Deepest drought issue: Beyond shallow look at groundwater

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Several years ago, west-side water leader Sargeant Green watched in amazement as a well-drilling crew pulled pieces of an ancient redwood tree out of a hole more than 1,000 feet deep.

How did that tree travel 100 miles west from the Sierra Nevada and land 1,000 feet deep on the arid west side of the San Joaquin Valley?

“It was probably moved in a big flood event many thousands of years ago and deposited at the bottom of a lake,” says Green, a former irrigation district leader and now a project manager for the California Water Institute at Fresno State University.

“If you drill long enough, you will catch up with deep history.”

“Deep history” has not been part of the bigger discussion during California’s epic drought. The media touched on it, widely reporting desperate well drilling in the Valley has begun to bring up water that “fell to the Earth 20,000 years ago.”

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But that just dates back to the latter part of the last Ice Age. The history beneath your feet in this Valley goes far deeper. It’s a piece of the story about the nation’s second-largest groundwater basin — California’s Central Valley, the San Joaquin and Sacramento valleys.

Why is it important to understand the whole groundwater picture now?

Severe droughts will become more common as the climate warms, scientists say. In the San Joaquin Valley, keeper of the state’s largest store of groundwater, the underground water is the go-to source cities and farms use to protect their residents and investments when river water is not available.

In this drought, thousands of wells have dried up, and people are drilling deeper.

“There were wells drilled down to 3,500 feet in the 1950s and 1960s,” says Ken Schmidt, longtime Fresno-based engineer who focuses on groundwater. “But there weren’t a lot of them. Now, it’s unbelievable. We’re seeing increases of 10 or 20 times the drilling. Maybe a lot more.”

Experts say California shouldn’t drain this resource down so far that it becomes too fouled with concentrated contaminants and unaffordable for those who can’t pay $1 million or more to drill wells 2,000 feet and deeper.

“We need to manage the water so everyone can use it decades from now,” says Dave Orth, general manager of the Kings River Conservation District. “We need to change the conversation from asking how long it will take to get to the bottom. We need to talk about keeping the level nearer the top.”

Deep water, depth of history

How much usable groundwater exists in the basin? There are only estimates. Orth’s organization has estimated 93

million acre-feet of water is located between the ground and the depth of 1,000 feet in the district's 1 million acres in Fresno, Tulare and Kings counties.

By comparison, the combined capacity of California's largest 200 reservoirs is about 41 million acre-feet. An acre-foot is 326,000 gallons, an 18-month supply for an average family in the Valley.

Where is the bottom of the fresh water in the Valley's underground? It's about 3,000 to 3,500 feet down in the center and west side of the Valley, engineers say. Below the fresh water, there are vast, salt water-saturated layers of soil that extend downward as much as five miles.

Those deep soils began filling when dinosaurs roamed the Earth and the ocean occupied this region. The time scale is in millions of years, not thousands.

The underground water in this 25,000-square-mile Valley is not a big bowl filled with river water from the last 20,000 years. It's not a big blob waiting to be tapped. It's sediment, clay layers, gravels and sands — miles deep in some places.

Some of it is rich in fresh water, some of it filled with mineral-tainted water and some almost dry.

The sediment comes from hundreds of thousands of spring runoffs along the Sierra Nevada and natural river flow over millions of years. Over time, these layers of sediment sink slowly as they settle.

Sinking at breath-taking speed

Is the ground sinking faster during the frenzied extraction of water? Yes, at an alarming rate, according to Michelle Sneed, hydrologist for the U.S. Geological Survey. Sneed, who measures the subsidence, says the ground is sinking at an average of a foot per year.

"That's orders of magnitude faster than the natural rate," she says. "It happens so broadly across the landscape that it's hard for people to visualize."

Roads, canals, dams, buildings and utility lines can be damaged in the process. The cost could be billions of dollars some day, according to some estimates. But Sneed says it may be difficult to determine if damage is attributable solely to subsidence or if other factors, such as seismic activity, played a role.

The land sinks because clay lenses of soil tend to collapse and compress as water is pumped out. Once they collapse, they don't return to the positions they occupied before, Sneed says. So they can't be fully refilled with water during wet seasons.

Some places in the Valley are not having the same problem with sinking landscape because soils below them are not dominated by clay. Fresno, for instance, has coarser, sandy soils, so the underground regions can be refilled when storms return, Sneed says.

"Fresno got big pulses of coarse-grained material related to the glaciation in the mountains above," she says. "It was carved by ice and carried by water down to the Valley."

But dense clay soil is a widespread feature in the Valley. It is connected to stream beds, ponds and lakes that have been a part of the Valley's past. Clay tends to trap water in various places because water does not easily pass through it.

Sneed says Corcoran clay is one of the more dominant features of the underground. It's an immense layer going down as far as 900 feet below ground level — the bed of Lake Corcoran, a glacial runoff lake spreading over the entire Valley about 1 million years ago.

Mineral-filled water from irrigation drainage and storm runoff on the west side can get trapped above the Corcoran clay, forcing farmers and cities to drill below it for acceptable water.

Green of Fresno State's California Water Institute says people are pumping out water that took a long time to accumulate.

"You gain a bigger sense of respect for the underground water," he said.

Overdraft and aftermath

Groundwater has been overdrafted by up to 60 million acre-feet in Tulare Lake Basin from the 1960s to 2000 — by far, the biggest overdraft problem in California. In wet years, it slows down and recovers a little, but the trend overall is downward, and losses continue to mount.

For decades, well owners have tried to save money by keeping wells as shallow as possible while drilling deep enough to assure a water supply for years to come. But thousands of wells have gone dry in the last two years.

Now a wide swath of rural residents with working wells are wondering if they will lose their water supply, too. Surrounding farmers worry about a new groundwater law, which won't be fully implemented for 25 years. Some farmers are drilling wells down to 2,500 feet, desperate to protect their investments.

A balance and sustainability can be achieved, says Orth of the Kings River Conservation District. But it won't be pretty.

"In Texas and Colorado, there's active groundwater management of basins," Orth says. "We need to ask them about it. They will say it was hard to get there, but people like it better than what they had."

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