Water Balanced: A Fairer Allocation Method for Florida's Water

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To better understand water use and water needs in the 21st century, water professionals must shed historic patterns of thinking and embrace a more holistic view of water use—and specifically, consumptive use. Throughout Florida, a majority of water users rely on groundwater. This source supplies water for public use, irrigation, industry, agriculture, power generation, and a myriad of other uses. Large uses of water are regulated by Florida's five water management districts (WMDs), which are tasked with the exceedingly complex job of managing the water resources for a specific region of the state. Unfortunately, water in an aquifer doesn't obey boundaries, water quality is a pervasive challenge, and stormwater-derived flood flows make flood protection a major concern for all of the districts.

Beyond managing these challenges, the districts are tasked with fairly allocating the state's most precious resource: water. To manage water supply, all of the districts write consumptive use permits (CUPs) for all water users that exceed 100,000 gal per day (gpd) of use; however, two users with equivalent CUPs may have vastly different impacts on the water source.

The focus of this article is the science of consumptive use and what these few words actually mean. In an age of increasing technology and measurement, there is no longer a need to simplify the science and assume that the volume of water that is pumped is the total impact of a user; rather, a complete water balance can measure, model, and estimate the actual water use and the resultant net impact on the water source. Application of a water balance can better allocate both water resources and the impacts associated with water withdrawal; furthermore, it encourages and promotes efficient use, and perhaps, even more importantly, aquifer recharge. Several examples are presented that demonstrate the benefits of this approach and the adaptability to all water users.

Background

Florida is viewed as a water-rich state, but water professionals know that it suffers from both abundance and dearth, depending on location and weather patterns. By adapting appropriate tools, the industry can better understand the varying needs and more effectively address them.

The United States is dominated by two forms of water resources management that are driven largely by the availability of water within the regions. Generally, in the western U.S., the prior appropriation doctrine rules, and in the eastern portion of the country, riparian rights are applied. Each of these systems has distinct advantages and disadvantages. Prior appropriation relies on a strict structure for allocating water based on ownership and consumptive use, whereby senior-rights holders have preference over junior water users. A primary downside of this system is that the ownership of water provides little incentive to improve water use practices and protection of environmental flows, and can result in exceptionally convoluted water management. Riparian rights in the eastern U.S. generally allow users to take water from a waterbody that is adjacent to their properties with a permit for use. By combining the benefits of a permit that can provide incentives for conservation and efficiency with the strict consumptive use calculations of prior appropriation, a better determination of user impacts can be developed to more fairly allocate and accurately account for water use.

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In the Southeast, a large limestone aquifer underlies Florida and portions of Georgia, Alabama, and South Carolina. The Floridan aquifer provides high-quality potable water to large areas of Florida and portions of southern Georgia. In Florida, this aquifer is partially confined by overlying clays, with unconfined areas located primarily in the central and western portions of the state. This variable geology has implications for water resources development and effluent disposal.

Table 1. Utility Characteristics

Characteristic	Utility A	Utility B
County	Marion	St. Johns
Water source	Floridan aquifer	Floridan aquifer
Population (#)	10,000	10,000
Per capita water use (gpd)	100	100
Total average water use (mgd)	1	1
Flow from WWTF (mgd)	0.6	0.6
Disposal method	RIBs	Surface water
Evaporation	5 percent	N/A

Florida Water Resources Management

Florida's WMDs were formed in 1972 by the Florida Legislature to manage water resources throughout the state. One mission of the WMDs is assigning CUPs to water users that withdraw more than a certain quantity of water (≥100,000 gpd). These permits give the holder a right to withdraw the specified quantity of water for five to 20 years. To apply for these permits the water user must show a need for the water; in the public supply realm, this must also include projections of water use and population, water conservation measures, and per-capita water demand. Despite the name, however, CUPs do not actually permit consumptive water use.

Consumptive Water Use

Consumptive water use, or consumptive use, requires a definition that accurately reflects the meaning of the term. This can be challenging in a state like Florida that has a diversity of water resources, geology, and water use types. Consumptive use can be defined as "water that is consumed as part of its use," but this does not capture the entire meaning. A more complete definition could be "water that is consumed as part of its use and that is not available for future use."

In Florida, there are both surface water and groundwater basins; as such, water withdrawn in one location and discharged in another might not be available to meet other water users' needs or environmental needs in the area from which it was taken (e.g., water withdrawn from the aquifer and discharged to a river). This consideration yields the definition for consumptive use that is applied here:

"Consumptive use is water that is consumed as part of its use and is not available for future use from the original source."

Consumptive Use Calculation

Consumptive use is carefully evaluated in the western U.S. because it provides a representation of the value of a water right. When evaluating the value of agricultural water rights, the historic consumptive use of the right is evaluated through strict calculation based on the acreage that was irrigated, type of irrigation, and crop type. A utility that purchases a water right typically moves the water to a different point of use so that it can withdraw the water and provide it to its customers. In this process, the utility can only take the historic consumptive use; however, the city can also reuse this consumptive use as many times as it can be recaptured. This has the result of 1 acre-ft of water, possibly providing several acre-ft of use before it's lost to evaporation and can no longer be recaptured.

In the context of water in Florida, utilities are issued CUPs that define a quantity of water that can be taken from a particular water source, but this number is virtually always in excess of what the utility needs to provide for future growth and does not actually represent what is withdrawn. Secondarily, a utility reports its consumption as what is withdrawn from the source; the problem with this number, however, is that it doesn't account for several important facts. These include that much of the water withdrawn by utilities is returned to wastewater treatment facilities, or septic tanks. In the case of septic tanks, the water infiltrates to either a surficial aquifer or the Floridan aquifer, depending on localized confinement. In the case of wastewater treatment facilities (WWTFs), the water is either recharged through sprayfields, aquifer storage recovery wells, wetlands, or rapid infiltration basins (RIBs); reused for another purpose; injected into a nonpotable aquifer; or discharged to a surface water body. In the case of agricultural water use, some portion of the water bypasses the root zone and recharges either the surficial aquifer or the Floridan aquifer, or may run off to a surface waterbody.

What is clear in both the agricultural and utility context is that all users are not the same. To illustrate this concept, consider two hypothetical utilities (A and B) and their characteristics, as shown in Table 1.

For the sake of this example, both utilities

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do not have any other classes of users, but this is largely irrelevant. What is clear from the chart is that, despite the water use being the same, the final disposition of the water is very different.

In the case of utility A, located in Marion County, a large portion of the treated effluent discharged to the RIBs will return to the Floridan aquifer and be available to meet future needs.

In the case of utility B, virtually none of the treated effluent will be returned to the Floridan aquifer. Simple calculations show that 0.57 mil gal per day (mgd) are returned to the Floridan aquifer (95 percent of 0.6 mgd) by utility A and none by utility B. While this example is simple compared to most utility systems, the basic framework of calculation remains the same for increasing levels of complexity.

Consumptive Use Water Balance Methodology

To evaluate the impact of a utility on a water resource, a water balance that accurately calculates the net impact of the use on the resource can be used. This net impact is the consumptive use of the water user and more accurately reflects the quantity of water that should be permitted. These calculations can be evaluated monthly or annually. The equation for this water balance is:

$$Q_{CUP} = Q_W - \sum(min[Q_{wi}, Q_{ri}])_i$$

Where,

Q_{CUP} is the consumptive use permit flow (mgd)
Q_W is the total flow withdrawn from all sources (mgd)
Q_{wi} is the total flow withdrawn from source i (mgd)
Q_{ri} is the flow recharged to source i (mgd)
i is the number of water sources and disposal locations

$$Q_{ri} = \sum(Q - Q_{ET} - Q_{roff})_i$$

Where,

Q is the flow to disposal method i (mgd)
Q_{ET} is the loss to evaporation and transpiration for disposal method i (mgd)
Q_{roff} is the loss of water to runoff from disposal method i (mgd)

$$CU\% = \frac{Q_{CUP}}{Q_W}$$

Where,

$CU\%$ is the consumptive use (percent)

To illustrate application of this methodology a series of examples are provided with varying levels of complexity.

Example 1: One Source With Recharge

Utility A withdraws an average of 1 mgd from the Floridan aquifer. After use and wastewater treatment, 0.6 mgd are disposed of at the utility's RIBs. Based on loading rates and daily evapotranspiration (ET) estimates from the Institute of Food and Agricultural Science (IFAS) – Florida Automated Weather Network (FAWN) it's determined that there is a 5 percent loss to ET.

Q_{CUP}
$= (1.00-[min\ \{1.00,(0.60\times(1.00-0.05))\}])$
$= 0.43$ mgd

$CU\%$
$= 0.43/1.00$
$= 43\%$

Example 2: One Source Without Recharge

Utility B withdraws an average of 1 mgd from the Floridan aquifer. After use and wastewater treatment, 0.6 mgd are disposed of to the St Johns River.

Q_{CUP}
$= (1.00-[min\ \{0.00,0.60\}])$
$= 1.00$ mgd

$CU\%$
$= 1.00/1.00$
$= 100\%$

Example 3: Two Sources

Utility C withdraws 1 mgd of flow from the Floridan aquifer and 1 mgd from surface water. After use and wastewater treatment, 1.4 mgd are disposed of in the surface water source.

Q_{CUP}
$= (1.00+1.00)[min\ \{1.00,0.00\}+min\ \{1.00,1.40\}]$
$= 1.00$ mgd

$CU\%$
$= 1.00/2.00$
$= 50\%$

Example 4: Two Disposal Methods

Utility D withdraws 2 mgd from the Floridan aquifer. After use and treatment, 1.4 mgd is returned to the Floridan aquifer through a combination of sprayfields (50 percent) and RIBs (50 percent). Based on IFAS – FAWN data, ET is calculated as 28 percent for the sprayfield and 5 percent for the RIBs.

Q_{CUP}
$= 2.00 - [min\ \{2.00,(0.70\times(1.00-0.28))\} + min\ \{2.00,(0.70\times(1.00-0.05))\}]$
$= 0.83$ mgd

$CU\%$
$=0.83/2.00$
$=42\%$

Example 5: One Source With Reuse

Utility E withdraws 1 mgd from the Floridan aquifer. After use and treatment, 0.7 mgd of flow is available. Water is sent to a combination of reuse (50 percent) and sprayfield disposal (50 percent). The sprayfield is calculated as having an ET loss of 28 percent and reuse irrigation is efficient with no overwatering and an ET of 100 percent.

Q_{CUP}
$= 1 - [min\ \{1.00,0.00\} + min\ \{1.00,(0.35 \times (1.00-0.28))\}]$
$= 0.75$ mgd

$CU\%$
$= 0.75/1.00$
$= 75\%$

At first glance it appears that the utility is receiving no credit for its reuse; however, on closer examination it can be seen that rather than 1 mgd, the utility is actually using 1.35 mgd (1 mgd withdrawn + 0.35 mgd reuse), with the reuse offsetting what would have likely been potable demands and additional withdrawals.

Summary

This methodology provides an adaptable framework for more accurately determining the net impact of water users on their water sources; furthermore, this method directly encourages utilities to conserve, reuse, and efficiently return their water to its original source. By developing consumptive use calculations that are reflective of actual consumptive use, and not simply water withdrawn, it's clear that two utilities with identical characteristics might have vastly different impacts on a water source, depending on the final disposition of their effluent. Rather than the historical view of effluent as a problem that has to be dealt with, today's evolving water resources require consideration of high-quality effluent as a resource that has value.

This shift in attitude is already being seen, with attention being paid to indirect potable reuse and direct potable reuse. In reality, indirect potable reuse has been taking place for as long as humans have been relying on the same source for both their water supply and their disposal. As water resources continue to become more strained, it's only logical to have a sound accounting framework in place that accurately addresses the question of consumption.