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Verde Watershed CURRENTS

VERDE WATERSHED ASSOCIATION

"In Arizona, if we pump and consume groundwater at a rate that exceeds the contribution of groundwater (base flow) to a connected river system, we eventually destroy the river's perennial flow and, along with it, the plant and animal populations and human lifestyles that the perennial river supports. "

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DEL RIO SPRINGS AND LITLE CHINO CREEK—A TALE OF STREAM CAPTURE

Introduction

In a natural (or predevelopment) groundwater/streamflow system—one in which no human-driven modification such as pumping or irrigation has yet occurred—groundwater recharge and groundwater discharge to springs, streams, and for consumption by riparian vegetation are in long-term balance. Of course, the balance may change seasonally or in response to variations in rainfall or snowfall from one year to the next or even over several years, but over the long term, in a natural (predevelopment) system, average groundwater discharge charge is assumed to equal average groundwater recharge.

Introduction of pumping from a well adds a new component of groundwater discharge from the aquifer, modifying the previous long-term balance between recharge and discharge. Hydrologists have long understood that all water withdrawn by a well is balanced by a loss of water from somewhere (Theis, 1940). As summarized by Alley and others (1999): *"The source of water for pumpage is supplied by (1) more water entering the groundwater system (increased recharge), (2) less water leaving the system (decreased discharge), (3) removal of water that was stored in the system, or some combination of these three".*

The Verde River and its perennial tributaries are connected to the Verde River basin's groundwater, and thus river flow and riparian vegetation connected to the groundwater system are eventually affected by pumping from wells. The effects of pumpage from a well near a perennial stream in a

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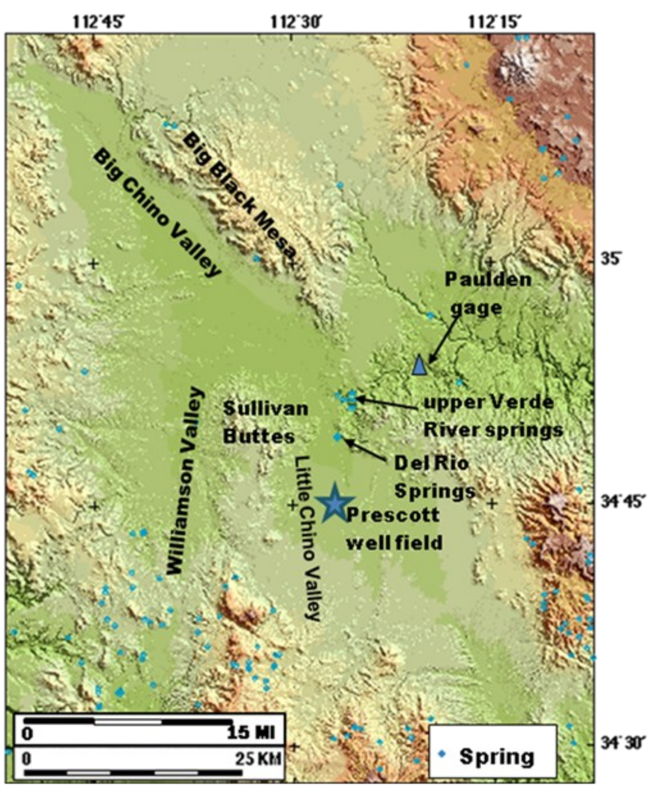
system like that of the Verde River basin are elegantly and very readably described by Leake and Pool (2010, pp. 3-6).

Critically, if the rate of withdrawal of water from the aquifer exceeds the rate of discharge of groundwater to connected surface-water features, those features lose their perennial supply of groundwater. Streams become ephemeral, flowing only at times of increased runoff, and riparian vegetation may be deprived of its life-sustaining groundwater source. The consequence is to devastate a formerly perennial river with a lush riparian zone—an all too common effect of groundwater pumping in Arizona (fig. 1).

Figure 1. Former riparian zone along the Santa Cruz River north of Nogales, Arizona. Photo courtesy of Dan Campbell, The Nature Conservancy.

Del Rio Springs and Little Chino Creek: A Local Example of Stream Capture



Capture of discharge to springs and depletion of streamflow by pumpage of groundwater is demonstrated by changes to Del Rio Springs (fig. 2) and Little Chino Creek since the mid-20th century. Del Rio Springs is near the north end of the Little Chino Sub-basin where groundwater flowing in the subsurface toward the Verde River headwaters is locally forced to the surface by relatively impermeable subsurface rocks.

Little Chino Creek (also called Del Rio Creek) was once perennial. Medora Krieger (1965), who mapped the geology of the Prescott and Paulden area during 1947 through 1955, wrote: *"Perennial flow in streams is limited to the Verde River and two of its tributaries. Granite Creek has a permanent flow of water below a spring…about 0.8 mile south of the Verde River. Del Rio Creek issues from springs* [Del Rio Springs] *that tap the Chino artesian basin, and flows north to the headwaters of the Verde River".*

Figure 2. Shaded relief map showing locations of Del Rio Springs, upper Verde River springs, Prescott well field in the Town of Chino Valley, and their regional topographic settings.

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Wirt (2005) concluded that "*Perennial flow in the Verde River historically began near Del Rio Springs…, but year-round flow to Sullivan Lake via Little Chino Creek had disappeared by the early 1970s…,owing to agricultural diversions and ground-water pumping".* Indeed, since the mid-20th century the head of the Verde River, where continuous free flow of the river begins, has shifted downstream approximately 5.7 miles from Del Rio Springs to the upper Verde River springs (fig. 2), which begin about 0.1 mile below the confluence of Granite Creek and the Verde River canyon.

Because of its abundant surface water, the Del Rio Springs area was selected as the site for the first capitol of the Arizona Territory in 1864. After a few months the capitol was moved to the area of Prescott for better proximity to timber and mining. Through the first half of the 20th century, the Atchison, Topeka, and Santa Fe Railroad stopped at Del Rio Springs to fill tank cars with water and to load local farm produce for delivery to northern Arizona railroad towns and the network of Fred Harvey hotels. In 1901 a pipeline was constructed to deliver water from Del Rio Springs to Prescott, about 19 miles to the south. However, owing to the excessive cost of pumping water 19 miles with an elevation gain of about 1,000 feet, the pipeline was eventually abandoned and dismantled (Krieger, 1965).

Sullivan Lake was created in the mid-1930s by construction of a small dam (fig. 3) just below the confluence of Big Chino Wash and Little Chino Creek at the upper end of a narrow steep-walled canyon cut into basalt. The dam was constructed to forestall headward cutting by the Verde River into the lower part of Big Chino Wash (Corkhill and Mason, 1995). The lake, originally envisioned as a recreational feature, was soon largely filled with sediment, and the lake's maximum depth now, when water is present, is no more than a few feet.

Figure 3. Low concrete dam that forms ephemeral Sullivan Lake. Dam, about 115 feet wide, is set into the head of a narrow steep-walled canyon cut into basalt. The dam marks river-mile zero on the Verde River, although continuous perennial flow now begins about two miles below the dam. View is westward.

Intensive groundwater pumping for irrigation began in the vicinity of the village of Chino Valley in the 1930s. In 1947, the City of Prescott drilled two wells within the village of Chino Valley about 5 miles south of Del Rio Springs. Since 1948 the well field (fig. 2), within the (now) Town of Chino Valley, has been Prescott's primary source of municipal and industrial water as well as a source of water for part of the Town of Chino Valley.

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Operators of the railroad built a weir in 1939 for measuring the discharge from the Del Rio Springs. From 1940 through 1945 discharge from the springs ranged from about 2,300 to 3,400 acre-feet per year (Corkhill and Mason, 1995). The low values apparently reflect diminished spring discharge correlative with pumping by the railroad at a rate of as much as 855 acre-feet per year. A projected water budget calculated by ADWR (Nelson, 2002) predicts steady decline of Del Rio Springs discharge, reaching zero by year 2025 (fig. 4).

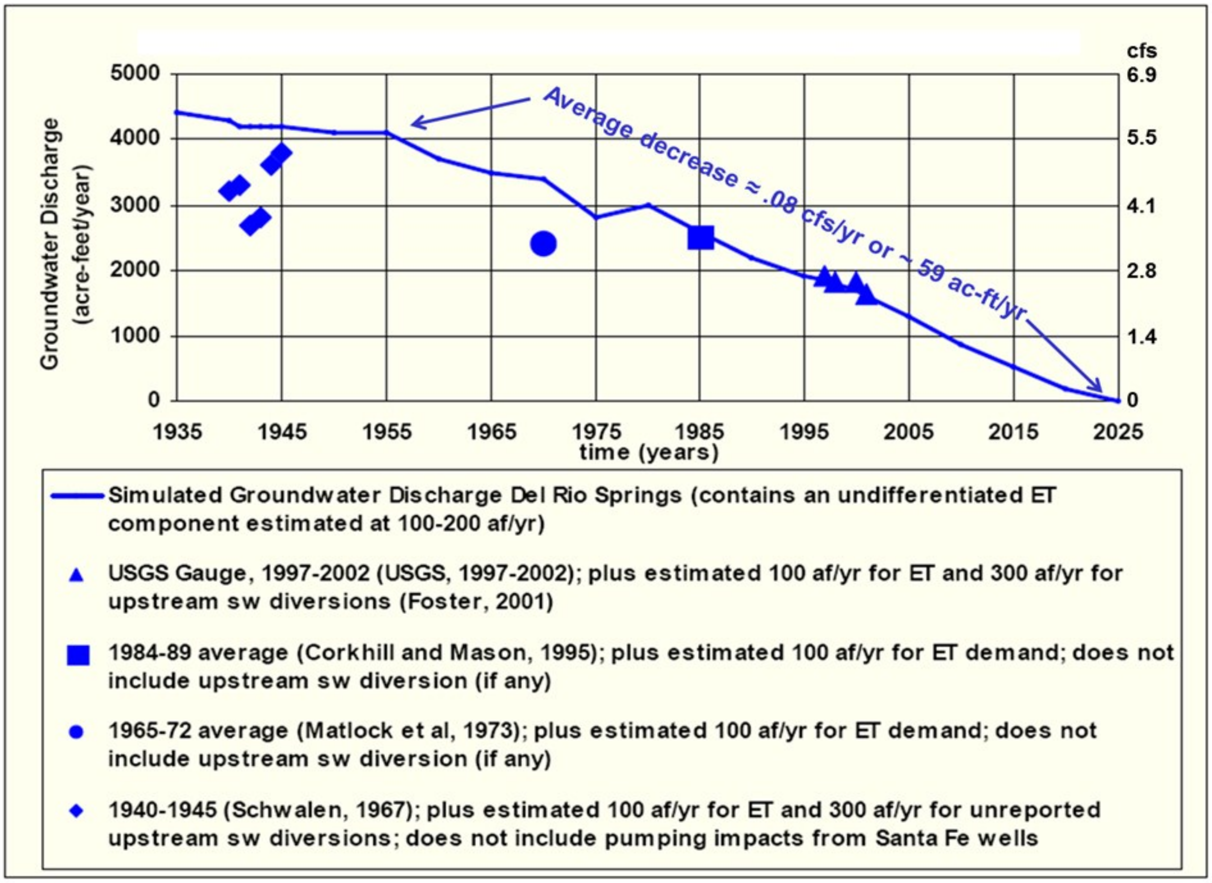

Figure 4. Hydrograph showing simulated groundwater discharge at Del Rio Springs from 1935 to 2025 (Nelson, 2002).

In 1996 the U.S. Geological Survey installed a streamgage in Little Chino Creek a short distance downstream from Del Rio Springs to record the rate of discharge from the springs. The record of that gage (fig. 5) clearly demonstrates that the springs are on track to be dry by 2025 if not sooner—a victim of capture by groundwater pumping. Since the winter of 1996-1997, winter low flow (average for seven consecutive days of lowest winter discharge) has decreased from about 2 cfs (about 1,400 ac-ft/yr) to 0.7 cfs (about 500 ac-ft/yr), and summer low flow (average for seven consecutive days of lowest summer discharge) has decreased from about 1.7 cfs (about 1,200 ac-ft/yr to 0.5 cfs (about 360 ac-ft/yr). The repetitive difference between winter and summer low-flow values reflects the differences each year between winter and summer evapotranspiration.

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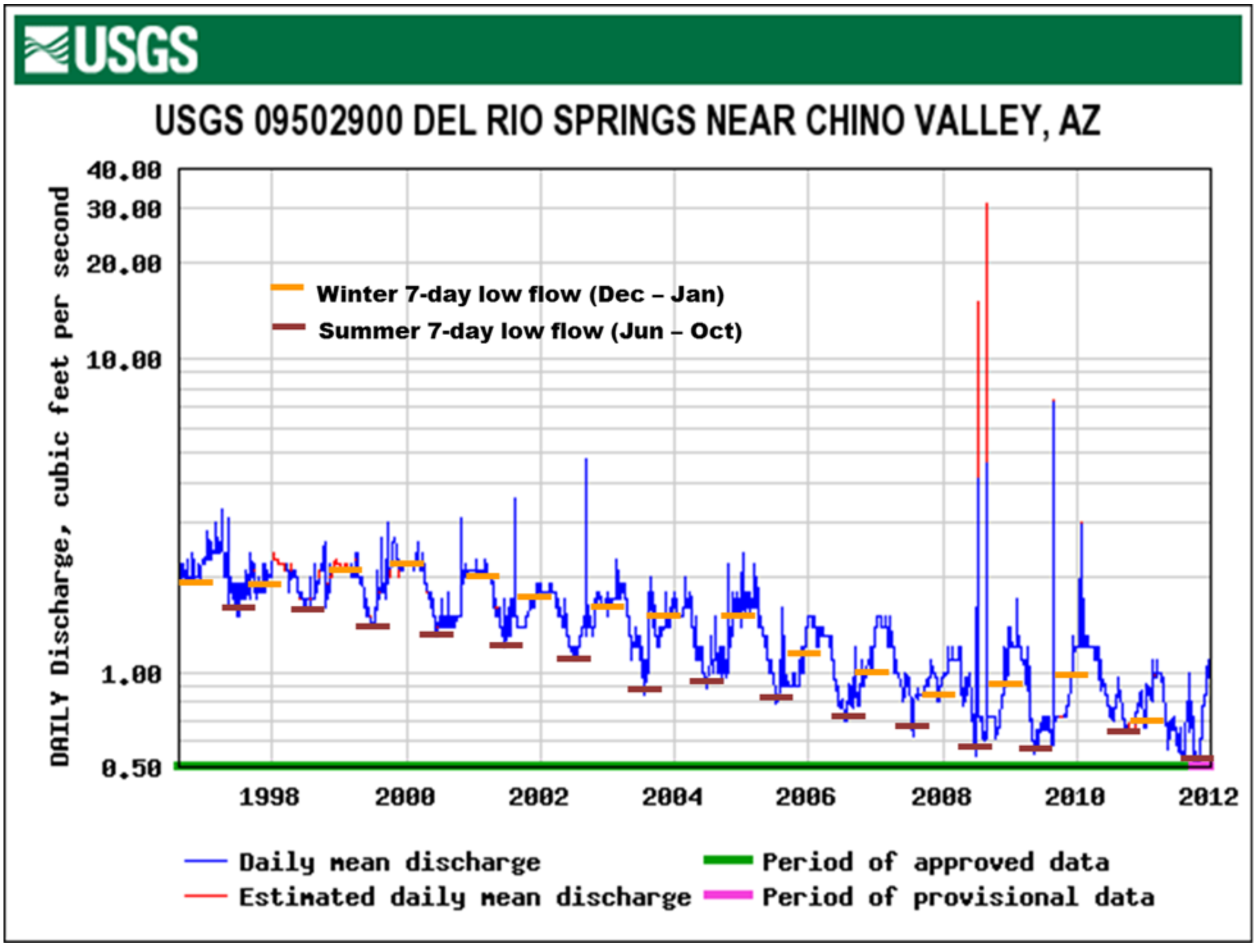

Figure 5. Hydrograph displaying daily mean discharge at the Del Rio Springs stream gage from August 8, 1999 through December 31, 2011.

Bottom Line

The question often asked is: How much groundwater is stored in the aquifer system? But from the standpoint of maintaining our perennial rivers, that question is irrelevant. In Arizona, if we pump and consume groundwater at a rate that exceeds the contribution of groundwater (base flow) to a connected river system, we eventually destroy the river's perennial flow and, along with it, the plant and animal populations and human lifestyles that the perennial river supports.

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Contributed by Ed Wolfe

Yavapai County Water Advisory Committee (WAC) Update

As we embark on a new year, the Yavapai County Water Advisory Committee (WAC) is committed to efforts to help communities plan for future water use. The WAC has signed a new Joint Funding Agreement (JFA) with the U.S. Geological Survey (USGS) for continued data collection for long term records and aquifer properties. The WAC will continue to work with the USGS and others to understand and appropriately utilize the recently released Northern Arizona Regional Groundwater Flow Model. The Central Yavapai Highlands Water Resource Management Study (CYHWRMS), with the Arizona Department of Water Resources (ADWR) and U.S. Bureau of Reclamation, is nearing completion of the appraisal portion. The WAC has also recently renewed its commitment to water resource education through the Yavapai County Cooperative Extension.

The USGS and others such as ADWR have put forth significant resources over the years to collect hydrogeologic data in the Verde watershed. The WAC has again renewed an agreement between WAC and USGS. The JFA is similar to past years and will focus on the Williamson Valley stream gage, water level monitoring in wells, chemical data for water source definition and flow paths, and gravity measurements to help determine aquifer properties. In addition to establishing data records and basic knowledge, these data will be used to inform conceptual and numerical models. A copy of the current JFA and work plan is available on the Yavapai County website under the January, 2012 meeting minutes and agendas (http://www.co.yavapai.az.us/meetings.aspx).

The Model Report for the current USGS Northern Arizona Regional Groundwater Flow Model has been released and the WAC is involved in a critical review process. The purpose of the review is to establish appropriate use and confidence in the model. Additionally, future work activities related to the model will be defined and prioritized. The TAC continues to hold technical sessions with the USGS regarding the model and questions that have been raised regarding its construction and use. The model report can be found on the USGS website (http://pubs.usgs.gov/sir/2010/5180/).

The CYHWRMS study team is analyzing alternatives to meet unmet future water demands that were identified in earlier phases. An alternatives analysis report and table will be produced this spring and will serve as a basis for evaluating potential alternatives. The alternative evaluation criteria include environmental, economic, legal and institutional analyses as well as Reclamation's four tests-of-viability (completeness, effectiveness, efficiency and acceptability). Upon completion of the alternatives analysis, the WAC and communities will decide whether or not to pursue an alternative(s) further through a feasibility analysis. The WAC website has additional information on the study in general and Phase 1and Phase 2 information (http://www.co.yavapai.az.us/Content.aspx?id=20562). The Technical Working Group (TWG) typically meets on the first Thursday of each month at 10:30 following the meeting of the Technical Committee of the WAC.

The WAC has agreed to continue to fund half of a full-time position of water-resource education through Edessa Carr at the Yavapai County Cooperative Extension Office (http://ag.arizona.edu/yavapai/). An annual summary report of activities has been published and Ms. Carr presented an update at the January 2012 WAC meeting. Some highlights include Master Watershed Stewards, Arizona Project WET, and Well-Owner Workshops. The WAC values the unbiased, practical education regarding water provided by U of A Cooperative Extension.

Please contact the WAC Coordinator, John Rasmussen, for meeting dates, details on any of the WAC activities or if you would like to be added to the WAC email-recipient list (john.rasmussen@co.yavapai.az.us or 928-442-5199).

Submitted by John Rasmussen

VERDE RIVER CONDITIONS—JANUARY 2012 UPDATE

Near normal precipitation this fall followed by a wet December (165% of normal) led to an early build up of snowpack. The early snow provided hope that the Verde River would have a better than average chance of near normal flows this winter and spring. Unfortunately, 2012 has been very dry and the snowpack has almost disappeared. The dry conditions are expected to continue as all climate indicators suggest that all of Arizona should see below normal precipitation through the remainder of the winter. Thus, any hopes for a strong stream flow season this winter and spring are fading. The current stream flow forecast for the Winter/Spring season (Jan-May) suggests a volume near 145,000-acre feet (near 80% of normal). However, if the medium to long-range weather forecast hold true, the actual amount of water received may be less than current forecasts indicate.

Contributed by Salt River Project

Membership Form for Verde Watershed Association

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Business for profit	$100 per year	**Verde Watershed Association**
Civic groups and non-profits	$50 per year	**P.O. Box 4001**
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