Utah FOUNDATION RESEARCH BRIEF

A Look at Water Conditions in the Second-Driest State

September 18, 2008

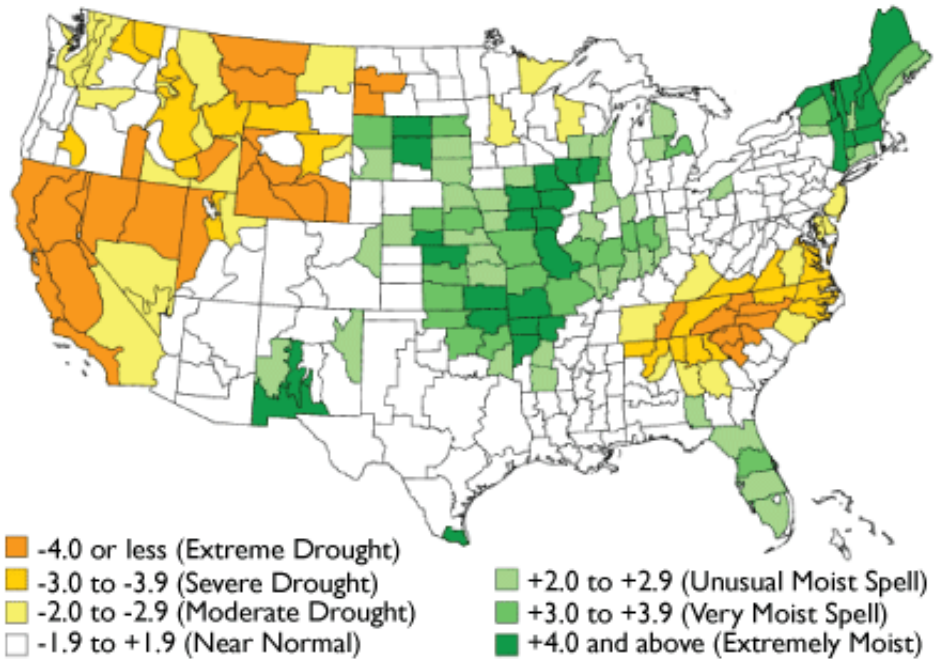
Utah is the second-driest state in the nation and home to over 2.6 million people. When Utah experiences drought conditions, water becomes a high-priority issue for Utah voters. Four years ago, in the 2004 Utah Priorities Survey, water supply and quality ranked third in the top 10 issues of concern after the state had experienced two years of extreme drought. Although drought conditions have mitigated in recent years, Utah's water supply and quality still ranked as the seventh most important concern in the 2008 Utah Priorities Survey. To help voters and candidates understand the issue better, this brief provides information on drought conditions, precipitation, water storage, water usage, and water quality in Utah.

Utah's Drought Conditions

Utah is known for its diverse climates, ranging from snowy mountains in the northeast to stony, arid deserts in the southwest. While most of Utah experiences a four-season climate, summers are typically dry, with average July temperatures of 93 degrees. These hot, dry temperatures increase the possibility of drought occurring around the state.

Drought conditions can be measured by the Palmer Drought Index, which indicates the severity of a drought in a particular region. An index score of -4.0 or less signifies extreme drought conditions and a score of 4.0 or more represents extremely wet conditions. Figure 1 shows the drought index scores for areas around the United States as of August 23, 2008. Even in normal years, Utah is a very dry state, and Figure 1 illustrates that about half of the state is not receiving the normal amount of moisture typical for this time of year and is therefore in a moderate to extreme drought.

Figure 1: Drought Severity Index by Division - Weekly Value for Period Ending August 23, 2008

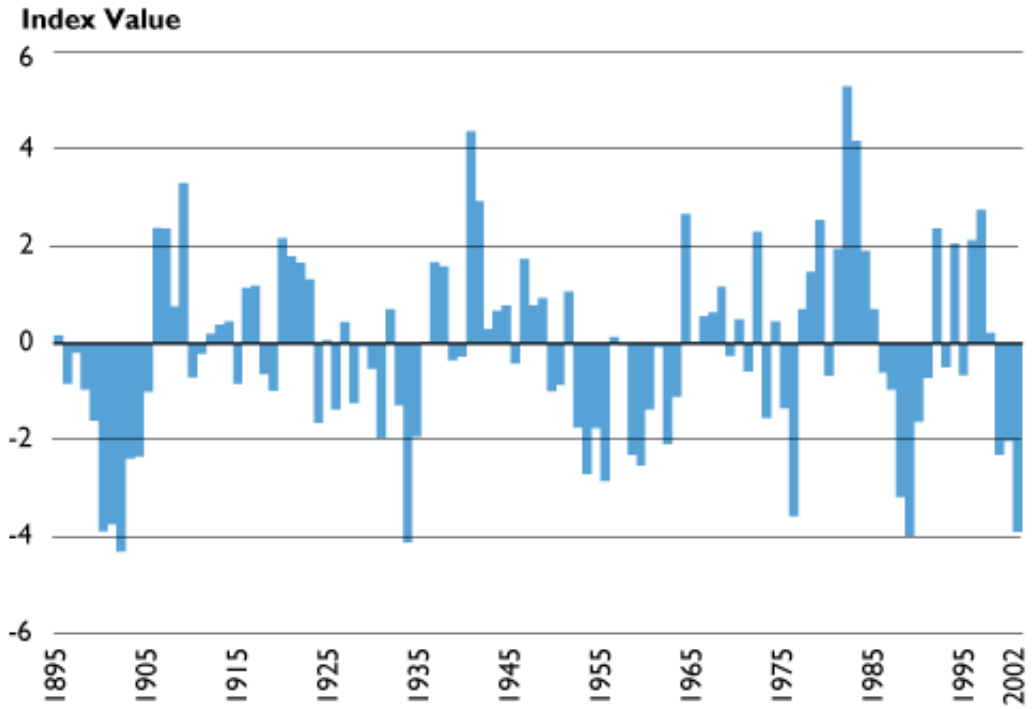


Source: Created by the National Oceanic and Atmospheric Administration.

The severity of drought in Utah fluctuates from year to year, depending on the amount of precipitation received.

Looking at long-term patterns, Figure 2 shows the Palmer Drought Severity Index (PDSI) for Utah from 1895 to 2002. According to the PDSI classification scale, the three most recent droughts (1977, 1988, and 2002) were much more severe than any since the "dust bowl days" of the 1930s. Interestingly, there appears to be a cyclical nature to the occurrence of droughts in Utah, with some recurrence of drought about every decade. Most of these droughts were followed by a number of wet years.

Figure 2: Palmer Drought Severity Index for Utah, 1895-2002



Source: Chris D. Wilkowske, David V. Allen, and Jeff V. Phillips, "Drought Conditions in Utah During 1999-2002: A Historical Perspective," USGS (April 2003).

A more current picture of Utah's drought situation is provided by the drought monitor, which is maintained by the University of Nebraska-Lincoln, in partnership with federal and state agencies. This tool synthesizes multiple indices to represent a consensus of federal and academic scientists in measuring drought conditions. The drought monitor is used to calculate the percentage of the state which suffers from drought classified as Abnormally Dry, Moderate, Severe, Extreme, and Exceptional.[1] The definitions for each classification are provided below.

Abnormally Dry

Going into drought: short-term dryness slowing planting and growth of crops or pastures; fire risk is above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.

Moderate Drought

Some damage to crops and pastures; fire risk is high; streams, reservoirs, or wells are low and some water shortages are developing or imminent. Voluntary water use restrictions are requested.

Severe Drought

Crop or pasture losses are likely; fire risk is very high. Water shortage is common and water restrictions imposed.

Extreme Drought

Major crop or pasture losses; extreme fire danger. There are widespread water shortages or restrictions.

Exceptional Drought

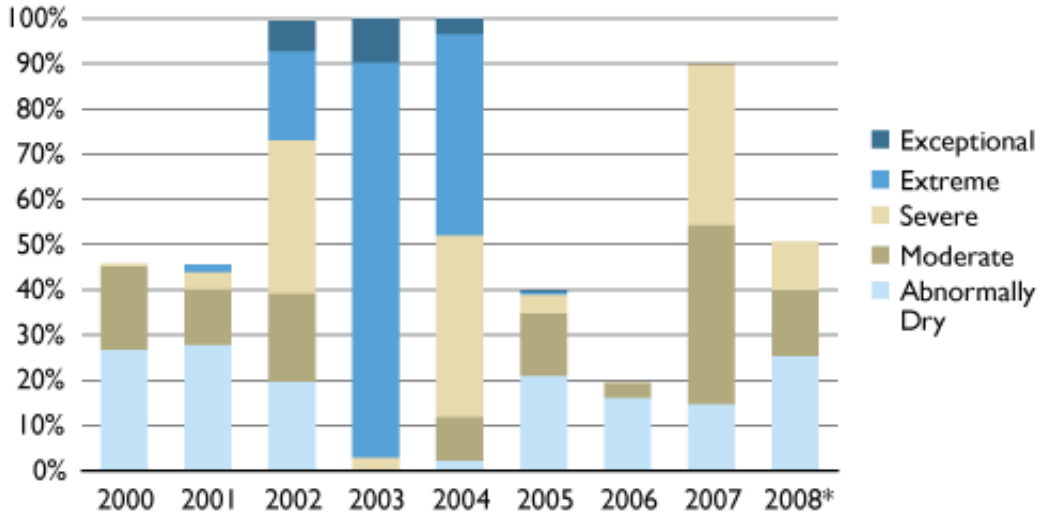
Exceptional and widespread crop or pasture losses; exceptional fire risk. There are shortages of water in

reservoirs, streams, and wells, creating water emergencies.

Figure 3 uses this data to illustrate the percent of the state that experienced various degrees of drought conditions from 2000 to 2008. These drought conditions increase by degrees; in order for exceptional drought to occur, the area must first experience abnormally dry conditions, then moderate, severe, and extreme drought. In 2003, 100% of the state experienced at least severe drought, 97.1% of the state experienced extreme drought, and 9.58% of the state had exceptional drought conditions. Figure 3 separates out these percentages and breaks down the portions of the state that experienced drought condition by highest degree of drought classification.

Between 2002 and 2004, almost 100% of the state experienced some sort of drought condition, and significant portions of the state experienced moderate, severe, extreme, and even exceptional drought, which increases the risk for fire and water-shortage emergencies. In 2005 and 2006, there was a significant decrease in drought conditions around the state. Approximately only 20% of Utah experienced drought conditions during 2006, before jumping back up to 90% in 2007. While parts of the state did experience moderate and severe drought in 2007, the severity of the conditions was nowhere near the drought experienced in 2002 to 2004. It also appears as though this year's wet winter and spring have prevented extreme or exceptional drought conditions from occurring, as measured by this monitor (note that the Palmer Index map in Figure 1 did show some areas in extreme drought using a different methodology).

Figure 3: Percent of Utah that Experienced Drought Conditions, 2000-2008

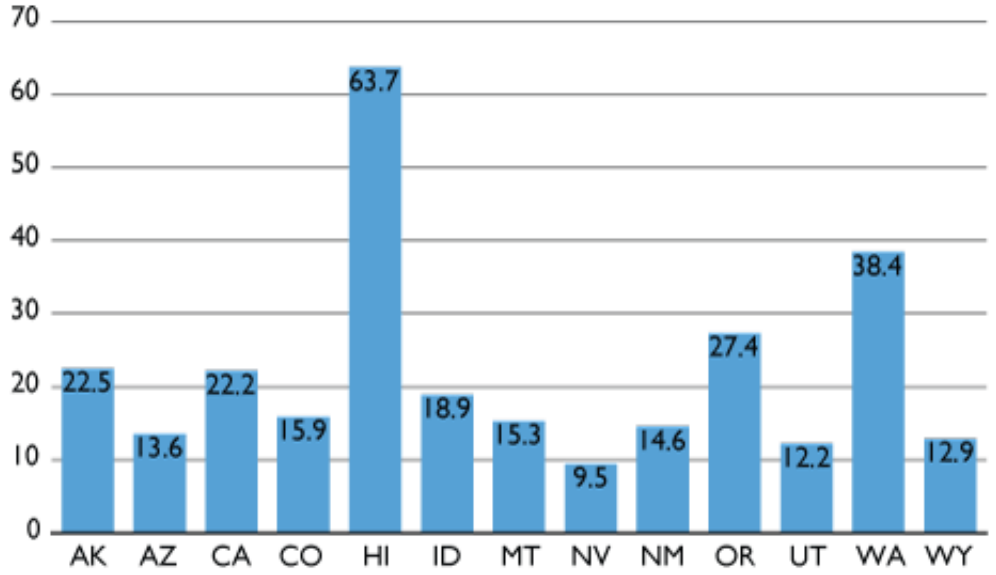


*2008 is January through August.
Source: Drought Monitor, University of Nebraska-Lincoln.

Precipitation

Figure 4 compares the average annual precipitation of western U.S. states. The statewide averages are obtained by dividing each state into climate divisions and calculating a precipitation value for each division. The values are then weighted by the amount of area within each division.[2] The state value is an average of 29 years, 1971 to 2000.[3] When compared to other western states, Utah ranks second lowest in terms of inches of precipitation per year; only Nevada received less precipitation than Utah during these years.

Figure 4: Average Annual Precipitation (in Inches) for U.S. Western States

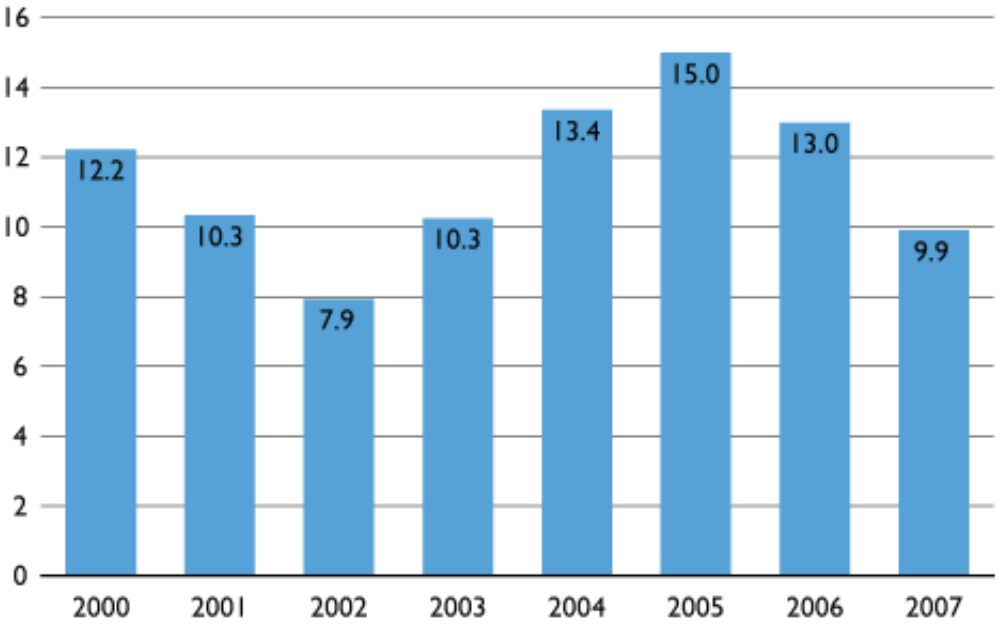


State averages are for years 1971-2000, and are an average of the total precipitation levels from different climate divisions in each state.

Source: National Climatic Data Center, Historical Climatography Series.

Figure 5 shows Utah's average annual precipitation for 2000 to 2007. Comparing this graph with Figure 3, one can see how annual precipitation levels affect the state's drought conditions. For instance, the lack of precipitation in 2002 and 2003 correspond with the severe to extreme drought conditions experienced during these same years. Water year 2005 was the wettest of the eight years and corresponds with one of Utah's mildest drought seasons. Precipitation data for 2008 has not yet been compiled.

Figure 5: Utah's Average Annual Precipitation (in Inches), 2000-2007



Source: National Climatic Data Center.

Data from the Western Regional Climate Center show that the regions around Wendover, Roosevelt, Delta, St. George, and Lake Powell are among Utah's driest, with annual precipitation levels of only four to eight inches. Some of the locations in Utah that receive an abundance of annual precipitation are Alta, Park City, Brian Head, and Sundance. Alta receives the most precipitation year to year, with an average annual precipitation level of 53.7 inches. The Wasatch Front valleys

generally receive around 15-20 inches of precipitation per year.[4]

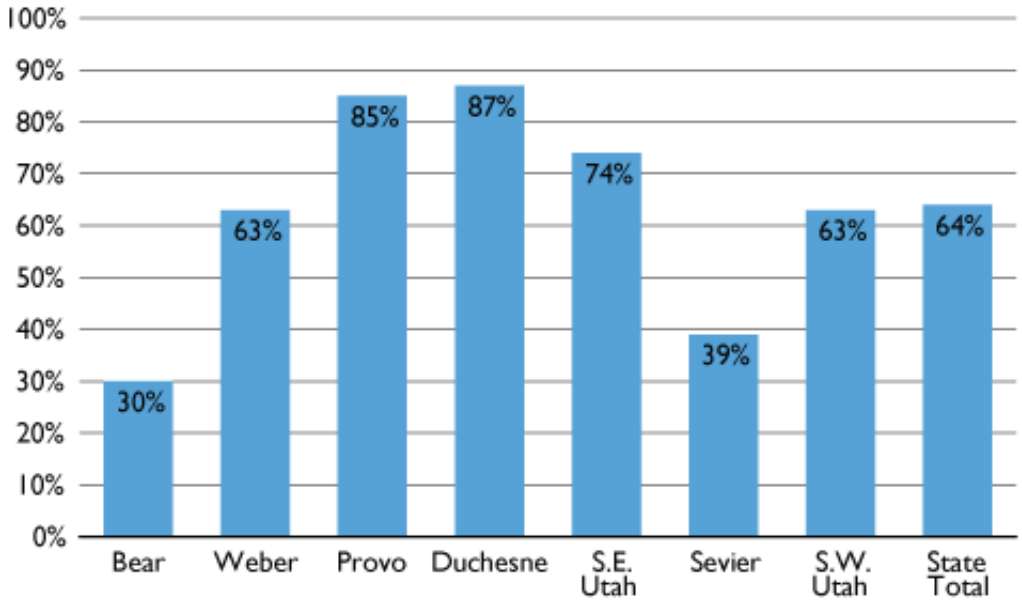
Snowpack

The amount of snowfall Utah accumulates each year plays a vital role in affecting the state's drought conditions. Snow accumulation during winter months is critical because the timing and volume of spring runoff determines the annual water supply in Utah and surrounding Intermountain states. If the statewide percent of normal snowpack levels are below 60% by January 1, the probability of reaching average snowpack by April 1 is unlikely, therefore significantly increasing the risk of drought.[5] As of April 15, 2008, Utah's snow water equivalent (the amount of water that could be obtained from the current snowpack level) was at 108% of the historical average.[6] This indicates the state was above average in terms of water supply in the spring, helping to minimize the impact of the drought conditions observed this summer. The measurements of snowfall show much higher numbers than the precipitation totals for the same communities. This is because hydrologists translate the snow depth into snow water equivalent figures that estimate how much water the snowpack contains. Data from the SNOTEL observation system show that Alta, Silver Lake-Brighton, Brian Head, and Park City receive the most snowfall of any sites in Utah, with more than 300 inches per year. Alta is a full 100 inches above the nearest site, with an annual average of 512 inches. Along the Wasatch Front, cities vary from 30-60 inches of annual snowfall, with the areas higher along the hills receiving more snowfall.[7]

Utah's Water Supply and Storage

Yearly precipitation and snowpack levels have a direct effect on Utah's ability to store and provide water. Most of Utah's water is stored in reservoirs located around the state which provide both drinking and irrigation water to Utah residents, farmers, and businesses. Figure 6 shows that, as of August 1, 2008, statewide water storage is at approximately 64% of total capacity. The regions that currently have the highest levels of water storage are Duchesne, Provo, and Southeast Utah, which includes reservoirs such as Huntington North and Joe's Valley. The basins with the lowest levels of water storage are Bear and Sevier, both which are at less than 40% of total capacity.

Figure 6: Utah Reservoir Storage by Water Basin as of August 1, 2008 (as a Percent of Total Capacity)

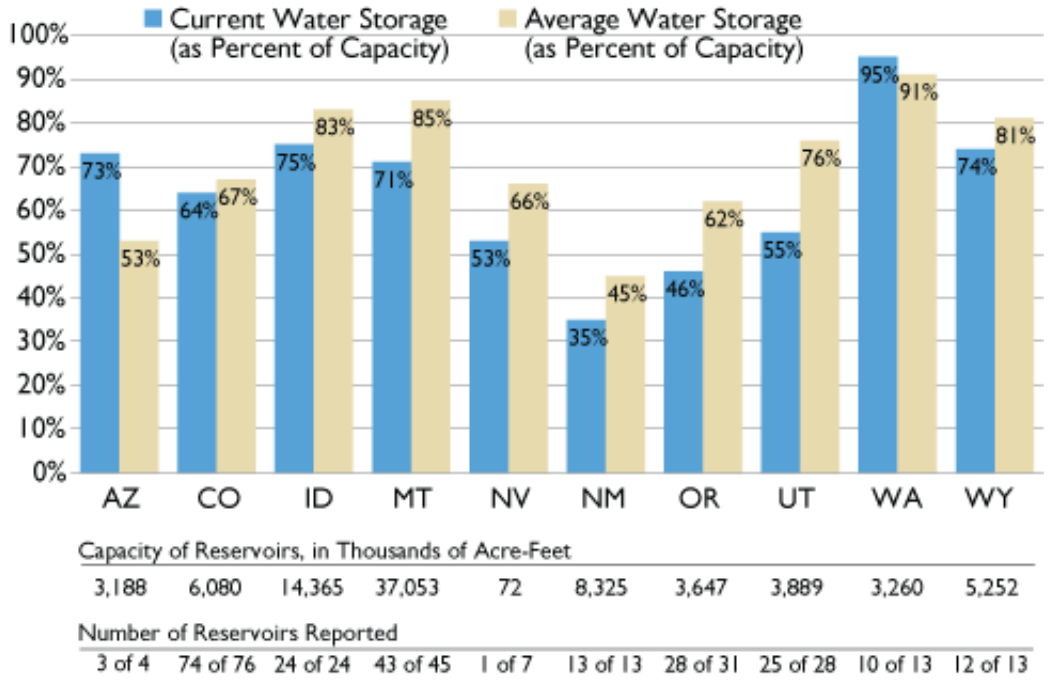


Source: Natural Resources Conservation Service.

The low level of Bear Lake highlights the current water supply problems in the Bear River Basin. As of the end of July 2008, Bear Lake was at only 33% of total capacity and at 45% of its historical average.[8] While smaller reservoirs, like Woodruff Narrows, are at 70% of total capacity, most reservoirs in the Bear River Basin have low water levels. On the other hand, the reservoirs in the Duchesne area currently have high water levels. Starvation Reservoir, for instance, is at 91% of total capacity, 105% of the historical average, and 127% of last year's water level.[9] The differences in water levels around the state illustrate how variable water storage can be depending on the region and how much precipitation has been received.

Water levels also differ considerably across states. Figure 7 compares Utah to other western states, illustrating which states have water levels above or below the states' average percent of total storage capacity. For water year 2008, Utah's statewide reservoir storage level was about 55% of total capacity on August 1; this is below the state's average of 76% for that date.[10] The only states that have water levels above the average are Washington and Arizona. As of August 1, Utah ranked seventh out of the ten for current storage levels, ranking only above New Mexico, Oregon, and Nevada.

Figure 7: Reservoir Storage as of August 1st, Water Year 2008



Note: Data are provisional and subject to change.
Source: National Water and Climate Center.

Municipal Water Usage in Utah

Part of the water stored in state reservoirs is used by Utah's municipal water system. Municipal water systems consist of water which is provided and monitored by the state. As of 2005, the Utah Division of Water Resources estimates the state's per capita municipal water usage to be 260 gallons per day.[11] Using the data provided by the Division, Figure 8 illustrates the amount of municipal potable and non-potable water used by four different categories. Residential uses include drinking, washing, sanitation, and irrigation of lawns and gardens at a residence. Commercial uses include small business operations such as gas stations, hotels, motels, restaurants, and stores (this excludes industrial use). Industrial uses include manufacturing plants, refineries, dairies, mining, electrical generation plants, or anything that produces a product. Institutional uses include public buildings, churches, parks, golf courses, cemeteries, and other similar facilities.[12] The daily per capita gallons of water used by each of these categories represent total outdoor and indoor use of public community system potable and non-potable water. Non-potable is unsafe to drink because it has not undergone a purification process and therefore contains pollutants, contaminants, or hazardous minerals. An example of this would be the recycled or "grey" water used on some municipal golf courses or "secondary" water provided by some cities to homeowners for watering landscapes. Secondary water is not recycled but is merely untreated water, generally from wells and canals.

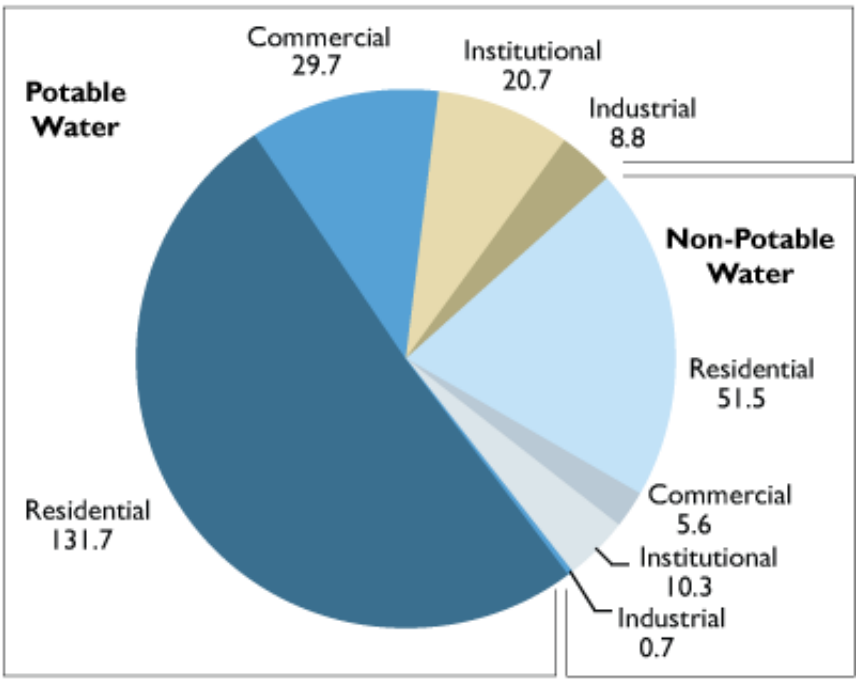
Figure 8 shows the largest use of municipal water is for residential purposes. Residential usage accounts for slightly more than half of the total municipal water used (132 gallons of potable water used per capita per day). The Division of Water Resources estimates that of indoor residential usage, more than half of the amount (53%) is used in the bathroom to flush the toilet and take a bath or shower. About 22% is used for laundry purposes and 14% is comes from water leaks around the home such as dripping faucets. Only 11% of indoor residential water usage comes from cooking, drinking, cleaning, and washing dishes in the kitchen.[13]

Including non-potable and potable sources, two-thirds of all water used by Utah residences is for outdoor use. This water is used almost entirely for watering lawns and plants. About half of the potable water consumed by residential users is for outdoor use, and all of the residentially consumed non-potable water is for outdoor use. [14] This is tied directly to Utah's dry climate; states with significantly higher precipitation have lower per-capita

water usage for outdoor purposes.

It is important to note that Figure 8 does not include non-municipal water usage, such as private agricultural irrigation, private water suppliers, mining, private industrial wells, and thermoelectric generation. Non-municipally supplied irrigation water typically makes up the largest portion of total water used in Utah. Utah Foundation's 2004 research brief on water usage shows non-municipal irrigation accounted for more than 81% of total fresh water usage in Utah.[15]

Figure 8: Utah's Daily Per Capita Municipal Water Usage, 2005
(Gallons Per Capita Per Day)



Source: Utah Division of Water Resources.

Water Quality

Utah Foundation's 2004 research brief on water usage and water quality revealed that Utah's water quality rates fairly well, ranking eighth nationally on river quality and seventh for lake/reservoir quality.[16] While this data has not been updated since the earlier research brief, Utah's Division of Water Quality releases information on the water system ratings of Utah public community water supply facilities. Data from July 2008 show that of the 455 municipal water supply systems located in Utah, 436 were approved, 1 required corrective action, and 18 were not approved.[17] Being approved means the systems met all of the drinking standards required by both the state of Utah and the Environmental Protection Agency (EPA). Requiring corrective action means the system currently has a plan with the state, as well as the financial means, to improve the current water system. Not being approved means the system has not met Utah or EPA guidelines.

Conclusion

In recent years, Utah's precipitation and snowpack levels have been high, limiting the extent of drought and increasing the water storage levels of most reservoirs. However, these years followed a period of severe to exceptional drought conditions between 2002 and 2004, which severely reduced Utah's water supply and increased water conservation around the state. Historical data show that periods of high levels of precipitation are followed by periods of drought, indicating that Utah will continue to experience drought conditions in the future and water supply will continue to be a priority issue for Utah residents. Elected officials should continue to work on water conservation strategies that will help maintain water supply and reduce water usage levels in both drought and pluvial periods.

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[1] "Drought Severity Classification," *Drought Monitor* (March 2003); http://www.drought.unl.edu/dm/archive/99/classify.htm.

[2] "Average Statewide Precipitation for Western U.S. States," *Western Regional Climate Center*; http://www.wrcc.dri.edu/htmlfiles/avgstate.ppt.html

[3] 2000 is the most current year available as new reports are released every 10 years. While annual averages have changed slightly over the years, the state rankings have stayed the same.

[4] "Utah Monthly Average Precipitation (Inches)," *Western Regional Climate Center*;

http://www.wrcc.dri.edu/htmlfiles/ut/ut.ppt.html. The number of years included in the averages for each area differs; some go back as far as 1862, but all include 2007 as the most recent year.

[5] Brian McInerney, "Assessing Water Supply Conditions for Utah," *Intermountain West Climate Summary* (January 2007).

[6] "Snow Precipitation Update – Utah," *National Water and Climate Center* (April 2008); http://www.wcc.nrcs.usda.gov/cgibin/past_up2.pl?report=ut&year=2008&month=04&day=15. The percent of average represents the snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Statewide percent of average is calculated using data from state's basin percents of average. The reference period for average conditions is 1961-90.

[7] "Utah Monthly Average Snowfall (Inches)," *Western Regional Climate Center*; http://www.wrcc.dri.edu/htmlfiles/ut/ut.sno.html.

[8] Natural Resources Conservation Service.

[9] Ibid.

[10] National Water and Climate Center. Water years run from October to September.

[11] Utah Division of Water Resources.

[12] Ibid.

[13] "Indoor Water Use," *Division of Water Resources* (2007); http://www.conservewater.utah.gov/IndoorUse/.

[14] Utah Division of Water Resources (2005).

[15] "Utah Water Use & Quality," *Utah Foundation* (August 2004).

[16] Ibid.

[17] "Utah Public Water Supply Facilities Water Systems Rating," *Utah Department of Environmental Quality Division of Drinking Water* (July 2008).

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