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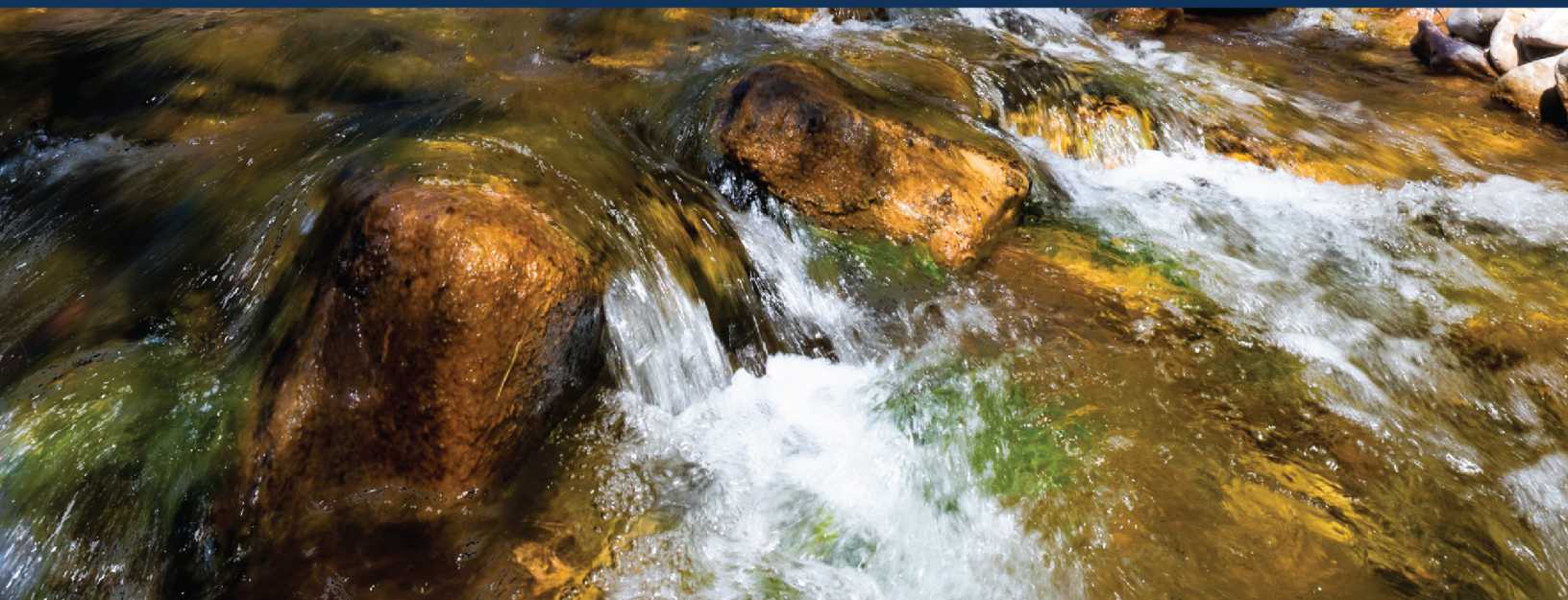
Utah Water Series: Background

Flowing into the Desert
A Background on Water in Utah



–FLOWING INTO THE DESERT–
A BACKGROUND ON WATER IN UTAH

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Research Report 811

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The Utah Foundation's mission is to produce objective, thorough, and well-reasoned research and analysis that promotes the effective use of public resources, a thriving economy, a well-prepared workforce and a high quality of life for Utahns. The Utah Foundation seeks to help decision-makers and citizens understand and address complex issues. The Utah Foundation also offers constructive guidance to improve governmental policies, programs and structures.

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Cover Photo: A Shallow Point of the Green River within Utah's Desolation Canyong Area, Credit: Bob Wick, BLM under license (CC BY 2.0)

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The wet winter of 2022-2023 provided a reprieve to Utah's water crisis that has been building in recent years, as characterized by falling levels of the Great Salt Lake and Lake Powell. That does not mean that Utah's water problems have come to an end. Utah ranks among both the nation's driest and fastest growing states. This means that approaches to water governance ensuring the sufficiency of affordable and high-quality water are a major concern.

This background brief provides a reference to explain some key ideas and definitions that are involved in discussions around water supply and use. This brief is a companion to a series of Utah Foundation reports exploring ongoing water concerns. These reports focus upon three topics:

- How is water in Utah governed?
- What do major conservation efforts look like?
- What are the issues surrounding two major water systems?

This initial report offers a primer on water in Utah and provides background information to support the subsequent reports. This background brief will be updated as needed to help explain any terms and concepts that become relevant in the upcoming water reports.

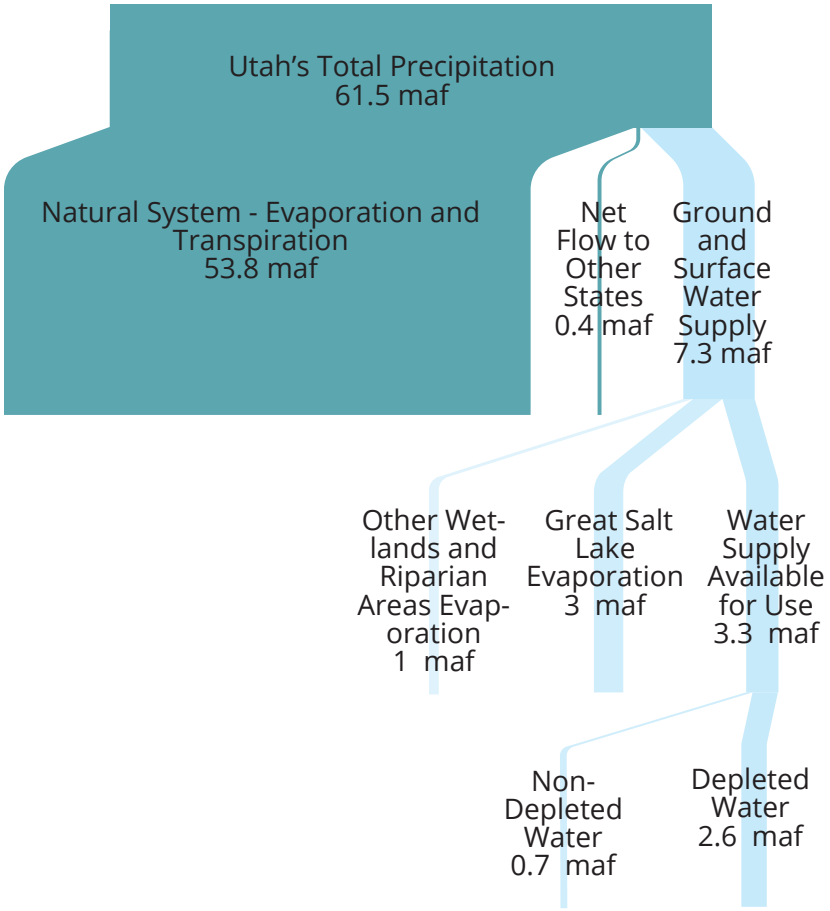
SOURCES OF UTAH'S WATER

Utah's long-term average annual precipitation is 61.5 million acre-feet (maf). Most of that water (87%) stays in the natural system through evaporation and transpiration – which is essentially evaporation through plants. Since state borders often do not align with watersheds, some of Utah's precipitation ends up in other states, and vice versa. Utah loses slightly more water than it gains (less than 1%) in these cross-border water flows. That leaves about 12% – or 7.3 maf – which becomes Utah's ground and surface water supply. Of Utah's surface and ground water supply, 4 maf (55%) evaporates from Utah's lakes and streams (3 maf evaporates from the Great Salt Lake alone) leaving 3.3 maf – just 5% of the total precipitation – available for use.[1]

Consumers use some water and pass it on for further use. For example, the water that runs down sinks or bathtubs is treated, put back into the natural water

Only 5% of Utah's total precipitation is available for society's use.

Figure 1: Water in Utah – Precipitation to Consumption



Source: Utah Division of Water Resources.

1 Office of Legislative Research and General Counsel "How Utah water works: An overview of sources, uses, funding, and pricing," (2012), https://le.utah.gov/interim/2012/pdf/00002706.pdf.

system, and subsequently used by someone else. So, while Utahns use the 3.3 maf available to them, only 2.6 maf are consumed. This leaves 0.7 maf of Utah's water unused, which flows downstream to other states.[2]

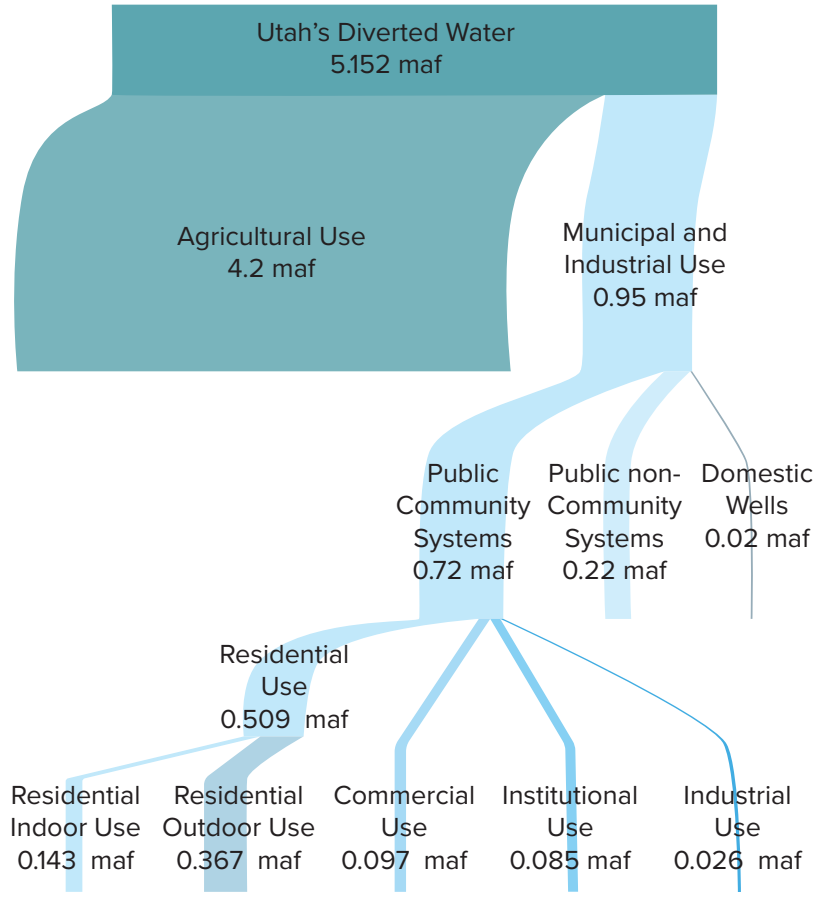
It should be noted that these are long-term averages and can vary substantially from year to year. In addition, changes in the climate can affect the amount of water that Utah has available.

USES OF UTAH'S WATER

As outlined above, Utahns have only 3.3 maf of water annually available for human use. However, some of that water can be used more than a single time without being consumed or depleted. The reuse of water effectively expands Utah's available water supply to 5.2 maf. Of the 5.2 maf of water Utah diverts, 82% goes to agriculture use. The remaining 18% – or 0.95 maf – supplies water for municipal and industrial (M&I) use. A small proportion, 15,000 acre-feet, is used in individual residential wells owned by homeowners. Another 220,000 acre-feet is self-provided by industries or other groups like state parks or campgrounds. The remaining 717,000 acre-feet is distributed to Utahns through the various public utility systems across the state. (See Figure 2.)

Only 14% of water diverted is used in a public community system.

Figure 2: Diverted Water Use in Utah



Source: Utah Division of Water Resources.

Of this water, industrial users (like refineries) use 3%, institutional users (like schools, churches, and governments) use 12%, commercial users use 14%, and residential users use 71%. Among residential users, 28% of the water is used for indoor purposes while 72% is used for outdoor purposes. (See Figure 2.) It should be noted that these are state averages and that the share of water used in different categories can vary substantially by region. For example, in areas with higher urban density, a smaller share of residential water is used outdoors.

CHALLENGES OF A QUICKLY GROWING POPULATION IN AN ARID ENVIRONMENT

Utah is the second driest in the nation, and it is expected to grow by more than 2.2 million residents by 2060 – an increase of 65%. The availability of water has helped to mold the state's growth

2 Office of Legislative Research and General Counsel, "How Utah water works: An overview of sources, uses, funding, and pricing," (2012), https://le.utah.gov/interim/2012/pdf/00002706.pdf.

patterns over time. Ensuring that residents have enough water for the future is a major consideration.[3]

As Utah's population grows, its household size is expected to decrease and housing density is expected to increase resulting in smaller lot sizes.[4] These two factors will help water resources stretch further.[5]

Some quickly growing communities across the state planned on meeting the growth needs of water through pipelines. Recent years have called into question whether those sources have enough water to fill those needs. There are strong arguments that the Colorado River System has been over-allocated, as seen by the emergency measures in the early 2020s to prevent Lake Powell from falling below the minimum level at which it could still generate power.[6] With such concerns, the proposed Lake Powell Pipeline – envisioned to help meet the water needs of quickly growing southwestern Utah – faces strong headwinds.

Similar challenges face Utah's Wasatch Front and the proposal of the Bear River pipeline. Again, emergency measures were taken in the early 2020's to prevent the ecological and economic collapse of the Great Salt Lake which was threatened by falling water levels and rising salinity levels.[7] Evidence indicates that diversions were primarily responsible for the record low water levels of the lake.[8] Diverting even more water to supply the population growth along the Wasatch Front without offsetting other diversions would only exacerbate the problem. The high-water period during 2022-2023 may have provided a temporary reprieve, but cannot be counted on to solve these problems long term.

IMPORTANT IDEAS IN WATER DISCUSSIONS

Consumption Versus Diversion

A diversion removes water from its natural course. Diverted water is also referred to as withdrawals. A portion of the diverted water returns to the natural system and can be available for later use. The remaining water that

3 Kem C. Gardner Policy Institute, "State and County Projections," (2017), https://gardner.utah.edu/wp-content/uploads/Projections-Brief-Final.pdf.

4 Perlich, Pamela S., Mike Hollinghaus, Emily R. Harris, Juliette Tennert and Michael T. Hogue, "Utah's long-term demographic and economic projections summary," *Kem C. Gardner Policy Institute, (2017),* https://gardner.utah.edu/wp-content/uploads/Projections-Brief-Final.pdf.

5 While density results in lower water per person, higher density neighborhoods still use more water overall because they are serving more people. A simulation by Jordan Valley Water Conservancy District estimated water use per person in townhomes would be one-third water use per person in quarter-acre single-family homes. However, the fact that for an equivalent space, there would be almost four times as many individuals in a townhouse complex means the total water use would increase. The simulated situation was also supported by analysis linking water distribution data to census data. Olsen, Matt and Todd Schultz, 2019, "Report on impact of density on per capita water use," Jordan Vally Water Conservancy District,

6 Marsh, Rene and Rachel Ramirez, 2022, "Lake Powell officials take unprecedented, emergency steps to delay water release as level plummets," https://www.cnn.com/2022/05/03/us/lake-powell-emergency-steps-drought-climate/index.html.

7 Office of the Governor, 2023, "Gov. Cox issues executive order to raise the Great Salt Lake causeway berm," https://governor.utah.gov/2023/02/03/gov-cox-issues-executive-order-to-raise-the-great-salt-lake-causeway-berm/.

8 Wartsbaugh, Wayne A. et. Al, 2017, "Decline of the world's saline lakes," *Nature Geoscience, vol 10* https://www.nature.com/articles/ngeo3052.epdf; Great Salt Lake Strike Team, 2023, "Great Salt Lake policy assessment: A synthesized resource document for the 2023 General Legislative Session," *Kem C. Gardner Policy Institute, University of Utah,* https://gardner.utah.edu/wp-content/uploads/GSL-Assessment-Feb2023.pdf?x71849.

Alicia, North Fork of the Duchesne River, Near Tabiona, Utah, Credit: Flikr User Ken Lund under license (CC BY-SA 2.0)

does not return to the natural system is considered to be consumed. Sometimes consumed water is also called depletion.

Some water diversions consume most of the water such as evaporative ponds or extremely efficient irrigation systems. Other water diversions consume a small amount of water – such as when water is used as a coolant for data centers or electrical generation. For example, PacifiCorp holds a water right for a large diversion, but does not consume any of that water. It is all returned back into the system and available for downstream users.[9]

When measuring water, it is important to understand the different ways of quantifying water and how diversions or withdrawals are different from consumption or depletion.

Water Rights

All water in Utah is declared to be "property of the public."[10] The State of Utah issues permits (known as water rights) that allow public and private entities to use the water in a designated way. To obtain these permits, entities submit applications through the Utah Division of Water Rights. These

9 Water Right 29-1506, https://waterrights.utah.gov/asp_apps/wrprint/wrprint.asp?wrnum=29-1506
10 Utah Code § 73-1-1, https://le.utah.gov/xcode/Title73/Chapter1/73-1-S1.html

water rights are tied to a specific use such as irrigation, stock-watering, mining, and domestic uses. Most rights have specific limits on how much water can be used – limited by either volume or flow. Water rights also designate from where water can be removed and how much water is expected to flow back into the system.

Prior Appropriation

Utah's water law uses the doctrine of prior appropriation. Essentially this means that the first person to use the water (or rather secure the right to the water) has the priority. In times of shortage, older claims have seniority – they can use all the water of their claims before more recently secured water rights can use any water.

Beneficial Use

The doctrine of beneficial use means that water rights can only be granted for specific uses that benefit the water user and the community (in broad terms). These uses include agriculture, domestic, industrial, irrigation, manufacturing, mining, municipal, power generation, stock watering, in-stream flow (reserving the water for the natural environment), and storage.[11] The principal of beneficial use includes limiting the amount of water needed for that specific use. It also involves limiting the term of water use. If water is not used for seven consecutive years, it is subject to forfeiture.

Measuring Water

Most individuals commonly measure liquid in terms of gallons or liters. When looking at how much individuals use, we consider gallons per capita per day or gallons per person per day. However, when discussing large amounts of water, it is much more common to measure the volume of water in acre-feet or the flow of water in cubic-feet-per-second.

Gallons per Capita per Day (GPCD). This measure is generally used to contextualize water use. This measure is sometimes categorized by residential, commercial, or industrial use. The calculation takes into account all the water use in an area, divides it by 365 days, and divides again by the applicable population. This may seem simple, but the calculation of "water use" is not standardized. Some states count only residential water use while Utah, for example, includes all water use. Some areas measure water consumed while Utah measures water diverted. When making comparisons, it is important to ensure measurements are being calculated in the same way.

Acre-Feet. This measure quantifies volume – think of how much water is sitting in a pool. An acre-foot is the amount of water it would take to cover an acre of land in a foot of water. (Think of 90 yards of a football field covered in a foot of water.) This is equivalent 325,852 gallons. An old rule-of-thumb states an acre-foot is enough water to meet the indoor needs of two typical households.[12] However, with modern appliances and practices,

11 Colorado School of Mines / Advanced Water Technology Center, "What are beneficial uses?" http://aqwatec.mines.edu/produced_water/intro/what/index.htm#table1.

12 Utah Division of Water Rights, 2018, "Water use information for water right applications," https://www.waterrights.utah.gov/wrinfo/policy/wateruse.asp.

some water districts report that an acre-foot is enough for the indoor water use of five households.[13]

Cubic Feet per Second. This measure quantifies flow – think of how much water is going down a stream every second. A cubic foot per second is equivalent to almost seven and a half gallons per second.

Types of Water

Culinary, Potable, and Domestic. This water has been purified and treated to meet all applicable federal, state, and local drinking water requirements to make it suitable for human consumption. In areas where only culinary water is provided, it is used for both indoor and outdoor use. Some entities will use one of the terms "culinary," "potable," or "domestic" to specify indoor water.

Secondary. This water is not purified and treated to meet the standards required of culinary water and is suitable only for outdoor use. Not all localities offer secondary water as an option. Generally speaking, those localities

13 Mojave Water Agency, 2011, "Evaluating the effectiveness of cash for grass programs," http://mojavewater.granicus.com/MetaViewer.php?view_id=2&clip_id=78&meta_id=7028; Aquacraft, Inc. and American Water Works Association Research Foundation, 1999, "Residential water use summary," accessed through archive.org, https://web.archive.org/web/20050312085643/http://www.aquacraft.com/Publications/resident.htm

Provo River Fall, Credit: Flikr User arbyreed under license (CC BY-NC-SA 2.0)

that do offer it supply it at lower price point than culinary water. As it is not treated and purified to culinary water standards, it is generally cheaper to provide.

Broad Categories of Water Users

There are two main categories of water users. One is agricultural while the other is municipal and industrial. As shown in Figure 2, the agricultural users divert about four-fifths of Utah's water. Municipal and industrial use is subdivided, with public community water systems diverting the lion's share. That use is further divided into residential, commercial, industrial, and institutional.

Agricultural. Broadly speaking, agricultural water is used primarily for irrigation purposes – whether the outputs are cash crops, food crops, or ornamental crops.

Municipal and Industrial. This is also known as M&I. This is an umbrella term water not used by agriculture, mining or power generation.[14]

Public Community Water Systems. This is the water collected and distributed by community providers which are usually local governments. Entities meet the definition of a community water system when they provide potable water to 15 service connections for year-round residents or provide water outside of a service connection and regularly serve 25 year-round residents. This is a subcategory of M&I water, but excludes domestic wells and the water that industrial users obtain through their private infrastructure.

Residential. This includes water used by residential dwellings for indoor or outdoor use. It is a subcategory of public and community water systems.

Commercial. This includes water used by commercial entities for indoor or outdoor use. It is a subcategory of public and community water systems.

Industrial. This includes water used as part of the manufacturing process. This could be things like mining, evaporative ponds, cooling systems, dairies, stock watering, and other such uses. It is a subcategory of public and community water systems.

Institutional. This includes water used by governments and public entities. This could include indoor water use of public buildings (such as schools and universities) as well as outdoor use (such as school grounds, parks, cemeteries, and public golf courses). It is a subcategory of public and community water systems.

Water Provider Roles

Retailers. Water retailers are typically municipal water departments, improvement districts, and occasionally water conservancy districts or private water companies that send water users a monthly bill. The primary job of retail water providers is to make sure water makes it to where the users need it to come out of the tap.

14 Hansen, Allen & Luce, Inc. and Bowen Collins & Associates, Inc. 2021, "Utah's regional M&I water conservation goals," Utah Division of Water Resources, https://conservewater.utah.gov/wp-content/uploads/2021/05/Regional-Water-Conservation-Goals-Report-Final.pdf

Big Springs of Zion, Credit: Flikr User Sathish J under license (CC BY-NC-ND 2.0)

Some locations might have multiple retailers, with the local municipality providing culinary water while another district or even private company provides secondary water for outdoor water use.

Some of these retail water providers will have water rights and directly collect the water to distribute to their service consumers. Others will purchase water from a water wholesaler.

Wholesalers. Water wholesalers are the metropolitan water districts and water conservancy districts that collect water from original sources and provide it to retailers. They not only collect and store the water using dams, reservoirs, wells, pipelines, and other such infrastructure, but they will often treat and purify the water before distributing it to retailers.

Some water agencies fulfill one of these roles while others fulfill both roles – in whole or in part. This creates a mesh of overlapping water providers. Some parts of Salt Lake County have three water providers – a water retailer purchasing from a wholesaler that in turn secures some of its supply from another wholesaler.

A subsequent report in the Utah Foundation's water series focuses on this localized form of water governance and the costs and benefits of water provider consolidation.

Types of Water Providers

Municipal Water Departments. The most common form of water provider is a city department. Municipalities generally only offer culinary (though

sometimes secondary) water services within their municipalities. However, sometimes historical growth patterns have created situations in which municipalities provide water outside their city borders.

Improvement Districts. Improvement districts are special districts often used to provide municipal services to unincorporated areas, although some of these areas incorporated after the improvement districts were established. In these cases, the improvement district continues offering services to the incorporated municipality.

Water Conservancy Districts. Water conservancy districts are a specific subset of special districts. Among other activities, they are tasked to "provide for the conservation and development of water and land resources," cooperate with the federal government for the development and management of water infrastructure, and control and manage unappropriated state water.[15] Not all water conservancy districts provide typical water services. Those that do often have expanded roles as well. The four largest water conservancy districts are substantial water providers in the state.

Metropolitan Water Districts. The final subtype of water-related special district is referred to as a metropolitan water district. These are organized and governed by cities to expand their water development capabilities.

Irrigation Companies. These are organizations that secure water rights for irrigation purposes and then build the infrastructure (such as canals) to make sure the water can get to agricultural users. These can be both for-profit and non-profit companies with communal organization.

Water Sources

Water is generally collected from surface sources or ground sources. In limited circumstances, water is collected as precipitation.

Surface water. This is water collected from water sources above the ground such as lakes, rivers, streams, and reservoirs. These are generally considered to be renewable sources of water. Often rights to flowing surface water are limited by flow in terms of cubic feet per second, while rights to stored water (such as from a reservoir) are measured by volume in terms of acre-feet.

Ground water. This is water collected through wells or springs. The geology that allows water to permeate and collect in specific places is complex and the degree to which ground water is a renewable source of water or a one-time resource depends substantially upon local conditions and is not always well understood. Often, rights to this water are limited by volume in terms of acre-feet.

Water Development Methods

When entities are looking for new water, they generally have three methods: conservation, conversion, and infrastructure.

15 Utah State Code § 17B-2-1002.

Conservation. Generally, the easiest way to get new water is by conserving water somewhere else. In an agricultural setting, that might look like more efficient irrigation measures to allow more intensive farming or the irrigation of additional fields.[16] In a municipal setting, that might look like all water users using less water to free up water for population growth.

Conversion. The second easiest way of getting new water is by purchasing it from someone else. For agricultural users, this could be purchasing shares in an irrigation company, or the purchase or leasing of water rights. For municipalities, this could be purchasing surplus water from a neighboring city, contracting for water from a water wholesaler, or even purchasing or leasing water rights from agricultural users and converting that water to water suitable for municipal use.[17]

Infrastructure. The most difficult method of adding new water to a system is to build the infrastructure to transfer water from somewhere else. A simple example might be digging a well to access a source of ground water. A complex example might be the Central Utah Project which diverts water into storage reservoirs and through tunneled pipelines in the Wasatch Mountains and supplies water through aqueducts to the Salt Lake Valley and Utah Valley.[18]

16 Using water on additional land would require a change of use application to update the existing water right.

17 There are limitations in the Utah Constitution to cities selling water. However state statute allows cities to sell surplus water. See Article XI, § 6 of the Utah Constitution, Utah Code § 10-8-14, and Gittins, Jeff, 2010, "What is a surplus water agreement?" *Utah Water Law and Water Rights*, http://utahwaterrights.blogspot.com/2010/07/what-is-surplus-water-agreement.html. As an additional note, the conversion of agricultural water to municipal use would involve legal and physical processes.

18 This example simplifies a complex infrastructure project that spans several counties. The Bonneville Unit (the part of the project that encompasses the infrastructure mentioned in the example) also includes Juab, Wasatch, Summit, and Duchesne Counties in addition to Salt Lake and Utah Counties.

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