the Provo and Weber rivers, ground water, and storage in Deer Creek, Jordanelle and Echo reservoirs.[21]

The Impacts of Settlement, Industry and Water Development on the Jordan River Ecosystem

Before settlement of the Salt Lake Valley, the Jordan River meandered from its entry into Salt Lake Valley at the Jordan Narrows across a broad floodplain to the Great Salt Lake. Periodic flood flows would inundate the floodplain, supporting a wide variety of vegetation and wildlife. A forest of cottonwood trees traced its path along the valley floor. Numerous oxbows, marsh areas, and riparian zones provided home to a diverse community of wildlife. The Jordan River is reported to have been an excellent fishery in the early years following the first settlement of the valley. Since that time, the forest has been cut, the river channeled, the water polluted, many oxbows and wetlands filled, flood flows captured in upstream reservoirs, and much of the wildlife displaced. A considerable amount of pollution resulted from mining operations in both the Wasatch Front canyons and the Oquirrh Mountains. These mining activities first affected Jordan River water quality before 1900 but were at a peak from the early to middle part of the last century. While some short sections of the Jordan River may have been straightened or channelized at an earlier date, the bulk of the Jordan River channelization occurred during the 1950's and 1960's under the now-challenged concept that a channelized river is the best method for handling flood flows.[22]

STATE WATER PLANNING: FULFILLING A STEWARDSHIP

One of the principal responsibilities of the Division of Water Resources is to conduct comprehensive water planning in Utah. Over the past several decades, the Division has conducted numerous studies and prepared many reports for the Jordan River Basin. The *Jordan River Basin Plan*, published in 1997, resulted from these studies and reports.

1997 Jordan River Basin Plan

Although this document, *Jordan River Basin—Planning for the Future*, touches upon many of the same topics presented in the 1997 *Jordan River Basin Plan*, there is a valuable collection of pertinent data and useful information contained in the original plan that will not be revisited here. Some of the topics that will not be repeated, but may be valuable to the reader, are listed below:

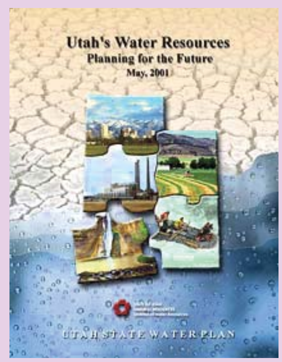
- *Section 7 – Regulation/Institutional Considerations:* A discussion of water-related laws and regulations and the responsibilities of various State and federal agencies with regard to carrying-out these laws.
- *Section 8 – Water Funding Programs*: A description of significant State and federal water funding programs.
- *Section 11.3 – Organizations and Regulations:* A discussion of local, State, and federal agencies as well as the various laws that regulate drinking water.
- *Section 13 – Disaster and Emergency Response:* A description of the various types of disasters and emergencies that could disrupt the supply of water and information on the the organizations and regulations that deal with them.
- *Section 16 – Federal Water Planning and Development:* A list of all the federal agencies involved directly or indirectly with water planning and development within the Basin and description of their respective responsibilities.

A copy of the entire 1997 *Jordan River Basin Plan* can be obtained at the Department of Natural Resources Bookstore, by contacting the Division of Water Resources, or online at the division's web site: **www.water.utah.gov**.

2001 Utah State Water Plan:
Utah's Water Resources—
Planning for the Future

Managing water resources in Utah is not an easy task. Supply is limited and competition between various uses continues to intensify. Add to that the unpredictable nature of wet vs. dry periods, and one gets an inkling of the complex challenges facing Utah's water planners and managers.

Utah's Water Resources - Planning for the Future attempts to bring the issues to light and to put together the pieces that are required to obtain balanced and efficient water management. It discusses the major issues facing Utah's water resources and provides valuable data and guidance that will help in the important effort to efficiently manage one of the state's most precious resources.



The 2001 Utah State Water Plan

In May of 2001, the Division of Water Resources updated the Utah State Water Plan with the publication of *Utah's Water Resources - Planning for the Future*. This plan addressed a host of issues important to Utah's future (see sidebar). The Utah State Water Plan is a valuable guide to water planners, managers and others interested in contributing to water-related decisions throughout the state. The specific needs of the state's various river basins are discussed in individual basin plans for each of the respective basins.

The Current Plan

This document, *Jordan River Basin - Planning for the Future,* is modeled in large part after the 2001 State Water Plan and provides the reader with more detail and perspective concerning issues of importance to the Jordan River Basin. It takes a look at the water resources of the basin. With increasing water demands water is becoming a more precious resource. The waters of the Basin will play an important role in meeting some of Utah's most critical future needs, and protecting the quality of this water and its ability to sustain the increased population is of concern. This basin plan has been developed to establish a framework that will help guide and influence water-related decisions within the Basin.

NOTES

[1] Utah Division of Water Resources, *Utah State Water Plan: Jordan River Basin Plan,* (Salt Lake City: Dept. of Natural Resources, 1997), page 5-6.

[2] Ibid. pp 3-6.

[3] Ibid.

[4] Ibid. pp 3-7 & 3-8.

[5] Utah State Data Center, *Utah Data Guide: A Newsletter for Data Users,* Summer/Fall 2005 (Salt Lake City: Governor's Office of Planning and Budget, 2005), 1.

[6] Young, Levi Edgar, *The Founding of Utah,* (New York: Charles Scribner's Sons, 1924).

[7] Harris, Fisher Sanford, *100 Years of Water Development*, (Salt Lake City: Metropolitan Water District of Salt Lake City, 1942), 1.

[8] Ibid. p 2

[9] Ibid. p 3

[10] Ibid.

[11] Ibid. pp 16-19.

[12] Ibid.

[13] Ibid. p 12

[14] Ibid. 21-24.

[15] Ibid. p 24

[16] Ibid. p 26

[17] Ibid. p 39

[18] Utah Division of Water Resources, 1997, page 3-11.

[19] Ibid.

[20] Ibid. pp 3-12.

[21] Ibid.

[22] Ibid.

2

WATER SUPPLY

This chapter provides an overview of the water supply in the Jordan River Basin. It begins with a discussion of climate and precipitation. Surface and ground water supplies are then discussed, followed by a water budget for the Basin and a section on developed water supplies. The chapter's final section is on water rights since it plays a key role in water supply and development.

CLIMATOLOGICAL INFLUENCES

The Jordan River Basin climate is typical of mountainous areas in the west, with wide ranges in temperature between summer and winter, and between day and night. The high mountain regions experience long, cold winters and short, cool summers. The lower valleys are more moderate with less variance between maximum and minimum temperatures. As part of the Great Basin Region lowlands, the Jordan River Basin is classified as semi-arid.

The Jordan River Basin experiences four distinct seasons with a major portion of the precipitation occurring as snow in the mountain regions during the winter months and producing high runoff during the spring snowmelt periods. The Jordan River Basin receives an average of 23 inches of precipitation annually. This precipitation is distributed as shown in Figure 2 and ranges from a low of about 12 inches near the central portion of the valley to over 60 inches in the upper parts of Big and Little Cottonwood Canyons.

FIGURE 2
Average Annual Precipitation

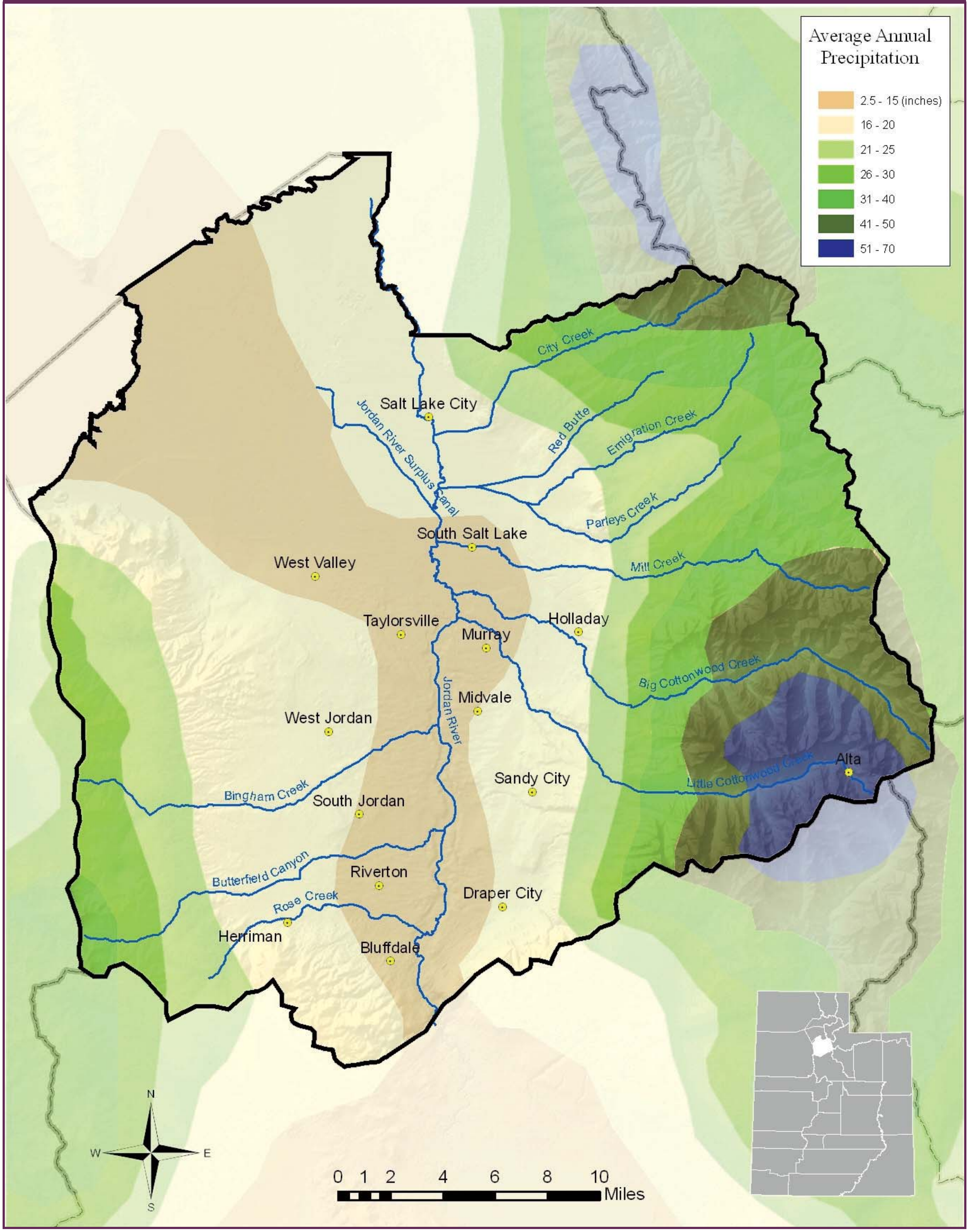


TABLE 1
Climatological Data

Weather Station	Temperature (Average Max. Min. and Mean in °F)								Precipitation		Avg. Ann EV[1] (in.)	Frost Free Days
	January			July			Record		Snow (in.)	Avg. Ann. (in.)		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.				
Alta	30	13	22	69	46	58	86	-26	501.2	54.9	27.4	89
Bingham	35	20	28	83	61	72	102	-17	97.1	21.5	35.5	153
Cottonwood	40	22	31	92	66	79	108	-15	88	25	42.3	171
Draper	42	23	30	95	62	78	111	-17	33.2	16.4	46.4	174
Lower Mill Creek	38	19	28	87	60	74	97	-5	96	20.4	41.3	174
Magna	40	20	30	91	61	76	101	-15	29.4	11.9	44.9	152
Midvale	39	19	29	92	59	75	105	-18	44.4	14.4	44.6	140
Mountain Dell	38	14	26	88	52	70	102	-30	101.2	23.9	42.6	116
Riverton	38	17	28	92	59	75	99	-3	24.1	13.2	44.8	124
Saltair	35	18	27	90	64	77	105	-17	22.9	13.1	39.7	172
Salt Lake Airport	38	21	30	93	63	78	107	-22	61.9	16	42.6	167
Silver Lake	31	9	20	72	44	58	87	-34	410.5	43.1	30.2	60
University of Utah	38	23	31	91	65	78	102	-15	62.6	18.8	42.9	177

1) Average Annual Surface Water Evaporation
Source: Utah Climatological Data

Normal annual precipitation ranges from 12 to 16 inches on the valley floor to 60 inches in the high mountain areas of the Wasatch Range. Precipitation in the lower elevations during the May-September growing season is only 5 to 6 inches, compared to a crop water requirement of 20 to 30 inches. A portion of the precipitation on both mountain ranges is absorbed into the soil and underlying bedrock during the runoff periods, providing recharge to the valley ground water reservoir.

Table 1 contains climatological data for the weather stations within the basin. Mean temperatures for January range from 20°F at the Silver Lake station to 31°F at the University Station. Average minimum temperatures for January range from 9°F at the Silver Lake Station to 23°F at the University of Utah Station, with average maximum temperatures ranging from 30°F at Alta to 40°F at the Magna Station. July's mean temperature ranges from 58°F at the Silver Lake station to 79°F the Cottonwood Station. Average minimum temperatures for July ranged from 44°F at Silver Lake to 66°F at the Cottonwood Station, while average maximum temperatures varied from 69°F at Alta to 95°F at the Draper station. The record minimum temperature recorded in the basin was a -34°F recorded at Silver Lake station at Brighton Ski resort. The record maximum temperature for the basin was a 108°F recorded at both the Cottonwood station and the Lower Mill Creek Station.

In the valley portion of the basin water surface evaporations range from 37.2 inches per year in Bingham to 48.1 inches per year in Draper. The average frost-free season for the valley area varies widely between 108 days in Draper to 174 days at the University of Utah Station.

AVAILABLE WATER SUPPLY

The Jordan River Basin's present water supplies come from three sources: ground water, local surface water and imported surface water. Local surface water sources include the Jordan River, Wasatch Range mountain streams and Oquirrh Mountain streams. Imported water as shown in Table 2 is delivered by Provo river Project deliveries from Deer Creek Reservoir, Central Utah Project (Bonneville Unit) deliveries from Jordanelle Reservoir, and additional water from the Provo, and Weber Rivers and Echo Reservoir. Also included is 10,000 acre-feet/year, imported from Tooele County by Kennecott Corporation for industrial use. An estimate of the total surface water supply for the Jordan River Basin is presented in Table 2.

The average annual flow of the Jordan River at the Jordan Narrows, including all diversions to canals, is 295,000 acre-feet. This is from the USGS Jordan River gaging station at the Jordan Narrows which has a period of record from 1914 through 1989.[1] Additional surface water inflow between Jordan Narrows and the Great Salt Lake

TABLE 2
Total Water Supply

Source	Average Annual Supply (acre-feet)
Jordan River (at the Narrows)	295,000[1]
Wasatch Mountain Streams	173,500[2]
Oquirrh Mountain Streams	4,500[2]
Ground Water	165,000[3]
Imported Water	171,000[4]
Total	**809,000**

1) Stream gage #1016700 Period of record 1914-1989
2) Salt Lake County Area-wide Water Study, 1982
3) Allowable withdrawals - State Engineer's ground water management plan.
4) Includes Salt Lake Aqueduct, Jordan Aqueduct, Welby-Jacob Exchange, and self-supplied industrial water for Kennecott from Tooele County.

TABLE 3
Streamflow Gaging Stations

Number	Description	Years of Record	Average Annual Flow (acre-feet)
Gaging Stations on the main stem of the Jordan River			
10167000	Jordan River at Narrows	1914-1989	295,000
10170500	Jordan River Surplus Canal	1942-present	268,800
10171000	Jordan River (below surplus canal)	1942-present	105,500
10170490	Jordan River + Surplus Canal	1942-present	374,300
Gaging Stations on Tributary Streams			
10167499	Little Cottonwood Creek	1981-1991	22,730
10167500	Little Cottonwood Creek (near Salt Lake City)	1964-1968,1980	35,910
10168000	Little Cottonwood creek (at Jordan Park)	1980-1991	39,870
10168300	Big Cottonwood Creek (Tailrace at Stairs Plant)	1925-present	40,430
10168500	Big Cottonwood Creek (near Salt Lake City)	1931-1990	44,380
10170000	Mill Creek	1964-1968,1980	9,190
10172000	Emigration Creek	1964-1968,1980	6,110
10172200	Red Butte Creek (Above Red Butte Reservoir)	1963-present	3,110
10172200	Red Butte Creek (Below Red Butte Reservoir)	1980-1991	2,100
10172500	City Creek (near Salt Lake City)	1964-1968,1980	10,370

average 173,500 acre-feet from the Wasatch Mountain streams, and 4,500 acre-feet from Oquirrh Mountain streams. This is from the Salt Lake County area-wide water study conducted in 1982.

Surface Water

The portion of precipitation not initially evaporated or transpired by vegetation, eventually makes its way into streams and other surface water-bodies, or percolates into the ground. Surface water can be quantified at gaging stations on streams segments. The U.S. Geological Survey, in cooperation with other federal and state entities, monitors an extensive network of gaging stations throughout Utah. Table 3 shows the average annual flow for selected gaged streams and rivers in the Jordan River Basin.

Figure 3 shows the average annual streamflow and depletions of the Jordan River as well as tributary inflows, diversions, and ground water inflows based upon 1941-90 data. The band widths represent the flows of the

FIGURE 3
Average Annual Stream Flow

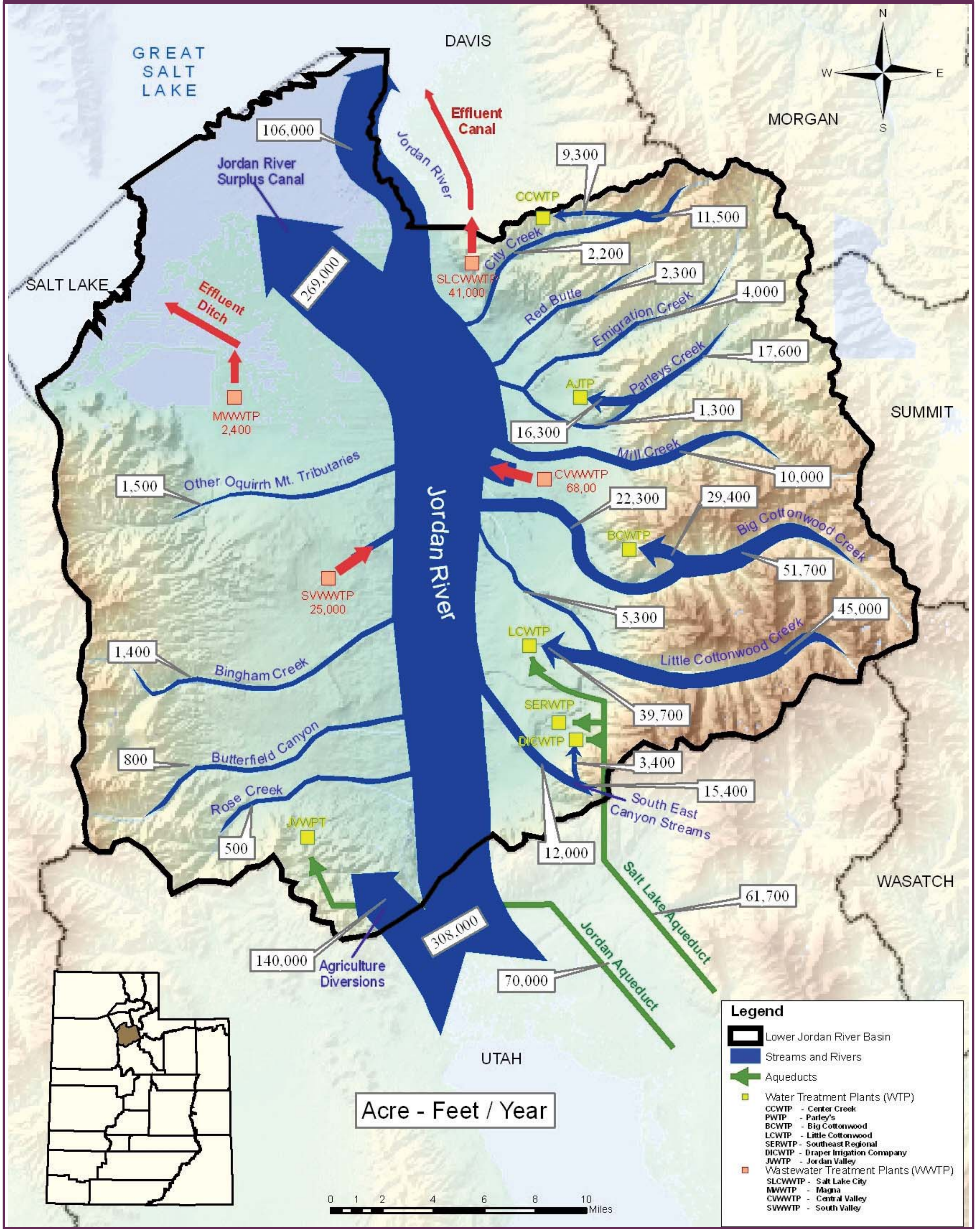


TABLE 4
Mountain Streams - Annual Flow

Canyon Stream	Flow Reliability	
	Average	90%
Wasatch Mountain Streams		
City	11,750	7,730
Red Butte	2,450	1,330
Emigration	4,440	1,290
Parley's	18,130	9,090
Mill	10,760	7,020
Neffs	4,280	2,500
Tolcats	650	470
Heughs	1,770	1,260
Big Cottonwood	51,240	36,300
Ferguson	1,450	1,030
Deaf Smith	4,520	3,230
Little Cottonwood	46,190	32,950
Bells	6,280	4,480
Middle Fork Dry	700	500
South Fork Dry	1,360	970
Rocky Mouth	910	650
Big Willow	2,080	1,490
Little Willow	1,660	1,190
Bear	1,260	900
Corner	1,520	1,170
Sub Total	**173,500**	**115,550**
Oquirrh Mountain Streams		
Rose	540	290
Butterfield	810	430
Bingham	1,530	800
Barney's	330	180
Harkers	460	240
Coon	790	420
Sub Total	**4,500**	**2,360**
Total	**178,000**	**117,910**

Scoure: Salt Lake County Area-Wide Water Study, April, 1982

Jordan River and its tributaries and are proportional to the average annual flow in acre-feet. Main stem gaging stations are indicated by rectangles, while diversions from the Jordan River and from tributaries are represented by arrowheads. Irrigation withdrawals and culinary diversions for water treatment are shown. Despite irrigation and culinary withdrawals, the Wasatch Range streams are all shown as terminating at the Jordan River. Oquirrh Mountain streams are also shown as terminating at the Jordan River, although because of the intermittent and ephemeral nature of these streams for much of the year, their surface water flows often do not reach the Jordan River.

Collectively, the average annual streamflow from the Wasatch Mountain Range is 173,500 acre-feet. The 90% reliable flow is 115,550 acre-feet. In other words, the flow from the Wasatch Mountain streams will exceed 115,550 acre-feet in 9 out of 10 years. The total amount of water flowing from the Oquirrh Mountain streams is considerably less than the total flow from Wasatch Mountain streams, at a mere 4,500 acre-feet on an average annual basis. The "9 out of 10 year" reliable flow from the Oquirrh Mountain streams is only 2,360 acre-feet.

TABLE 5
Summary of Ground Water Recharge

Source	Annual Mean
Natural Recharge	
Seepage from mountain bedrock	135,000
Seepage from precipitation onto the valley floor	60,000
Underflow through the Jordan Narrows	2,500
Seepage from creek channels	20,000
Underflow in channel fill of mountain streams	1,500
Subtotal	**219,000**
Managed or man-created recharge	
Seepage from major canals	48,000
Seepage from irrigation fields	81,000
Seepage from lawns and gardens	17,000
Seepage from tailing ponds	2,000
Subtotal	**148,000**
Total	**367,000**

Source: Technical Publication 31: Water Resources of Salt Lake County, State of Utah, Department of Natural Resources; 1971

Ground Water

Ground water is an important source of M&I water in the Jordan River Basin. The total ground water recharge to the Salt Lake Valley as identified by the Department of Natural Resources Technical Publication 31, published in 1971 was 367,000 acre-feet/year.[1] That figure, however, included a considerable amount of non-natural or human-induced recharge from irrigation activities and over-irrigation of lawns and gardens. Table 5 shows the estimated recharge figures from that report, divided into natural recharge and managed or human-induced recharge. As can be seen from the table, the natural annual recharge is 219,000 acre-feet/year. At the time of publication of Tech Pub 31, the human-induced recharge was 148,000 acre-feet, primarily coming from seepage from irrigation fields, canals, and the over-watering of lawns and gardens. It should be noted that most of the human-induced recharge occurs in the shallow aquifer, not the deeper principal aquifer, which is the drinking water source. Since 1971, irrigated agriculture in the Basin has been dramatically reduced. Although water is still conveyed through the canals and undoubtedly seepage from canals remains high, the seepage from irrigated fields has been significantly reduced. Furthermore, water conservation efforts over the past 10 years have in all likelihood reduced seepage from lawns and gardens. This will likely continue to decline as home owners and landscapers become more efficient with their application of irrigation water.

The main source of natural recharge water for the Salt Lake Valley's principal aquifer is the Wasatch Range to the east, the Oquirrh Mountains to the west and the Traverse Mountains to the south. This recharge to the

Salt Lake aquifer resulting from seepage from mountain bedrock accounts for 135,000 acre-feet or more than 60 percent of the ground water Basin's recharge. Lateral ground water movement is from the mountains towards the center of the valley then northerly to the Great Salt Lake.

The Salt Lake Valley ground water basin consists of a principal aquifer of deep, unconsolidated sediments, confined by a relatively thin layer of impervious material, which in turn is overlaid by a shallow unconfined aquifer. Figure 4 shows a cross-sectional view of the Salt Lake Valley ground water regime. The confining layer of impervious soil between the shallow unconfined water and the principle aquifer is not continuous, but more closely resembles a series of interlaced clay lenses, and does not extend to the edges of the valley fill. Thus, near the mountain fronts, the principle aquifer is unconfined.

FIGURE 4
Ground Water Cross-Sectional Schematic

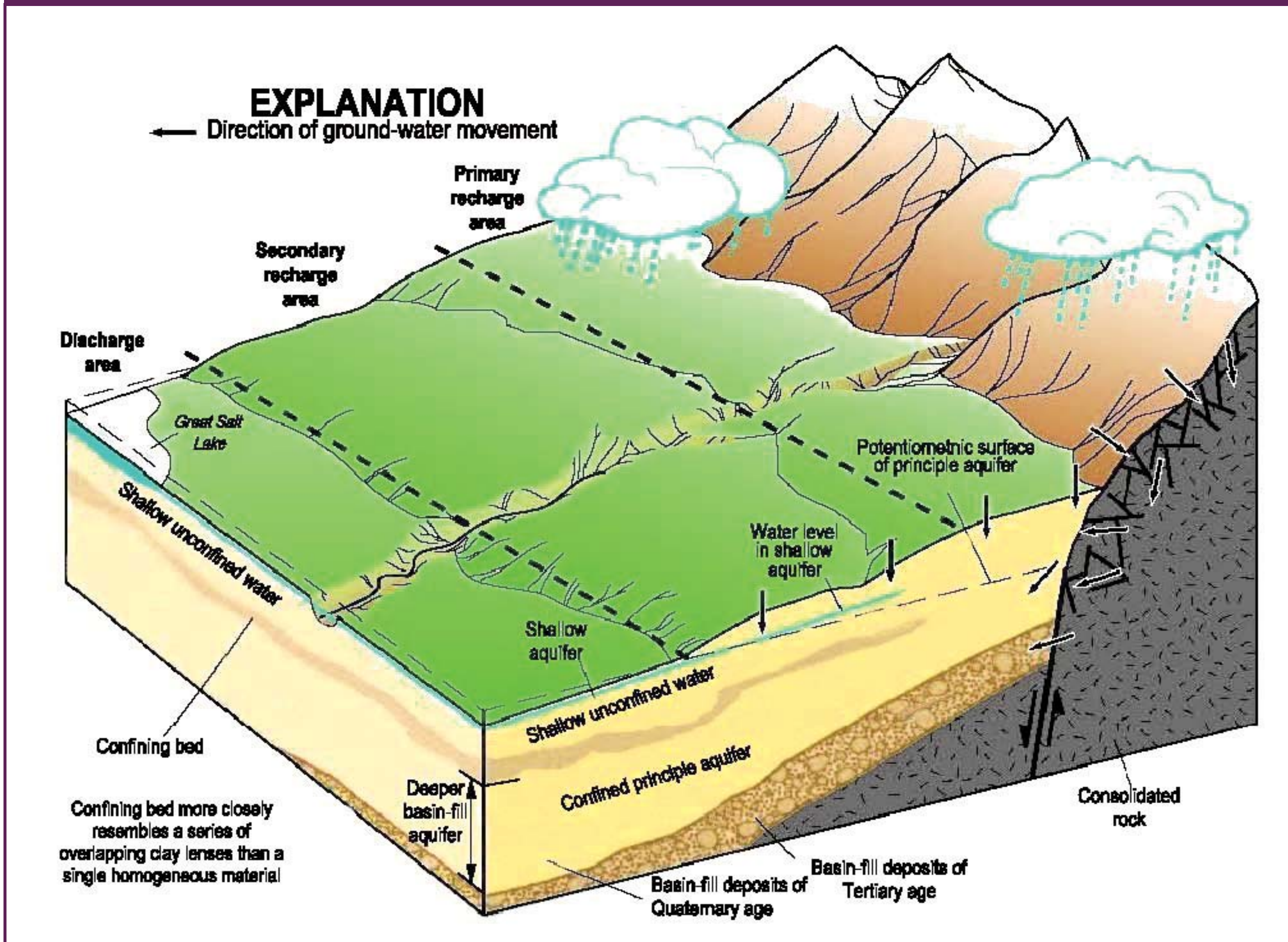


TABLE 6
Regional Safe Yields

Region	Safe Yield (acre-feet/year)
Western	25,000
Eastern	90,000
Central	20,000
Northern	30,000
Total	**165,000**

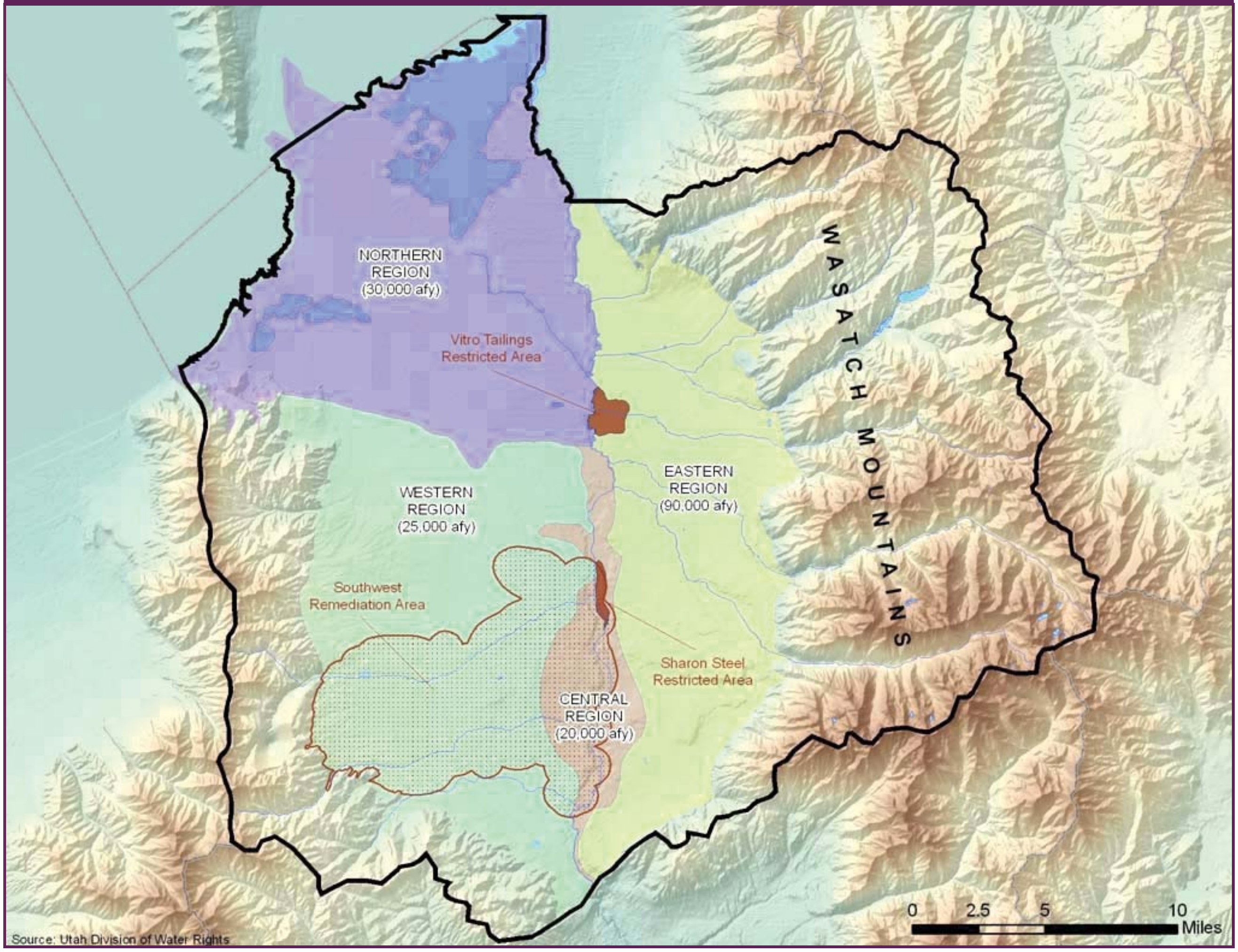
Source: Salt Lake Valley Ground Water Management Plan, June 25, 2002

The shallow unconfined aquifer is susceptible to contamination from activities and processes that occur on the land surface. Relatively high concentrations of trace metals, organic compounds, and dissolved solids have been found in water from some parts of the shallow unconfined aquifer.[2] Excessive withdrawals from the principal aquifer could alter the hydraulic-head gradients enough to induce the movement of water from the shallow unconfined aquifer into the confined principal aquifer.[3] See the ground water contamination section of Chapter 8.

On June 25, 2002 the State Engineer's Office released the Salt Lake Valley Ground Water Management Plan, which replaced the interim plan implemented in 1991. The objectives of the plan are to promote wise use of the ground water resource, protect existing water rights, and address water quality issues and over-appropriation of ground water in the valley. The plan states that the valley is closed to new appropriations of ground water from the principal aquifer including fixed-time appropriations, and all pending unapproved applications for water in the principal aquifer will be rejected.[4] This action was deemed necessary because of the over-appropriation of ground water resources that exists in the valley.

The State Engineer's over-riding consideration in the development of a ground water management plan was preserving the integrity of the water quality within the principle aquifer. For that reason the Salt Lake valley was divided into regions (See Figure 5) and a safe yield value was calculated for each region. These safe yield values (listed in Table 6) were developed in order to maintain the natural hydrologic characteristics of the aquifer, with ground water flowing from the mountains towards the center of the valley then northerly to the Great Salt Lake. These safe yield values were developed through extensive investigation and modeling to protect the integrity of the aquifer's water quality. The plan points out that the ground water system will be monitored, and if necessary, further restrictions may be imposed as needed to protect the aquifer.

FIGURE 5
Ground Water Withdrawal Regions



Source: Utah Division of Water Rights – Salt Lake Valley Ground Water Management Plan.

A portion of the aquifer in the southwestern part of the valley has been contaminated with high sulphate concentrations, as a result of past mining activities in Bingham Canyon. This area is currently being remediated through ongoing cleanup efforts. As part of the remediation efforts, Kennecott Utah Copper Corporation has committed to assist affected water users in obtaining adequate replacement water for adversely affected supplies. (for more information see Chapter 8)

In addition to the southwest remediation area, the plan lists two areas of restricted use due to localized contamination: the Vitro Tailing site in West Valley City and the Sharon Steel site in Midvale (For more information see Chapter 8). In order to protect the quality of the water and prevent changes in the hydraulic gradient and mobilization of contaminants from these sites, the transfer of water rights into these areas will not be allowed. These restricted areas are based on the best available data and may change as new data is obtained. Additionally, the plan indicates that new restricted areas may be added if new data "supports such a designation."[5]

Imported Water

The Metropolitan Water District of Salt Lake and sandy can import as much as 61,700 acre-feet of Provo River Project water, 28,600 acre-feet of CUP Bonneville Unit water, and 3,000 acre-feet of Ontario Drain Tunnel water from the Utah Lake Basin. This water can be diverted into the Salt Lake Aqueduct, the Jordan Aqueduct (Olmstead Diversion), the Provo Reservoir Canal, and/or Utah Lake. The Salt Lake Aqueduct flow can be delivered to the MWDSLS. Little Cottonwood Water Treatment Plant, the Jordan Valley Water Conservancy District (JVWCD) Southeast Regional Water Treatment Plant, the WaterPro, (formerly know as Draper Irrigation Company) Water Treatment Plant , and/or various rirrigation system turnouts in Utah and Salt Lake Counties.

Water diverted into the Jordan Aqueduct via the Olmstead Diversion may be, conveyed to the Jordan Valley Water Treatment Plant (jointly owned by JVWCD and MWDSLS) and/or the MWDSLS point of the Mountain Water Treatment Plant. A pump station gives the system increased flexibility making it possible to pump water from the Jordan Aqueduct to the Salt Lake Aqueduct. Additional valves and piping make it possible to move Salt Lake Aqueduct water to the Jordan Aqueduct.

Once the various water supplies are treated to drinking water standards, the finished water aqueduct systems allow for a high degree of flexibility, reliability, and redundancy in distributing the water supplies to the desired places of use.

The exchange of Utah Lake water for higher quality Provo River water, between MWDSLS and the Utah Lake Distributing Company (ULDC), provides an average annual supply of approximately 25,000 acre-feet. This exchange entered into in 1958, provides the ability to utilize Utah Lake/ Jordan River water in lieu of Provo River Project water for irrigation needs in the western portions of Utah and Salt Lake counties. The Welby-Jacob Exchange of Utah Lake water for higher quality Provo River water between JVWCD and the Welby-Jacob Water Users Company provides an average annual supply of 29,400 acre-feet. The estimated amount available in dry years, however, is only 17,500 acre-feet.

The Central Utah Project (CUP) delivers an annual average of 70,000 acre-feet of municipal and industrial water to the Jordan River Basin.

An estimated 10,000 acre-feet per year is imported to Salt Lake County from Tooele County by Kennecott Utah Copper for self-supplied industrial use.

Total Available Supply

The total precipitation within the Jordan River Basin is about 900,000 acre-feet per year (See Table 7). It is estimated that 219,000 acre-feet of that water, referred to as ground water recharge, makes its way into the valley ground water aquifer system. The average annual surface water runoff, originating within the basin, is 178,000 acre-feet (173,500 acre-feet coming from the Wasatch Range mountain streams and 4,500 acre-feet from the Oquirrh mountain streams). Totaling these two figures (ground water recharge and the surface water runoff) results in a basin yield of 397,000 acre-feet per year. This means that about 503,000 acre-feet, or 56 percent, of the basin's total precipitation is used by the vegetation and natural systems, including evaporation.

The average annual flow of the Jordan River coming into the basin at the Jordan Narrows, including all diversions to canals, is 295,000 acre-feet. Combining the Jordan River flow, the Basin Yield, and water imported into the basin (171,000 acre-feet), the total available supply for the basin is 863,000 acre-feet. See Table 7 for the estimated water budget for the basin.

TABLE 7
Estimated Water Budget

Category	Water Supply (acre-feet/year)
Total Precipitation	900,000
Used by vegetation and natural systems	503,000
Ground Water Recharge	219,000
Surface Water Flow	178,000
Basin Yield (Ground Water + Surface Water)	397,000
Inflow to the Basin (Jordan River)	295,000
Imports to the basin	171,000
Total Available Supply	863,000
Groundwater Withdrawals	165,000
Agricultural Depletions	32,000
M&I Depletions	181,000
Other Depletions (Wet/Open Water Areas)	95,000
Flow to the Great Salt Lake*	501,000

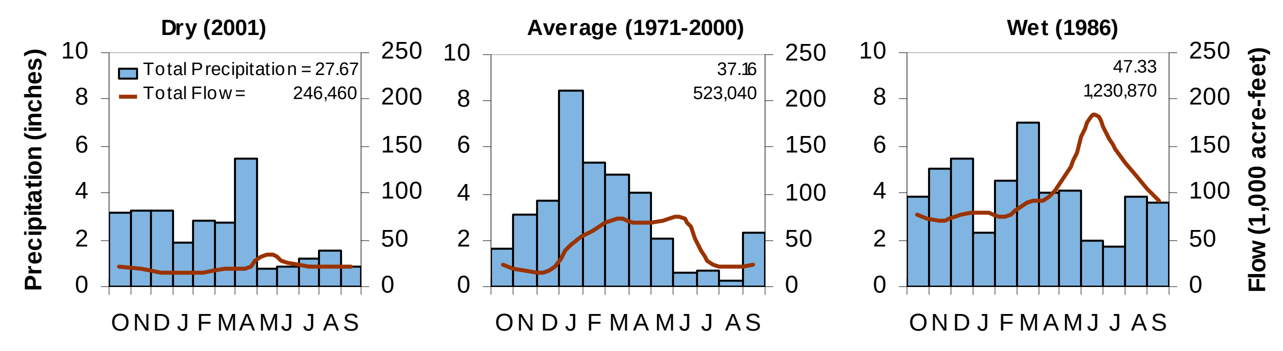
* Flow to the Great Salt Lake = Total Available supply – Ground Water Recharge + Ground water withdrawals – Depletions

It should be clarified that the total available supply is not the same thing as the total developable supply. As previously pointed out in the ground water section, ground water recharge is estimated to be 219,000 acre-feet, but the safe yield for the basin is set at 165,000 acre-feet. Consequently, the total developable ground water supply is 165,000 acre-feet, not 219,000 acre-feet. The same is true for surface water – not all available surface water supplies are necessarily developable.

Variability of Supply

For the sake of convenience, the discussion to this point has focused on the Jordan River Basin's average annual water supply. Actual water supply conditions rarely match these averages. In fact, it is not unusual to experience water supply conditions that are extremely drier or wetter than average. Figure 6 illustrates this point with a comparison of a dry, an average and a wet year. The blue bars show monthly precipitation in inches received at the Basin's Snotel sites, while the red line shows monthly streamflow of the Jordan River in acre-feet.

FIGURE 6
Water Year Scenarios



Precipitation at Basin Snotel sites and Flow at gage 10170490 (Jordan River +Surplus Canal)

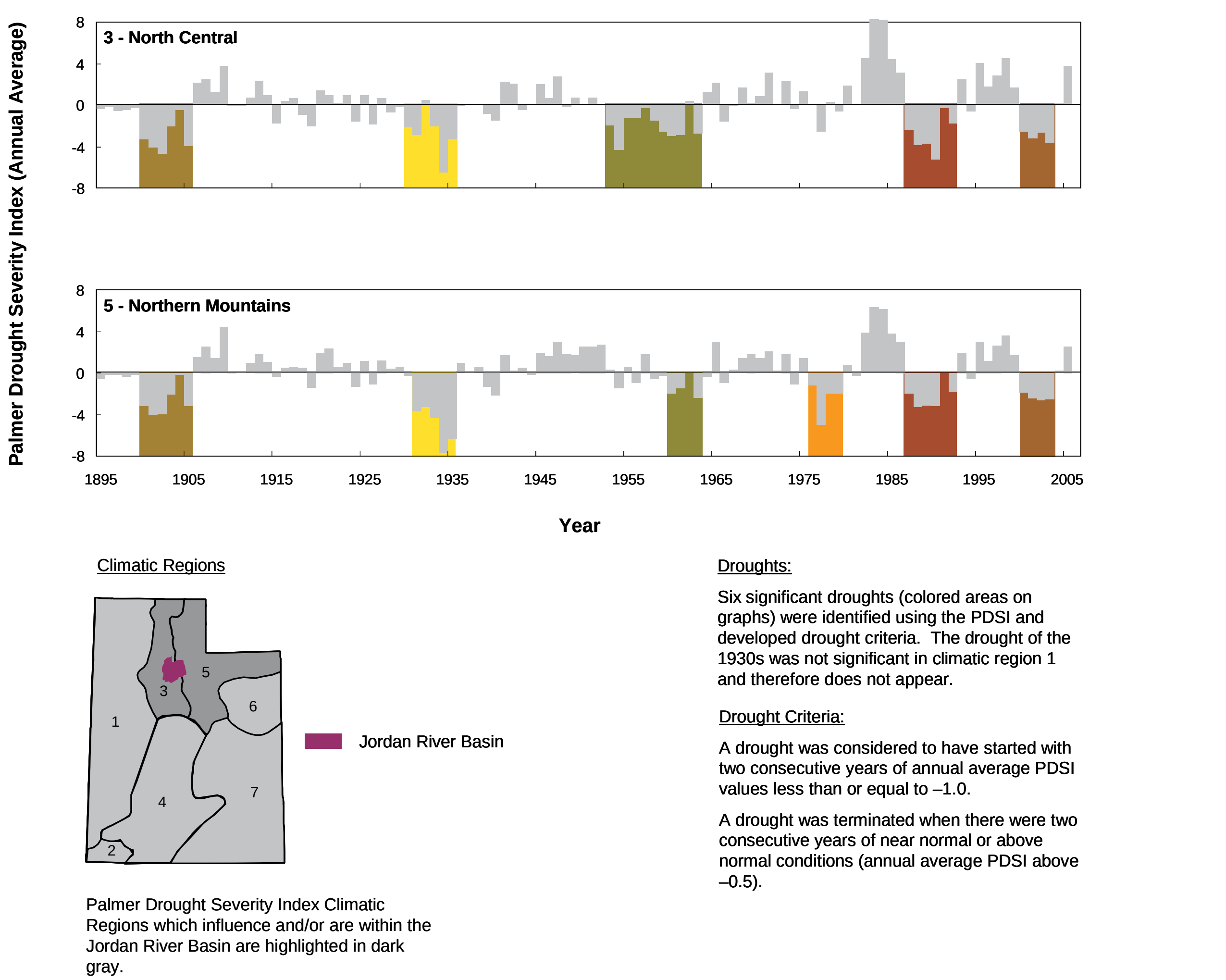
Figure 6 shows that the actual water supply can vary substantially from the average amounts. On average, the Jordan River has delivered 523,040 acre-feet to the Great Salt Lake (1971-2000). During the drought year of 2001, the total flow of the Jordan River to the Great Salt Lake was 246,460 acre-feet, less than half of the average. In the wet year of 1986, 1,230,870 acre-feet flowed from the Jordan River into the Great Salt Lake, more than twice the annual average. This variability illustrates the need for water storage, either surface or subsurface and the possible scenarios that may come to fruition during any given water year that water suppliers must take into account in their planning activities. Without the benefits of storage, the effects of poor water years, such as prolonged drought, would be severely felt, as would the effects of flooding during wet periods. Instead, surface and subsurface storage allows much of the excess flows available during wet years to be captured and held for use in drier years.

Drought

For planning purposes, it would be useful to be able to predict periods of drought; their duration and intensity. Meteorologists have attempted to make such predictions and are continually fine tuning their models as their understanding of climate-influencing factors expands. There has been limited success to date. Drought prediction or other “early warning” systems could provide the needed stimulus during wet periods for implementing conservation measures and for investing in infrastructures such as reservoirs, aquifer storage and recovery projects, and water reuse; helping to foster a more proactive approach to managing drought.

Currently, officials use one or more of several indices to measure the relative severity of droughts. The State of Utah uses both the Palmer Drought Severity Index (PDSI), based upon precipitation and temperature, and the Surface Water Supply Index (SWSI) based upon precipitation, stream flow, snowpack and reservoir storage, when declaring drought status. Figure 7 shows the PDSI record (over 100 years of drought record) for Utah's climatic divisions 3 and 5, which are presented here because they either included the mountainous

FIGURE 7
Palmer Drought Severity for Utah's Climatic Region 3 and 5



regions where the majority of the area's moisture is derived or contain part of the Jordan River. Positive PDSI values are indicative of wet conditions whereas negative values represent dry or drought conditions.

Six droughts have been identified using the PDSI and developed drought criteria (see Figure 7 for drought criteria). Each drought is distinctly colored to allow comparison between the climatic regions. For example, the Dust Bowl Years, the drought which started in the early 1930s in these regions, is identified by the yellow shading on the figure. The width correlates with the duration and the gray shading (or negative PDSI values contained within the yellow shading) can be used to determine the drought's severity(see Table 8 for drought severity—average PDSI over the duration of the drought in each region).

Looking at Figure 7, a couple of items can be noted: (1) wet periods generally follow dry periods (and vice versa), and (2) droughts, longer and with similar or greater severity than the statewide drought of 1999, have occurred several times in the last 110 years. As can be seen each drought varied between the two regions shown in Figure 7, with some similarities in intensity and duration.

Impacts of each of these droughts are also varied due to the development of water supplies, economic conditions, population growth, water demand and other regional and local characteristics. The impacts of the most recent drought (1999-2004; which in some areas may be continuing) were amplified by large population increases that have occurred over the past fifty years. This population increase is taxing the limited surface supplies. In 2002, ground water levels in the majority of the water supplier's wells steadily declined throughout this most recent drought and some suppliers purchased "extra" water to meet demands and contracts, such as Salt Lake City, who purchased "spot market" water to ensure peak summer demands would be met. Some cities instituted outdoor watering ordinances, such as West Jordan and Sandy, to lessen the strain on the water supply. Water suppliers in the Basin were able to meet demand largely due to the "Slow the Flow" campaign (an aggressive water conservation and education program), which was instituted state-

TABLE 8
Drought Duration and Severity

Climatic Regions	Drought	Duration	PDSI Average
3	1900-1905	6	-3.11
	1930-1935	6	-2.74
	1953-1963	11	-1.96
	1987-1992	6	-2.89
	2000-2003	4	-3.03
5	1900-1905	6	-2.77
	1930-1935	5	-5.08
	1960-1963	4	-1.45
	1976-1979	4	-2.53
	1987-1992	6	-2.24
	2000-2003	4	-2.37

Source: Utah Division of Water Resources Analysis, 2007
Note: The range of years shown for each drought includes the ending year, for example in climatic region 3, the 1900-1905 drought includes the year 1900 in its entirety and is through 1905, resulting in a total of 6 years

wide. Several water suppliers reported a 10-15% decrease compared to the previous year and this decrease in water use was continued throughout the drought, despite an increase in population.

Drought events, the natural variability of the water supply, in the future will likely be more of a concern because of high population growth and the lack of available water to develop. The established conservation ethic within the basin will likely be put to the test. In addition, much of Utah already depends upon ground water sources for their culinary supplies, as in the Jordan River Basin, from where deficiencies in surface supplies are compensated for during drought. These demands can place Utah's aquifers at risk from the problems associated with ground water declines and need to be managed appropriately. One observation that can be made through viewing either drought index is that "average" conditions are rare. Extended periods where index values are close to "average" are as variable as extended wet or dry periods. Drought in the Jordan River Basin and surrounding areas will happen again, the exact duration and severity may not be known, however steps can be taken now to mitigate its impacts. To further investigate drought and possible mitigation strategies, refer to the Utah Division of Water Resources' report on drought titled, *Drought in Utah: Learning from the Past—Preparing for the Future*, accessible online at: http://www.water.utah.gov/.

DEVELOPED SUPPLY

Historically, surface water sources were first developed for irrigation, while ground water was used for domestic and culinary needs. With increasing population, a series of exchanges were employed to convert the highest quality surface water to municipal and industrial use. Consequently, Wasatch Range streams now provide an annual average of 68,200 acre-feet for public water supplies (See Table 9). With the decreasing agricultural activity in the basin, only about 60,000 acre-feet of surface water is currently used to irrigate approximately 12,000 acres, although considerably more water is diverted into the canals. At the end of the Jordan River system are a number of private duck clubs and a bird refuge. Many more acre-feet of water is delivered to these sites in accordance with their existing water rights but the actual depleted water is estimated to be 94,500 acre-feet, lost through evaporation from wetlands and ponds.

The valley's current total ground water use is estimated to be 136,100 acre-feet. This includes all sources of public drinking water supplies (80,800 acre-feet), private domestic and stock watering wells (24,300 acre-feet), self-supplied industrial (20,200 acre-feet), irrigation water use (5,000 acre-feet), and 5,800 acre-feet of managed ground water recharge.

The basin's currently developed public water supply is listed in Table 10. On an average annual basis, the Wasatch Mountain streams provide 72,200 acre-feet of water. However, due to lack of storage capability this supply is subject to significant variability and can only be relied upon for about 42,000 acre-feet in a drought year. The Welby-Jacob exchange water is also subject to variability providing 29,400 acre-feet on an average annual basis, but only 17,500 acre-feet in dry years. This variable nature of some of the Basin's surface water sources was discussed in more detail in a previous section.

TABLE 9
Presently Developed Water Supplies

Source/Description	Average Annual (acre-feet/year)
Surface Water	
Irrigation	60,000
Wasatch Mountain Streams	68,200
Wet/Open Areas	94,500
Secondary Water	18,000
Private Industrial	6,000
Subtotal	**246,700**
Ground Water*	
Public supply wells and Springs	80,800
Private domestic	24,300
Self supplied Industrial	20,200
Irrigation wells	5,000
Managed ground water recharge	5,800
Subtotal	**136,100**
Imported Water	
Deer Creek Reservoir	61,700
Central Utah Project	70,000
Welby-Jacob Exchange	29,400
Tooele County	10,000
Subtotal	**171,100**
Basin Total	**553,900**

* Reported and estimated ground water use for 1996-2000, from the Salt Lake Valley Ground Water Management Plan Update

Average annual ground water withdrawals (1996-2000) have provided the valley's public drinking water systems with 80,800 acre-feet/year. Because the valley's total ground water withdrawals (see Table 9) have not exceeded the State Engineer's limitation of 165,000 acre-feet, there appears to be another 29,000 acre-feet of ground water that could be withdrawn during times of drought or shortage. Managed ground water recharge could provide up to an average annual 5,800 acre-feet, although to date, the Jordan Valley Water Conservancy District has been averaging less than 900 acre-feet per year. Deer Creek Reservoir also provides a very reliable annual supply of 61,700 acre-feet. Because of the unreliable nature of some of the Basin's surface water sources, namely the Wasatch Mountain streams and Welby-Jacob exchange, the Central Utah Project is managed to bring 84,000 acre-feet into the Basin during drought years while only providing an average annual water supply of 70,000 acre-feet. This management strategy shores up the supply of municipal water during drought years. In practice, however, multiple drought years make it impossible to maintain the delivery of 84,000 acre-feet after three or four years of drought. Consequently, the Dry Year Supply of Central Utah Project water is 70,000 acre-feet.

In addition to public supplies, there is still a considerable amount of privately developed water in the Jordan River Basin. Although declining, due to urbanization and the expansion of municipal water supplier's service

TABLE 10
Public Water Supply

Source	Average Supply (acre-feet)	Dry Year Supply (acre-feet)
Wasatch Range Streams		
City Creek	8,270	4,420
Parley's Creek	7,940	3,100
Big Cottonwood Canyon	26,050	18,180
Little Cottonwood Canyon	24,360	16,320
Small Mountain Streams	5,580	2,740
Subtotal	**72,200**	**44,760**
Welby-Jacob Exchange	29,400	17,500
Central Utah Project	70,000	70,000
Deer Creek Reservoir	61,700	61,700
Ground Water	80,800	110,000
Managed Ground Water Recharge	5,800	1,060
Subtotal	**247,700**	**260,260**
Total	**319,900**	**305,020**

Privately Developed Water Supplies

Description	Use	Annual Average (acre-feet)
Private domestic and stock wells	Private	24,600
Industrial wells	Self-supplied Industry	26,500
Surface and Springs	Self-supplied Industry	3,200
Imported from Tooele County	Self-supplied Industry	10,000
Irrigation (Jordan River)	Agriculture	140,000
Irrigation wells	Agriculture	3,000
Lawn and gardens	Secondary	10,000
Developed wetlands	Environmental	94,500
Total	**-**	**311,800**

areas, there is still estimated to be 24,600 acre-feet of private domestic and private stock watering wells in the valley. This number is expected to decline over the next few decades with municipalities and their service areas expanding to encompass virtually the entire valley. Self-supplied industrial water from wells and springs, and surface water imported from Tooele County is currently estimated to be 39,700 acre-feet. This figure is expected to remain constant over the next few years, but could increase. Irrigated agriculture has declined significantly in recent years and is expected to decline further to nearly zero by 2035. This is covered in more detail in the section entitled Agricultural to M&I Water Conversions in Chapter 6.

FIGURE 8
Water Rights Areas

WATER RIGHTS

Under Utah water law, the distribution and use of water is based upon the doctrine of prior appropriation. The Division of Water Rights, under the direction of the State Engineer, regulates water allocation and distribution according to state water law. To facilitate the administration and management of water rights, the Salt Lake County portion of the Jordan River Basin has been divided into two management areas (See Figure 8): The area east of the Jordan River is designated as Area 57, while the area to the west of the Jordan River is designated as Area 59.

TABLE 11
General Status of Water Rights

County	Area	Subarea	General Policy
Salt Lake	57 East Salt Lake Valley	General	● Surface water appropriations are closed ● Ground water appropriations are generally closed valley wide except for domestic wells limited to one acre-foot per year.
		Mountain and Canyon Areas	● Closed
		Jordan Narrows	● Some additional limitations may be applied to hot and cold water sources depending upon the intended use of the water.
	59 West Salt Lake Valley	General	● Surface water appropriations are closed ● Ground water appropriations are generally closed valley wide except for domestic wells limited to one acre-foot per year.
		Mountain and Canyon Areas	● Closed
		Rose Canyon	● The area is closed above Rose Canyon Irrigation Company

Although the Jordan River Basin has not yet been fully adjudicated, Proposed Determination Books have been prepared for Emigration Canyon in area 57 and the entire area 59. The State Engineer has established water rights policy for both of these areas, including a ground water management plan. These policies have a profound impact on the availability and management of water resources, and are summarized in Table 11.

At the present time, the State Engineer has determined the surface water flows in the Jordan River Basin to be fully appropriated. This means that the Division of Water Rights will not approve new applications to appropriate surface water in either area 57 or 59. Ground water is also considered fully appropriated.

However, the State Engineer will accept applications to appropriate up to one acre-foot per year of ground water for domestic purposes where no adequate public water supply is available. Such appropriations are temporary, (limited to 10 years) and subject to cancellation if an adequate public water supply becomes available.

NOTES

[1] U.S. Geological Survey Water-Data Report UT-89-1, U. S. Geologic Survey, 1989

[1] *Water Resources of Salt Lake County, Utah*, State of Utah, Department of Natural Resources, Technical Publication No 31, 1971.

[2] Thiros, Susan A., *Chemical Composition of Ground Water, Hydrologic Properites of Basin-Fill Material, and Ground Water Movement in Salt Lake Valley, Utah*, (United States Geological Survey, in cooperation with the Utah Department of Natural Resources, Division of Water Rights and Utah Department of Environmental Quality, Division of Water Quality) 1995, 2.

[3] Ibid, 3.

[4] *Salt Lake Valley Ground Water Management Plan*, Department of Natural Resources Division of Water Rights, June 25, 2002.

[5] Ibid.

3

POPULATION AND WATER USE TRENDS AND PROJECTIONS

A PROMISING ERA OF GROWTH AND PROSPERITY

The 21st century holds bright prospects for the Jordan River Basin. Desirable communities, education and employment opportunities, a pleasant climate, beautiful mountains, and a broad range of recreational opportunities encourage current residents and their children to stay and nonresidents to move into the region. As a result, the population of the Wasatch Front is expected to continue to grow well into the foreseeable future.

With such growth comes an abundance of issues and challenges for leaders in the area. How to plan infrastructure and manage resources are some of the important issues that leaders will need to resolve effectively. One certainty is that additional water will be needed to meet the demands of municipal and industrial (M&I) growth. This chapter looks at some of these issues and attempts to quantify the amount of water that will be needed to meet future needs. Chapters 4, 5, 6, and 7 address how these needs will likely be met.

As the Basin's economy grows with time, planning at all levels of government will depend on reliable and consistent data detailing the demand for water. This section presents data to help local leaders anticipate the need for timely water resources development. This data along with the latest technology for delivery, use and conservation of water should provide planners and managers with tools that will guide them in the coordination and management of their water resources.

POPULATION TRENDS AND PROJECTIONS

The economy of the Salt Lake Valley is characterized by a commercial and industrial urban core in Salt Lake City with suburban communities expanding to the south and west. Some limited agricultural production is still evident, mainly in the southwest part of the Valley. A revived real estate market, however, is rapidly displacing most farmers, and reducing the land base available to those that remain.

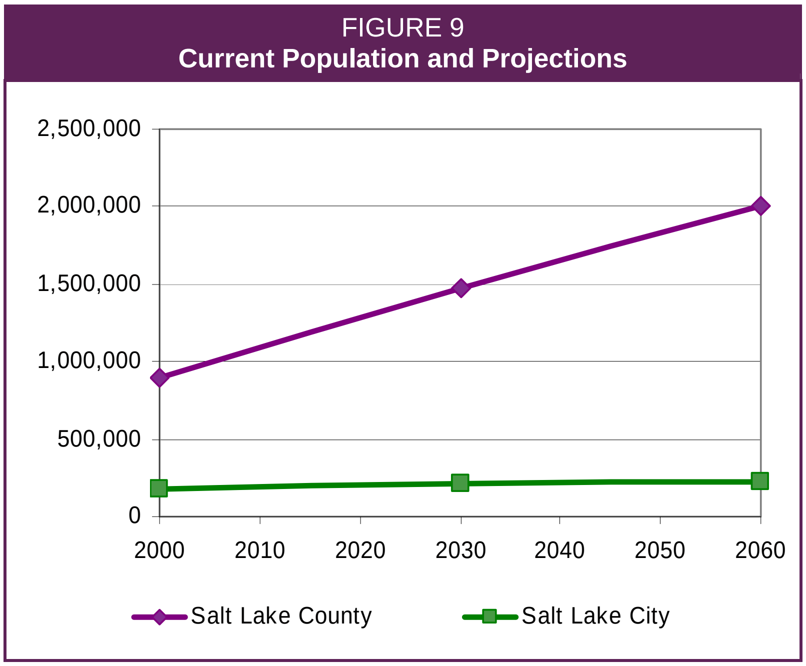
The 2000 U.S. Census put the population of Salt Lake County at 898,000 persons. The Governor's Office of Planning and Budget projects that the county's population will increase by about 1.65 percent per year to nearly 1,500,000 in 2030 and then by just about one percent per year to about 2,000,000 in 2060.

TABLE 12
Population Projections

Cities	2000	2030	2060
Alta	370	378	400
Bluffdale	4,700	55,219	62,988
Cottonwood Heights	35,168	45,920	50,990
Draper (pt.)	25,220	54,006	57,989
Herriman	1,523	47,689	82,637
Holladay	14,561	34,333	44,508
Midvale	27,029	46,566	65,497
Murray	34,024	73,792	77,985
Riverton	25,011	54,063	82,663
Salt Lake City	181,743	208,822	225,956
Sandy	88,418	98,298	120,348
South Jordan	29,437	102,406	139,973
South Salt Lake	22,038	32,391	47,530
Taylorsville City	57,439	70,062	90,477
West Jordan City	68,336	138,549	174,966
West Valley City	108,896	160,637	179,965
Balance of County	174,474	245,484	499,902
TOTAL	**898,387**	**1,468,615**	**2,004,773**

Source: Governor's Office of Planning and Budget, "2008 Baseline City Population Projections," (Salt Lake City: May, 2008).

Population projections for Salt Lake County and its communities are shown in Table 12 and illustrated in Figures 9 through 11. The four largest cities in the County - Salt Lake City, West Valley City, Sandy, and West Jordan - are home to nearly 500,000 people, roughly half of the county population and more than one-fifth the state's total population (2000 Census).

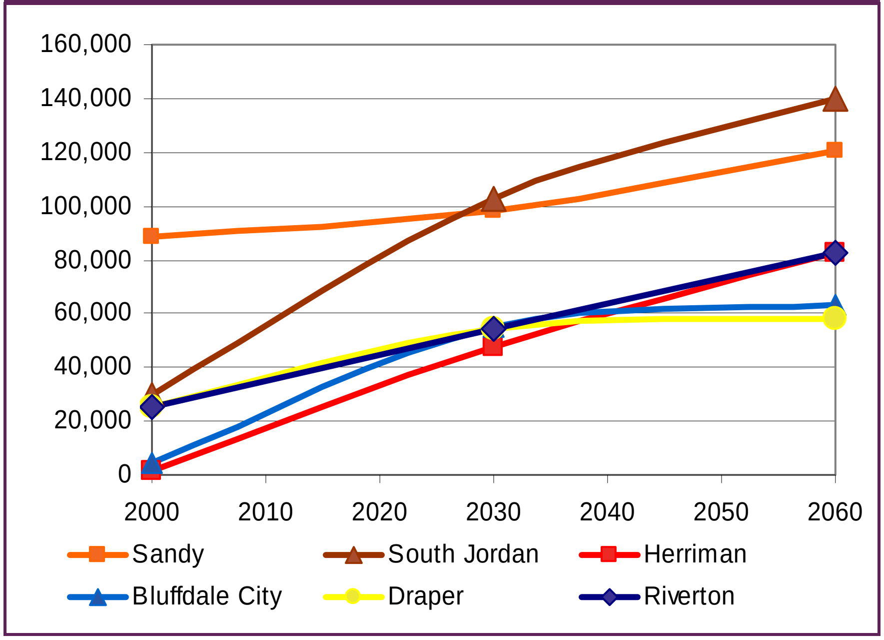


Source: Governor's Office of Planning and Budget.

Figure 9 shows that Salt Lake City, which is essentially land-locked by communities to the south, mountains to the east and north, and the Great Salt Lake to the northwest, will experience very little of the County’s projected growth. Salt Lake City does have undeveloped land within City boundaries to the west. At the present time, however, there is little development taking place in that portion of the City.

At the present time, urban expansion and growth is primarily occurring in the southern and western portions of the Valley. This is attested to by the population projections illustrated in Figures 10 and 11. Figure 10 shows the current population and projections for the south valley communities. Sandy City, currently the largest south valley community, is projected to increase from a current population of about 90,000 to just over 120,000 by 2060. South Jordan will experience tremendous growth through 2030, but a decreasing growth rate between 2030 and 2060 as it fills in its developable lands. Draper, which has experienced tremendous growth in the past ten years will continue to expand but at a decreasing rate. Draper’s decreasing growth rate reflects the City’s land-locked situation with Sandy to the north, Riverton and Bluffdale to the west and the

FIGURE 10
South Valley Population and Projections

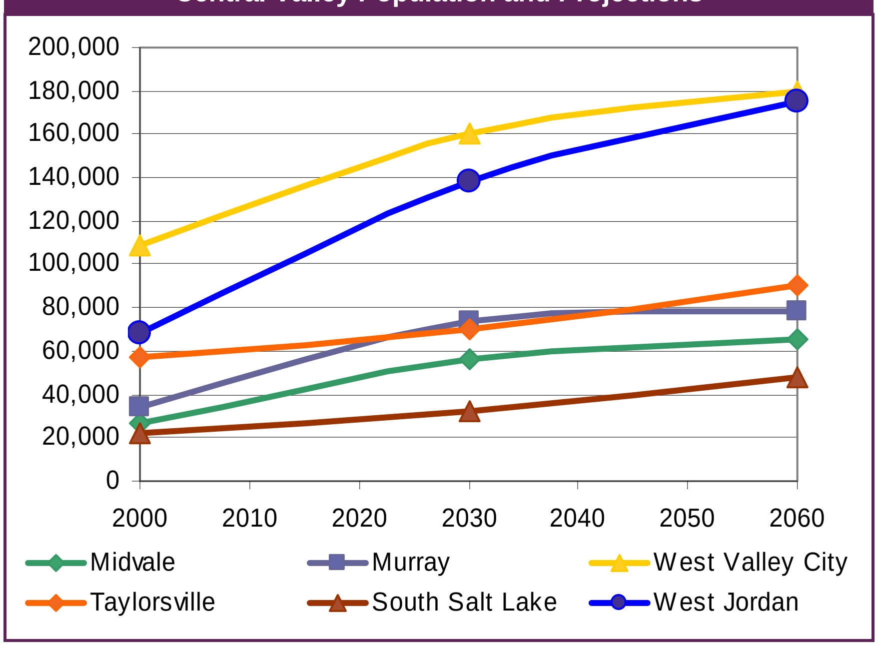


Source: Governor's Office of Planning and Budget.

Mountains to the east and south. Riverton's current population and projected growth are nearly identical to that of Draper, illustrating the fact that Riverton is also entirely surrounded by other communities. Herriman, recently identified as Utah's fastest growing community (33% over the past year) is projected to increase from 1,500 residents in 2000 to over 82,000 by 2060. Bluffdale is expected to experience similar growth increasing from just under 5,000 residents in 2000 to just over 60,000 by 2060.

Most of the communities in the central portion of the valley, Murray, Midvale, Taylorsville, and South Salt Lake will experience only slight population increases due to their land locked situations. West Valley City and West Jordan will be the exceptions in the Central Valley. These two communities with

FIGURE 11
Central Valley Population and Projections



lands available to the west will be able to enlarge their population base considerably. West Jordan is projected to increase from just over 68,000 to 175,000 by 2060. West Valley City, already with a population of 109,000 is projected to nearly reach 180,000 by 2060.

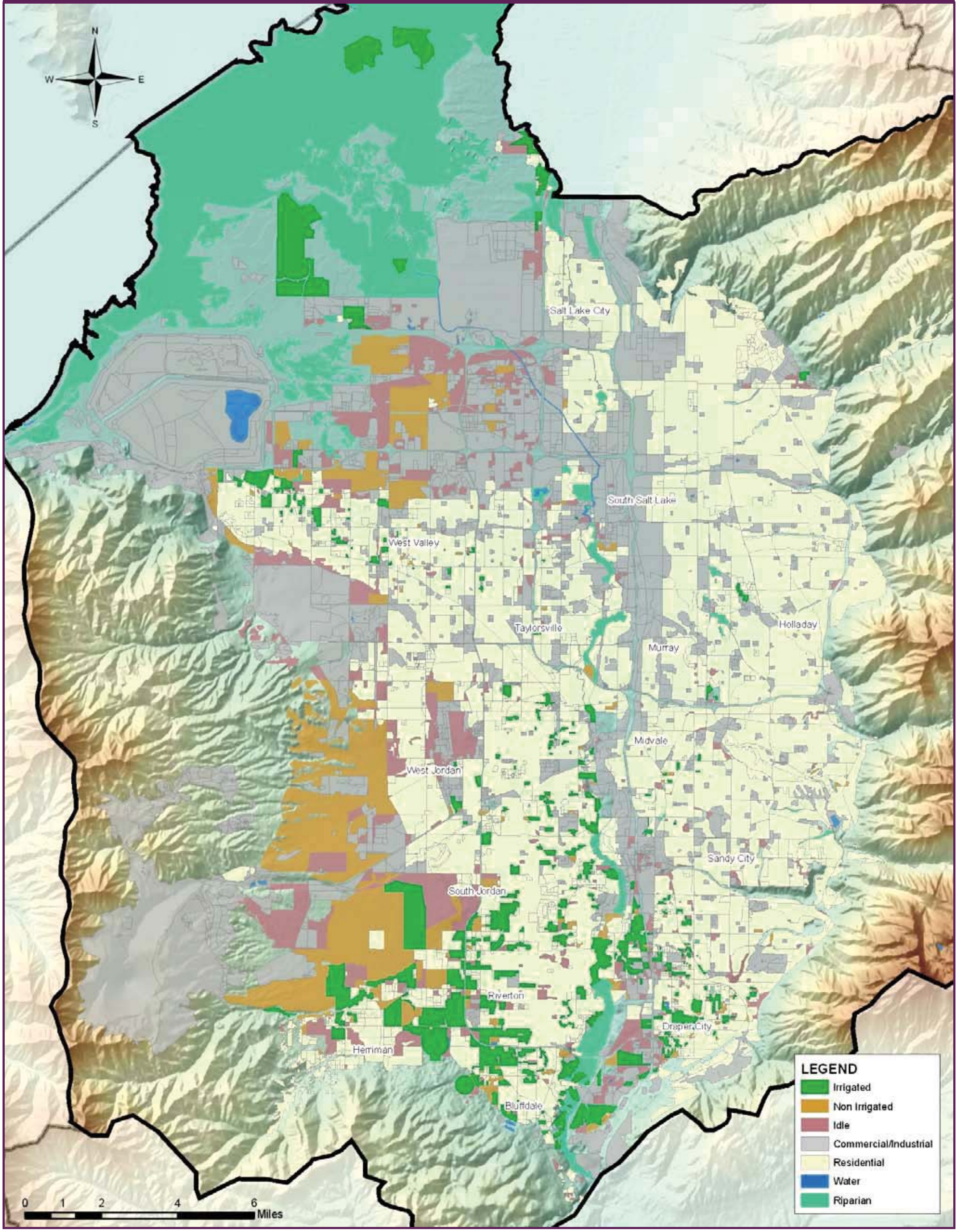
ECONOMIC TRENDS AND PROJECTIONS

Employment opportunities directly influence population growth. Utah's population and economic growth rates are projected to continue to outpace the nation through the year 2020. Utah experienced a population increase of 29.6 percent between 1990 and 2000. This increase was more than twice the U.S. national average of 13.3 percent over the same period of time. Utah's population growth rate over the last decade was fourth highest in the nation, exceeded only by Nevada (66%), Arizona (40%) and Colorado (30%). The population growth rate for Salt Lake County was slightly lower than that of the State's 23.75 percent. According to the Bureau of Economic analysis data Utah experienced a growth in total employment of 47 percent during the same period, with only two states posting better figures namely, Nevada (65%) and Arizona (48%). Both Nevada's and Arizona's increase in total jobs were close to their population increase. Utah's increase in total jobs however, exceeded its population growth by nearly 20 percent. This is a strong indication that the state's economic growth is more than keeping pace with the state's population growth, particularly along the Wasatch front and in Salt Lake County.

Land Use Patterns

Most of the land in Salt Lake County, especially in the Valley, is privately owned. Although Salt Lake City owns and manages 24,000 acres of the upper watershed, most of the lands in the upper watershed are owned and managed by federal agencies. The Forest Service administers about 92,000 acres of national forest lands in the Wasatch Range. The next largest federal land managing agency is the U.S. Army, which controls about 14,000 acres around Camp Williams in the southern end of the valley. The only other significant federal land holding is roughly 3,000 acres of public domain managed by the Bureau of Land Management (BLM).

FIGURE 12
Land Use



The state of Utah has scattered land holdings of about 10,000 acres. The state also owns the beds of all navigable streams and lakes.

The general pattern of land use, as shown in Figure 12, reveals that lands for residential, commercial, industrial, and agricultural uses are confined almost exclusively to the Valley. The exceptions are industrial development in Bingham Canyon in the southwest portion of the Valley, residential development in Emigration Canyon to the northeast, and limited residential development in Big and Little Cottonwood Canyons in the southeast portion of the county. One detail not apparent from the land use map is that recreational use is prevalent in almost all of the canyon and mountainous areas on the valley's east side. Most heavily used are Big and Little Cottonwood Canyons, both of which have world-class ski resorts and spectacular vistas that attract people year-round. Also receiving heavy usage is Mill Creek Canyon with its developed day-use. Parleys Canyon, which serves as one of the Valley's primary transportation corridors, also has golfing and camping facilities and is heavily used for recreation and transportation.

The land use data (Figure 12) show that residential lands are clustered primarily on the eastern half and central portions of the Valley. Industrial/commercial land is scattered throughout the Valley, but with large concentrations in the northwest and western portions of the Valley. There are small tracts of irrigated land scattered throughout the western and south central portion of the Valley but these are disappearing as residential development expands.

WATER USE TRENDS AND PROJECTIONS

Agriculture

In recent decades, Salt Lake Valley has experienced widespread population growth. Much of the residential expansion has been in predominantly agricultural areas of the western, south central, and southeast portions of the Valley, primarily the West Valley City, West Jordan, South Jordan, Draper, Riverton and Bluffdale areas with considerable growth also in the Sandy City area. Historically, these are lands that have been served by several canals on both the west and east sides of the Valley.

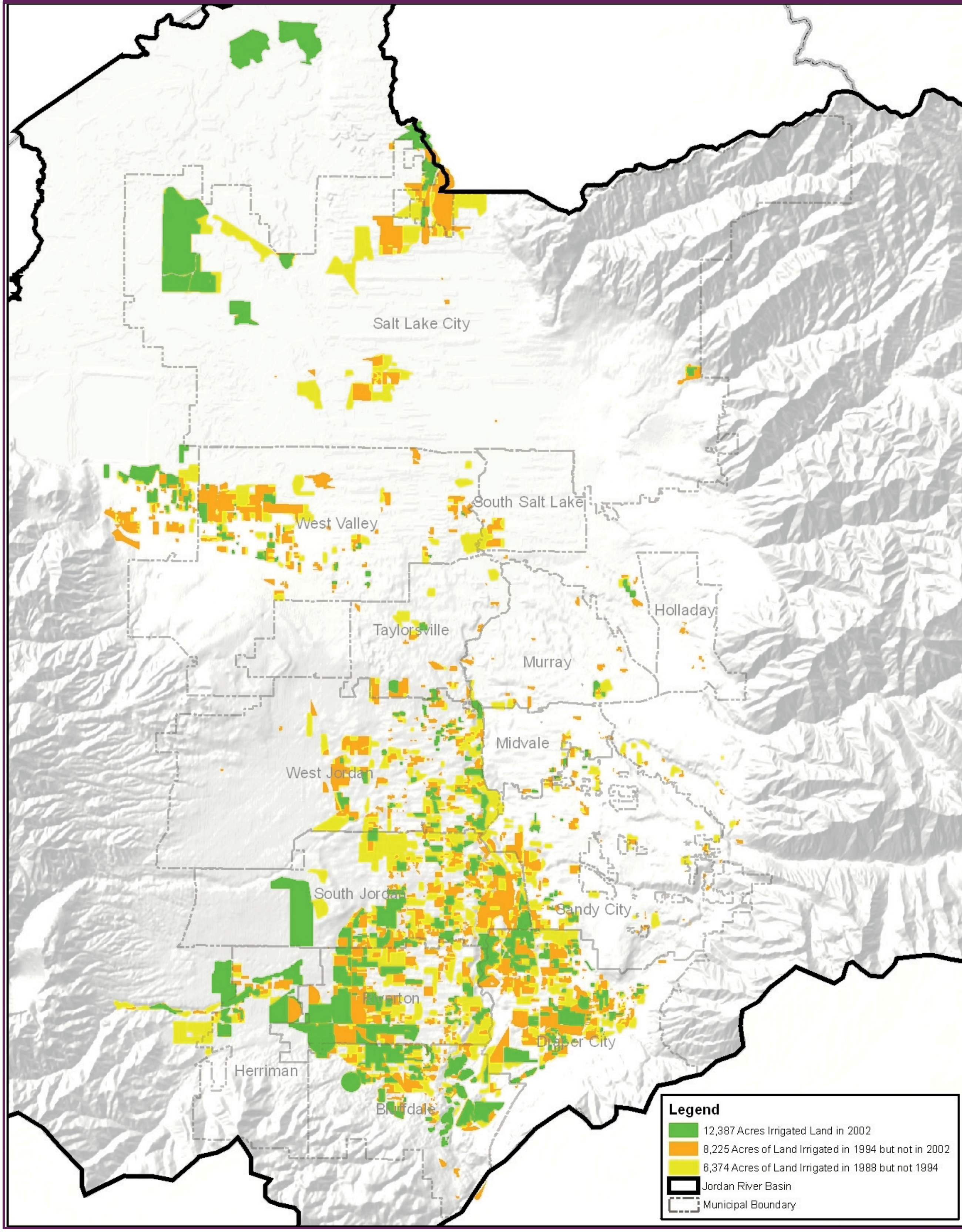
TABLE 13
Irrigated Land by Year

Year	Irrigated Acres
1979	51,200
1988	38,800
1994	25,300
2002	14,000

The Division of Water Resources conducted water-related land use surveys in the Jordan River Basin in 1988, 1994, and 2002. In addition to the land use data collected by the Division, Table 13 includes a land use inventory of Salt Lake County which used 1979 color infrared aerial photography.[1] The data show that the irrigated lands within the Jordan River Basin have declined rapidly over the past two and a half decades from 51,200 acres in 1979 to 14,000 acres in 2002, a loss of nearly 73 percent over 23 years. Urban expansion has retired a lot of farmland, particularly in the south and west parts of the Valley. West Valley, West Jordan, Taylorsville and Sandy City experienced tremendous growth in the early part of that period and continue to grow. The last decade has seen an explosion of suburban development in Draper, Herriman, Riverton, Bluffdale, and South Jordan. At the current rate of urban expansion, agricultural activity in the Basin will be virtually non-existent by 2060.

Figure 13 shows the irrigated lands that have been lost to residential development since 1988. In Figure 13, the lands depicted by all three colors (yellow, orange and green) were irrigated in 1988. The Lands depicted in yellow were no longer irrigated in 1994. The lands depicted in orange were no longer irrigated in 2002. Lands shown in green were still being irrigated in 2002 at the time of the most recent land use survey. Figure 12 shows the extent and pattern of urbanization of irrigated ground in Salt Lake Valley.

FIGURE 13
Irrigated Land Losses



Municipal and Industrial Water Use

The Division of Water Resources recently completed an intensive study of M&I water supply and use in the Jordan River Basin. Table 14 shows a summary of the Basin's M&I water use as estimated by this study. As shown, potable water (treated to drinking water standards) use amounted to just over 213,000 acre-feet per year, or roughly 64 percent of total M&I use, in 2005.

TABLE 14
Total M&I Water Use (2005)

Use Category	Water Use (acre-feet)
Potable Suppliers	
Public Community Systems	205,950
Public Non-Community Systems	380
Self-Supplied Industries	6,120
Private Domestic	600
Potable Total	**213,050**
Non-Potable Suppliers	
Secondary Irrigation Companies	18,060
Non-Community Systems	1,450
Self-Supplied Industries	101,140
Private Domestic	0
Non Potable Total	**120,650**
TOTAL	**333,700**

Source: Utah Division of Water Resources, *Municipal and Industrial Water Supply Studies,* 2009.

Also evident from Table 14 is that the majority of the Basin's Potable M&I water is supplied by public community systems. In 2005 water supplied through these systems amounted to nearly 206,000 acre-feet, nearly 97 percent of the basin's Potable M&I use. Non-community systems, self-supplied industries and private domestic users account for less than 4 percent of the Basin's potable M&I water use.

Table 15 lists the Basin's Public Community Water Systems and shows how much potable and non-potable water each system delivered in 2005.

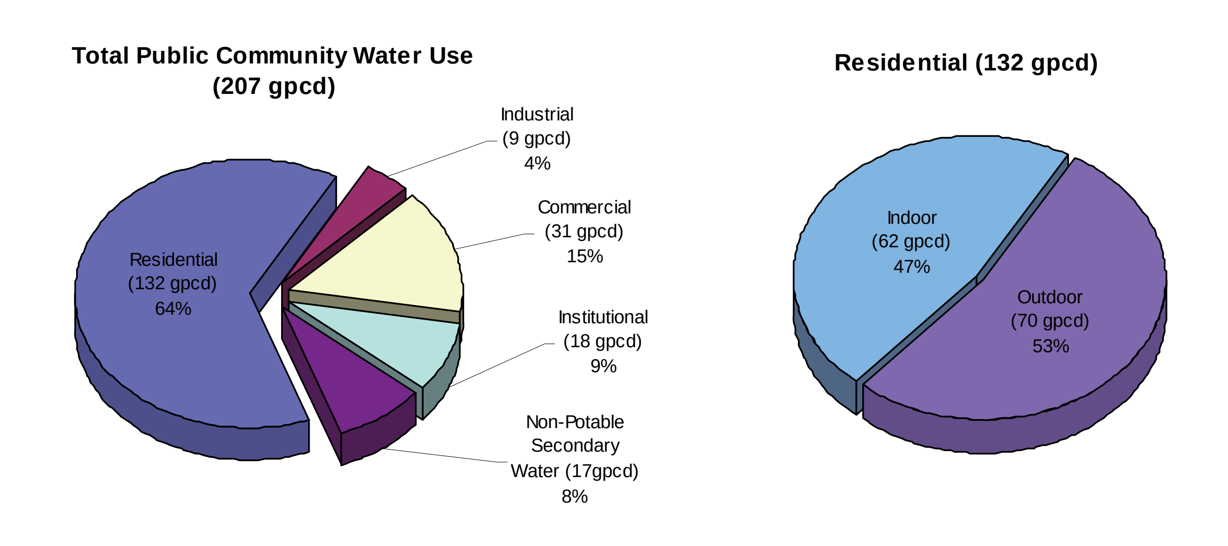
Figure 14 shows the average per capita use rate of all the public community and secondary water systems in the Basin as observed in the division's 2005 study. Water used by self-supplied industries, private domestic and non-community systems is not shown. As indicated, residential water use was 132 gallons per capita per day (gpcd), or 64 percent of the total public use (207 gpcd). This total public use includes 17 gpcd (8 percent) of non-potable secondary irrigation water use. Institutional water use represents 18 gpcd (9 percent), commercial 31 gpcd (15 percent), and industrial 9 gpcd (4 percent). The portion of residential water use that

TABLE 15
Potable and Non-Potable (Secondary) Water Use in Public Community Water Systems 2005

Public Community System	Water Use (acre-feet/year)		
	Potable	Non-Potable	TOTAL
Alta Town Water System	116	0	116
Bluffdale	1,153	256	1,409
Boundary Springs	43	0	43
Copperton Water Company	167	0	167
Dansie Water Co	82	0	82
Draper City Works	2,355	1,360	3,715
EID/Oaks Water System	148	0	148
Granger-Hunter WID	20,592	310	20,902
Herriman	2,113	174	2,287
Hi-County Estates #1	68	4	72
Hi-County Estates #2	141	0	141
Holladay Water	3,695	185	3,880
Jordan Valley Water Con	9,199	250	9,449
Kearns	7,690	500	8,190
Magna	4,055	180	4,235
Midvale City Water	2,807	0	2,807
Murray City Water	7,347	300	7,647
Riverton Water	3,818	5,800	9,619
Salt Lake City Department of Public Utilities	68,020	1,250	69,270
Snowbird	214	0	214
Sandy City	22,738	880	23,618
Silver Fork Pipeline Corporation	55	0	55
Silver Lake Company	51	0	51
South Jordan	9,088	530	9,618
South Salt Lake Water	2,987	0	2,987
Spring Glen Water Company	11	0	11
Taylorsville-Bennion	12,842	150	12,992
Water-Pro	4,662	4,602	9,264
Webb Wells	55	10	65
West Jordan City Water	17,021	1220	18,241
White City Water	2,616	105	2,721
Young Oaks Water Corporation	5	0	5
TOTAL	**205,954**	**18,066**	**224,019**

is applied to outdoor landscapes was 70 gpcd or 53 percent of the total residential water use. This is slightly higher than the 2006 statewide average of 66 gpcd.

FIGURE 14
Breakdown of Public Community Water Use Including Secondary Water Use (2005)



Population projections for the Salt Lake Valley communities were shown earlier in Table 12. Unfortunately, the service boundaries of the basin's community water systems do not correspond well with city boundaries. An example of this is Murray City which has its own community water system, although portions of the city are serviced by Jordan Valley Water Conservancy District (JVWCD). Some portions of Midvale receive water from Sandy City Public Utilities while other areas receive water from Jordan Valley Water Conservancy District (JVWCD) with the balance being served by Midvale's own community water system. South Salt Lake City is similarly served by multiple providers. The same is true of South Salt Lake City. Additionally, JVWCD makes retail water deliveries to unincorporated portions of Salt Lake County. Consequently, population projections by community are of little value when it comes to projecting water supply demands for the Basin's Public Community Systems. In order to project the water demands for the Basin's public community water systems the Division developed a model that distributes the valleys projected growth by Public Community Systems service areas. The resulting projected service area populations are tabulated in Table 16.

The water demands created by the population projections were then calculated and are presented in Table 17. The water demand numbers for the year 2000 are historical while the demand numbers for 2010, 2030, and 2060 are calculated demands based upon the population projections. These projected demands reflect the current water use rate for each service area and the State's goal for 25% conservation by 2050. The conservation is distributed evenly over the fifty years, 5% by 2010, 15% by 2030, and 25% by 2050.

It is important to understand the difference between the demand and the supply. The estimated demand as shown in this and other Division publications, along with the Division's calculation of water conservation, are made at the customer level. In other words, the 132 gallon per capita per day of residential water use shown in Figure 14 is an actual metered reading of water use. The supply is the amount of water needed by the water provider in order to meet that end user demand. These two figures would be the same, if water could be treated and delivered with 100 percent efficiency. There are, however, losses in conveying water from its source to the treatment plant, there are losses during the treatment process and there are losses conveying the water, after treatment, to the end users. Many of these losses are unavoidable. Anytime a fire hydrant is opened to fight a fire there are unmetered losses to the system. It makes little sense to meter the flow through a hydrant as this would restrict flow and reduce the water pressure vital to fighting the fire. Consequently, anytime a hydrant is used, vandalized or damaged there are unmetered losses. Also, aging pipes leak and break resulting in unmetered losses.

Recent comparisons between the treated water and the delivered water within the valley indicate that there is a need to have a supply that exceeds the projected use by about 10 percent. The demand projections shown in Table 17 do not reflect this need for additional supplies to address system inefficiencies and other unmetered system losses, but instead show only the demand at the end user level.

TABLE 16
Public Community Water System's Current and Projected Service Populations

Water System	2000	2010	2030	2060
Jordan Valley Water Conservancy District (JVWCD)				
Bluffdale	5,731	28,154	55,219	62,988
Draper City Water	8,809	13,553	16,984	20,044
Draper Irrigation Company (Water Pro)	23,530	27,234	33,121	40,276
Granger-Hunter WID	104,022	113,194	149,039	166,971
Herriman	2,530	23,462	47,689	82,637
JVWCD Retail System	31,125	33,421	49,250	52,047
Kearns WID	41,173	61,483	108,012	225,524
Magna Water Company	23,715	35,414	62,214	129,899
Midvale City Water	12,873	17,835	23,653	33,269
Riverton Water	18,085	26,339	37,225	56,917
South Jordan	35,367	56,144	102,406	139,973
South Salt Lake Water	10,741	11,021	16,027	23,517
Taylorsville-Bennion WID	66,347	58,482	70,062	90,477
West Jordan City Water	67,906	86,742	111,068	140,262
White City Water	14,442	15,180	15,783	19,323
JVWCD Total	466,396	607,658	897,752	1,284,124
Metropolitan Water District of Salt Lake City and Sandy				
Salt Lake City Public Utilities	286,431	316,753	391,989	504,844
Sandy	96,647	101,587	105,620	129,313
MWDSLS Total	383,078	418,340	479,609	634,157
Other Independent Water Systems				
Alta Town System	320	359	378	400
Boundary Springs	100	100	100	100
Copperton Water Company	726	1,084	1,905	3,977
Dansie Water Company	100	100	100	100
EID/Oaks Water System	400	597	1,049	2,191
Hi-Country Estates #1	698	364	418	500
Hi-Country Estates #2	732	500	500	500
Holladay Water	11,200	15,909	19,183	24,868
Murray City Water	33,803	30,145	44,423	46,946
SL Co. #3 - Snowbird	163	243	428	893
Silver Fork Pipeline Corp	150	224	394	822
Silver Lake Company	26	26	26	26
Spring Glen Water Company	51	76	134	279
Webb Wells	200	299	525	1,096
Young Oaks Water Corp	35	52	92	192
Other System Totals	48,704	50,078	69,655	82,890
Basin Totals	898,178	1,076,000	1,465,016	2,001,171

Environment

More concern is being expressed about the environment, with it an awareness of society's effects on ecosystems. The Jordan River, its tributaries and the Great Salt Lake are all important parts of the environment within the Jordan River Basin. Stream flows in the Jordan River and its tributaries sustain valuable habitat for wildlife, as do the wetlands of the Great Salt Lake, which is considered to be one of the State's most precious resources. Properly balancing these environmental needs with other important water management objectives will allow future M&I demands to be met without compromising the quality of life that comes with healthy ecosystems.

No minimum flow requirements have been established in the Jordan River Basin. In general, the flow in the Jordan River has been maintained in large part because of water rights held by public and private water fowl management areas in the Jordan River Delta, but also because of irrigation return flows, and natural reach gains.

An estimated 2,000 acres of wetlands remain along the undeveloped reaches of the Jordan River between the Salt Lake County line and 2100 South. The scarcity of wetlands reflect the need for increased protection, conservation, management and restoration efforts by local, state and federal agencies. Imprudent development of the Jordan River corridor will result in loss of critical flood storage, increased nutrient and pollutant loading, loss of fish and wildlife habitat, and loss of recreational opportunities.

In 1994 Salt Lake County passed an ordinance that established a Jordan River Meander Corridor. The ordinance established the boundaries of the Jordan River's natural meander pattern, and set limits on the types of development and uses that can occur within the designated corridor. The efforts followed closely on the heels of the county's Jordan River Stability Study, published in December 1992. That study defined the Jordan River as "…continually undergoing the processes of bank erosion, long-term channel bed degradation, bridge scour, sediment deposition and meander migration." In addition to reducing flooding potential along the river, the establishment of a meander corridor should have a positive impact upon wildlife and the environment, as the river is allowed to take a natural sinuous course and the stream banks are allowed to stabilize.

Recreation

Aside from the Jordan River, the Great Salt Lake, and a few small reservoirs in the Wasatch Mountains, there are no major lakes, rivers or reservoirs in Salt Lake County. Consequently, there are limited opportunities for recreational activities involving direct contact with water. At the north end of the county, the Great Salt Lake represents the largest recreational water attraction. Ever since the first settlers entered Salt Lake Valley, the Great Salt Lake has been a source of curiosity and a recreational attraction. Current recreational facilities on Great Salt Lake within Salt Lake County include the Great Salt Lake State Park and Saltair Resort, a privately developed facility.

Other water related recreational activities include a significant number of county and city owned swimming pools, as well as several privately owned and operated water theme parks and swimming pools. Many city and county parks offer picnicking and other day-use activities in the immediate proximity to ponds, small lakes, and streams.

One of the major uses of Jordan River water has been the establishment of privately owned and operated duck clubs. These facilities use existing flows of the Jordan River and water in irrigation canals to enhance marsh areas along the shoreline of the Great Salt Lake.

The skiing industry is a major recreational activity in the Jordan River Basin and has a favorable economic impact upon the entire state. The Forest Service manages approximately 92,000 acres of forested lands in the

Wasatch Range including much of the lands used by both alpine and cross-country ski enthusiasts. This gives the Forest Service land management oversight over much of the skiing activities in the Basin.

There are numerous county and city parks throughout the Basin. Many of these are not located near large bodies of water, though efforts have been made to incorporate direct and indirect water use when possible. Excellent examples include: Liberty Park, Sugarhouse Park and Murray City Park. Water courses have been effectively used at each of these locations. The county and others are presently working to improve the facilities around Decker Lake in an effort to promote recreational activities at what is presently used as a storm drainage and flood control facility. There are also city and county swimming pools and golf courses located in virtually every community. In the past ten years, there has been a coordinated effort to develop a Jordan River Parkway that runs from Bluffdale to Rose Park. The cities of Bluffdale, Riverton, South Jordan, West Jordan, Murray, Midvale, West Valley City, South Salt Lake and Salt Lake City, along with the County and State, are all involved in the planning and development of an integrated parkway that will eventually run the length of the river.

Recently, Salt Lake City and the LDS Church worked jointly to complete a downtown park which features City Creek. For years, City Creek has flowed through the downtown area in buried culverts. Although flood flows will continue to flow underground, the creation of a new park with some of City Creek flow returned to the surface is an indication of the public's desire to include water in their parks and living space.

NOTES

[1] 1982 Land Use Inventory of Salt Lake County, by Kevin Price, Reynold Willie, and Merrill Ridd

4

MEETING FUTURE WATER NEEDS

Chapter 2 discussed the water supply available within the Jordan River Basin. Chapter 3 described the Basin’s current population and water use and made some general estimates of future water need based on population projections made by the Governor's Office of Planning and Budget (GOPB). Chapter 4 provides a detailed assessment of future water needs and presents a general strategy for how water suppliers in the Basin plan to satisfy these needs. Particular emphasis is given to future municipal and industrial (M&I) water needs, as these will experience the most significant increases due to future population growth.

MUNICIPAL AND INDUSTRIAL WATER NEEDS

Water use in public community water systems makes up about 89 percent of the total M&I water demand in the Jordan River Basin and is the only component of M&I demand projected to increase significantly in the future. As a result, the discussion of M&I water needs in this chapter is limited to community water systems.

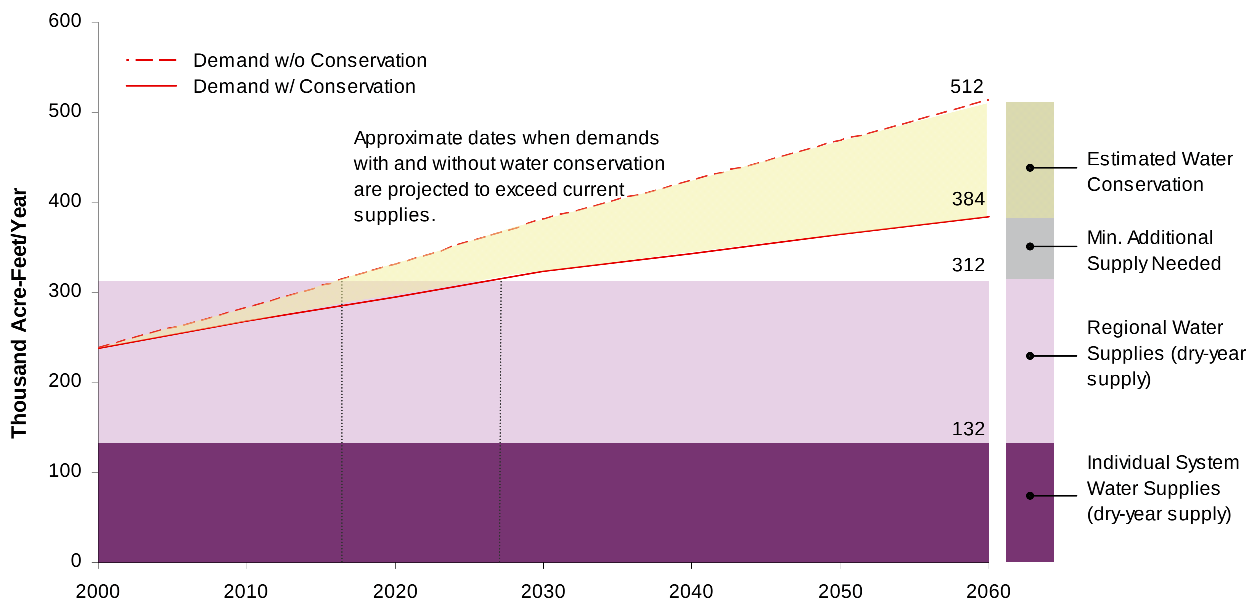
Table 17 summarizes the Utah Division of Water Resources’ estimates of current dry-year supply for 2010 and the projected demand for the 32 public community systems within the Jordan River Basin. The projected water demands are shown for 2010, 2030 and 2060. These figures reflect the state’s water conservation goal of 25% by the year 2050. The projected demands are compared to dry-year supplies rather than average annual supplies. Dry-year supply is the amount of water that would be available for use if the Basin were to experience a repeat of the driest year on record.

TABLE 17
Current Public Community System Water Supplies vs. Future Demands

Water System	2010 Demand (acre-feet)	2010 Dry-year Supply* (acre-feet)	Water Use Projections w/ Water Conservation† (acre-feet) 2030	2060	Water Supply Deficits/Surpluses‡ (acre-feet) 2030	2060
Jordan Valley Water Conservancy District (JVWCD)						
Bluffdale	5,957	0	10,454	10,551	(10,454)	(10,551)
Draper City Water	4,642	0	5,205	5,435	(5,205)	(5,435)
Draper Irr. Co. (Water Pro)	11,574	4,583	12,595	13,551	(8,012)	(8,968)
Granger-Hunter WID	22,896	9,393	26,974	26,737	(17,581)	(17,344)
Herriman	4,680	434	8,512	13,050	(8,078)	(12,616)
Kearns WID	11,758	1,816	18,481	34,141	(16,665)	(32,325)
Magna Water Company	6,081	4,308	9,558	17,657	(5,250)	(13,349)
Midvale City Water	3,905	2,800	4,934	5,767	(1,834)	(2,967)
Riverton Water	11,175	5,040	14,132	19,118	(9,092)	(14,078)
South Jordan	13,174	0	21,499	26,000	(21,499)	(26,000)
South Salt Lake Water	3,364	3,157	4,376	5,682	(1,219)	(2,525)
Taylorsville-Bennion WID	12,490	7,500	13,388	15,297	(5,888)	(7,797)
West Jordan City Water	21,248	3,000	24,343	27,199	(21,343)	(24,199)
White City Water	2,948	4,052	2,742	2,971	1,310	1,081
JVWCD	11,391	102,335	15,019	14,043	87,316	88,292
JVWCD TOTAL	**147,283**	**148,418**	**191,912**	**237,199**	**(43,494)**	**(88,781)**
Metropolitan Water District of Salt Lake and Sandy (MWDSLS)						
Salt Lake City Public Utilities	79,501	59,500	88,028	100,308	(44,426)	(56,706)
Sandy City Water	25,589	28,026	23,805	25,786	(3,805)	(5,786)
MWDSLS	0	53,514	0	0	77,438	77,438
MWDSLS TOTAL	**105,090**	**141,040**	**111,833**	**126,094**	**29,207**	**14,946**
Other Independent Water Systems						
Alta Town Water System	121	238	115	107	123	131
Boundary Springs	47	162	42	37	120	125
Copperton Water Co.	240	625	377	697	248	(72)
Dansie Water Co.	89	282	79	70	203	212
EID/Oaks Water System	214	291	336	620	(45)	(329)
Hi-Country Estates #1	81	81	83	88	(2)	(7)
Hi-Country Estates #2	152	53	136	121	(83)	(68)
Holladay Water	4,713	5,763	5,084	5,832	679	(69)
Murray City Water	9,218	13,958	12,154	11,365	1,804	2,593
SL Co. #3 - Snowbird	307	560	482	890	78	(330)
Silver Fork Pipeline Corp.	79	62	124	229	(62)	(167)
Silver Lake Company	55	81	49	43	32	38
Spring Glen Water Co.	16	28	25	46	3	(18)
Webb Wells	94	137	147	272	(10)	(135)
Young Oaks Water Corp.	7	15	11	20	4	(5)
OTHER SYSTEM TOTAL	15,433	22,336	19,244	20,437	3,092	1,899
BASIN TOTAL	**267,806**	**311,794**	**322,989**	**383,730**	**(11,195)**	**(71,936)**

* Includes an estimate of the regional water supply available to each system from JVWCD and MWDSLS, respectively.
† All water use projections come from the Utah Water Demand/Supply Model and include incremental estimates of water conservation, with a total of 25% by 2050.
‡ Positive number indicate surpluses; numbers in parentheses (purple text) are deficits.

FIGURE 15
Water Supply vs. Demand for the Jordan River Basin



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I water supply and use data collection program, 2005.

Figure 15 compares the basin-wide demands with the current estimated 2010 dry-year supply of 312,000 acre-feet per year. The solid red line shows the projected demand with conservation, while the dashed red line shows what the water demand will be without water conservation. As shown, the basin's total water demand for public community water systems was 237,000 acre-feet per year in 2000. The Division estimates that the demand will be approximately 268,000 acre-feet per year in 2010 and increase to approximately 384,000 acre-feet per year in 2060 with water conservation (512,000 acre-feet per year without conservation). The Division estimates the Basin's 2010 dry-year supply of 312,000 acre-feet per year to be in excess of 2010's projected demand by about 44,000 acre-feet or approximately 14 percent.

If the state's water conservation goals are achieved the Basin's dry-year supply is adequate to meet projected demands through about 2027. The basin's water providers will need to develop a minimum additional water supply of approximately 11,000 acre-feet per year to meet projected demands in 2030, and 72,000 acre-feet per year to meet demands in 2060 (see Table 17). However, this simple analysis is predicated on the following major assumptions:

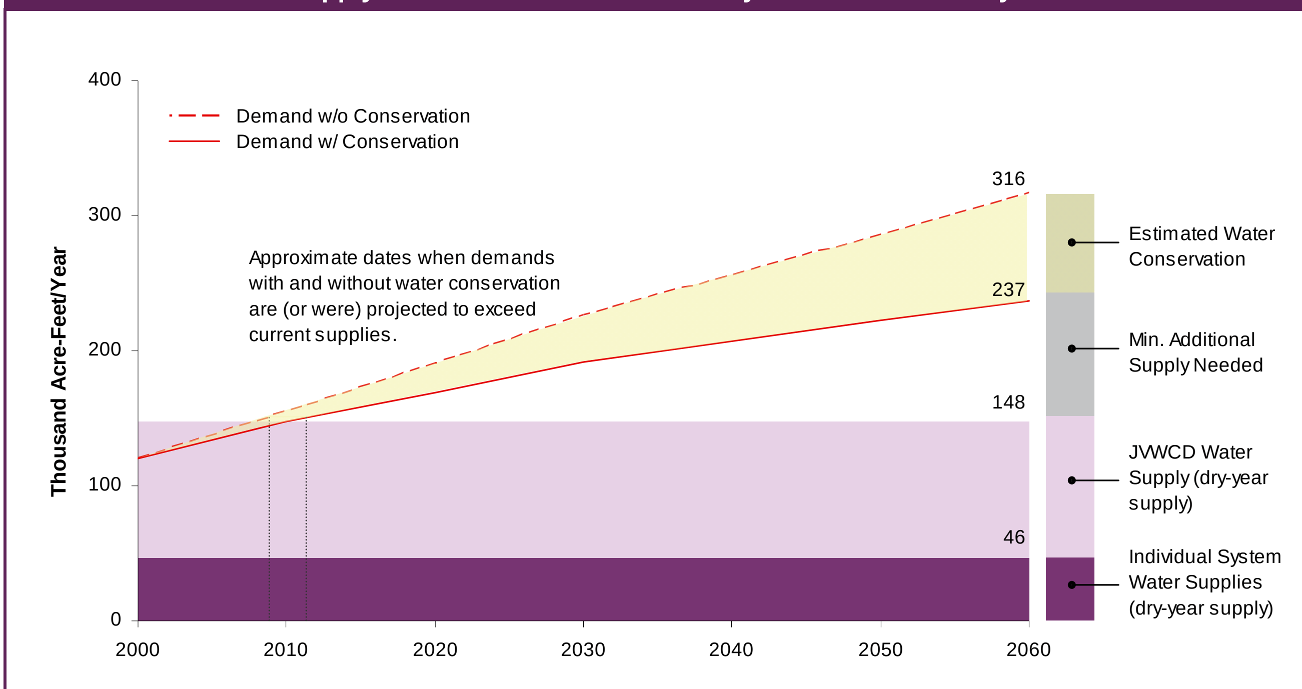
- Water conservation goals will be met.
- All water suppliers within the Basin will be willing and able to share their surpluses.
- A future dry-year water supply equal to projected demand is adequate to reliably satisfy demand.

The following paragraphs provide the reader with further details regarding the water supplies and projected demands of the two major water suppliers within the Basin and other selected individual water systems.

Jordan Valley Water Conservancy District (JVWCD)

Figure 16 shows the water supply and demands for the area of the Salt Lake Valley served by JVWCD. Data for all public community water systems within the District was listed previously in Table 17. The Utah Division of Water Resources estimates the public community system water demand within the district is approximately 147,000 acre-feet in 2010. This is projected to increase to approximately 237,000 acre-feet by

FIGURE 16
Water Supply vs. Demand for Jordan Valley Water Conservancy District



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I Water Supply and Use Data collection program, 2005.

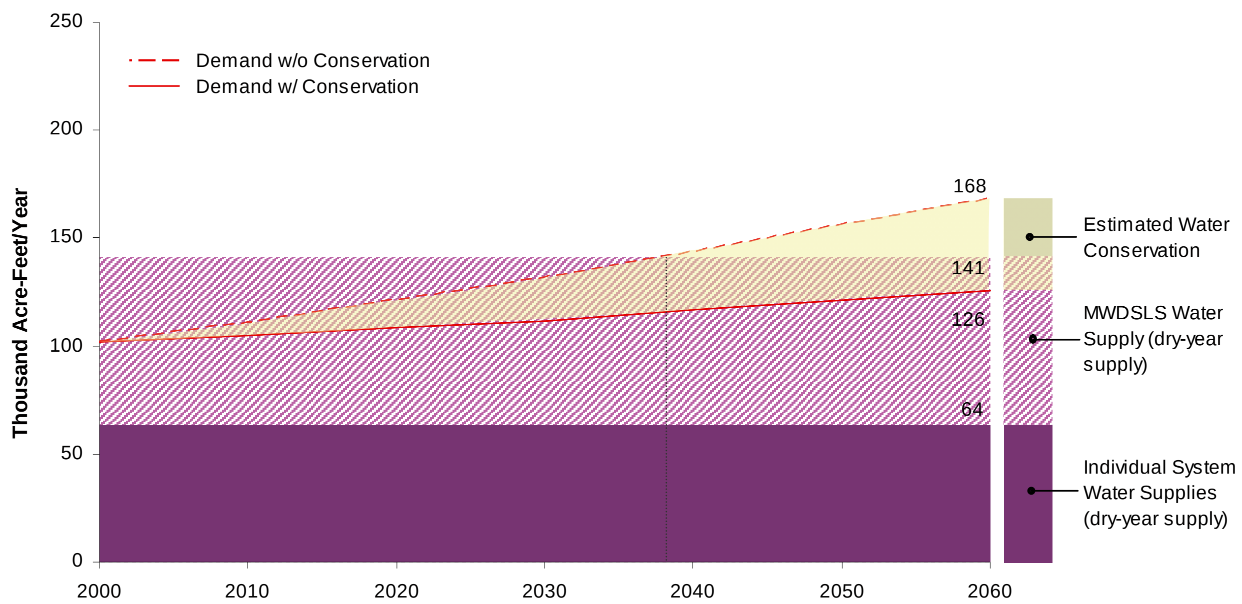
2060 with water conservation (316,000 acre-feet per year without conservation). From information provided by the District, in their Salt Lake County Demand and Supply Study, the District's 2010 dry-year supply, including member agency supplies, is about 150,000 acre-feet per year. This total includes approximately 46,000 acre-feet per year of water independently owned by the individual water systems served by the district and a dry-year supply of about 102,000 acre-feet per year provided by JVWCD.

According to Utah Division of Water Resources demand projections, with conservation, JVWCD has adequate dry-year water supplies to meet demands through about 2012 (see Figure 16) and will need to develop an additional water supply of approximately 41,000 acre-feet per year to meet projected demands of 2030 and an additional 86,500 acre-feet per year by 2060. As discussed later in this section, JVWCD has already secured additional water supplies to meet these projected demands.

Metropolitan Water District of Salt Lake and Sandy (MWDSLS)

Figure 17 shows the water supply and demands for the area of the Valley served by MWDSLS. Data for Salt Lake City Public Utilities and Sandy City, the only two public community water systems within the district, were shown previously in Table 17. As indicated in Figure 17 and Table 17, the water supply for MWDSLS is better than for the Basin as a whole or JVWCD. As shown, the Utah Division of Water Resources estimates the District's annual public community system water demand is 105,000 acre-feet in 2010. This is projected to increase to approximately 126,000 acre-feet in 2060 with water conservation (168,000 acre-feet per year without conservation). From information provided by the District in the Salt Lake County Demand and Supply study, the District currently has a dry year supply of 141,000 acre-feet per year. This total includes 64,000 acre-feet per year of water independently owned by Salt Lake and Sandy cities, and 77,000 acre-feet per year of water provided by MWDSLS. With conservation, the District's dry-year supply appears sufficient to meet projected demands well beyond 2060. Without water conservation, the District's dry-year supply would only be sufficient until about 2038

FIGURE 17
Water Supply vs. Demand for Metropolitan Water District of Salt Lake & Sandy



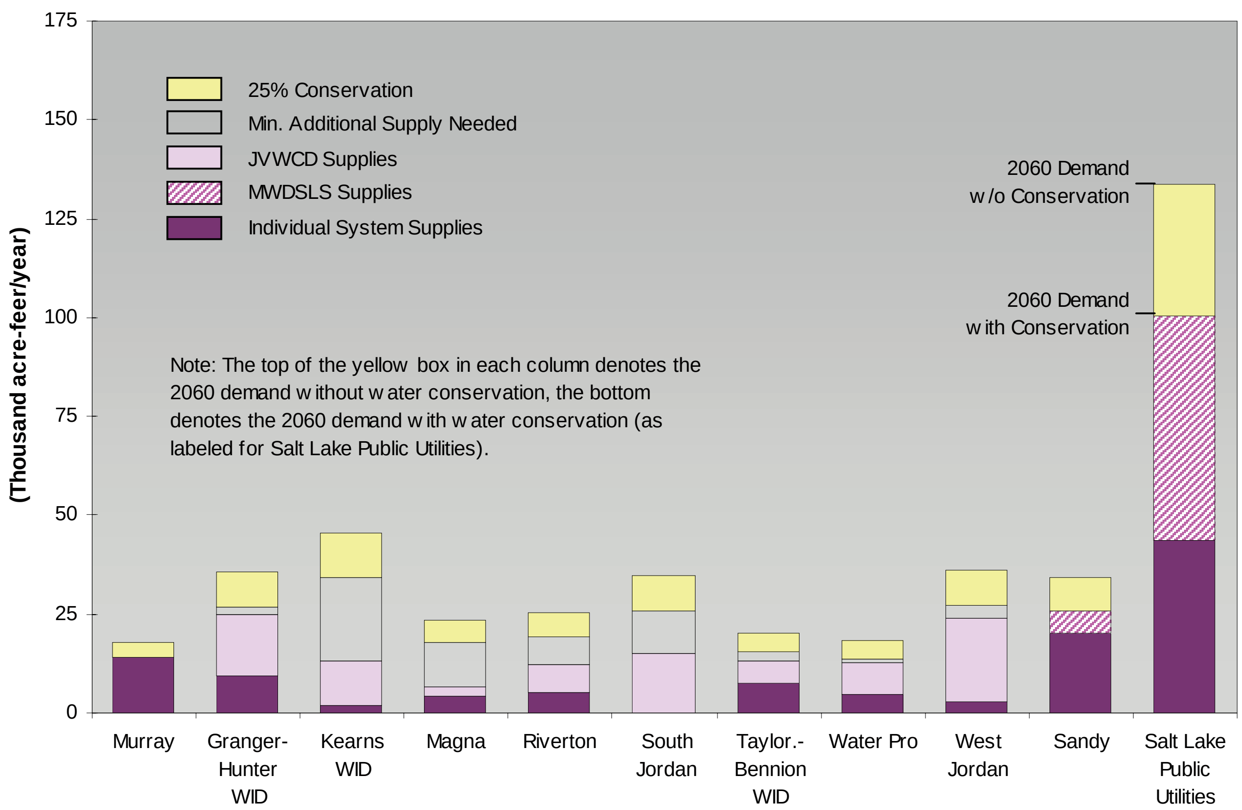
Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I Water Supply and Use Data Collection program, 2005.

Selected Individual Water Systems

Figure 18 compares the estimated water supplies currently available to the 11 largest individual Community water systems in the Basin[1] to their respective 2060 water demand projections. Murray City (shown on the far left of Figure 18) is the only water system shown that is not a member agency of either JVWCD or MWDSLS. The fact that it appears to have enough water supply to meet its 2060 demand helps explain why it has chosen to remain independent of the regional water suppliers.

The next eight (left to right) community water systems shown in Figure 18 are member agencies of JVWCD. The amount of JVWCD water supply that is shown for each entity is not a contracted amount. Rather, it is an estimate of how much supply each entity may receive in the future based on what percentage of this supply they currently use. Even with water conservation, all systems are projected to need additional supplies to meet 2050 demands. The projected minimum additional water supply needed by Kearns Water Improvement

FIGURE 18
Current Supplies vs. 2050 Demands for Selected Individual Water Systems



Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model* and M&I Water Supply and Use Data Collection Program, 2005.

District, Magna, and South Jordan are particularly significant. For numerical estimates of each system's 2060 water supply deficit, see Table 17.

Salt Lake City Public Utilities is by far the largest water system within the Jordan River Basin. Along with Sandy City, it is served by MWDSLS (see the two columns on the right of Figure 18). The amount of MWDSLS's water supply that is shown for each entity is not a contracted amount. Rather, it is an estimate of how much supply each entity may need in the future based on what percentage of this supply they currently use. As shown, Salt Lake City has enough surplus supply to satisfy projected 2060 water demands if water conservation is implemented. Even with water conservation, Sandy City will have a small deficit and will need to obtain additional supplies. Without water conservation, Salt Lake City would also not have sufficient supply. For numerical estimates of Salt Lake City's 2060 water supply surplus and Sandy City's deficit, see Table 17.

Proposed Water Management Strategies and Development Projects

Planning for Jordan River Basin's future water needs has become a complex task. In the past, water planning consisted primarily of developing new water sources. In the future, there are a number of potential water sources that can be developed to meet the projected water needs. However, these new developable sources are all expensive propositions.

Ultimately, Utah's citizens may be willing to absorb the cost of developing the new and expensive water sources rather than effecting a change in lifestyle. However, it is incumbent upon today's water planners to consider both the supply-side approach and the demand-side approach to water planning. Effective demand-side water planning such as water conservation, reuse, reduced system losses, and improved efficiency, can reduce the need for additional supplies. A brief discussion of water conservation alternatives is included in this chapter. A more thorough discussion of Municipal and Industrial Water Conservation can be found in Chapter 5.

Alternatives for meeting future water needs in the Jordan River Basin can be classified in nine basic groups as follows:

- Water Conservation
- Agricultural Water Conversion (Develop Utah Lake/Jordan River water),
- Convert industrial water to municipal use
- Water Reuse
- Conjunctive Management of Surface and Ground Water (including ground water recharge)
- Completion of Central Utah Project
- Develop additional water from the Wasatch Range streams
- Develop additional ground water
- Bear River water development

The first five alternatives: water conservation, agricultural water conservation, converting industrial water to municipal use, water reuse, and conjunctive management of surface and ground water all fall under the general heading of Managing Existing Water Supplies. The last four alternatives: completion of Central Utah Project, Develop additional water from the Wasatch Mountain Streams, Develop additional ground water, and Bear River Water Development, can all be grouped under the heading of New Water Development.

Given today's political and environmental climate, some of the alternatives listed above have more merit than others. Based upon current growth projections, meeting the future water demand will require some combination of the alternatives listed above. Each alternative may at one time or another play a part in the future.

Both JVWCD and MWDSLS have plans to implement various water management strategies, as well as to pursue traditional water development projects, to meet their respective future water needs. Details are provided below for the most significant strategies and projects.

Water Conservation

The State of Utah has adopted a goal to reduce "per capita" demand of public community water system by at least 25 percent by 2050. JVWCD and MWDSLS, as well as the majority of the individual community water systems in the Basin, fully support this goal. As shown previously in Figures 15 through 18, water conservation will play a significant role in reducing future M&I water demands and thereby helping the Basin's water suppliers meet growing water needs. Table 18 shows estimates of just how significantly 25 percent conservation will reduce future demands for the basin's major water suppliers and other independent systems. As shown, Basin-wide demands in 2050 could be reduced by over 117,000 acre-feet.

TABLE 18
Estimated Water Conservation (2050)

Water Supplier	Water Conservation (acre-feet)
JVWCD	67,400
MWDSLS	44,700
Other Systems	5,600
TOTAL	**117,700**

Source: Utah Division of Water Resources, *Utah Water Demand/Supply Model,* 2005.

Achieving the water conservation goal will require a concerted effort by the State and all the water suppliers in the Basin. Fortunately, the State and these local water suppliers have already established a strong water conservation program as a framework upon which to build. For further details regarding efforts to conserve water within the Basin as well as estimates of conservation that has already been realized, see Chapter 5 – Municipal and Industrial Water Conservation.

Agricultural Water Conversions

Table 19 contains estimates of agricultural water that will likely be converted to other uses by 2050. These estimates assume that nearly all agricultural land in the basin that is currently irrigated within each of the water system boundaries will be converted to meet growing M&I uses. Although it is impossible to predict exactly how this water will be put to use, it is likely that it will be placed in secondary irrigation systems similar to those already in place in Riverton, Draper, South Jordan and Magna. (For further details on the conversion of agricultural water to meet growing urban water demands within the Basin, see Chapter 6 - Agricultural Conversions and Other Management Strategies.)

TABLE 19
Estimated Agricultural Conversions (2050)

Water Supplier	Agricultural Conversion (acre-feet)
JVWCD	19,600
MWDSLS	5,300
Other Systems	300
TOTAL	**25,100**

Source: Unpublished report on irrigated agriculture in Utah by the Utah Division of Water Resources.

Industrial Water Conversion to Municipal Use

In addition to agricultural water conversions, there is the potential to convert some of Kennecott Corporation's industrial water supply to municipal use as the company retires its mining operations. This potential water supply is covered in more detail in Chapter 7- Water Development. It is not known when Kennecott Copper Corporation will close down its mining operations in Salt Lake County. Furthermore, it is not known just how much of Kennecott's water supply could be made available for culinary use. At the present time it is estimated that perhaps 20,000 acre-feet would be of adequate quality for culinary use and perhaps another 30,000 acre-feet could be converted to secondary use. Because of the many uncertainties associated with this potential source, it has been included here in the discussion but not in the figures and tables as a firm supply.

Water Reuse

In addition to water conservation and agricultural and industrial water conversions, there are many ways that water suppliers in the Jordan River Basin could more fully utilize the water supplies that are already developed to help meet future water needs. Some of the strategies that have proved successful elsewhere include water reuse, conjunctive management of surface and ground water, water banking and cooperative agreements, and pressurized secondary water systems. A combination of these methods will be used to help satisfy future demands in the Basin.

As part of the Central Utah Project, the Central Utah Water Conservancy District (CUWCD) has entered into an agreement with the U.S. Department of Interior to implement 18,000 acre-feet of water reuse within the Salt Lake Valley by the year 2030. Table 20 contains an estimate of how much water reuse will occur within the boundaries of each of the Basin's two major water suppliers as well as how much will occur in other independent systems.

TABLE 20
Estimated Water Reuse (2030)

Water Supplier	Water Reuse* (acre-feet)
JVWCD	9,600
MWDSLS	8,400
Other Systems	100
TOTAL	**18,100**

Source: CH2MHill in association with Hansen Allen & Luce, *Jordan River Return Flow Study,* (Salt Lake City: 2005), page 6-2.
* The values shown were used as model inputs for the *Jordan River Return Flow Study,* referenced above.

Conjunctive Management of Surface and Ground Water

Both JVWCD and MWDSLS have, or are developing projects, to conjunctively manage surface and ground water. To date, JVWCD has not been able to utilize the full capacity of its aquifer storage and recovery project (about 5,800 acre-feet per year). In the future, however, JVWCD will rely more upon this water supply to meet their needs. MWDSLS recently received funds to construct a pilot project to demonstrate the feasibility of aquifer storage and recovery. The pilot project will develop approximately 300 acre-feet per year of water for future use. If successful, MWDSLS has identified approximately 25,000 acre-feet per year of surplus stream flow that it may be able to develop for future use, using this technology.

(For further details regarding these and other water management strategies being investigated to help meet future water needs within the Basin, see Chapter 6 – Agricultural Conversions and Other Management Strategies.)

Water Development

Major water suppliers in the Basin have been working for many years on several water development projects that will soon be completed. These projects, along with additional projects planned over the next 25 years, will significantly increase the available water supply. Both JVWCD and MWDSLS receive large amounts of water from the completed portions of the Central Utah Project (CUP). MWDSLS is utilizing its allotment of 20,000 acre-feet per year of water from these completed portions of the CUP (see Table 21). This supply is already included in the 2010 dry-year supply as shown in figures 15 through 17. Once the Utah Lake System of the CUP is completed (est. 2021), JVWCD will receive an additional water supply of 21,400 acre-feet per

TABLE 21
Planned Water Developments

Water Development	Approximate Year(s)	JVWCD (acre-feet)	MWDSLS (acre-feet)	Salt Lake City (acre-feet)	TOTAL
New Groundwater Wells	2015-2020	5,000		12,000	**17,000**
MillCreek Surface Water	2013			3,300	**3,300**
Little Cottonwood and Bell Canyon	2010-2020		1,094		**1,094**
Central Utah Project, Utah Lake System†	2020-2030	21,400	8,600		**30,000**
Central Water Project	2014	11,680			**11,680**
Bear River Project	2040	50,000			**50,000**
TOTAL	**-**	**88,080**	**8,094**	**15,300**	**113,074**

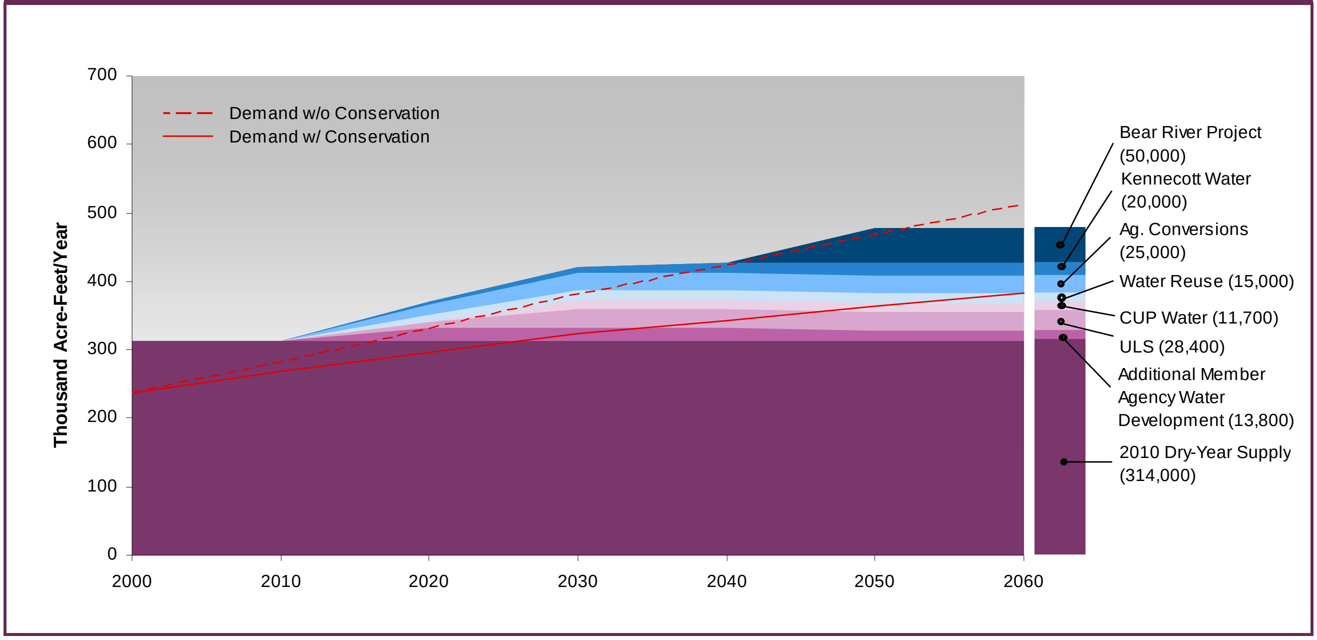
† Planned deliveries from the portion of the CUP that has not yet been constructed.

year and MWDSLS will receive 8,600 acre-feet per year. These amounts may change to 16,400 acre-feet per year for JVWCD and 5,600 acre-feet per year for MWDSLS once the Provo Reservoir Canal Enclosure Project is completed. This reduction of 8,000 acre-feet will be offset by seepage and evaporation savings from the enclosure.

Salt Lake City is currently pursuing several new water sources. Salt Lake City is planning on developing additional wells at various locations. The plan is to manage these well in a conjunctive use fashion. That is to say that the city will use surface water when it is available and only call upon these new wells in dry-years. Managed this way, the new wells will yield an average of 3,000 acre-feet per year, but could provide up to 12,000 acre feet during a dry-year. Salt Lake City also has plans to develop an additional 3,300 acre-feet per year from Mill Creek.

Beginning in 2007, JVWCD will have a ground water supply of 8,200 acre-feet available as a part of the Southwest Jordan Valley Ground Water Treatment Project. This project is expected to operate only until about 2040 and, therefore, will only be an interim supply. JVWCD also plans to develop 5,000 acre-feet per year of additional ground water and receive a substantial boost to its supplies as the recipient of 50,000 acre-feet per year of water from the Bear River Project. Salt Lake City has plans to develop additional water supplies independent of the activities of JVWCD and MWDSLS from both ground water (12,000 acre-feet per year) and surface water sources (3,300 acre-feet per year). The combined total of all these development projects will make approximately 106,474 acre-feet per year of water available to meet future demands. (For further details regarding State and local efforts to develop additional water supplies within the Basin, see Chapter 7 – Water Development.)

FIGURE 19
Projected Future Water Supply vs. Demand for the Jordan River Basin



Source: Utah Division of Water Resources, Jordan Valley Water Conservancy District and Metropolitan Water District of Salt Lake & Sandy.

Summary

As estimated previously in Table 17 and Figure 15, the Basin's current dry-year supplies are sufficient to match growing demands until about 2027 if water conservation is implemented. In 2060, even with a net reduction in water demand due to water conservation of approximately 117,000 acre-feet per year, demands will outstrip the currently available water supply by approximately 70,000 acre-feet per year. This "deficit" will be satisfied by a combination of innovative water management strategies and other traditional water development projects estimated to amount to approximately 150,000 acre-feet per year (combined total of Tables 19 thru 21). Figure 19 shows how the projected future water supplies in the Basin will provide a significant cushion above the future projected demands with water conservation. This cushion, estimated at about 25 percent, will help the Basin's water suppliers maintain a reliable supply to satisfy future water needs beyond 2060.

AGRICULTURAL, ENVIRONMENTAL AND RECREATIONAL WATER NEEDS

As stated previously in Chapter 3, agricultural water demands in the Jordan River Basin are declining and will not represent a significant use of water by the year 2060. Any agricultural water needs remaining in 2060 will easily be met using existing water rights.

As the Basin's population nearly doubles over the course of the next several decades, the water needs of the environment will become more and more acute. However, as new water is imported into the Basin to satisfy growing M&I demands (CUP and Bear River Project), return flows from these imports will tend to offset some of the negative environmental impacts. In the future, water quality concerns within the Basin will likely be the most critical environmental issues. More stringent monitoring and adoption of stricter water quality regulations may be necessary to preserve and sustain the delicate ecological functions unique to the Basin. Water planners and managers should continue to work closely with the environmental community and water quality professionals to identify issues and craft appropriate solutions. (For more detail on what needs to be done to preserve the environment and improve water quality in the Basin, see Chapter 8 – Water Quality, the Environment, and Other Considerations.)

Recreational water needs within the Basin will increase as the population increases. In order to satisfy these needs, additional facilities at the Basin's various water bodies may be required. Instream flows in the Jordan River and its tributaries may also become a significant issue that may compete with water reuse and other water development options. Careful consideration and public input will be required. Water planners and managers should work to incorporate these needs into their policies and long-term water management strategies.

NOTES

[1] As noted in Table 1, JVWCD and MWDSLS surplus supplies are divided amoung their member agencies based on the current percentage of the total supply that they need to meet their demands. These are not contracted amounts and are only shown here to provide the reader with an idea of where significant deficits or surpluses may exist.

5

MUNICIPAL AND INDUSTRIAL WATER CONSERVATION

Water conservation plays an important role in satisfying future water needs in the Jordan River Basin by reducing future water demands, as well as decreasing the costs associated with additional water development. If water providers implement water conservation programs and measures now, they will be better able to meet short-term and long-term demands. Since the bulk of new water demands will be in the municipal and industrial (M&I) sector, the focus of Chapter 5 is M&I water conservation.

UTAH'S MUNICIPAL AND INDUSTRIAL (M&I) WATER CONSERVATION GOAL

The State has developed a specific goal to conserve municipal and industrial (M&I) water supplies. This goal is to reduce the 2000 "per capita" water demand from public community water systems[1] by at least 25 percent before 2050. Specifically, statewide per capita demand will need to decline from 295 gallons per person per day (gpcd) to a sustained 220 gpcd or less. This goal is based on modeling and research indicating that indoor and outdoor water use can be reduced by at least 25 percent without a significant change in lifestyle. Indoor reductions will be realized through the installation of more efficient fixtures and appliances as well as public education to change people's water wasting habits. Outdoor reductions will be realized through public education, emphasizing more efficient application of water on landscapes, and proper maintenance of those landscapes. Consuming about 45 percent of the total public water supply, outdoor residential demand is the largest area of consumption.[2] This outdoor usage represents the greatest potential for water conservation of all M&I water uses.

Reducing outdoor water waste will play an important role in meeting future water needs.

The per capita water consumption in Utah is sometimes compared to other states and to the national average of 179 gpcd. Such comparisons are problematic since they are often made without consideration of several important factors. Residents of states receiving high amounts of precipitation do not use public water supplies to water lawns and landscaping. The residents of the more arid states, however, must use public water supplies to water lawns and gardens. Another important factor is that the northern states have shorter growing seasons and water for lawns and landscaping require less water than do the southern states. Also, heavily industrialized states have a higher gpcd since the industries often use public water supplies for their processes. The cost of water can vary widely depending on distance from its supply source to its end-use, its need for pumping, treatment and other factors.

Similarly, it is not valid to make direct comparisons of total gpcd use between cities within a given state. Some cities are “bedroom communities” with little or no industry. Some cities have large industrial areas, which drive up the per capita water use. Other cities have a large daily influx of commuters who use water in the course of their jobs and then leave at the end of the day. This affects the water use in both the city they live in and the one to which they commute. Salt Lake City has a ratio of 2.45 commuting workers for every resident worker,[3] the second highest ratio in the whole country.[4] Finally, residential lot sizes, types of landscaping, and other water uses vary among communities. Given all these variables, per capita comparisons between states and between cities are meaningful only when relevant factors are considered. It is more beneficial for individual water suppliers and water consumers to track their own usage and focus on conserving water in the ways that make the most sense for their respective circumstances.

Probably the most equitable way to compare water use between communities is to consider only the indoor residential water use. The American Water Works Association has found that such indoor use is consistent throughout the United States at about 69 gpcd.[5] The Utah Division of Water Resources conducted an independent assessment that indicated that Utahns use, on average, 65gpcd for indoor residential use; slightly less than the national average.[6]

Water suppliers within the Jordan River Basin have set specific water conservation goals that will help them and the State reach their respective objectives. Jordan Valley Water Conservancy District (JVWCD) has developed a detailed plan to meet its aggressive goal of reducing water use by 25 percent by 2025.[7] Similarly, South Jordan Municipal Water has set a goal to reduce per capita consumption by 25 percent by the same year. Magna Water Company has set a goal to reduce per capita water consumption in its city five percent per year on an ongoing basis. Achievement of these goals will allow JVWCD and these cities to delay or reduce the costs associated with new water supply infrastructure construction. Salt Lake City, Sandy City, and the Metropolitan Water District of Salt Lake & Sandy have each established conservation goals and plans. As part of the petition for CUP Utah Lake System water, contractual goals have been established to reduce per capita water consumption by 25 % by the year 2050. This is consistent with goals established by the State. It would be wise for other water suppliers in the Basin to follow and set specific water conservation goals and develop plans and policies to meet them.

Establishment of Baseline Water Use

In order to monitor the success of water conservation measures, water providers must accurately determine baseline water use. This typically includes all public M&I uses but does not include self-supplied industries, private domestic, and other non-community systems. Establishing the specific local baseline water use enables water suppliers to track the success of their own conservation efforts. This baseline use is usually expressed as gallons per capita per day (gpcd). Although Statewide and Basin values provide useful information for comparison purposes, individual communities should establish their own baseline use rates. This will assist them in setting appropriate goals and monitoring progress toward reaching those goals through the various conservation measures and programs they implement.

PROGRESS THUS FAR

Statewide Summary

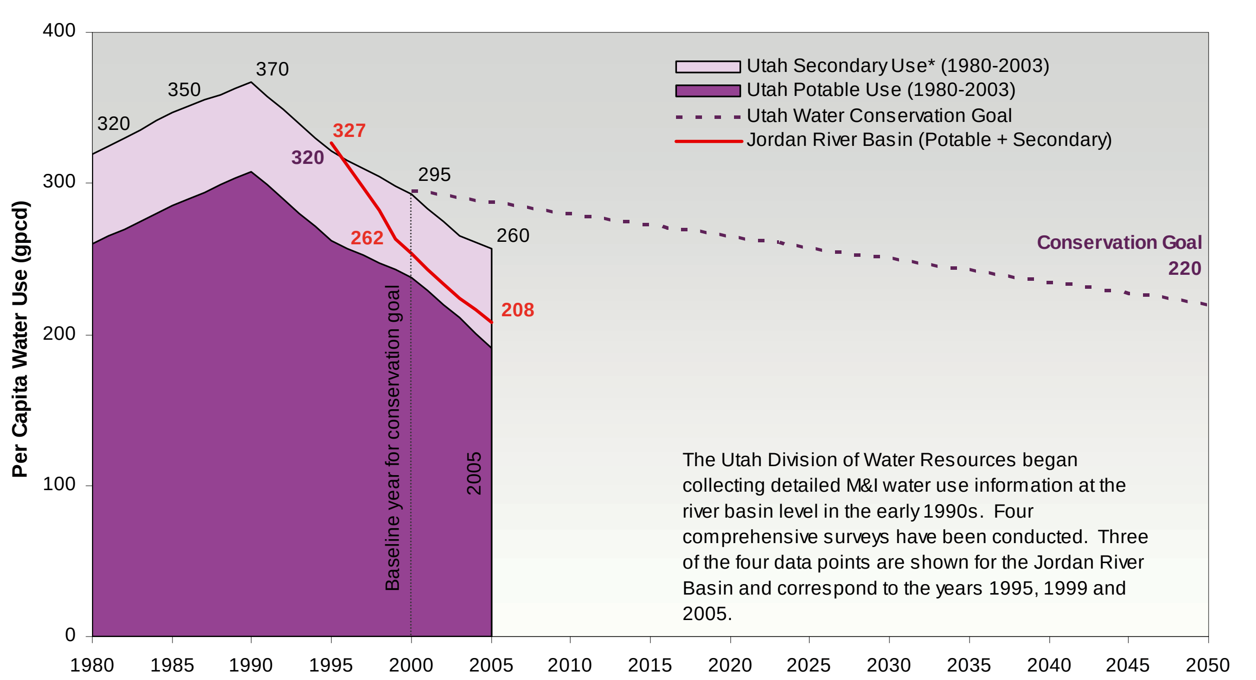
The Division of Water Resources recently completed a statewide summary of M&I water use. According to data in the summary, the statewide 2005 per capita use of publicly supplied water has declined from the 1995 level of 321 gpcd to 260 gpcd, a reduction of 19 percent in ten years. This represents an overall 2 percent per year reduction, which is significantly better than the 0.5 percent per year reduction needed to meet the goal of a 25 percent reduction by 2050. While the overall goal has not yet been met, it is clear that the State is making excellent progress.

Jordan River Basin

The initial survey, which established a statewide per capita water use, also determined that the total use of public water supplies was 327 gpcd in the Jordan River Basin (similar to the statewide estimate of 321 gpcd). In 2005, the Jordan River Basin value dropped to 207 gpcd. This is a 37 percent reduction in only ten years and represents and overall reduction of 3.7 percent per year. It also exceeded the target goal of 240 gpcd. Clearly, water suppliers and their customers in the Jordan River Basin have responded to the call for water conservation and have achieved significant results.

The Division has collected total M&I water use data from the Jordan Valley Water Conservancy District (the Basin's largest water supplier) every year since 2000. According to these data, water use within the District in 2001 declined about 14 percent below 2000 levels. In 2002, an additional 9 percent decrease in water use was realized. In 2003, water use remained the same, and in 2004, water use increased 5 percent. The result is

FIGURE 20
Per Capita Water Use of Public Community Systems in Utah and the Jordan River Basin



Source: USGS, *Estimated Water Use in the United States,* 1980, 1985 & 1990, and Utah Division of Water Resources, M&I Data Collection Program.

a net decrease over the four-year period of 18 percent. This represents an overall 4.5 percent per year reduction, and indicates the District is well on its way to meeting its aggressive conservation goal of 25% by 2025.

The reduction in total M&I use observed throughout the Jordan River Basin seems to indicate that the water conservation message is being heard, and that Basin residents are modifying their habits to become more efficient in their water use. This is very encouraging. However, it remains to be seen how much of this reduction is due to the severity of a recent drought and how much is the result of permanently-changed habits.

WATER CONSERVATION'S ROLE IN MEETING FUTURE NEEDS

If Utah successfully achieves its M&I water conservation goal of at least 25 percent per capita reduction by 2050, the total statewide demand will be reduced by approximately 500,000 acre-feet per year. This represents the most significant component in meeting Utah's future water needs. Approximately 25 percent of this amount, or 117,000 acre-feet per year, will occur within the Jordan River Basin. Without water conservation, it is estimated that by the year 2050 the Jordan River Basin would experience a water demand of about 508,000 acre-feet per year. With conservation, this demand can be reduced to approximately 391,000 acre-feet per year. The next section details specific activities water suppliers can employ to achieve further water conservation.

WATER PROVIDER ACTIVITIES TO MEET WATER CONSERVATION GOALS

In July 2003, the Division of Water Resources published an M&I water conservation plan for the State of Utah.[8] This plan outlines the State's strategy to meet its water conservation goal and contains specific programs and other activities to help water providers meet their goals. These are provided below. The Division is responsible for administering these strategies and will help water providers achieve their goals.

- Prepare Water Conservation Plans
- Support the Public Information Program of the Governor's Water Conservation Team
- Implement Best Management Practices
- Set an Example at Publicly-Owned Facilities

Prepare Water Conservation Plans

In 1998 and 1999, the Utah Legislature passed and revised the Water Conservation Plan Act. This Act requires water retailer with more than 500 connections and all water conservancy districts to prepare water conservation plans and submit them to the Division of Water Resources by April 1999. Those required to submit water conservation plans must update and resubmit them every five years from the date of the original plan.

In 2004, the Legislature revised the Act, making some significant changes to enhance the quality of water conservation plans and increase the likelihood of compliance. The changes made in the 2004 Amendment to the Act are summarized below:[9]

- Water conservation plans shall include an overall water use reduction goal, implementation plan, and a timeline for action and measuring progress.
- Water conservancy districts and water providers shall devote a part of at least one regular governing body meeting every five years to discuss and formally adopt the water conservation plan and allow public comment.
- Water conservancy districts and water providers shall deliver a copy of the plan to the local media and the governing body of each municipality and county to whom they provide water.
- The Division of Water Resources shall publish an annual report in a newspaper of statewide distribution a list of water conservancy districts and water providers that have not submitted a plan or five-year update to the division.
- No entity shall be eligible for State water development funding without satisfying the water conservation plan requirements outlined in the act.

In addition to these legislative requirements, the Board of Water Resources also requires that petitioners for its funds implement a progressive water rate structure and a time-of-day watering ordinance (explained later in this chapter).

Table 22 shows the status of the required conservation plans within the Basin as well as the dates the updates are due. The “recommended measures” and “implemented measures” as shown in Table 20, were derived from *easily* identifiable conservation goals (or intended future actions) and current measures being implemented as stated within the conservation plan updates.

As of April, 2007, 95 percent (18 out of 19) of the water retailers and conservancy districts in the Jordan River Basin, who are required to submit a plan or update, have done so. South Salt Lake Culinary Water is the only supplier that has not submitted a timely update to their original plan. In addition, 56 percent (5 out of 9) of the water suppliers who are not required to submit conservation plans have voluntarily done so (see Table 23).[10]

TABLE 22
Status of Water Conservation Plans—Required Communities

Community System	Update Due	Measures Recommended	Measures Implemented	Community System	Update Due	Measures Recommended	Measures Implemented
Bluffdale Water System	Aug 2009	2,4,5,6,7	2,3,4,5,6,7	Riverton Culinary Water	June 2009	1,3,4,6,7	1,3,4,6,7
Draper City Water System	Dec 2009	4,6,7	1,6	Salt Lake City Corporation Culinary Water	April 2009	2,4,6,7	2,3,5,6,7
Granger-Hunter Improvement District	May 2009	2,3	2,6,7	Sandy City Corporation	Oct 2009	2,3,6,7	1,2,3,4,5,6,7
Herriman City	Dec 2009	7	1,2,3,7	South Jordan Municipal Water	Nov 2009	4,5,6,7	2,3,4,5,6,7
Holladay Culinary Water	Dec 2009	1,2,3,6,7	1,3,6,7	South Salt Lake Culinary Water	**June 2005**	3,5,6,7	7
Jordan Valley Water Conservancy District	April 2009	2,3,4,6,7	2,3,6,7	Taylorsville-Bennion Improvement District	Oct 2010	2,3,6,7,	4,6,7
Kearns Improvement District	Feb 2011	2,5,6,7	3,6,7	Water Pro	Aug 2009	2,3,5,6,7	3,5,6,7
Magna Water Company	July 2010	4,6,7	1,2,3,4,5,6,7	Magna Improvement District	July 2011	2,3,4,6,7	2,3,4,5,6,7
Midvale City Water System	Nov 2009	2,3,6,7	2,6,7	White City Water Improvement District	Jan 2012	3,5,6,7	3,5,6,7
Murray City Water	Feb 2009	2,5,6,7	1,3,4,6,7				

Source: Utah Division of Water Resources, 2007.
List of measures:

1- Time-of-day or other water restrictions
2- Landscape ordinances and/or programs
3- Conservation pricing
4- Secondary system upgrades and/or Water reuse
5 Water metering upgrades
6 Public education and outreach programs
7 Other state recommended measures

Water providers within the Basin clearly recognize the importance of water conservation plans and have set a good example for other water providers throughout the State. Their success in achieving a 37 percent reduction of water use in ten years indicates that these plans are working. The majority of these water providers outlined overarching water conservation goals, such as reducing per capita or outdoor water use by 5 to 25 percent by 2025 (inline with the Jordan Valley Water Conservancy District goal) or during the five years until the next plan update is required. In order to accomplish this and other goals, water providers and community systems have identified conservation measures that are applicable for their region.

At the crux of many of these plans, is a well thought out and implemented public education and outreach program. Many conservation actions, if not all, require public participation to some degree. Education and outreach programs are an integral aspect in increasing public awareness regarding wise water use and ultimately fostering action taken by the public to conserve water. Several water communities, such as Kearns Improvement District and Magna Water Company, have presented within their respective conservation plans the need for continuous and bolstered public education and outreach programs. These programs range in simplicity from water conservation-oriented websites to active and more complex programs involving elementary school youth, all in effort to instill a long-term water conservation ethic. Other water providers such as JVWCD, Sandy City and Salt Lake City and Metropolitan Water district of Salt Lake and Sandy have constructed education gardens that allow visitors to learn of water conserving practices and see them in action. Public education and outreach is an important strategy to be implemented by water providers in order for these providers to meet their specific water conservation goals and increase public involvement.

TABLE 23
Non-required Communities*

Community System	Submitted Plan
Boundary Springs Water Users	No
Cool Springs Mutual Water Company	Yes
Copperton Improvement District	No
Golden Gardens	No
High Country Estates	No
McDonald Condominiums	Yes
Metropolitan Water District of Salt Lake and Sandy+	Yes
Silver Lake Company	Yes
Snake Creek Subdivision	Yes

Source: Utah Division of Water Resources, 2007.
* No conservation plan or update required (fewer than 500 connections).
+ Metropolitan Water District of Salt Lake and Sandy sells water wholesale only.

Some water providers have adopted the Jordan Valley Water Conservancy

District's (JVWCD) approach to conserve water or expressed their intention to participate with the JVWCD in accomplishing their own, as well as the District's water conservation goals. A large component of this effort is that of decreasing outdoor water use through efficient landscaping techniques and irrigation practices. Landscape ordinances, such as the "Model Water-Efficient Residential and Commercial Landscape Ordinances" developed by the JVWCD to promote water-efficient landscapes, should be pursued and adopted or similar ordinances crafted. Some water providers briefly discussed such actions in their conservation plans. For example, Midvale City Corporation sponsored classes, which provided an opportunity for participants to acquire the knowledge and skill needed regarding landscape design and low-water landscaping principles.

In order to ensure action is taken, some water suppliers provided a "cost-benefit analysis" within their conservation plan, briefly describing the expected results of the implemented conservation action as well as presenting an implementation schedule and budget, such as in the West Jordan City Utilities' and Jordan Valley Water Conservancy District's conservation plans. Such effort is encouraged by the Division of Water Resources.

These are a few examples of measures detailed within community system water conservation plans. These plans are meant to be modified as local circumstances change and be utilized in such a manner to ensure effective conservation measures are identified and implemented following a timeline deemed appropriate by community leaders, water managers and suppliers. The Division of Water Resources encourages each community to implement and/or assess measures stated within their respective conservation plans.

Support the Public Information Program of the Governor's Water Conservation Team

All local water providers have the opportunity to choose between creating their own Public Information Program (PIP) or simply providing support for the public information program created by the Governor's

Water Conservation Team. These programs are designed to educate the public by providing water conservation information and education. The Division of Water Resources supports these programs by providing information through a water conservation web page, a water-wise plant tagging program and web page, and water conservation workshops, all of which are available to water providers for use in their own PIP campaigns.

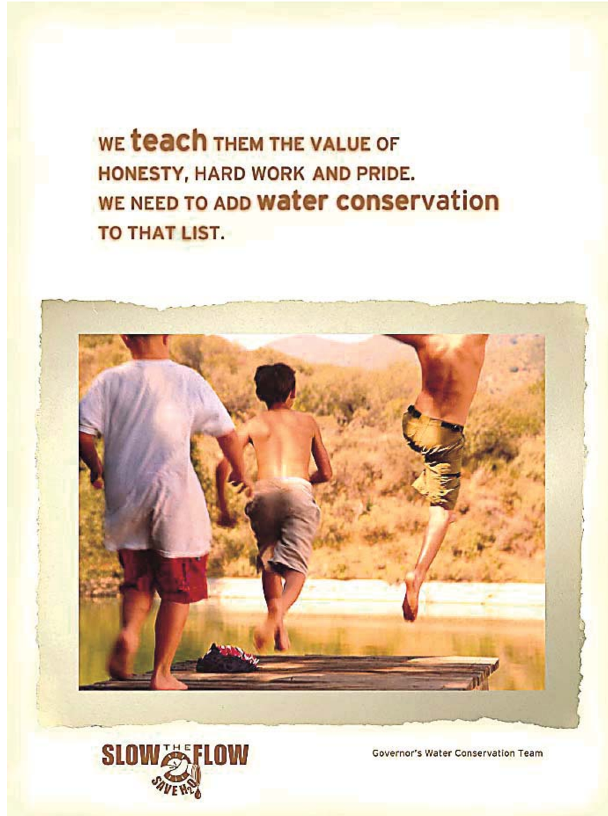
Governor's Water Conservation Team

During the recent drought, Utah's Governor created the Governor's Water Conservation Team to coordinate a statewide water conservation media campaign. The team is chaired by the Director of the Utah Division of Water Resources and is made up of key water officials from the State's five largest water conservancy districts and metropolitan water districts (including the Metropolitan Water District of Salt Lake and Sandy, and the Jordan Valley Water Conservancy District), and representatives from the Governor's Office of Planning and Budget, the Rural Water Association of Utah, the Utah Water Users Association, the landscape industry, and others.

The mission of the Team is to develop a statewide water conservation ethic that results in a reduction in M&I water use of at least 25 percent by the year 2050. Building upon the successes and name recognition of Jordan Valley Water Conservancy District's "Slow the Flow" campaign, the team is working together to educate Utahns about water conservation. The intent is for State and local entities to better communicate a consistent water conservation message to their constituents.

Media Campaign

The media campaign consists of a variety of radio, television and print ads disseminated as broadly as possible to Utah residents. Although these ads had their largest exposure during key periods of the recent drought (2001-2004) they continue to be produced and disseminated to remind Utahns of the need to develop a long term conservation ethic. All ads are available online at: www.conservewater.utah.gov and www.slowtheflow.org.



The Governor's Water Conservation Team has produced several posters, brochures, TV, radio and printed ads.

Water Conservation Web Page – www.conservewater.utah.gov

Over the past few years of drought, public interest in water conservation has grown tremendously. With it has come a demand to communicate a consistent and effective water conservation message. Recognizing this need, the Division of Water Resources created a water conservation web page to promote effective water conservation habits in Utah. This web page has been online since the spring of 2002 and contains valuable materials for individuals, educators, and water supply agencies.

Water-Wise Plant Tagging Program and Web Page – www.waterwiseplants.utah.gov

The Division of Water Resources, in cooperation with USU Extension, has developed a water-wise plant tagging program to promote the use of native and other drought-tolerant plants in Utah landscapes. This program distributes promotional posters and plant tags to participating nurseries and garden centers. Tags attached to the plants help customers find and identify water-wise landscaping species. Information to identify and select plants for landscapes, including nearly 300 plant species with pictures and descriptions of water needs, hardiness, and other characteristics, is available on the above-mentioned website. To date, the program has provided well over 500,000 tags, which are displayed in nearly 80 nurseries and garden centers throughout the State.

Water Conservation Workshops

Since the winter of 2000, the Division of Water Resources has conducted numerous workshops in communities around the State to introduce water conservation planning concepts. The workshops are well-attended and highlight concepts to create effective Water Conservation Plans and also include ways water suppliers can use water rates as a means to provide conservation incentives to their customers. As a result of these workshops, several communities have adopted such water rate structures. The workshops have been a success and the Division will continue to conduct them, along with private consultations, to help interested entities with their water conservation efforts.

In addition to these educational workshops, the Division and other State and local agencies have co-sponsored several Large Water User Workshops, administered by the USU Extension office, throughout the State. Aimed at large commercial and institutional landscapes, these one-day workshops give landscape managers and their crews the opportunity to learn about irrigation system efficiency, plant health, and proper turf maintenance. Each participant in the workshop receives a complete class workbook, a full set of water audit catch cups, and a soil probe. Details of the workshop, schedule, and enrollment information are available at: www.conservewater.utah.gov/lwuw

Implement Best Management Practices

The Division of Water Resources recommends that the Basin's water providers consider using the following list of Best Management Practices (BMPs) in their water conservation planning efforts. Water providers should implement the mixture of these practices that best fits their own unique needs. Broad implementation of these BMPs will help the individual water suppliers and the State achieve declared water conservation goals.

BMP 1 - Comprehensive Water Conservation Plans

- Develop a water management and conservation plan as required by law. Plans are to be adopted by the water agency authority (for example, city council, water district board of trustees) and updated no less than every five years.

Currently, all of the Jordan River Basin's water suppliers have water conservation plans in place.

BMP 2 - Universal Metering

- Install meters on all residential, commercial, institutional, and industrial water connections. Meters should be read on a regular basis.
- Establish a maintenance and replacement program for existing meters.
- Meter secondary water at the most specific level possible, somewhere below source water metering. Individual secondary connection metering should be done as soon as technology permits.

In order to effectively bill customers according to the amount of water they use, the connection must be metered and these meters must be read frequently. The metering of potable (drinking) water connections is a high priority for most public community water systems within the Jordan River Basin. As indicated in the water conservation plans submitted to the Division of Water Resources, not only do these systems meter their connections but most of them actively read and replace meters to assure they are functioning properly.

While potable water lines are metered, individual secondary water connections are rarely monitored. Meters on secondary water lines typically clog and otherwise malfunction because secondary water is rarely treated to remove sediment and debris that is removed in drinking water treatment. These problems are not easy to overcome and may require expensive retrofits that are not currently feasible. Eventually, however, a better accounting of secondary water use by the end user will be required. This may make it necessary for secondary water providers to apply some degree of treatment for the water or use a meter that will operate satisfactorily with untreated water.

BMP 3 - Incentive Water Conservation Pricing

- Implement a water pricing policy that promotes water conservation.
- Charge for secondary water based on individual use levels as soon as technology permits.

Table 24 lists average water prices for potable water of several cities in the Jordan River Basin. As shown, the cost per 1,000 gallons in the Basin is slightly higher than the Utah average but is still well below the national average. Some reasons that may explain why these costs are lower than the national average include the following:

- Much of the Basin's population is located near mountain watersheds which have been easily developed to gravity feed a significant portion of the water needs;
- Water derived from the mountains is of high quality, without pollutants, and needs less treatment.
- Property taxes are used to pay a portion of the water costs.
- Some communities have secondary water systems which provide less expensive, untreated water for outdoor irrigation; and
- Federally subsidized water projects provide inexpensive water to a significant portion of the population.

Simply raising water rates may not be the best solution to conserving water. Water pricing strategies that provide an incentive to customers to became more efficient and use less water should be implemented. Rate structures should also be designed to provide sufficient income to finance system maintenance and improvements and avoid capital shortfalls, as successful conservation generally reduces revenue. Some of the more effective rate structures are discussed briefly below. See Figure 21 for a visual representation and example bill summaries for each rate structure.

In the Jordan River Basin, all of the 23 major suppliers charge a base fee. The lowest base fee is $2.88 per month, the highest is $36.00 per month, while the average is $14.33 per month. In some cases this base fee provides a minimum amount of water, while in other cases it does not. The amount of water provided for the base fee ranges from zero (6 suppliers) up to 20,000 gallons per month. Ideally, base rates should include only operating costs and not provide any water associated with it.

Uniform Rates

In this rate structure the unit price for water is constant or flat, regardless of the amount of water consumed. It provides no price incentive for water conservation.[11] Eleven of the 23 major water suppliers in the Jordan River Basin (48%) have a uniform rate structure. The unit price varies from a minimum of $0.72 per 1,000 gallons to a maximum of $2.07 per 1,000 gallons with an average of $1.39 per 1,000 gallons.

TABLE 24
Potable Water Prices of Various Communities in the Jordan River Basin[1,2]

Community System	Number of Accounts	Estimated Cost per 1,000 gallons	Average Monthly Bill
Alta	63	$2.00	$89.66
Bluffdale	1,120	$1.21	$28.81
Draper	2,510	$2.79[3]	$44.99
Herriman City	340	$0.99	$27.91
Holladay	3,750	$1.01	$33.62
Midvale	2,650	$0.93	$21.52
Murray	8,500	$1.66[4]	$37.37
Riverton	6,700	$1.42	$22.62
Salt Lake City	80,500	$1.55	$38.47
Sandy	25,400	$2.27	$40.53
South Jordan	11,300	$2.60[5]	$52.00
South Salt Lake	2,250	$1.65	$44.17
Taylorsville-Bennion	16,000	$1.00	$24.56
West Jordan	22,330	$1.84[5]	$25.83
West Valley City	24,000	$1.08	$35.17
Jordan River Average	--	$1.60	$35.87
Utah State Average	--	$1.15	$32.96
National Average	--	$2.50	$25.70

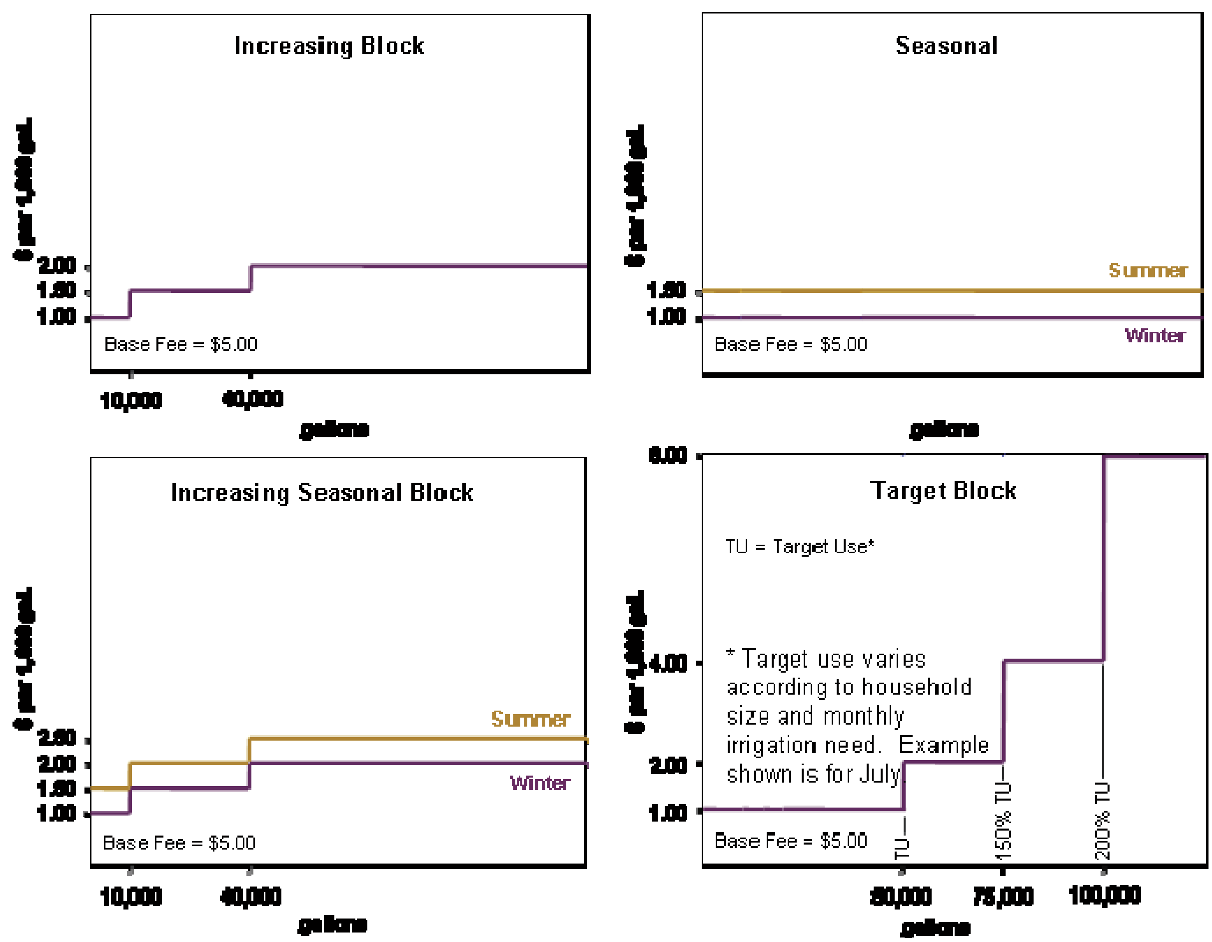
1. Except for the Jordan River average cost per 1,000 gallons, all averages are weighted averages.
2. Does not include non-potable water, which is generally cheaper, that may be delivered within the listed community.
3. Unless otherwise noted, data from: *Utah Division of Drinking Water, Survey of Community Drinking Water Systems, 2002.*
4. Ibid., 2001.
5. Ibid., 2003.
6. Ibid., 2005.

Increasing Block Rates

Most pricing structures typically have a base fee, which must be paid whether or not any water is used. Sometimes a fixed amount of water is made available at no additional cost. The price of subsequent increments of water supplied then increases in a step-wise fashion. This rate structure encourages efficiency only if the steps in the incremental price are sufficient to discourage excessive use.

The increasing block rate (sometimes called progressive rate structures) is currently used by about 42 percent of Utah's drinking water systems.[12] In the Jordan River Basin, 52 percent (12 of 23) of the major suppliers employ this type of rate structure. Base fees in systems with increasing block rate structures range from a low of $5.79 to a high of $36.00, with an average of about $16.18. The amount of water included in the base rate ranges from a low of zero gallons (3 suppliers) to a high of 20,000 gallons, with an average of about 5,790 gallons. The price of the first additional increment of water (not supplied as part of the base charge) ranges from a low of $0.80 per 1,000 gallons to a high of $16.93 per 1,000 gallons, with an average of about $2.34 per 1,000 gallons. There are a maximum of four blocks for suppliers in the Basin. The price of the three additional increments above the first block ranges from a low of $0.80 to a high of $73.81, with an average of about $3.69.

FIGURE 21
Examples of Rate Structures and Bill Comparison



Seasonal Rates

This rate structure has a base charge just like other rate structures. The main difference is that instead of rate increases based upon the volume of water used, rates are set according to seasons. The price for each unit of water delivered in winter is lower than for water delivered in the summer. The summer price is set strategically to encourage consumers to be more conscious of irrigation habits during the months when peak demands often strain the delivery system. If desired, a spring and fall use rate can also be applied to help reflect the rising and falling costs associated with typical use patterns within the water system. It also provides water suppliers with an opportunity to remind consumers that irrigation needs are typically less during the spring and fall months and, therefore, sprinkler timers should be adjusted accordingly. Six of the 23 major suppliers (26%) in the Jordan River Basin employ a seasonal rate structure. None currently adjust rates in both the spring and the fall.

Increasing Seasonal Block Rates

This rate structure is a combination of the increasing block and seasonal rates. Like the seasonal rate, it has a price for each unit of water delivered in winter that is lower than for water delivered in the summer. However, instead of a flat rate for a given season, the increasing seasonal block rate has an increasing block rate for each season (see Figure 21). If desired, an increasing rate for the spring and fall seasons can also be applied. This type of rate structure is new to Utah. Salt Lake City is the only water supplier in the Jordan River Basin currently using an increasing seasonal block rate from April to October (7 months). A flat rate applies during the winter months.

Target Block Rates

This rate structure requires that a target use be established for each customer. This target is based on the water needs of the landscape and the number of people in the home or business. Landscape water need is determined by using evapotranspiration rates for turf grass from local information sources and landscape size. Then, each unit of water is priced in such a way so as to reward the consumer for using no more than the target use for their individual property or penalize the consumer for using amounts that exceed the target use (see Figure 21). Water providers can assess penalties by using a sequentially higher rate. Because of the effort required to obtain and maintain accurate data on each customer, the target block rate may initially require more capital resources and staff attention than other rate structures.

In January 2003, West Jordan City implemented this type of rate structure. “Target Billing” was offered as an optional means of water billing. Four commercial and industrial accounts accepted the offer. A target was established for each month and consumption was tracked and billed after comparison to the target. Separate meters were installed to track only that water used for landscaping and to exclude the other water uses of the accounts. Two accounts had large landscapes, averaging 3.25 acres, while the other two were small, both 0.5 acres. The two large accounts did well at meeting targets, generally getting better during the three years of experience. In 2005, the averaged use was about 80 percent of the target for the year. The two small accounts did not do as well and missed their targets all three years. In 2005, the averaged use was 229 percent of the target for the year. Since this new billing involved separate metering, no comparison to landscape consumption in previous years was possible.[13] This comparison bears out similar experiences which indicate small landscape areas tend to be over-watered more than large areas. Still, this experience shows that, where appropriate, this billing method encourages conservation while maintaining supplier revenues.

BMP 4 - Water Conservation Ordinances

- Adopt an incentive water rate structure.
- Adopt a time-of-day watering ordinance.
- Adopt an ordinance requiring water-efficient landscaping in all new commercial development. This should include irrigation system efficiency standards and an acceptable plant materials list.
- Adopt an ordinance prohibiting the general waste of water.

For sample ordinances, go to **www.conservewater.utah.gov** and click on “Agency Resources.”

Outdoor Watering Guidelines and Ordinances

If residential outdoor conservation were practiced, the potential water savings would be significant since it makes up the biggest part of wasted water in the Jordan River Basin. The Division of Water Resources estimates that the water needed to produce a healthy lawn on a typical residential landscape could be reduced at least 25 percent by following two simple steps. These are: (1) watering to meet the turf water requirement -- the amount of water needed by a turf to produce full growth; and, (2) maintaining a sprinkler distribution uniformity (how evenly the sprinkler system spreads the water) of at least 60 percent.[14]

TABLE 25
Recommended Irrigation Schedule for Salt Lake County*

Irrigation Period	Watering Interval (days between watering sessions)
Startup until April 30	6
May	4
June	3
July	3
August	3
September	6
October 1 until shutdown	10

* This schedule assumes an application of ½ inch of water per watering session and is based on historical turf water requirements from Hill, Robert, *Consumptive Use of Irrigated Crops in Utah,* (Logan: Utah Agricultural Experiment Station, 1994).

Table 25 contains a general recommended irrigation schedule for Salt Lake County. These recommendations should only be used as a starting point from which to establish an optimum watering schedule for each individual lawn. Residents should consult their community water supplier to see if they have site-specific recommendations. Finally, each irrigation system delivers different amounts of water per unit time depending on water pressure, sprinkler type, and other variables. Watering to only meet and not exceed the turf water requirement also produces a healthier and better-adapted turf. Average residential sprinkler uniformities in Utah have been found to be about 51 percent.[15] Increasing these to 60 percent, or more, can be easily achieved by designing sprinkler systems properly and by regularly inspecting and maintaining their performance.

If a homeowner were to implement additional outdoor watering guidelines, overall residential water consumption could be reduced beyond 25 percent.[16] Other conservation measures include setting watering durations to suit different soil types and micro-climates, using several short durations (cycling) to water deeply while avoiding runoff, and watering flower and shrub areas less than turf areas.

Time-of-Day Watering Ordinance

Another method that has proved effective in reducing water consumption is simply confining watering to times during the day that minimize evaporation, between 6 p.m. and 10 a.m., and then reducing the watering-time duration to accomplish the reduced evaporation losses. These recommendations should be made to the public during both wet and dry climatic conditions.

The Bountiful Water Sub-Conservancy District was one of the first water suppliers along the Wasatch Front to implement a time-of-day watering restriction. After recommending a voluntary restriction in watering during the daytime hours in the mid-1980s, the District immediately realized a decrease in water consumption of about 17 percent.[17] In 1999, the Sub-Conservancy District adopted this restriction as a formal ordinance. Since that time, the Weber Basin Water Conservancy District and numerous communities across the State have adopted similar ordinances.

Water Efficient Landscape Guidelines

The types of plants that make up a landscape and the total area that requires irrigation can have a significant impact on overall water consumption. Irrigation methods and human behavior play a large role in water use and water waste. One way to help change behavior includes changing the style of landscaping. The replacement of typical turf grass and other water-intensive vegetation with native or adapted low water-use plants, in lower no-use areas, significantly reduces outdoor water needs. Hardscaping a portion of the landscape eliminates the need to water that area. If the low water-use vegetation is irrigated using efficient irrigation practices, outdoor water use can be reduced more than the 25 percent goal currently set by the State.

Not only do water-wise landscapes conserve water, they require lesser amounts of chemicals (herbicides, pesticides and fertilizer), require less maintenance than typical turf, and add variety, interest, and color to the ordinary landscape.

Changing the way people landscape to more closely match the conditions of Utah's semiarid climate is an important aspect of long-term water conservation. Demonstration gardens and public education programs that communicate efficient landscaping techniques, as well as ordinances that promote more "natural" landscaping practices, are important components of an outdoor water conservation program. While parks and green spaces make significant contributions to city life, ordinances that require unnecessary lawn space or other water intensive planting and encourage excessive water use should be eliminated.

BMP 5 - Water Conservation Coordinator

- Designate a water conservation coordinator to facilitate water conservation programs. This could be a new person or an existing staff member.

The Division of Water Resources recommends that the individual appointed to the position of Water Conservation Coordinator have knowledge or training in as many of the following areas as possible:

- principles and practices of water conservation, including residential and commercial water audits;
- techniques and equipment used in landscape design and installation;
- Utah native and adapted plants, and turf grasses;
- laws and regulations applicable to water management;
- ability to conduct residential, light commercial, and irrigation water audits;
- make presentations to community, technical or professional groups;
- maintain computer records and customer databases;
- research and implement State and local water conservation requirements;
- review architectural and landscape plans for water efficiency requirements;
- communicate effectively verbally and in writing;
- design simple informational publications; and
- education equivalent to completion of college level course work in landscape architecture, horticulture, computer operations, public relations, architecture or a closely related field.

BMP 6 - Public Information Programs

- Implement a public information program consistent with the recommendations of the Governor's Water Conservation Team. Such programs can be adapted to meet the specific needs of the local area and may use the "Slow the Flow" logo with approval of the Division of Water Resources.

Local water providers need to bring water conservation to the attention of individual families and businesses. The intent is to make conservation a permanent part of everyday life. One suggestion is to permanently add water conservation-related website addressess, prominently on all water bills (see Table 26). Another suggestion would be to add flyers promoting water conservation in the envelope with water bills every three or four months. Internet sites with representative flyers are shown in Table 26.

TABLE 26
Water Conservation Internet Websites

1	**Site:** www.conservewater.utah.gov **Sponsor:** Utah Division of Water Resources **Features:** Water Wise Plants for Utah, Water Conservation Case Studies (includes flyers for water bills), Lawn Maintenance Tips, Reasons to Conserve, Utah's M & I Water Conservation Plan, Water Conservation Plans and Pricing Database, Slow The Flow "Infomercial".
2	**Site:** www.slowtheflow.org **Sponsor:** Jordan Valley Water Conservancy District (JVWCD) **Features:** 12 different Water Wise Landscaping Classes, Suppliers of Water-Wise Plants, Model Landscape Ordinances for Cities, Description of JVWCD 2-acre Demonstration Garden (examples for homes & businesses), Landscaping Workshops, Ultra Low-Flush Toilet Replacement Program, Landscaping Information Pamphlets for Many Different Plants, and many other useful features.

Source: Utah Division of Water Resources, November 2005

BMP 7 - System Water Audits, Leak Detection and Repair

- Set specific goals to reduce unaccounted for water to a specific, acceptable level.
- Set standards for annual water system accounting that will quantify system losses and trigger repair and replacement programs, using methods consistent with American Water Works Association's Water Audit and Leak Detection Guidebook.

In some water systems, the best way to conserve water may be to discover and repair leaks within the distribution system. Leak detection and repair programs often receive substantial capital investment because the results of such efforts are quantified. Murray City reduced leaks from about 50 (known occurrences) per year in 1995 to 25 per year in 2005.[18] However, if a thorough investigation determines that leaks are not a significant problem, such programs may not yield savings as significant as other conservation measures.

Many water providers in the Jordan River Basin who submitted water conservation plans to the Division of Water Resources indicated the importance of leak detection and repair programs to their operations. Water utilities should carefully weigh the costs of infrastructure repair and replacement against all possible conservation measures in order to determine which will most economically attain the desired objective of water conservation.

BMP 8 - Large Landscape Conservation Programs and Incentives

- Promote a specialized large landscape water conservation program for all schools, parks, and businesses.
- Encourage all large landscape facility managers and workers to attend specialized training in water conservation.
- Provide outdoor water audits to customers with large landscape areas.

The Division of Water Resources currently sponsors a series of Water Use Workshops aimed at large landscape water users. These daylong workshops cover topics including water checks, weather, plants, soils, and irrigation. Participants are given education and training by qualified USU Extension instructors, as well as a workbook, a set of catch-cups, and a soil probe.

The Jordan River Basin qualifies for financial assistance to implement water conservation measures. The Central Utah Project Completion Act, enacted by the U.S. Congress in October 1992, provided major water distributors and users an opportunity to conserve and save significant amounts of water. The CUPCA legislation only applies to areas within the Central Utah Water Conservancy District (CUWCD), which includes Salt Lake, Utah, Wasatch, Duchesne, Uintah, East Juab, Sanpete, Piute and Garfield counties. The Act provides an incentive by authorizing federal funds to finance up to 65 percent of the cost of the water conservation measures.

To date, the CUPCA water conservation program has resulted in the implementation of 33 projects which conserved almost 95,000 acre-feet of water during the 2004 irrigation season. These water conservation projects have also provided nearly 14,000 acre-feet of water for instream flow to enhance environmental purposes during that same period.

CUWCD has three financial assistance programs that address water conservation by encouraging participation from those that will benefit from such projects.

Water Conservation Credit Program

As required by the CUPCA, federal money is provided on a cost-share basis to public and private entities that demonstrate need and appropriate planning for larger water-saving projects. Projects submitted for consideration undergo rigorous examination by committee members from CUWCD, the Department of Interior and private citizen groups. Through summer, 2002, the Credit Program is recognized by the Department of Interior with saving over 50,000 acre-feet of water per year. For additional information on the Credit Program and active projects, see www.cuwcd.com/cupca/wccp.htm

Water Conservation - General Administration Fund

The District encourages the continued development of technology that will increase water use efficiency. This is accomplished by offering cost-share assistance to organizations interested in pursuing irrigation improvements on a smaller scale than is usually attempted by the Conservation Credit Program. Utah Valley State College (Orem) and Jordan Valley Water Conservancy District (Salt Lake Valley) were recipients of grants in 2002. Additional grants, particularly to schools, parks, and residential developments are planned. The District also provides funding for statewide water conservation education through the State Office of Education, the Living Planet Aquarium, and, in the Uinta Basin, the PAWS-On program of the Dinosaurland RC&D.

Water Conservation Technology Grants

Challenges associated with drought, as well as concern for long-term water supplies for our growing population, have prompted CUWCD to encourage a variety of innovative responses to water conservation. The District makes cost-share grants to smaller-scale enterprises such as schools, municipalities, housing developments, condominium homeowners associations, and individual property owners that demonstrate need and initiative in water management.

Termed "Water Conservation Technology Grants," funds are distributed on a 50 percent (or less) cost-share basis up to $5,000. Grants exceeding $5,000 and up to a 50 percent cost-share may be considered on a case by case basis for projects of unusually large scope and for projects that demonstrate exceptional water conservation savings. Recipients of Water Conservation Technology Grants to date include Utah Valley State College and the American Fork Cemetery for the installation of soil moisture sensors. A parking strip sprinkler and planting display and a small demonstration garden are among pending projects.

The CUWCD headquarter's seven-acre property, at 355 West University in Orem, has been upgraded to more wisely use water. The original landscaping and irrigation system were designed with the best technology available 35 years ago. Since that time, major improvements have been made in both the landscaping and watering strategies. Approximately one quarter of the CUWCD site was landscaped specifically to showcase low-water use plants and advanced irrigation system layout and equipment. Older sections of the CUWCD landscape are being replaced and renovated as opportunities and needs arise. CUWCD has submitted its landscape to Slow-the-Flow water audits during 2001 and 2002 and continues to actively pursue efficient water use strategies on its own properties. Significant water savings are being realized at the headquarters site.

BMP 9 - Water Survey Programs for Residential Customers

- Implement residential indoor and outdoor water audits to educate residents on how to save water.

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

Beginning in 1999, the Jordan Valley Water Conservancy District, in cooperation with its member agencies and Utah State University Extension Service, initiated a free "water check" program in Salt Lake County. A water check is basically a simplified outdoor water audit for residents. As of December 2005, the program had been adopted and implemented by other agencies and was operational throughout Cache, Salt Lake, Utah, Juab, Duchesne and Uintah counties. A flyer describing the water check program could be included with water bills and can be found at: www.slowtheflow.org/programs/H2Oprogram.asp Sandy City performed 4,354 residential water checks from 1999 to 2004. Interestingly, the number of checks during 1999 (the only non-drought year) was about half the number done during most of the drought years. Sandy City also did 210 large water checks from 2001 to 2004.[19]

Homeowners may receive a free outdoor "Water Check" by calling 1-877-SAVE-H20.

BMP 10 - Plumbing Standards

- Review existing plumbing codes and revise them as necessary to ensure water-conserving measures in all new construction.

- Identify homes, office building and other structures built prior to 1992 and develop a strategy to distribute or install high-efficiency plumbing fixtures such as ultra low-flow toilets, showerheads, faucet aerators, hot water recirculators, and similar technologies.

Retrofit, Rebate, and Incentive Programs

It has long been known that the largest indoor consumption of water occurs by flushing the toilet. This fact prompted legislation to phase out the manufacture of old-style toilets, which typically consumed 3.5 to 7.5 gallons per flush, and replace them with newer, low-flow devices that consume 1.6 gallons or less. Since 1992, Utah law requires the installation of low-flow toilets in new construction. Federal law has prohibited the manufacture of higher-flow toilets since 1994. This change reduces indoor residential water consumption in new construction by an estimated 6 gpcd.[20]

Replacing old-style toilets with newer water-efficient designs is recognized by many utilities across the country as an effective way to produce water savings. This is accomplished through retrofit programs or rebates that provide an incentive for residents to remove their old appliances. Because it is fairly easy to estimate the water savings that retrofit, rebate, and incentive programs are likely to produce, these programs could become a popular method used to help reach water conservation goals in Utah.

In 2002, a pilot Ultra-Low-Flush Toilet (ULFT) Replacement Program was developed and implemented by JVWCD to replace existing toilets with ULFTs within their retail service area. A contractor was hired to install 275 toilets. Water use monitoring equipment was used on approximately 15 percent of the installed toilets. Customer satisfaction with the new ULFTs was high, with an overall performance rating average of 8.4 out of 10 (10 being excellent).[21] The water savings achieved from this program were found to be two-fold. First, there was water savings associated with the reduced flush volume. Secondly, water savings were achieved through a reduction of leaks associated with the older high-flush toilets. Based on the data, a savings of 42 gallons per household per day, (15,500 gallons per household per year) was achieved by this program.[22] Therefore, the total water savings achieved by this program is estimated to be 13.1 acre feet

(4,265,000 gallons) per year, or 262 acre-feet (85,310,000 gallons) over a 20 year period.[23] This program is cost effective when compared to the estimated cost of future water development projects currently being planned.

In 2003, JVWCD implemented a ULFT Replacement Voucher program in its retail service area. Costs were lower for this program because new ULFTs were not installed as in the pilot program. Namely, the participants were fully responsible for installation. In this program, 1,045 toilets were given to eligible residential retail customers who wanted to participate.[24] Since JVWCD is largely a wholesale water supplier, these programs are no longer active. However, JVWCD still encourages replacement of old toilets. The District is working to create a funding program to assist its water agency customers to implement their own conservation programs.[25]

BMP 11 - School Education Programs

- Support state and local water education programs for the elementary school system.

For more information, go to: www.watereducation.utah.gov.

BMP 12 - Conservation Programs for Commercial, Industrial and Institutional Customers

- Change business license requirements to require water reuse and recycling in new commercial and industrial facilities where feasible.
- Provide comprehensive site water audits to those customers known to be large water users.
- Identify obstacles and benefits of installing separate meters for landscapes.

Set Example at Publicly Owned Facilities

It is important that government entities within the Basin be good examples of water conservation for the citizens they serve. To help accomplish this at State facilities, the State recently revised its building guidelines and policies to incorporate water-wise landscapes and more water-efficient appliances (faucets, showerheads, toilets) at new facilities. In addition, by Executive Order, Governor Leavitt mandated that all State facilities avoid watering between 10 a.m. and 6 p.m. Local governments should consider making similar adjustments to their building guidelines. This will help ensure that water use at public facilities does not deter citizens from conserving water on their own landscapes.

The Division of Water Resources has a large collection of materials that can help local governments strengthen their water conservation ethic. Various guidelines and recommendations, including sample ordinances, water-wise landscaping manuals and other resources are all available through the division. Many of these materials are also available online at the state's water conservation web page:

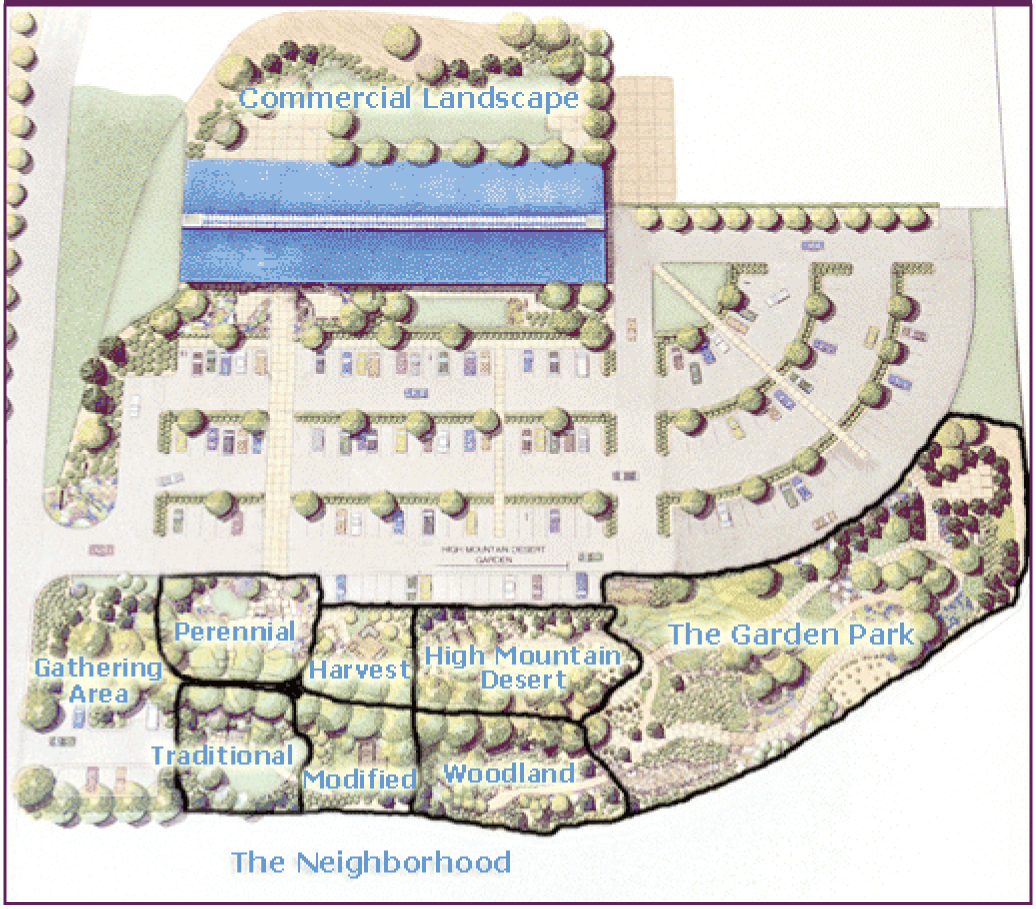
www.conservewater.utah.gov.

Finally, the Division recommends the three texts listed in the last endnote of this chapter. They are all suitable for landscape and garden plant selection in Utah.[26]

The Jordan Valley Water Conservancy District's Demonstration Garden is a valuable resource for those interested in water-wise landscaping. In 2000, JVWCD re-landscaped its administrative headquarters site (approximately 2 acres) to provide an example of a water-wise commercial landscaping. An area of 100 percent bluegrass turf was reduced to 24 percent turf. The District provides a model commercial landscape ordinance for cities to adopt that is similar to the criteria used for landscaping around the administration building. The re-landscaping included a retrofit of the existing irrigation system, more hardscape and pathways, and parking strips and other areas converted from turf to trees, shrubs, and perennials. (See Figure 22).

In addition to retrofitting the administration headquarters landscaping, JVWCD also constructed an additional portion of the Demonstration Garden consisting of two main parts: the Neighborhood and the Garden Park. The Neighborhood is about 1.5 acres in size and was completed during the fall of 2000. It features six sample landscapes along a mock residential street. These landscapes demonstrate water-efficient practices that can be used as attractive alternatives to a typical predominantly bluegrass landscape. Each landscape contains a structure to represent where a home could be. Water use for each landscape is metered to track the actual amount of water being applied. Irrigation water use is monitored closely for efficiency throughout the season, and posted for the public to see the results from efficient watering. The six demonstration landscapes include Perennial, Harvest, High Mountain Desert, Traditional, Modified, and Woodland.

FIGURE 22
Jordan Valley Water Conservancy District Demonstration Gardens



Source: Retrieved from Jordan Valley Water Conservancy District's water conservation web page: www.slowtheflow.org/garden/gardenmap.html , December 2005.

The Garden Park is about one acre in size and was completed in the fall of 2001. This area of the garden is less formal, with wandering paths, a dry creek bed, bridges, a raised vegetable garden, and container plantings. Plants in the Garden Park range from Utah natives to annuals, vegetables, turf grasses, and ornamental grasses. The selection of alternative turf grasses offers a range of color and texture, and irrigation for each turf plot is individually metered and posted for comparison. The raised vegetable garden illustrates drip irrigation. Details for all of JVWCD Demonstration Gardens can be found at:

www.slowtheflow.org/garden/garden.asp

They are located at 8215 South 1300 West in West Jordan, Utah.

JVWCD is also beginning a feasibility study to identify ways to expand the current Demonstration Garden into a ten-acre space, focused solely on water conservation landscaping and education.[27] A landscape architecture firm is developing a master plan that would be implemented in phases over the next 12 years. The expanded Master Garden would feature indoor and outdoor classrooms, specialty gardens, and comprehensive how-to exhibits that will focus on all aspects of low-water landscaping. The intent is "to enrich and inspire Utah residents through displays and hands-on education on how to have an attractive water-wise landscape."[28] The vision is to "create a one-stop education center, a place where people could come from all over Utah and learn conservation landscaping step-by-step."[29]

NOTES

[1] A privately or publicly owned community water system which provides service to at least 15 connections or 25 individuals, year-round.

[2] Utah Division of Water Resources, *Utah's M & I Water Conservation Plan*, (Utah Division of Water Resources, July 2003), p 3.

[3] *Salt Lake Ranks No. 3 in Commuter Use*, Deseret Morning News, October 21, 2005.

[4] Ibid.

[5] Peter W. Mayer, William B. DeOreo, Eva M. Opitz, Jack C . Kiefer, William Y. Davis, Benedykt Dziegielewski, and John Olaf Nelson, *Residential End Uses of Water*, (Denver, CO: AWWA Research Foundation and American Water Works Association, 1999), pp 86 & 87.

[6] Preliminary data to be published in the next *Jordan River Basin*, *Municipal and Industrial Water Supply & Use Reports*.

[7] Jordan Valley Water Conservancy District, *2004 Water Conservation Plan Update*, (March 2004), p 28.

[8] Utah Division of Water Resources, *Utah's M&I Water Conservation Plan*, (Salt Lake City: Department of Natural Resources, 2003). This plan is available through the Division's web page at: www.conservewater.utah.gov .

[9] *Utah Administrative Code*, *Title 73-10-32*, (2004).

[10] For an updated list of systems that have submitted plans to the Division of Water Resources, visit the following web page: www.conservewater.utah.gov/agency/plans/WMCP.html All plans are available to the public at the Division's office in Salt Lake City.

[11] Western Resource Advocates & Utah Rivers Council, *Water Rate Structure in Utah: How Cities Compare Using This Important Water Use Efficiency Tool,* (January 2005), p.4, p.6.

[12] Utah Division of Drinking Water, *2001 Survey of Community Drinking Water Systems,* (Salt Lake City: Dept. of Environmental Quality, 2002). A total of 28 systems within the Jordan River Basin responded with information about their water rate structures. 12 of these employed a uniform rate structure; 16 employed an increasing block rate structure. Conclusions cited in the text are based upon the data provided by these systems only and may not be representative of all systems within the Basin.

[13] Ibid.

[14] Utah Division of Water Resources, *Identifying Residential Water Use: Survey Results and Analysis of Residential Water Use for Thirteen Communities in Utah,* (Salt Lake City: Dept. of Natural Resources, 2000), 27. Jordan River Basin communities that were included in the study are (TBD Eric Klotz). A copy of this document can be obtained online at the Division's web site: www.water.utah.gov .

[15] Jackson, Earl, *Results and Impacts Report: Water Check 2001, Salt Lake County,* (Salt Lake City: USU Extension, 2002), Table 6.

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

[17] Utah Division of Water Resources, *An Analysis of Secondary Water Use in Bountiful, Utah.* This is a unpublished report.

[18] Personal communication with Phil Markham, Murray City Public Services Manager, (December 20, 2005).

[19] Sandy City, *Sandy City Public Utilities, Summary of Operations,* (Sandy City: 2004), p 12.

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

[21] Jordan Valley Water Conservancy District, Retrieved from JVWCD Internet web page: www.slowtheflow.org/programs/ulft.html , December 2005.

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Personal communication with David Rice, JVWCD Water Conservation Specialist, (December 2005).

[26] Wendy Mee, Jared Barnes, Roger Kjelgren, Richard Sutton, Teresa Cerny, Craig Johnson, *Water Wise Native Plants for Intermountain Landscapes,* (Logan, UT: Utah State University, State University Press, 2003).

Denver Water & American Water Works Association, *Xeriscape Plant Guide, 100 Water-Wise Plants for Gardens and Landscapes,* (Golden, CO: Fulcrum Publishing, 1998).

Janice Busco & Nancy R. Morin, *Native Plants for High-Elevation Western Gardens*, (Golden, CO: Fulcrum Publishing, in partnership with The Arboretum at Flagstaff, 2003).

[27] American Water Works Association, Fall 2005 Newsletter, *Jordan Valley Water Conservancy District, Demonstration Garden*, page 9.

[28] Ibid.

[29] Ibid.

6

AGRICULTURAL CONVERSION AND OTHER WATER MANAGEMENT STRATAGIES

Using existing developed water supplies efficiently is an important element in successfully addressing the future water needs of the Jordan River Basin. Increased competition for the Basin's water supplies will boost the value of those supplies and will allow creative and innovative water management strategies to be implemented. In some instances, the economic incentive created by increased competition may also lead to the outright transfer of water from one use to another, thereby maximizing the beneficial use of existing water supplies. Chapter 6 discusses the nature of some of these water transfers and highlights some of the other management strategies. These include conjunctive use of surface and ground water, secondary water systems, cooperative water operating agreements, and water reuse.

AGRICULTURAL TO MUNICIPAL AND INDUSTRIAL CONVERSIONS

Agricultural water use within the Jordan River Basin has been declining rapidly in recent years. The most recent land-use survey (2002) identified only 12,387 acres of irrigated ground in the Salt Lake valley. That is less than half of the 25,000 acres of irrigated ground identified as irrigated in 1995, and a 58 percent decrease since 1988 when 29,800 acres of irrigated ground were inventoried.

Urban expansion has retired a considerable amount of farmland, particularly in the south and west parts of the Valley. West Valley, West Jordan, Taylorsville, and Sandy experienced tremendous growth in the 1980's and 1990's, and continue to grow. The last decade has seen an explosion of suburban development in Draper, Herriman, Riverton, Bluffdale, and South Jordan. At the current rate of urban expansion, agricultural activity in the Basin will be virtually non-existent by 2050, and potentially much sooner. Many of Salt Lake Valley's key growth areas are included in Table 27 along with their current population densities and projections. Based upon these current population densities and growth projections, the Salt Lake Valley will need an additional 66,000 acres of urban land by 2020 and 149,000 acres by 2050. Table 27 uses current population densities, projected growth rates, and the percentage of irrigated land (for both within the incorporated area, and immediately outside the incorporated areas) to project just how many acres of irrigated ground will be affected by urbanization.

TABLE 27
Urbanized Land

Counties And Towns	Urban Density (People /acre)	Undevel-oped Land (acres)	% Irr	(New Land) % Irr	Population			Additional Urban Acres Needed		New Lands Needed		Converted Irrigated Acres	
					2000	2030	2050	2030	2050	2030	2050	2030	2050
Salt Lake County													
Salt Lake City	5.4	37,150	5%	5%	181,743	203,059	225,066	3,914	7,989	0	0	196	399
West Valley City	6.8	6,223	4%	1%	108,896	144,207	167,413	5,193	8,605	0	2,382	208	273
West Jordan	7.3	7,997	8%	2%	78,721	144,925	182,080	9,069	14,159	1,073	6,162	660	763
South Jordan	2.9	6,128	26%	15%	29,437	99,168	112,482	24,045	28,636	17,917	22,508	2,480	4,970
Draper	4.2	12,545	11%	11%	25,220	50,077	60,676	5,918	8,442	0	0	651	929
Riverton	5.6	2,895	63%	26%	25,011	51,773	63,081	4,779	6,798	1,884	3,903	2,314	2,839
Balance of County	5.4			10%	449,968	688,310	849,597	44,412	74,465			4,441	7,446
County Total					**899,178**	**1,381,519**	**1,660,395**	**97,330**	**149,095**			**12,750**	**17,620**

Urban Density: People per acre, within the developed portion of the incorporated city boundaries.
Undeveloped Land: The undeveloped land within the incorporated city boundaries.
Percent Irrigated: The percentage of undeveloped land within the incorporated city boundaries that is irrigated.
New Land Percent Irrigated: The percentage of undeveloped land immediately outside of the incorporated city boundaries that is irrigated.
Population: 2000 from U.S. Census Data. Projections for 2020 and 2050 are from the Governor's Office of Planning and Budget.
Additional Urban Acres Needed: Calculated by multiplying Urban Density times the change in population.
New Lands needed: Calculated by subtracting the Undeveloped Land from the Additional Urban Acres needed.
Converted Irrigated land: Calculated by multiplying the Undeveloped Land needed times the Percent Irrigated plus the New Lands needed times the New Lands Percent Irrigated.

As can be seen from Table 27, at the present time, 26 percent of the undeveloped land within the South Jordan city limits is currently under irrigation. Since South Jordan City is bounded to the north by West Jordan City, to the east by Sandy City, and to the south by Riverton and Herriman, any annexation of new lands will have to be to the west. At the present time, irrigated lands only constitute about 15% of the land immediately to the west of South Jordan. This is so because the Valley's irrigated lands were concentrated at the lower elevations below the agricultural water delivery canals. The lands at higher elevations, around the periphery of the Valley, were used more for dry cropping and rangeland. Consequently, as communities have expanded from the Valley's center to the south and west, they have already urbanized the areas with the highest concentration of irrigation, and are now expanding into the dry-crop and rangeland areas. If South Jordan continues to grow at its current density of 2.9 people per acre it will need an additional 16,000 acres of urban land by 2020 and 29,000 additional acres by 2050. At the present time South Jordan only has about 6,000 acres of undeveloped land within its incorporated city limits. This means that South Jordan will need to expand city boundaries by nearly 10,000 acres by 2020 and nearly 23,000 acres by 2050 or increase the population density. Based upon the percentages in Table 27, South Jordan will urbanize over 2,400 acres of irrigated land by 2020 and nearly 5,000 acres by 2050.

Table 27 shows the calculation of urbanized, irrigated ground for six of the Basin's communities. Assuming an average population density of 5.4 people per acre and an average of 10 percent irrigated lands for the balance of the county, it is estimated that over 9,000 acres of irrigated ground will be lost to urbanization by 2020 and the remaining irrigated ground within the Basin will be urbanized by 2030.

In the past, as agricultural ground has gone out of production, the best quality water supplies have been made available for M&I water use through purchases and exchanges. The irrigation water supplies that remain are primarily surface water flows from Utah Lake and the Jordan River and are of poor quality. Total dissolved solids (TDS) levels in Utah Lake are already so high that conventional treatment of Jordan River water, which emanates from Utah Lake, is not feasible. As the Jordan River flows northward toward the Great Salt Lake, TDS levels are further increased along with other pollution parameters, including coliform bacteria, inorganics, and heavy metals. These problems make the use of the Jordan River for M&I purposes an expensive proposition. Despite these problems, in 1995 the Salt Lake County Water Conservancy District experimented with treating Jordan River water and blending it with high quality water to stretch existing supplies. However, taste and odor problems were reported by consumers, and at the present time this approach has been discontinued.

Another approach would be to use more advanced water treatment methods to treat Jordan River water. Current state-of-the-art treatment methods could be employed to treat Jordan River water to present-day drinking water standards. These methods, however, are expensive ($500-$800 per acre-foot) and could result in a significant cost increase to the water users. Still another approach would be to buy Jordan River water rights, then leave the water in Utah Lake and transfer the water right to groundwater withdrawals in Utah County. While this approach is hydrologically sound, and would probably meet with approval from the State Engineer, it would likely meet with stiff opposition from ground water users in Utah County. Finally, poorer quality water could be used for secondary systems, reducing the demand for high quality culinary water.

AGRICULTURAL WATER-USE EFFICIENCY

With agricultural acreage in the Salt Lake Valley diminishing so rapidly, there is little incentive to pursue agricultural water-use efficiency improvements. Most of the Valley's remaining irrigated lands will be converted to urban land within the next decade or two. Infrastructure improvements such as canal lining and upgraded irrigation delivery systems come with expensive price tags. It would be difficult for such improvements to pay for themselves with such a short project life.

WATER REUSE

Only about 20 percent of a community's indoor water use is consumed and unavailable for further use. The remaining 80 percent returns to the hydrologic system as municipal wastewater. In the past, this wastewater was often viewed as a nuisance to be disposed of. However, due to an ever-increasing population and limited water supplies, views towards treated effluent (reclaimed water) are changing. Reclaimed water is becoming more appealing as an M&I water source, particularly as a replacement for the use of potable water in non-potable applications, such as landscape irrigation.

Water has always been used and reused by humans as a natural part of the hydrologic cycle. The return of wastewater effluent to streams and rivers and the reuse of these waters by downstream users is not new. However, in this document, "water reuse" refers to the deliberate reuse of treated wastewater. Planned reuse typically requires varying degrees of additional treatment and disinfection that make the effluent more suitable for use in close proximity to human populations.

Reuse Options

In Utah, municipal wastewater treatment plants must treat their wastewater to secondary effluent standards or better if they are to be discharged into waters of the state. Non-discharging treatment plants typically dispose of their effluent through evaporation. All wastewater treatment plants in the Salt Lake Valley discharge their effluent into the Jordan River or the Great Salt Lake and thus are subject to the requirements of treating their wastewater to secondary effluent standards[1]. In order to directly reuse these effluents, further treatment is required. Utah *Administrative Code, Title R317-1-4*, provides regulations that must be followed for reuse of treated wastewater. These regulations describe the water quality standards[2] that must be met for two distinct categories of reuse -- Type II reuse, where human contact is unlikely, and Type I reuse, where human contact is likely. Type II water quality standards require secondary level treatment plus disinfection. Type I water quality standards require tertiary level treatment (advanced filtration and disinfection), which also includes a higher level of disinfection and monitoring. The allowable applications for Type II and Type I reuse categories are listed in Table 28.

The number of reuse projects in Utah is growing. Most projects to date have used reuse water for agricultural irrigation of animal feed crops and have done so primarily to avoid discharging the effluent to a water body of higher quality.[3] However, recent projects in Salt Lake and Tooele counties have used reclaimed water to irrigate golf courses and land surrounding the treatment plants. Although not yet in operation, several developing water reuse projects throughout the State will also use reclaimed water to irrigate commercial and residential landscapes.

Existing Water Reuse in the Jordan River Basin

Indirect water reuse in the Salt Lake Valley has been going on for as long as communities have been discharging sewage into water bodies upstream of, and into the Jordan River. Nearly all communities in the Utah Valley discharge treated effluent into Utah Lake's waters. A portion of the Jordan River's water emanates from the north end of Utah Lake and is, in turn, used by farmers in the Salt Lake Valley. Additionally, it is estimated that of the 375,000 acre-feet of Jordan River water that flows into the Great Salt Lake, 165,000 acre-feet (or 65 percent) is return flow. Of the 165,000 acre-feet of return flow, it is estimated that 128,000 acre-feet is treated wastewater effluent[4]. When compared with the 375,000 acre-feet total of river flows that reach the Great Salt Lake annually, effluent represents a significant contribution. Of course the percentage of effluent varies along the river, as tributaries and effluents enter and canal diversions take place. During the winter months, when no water is released from Utah Lake and tributary stream flows are low, return flows from effluent sources (which fluctuate only slightly throughout the

TABLE 28
Acceptable Uses for Reclaimed Water in Utah

Type II – Human Contact Unlikely
1. Irrigation of sod farms, silviculture (tree farming), limited access highway rights-of-way, and other areas where human access is restricted or unlikely to occur.
2. Irrigation of food crops where the applied reclaimed water is not likely to have direct contact with the edible part, whether the food will be processed or not (spray irrigation not allowed).
3. Irrigation of animal feed crops other than pasture used for milking animals.
4. Impoundments of wastewater where direct human contact is not allowed or is unlikely to occur.
5. Cooling water. Use for cooling towers that produce aerosols in populated areas may have special restrictions imposed.
6. Soil compaction or dust control in construction areas.
Type I – Human Contact Likely
1. All Type II uses listed above.
2. Residential irrigation, including landscape irrigation at individual houses.
3. Urban uses, which includes non-residential landscape irrigation, golf course irrigation, toilet flushing, fire protection, and other uses with similar potential for human exposure.
4. Irrigation of food crops where the applied reclaimed water is likely to have direct contact with the edible part. Type I water is required for all spray irrigation of food crops.
5. Irrigation of pasture for milking cows.
6. Impoundments of treated effluent where direct human contact is likely to occur.

Source: *Utah Administrative Code, R317-1-4.*

year) constitute an even greater portion of the river flow. Direct reuse of sewage effluent in the Salt Lake Valley however, is currently limited to one project completed at the Central Valley Water Reclamation Facility.

Central Valley

The Central Valley Water Reclamation Facility (CVWRF) located just west of I-15 at 800 W. 3100 S., completed a reuse project in 2000 which provides treated effluent for the irrigation of a public golf course and the treatment plant itself. Because of the likelihood of human contact with the effluent, the project needed to meet stricter State water quality standards (Type I) for the irrigation water applied to the course. The construction cost associated with the additional treatment processes (Type I water reuse) was about $1.5 million. Construction included the addition of three continuous backwash sand filters, transmission lines and pumps to deliver the reuse water. The system, which has the capacity of approximately 1.5 million gallons per day (mgd), currently produces 0.6 mgd for irrigation of the 80-acre site adjacent to the Central Valley Water Reclamation Facility. The reuse project now irrigates a golf course, a driving range and the landscaped area of the Salt Lake County Solid Waste Transfer Station. Water is applied to the golf course and transfer station grounds at night by means of a spray irrigation system. Shrubs, trees and grass appear to have responded well to the managed watering system. The need to fertilize the grounds has also been reduced due to the nutrients available in the reclaimed water. The estimated total operation and maintenance costs to deliver water to the golf course, not including capital depreciation, are approximately $60 per acre-foot.[5]

The remaining reuse capacity is to be utilized for either or both of two proposed projects for the Central Valley Water Reclamation Facility; the Open Space Irrigation Project or the Canal Diversion Exchange Project (both described below in potential projects).

Potential for Reuse

There is considerable potential for wastewater reuse in the Jordan River Basin. As shown in Table 29, the current annual volume of effluent discharged from wastewater treatment plants in the Salt Lake Valley is 132,000 acre-feet (2009). In reality, only a portion of this effluent would be available for reuse due to water rights and environmental issues, seasonal requirements, and limited storage for the treated effluent.

Because irrigation requirements vary throughout the growing season, reaching a peak in mid-summer, without storage facilities the division estimates that only 40 percent of the annual effluent volume from discharging facilities could reasonably be utilized.[6] Quantities shown in Table 29 include estimates of the volume of effluent that could potentially be developed in the valley based on irrigation usage, and have been reduced to reflect the estimated losses at each discharging facility.

Larger reuse projects generally benefit from "economies of scale" where development, as well as maintenance and operational costs, are spread over a larger amount of product and a greater number of customers, thus reducing the unit cost of recycled water. Several facilities listed in Table 29 currently discharge more than 10 million gallons per day (mgd) and could implement large-scale water reuse projects.

Of the four treatment facilities in the Basin, only the Central Valley Wastewater Treatment Plant already treats a portion of its water to Type I standards. As of October 2004, the other three plants would only be able

TABLE 29
Wastewater Treatment Facilities in the Jordan River Basin (2009)

Facility	Average Flow (mgd)	Average Annual Flow (acre-feet per year)	Potential Reuse (acre-feet per year)*
Central Valley	50	56,000	24,559
Magna	2.6	3,000	990
Salt Lake City	33	37,000	15,312
South Valley	32	36,000	10,324
	117.6	132,000	51,185

* Based on 40 percent of treatment plant effluent flows without storage.

to apply reclaimed water for purposes listed as Type II, where human contact is unlikely. Even this would require a slight upgrading of their current treatment processes, including adding disinfection and more frequent testing. Type II reuse is not readily applicable for use within the confines of more densely populated city areas since land application of Type II water is limited by Utah Code due to health risks and objectionable odor.

In addition to water quality considerations, the appropriateness of any individual reuse project also depends upon how it will affect existing water rights and the environment. Often, downstream users, including the environment, depend upon the wastewater effluent to satisfy their needs. These needs must be addressed as part of the feasibility of any reuse project.[7]

With the possible exception of the effluent from the Magna Wastewater Treatment Facility, little of the Valley's reuse water would find practical application on farmland since there is little irrigated acreage remaining. Most of the potential for reuse will be non-agricultural and will likely come in the future as urban growth continues westward from the Wasatch Range to fill the Salt Lake Valley. However, because of the high cost of treating effluent to standards acceptable for municipal and industrial use, reuse within the Basin will be competing with other equally expensive yet more palatable, water supply options. For a more detailed description of water reuse options for Utah, see "Water Reuse in Utah,"[8] on line at:

www.water.utah.gov/WaterReuse/WaterReuseAA.pdf.

In order to economically use treated effluent, wastewater treatment facilities need to be near their intended customers, such as the service population, irrigated lands, power generation facilities, etc. Several Salt Lake Valley cities have had irrigation ditch systems since the 1800s (with many reusing effluent indirectly). Newer communities have more recently been installing pressurized irrigation systems that could utilize Type I reuse water with some modification. Recent changes in Utah's water reuse rule (R317-1) now allow hose bibs (outdoor water faucets) with some restrictions. Other changes in the rule specifically address retrofitting of secondary systems to use Type I reuse water. The frequency of some required effluent quality tests has also been reduced, which may help to lower costs -- making water reuse a more appealing alternative for many communities.

Since treatment to suitable quality for residential reuse (Type I treatment) is expensive, the first reuse projects have been located in growing “water-short” urban areas where their expense can be justified. A relatively new trend in water reuse is the employment of “scalping plants,” small wastewater treatment plants that remove and treat only a portion of a community’s effluent for reuse locally. These plants can be located nearer to communities where pressurized distribution lines are installed, thus minimizing the distance to and from the WWTP, which in turn, reduces the associated piping and pumping costs.

Other non-seasonal uses have the potential to increase the amount of effluent that could be utilized each year. Industrial processes that require large quantities of water such as the production of metals, wood, paper, chemicals, gasoline and oils could use reclaimed water. The most suitable reuse projects though, will likely be similar to the Central Valley project or to a project located adjacent to the Tooele WWTP, which supplies irrigation water for a golf course with several holding ponds and water features and the nearby Overlake subdivision.

Potential Projects

Salt Lake City Wastewater Treatment Plant

At existing treatment plant 1900 North Redwood Road

A reuse project being studied for the Salt Lake City Department of Public Utilities Water Reclamation Plant (SLCWRP) would be similar to the Tooele project and would supply golf course, sports complex, and industrial customers. Phase I of this project (called the Demonstration Project) would provide 4 mgd (2089 acre-feet per year) of reuse water at an estimated total cost of $868 / acre-feet. The plant would utilize reverse osmosis and an advanced filtration process to produce high quality reuse water. The study has identified nearly 30 potential customers that could use large amounts of reuse water. The "ultimate" project envisioned for the plant would supply 12 mgd (5,756 acre-feet per year) of reuse water in two additional phases. Potential customers include: Wing Point golf course, Constitution Park, Cottonwood Park and UDOT in one phase, and the Tesoro Refinery, Utah Power and Light, Staker Gravel and SLC International Airport in the other phase.

South Valley Sewer District Reuse Project for Riverton City

New WWTP at 13500 South 800 West:

South Valley Sewer District (SVSD) is in the process of constructing a new wastewater treatment plant. Proposed reuse would include Type I treated effluent for use in Riverton City's secondary water system as well as irrigation water for placement in the Draper Irrigation Company canal. The initial project would supply 2,500 to 3,000 acre-feet of reuse water annually. Potential future expansion would extend the project to Herriman, Bluffdale, and the southern portions of Sandy and South Jordan cities.

Central Valley Water Reclamation Facility Large Irrigation Users Project

At existing treatment plant, 800 West 3100 South:

This project would provide between 8,049 and 8,799 acre-feet of Type I irrigation water for large open spaces (2,542 to 2,779 total acres) located within West Valley City, Murray City, Cottonwood Improvement District, and Salt Lake City Suburban Sanitary District No. 1, and the 4500-4700 South corridor in the Taylorsville-Bennion Improvement District. The project was originally scheduled to be operational in 2009.

South Valley Water Reclamation Facility Irrigation for Association of South Valley Communities

At the existing treatment plant, 7495 South 1300 West:

An inter-local agreement, which created the Association of South Valley Communities (ASVC) consisting of the cities of Bluffdale, Herriman, Midvale, Riverton, Sandy, South Jordan, West Jordan, as well as Salt Lake

County, proposes to pump Type I effluent southward for wholesale summer delivery to communities along the service line. The project would be phased to first deliver 10 mgd of reuse water to West Jordan, South Jordan, Sandy and Riverton cities. As other cities developed their planned secondary systems, the treatment plant capacity would be increased to 25 mgd. This project would utilize chemical coagulation, sand filters, and chlorination to produce Type I irrigation water for between 1,700 to 4,300 acres.

Inter-local agreement for Water Reuse Projects

As a result of a legal dispute between Salt Lake City Suburban Sanitary District No. 1 and numerous entities over water rights to effluent collected by the sanitary district, an *Inter-local Agreement for Water Reuse Projects* was worked out between the main parties in order to avoid a lengthy trial. The Central Valley Water Reclamation Facility, Cottonwood Improvement District, Salt Lake City Suburban Sanitary District No. 1, Central Utah Water Conservancy District, and Jordan Valley Water Conservancy District, as well as the Bureau of Reclamation and Department of the Interior, signed the agreement in the fall of 2005. The agreement stipulates procedures for the development of water reuse projects involving effluents from any of the parties to the agreement.

CUPCA Repayment

The Central Utah Project (CUP), which is being built to develop part of Utah's share of the Colorado River, will ultimately deliver to the Salt Lake Valley 70,000 acre-feet from the Bonneville Unit M&I System (Jordanelle Reservoir) and 30,000 acre-feet from the Utah Lake System (Strawberry Reservoir).[9] Return flows to the Jordan River (largely effluent) from this water, based on service area, use and topography, are estimated to be 21,000 acre-feet. Of these return flows, 15,000 acre-feet will return to the JVWCD service area and 6,000 acre-feet will return to the MWDSLS service area. Of the 6,000 acre-feet of return flows returning to the MWDSLS service area, 3,000 acre-feet will return to the SLCWWTP, located on the shore of the Great Salt Lake, where it will not be economical for either of the two Salt Lake Valley conservancy districts to reuse the water. That leaves 18,000 ace-feet of return flows from CUP water that can be reused.[10]

Both the MWDSLS and the JVWCD have contracted for water from the CUP project, through the Central Utah Water Conservancy District (CUWCD). The Utah Lake System repayment contract between the CUWCD and the U.S. Department of the Interior requires the CUWCD and its petitioners in Salt Lake County to demonstrate progress towards recycling up to 18,000 acre-feet of water per year by the year 2033. The amount specified in the repayment contract begins with 1,000 acre-feet per year by the year 2016 and increases annually by 1,000 acre-feet per year until reaching the full amount of 18,000 acre-feet per year by the year 2033. Thereafter, a minimum of 18,000 acre-feet must be recycled each year until the year 2050. For every year that the CUWCD fails to fulfill this requirement, it must assess itself a surcharge as specified in the amendment to the Central Utah Project Completion Act. Under Section 207 of the Central Utah Project Completion Act, any surcharges collected are to be used by CUWCD to help fund water reuse projects that are created within its service area.

Salt Lake City, however, is planning to reuse (by approximately 2015) over 5,000 acre-feet of effluent per year from their treatment plant for their planned irrigation of two large golf courses, a park, and nearby industrial customers.

Reuse Risks

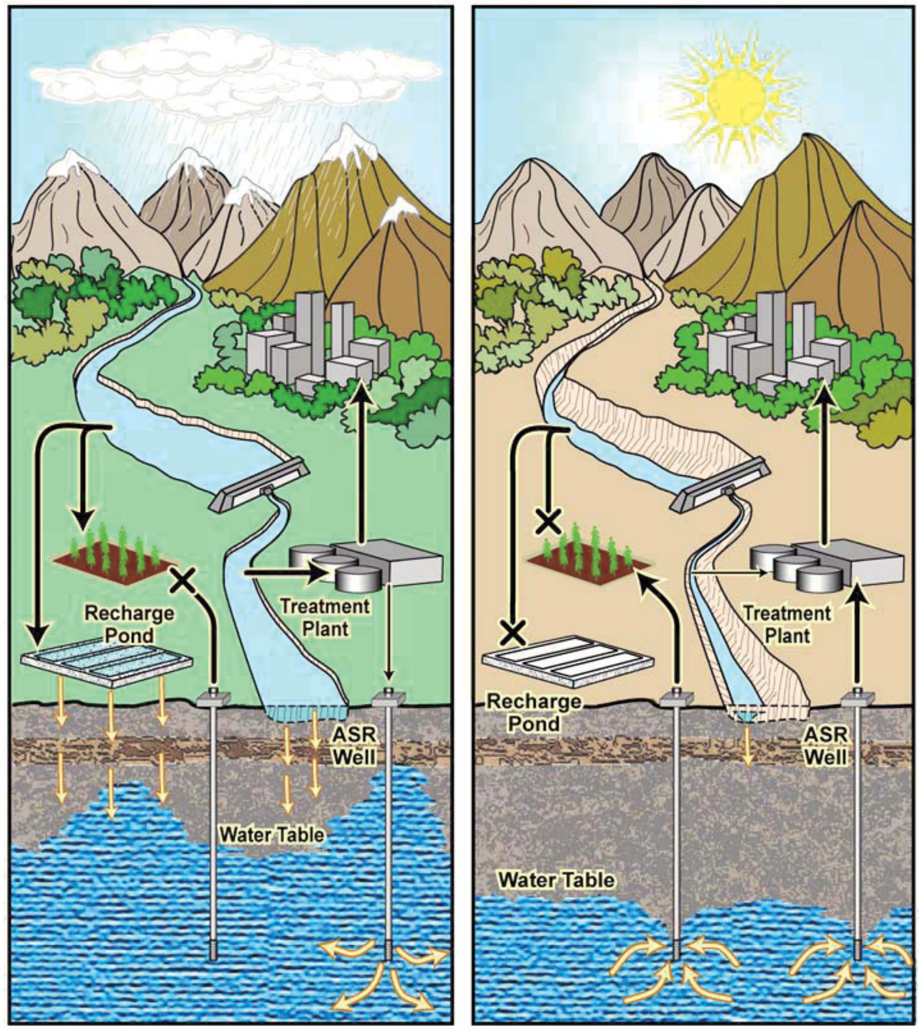
Water Reuse poses risks to the environment and human populations. Although pathogens and organic matter have been destroyed and removed through treatment and filtration, treated effluent typically retains high concentrations of salts and other chemicals that, when used for irrigation, can build up and render some soils saline. Fine-grained clayey soils can be especially problematic in that they can quickly plug. Sandy soils perform better in this regard and in some cases only require a periodic over-application of water to reduce salt build up in the upper few inches of soil.[11] Chemicals and pharmaceutical drugs are not readily removed by biological treatments or sand filtration. Endocrine blockers that can disrupt the production of natural hormones can make their way into underground aquifers from the surface application of reuse water. Shallower ground water is more at risk of contamination initially, but harmful constituents may eventually reach the deeper drinking water aquifers in the Valley. Many of the chemical constituents left in reuse water can be substantially reduced by reverse osmosis filtration, however, this is a very expensive option that could make reuse impracticable. Alternatively, thoughtful matching of reuse water to individual project requirements and applications can minimize risks associated with reuse water.

CONJUNCTIVE MANAGEMENT OF SURFACE AND GROUND WATER

Definition of Conjunctive Management[12]

Conjunctive management is the coordinated and combined use of surface water and ground water. The underlying philosophy is to use more surface water and less ground water during wet periods, when surface water is available. Unused surface water is stored, above and/or under ground, during wet periods. Wet periods include the annual spring season snowmelt and consecutive years of above-normal precipitation. Conversely, less surface water and more ground water is used during dry periods when surface water supplies are reduced. Water previously stored is taken out of storage during dry periods. Dry periods include the annual summer months and consecutive years of below-normal precipitation. The key point is that unused surface water is intentionally stored (above and/or underground) in order to have it available when it is needed. This can be accomplished on an annual basis by storing water in the spring and withdrawing it in the summer. It can also be accomplished on a long-term basis by storing water during a wet year (or consecutive wet years) and withdrawing it during a dry year (or consecutive dry years). Such coordinated management can change the timing and location of water use to result in greater efficiency. It transfers water from the high supply season to the high demand season. See Figure 23 for a graphical illustration of conjunctive management. Conjunctive management of surface and ground water can be an effective tool to improve the efficiency of water use, increase the amount of water available, and enhance the reliability of the supply. Moreover, it helps solve the problem of inadequate water supplies during drought times. These important benefits to water suppliers can be achieved thru application of this technology. While this section provides a brief overview of the topic, a complete discussion of the subject can be found in *Conjunctive Management of Surface and Ground Water in Utah*, a July 2005 publication of the Utah Division of Water Resources.

FIGURE 23
Schematic Representation of Conjunctive Management



Source: Utah Division of Water Resources, *Conjunctive Management of Surface and Ground Water in Utah,* (Salt Lake City: Dept. of Natural Resources, 2005), cover page.

In nature, surface water and ground water are interconnected. Virtually, all of the State's water is derived from the limited precipitation received in Utah. Rain and snowmelt contribute to streamflow and some water from each of these sources percolates into the ground to become ground water. The purpose of this section precludes an extended geologic explanation of surface and ground water interaction. However, a simple description of streams indicates that at one time, or location, the stream may be losing water into the ground, while at another time or location, the same stream may be gaining water from the ground. Changes in either the surface water or ground water component of the hydrologic system will affect the other component. Typically, the management of surface water and ground water has not been fully coordinated. Often each has been used independently, without consideration of the inter-connection. Surface water and ground water need to be used and managed jointly so as not to overdraw the total resource.

There are two basic conjunctive management strategies that can be employed. The first is conjunctive use -- the deliberate, planned, and coordinated use of surface and ground water resources with the intent of fully utilizing those resources. This strategy involves planned timing of surface and ground water use, and significant cooperation among water suppliers to best utilize both resources for mutual advantage. Surface water supplies are fully utilized when available under the conjunctive use philosophy. When surface water supplies are short, the use of ground water supplies is increased. The second strategy is conjunctive use, as just explained, coupled with aquifer storage and recovery (ASR). This involves intentionally storing excess surface water in underground aquifers in order to withdraw it later when needed. Most conjunctive management projects include ASR. The aquifer is viewed and managed much the same as a surface reservoir. Water can be stored in the aquifer using surface recharge basins or ASR wells. A major advantage of ASR is that unused water available during normal and wet years can be stored and later recovered during drought years.

Jordan River Basin Opportunities without ASR

Opportunities for conjunctive management without ASR exist throughout the Basin. Perhaps the most simple and inexpensive strategy is to maximize deliveries of treated surface water and reduce or eliminate ground water pumping when surface flows are available. This strategy involves the maximum utilization of surface storage reservoirs, in accordance with the respective reservoir administration plan. Fully utilizing surface water sources in this manner allows the ground water aquifer to "rest" and naturally recharge its capacity. This results in water storage without the added construction cost associated with new surface impoundments. In order for this strategy to work, water suppliers providing the treated surface water might need to lower prices as an incentive for local communities to buy more surface water and reduce their ground water pumping. One real advantage of this approach is that the State Engineer's limitation of 165,000 acre-feet for ground water withdrawals is on an average annual basis. During a period of drought more than 165,000 acre-feet of ground water would be available, if less water had been withdrawn during times of abundant surface water supply.

Collaborative actions among water providers can promote conjunctive management on a local or even a regional basis. Such cooperation can result in a advantageous situation for all parties, including benefits described earlier. Providers could work together to reallocate their "water rights portfolios" to optimize their use of both surface and ground water. There would be challenges to such an agreement, including the determination of a fair value of the water rights that may need to be exchanged. Depending on physical locations, additional pipelines might need to be constructed to transfer water from one supplier to another. The needed infrastructure might be less costly than building new surface reservoirs or adding more wells. Another advantage could be to postpone the construction of new facilities by either or both providers. Water exchanges could include raw water as well as treated water. Further discussion is contained in the next section of this document.

Jordan River Basin Opportunities with ASR

Opportunities for aquifer storage and recovery exist throughout most of the Jordan River Basin. The geology of this part of the Basin and Range Province is conducive to such projects due to the deep unconsolidated

Basin fill aquifers found there. See the Ground Water section of Chapter 2 of this document for additional information. Water can be stored in the aquifers using surface recharge methods in the areas of natural recharge found primarily along the east side of the Basin at the mouths of canyons and along the base of the mountains. There may also be opportunities for surface recharge along the west side of the Basin. ASR wells can be used almost anywhere in the Basin.

Jordan Valley Water Conservancy District

Jordan Valley Water Conservancy District (JVWCD) first began to study ASR in 1983. In 1986, a pilot project involving two ASR injection wells, two recovery wells, three monitoring wells, and an in-line filtration process was partially funded by the U.S. Bureau of Reclamation. The full-scale project was completed in 2002. The project consists of 13 existing production wells that were retrofitted to accommodate ASR operation as well as six new ASR injection wells. It also includes a new 30-inch pipeline and a new 20-inch pipeline for the distribution system to handle increased water flow. A new bi-directional booster station was also added. In addition, the regional treatment plant was upgraded to double its previous peak capacity (10 mgd to 20 mgd) and an on-line microorganism toxicity monitoring station was added.

The project was prompted by a difficulty meeting peak demand during the summer months when the aqueduct was operating at capacity. Decreasing ground water levels in several locations was also increasing pumping costs. Finally, the availability of a $5 million cost-share grant available through the Central Utah Project Completion Act made action, at the time, more attractive.

Although JVWCD's full-scale project has been in operation for three years, it has not realized its full potential due to the lack of excess water supplies during the recent drought. The reduced spring runoff volumes have not greatly exceeded the existing demands. Still, the treatment plant alterations have improved the efficient use of surface water runoff and effectively reduced ground water withdrawals. Thus, some conjunctive use benefits have been realized even though the extent of ASR has been much less than the project design levels.

JVWCD expects to realize a greater benefit from the project in coming years, when available surface water runoff increases. Streams that contribute flows to this project include: Provo River, Middle Fork Dry Creek, Little Cottonwood Creek, South Fork Dry Creek, Bell Canyon Creek, Rocky Mouth Creek, and Big Willow Creek.

Metropolitan Water District of Salt Lake and Sandy

In 2003, the Metropolitan Water District of Salt Lake and Sandy (MWDSLS) completed a *Phase 1 Feasibility Assessment and Conceptual Design for Aquifer Storage and Recovery Project*.[13] The study area encompassed the southeast portion of the Salt Lake Valley, mainly along the benches. Potential recharge water supplies were identified and included both raw (untreated) water and treated water.[14] Hydrogeology, as well as water quantity and quality, were investigated and results indicate likely success for the project. The District anticipates that a combination of recharge basins and ASR wells will eventually be used. Five alternative sites, located in the primary recharge zone, and totaling 55 acres, were identified for recharge basins. Three alternative schemes of ASR wells were identified. These include combinations of retrofitting existing wells and installing new wells.[15]

In October 2005, MWDSLS was awarded a $300,000 grant from the U.S. Bureau of Reclamation to pursue a pilot project for aquifer storage and recovery. Combined with a $100,000 grant from the Utah Division of Water Resources and the District's own funds, project design was completed and construction began in March 2006. The intent of the pilot project is to demonstrate the feasibility of using selected surface methods to recharge water into the Salt Lake Valley aquifer and recover that water later. Determination of the number of acres needed for full-scale implementation is another goal. Initially, the project will involve only 300 to 420 acre-feet per year. However, depending on results of the pilot, there is the potential to store over 23,790 acre-feet per year. The pilot project will use surface water from Little Cottonwood Creek. The final project would also use water from Big Cottonwood Creek and Deer Creek Reservoir.

There is considerable funding available for water suppliers interested in constructing conjunctive management projects. The Central Utah Project Completion Act (CUPCA) alone has $8 million available. In addition, there are three other federal agencies and three Utah agencies with money available for such projects. Some are grants, while others are loans, and some involve cost-sharing arrangements.

WATER BANKING AND COOPERATIVE AGREEMENTS

A water bank can best be defined as "an institutional mechanism that facilitates the legal transfer and market exchange of various types of surface water, ground water and storage entitlements."[16] For years, water banks have existed in many of the western states in various forms. The common goal of these banks has been to act as a mediator -- or broker -- in bringing together willing sellers (or lessors) and buyers to facilitate the transfer of lower-valued uses to higher-valued uses. Other reasons to establish a water bank may include one or more of the following:[17]

- to create reliability in water supply during dry years,
- to create seasonal water reliability,
- to ensure a water supply to meet future needs,
- to promote water conservation by encouraging water-right holders to conserve and deposit water rights into the bank,
- to resolve issues of inequity between ground water and surface water users, and
- to ensure compliance with intrastate agreements of instream flow.

Many benefits are created by simply providing a mechanism for the locating and transferring of water rights. Those with interruptible water uses of those simply willing to sell or lease a water right are matched to those in greater need during dry periods. Transactions may occur between individual persons, between a municipality and individual, or even between various organizations. Water banks may vary in the timing of their operations by providing services only during times of drought, or on an on-going basis regardless of the hydrologic situation.

Although water banking is often associated with aquifer storage and recovery, it is not limited to this method of operation. The three general types of water banks in the West include institutional, surface storage, and ground water storage. Institutional water banks provide services primarily to aid the transfer of legal documents or entitlements to a specific quantity of natural-flow, surface water. These types of banks are developed largely in areas where little or no storage is available or for large geographic areas. Surface storage banks are typically established in areas with a reservoir or series of surface storage areas where storage allotments can be stored and exchanged. Unlike institutional banks where the right is only to a natural flow, exchanges through a surface storage bank are backed by a physical block of water, which typically provides a greater level of reliability. Ground water banking is a relatively new type of banking, but it operates much like a surface storage bank with the reservoir located underground. Ground water banks typically operate by depositing water that is later withdrawn by the same entity or sold to someone else.

Administration and Pricing of Water Banks

Each water bank is operated by an administrative body that oversees transactions and outlines operating procedures, rules, and services. There are several different administrative structures which include public, private nonprofit, private for-profit, and public-private partnerships. The majority of water banks are public and are operated by a local, state, or federal agency. The second type of administrative structure, a private nonprofit organization, could be created from representatives from all involved stakeholder groups or by contracting with an existing agency for the purpose of governing a water bank. A few attempts by private individuals have been made to create water banks for profit. However, profits have been marginal and potential participants have often been skeptical of the banks. The fourth type of administrative body is a partnership that involves a public and private entity investing capital together and sharing responsibility for the bank's operation.[18]

The level of services provided by each water bank varies significantly. Some of the administrative services provided by water banks may include:[19]

- registry (listing) of water rights or entitlements,
- regulating or setting market prices,

- setting and implementing long-term strategic policies and daily operations,
- establishing whether the bank operates on a year-by-year or continual basis,
- determining which rights can be banked,
- quantifying the bankable water,
- specifying who can purchase or rent from the bank,
- setting transfer or contract terms,
- dealing with any regulatory agencies, and
- resolving disputes.

The simplest banks merely provide a service to accumulate water supplies from willing sellers and to present water supplies to willing buyers. Other banks take a more active role and act as a broker, clearinghouse, or market-maker. As a broker, a bank locates and solicits buyers and sellers to increase trading activity. As a clearinghouse, a bank maintains a collection of bid and offer information and facilitates regulatory requirements for trades. As a market-maker, a bank creates liquidity in a market by purchasing surplus water supplies or selling reserve water within a set price range even when a buyer or seller is not present. This is particularly beneficial in new markets or in markets with little activity.[20]

Another important administrative aspect of water banks is the establishment of the market structure or pricing scheme. Because a water bank plays an intregal role in facilitating trades between buyers and sellers, the market structure or pricing that is set up is particularly important during the start up stage of a bank to encourage participation. The most common and simplest type of market structure is a clearinghouse where buyers and sellers post their intent to buy and sell. The next most commonly used type is fixed pricing. This method helps to avoid speculation and price gouging in that each individual is offered the same price. Other less common structures include water supply options, auctions (opened and sealed bids) and contingent contracts.[21]

The methods to cover the costs of operating a water bank are as varied as the market structures and services provided by different banks. The two most commonly used methods include charging a flat fee for any services provided by the bank or charging a fee based on the size of the transaction or level of services required for a transaction. Most individuals served by a water bank are willing to pay fees, because any transaction without bank assistance would undoubtedly require extensive effort to locate available water and retain the legal assistance needed for any transaction. Fees at the water bank are typically split equally between buyer and seller.

Utah Law Regarding Water Banking

Currently, there are no water banks or related laws in effect in Utah. However, this does not mean the potential for water banking does not exist. In fact, activities similar to water banking have occurred in Utah with various entities cooperating on numerous occasions to increase water supplies during dry years. Many other opportunities exist as urban development spreads and developers search for much needed water supplies.

The current Utah laws regarding water transfers could be utilized to facilitate water banking. The law provides that any water right holder may change the point of diversion, place of use, or type of use either permanently or temporarily.[22] A water right may also be transferred by deed in substantially the same manner as real estate.[23] Any such change or transfer must be approved by the State Engineer to ensure that other water users' interests are protected. Typically, the process of approval for exchanges through the State Engineer requires a minimum of 90 days.[24] As far as long-term exchanges are concerned, this time frame will not likely be a deterrent. However, short-term or temporary exchanges -- defined by *Utah Code*[25] as lasting for less than one year -- could be hampered due to the comparative length required for approval. Revision of the approval process may be necessary in order to shorten the length of time necessary for a short-term transfer or exchange to allow a water bank to operate efficiently and beneficially.

Another part of the law that affects water banking is in the *Utah Constitution*. *Article XI*, *Section 6* prohibits municipal corporations from selling or leasing water rights or sources of water except when the rights or sources are exchanged for water of equal value. However, the Utah Supreme Court interpreted this law to allow the sale or lease of municipal water as long as it does not involve a perpetual obligation.[26] Thus, the law provides a basis for which municipalities as well as other various water agencies without similar restrictions (e.g., irrigation districts, water conservancy districts, etc.) would be able to participate in a water bank.

Possibilities for Water Banking in the Jordan River Basin

Several possibilities exist for water banking to aid in the efficient management and transfer of water from one user to another in Utah. The basic market structure of a water bank encourages the best use of water, since the highest valued uses will be willing to pay the most for the available water supplies. The greatest area of application for a water bank may be in rapidly developing areas where developers are required to find existing sources of water. This is the case in the Jordan River Basin. Currently, this often leads to the suboptimal allocation of water due to the lack of market knowledge developers may have of available water from converted agricultural land or other sources. Water banking services may help to ensure that the best possible source of water is found.

Municipalities and water districts with surplus supplies, as well as those searching for available water on a temporary basis, would also benefit from a water bank. In order to meet growing demands, municipalities and other water suppliers often obtain water rights in large blocks. Subsequently, during recurring predictable periods, water suppliers have large excesses in their supplies. These surplus supplies could be leased through a water bank to the highest bidder providing revenue to the municipality or other supplier. This would help offset the cost of development and in turn lower the pressure placed upon rate-payers to pay for supplies that technically would not be needed for several years.

Another possible area of application for a water bank in Utah deals with agricultural water rights in Salt Lake Valley and elsewhere. Numerous agricultural water rights are thought to be diverting water in excess of their need for uses. Eventually these water rights will be quantified through the adjudication process where portions of them may be lost due to non-use if conversion to other uses does not occur. It may be possible to create a temporary, short-term bank to allow the water to be used while a permanent, long-term conversion of use is being negotiated.

Another possible situation that could benefit from a water bank involves future large trans-basin diversions such as the Bear River Project and the Central Utah Project. Because a large percentage of the total water to be developed must be contracted for sale before a project can proceed or before funding can be obtained, some developers may hastily fulfill this obligation in a manner that may not be the most efficient in order to hasten the construction of a project. If a certain percentage of the necessary water could be deposited into a bank or made available for leases through a water bank to fulfill the obligation, a larger amount of water could possibly be put to more beneficial uses as situations arise in subsequent years. A portion of the water may even be allowed to be "deposited" in the Salt Lake Valley Aquifer to be banked for future use. This would utilize available underground storage as well as provide the environmental benefit of protecting the water level in the aquifer.

One entity in the Jordan River Basin is currently investigating such a possibility. As described in the previous section, under Conjunctive Management of Surface and Ground Water, Metropolitan Water District of Salt Lake City and Sandy is proposing to artificially recharge the Salt Lake Valley aquifer with 300 to 420 acre-feet of water per year. The recharged water would be allowed to accumulate over several years, providing a substantial amount of water to be recovered during drought conditions and peak seasonal periods.

If there is sufficient success with the initial phase of storing water from Little Cottonwood Creek, a second phase will include water from Big Cottonwood Creek and Deer Creek Reservoir. As part of the additional phase, the District and its member agencies will develop a water banking agreement and rate structure for lease or sale of the water to various users in the Salt Lake Valley. This should help reduce the conflict caused by over-appropriation of ground water in the area. The District Water Bank is intended to provide a "strategic water reserve" that will help meet demands during drought and peak seasonal periods. The project will improve the reliability of the ground water supply during dry periods, help to minimize the impacts from over-pumping and restore declining ground water levels.[27]

SECONDARY WATER SYSTEMS

A secondary (or dual) water system supplies non-potable water for uses that do not have high water treatment requirements, such as residential landscape irrigation. A secondary system's major purpose is to reduce the overall cost of providing water by using cheaper, untreated water for irrigation and preserving higher-quality, treated water for drinking water uses. Secondary systems are also an efficient way to transfer agricultural water to M&I uses as farm lands are sold and are converted to urban lands. Many of the same facilities and right-of-ways that were used to deliver water to farms can be used to deliver secondary water to homes.

Utah—A Leader in Providing Secondary Water

While water professionals around the country are clamoring for the day that secondary (or dual) water systems will exist on a large scale in their respective areas, that day has already arrived for parts of Utah. Water suppliers in the Weber River Basin, for instance, deliver a large amount of non-potable water to their customers for outdoor irrigation. In 2003, approximately 43 percent of the total M&I water demand and 68 percent of the total outdoor water demand in the Weber River Basin was provided by secondary systems.[28] This high percentage is in large part the result of the Basin's water managers and planners working together with local governments to enact ordinances requiring secondary irrigation of landscapes.

In 2005, over 18,000 acre-feet of secondary water was delivered to residents of the Jordan River Basin (see Table 14). This represents over 7 percent of the total M&I water demand and nearly 15 percent of the total outdoor water demand in the Basin.[29] As shown in Table 15, almost 96 percent of this use occurred within the boundaries of only four public community water suppliers in the southeastern part of the Basin (Bluffdale, Draper, Riverton, and Water Pro). These areas have experienced rapid growth over the past few decades and have clearly relied on secondary water systems to help ease the burden that this growth has placed upon drinking water sources. Some of the land in these areas was previously devoted to agricultural activities. As the lands were converted to residential developments, water that was used to irrigate crops was placed in a secondary system to irrigate yards and gardens. As the communities served by these water systems continue to grow, it is likely that expanding existing secondary water systems and constructing new ones will meet more outdoor water demands.

High Water Use in Secondary Systems

Secondary systems free up treated water supplies for drinking water purposes. However, it is important to recognize that they usually result in higher overall water use than a typical potable (drinking water) system that provides water for both indoor and outdoor uses. This is because most secondary connections are currently not metered and users pay a flat rate for all the water they use. The Division of Water Resources is currently studying the water use in several secondary systems located in Davis, Weber, and Tooele counties. Preliminary results from this study indicate that secondary water users over-water their landscapes by 25 to 150 percent with an average of nearly 50 percent more water applied than is necessary. In a separate study of outdoor water use in potable water systems, the Division found that homeowners over-water their landscapes by an average of only 20 percent.[30]

The Utah Division of Water Resources has been investigating ways to reduce high water use in secondary systems. One way to deal with over-watering is to meter the water and charge according to an incentive pricing rate structure. However, conventional meters plug up and wear out quickly on secondary systems, because of grit and other solids. Treatment processes, such as filtration, can be used to remove these materials and protect the water meters but the cost may be prohibitive.

TABLE 30
Secondary (Non-potable) Water Use in Public Community Systems (2003)

Water Supplier	Residential (acre-feet)	Commercial (acre-feet)	Institutional (acre-feet)	Total Secondary (acre-feet)
Bluffdale	1,638	0	0	1,638
Draper City Water	1,067	0	281	1,348
Granger-Hunter Water Improvement District	0	128	0	128
Herriman City (Includes Herriman Pipeline Co.)	115	0	0	115
Hi-Country Estates #1	7	0	0	7
JVWCD Retail System	244	0	0	244
Kearns Water Improvement District	0	245	0	245
Magna Water Company	0	178	0	178
Murray City Water	0	83	473	556
Riverton Water	2,824	0	0	2,824
Salt Lake City Department of Public Utilities	10	505	872	1,387
Salt Lake County Parks and Recreation	0	0	663	663
Sandy City Water	10	329	0	340
South Jordan	36	323	331	690
Taylorsville-Bennion Water Improvement District	36	122	278	435
Water Pro*	5,254	301	549	6,104
West Jordan City Water	4	0	310	314
JORDAN RIVER BASIN TOTAL	**11,247**	**2,214**	**3,755**	**17,217**

(Source: Utah Division of Water Resources, *Municipal and Industrial Water Supply Studies.*)
* This is the only entity that does not receive the water listed from an independent irrigation company.

Another option that would help reduce the amount of water used by secondary water customers would be to install some type of “smart” timer that automatically applies water according to the needs identified by a local weather station or a soil moisture sensor. The Division has been studying the use of two such timers in recent years. Preliminary results from these studies show that water use can easily be decreased anywhere from 10 to 50 percent. These studies also demonstrate that targeting the highest water users with a “smart” timer is extremely effective, with an average savings of 50 percent. Whatever the solution, making water use in secondary systems more efficient is an important component of future water management within the Basin.

Health Issues

Because secondary water is untreated, care must be taken to protect the public from inadvertently drinking secondary water and probable illness. Codes and ordinances prohibiting cross-connections and providing adequate backflow prevention devices need to be enforced. And, secondary lines and connections need to be clearly labeled. In public areas, signs need to be installed to warn individuals against drinking from the irrigation system.

NOTES

[1] Secondary effluents are not suitable for direct use in secondary water systems. Secondary effluents are often mistakenly identified as suitable for use in secondary systems. Secondary effluent, once it has been discharged into a receiving body of water (such as the Jordan River) can be indirectly used in secondary systems.

[2] The minimum standard to meet for discharging sanitary effluent into the State of Utah's waters is secondary treatment. Typical secondary treatment entails historical primary treatment with coarse screening to remove large particles, and settlement and floatation to remove smaller non-floating particles, oils and grease, with subsequent biological treatment with microbes to remove organic carbon. After biological treatment, secondary effluents are then disinfected to reduce viruses, microbes, bacteria, and parasites. Achieving type II effluent standards requires the addition of disinfection. Testing requirements for secondary and Type II effluents are nearly identical, entailing testing for total suspended solids (TSS), biochemical oxygen demand (BOD), and fecal and total coliform bacteria. Achieving Type I effluent standards requires filtering and turbidity testing prior to final disinfection (chlorine or equivalent), and additionally, more frequent and stringent testing for BOD and fecal coliforms as well as testing for residual chlorine (or equivalent).

[3] Utah law prohibits the degradation of natural water sources through effluent discharges.

[4] CH2M Hill in association with Hansen, Allen & Luce, *Jordan River Return Flow Study,* (Salt Lake City: 2005), ES-2.

[5] Utah Division of Water Resources, *Water Reuse in Utah,* (Salt Lake City: 2005), 22. Communication with Ron Roberts, Engineer at Central Valley Reclamation Plant, July 2004.

[6] Ibid., Utah Division of Water Resources, 2005, 31, Sum of Salt Lake County effluents.

[7] For more information on water reuse and water rights, see the Utah Code, Title 73, Chapter 3c. The entire code is available online at: www.le.state.ut.us/%7Ecode/code.htm.

[8] Utah Division of Water Resources, *Water Reuse in Utah,* (Salt Lake City, Utah: Utah Department of Natural Resources, April 2005).

[9] Central Utah Water Conservancy District, *Utah Lake Drainage Basin Water Deilivery System Final Environmental Impact Statement,* (: 1.B.02.029.E0.643, September 2004), pp 1-81.

[10] Pending determination by the State Engineer.

[11] Presentation given by Dan Olson, Tooele Reclamation Plant Superintendant, to the Water Environment Coalition, November 2003.

[12] The following paragraph is modified from the California Department of Water Resources, *California's Groundwater, Bulletin 118, Update 2003,*page 100, (Sacramento: 2003) to fit this publication.

[13] Metropolitan Water District of Salt Lake and Sandy, *Phase 1 Feasibility Assessment and Conceptual Design for Aquifer Storage and Recovery Project,* (2003), Title page.

[14] Ibid.. page ES-2.

[15] Ibid.. page ES-5.

[16] Clifford, Peggy and Clay Landry and Andrea Larsen-Hayden, *Analysis of Water Banks in the Western States*. Publication No. 04-11-011 (Washington Department of Ecology, July 2004). ii.

[17] Ibid.. 3.

[18] Ibid.. 27.

[19] Ibid.. 7.

[20] Ibid., 6.

[21] Ibid., 6-11.

[22] *Utah Code, Section 73-3-3*, *Permanent or temporary changes in point of diversion, place of use, or purpose of use*, (2001).

[23] *Utah Code, Section 73-1-10 (1)(a). Conveyance of water rights – Deed – Exceptions - Filing and recording of deed—Report of water right conveyance*, (2003).

[24] Bagley, Jay M. and Kirk R. Kimball and Lee Kapaloski, *Feasibility Study of Establishing a Water Rights Banking/Brokering Service in Utah*. UWRL/P-80/02 (Utah Water Research Laboratory, June 1980), 20.

[25] *Utah Code, Section 73-3-3*, *Permanent or temporary changes in point of diversion, place of use, or purpose of use*, (2001).

[26] Bagley, Jay M. et al., 14.

[27] Executive Summary of an application submitted by Metropolitan Water District of Salt Lake City & Sandy to the U.S. Bureau of Reclamation's Water 2025 Challenge Grant Program. The application was submitted January 19, 2005.

[28] Utah Division of Water Resources, *Weber River Basin - Planning for the Future*, (Salt Lake City: Dept. of Natural Resources, 2006), 56. *This document has not yet been published, so the page reference will need to be verified once it is.*

[29] Utah Division of Water Resources, "2003 Public Community System Water Use," March 4, 2005. This data comes from an unpublished, statewide summary of potable and nonpotable water supply and use data collected as part of the Division's Municipal and Industrial Water Supply Studies program.

[30] Utah Division of Water Resources, *Identifying Residential Water Use: Survey Results and Analysis of Residential Water Use for Thirteen Communities in Utah,* (Salt Lake City: Dept. of Natural Resources, 2000), p 2.

7

WATER DEVELOPMENT

Water development was an essential element of early settlements. The availability of water resources was critical to successful settlement of Utah's semi-arid environment. Early Mormon church leaders stressed community development over individual ownership, especially with regards to natural resources. The early pioneers' approach was to develop cooperative water distribution systems. Those early ideals laid the foundation for many of the principles embodied in today's Utah Water Law, and the methods now employed to administer and manage the State's water resources. Community rights led to a standard of "beneficial use" as the basis for the establishment of an individual water right. The overriding principle of Utah's water law is that all water belongs to the citizens of the State collectively, not individually. An individual citizen may own a water right entitling them to put the water to beneficial use, but the actual ownership of the water continues to rest, collectively, with the citizens of the State. Throughout the years, water planning and development has been founded upon this principle.

WATER DEVELOPMENT PROJECTS

Water development in Salt Lake Valley began with the first settlements of pioneers in the late 1840s. Over the course of the next two decades, each of the valley's mountain streams was developed for irrigation use. During the same period of time, wells were dug to provide culinary water for the settlements. As early as 1864, Salt Lake City began searching for additional culinary water supplies. The search ultimately lead to the first "Exchange Agreement" in 1888. This agreement resulted in Jordan River water being applied to irrigated fields in exchange for higher quality Emigration Creek and Parley's Creek water which was made available for culinary use. Since that precedent, many other exchanges have been enacted resulting in much of the valley's high quality water being converted to culinary use while poorer quality water has been used for irrigation.

TABLE 31
Existing Reservoirs

Name	Year Built	Stream	Owner	Total Storage (Acre-feet)
Little Dell	1993	Dell Creek & Parley's Creek	Corp of Engineers	20,500
Mountain Dell[a]	1925	Dell Creek & Parley's Creek	Salt Lake City	3,514
Jordan Valley Water Purification				
Upper Pond	1981		JVWCD	550
Lower Pond	1982		JVWCD	46
Twin Lakes	1914	Big Cottonwood Creek	Salt Lake City	486
Red Butte[b]	1930	Red Butte	U.S. Army	265
White Pine Lake	1933	Little Cottonwood Creek	South Depain Ditch Co.	315
Red Pine Lake	1929	Little Cottonwood Creek	Little Cottonwood	202
Lake Mary-Phoebe	1915	Big Cottonwood Creek	Salt Lake City	85
Secret Lake	1926	Little Cottonwood Creek	Water Association	60
Bell Canyon (Lower)	1907	Bells Canyon Creek	Bell Canyon Irr. Co.	25

a. Mountain Dell Reservoir was originally built in 1917 and enlarged to its present capacity in 1925
b. Red Butte has been inactive for several years but is currently being renovated to meet state dam safety standards and will be used for flood control and for the June Sucker recovery program.

A few reservoirs have been constructed on the mountain streams and in the Jordan River Basin to facilitate the development of water resources. See Table 31 for a listing of existing reservoirs. Other past water development projects included the construction of canals, canal lining, culinary water systems, culinary water storage tanks and ponds, and wastewater treatment facilities.

The Utah Water and Power Board began the still current practice of funding water projects in 1947. The Utah Legislature created the Board of Water Resources and Division of Water Resources in 1967 to continue providing State support and funding of water development projects. Table 32 displays the projects funded by the Water and Power Board and the Board of Water Resources.

TABLE 32
Board of Water Resources Development Projects

Sponsor	Type	Year Built	Project Cost	Funded Amount
Alta Town	Cl-Tank	1977	$391,327	$160,000
Alta Town	CL-Pipe	1995	$325,867	$235,867
Bell Canyon Irrigation Company	Pr-Pipe	1953	$11,227	$10,000
Bell Canyon Irrigation Company	Dual-Ws	1954	$16,952	$12,519
Bell Canyon Irrigation Company	Dual-Ws	1957	$50,767	$38,118
Bell Canyon Irrigation Company	Misc	1993	$174,433	$148,444
Bell Canyon/N Dry Creek Irrigation Co.	Dam-Enl	1948	$29,873	$29,873
Bell Canyon/N Dry Creek Irrigation Co.	Dam-Enl	1959	$67,445	$52,488
Bluffdale City	Cl-Pipe	1979	$138,000	$100,000
Brighton & North Point Irrigation Companies	Div-Dam	1986	$254,005	$51,005
Castro Springs Irrigation Company	Dual-Ws	1954	$11,613	$8,807
Central Utah Water Conservancy District	Cl-Trmt	1973	$8,590,000	$1,000,000
Central Utah Water Conservancy District	Cl-Tank	1994	$14,000,000	$3,567,200
Draper Irrigation Company	Div-Dam	1988	$273,980	$204,000
Draper Irrigation Company	Dual-Ws	1993	$7,977,632	$6,876,000
Granite Water Company	Cl-Pipe	1949	$7,540	$7,500
Herriman Irrigation Company	Pr-Pipe	1953	$16,885	$16,885
Herriman Irrigation Company	Pr-Pipe	1970	$32,573	$12,351
Herriman Pipeline and Development Company	Cl-Tank	1987	$205,649	$155,808
Herriman Pipeline and Development Company	Cl-Well	1993	$96,434	$72,600
Herriman Pipeline and Development Company	CL-Tank	2002	$796.000	$637,000
Holliday Water Company	CL-Tank	2004	$3,702,000	$1,500,000
Jordan Valley Water Conservancy District	CL-Pipe	1993	$1,096,168	$932,658
Jordan Valley Water Conservancy District	Misc	1997	$16,050,000	$50,000
Jordan Valley Water Conservancy District	Misc	1998	$15,063,914	$63,914
Jordan Valley Water Conservancy District	CL_Well	2000	$22,143,490	$162,000
Jordan Valley Water Conservancy District	Misc	2003	$33,708,008	$150,000
Lark Water Users	Cl-Syst	1967	$29,398	$21,750
Metropolitan Water District of Salt Lake City	Dam	1986	$52,000,000	$1,600,000
Metropolitan Water District of SLC & Sandy	CL-Trmt	2004	$90,950,000	$950,000
Magna Water Co and Improvement District	CL-Well	1997	$4,594,794	$1,000,000
Magna Water Co and Improvement District	Dual-WS	2003	$2,090,000	$1,175,000
Mount Air Water Corp	Cl-Syst	1985	$256,550	$173,000
North Dry Creek Irrigation Company	Cl-Tank	1959	$28,305	$20,500
North Jordan Irrigation Company	Div-Dam	1986	$200,976	$139,441
Provo Reservoir Water Users Company	Cnl-Lng	1956	$60,033	$45,025
Richards Irrigation Company	Dual-Ws	1986	$596,463	$524,796
Riverton City	Cl-Pipe	1989	$2,246,833	$1,600,000
Riverton City	Dual-WS	2000	$18,066,561	$1,500,000

TABLE 32 (continued)
Board of Water Resources Development Projects

Rose Creek Irrigation Company	PR-Pipe	1962	$29,016	$17,000
Salt Lake City Corporation	Cl-Tank	1982	$12,700,000	$5,000,000
Salt Lake City Corporation	Dam-Rep	1997	$1,415,567	$1,132,454
Salt Lake City Corporation	Dam-Rep	1998	$897,767	$718,454
Sandy Canal Company	Lh-Pipe	1994	$597,767	$447,132
South Despain Ditch Company	Dam-Res	1949	$2,195	$988
South Despain Ditch Company	Dam-Enl	1963	$77,585	$56,636
South Despain Ditch Company	Dual-Ws	1978	$375,520	$272,975
South Despain Ditch Company	Dam-Rep	1984	$203,067	$188,067
South Jordan City	CL-Pipe	2003	$23,330,000	$130,000
Spring Glen Water Company	Cl-Tank	1991	$144,000	$108,000
West Jordan City	CL-Syst	2005	$2,625,000	$25,000
Total			$338,748,153	$33,099,388

CL-Tank: Culinary Tank	CL-Syst: Culinary System	PR-Pipe: Pressure Irrigation Pipe
CL-Pipe: Culinary Pipe	Cnl-Lng: Canal Lining	Dual-WS: Dual Water System
CL-Trmt: Culinary Treatment	Dam-Rep: Dam Repair	Dam-Enl: Dam Enlargement
CL-WellL Culinary Well	LH-Pipe: Low Head Pipe	Div-Dam: Diversion Dam

Over the years, the Board of Water Resources has provided technical assistance and funding for 51 projects in the Jordan River Basin, providing a little over $33 million in funding assistance. These projects are listed in Table 32.

Completion of the Central Utah Project

In 1992 the Central Utah Project Completion Act (CUPCA) was passed by Congress and signed by President George Bush. This act transferred the authority and responsibility to complete the Central Utah Project (CUP) from the Bureau of Reclamation (BOR) to the Central Utah Water Conservancy District (CUWCD), which was established on March 2, 1964. The original counties included in the CUWCD were Salt Lake, Utah, Juab, Wasatch, Summit, Duchesne, and Uintah. In 1967 the District was expanded to include the Sevier River Basin counties; Sanpete, Sevier, Millard, Piute, and Garfield. As allowed by Section 206 of CUPCA Sevier and Millard Counties withdrew from the CUWCD in 1994.

The Central Utah Project includes five units: the Vernal Unit, the Jensen Unit, the Upalco and Uintah Unit, the Ute Unit, and the Bonneville Unit. The Bonneville Unit is the largest and most complex of the CUP, and the only unit that brings water into the Jordan River Basin. The BOR prepared a definite plan report for the Bonneville Unit, which was approved on November 5, 1965, and construction started in 1966. It has been under construction since that time but the scope of the project has changed several times.

The Bonneville Unit includes facilities to develop and more fully utilize waters tributary to the Duchesne River, and to facilitate a transbasin diversion from the Colorado River Basin to the Utah Lake and Jordan River Basins, and to develop and distribute project water in these basins. For planning and coordination purposes, the Bonneville Unit was divided into six systems: (1) Starvation Collection System, (2) Strawberry Collection System, (3) Ute Indian Tribal Development, (4) Diamond Fork System, (5) Municipal and Industrial System (M&I), and (6) the Irrigation and Drainage System System now known as the Utah Lake Drainage Basin Water Delivery System (ULS). All of the Bonneville Unit Systems have been completed except for the ULS system.

The M&I System provides M&I water to Salt Lake County, north Utah County, and Wasatch County. It also provides supplemental irrigation water to Wasatch and Summit counties. The Jordanelle Dam on the Provo River is the main feature of this system. It was completed in 1994 and has an active capacity of 314,000 acre-feet. The water supply for this system is the surplus flows of the Provo River and, by exchange, water rights owned by CUWCD in Utah Lake and water from Strawberry Reservoir released to Utah Lake. The Salt Lake Aqueduct, the Murdock Canal, and the Jordan Aqueduct convey water to Salt Lake County. North Utah County receives its water from the Alpine Aqueduct. Water for Wasatch County is delivered from Jordanelle Reservoir. On average, the M&I System brings 70,000 acre-feet of water per year from the Uintah Basin to Salt Lake County.

The Irrigation and Drainage System would have provided irrigation water to south Utah County, eastern Juab County, and the Sevier River Drainage. The name was changed to the Spanish Fork Canyon / Nephi Irrigation System (SFN) when Millard and Sevier Counties withdrew from the CUWCD in 1994 and the scope of the project was changed. Because of issues raised by the Environmental Impact Statement released in 1998 the scope of the project was again changed from an irrigation project to an M&I project and the name was changed again, to Utah Lake Drainage Basin Water Delivery System (ULS). The ULS system is scheduled to be completed by 2016, but because of budgeting problems may actually not be completed until 2021. When completed the ULS system will bring an additional 30,000 acre-feet of Uintah Basin water into Salt Lake County, and 30,000 acre-feet to south Utah County.

Develop Utah Lake/Jordan River Water

At the present time, there is a significant supply of water tributary to Utah Lake and eventually flowing through to the Jordan River. The supply available to M&I uses from these sources should continue to increase with time as more agricultural lands are converted to residential and commercial uses. Unfortunately, Jordan River water is of poor quality and will prove costly to treat to drinking water standards. Total dissolved solids (TDS) levels in Utah Lake are already so high that conventional treatment of Jordan River water is not economically feasible. As the Jordan River flows northward toward the Great Salt Lake, TDS levels are further increased along with other pollution parameters, including coliform bacteria, inorganics and heavy metals. These problems make the use of Jordan River for M&I purposes very expensive except when used in secondary (non-culinary) systems. Despite these problems, in 1995 the Jordan Valley Water Conservancy District experimented with treating Jordan River water and blending it with high quality water to stretch existing drinking water supplies. Many taste and odor problems were reported by consumers and at the present time, this approach to developing Jordan River water has been discontinued.

Another approach to make Jordan River water acceptable for drinking water purposes would be to use more advanced water treatment methods. Current state-of-the-art treatment methods could be employed to render Jordan River water drinkable. These methods, however, are expensive ($600-$800 dollars per acre-foot) and could result in a significant cost increase to the water users.

Currently, using Jordan River water in secondary systems appears to be the most likely scenario. Secondary water systems could deliver Jordan River water for commercial and industrial and other non-culinary uses such as watering large grass areas, (i.e., parks and golf courses) and residential landscapes. This approach could reduce the amount of treatment required to meet culinary water needs and is being used to some extent by several cities. The capital expense of building an infrastructure to deliver secondary water would be considerable, and should be weighed against the cost of other alternatives.

Still another approach for the development of Jordan River water would be to buy Jordan River water rights, then leave the water in Utah Lake and transfer the water right to ground water withdrawals in Utah County. While this approach is hydrologically sound and would probably meet with approval from the State Engineer, it would likely meet with stiff opposition from water users in Utah County.

Convert Industrial Water to Municipal Use

Perhaps the single biggest change in the Basin's water supply situation in recent years is the announcement by Kennecott Copper Corporation that it will eventually close down mining operations in the Salt Lake Valley and convert its vast holdings of land and water rights for residential and commercial development. The formation of a sister company, Kennecott Land Corporation, in 2001 and the initial construction at the Daybreak development project in 2004 is the beginning of the company's transition from mining to land development.

Kennecott has not announced a date when mining operations will cease completely. It is believed that copper ore concentrations in the pit are sufficient to sustain surface mining operations through at least the year 2025. Once surface mining becomes unprofitable it may still be possible to continue mining copper ore through underground methods. However, the profitability of continued copper mining in the Oquirrh Mountains will ultimately be a function of the price of copper on the world markets, coupled with the advancement of mining technology and the associated cost-efficiency of those advanced mining methods. Additionally, Kennecott's land development undoubtedly constitutes a competing interest with its own mining operations in terms of resource management and logistics. This competing interest for resources will also contribute towards the termination of mining operations. Consequently, it is very difficult to predict just when copper mining operations will cease in the Salt Lake Valley. However, when mining operations are terminated, part or all of Kennecott's vast industrial water rights holdings may become available for municipal or other industrial uses.

For a number of reasons it is very difficult to quantify just how much municipal water can be developed from Kennecott's industrial water supply. As expressed in the 1997 Jordan River Basin Plan, the single biggest obstacle in identifying Salt Lake County's total industrial water use is that many industrial water users view their water-use data as proprietary information. Because it is part of a patented mining process, the actual amount of water used in Kennecott's mining process is considered confidential information.[1] It is now believed that the 55,100 acre-feet of industrial water use reported in the 1997 Jordan River Basin Plan understated Kennecott's actual water use, perhaps by a factor of almost two. Kennecott's actual approved water rights are greater still. Further complicating the matter is the fact that the Basin's ground water has been over-appropriated. Since the Basin has yet to be adjudicated, it is impossible to predict just how much of the outstanding approved, but as of yet unperfected, ground water rights will be allowed. Consequently, quantifying Kennecott's actual water supply is, at the present time, a daunting task that is beyond the scope of this report.

Further complicating the issue is the fact that poor water quality and allowable depletion limits will significantly limit the amount of water that can be moved to municipal use. Much of the water currently used by Kennecott is of poor quality, with high TDS and/or other contaminants. While these pollutants may not pose a problem for Kennecott's current industrial processes, they pose particular problems that will preclude the use of much of the water for municipal purposes with only conventional water treatment methods available for consideration.

Based upon discussions with representatives of Kennecott Land Corporation and with the Office of the State Engineer a conservative estimate is that ultimately about 20,000 acre-feet of presently used industrial water is of sufficient quality that it could be converted to culinary or drinking water standards. An additional 30,000 acre-feet per year of water could be put to use for secondary purposes. Additional infrastructure would need to treat and deliver water for municipal use.

Develop Additional Water from the Wasatch Range Streams

The development of additional water from the Wasatch Range streams holds a limited potential for addressing future needs. There are already plans in place to enlarge some of the water treatment facilities and put more of this high quality water to use. Salt Lake City has water rights in place and plans to develop an additional 3,300 acre-feet per year of water from Mill Creek. Further development of these streams, however, is a sensitive environmental issue.

A significant quantity of high quality water flows from the mountain streams to the Jordan River and subsequently to the Great Salt Lake. The average annual flow into the Salt Lake Valley from Wasatch Range streams is 173,000 acre-feet. In dry years this figure drops to about 115,000 acre-feet. (See Table 4 in Chapter 2 for a detailed breakdown of Wasatch Range stream flows.) At the present time, approximately 90,000 acre-feet per year of that water is incorporated into public water supplies. That leaves a significant

TABLE 33
Water Treatment Facilities

Treatment Plant	Current Capacity (mgd)	Planned Enlargement (mgd)
City Creek	20	-
Parley's	45	-
Big Cottonwood	46	-
Little Cottonwood (MWDSLS)	143	-
Southeast Regional	20	-
Draper Irrigation Company	6	3
Jordan Valley (JVWCD)	180	75
Point of the Mountain (MWDSLS)*	70	80
Total Capacity	**530**	**168**

*Point of the Mountain Treatment plant is scheduled to go on line in the spring of 2007.

quantity of high quality water in the Wasatch Range streams that is currently not used for M&I uses. It is estimated that about 75 percent of the flow from these streams (about 130,000 acre-feet per year) comes during the spring runoff period from mid-April through mid-July. To fully develop this high quality water for drinking water uses, it would be necessary to construct reservoir storage, develop adequate ground water recharge, or provide treatment plant capacity equivalent to the peak runoff.

The feasibility of reservoir construction on Wasatch Range streams and within the Salt Lake Valley has been investigated. The Salt Lake County Area-Wide Water Study, conducted jointly by the Metropolitan Water District of Salt Lake City, the Salt Lake City Corporation, the Jordan Valley Water Conservancy District and the Division of Water Resources in 1982, identified several potential reservoir sites in the Wasatch Range canyons as well as various locations within Salt Lake Valley. However, it is widely held that for political, economical and environmental reasons, the construction of additional reservoirs within the Jordan River Basin is not a viable option.

Without additional surface reservoir storage or new ground water recharge development, the only way to increase culinary water use of Wasatch Range streams would be to provide treatment plant capacity. The capacity would need to equal the peak runoff during periods of time when runoff flow rates can be absorbed by municipal water demands. The peak monthly runoff from all of the Wasatch Range streams is about 40,000 acre-feet/month. This translates to 435 million gallons per day (mgd). At the present time, the capacity of treatment plants on the east side of the Valley is 350 mgd. These east-side treatment plants (City

Creek, Parley's, Big Cottonwood, Metropolitan, Southeast Regional, Draper, and the new Point of the Mountain Treatment Plant) are currently being used to treat the mountain stream runoff. In addition to these facilities, there is the Jordan Valley treatment plant located in Bluffdale. This facility currently has the capacity to treat 180 mgd with the potential to enlarge to 255 mgd. The total current treatment capacity for the Basin is 530 mgd with the potential to enlarge to 698 mgd (see Table 33). There is sufficient capacity in the Valley's water treatment plants to treat and use more of the outflow from the Wasatch Range streams. However, there would be tremendous cost associated with conveying the short duration flows across the Valley to the Jordan Valley treatment plant. Furthermore, since the Wasatch Range peak runoff occurs in May, it does not match up with the Valley's peak demand, which takes place in July and August. Consequently, substantial storage would still be necessary to effectively develop additional water from the Wasatch Range streams.

Develop Additional Ground Water

This is an option that until recently held more promise than it does today. Many municipalities in the Basin have had plans to develop additional ground water sources and in many cases hold approved, but unperfected ground water rights. In June of 2002, the State Engineer published the Ground Water Management Plan for the Jordan River Basin. This new plan sets the limitation of ground water withdrawals at 165,000 acre-feet per year. The estimate of current ground water withdrawals is very close to, if not in excess of, that figure already. Consequently, there may be very little new ground water withdrawals in the Jordan River Basin.

Bear River Water Development

The Bear River has long been viewed as an available water resource. An average annual flow of over a million acre-feet flows from the river to the Great Salt Lake. However, water is available only during the winter and spring months and is of poor water quality. As a result, it has remained an untapped resource. In

1986, the Jordan Valley Water Conservancy District submitted an application to the Board of Water Resources for assistance in developing 50,000 acre-feet per year of water from the Bear River.

During the flooding of the early 1980s, the Division of Water Resources was directed by the Legislature to investigate Bear River water storage options that would help control the level of the Great Salt Lake. In 1990, a joint legislative/gubernatorial Bear River task force was created to look at water development options on the Bear River. This Bear River Task Force recommended that the legislature apportion the State's Bear River water rights to Cache County, Bear River Water Conservancy District, Weber Basin Water Conservancy District, and Jordan Valley Water Conservancy District. The legislature followed their recommendations and allocated 60,000 acre-feet per year to each of the counties and 50,000 acre-feet per year to each of the districts.

The Division was directed by the Task Force to prepare a plan for delivering the apportioned water rights. In 1991, the *Bear River Pre-Design Report* was published. It identified a plan for development that had four major parts: First, development of a water storage reservoir in the upper basin to provide replacement for ground water withdrawals; second, a diversion from the Bear River to move water via canal or pipeline to Willard Bay Reservoir; third, the construction of transmission facilities to move project water from Willard Bay south to Davis, Weber, and Salt Lake counties; and fourth, the construction of a reservoir on the lower Bear River. The current plan has been modified to: (i) construct a pipeline or canal from the Bear River to Willard Bay Reservoir, (ii) construct a water treatment facility in Weber County, and (iii) construct the necessary conveyance facilities to get 100,000 acre-feet per year of water to its point of use. The estimated cost of this project is approximately $300 million.

The Jordan Valley Water Conservancy District (JVWCD), in cooperation with the Weber Basin Water Conservancy District (WBWCD), is proposing the construction of a water treatment plant in central Weber County. The JVWCD has purchasing land for the plant. Also, in cooperation with WBWCD, JVWCD has investigated pipeline alignment alternatives and is acquiring right-of-way to convey Bear River water from the proposed plant south to Salt Lake County and the east shore area of Davis and Weber Counties. This pipeline will deliver needed water to JVWCD as well as alleviate an infrastructure problem for WBWCD in the east shore area of Davis and Weber counties. These proposed facilities would provide the infrastructure to move water south from the Bear River to Salt Lake County and also provide the opportunity for various Weber Basin water suppliers to lease water to JVWCD.

WEATHER MODIFICATION

Some western United States winter cloud seeding projects for augmentation of mountain snowpack have been operated annually for more than 30 years. These projects indicate that increases of 5-15 percent in seasonal precipitation can be achieved. Cloud seeding in Utah is administered by the Division of Water Resources.

Project operations have used selective seeding, which has proved to be the most efficient and cost effective method, and has produced the most beneficial results. Selective seeding, which eliminates seeding storms in which natural precipitation has little or no chance of being enhanced, is based on several criteria which determine whether of not a storm will be seeded. These criteria deal with the air mass structure of the cloud mass (temperature, stability, humidity, wind flow direction and moisture content).

The Wasatch Front target areas have been Big and Little Cottonwood canyons, City Creek and Parleys Creek. Ground-based seeding generators are used to seed the target areas. The increase in precipitation in the target areas has been seven to nine percent greater than might have been predicted from nearby control observations. This increase represents approximately 1.5 inches (water equivalence) within the targeted areas.

NOTES

[1] Utah Division of Water Recources, Utah State Water Plan: Jordan River Basin Plan 1997, (Salt Lake City: Department of Natural Resources, 1997), page 18-1

8

WATER QUALITY AND THE ENVIRONMENT: CRITICAL COMPONENTS OF WATER MANAGEMENT

If water planners and managers in the Jordan River Basin are to effectively meet future water needs, they will need to do more than simply provide adequate water supplies and delivery systems and encourage conservation. The water supply decisions they make can greatly impact water quality, the environment and recreation. For the most part, water planners and managers are aware of these impacts and are working to develop plans and strategies that will protect these important values. Chapter 8 discusses the importance of water quality and the environment to the management of the Jordan River Basin’s water resources, and describes some of the things being done to safeguard these important values.

WATER QUALITY

Regulation of water quality in Utah began in 1953 when the State legislature established the Water Pollution Control Committee and the Bureau of Water Pollution Control. Later, with the passage of the Federal Clean Water Act in 1972 and the federal Safe Drinking Water Act in 1974, strong federal emphasis was given to preserving and improving water quality. Today, the Utah Water Quality Board and Division of Water Quality and the Utah Drinking Water Board and Division of Drinking Water, under the Department of Environmental Quality are responsible for the regulation and management of water quality in the State of Utah.

As a result of these agencies and regulations, residents of the Jordan River Basin enjoy safer water systems than the Basin's early settlers did. However, due to the magnitude of growth and development that is projected to occur and the increased pollution loads that this growth will bring, the Jordan River Basin will continue to face water quality challenges. Water resource planners and managers within the basin need to be increasingly aware of these issues and work closely together to satisfy future water quality needs.

The State Water Plan identified the following water quality programs or concerns that are of particular importance to the future of the State's water resources. These are also of concern to the Jordan River Basin:

- Total Maximum Daily Load program
- Preservation and restoration of riparian and flood plain corridors
- Storm water discharge permitting
- Nutrient loading
- Concentrated animal feedlot operations
- Septic tank densities

How each of these topics affects the water resources of the Jordan River Basin is discussed below. In addition to these items, ground water contamination is also of great concern in the Basin.

Total Maximum Daily Load Program

Section 303 of the Federal Clean Water Act directs each state to establish water quality standards to protect beneficial uses of surface and ground water resources. The Act also requires states to identify impaired water bodies every two years and develop a total maximum daily load (TMDL)[1] for pollutants that may cause impairments in the various water bodies.

The Division of Water Quality (DWQ) has identified stream segments in the Jordan River Basin that are fully supporting, partially supporting or not supporting, their beneficial uses (see Figure 24). Table 34 lists the three impaired water bodies for which TMDLs are required, the pollutant or nature of impairment, and the status of the TMDL.

FIGURE 24
Water Quality Impairments and Beneficial Use Support Assessment

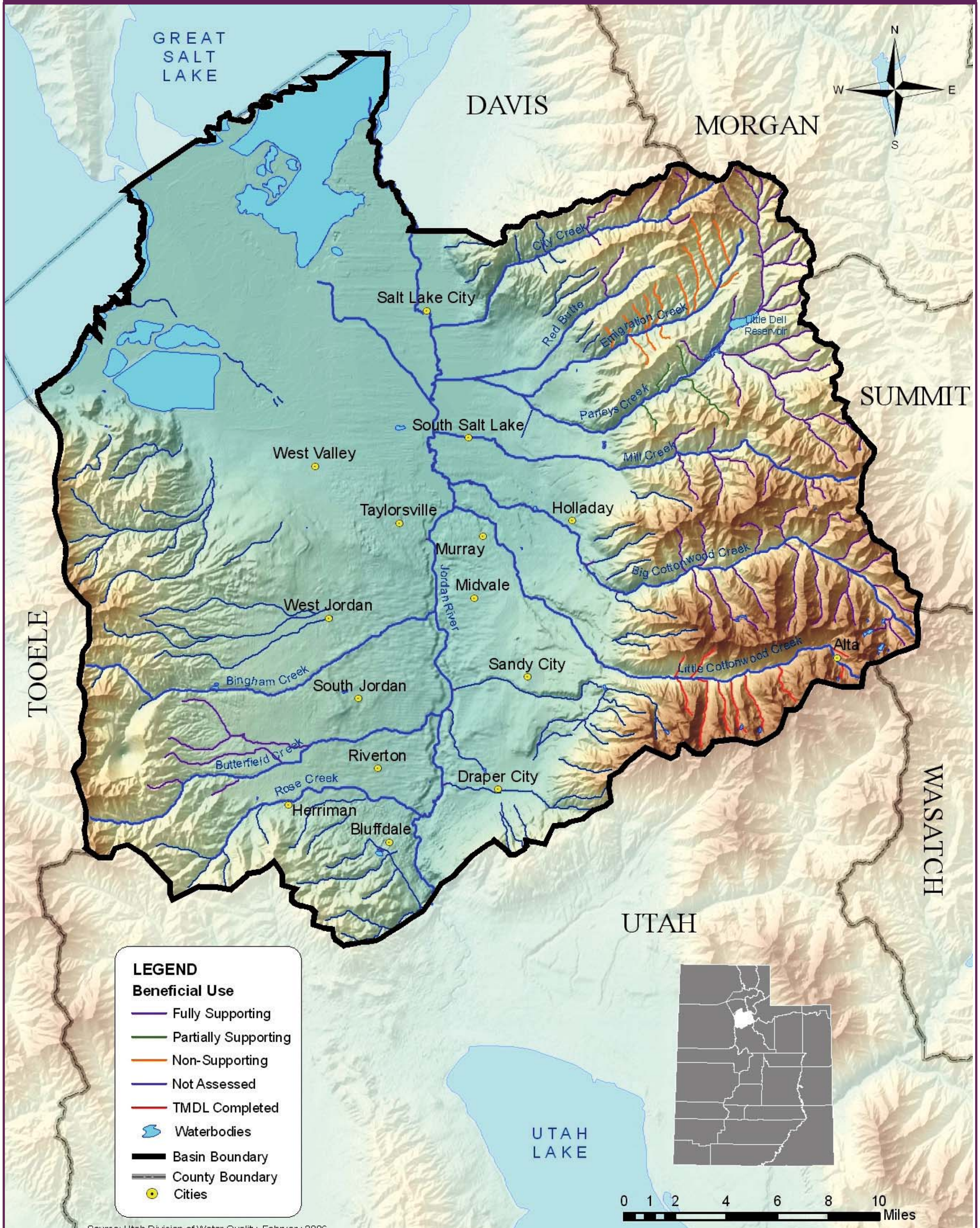


TABLE 34
TMDLs in the Jordan River Basin

Water Body	Pollutant(s) or Stressor(s)	TMDL Status
Jordan River	Salinity,TDS, E. Coli Chlorides, Dissolved Oxygen, Temperature	targeted
Emigration Creek	pathogens	targeted
Little Cottonwood Creek	Ammonia, Total Chlorine Residual	completed March 2002

Source:

In cooperation with State, federal, and local stakeholders, DWQ organizes and facilitates locally-led watershed groups for each of the impaired water bodies targeted for a TMDL. Although a study is under way for the Jordan River, further investigation will be needed to determine the full extent and sources of contamination in both the Jordan River and Emigration Creek. Below is a brief description of the Little Cottonwood Creek TMDL that has been approved and the progress that has been made to date. The status of current or completed TMDL studies can be found on the DWQ website at www.waterquality.gov.

Little Cottonwood Creek TMDL

Little Cottonwood Creek is classified by DWQ as a high quality, cold water fishery. The watershed is also protected by Salt Lake City as a source of drinking water. In 1994, DWQ and Salt Lake City conducted an intensive monitoring program and found that dissolved zinc concentrations in Little Cottonwood Creek exceeded the stream's classification criteria. The suspected cause was historic mining operations in Little Cottonwood Canyon around Snowbird and Alta. As a result, the stream was listed on the State's 303(d) list of impaired water bodies, and a TMDL study, in conjunction with the Little Cottonwood Canyon Watershed Group, was completed in March 2002. Despite various management attempts, the stream water quality has not yet been restored to an acceptable level.[2]

Preservation and Restoration of Riparian and Flood Plain Corridors

Riparian corridors can best be defined as the transitional areas between a stream channel and the upland terrestrial habitats. The landscape typically possesses unique soil and vegetation characteristics that are dependent upon the presence of water. While riparian corridors cover a small percentage of the landscape, these habitats harbor a large number of wildlife. The corridors also provide flood protection and perform a number of ecological functions that maintain the integrity of the stream channels and the quality of the water passing through them.

Many riparian zones adjacent to the Jordan River and its tributaries have been severely impacted by flood plain development. As human population increases, the riparian and flood plain corridors are subjected to greater impacts. In 2002, DWQ estimated that municipal and industrial (M&I) wastewater effluent, urban runoff, septic systems, resource extraction, and habitat alteration affected about 52 stream miles in the Jordan River Basin. One segment through Parleys Canyon has been permanently altered because of construction of the interstate highway (I-80). As a result, it is under consideration to have its classification as a cold water fishery changed.[3]

The management and restoration of riparian corridors is becoming increasingly important. Several studies have shown that properly maintained riparian corridors and flood plains can protect and improve water quality by intercepting nonpoint source pollutants in surface and shallow subsurface flows. The ability of the riparian strip to provide various restorative functions depends upon its width, soil type, the density and type of vegetation, and other factors.[4]

One entity currently working to protect and restore riparian corridors along the Jordan River is the Utah Reclamation Mitigation and Conservation Commission. This commission is an entity of the federal government responsible for the funding, design, and implementation of projects to offset the impacts to fish, wildlife, and other resources caused by the Central Utah Project and other federal projects in Utah. The commission has been involved with planning and implementing habitat restoration along the Jordan River corridor since 1994. Part of these efforts has included securing segments of land to establish a natural conservation corridor along the River. This was recommended to the Commission in a 2000 Jordan River Natural Conservation Corridor Report prepared by the National Audubon Society. The report recommends securing 650 to 900 acres along the Jordan River as reserved, nature parks to restore native vegetation and the natural riparian corridor.[5] The locations of these areas are described in Table 35.

TABLE 35
Recommended Additions to the Jordan River Natural Conservation Corridor

Recommended Area	Approximate Acreage	Rationale for Inclusion
West side of River between Riverbend Golf Course and Bangerter Highway	200 acres	This large area was identified as a high priority wetland area in the WAIDS (a Salt Lake County wetlands) study. The "Colby," Riverbend Nature Area, and the "Prison Property", which are east of this property, currently constitute the largest single block of reserved, nature park and undecided areas along the Jordan River. The addition of this area would provide continuous habitat along both sides of the River.
Bangerter Highway to 14600 South	150-200 acres	This large area is identified as a high priority wetland area in the WAIDS study. It would be south of Bangerter Highway and is next to the property proposed in the area above. This is a large area that includes property on both sides of the River.
The Jordan Narrows area, which would include areas roughly up to 1.5 miles north of the Salt Lake County and Utah County Border.	150-200 acres	The Jordan Narrows includes the best representation of native vegetation along the entire Jordan River. This is also where the river is braided and connected to its floodplain. Previous bird surveys indicate that this area already includes significant breeding habitat for migratory birds such as yellow-breasted chats and willow flycatchers. One of the reasons for the high diversity in vegetation and good avian breeding habitat is that the narrows is very difficult to access.
Utah County, south of Thanksgiving Point to Inlet Park	150-300 acres	Utah County has an extensive flood plain and wetland area by the Jordan River. A rough estimate indicates that over 1,360 acres of land is in the floodplain and over a square mile or 640 acres could be considered wetland habitat. While there is one reserved area and some nature parks along the Jordan River in Utah County, a large piece of land could be acquired, or in some other manner reserved for wildlife.

Source: National Audubon Society, "Jordan River Natural Conservation Corridor Report," page 3-3 and 3-4. This report was retrieved from the Utah Reclamation and Mitigation and Conservation Commission's Internet webpage: www.mitigationcommission.gov.

The U.S. Army Corps of Engineers is also working to restore several sections along the Jordan River. In January of 2001, the Corps completed a draft Ecosystem Restoration Report and Environmental Assessment for the section of the Jordan River between 600 South and 16600 South. The proposed plan includes efforts to prevent habitat loss, prevent erosion and sedimentation due to channel instability, and restore riparian and wetland habitat to increase the biodiversity of, and the carrying capacity for, plant and animal species. The plan would create about 14 acres of habitat and would cost around $7 million.[6]

Another section of river being studied for restoration is the lower portion of City Creek. The studied section of the river is the last 1.25 miles from 500 West to its confluence with the Jordan River. In 1905, a large portion of City Creek was diverted underground through the North Temple Street culvert. The U.S. Army Corps of Engineers now proposes to restore the studied section to a partially natural surface flow condition. The proposed project would create a riparian corridor through Folsom Avenue approximately 100 feet wide. The restoration would include separate habitat and trail corridors with controlled access points for maintenance crews and also public enjoyment. The restoration of City Creek would provide valuable riparian habitat as well as important urban fishery benefits.[7]

County and city planners need to work together with the Utah Reclamation Mitigation and Conservation Commission, the U.S. Army Corps of Engineers, and other agencies to preserve the riparian zones and flood plains from unwise development. Zoning laws and master plans need to consider the ability of these lands to improve water quality and protect the populace from the impacts of flooding. If development is not kept an adequate distance from the river, hard structures such as bridges, roads, houses, and businesses will replace the important buffer zones that help to protect water quality.

Storm Water Discharge Permitting

Pollution from storm water discharge is a result of precipitation and runoff flowing over land, pavement, building rooftops, and other impervious surfaces where it accumulates pesticides, fertilizers, oils, salt, sediment, and other debris.[8] As mentioned in the previous section, urban runoff is a major contributor to the pollution of the Jordan River system. The main problem that comes from runoff for the Jordan River is organic loading. Organic materials and byproducts consume oxygen as they decompose. This creates a large oxygen demand in the river that lowers the level of oxygen dissolved in the water below state standards.[9]

To minimize the amount of pollutants that enter the nation's water bodies through storm water runoff, the U.S. Environmental Protection Agency (EPA) initiated a two-phase process for implementation of storm water regulations. Implementation of Phase I began in 1990, and affected certain types of industry, construction sites larger than five acres, and cities or counties with a population larger than 100,000. Because Salt Lake County falls under this category, nearly all of the cities in the Jordan River Basin are also required to comply with Phase I regulations. Table 36 lists the entities within the Basin that are required to comply with these rules. DWQ is working closely with these communities to help them comply.

Phase II of EPA's storm water regulations, which began implementation in 2003, affects smaller construction sites and any area designated as an "urbanized area" by the U.S. Census Bureau.[10] Phase II rules also apply to any community outside an urbanized area that has a population greater than 10,000 and a population density higher than 1,000 people per square mile. Effected communities were required to apply for a storm water discharge permit with DWQ by March 10, 2003, and must fully implement a storm water management program in compliance with the permit within five years.

Nutrient Loading

Nutrient over-enrichment continues to be one of the leading causes of water quality impairment in the Jordan River Basin. Although these nutrients (nitrogen and phosphorus) are essential to the health of aquatic ecosystems, excessive loads have resulted in the undesirable growth of aquatic vegetation and algae, resulting in oxygen depletion in several of the Basin's water bodies, particularly the Jordan River. .

Nutrients enter the Basin's waterways primarily through urban and agricultural storm water runoff. In between storms, nutrients, pesticides, volatile organic compounds, and other contaminants accumulate on impervious surfaces and are later washed into waterways during storms. For example, a storm in April 2000 resulted in phosphorus and nitrogen concentrations in Little Cottonwood Creek exceeding the U.S.

Environmental Protection Agency's recommended levels. Another example is a result of increased sodium and chloride levels in streams due to de-icing of roadways in the winter.[11] On agricultural and urban landscapes, the careful management of chemicals for de-icing and other purposes, proper application of fertilizer, and efficient irrigation could help reduce the amount of these contaminants entering waterways.

TABLE 36
Communities Affected by EPA's Phase I Storm Water Rules

Storm Water Entity	Population	Population Density (people/mi^2)	In Designated Urbanized Area?
Bluffdale	3,934	240	Yes
Canyon Rim	10,428	5,038	Yes
Cottonwood Heights	27,477	4,042	Yes
Cottonwood West	18,727	4,656	Yes
Draper	23,578	1,044	Yes
East Millcreek	21,385	4,805	Yes
Granite	1,979	1,348	Yes
Herriman	1,051	115	Yes
Holladay	14,513	2,719	Yes
Kearns	33,659	6,998	Yes
Little Cottonwood Creek Valley	7,221	2,778	Yes
Magna	22,641	3,051	Yes
Midvale	27,029	4,631	Yes
Millcreek	30,377	6,164	Yes
Mount Olympus	6,857	2,026	Yes
Murray	34,024	3,545	Yes
Oquirrh	10,390	5,954	Yes
Riverton	24,849	1,978	Yes
Salt Lake City	180,157	1,633	Yes
Sandy	88,177	3,949	Yes
South Jordan	28,926	1,376	Yes
South Salt Lake	22,038	3,193	Yes
Taylorsville	57,439	5,380	Yes
West Jordan	68,201	2,208	Yes
West Valley City	108,712	3,068	Yes
White City	5,988	6,915	Yes
AVERAGE	**33,837**	**3,417**	**-**

(Sources: Division of Water Quality and the U.S. Census Bureau's web page: www.census.gov/main/www/cen2000.html.)

Other sources of nutrients include wastewater treatment plant effluent and septic tank systems effluent. Although it is a relatively easy process to reduce nutrient levels in wastewater (a point source), it is not feasible to completely eliminate them. Controlling nutrients from non-point sources is more difficult. In the few areas of high septic tank densities in the Basin, sewer systems need to be installed and nutrients reduced at a wastewater treatment plant. With a concerted effort by all those living within the Basin, nutrient loads can be reduced and the quality of the Basin's waterways improved.

Concentrated Animal Feeding Operations

Another water quality concern within the Jordan River Basin is the impact animal feeding operations (AFO) and concentrated animal feeding operations (CAFO) have on water quality. These operations, where large numbers of animals are grown for meat, milk, or egg production, can increase the biological waste loads introduced into rivers, lakes, and surface reservoirs or ground water aquifers. Animal manure contains nutrients, pathogens and salts.

The Utah Department of Environmental Quality has prepared a Utah AFO and CAFO strategy.[12] This strategy has three primary goals: (1) to restore and protect the quality of 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. The strategy provides a five-year window for facilities of particular concern 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. Funding is also available through the program, and through the summer of 2004, more than $7.1 million in Federal and State funds have become available for Utah's water quality efforts in relation to animal feeding operations.

The first step in implementing this strategy - completing a statewide inventory of AFO and CAFO - is complete. As of December 31, 2005, the inventory has identified 2,056 AFOs and 454 CAFOs or potential CAFOs. Only one of the State's AFOs are located within the Jordan River Basin; 12 of the state's CAFOs or potential CAFOs are located in the Basin.[13]

TABLE 37
Jordan River Basin Feedlot Nutrient Load Reduction Summary

Animal Type	Total Number of Animals	Nitrogen Load Before	Nitrogen Load After	Phosphorus Load Before	Phosphorus Load After	BOD_5 Load Before	BOD_5 Load After
Horses	10	293	0	69	0	1,257	0
Cattle	12	367	46	86	11	1,571	196
Swine	15	62	0	28	0	305	0
TOTAL	**37**	**722**	**46**	**183**	**11**	**3,133**	**196**

Source: Mark Peterson, 2006 Annual Progress Report--AFO/CAFO Inventory and Assessment Project, an unpublished report by the Utah Farm Bureau, December 31, 2005.

In only a few years of operation, this program has enjoyed full cooperation from all AFO and CAFO operators. All but seven operators have already completed a plan with the remaining plans currently being developed. The program has been extremely successful in the Jordan River Basin with 9 of the 13 AFOs and CAFOs already in full compliance. A Utah Animal Feedlot Runoff Risk Index Model was run on three of those in full compliance and has shown significant reduction in pollutants. The results are shown in Table 37.

Septic Tank Densities

In some areas of the Basin, regional wastewater treatment facilities have not yet been constructed and individual septic tank systems are used to dispose of domestic wastes. Septic tanks are designed to partially treat domestic waste and disperse the remaining pollutants into the natural environment in quantities that the environment can satisfactorily assimilate. When densities become too high, concentrations of certain pollutants (nitrogen, for example) can begin to cause problems. One area that appears to be problematic is Emigration Canyon. Preliminary testing has shown that fecal coliforms are unusually high and it is thought that septic tanks are the source of contamination. Further investigation will be necessary to determine the actual cause and the necessity of a TMDL, as mentioned earlier in this chapter.

Ground Water Contamination

Because most of the Salt Lake Valley's population receives some ground water for culinary use, the quality of this source is crucial to the continued health and growth of the population. In 1999, the U.S. Geological Survey studied the effects that development has had on the ground water under an 80 square mile area in the Salt Lake Valley from 1963 to 1994. The study was part of the National Water Quality Assessment (NAWQA) program.

One significant finding of the study was that the shallow ground water has been significantly impacted by human activity. The shallow ground water was found to contain elevated concentrations of nitrate, 25 of 30 monitoring wells had detectable level of at least one of the four herbicides tested, 27 of 30 wells had detectable levels of chloroform (possibly from chlorinated water used to irrigate lawns and gardens), and 16 of 30 wells had detectable levels of a dry cleaning agent and solvent known as tetrachloroethene.[14] In fact, the median concentration of nitrate was almost five times the national NAWQA median for urban ground water studies and was the highest in all 34 of the studies conducted across the nation.[15]

Because the shallow aquifer is unconfined and is not far from the surface, it is more easily affected by human activities than are the deeper confined and unconfined aquifers. Salt Lake Valley residents do not currently use shallow ground water as a drinking water source. However, the deeper aquifers are used extensively as a drinking water supply and are susceptible to contamination through secondary recharge from the shallow unconfined aquifer.[16] In the center of the Valley, the gradient or flow of ground water is typically upward from the confined aquifer to the land surface, but withdrawals from the aquifer for public supply appear to have reversed this direction in some areas. This has caused water that is recharged in the Valley with a higher concentration of dissolved solids to move into the deeper aquifers.[17] This reversal can also cause other contaminants to enter the water supply, if the aquifers are not carefully managed.

Many of the municipalities in the Basin, particularly Salt Lake City and Murray, are concerned by the presence of contaminants in the aquifers. Salt Lake City has lost production in four of its wells due to the presence of dry cleaning agents, and has subsequently had to spend millions of dollars for treatment. Salt Lake City is also worried about the poor quality of the shallow ground water aquifer, as it may eventually need to be used as a drinking water source. One site, located at 1500 East and 500 South, is even being considered for Superfund status as part of the National Priorities List. The suspected source of contamination is the Veterans Administration Hospital that once had a dry cleaning operation in the area.[18]

Another point of concern is that the bulk of the ground water has an apparent age of less than 50 years. Ground water is generally older the further it moves from the base of the mountains, the oldest water is found near the center of the valley.[19] This increases the risk of contamination and heightens the importance of controlling the amount and type of substances allowed to enter the ground water. Contaminants that are allowed to enter the ground water supply will have a more direct influence on the near future of the basin's drinking water supplies.

There are numerous cases of ground water contamination identified in the Jordan River Basin NAWQA study. Four of these instances are discussed in the following text, three of which have been listed on the U.S. Environmental Protection Agency's Region 8 Superfund list. The fourth site is one of 24 sites nation-wide under the responsibility of the Environmental Management program as part of the Uranium Mill Tailings Radiation Control Act.

Kennecott Copper Superfund Site

Mining activities in the Oquirrh Mountains in the southwest part of Salt Lake County began in the early 1860s. Since around 1900, Kennecott Copper has operated various mining, mineral processing and ore production facilities. These activities have resulted in a large plume of contaminated ground water in the South Jordan area. In August 2003, Kennecott Utah Copper Corporation and the Jordan Valley Water

Conservancy District submitted a remediation proposal to the Natural Resources Damage Trustee for the state of Utah. The proposal, approved in August 2004 and amended in November, 2009, lays out a plan to clean up the 37 square mile site over the next 40 years. It includes extracting and treating sulfate-contaminated ground water from the contaminated zones in the confined aquifer to provide an average of 8,235 acre-feet per year of drinking water to residents in the affected area for the duration of the project. The project, known as the Southwest Jordan Valley Groundwater Project, will improve ground water quality and prevent further migration of the contaminants to other parts of the Valley.[20]

Sharon Steel Superfund Site[21]

The Sharon Steel Superfund site covers about 460 acres within Midvale City limits. Numerous smelting, refinery, and mining companies have operated on the site since before 1900. Most recently, Sharon Steel Company took ownership in 1981, receiving lead, copper, and then zinc ores and extracting the sulfide concentrates of these metals on site. The company also operated as a custom mill, performing various extractions according to customer specifications. Disposal of the wastes from these operations was via stockpiling of unconsolidated tailings in piles on site.

Cleanup of this site included fencing, stabilizing the banks of the Jordan River, removing old mill buildings, capping tailings and reclaiming surrounding areas, installing monitoring wells in the shallow unconfined aquifer to monitor contaminated ground water and verify it does not migrate, and removing contaminated soil. In May 1999, the cleanup was completed and the site was deleted from the National Priorities List in 2004. Monitoring of the ground water and the cap is ongoing. This is particularly important to ensure that the five drinking water wells Jordan Valley Water Conservancy District is adding nearby will not affect the movement of the contaminated ground water plume.

Murray Smelter Superfund Site

From 1872 to 1949, lead smelting and arsenic refining operations took place in Murray. These operations affected the soil, shallow ground water in the unconfined aquifer, surface water and sediment of the 142-acre site and the surrounding area. The site was added to the Environmental Protection Agency's (EPA) National Priority List in 1994. A Consent Decree issued by the EPA in 1998 settled the liability at the site and established the responsibilities for cleanup among Murray City, EPA and the American Smelting and Refinery Company - the operator of the site from 1902 to 1949.

Cleanup efforts included excavation and off-site disposal of soil with high levels of arsenic, capping of other soil with lower levels of lead and arsenic, reducing levels of arsenic in ground water and surface water by natural attenuation, and installing monitoring wells to track the attenuation and movement of contaminants. The majority of the cleanup was completed in the summer of 2001.[22]

A public health assessment conducted in 1997 concluded that there was no apparent public health hazard from the presence of the contaminants in some of the soil and in the shallow ground water aquifer. This conclusion is based largely on the low risk of exposure to the contaminants and the fact that the shallow aquifer is not being used as a drinking water supply.[23]

Vitro Uranium Mill Tailings Radiation Control Act Site

During World War II a plant was built to provide aluminum, and later uranium, for the United States Government. Contamination of the soil and shallow ground water in the unconfined aquifer occurred from the residual tailings that remained from the extraction of uranium. By 1968, production ceased and the plant was dismantled by 1970. The 128-acre site is surrounded by the Jordan River, Mill Creek, and a small wetland and is traversed by the South Vitro Ditch.

In May 1989, surface cleanup was completed through remediation of nearly 2,060,000 cubic meters of contaminated materials. Radioactive material was moved to a disposal site at Clive, Utah. Approximately 700 million gallons of contaminated shallow ground water still remain, and studies are currently being conducted to determine what actions will need to be implemented.[24]

THE ENVIRONMENT

While the Jordan River Basin was first being settled, little thought was given to the health of the ecosystems surrounding the Jordan River. Before modern civilization entered the Salt Lake Valley, the Jordan River was largely a highly braided stream that meandered over a large floodplain. Early efforts to control the river focused mainly on the need to maximize development. Channelization projects straightened the river, many oxbows and wetlands were filled, and development consumed much of the area along the river. Wildlife was displaced and the confined river's ability to support various habitats was compromised. For years, untreated wastewater was dumped into the River, and multiple mining and refinery operations impacted the River.

At the time these projects were constructed, environmental values associated with riparian ecosystems were not well understood. Since then, however, the arena in which water managers and planners operate has undergone enormous change. Environmental issues are now better understood and there is an effort throughout the country and within the Jordan River Basin to protect the environment from unnecessary degradation and to mitigate or restore areas impacted from past actions. Water planners and managers within the basin routinely integrate environmental policies and strategies into their operations to provide balanced and comprehensive solutions to water supply problems. This will continue to be important to the success of any future water development project or management measure.

Some of the environmental values that affect the water resources of the Jordan River Basin, or have the potential to do so, include:

- Threatened, endangered and sensitive species,
- Wetlands and the Great Salt Lake ecosystem,
- Instream flow maintenance, and
- Wild and Scenic River designation.

Each is discussed briefly below.

Threatened, Endangered, and Sensitive Species

In 1973, the federal Endangered Species Act (ESA) was passed by Congress to prevent plant and animal species from becoming extinct. Although ESA has had some success, it has been widely criticized because of its negative impacts on the communities located near threatened and endangered species. Once a species is federally listed as either threatened or endangered, ESA restricts development, land management, and other activities that may impair recovery of the species.[25]

As of 2005, one plant species and three animal species in the Jordan River Basin were listed as threatened or endangered.[26] The only endangered species located in the Basin is the June Sucker, a fish that is not native to the Basin and exists only in Red Butte Reservoir as part of a recovery effort. Its presence will not affect Basin water development or management. The three threatened species found within the Basin are the Ute Ladies-tresses (a plant species associated with wetland vegetation), the bald eagle and possibly the Canadian Lynx.

To avoid the difficulties encountered when a species becomes federally listed as threatened or endangered, and to better protect Utah's plant and wildlife resources, the Utah Division of Wildlife Resources (DWR) has developed the Utah Sensitive Species List. The list identifies species most vulnerable to population or habitat loss. In addition to the four species previously mentioned, 23 species that reside within the Jordan River Basin are listed on Utah's Sensitive Species List. Of these, 13 are bird species, many of which have critical habitat along the east shore of the Great Salt Lake (including the American White Pelican, and Long-billed Curlew); three are mammals (Kit Fox, Spotted Bat, and Townsend's Big-Eared Bat); two are amphibians

(Columbia Spotted Frog and Western Toad); two are invertebrates (Lyrate Mountainsnail and Western Pearlshell); two are fish species (Bonneville Cutthroat Trout and Least Chub); and one is a reptile (Smooth Greensnake).[27] The Division of Wildlife Resource's goal is to develop and implement appropriate conservation strategies for these species that will preclude their being listed as threatened or endangered.[28]

In 1998, the Utah Legislature created the Endangered Species Mitigation Fund (ESMF) to help protect essential habitat for Utah's threatened, endangered, and sensitive species. The Fund makes it possible for Utah land and water developers to continue responsible economic growth and development throughout the State while providing for the needs of various wildlife species. Through innovative, cooperative partnerships funded by ESMF, state wildlife managers are working hard to create conservation and habitat agreements aimed at down-listing existing threatened and endangered species and avoiding the listing of other sensitive species. ESMF provides a stable, non-lapsing revenue base which addresses the needs of Utah communities, local government and citizens who have struggled financially to comply with the requirements of federal law.[29]

In 2001, the State Wildlife Grants (SWG) program was established to increase funds necessary for the conservation of fish and wildlife species. SWG is now the nation's core program to help keep fish and wildlife from becoming federally threatened or endangered. Efforts are underway in Utah to restore habitat, enhance or reintroduce native species, and improve the stewardship of public and private lands using State Wildlife Grants. In order to receive these grants from the federal government, states are required to submit a Comprehensive Wildlife Conservation Strategy outlining conservation priorities for up to 10 years that will:

- identify priority fish and wildlife species and their habitats,
- assess threats to their survival, and
- identify actions that may be taken to conserve them over the long term.

Utah's strategy was accepted and approved by the U.S. Fish and Wildlife on September 9, 2005, and will help sustain and enhance the ecological, social, and economic viability of communities to ensure a better quality of life for all.[30]

Wetlands and the Great Salt Lake Ecosystem

Prior to, and during, the early years of modern civilization in the Salt Lake Valley, the wetlands along the Jordan River and surrounding much of the Great Salt Lake were some of the region's richest avian resources. These habitats are an important breeding, wintering, and migrating area for numerous bird species. They provide natural flood protection, improve water quality, and assist in storm water management. Because much of the River has been channelized and many wetlands have been dried up and developed, a significant portion of the habitat has been lost.

In order to try and restore balance to these important ecosystems, the Utah Reclamation Mitigation and Conservation Commission is working to acquire large parcels of land along the Jordan River to restore wetland areas to their original state as discussed earlier in this chapter. In October 2002, a Memorandum of Understanding was signed by 28 members, including local, city, state, and federal entities and private and non profit organizations. Other entities have since joined to work together to restore and preserve the natural Jordan River corridor.[31]

The Mitigation and Conservation Commission has also partnered with the Utah Audubon Society to create the South Shore Ecological Reserve that includes approximately 8,000 acres along the south shore of the Great Salt Lake. A large portion of this area has been acquired by entities with a need to mitigate wetland impacts with about half coming from Kennecott Utah Copper and the Salt Lake Airport Authority. These efforts play an important role in preserving sensitive lands as sanctuaries for wildlife and insuring the enjoyment of these areas for future generations.[32]

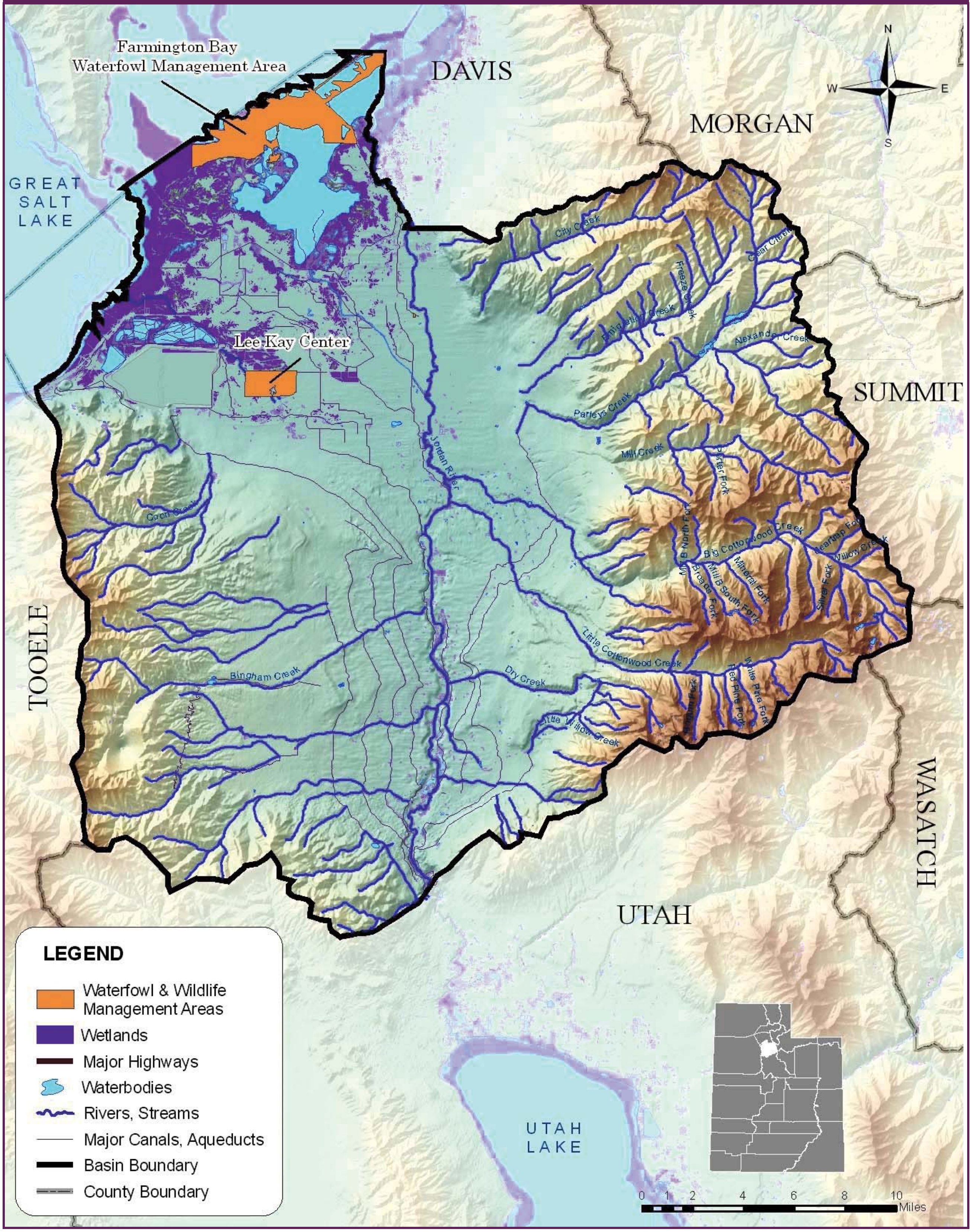
Instream Flow Maintenance

An instream flow is often defined as "free flowing water left in a stream in quantity and quality appropriate to provide for a specific purpose."[33] In general, the purpose of an instream flow is to provide habitat for fish and other aquatic wildlife. However, an instream flow may also provide water for terrestrial wildlife and livestock watering, maintain critical riparian vegetation, accommodate certain recreational purposes, or simply enhance the aesthetics of the natural environment. The necessary quantity and timing of instream flow varies with each purpose and is not necessarily the same as a minimum flow.

In Utah, there are several ways to obtain instream flows; these are listed below:

- <u>Instream Flow Agreements</u> – When water storage and diversion facilities are constructed, minimum instream flows are often negotiated among the various water users as a means of mitigating negative impacts of the project to fish and wildlife habitats. These agreements often describe conditions where the minimum flows may be compromised and have no legal mechanism of enforcement. Instream flow agreements are the most common form of stream flow maintenance in Utah.
- <u>Conditions on New Water Rights Appropriations</u> – Since 1971, the State Engineer has had the authority to place a condition on the approval of a water right application if, in his judgment, approval of the full requested right would "unreasonably affect public recreation or the natural stream environment." In other words, the State Engineer can reject (or reduce the amount of) a new appropriation or reject a change application in order to reserve sufficient flow for recreation or the environment. As of the end of 2005, there were no instances in the Jordan River Basin where the State Engineer was required to exercise this authority.
- <u>Conditions of Permits or Licenses</u> – Hydroelectric facilities must receive a license from the Federal Energy Regulatory Commission to operate. Alterations to streams must receive a permit from the Utah Division of Water Rights. Before a license or permit is issued or renewed, the public is given the opportunity to comment. If this process identifies instream flows as critical to other uses of the water, such as wildlife habitat, these flows may become part of the permit or license conditions.
- <u>Instream Flow Water Rights</u> – In 1986, the Utah Legislature amended the water rights law of the State to allow the Utah Division of Wildlife Resources to file for changes of a perfected water right to provide sufficient instream flow for fish propagation. These water rights may be obtained through purchase, lease, agreement, gift, exchange or contribution. Acquisition of such flows must be approved by the legislature before the State Engineer can make a determination. Later, the Utah Division of State Parks and Recreation was given the same authority.

FIGURE 25
Wetlands, Wildlife Management Areas and Wildlife Preserves



Wild and Scenic River Designation

Currently there are no rivers in Utah with Wild and Scenic River designation. In recent years, however, national forests and other federal agencies have made inventories of streams for consideration as wild and scenic rivers and found numerous stretches to be eligible.

Wilderness Areas

In 1976, Congress passed the Federal Land Policy and Management Act. This Act directed the Bureau of Land Management (BLM) to conduct a study of its remaining roadless areas and make recommendations as to whether or not each area should become a Congressionally-designated Wilderness Area. In 1980, BLM completed an inventory of the roadless areas in Utah and identified 95 Wilderness Study Areas totaling about 3.3 million acres. In order to be considered a Wilderness Study Area (WSA), an area must possess the following characteristics as identified in the Wilderness Act:[34]

- Size - roadless areas of at least 5,000 acres or of a manageable size, and roadless islands;
- Naturalness - generally appears to have been affected primarily by the forces of nature;
- Opportunities - provides outstanding opportunities for solitude or primitive and unconfined types of recreation.
- WSAs may also possess special qualities such as ecological, geological, educational, historical, scientific and scenic values.

Once an area is designated as a WSA, BLM manages the area as a wilderness area until Congress determines if an area should indeed be classified as wilderness by law. In managing a WSA, the BLM must provide opportunities for the public to use wilderness for recreational, scenic, scientific, educational, conservation, and historical purposes in a manner that will leave the area unimpaired for future use and enjoyment as wilderness.[35] There are three areas in the Jordan River Basin that already have Wilderness Area designation. These are Mt. Olympus, Twin Peaks and Lone Peak Wilderness Areas.

OBTAINING BALANCE BETWEEN COMPETING VALUES

In recent decades, water quality and environmental issues have emerged as important players in the water resources arena. Taking their place alongside the traditional role of supplying the public with adequate water supply, these important issues have changed the landscape within which water planners and managers operate. Water resources are now subject to numerous federal and state laws, which are intended to help keep water clean and protect the environment.

Water quality and environmental laws help sustain the beneficial use of water and bring valuable balance to the water resources arena, where growing demands are causing increased competition and are often in conflict with natural environmental needs. While this balancing act is not easy, if orchestrated properly, it will lead to better water planning and management, higher quality water, and a healthier and more enjoyable environment.

Water planners and managers, local leaders, and interested individuals within the Jordan River Basin all play important roles in the management of the Basin's water resources. By working closely together, they can help meet future water resource challenges. Following the spirit of the pioneers, who first settled the Basin, they too can assure a promising future for future generations.

NOTES

[1] A TMDL sets limits on pollution sources and outlines how these limits will be met through implementation of best available technologies for point sources and best management practices for nonpoint sources. For more information, see U.S. Environmental Protection Agency, "Total Maximum Daily Load (TMDL) Program." Retrieved from EPA Internet web page: www.epa.gov/owow/tmdl/intro.html, December 2005.

[2] Miller, Sheperd, *Total Maximum Daily Load for Dissolved Zinc in Little Cottonwood Creek,* (Salt Lake City: Utah Division of Water Quality, March 2002), p 1.

[3] Utah Division of Water Quality, *Utah Lake – Jordan River Watershed Management Unit Stream Assessment,* (Salt Lake City: Dept. of Environmental Quality, 2002), 14 & 19. This report is also available online at the Division of Water Quality's web page: www.waterquality.utah.gov.

[4] Fischer, Richard A. and J. Craig Fischenich, "Design Recommendations for Riparian Corridors and Vegetated Buffer Strips," (April 2000), p 2 & p 13. This publication was developed under the U.S. Army Corps of Engineers Ecosystem Management and Restoration Research Program and was taken from Wisconsin Department of Wildlife Resources Internet webpage: http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/sr24.pdf.

[5] National Audubon Society, “Jordan River Natural Conservation Corridor Report,” page 3-3 and 3-4. This report was retrieved from the Utah Reclamation and Mitigation and Conservation Commission Internet webpage: www.mitigationcommission.gov.

[6] U.S. Army Corps of Engineers, *Upper Jordan River Section 206 Aquatic Ecosystem Restoration Salt Lake County, Utah Final Ecosystem Restoration Report And Environmental Assessment*, (Sacramento District, CA: U.S. Army Corps of Engineers, January 2001).

[7] U.S. Army Corps of Engineers, *City Creek Section 206 Aquatic Ecosystem Restoration Detailed Project Report Salt Lake City, Utah,* (Sacramento District, CA: U.S. Army Corps of Engineers, December 2003).

[8] U.S. Environmental Protection Agency, "Storm Water Phase II Final Rule," Fact Sheet 1.0, (Roanoke, Virginia: EPA, 2000), p 1. This fact sheet is a concise, four-page description of the Phase II rules, their intent, and who is required to comply. A copy of this and other fact sheets can be obtained from EPA web page at: www.epa.gov/owm/sw/phase2.

[9] Utah Division of Water Quality, 2002, 14.

[10] U.S. Census Bureau, "United States Census 2000." Retrieved from the U.S. Census Bureau Internet web page: http://www.census.gov/main/www/cen2000.html, January 2003. As defined by the Bureau, an urbanized area is "an area consisting of a central place(s) and adjacent territory with a general population density of at least 1,000 people per square mile of land area that together have a minimum residential population of at least 50,000 people."

[11] Waddell, Kidd M. et al., *Water Quality in the Great Salt Lake Basins, Utah, Idaho, and Wyoming,* (Reston, Virginia: U.S. Geological Survey, 2004), 11-12. This publication was retrieved from U.S. Geological Survey Internet webpage: http://pubs.usgs.gov/circ/2004/1236/#pdf. November 2005.

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

[13] Mark Peterson, 2006 *Annual Progress Report--AFO/CAFO Inventory and Assessment Project*, an unpublished Report by the Utah Farm Bureau, December 31, 2005.

[14] U.S. Geological Survey, “Quality of Shallow Ground Water in Areas of Recent Residential and Commercial Development in Salt Lake Valley, Utah, 1999.” USGS Fact Sheet 106-00. (U.S. Department of the Interior), July 2000.

[15] Waddell, Kidd M. et al., 2004, 11.

[16] U.S. Geological Survey, 2000.

[17] Waddell, Kidd M. et al., 2004, 10.

[18] Bauman, Joe, "Low Levels of Chemical Found in Salt Lake Water Well," (Salt Lake City: Deseret Morning News, January 6, 2006).

[19] Ibid., p. 16.

[20] "Natural Resource Damage Trustee - Findings and Conclusions," (Utah Department of Environmental Quality, August 2004), 1. This document was retrieved from the Division of Water Quality Internet webpage: www.deq.utah.gov/issues/nrd.

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[23] U.S. Department of Health and Human Services, "Public Health Assessment, Murray Smelter" CERCLIS NO. UTD980951420, (Atlanta, Georgia: U.S. Environmental Protection Agency, January 1997), 1. This document was retrieved through the U.S. Environmental Protection Agency's website using the CERCLIS query form at http://www.epa.gov/enviro/html/cerclis/cerclis_query.html. November 2005.

[24] U.S. Office of Environmental Management, "Salt Lake City, Utah (UMTRA Site)." Retrieved from the U.S. Department of Energy's Internet web page: http://web.em.doe.gov/bemr96/salc.html, November 2005.

[25] Utah Division of Wildlife Resources, *Species on the Edge Benefits to Local Communities*, (Salt Lake City: Dept. of Natural Resources, 2002), 7.

[26] Utah Division of Wildlife Resources, "Federal Threatened and Endangered List by County," (Salt Lake City: Dept. of Natural Resources, October 2005). This and other lists are updated frequently and can be obtained online at the division's Conservation Data Center: http://dwrcdc.nr.utah.gov/ucdc.

[27] Utah Division of Wildlife Resources, "Utah's Sensitive Species List," (Salt Lake City: Dept. of Natural Resources, October 26, 2005).

[28] Utah Division of Wildlife Resources, 2002.

[29] Ibid., p. 3 & p. 4.

[30] Utah Divison of Wildlife Resources, "Utah Comprehensive Wildlife Conservation Strategy." Retrieved from the Utah Division of Wildlife Resources Internet web page: http://wildlife.utah.gov/cwcs/, November 2005.

[31] Utah Reclamation Mitigation and Conservation Commission, "Jordan River Wetlands." Retrieved from the Utah Reclamation Mitigation and Conservation Commission Internet web page: http://www.mitigationcommission.gov./wetlands/wetlands_jordan.html, November 2005.

[32] Utah Reclamation Mitigation and Conservation Commission, "South Shore Ecological Reserve." Retrieved from the Utah Reclamation Mitigation and Conservation Commission Internet web page: http://www.mitigationcommission.gov./wetlands/wetlands_southshore.html, November 2005.

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[35] Ibid.